

THE NEW YORK AFRICAN BURIAL GROUND

SKELETAL BIOLOGY FINAL REPORT

VOLUME I

Section I: Background of the New York African Burial Ground Project

Section II: Origins and Arrival of Africans in Colonial New York

Section III: Life and Death in Colonial New York

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THE AFRICAN BURIAL GROUND PROJECT

HOWARD UNIVERSITY

WASHINGTON, DC

FOR

THE UNITED STATES GENERAL SERVICES ADMINISTRATION

NORTHEASTERN AND CARIBBEAN REGION

December 2004

*Howard University's New York African Burial Ground Project
was funded by the U.S. General Services Administration Under
Contract No. GS-02P-93-CUC-0071*



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ACKNOWLEDGEMENTS

It would be impossible to thank all of those in every walk of life who have helped the African Burial Ground Project over the past 12 years. All of those who stood for its preservation and dignity do, however, bear some responsibility for creating the information within this report, and we researchers are deeply indebted to them. We want to thank our supporters: the school children and their teachers. We also thank the churches, the civic and cultural organizations, the grass-roots political organizations, and the hundreds of visitors from around the world, who visited our laboratories and offices. Other organizations that deserve recognition are: the Federal Steering Committee, the Schomberg Center, Friends of the African Burial Ground, the Committee of Descendants, Transafrica Forum, Malik Shabazz Human Rights Institute (NYC), Lift Every Voice, Inc. (Los Angeles), and many other organizations and institutions whose members have made this work possible by their moral and political support. Lastly, we would like to acknowledge New York City, State legislators and their national counterparts, as well as our academic and professional colleagues. As opportunities are presented, we will continue to recognize every individual effort that has made this project possible.

We want especially to take the opportunity to thank those who assisted in the preparation of this report. Even though most are named on the preceding pages, we want to especially thank the staffs of the Howard University Cobb Laboratory, the College of William and Mary Institute for Historical Biology, and the Department of Anthropology at the University of Oklahoma. These individuals conducted research and prepared reports under extraordinarily difficult circumstances, and they did this in the spirit of humane commitment and with high standards. These students, technicians, and senior

researchers and directors often sacrificed by working without funding. Although at times there was uncertainty about the security of the project's future, they were nevertheless faithful to the mission for which these volumes mark the culminating success. It is only by virtue of that commitment that we were able to succeed. Among these there were those who devoted many years of their lives working to see that the laboratories and offices functioned for researchers and the public—that the work was done and the data properly organized. These prominently include the office manager of the Cobb Laboratory, Reba Brewington, and its laboratory director, Mark Mack, who devoted at least a decade of their lives to long days of excellence on behalf of the history of the colonial Africans we report on here. All of the writing of this final report and previous drafts relied on their contributions.

The final draft report was prepared starting in January 2003 and the final report unedited version was completed and submitted for transmission to the members of the peer review board near the end of June 2004. In the course of this work, as preparation of the final report versions, involving the merger of submissions from the various authors, was undertaken, all of the database, imaging, and text problems that had not occurred during the writing of the individual chapters and completion of the initial draft versions began to emerge. The smart and dedicated work of Christopher Null of the University of Massachusetts-Amherst and Shannon Mahoney at William and Mary corrected and refined the database and kept the information flowing to the authors. Autumn Barrett, also of the Institute at William and Mary, performed tirelessly and with an extraordinary range of skills as our editorial assistant. All of this was done in addition to their own graduate work and research contributions to the project. Thanks also to Cecelia Moore,

administrative assistant, for unflinchingly hard work and dedication to the writing project. Paul Gattis at the University of Oklahoma also contributed to final database development in essential and important ways. Ryan Seltzer of Illinois State University provided key statistical advice. The project has been enormously fortunate to have received the focused attention of these special individuals.

Standing behind us were mentors and senior colleagues without whom there may have been more open fronts of professional warfare than we could have handled. George Armelagos at Emory University and Don Ortner of the Smithsonian Institution have given generously and courageously of their support to this project. As Colleagues who shared our goals, Howard Dodson and Leith Mullings worked tirelessly from the very beginning to ensure that our efforts on behalf of this project received a fair airing in New York. Finally, we thank the three peer reviewers for useful criticisms of drafts of this manuscript.

Michael L. Blakey and Lesley M. Rankin-Hill

Howard University gratefully acknowledges the efforts of the African Burial Ground project directors, under the leadership of Professor Michael L. Blakey, the other authors, and the Skeletal Biology Component research team members for their contributions to this report. A tremendous debt of gratitude is owed to the three members of the Advisory Review Board (ARB), jointly appointed by the GSA and Howard, for the excellence and professionalism of the critiques that they provided for the several iterations of this final report. The staff and other contributors of the subcontractor, the College of William and Mary Institute for Historical Biology, again under the leadership of Professor Blakey, also are acknowledged for their work.

In addition, several individuals at Howard University contributed significantly to the preparation and production of the *Skeletal Biology Final Report* volumes. In particular, appreciation is expressed to Ms. Alma Kemp, administrative assistant, and Ms. Sharon Brown, administrative officer, Office of the Dean, College of Arts and Sciences, for their conscientious efforts in handling administrative tasks in the college associated with report production, as well as their careful word processing of the final document. Ms. Kemp was also the key person over the last two years with responsibility for the ABG project's administrative interface with the university's Office of Research Administration related to the timely processing of documents. Ms. Lori Sweet, administrative assistant, Office of the President, was responsible for word processing and proofing several chapters of the final report. Ms. K. Denise Moore, special assistant to the President, assisted with word processing, formatting and proofing of sections of this final report. The technical expertise brought to this enterprise by both Mr. Vancito Wallace, senior technology officer in the Office of the Provost, and Ms. Stephanie Payne-Roberts, technical assistant, Office of the Dean, College of Arts and Sciences, was crucial to the capacity to incorporate the many illustrations, tables, figures, and images that are found in this report. Mr. David Austin, coordinator of duplicating services, College of Arts and Sciences, was responsible for copying and binding the report. The talents of Ms. Regina Drake, technical writer, Office of the Provost, were utilized in copyediting and coordinating formatting of the production report. In addition, James A. Donaldson and O. Jackson Cole assumed primary responsibility for copyediting and review of the production report.

SECTION I:
Background of the New York African Burial Ground Project

Chapter 1

Introduction

Michael L. Blakey

The New York African Burial Ground (NYABG) was “rediscovered” in 1989 in the process of preparation for the construction of a proposed 34-story Federal office building by the U.S. General Services Administration (GSA) at 290 Broadway in New York City (Ingle et al. 1990). The site for the proposed building was once part of the African Burial Ground (ABG) that extended “from Chambers Street on the south to Duane Street on the north and from Centre Street on the east to Broadway on the west” (Yamin, 2000: vii). A full-scale archaeological excavation was conducted by Historic Conservation and Interpretation (HCI) and John Milner Associates, Inc., preceding the building project, as required under Section 106 of the National Historic Preservation Act of 1966 (as amended) in order to mitigate the destruction of potential cultural resources (see Figure 1.1). The excavation and construction site on the ABG is located at Foley Square, in the



Figure 1.1: Early Archaeological Excavation of the African Burial Ground

city block bounded by Broadway, Duane, Reade, and Elk Streets in Lower Manhattan, one block north of City Hall.

Archaeological excavation and building construction began during the summer of 1991 and ended in the summer of 1992, when the U.S. Congress called for work on the site to cease in response to the public demand to properly memorialize and, ultimately, to learn about the people buried there. A research team was assembled by Michael Blakey of Howard University's Department of Sociology and Anthropology, beginning in April of 1992, for post-excavation analysis, laboratory, and interdisciplinary studies. The research team members, who studied the skeletal remains of the 419 individuals representative of eighteenth century interred African captives and their descendants, were from Howard's W. Montague Cobb Biological Anthropology Laboratory and eight other affiliated universities. This report presents the data and analyses of human skeletal remains from the NYABG produced after more than nine years of research.

Historic Background and Significance of the Cemetery

The original cemetery had been established by 1712 when it was reportedly the location of the executions of participants in an African rebellion during that same year. Its use officially ended in 1794. There is no written record of the cemetery prior to 1712; however, a 1697 ban barring the burial of "blacks, Jews and Catholics" by Trinity Church suggests that the cemetery might have been created earlier than 1712 in response to a growing need for burial space. In 1712, Chaplain John Sharpe wrote of the burial of Africans "in the Common by those of their own country and complexion without the office, on the contrary the Heathenish rites are performed at the grave by their countrymen" (Sharpe 1712). The part of the Common on which the African (or

“Negroes”) Burial Ground was established (see Figure 1.2) began outside the palisade of the colonial town near the summit of a hill whose slope inclined toward the fresh water pond known as the Collect (Kalkhook) (Foote 1993; Medford 2004, The New York African Burial Ground History Final Report/The African Burial Ground Project). The cemetery extended across 5.5 to 6 acres of land. Less than one city block of this site was excavated by archaeologists in 1991-1992. The filling of the Collect and grading and

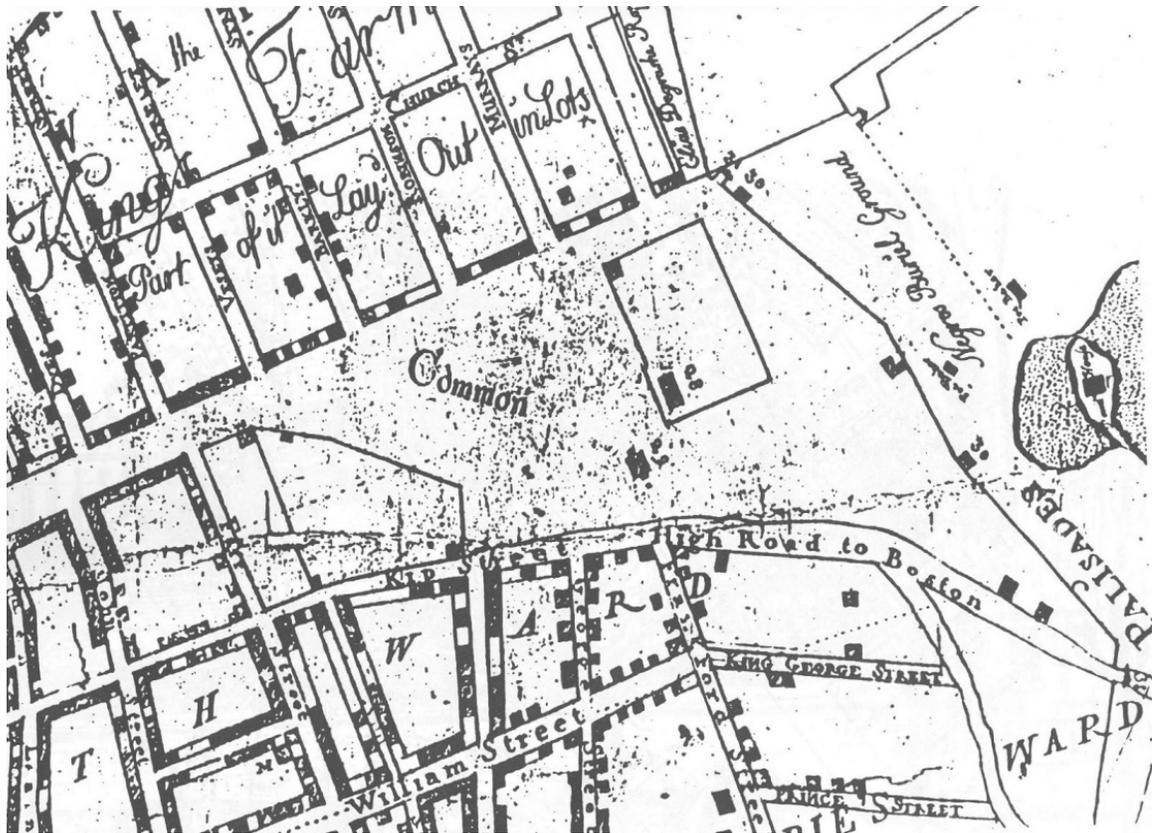


Figure 1.2: Map of the Eighteenth Century African Burial Ground, Maerschallck Plan (1755) in African Burial Ground and The Commons Historic District Designation Report, New York Landmarks Preservation Commission, February 1993.

flattening of that part of Manhattan Island at the turn of the nineteenth century preserved the excavated portion of the cemetery under 16-28 feet of fill.

The African Burial Ground (ABG) appears to have been one of the first social institutions built by Africans in colonial New York City (Medford, 2004). Burial of the dead and other funerary rituals are definitive characteristics of human existence. Such mortuary activities are as old as our species, and are both ubiquitous and unique to humanity. The cemetery may well have taken on special significance for affirming that they were human beings, for preserving cultures, and for maintaining a sense of hopefulness among New York's African community. In the main, Africans in colonial New York were enslaved, not free laborers, and thus experienced a particularly intensive contestation of their humanity by Europeans who were intent upon objectifying Africans as property. It is now obvious that in New York, as throughout the slave-holding Americas, enslaved Africans were arbitrarily stripped of names and renamed; family members were separated to be sold apart; social institutions and religious practices were disallowed or went underground; the use of African languages was suppressed, and the cultural history of those Africans was denigrated by slave-holders. In the urban context of colonial New York City, there were strikingly few opportunities for social interaction among African men, women, and children held in the isolated houses and businesses where they worked and slept (Medford, 2004).

Thus, efforts were made to deny these Africans the basic qualities that were associated with a distinctly human existence, which even the poorest European colonist could claim. The attribution of the role of "slave" or property to a human being (their conversion to chattel) required a method for denying the existence of the African's

humanity if both Africans and Europeans were to be convinced of the legitimacy of the master-slave relationship. Questioning of moral or other ideological legitimacy makes such inequitable structures vulnerable to internal questioning, conflict, and destruction (see for example Habermas' *Legitimation Crisis* (1975) or Frederick Douglass' 1854 analysis (Douglass 1950) of the use of racist science in the mid-nineteenth century attempts to justify slavery). New York's ABG, then, can be viewed as an important location in which human qualities and rights were struggled for simply by virtue of careful, customary burial practices that no human society has been willing to do without. This act of assertion of humanity simultaneously represented resistance to the legitimation of slavery.

The ABG was also a location for the contestation of African humanity and for the establishment of white authority. The ban on African internments at Trinity Church (see Figure 1.3) and other Christian church cemeteries reflected the creation of social distance (the construction of the "Other") based not only on religion, but also increasingly upon "race" (see Epperson 1999 for an interesting discussion of the emergence of the race concept relative to the ABG).

Whether Africans were or were not Christian was an important distinction for the justification of enslavement. Like other attempts to distinguish enslaved blacks from true human beings, religious justification became a tangled web of desperate attempts to resolve its fundamental contradiction with the fact that blacks were indeed both human and considered property. The narrative of John Jea, who was brought to New York City from Calibar (bordering West and West Central Africa) and enslaved in the eighteenth century, is instructive (Gates and Andrews 1998). Jea describes his enforced conversion



Figure 1.3: Trinity Church in lower Manhattan today

to Christianity as a punishment by his “mean master” for questioning the duplicity of Christians who enslaved people. It was important that in the religious justification slaveholders affirmed their morality with black inferiority, by asserting that slavery constituted an act of Christian charity that sought to save African souls (see Douglass, 1950 [1854] and the discussion of Christian Central Africans in *The New York African Burial Ground History Final Report*. Jea discovered, however, that as a Christian convert, he obtained a legal right to manumission in New York. The project director argues that Jea had obtained by conversion a crucial measure of humanity in the logic of Western Europeans. This rather large contradiction or ‘loophole’ in the ideological justification of slavery in eighteenth century New York was amended by the requirement that Africans like Jea demonstrate the ability to read and understand passages from the Bible; although he was as illiterate as most of the colonial population, European, or

African. Jea claimed to have satisfied this requirement by divine intervention and gained his freedom (Jea in Gates and Andrews 1998).

The spatial exclusion of blacks from burial with whites in Christian sacred space was a significant part of the attempt to establish ideas to bring about the social control of New York Africans. Yet, as in the above reference to Sharpe's criticism of traditional African religious rites, the ABG on the municipal Commons also presented a threat of autonomous African thought and activity.

Even in the unsanctified space of the Commons, tight control of African activities was attempted. Night funerals were banned by law in 1722, and the gathering of more than "12 slaves admitted by the owner of the dead slave" was outlawed by a 1731 amendment to the law. The assembly of larger numbers of Africans who expressed cultural independence (conducted African funeral rituals) alarmed enslavers who were concerned that they were "plotting and confederating" for revolts and other "mischief" during funerals (Minutes of the Common Council 1722). African revolts occurred regularly in the Atlantic World. It is perhaps not insignificant that of the few written references made regarding the ABG by eighteenth century whites, most refer to its possible use for organizing revolts, as a place where African rebels were executed, or as the location of objectionable independent (traditional African or syncretic activity such as Pinkster Day) cultural activity.

The research team has considered individual cases in the ABG for what they might reveal about these events. At best such cases are only suggestive and cannot be established as having direct bearing on the revolts. For example, Burial 137, a 25-35 year old adult (see Figure 1.4), and Burial 354, a 35-45 year old male, contain bones whose

darkened, highly polished appearance is consistent with slight burning or singeing of bone. Historical evidence points to individuals being burned at the stake on the burial ground who were convicted of participating in the African revolt of 1712. The causes of the burns to Burials 137 and 354 are unknown. Other possible relationships between specific burials and corporal punishment or acts of terror are taken up in a previous report by Augustin Holl (2000), and are considered in the forthcoming *New York African Burial Ground Archaeology Final Report* that is in preparation.



Figure 1.4: Rib ends from Burial 137 showing likely heat induced darkening

The ABG was desecrated in diverse ways that relate to the contestation of African humanity. Archaeologists have found industrial waste from an adjacent ceramics factory on the site demonstrating its use as a dump by Europeans in the mid-to-late eighteenth century. In April 1788, the violent Doctors' Riot broke out when the petitions and published warnings of free black against grave robbers went unheeded by New York's medical establishment:

That it hath lately been the constant Practice of a number of Young Gentlemen in this City who call themselves students of Physick to repair to the Burying Ground *adjudged* for the use of your Petitioners and under cover of the night and in the most wanton sallies of excess to dig up the bodies of the deceased friends and relatives of your Petitioners, carry them away, and without respect to age or

sex, mangle their flesh out of a wanton curiosity and then expose it to Beasts and Birds (Unfiled Papers of the Common Council, see February 4, 1788, New York Municipal Archives).

The abductors were subsequently warned that “...they may not alone suffer abduction of their wealth, but perhaps their lives may be forfeit of their temerity should they dare to persist in their robberies, especially in unlawful hours of the night” (February 15, 1788, *The Daily Advertiser*). Again, these warnings suggest that the cemetery may have been especially important as an institution for the affirmation of African and African-American humanity under the material conditions of slavery and in the pervasive presence of the psychological affront to black humanity required to morally justify those conditions.

Here too, a case can be presented that is possibly, though not certainly, associated with events surrounding the early desecration of the cemetery. Burial 323 is a 19-30 year old male exhibiting evidence of substantial biomechanical stress and healed skull lesions that may represent an earlier period of nutritional inadequacy. The initial morphological assessment by the Metropolitan Forensic Anthropology Team (MFAT), a group of consulting physical anthropologists from the City University of New York’s Lehman College, indicated a “Caucasian” affiliation for this individual. He is among the 7 percent of individuals of the ABG sample who were assessed as non-African or ambiguous using racial typology. Strontium data points to an American place of birth for this individual, which would be unusual for adult enslaved Africans in New York (see Chapter 6 for the methodology pertaining to these findings). This individual was buried holding the top half of his skull in his arms (see Burial Descriptions section of this report). The skull had been deliberately sectioned, transversely, using a saw as is done in

autopsy or dissection in a gross anatomy laboratory (Figures 1.5 and 1.6). The burial is suggestive of the frequent grave robberies that had lead to the Doctors' Riot of 1788. If this burial had previously been looted (which can only be speculated) a careful, unusual reburial is intriguing.



Figure 1.5: Burial 323 Transverse section of caldarium (top of skull)



Figure 1.6: Burial 323 magnified saw marks

The ABG was closed in 1794 in the wake of the Doctors' Riot, the cemetery's overcrowding, and the petition of African Americans for a second "African Burial

Ground.” The land comprising the cemetery was restored to the Van Borsum heirs (who had long claimed to own this part of the Commons) who divided it into house lots. The archaeological excavation showed that their privies and foundations were often dug into the burials.

Finally, the site was buried under several feet of fill at the turn of the nineteenth century and nearly forgotten. It is not known what African Americans thought of the elimination of their old cemetery. It is nonetheless evident that their century-long humane struggle to maintain their cemetery as sacred space was often challenged by desecration by whites, and that the first ABG was eventually overwhelmed by those challenges. The ABG reemerged two centuries later surrounded by disturbingly similar issues to the human rights concerns of the eighteenth century.

Blacks, who had been 20 percent of New York City’s population at the time of the American Revolution, became a proportionately smaller community afterward. Although the massive waves of European immigration throughout the nineteenth and early twentieth centuries account for much of the relative diminishment of blacks in the city, it should be mentioned that a major out-migration had occurred with the departure of the British and Tories right after the Revolution. Africans had fought for their own liberation on both sides of the Revolutionary War. Many of those who joined the British were manumitted and relocated to slave-holding Nova Scotia. Many of them remained dissatisfied and successfully negotiated relocation to Sierra Leone in West Africa.

In 1799, a law was passed that assured gradual emancipation in New York State, an emancipation that was effective with few exceptions in 1827. A dynamic free community then developed with important educational, religious, economic, cultural, and

political institutions that continued to struggle with subtler forms of racial discrimination than experienced during slavery. Religious justifications for social inequities were replaced by anthropological notions of the racial inferiority of blacks who, by mid-century, were predominantly Christian. A great migration occurred during the first half of the twentieth century as African Americans left the desperate conditions of the tenant farms in the post-plantation economy and Jim Crow segregation of the south in search of jobs in northern cities. New York's black community saw renewed growth, even a "Renaissance" of the "New Negro" in Harlem, despite continuing problems of racism and poverty that also motivated anti-lynching campaigns and a Back-to-Africa movement there. Civil Rights, Pan African, Left, Black Consciousness, Black Nationalist, Integrationist, and other political tendencies would characterize the diverse views of African Americans regarding their identity and betterment in New York throughout the second half of the twentieth century.

Recent Public Significance of the African Burial Ground

Much had changed by the time New York's ABG reemerged as a public concern. Indeed, in 1991 New York City had its first African-American Mayor, the Honorable David Dinkins and African Americans were represented on the city council and key legislative posts. Yet, the contestations about the humanity of blacks had continued. It seems that in the 1990s, the struggle for human equality had to do with the affects of racism in lending institutions, the workplace, police departments, the courts, and education (including anti-racist efforts to incorporate African and African-American history in public school curricula). While the protection of cemeteries as exemplars of

human dignity never seemed to emerge, the reaffirmation of the fundamental significance of the cemetery was stunning upon the rediscovery of the ABG.

The U.S. General Services Administration (GSA) took an expeditious approach to its building project at the burial ground in 1991 and 1992 that was broadly perceived as desecration. Archaeological mitigation of the project's destructive effects was also rushed, as archaeologists worked 11 hours per day, 7 days per week to remove remains without benefit of the guidance of a research plan. At regular meetings between the African-American public and the GSA, William Diamond, GSA Regional administrator, claimed to take up the public's demands with his superiors. Later, Diamond admitted in a Congressional hearing that he had never done so. The public requested an end to excavation and a fitting memorial. The GSA continued archaeological removal and building construction. Mr. Diamond described his feelings about those requests as resistance to being "blackballed or blackmailed" in a climate similar to the "Rodney King" incident (see the documentary film, *African Burial Ground: An American Discovery*, produced by David Kutz and written by Christopher Moore, 1994). The situation was indeed tense, as the African-American public became increasingly impatient with the GSA's dismissive attitudes that many felt would not have been directed toward the concerns of non-blacks in regard to the dignity of an historic cemetery (see testimony of Mayor David Dinkins, p. 189-194, Laurie Beckelman, Chair of the New York Landmarks Commission p. 212, and others during Congressional Hearings on July 27 in New York City and September 24 in Washington, DC, before the Subcommittee on Public Buildings and Grounds of the Committee on Public Works and

Transportation, House of Representatives (102-80), US Government Printing Office 1992).

A Federal Advisory (“Steering”) Committee would ultimately be established in the wake of massive protests, prayer vigils, and powerful black legislative intervention (Harrington 1993; LaRoche and Blakey 1997). The background to this situation, described in the Committee’s recommendations to GSA and to Congress, is summarized next:

In June 1991, human remains were discovered during archaeological testing of the site. By October 1991, excavation for the Foley Square Federal Office Tower Building had begun. ACHP [Advisory Council on Historic Preservation] and LPC [New York’s Landmarks Preservation Commission] recommended that excavation only continue with an approved research design and with the input of the African [American] community. Unlike the burial grounds of Native Americans that are protected by law from this type of desecration [NAGPRA legislation of 1990], however, there is no specific law preventing the desecration of the burial grounds of Africans. Without a specific law preventing the desecration of the burials of Africans, GSA felt no obligation to halt the exhumations, consult with the community, or even respond to the very community whose ancestors’ remains were being disinterred. Over the course of the next year, community groups, individual members of the community, and other government offices registered ongoing concern and dissatisfaction with the continued excavation. In May 1992, Mayor David Dinkins of New York City called together a group of citizens and formed the Mayor’s Task Force on the African Burial Ground. Members of the Task Force formed the basis of the Steering Committee. By July 1992, at least 390 burials had been removed....

In response to a letter from Mayor Dinkins, GSA [indicating their violations of the National Historic Preservation Act by not responding to the community or having an acceptable research design] stated that they would excavate an additional 200 burials on a portion of the site that was to become a four-story pavilion beside the office building. GSA’s position was essentially that the voice of the citizens, or even the voice of the local government, was not its concern, and that it would only respond to specific instructions from Congress. On July 27, 1992 after a one-day hearing held by Congressman Augustus Savage [African-American, Democrat from Illinois], Chairman of the House of Representatives’ Subcommittee on Buildings and Grounds, GSA received those

instructions. Congressman Savage heard testimony from Mayor Dinkins, LPC, GSA, and Dr. Sherrill Wilson (an African American anthropologist and historian), and Dr. Michael Blakey (an African American physical anthropologist). The Congressman expressed his dissatisfaction that, despite the recommendations to the contrary by both ACHP and LPC, construction had continued on the site without a research design that addressed the presence of human remains associated with the African Burial Ground. Congressman Savage found that the GSA had failed to live up to its Section 106 responsibilities and instructed the construction on the pavilion site halt immediately. Congressman Savage further informed GSA that no additional GSA projects would be funded until a meeting took place between the GSA Administrator and Congressman Savage.

In late July, meetings took place between GSA and Congressman Savage, Congressman Robert Roe (Chairman of the House Public Works Committee), and Congressman John Paul Hammerschmidt. Additional meetings took place between city agencies involved, and the decision was made that a Federal advisory committee of primarily descendant African community leaders and professionals be established to make recommendations to GSA with regard to its Section 106 responsibilities at the site...

The Steering Committee...was chartered in October 1992 to represent the interests of the community and make recommendations to GSA and Congress regarding the present and future activities affecting the pavilion portion of the Federal construction site now known as the African Burial Ground. [Building of the tower portion of the site was permitted, including interpretive elements regarding the Burial Ground on its first floor]. Its mandate includes: (1) the review of proposals regarding the human remains on the Pavilion site, (2) the analysis, curation, and reinterment of remains removed from the African Burial Ground and (3) the construction of a memorial or other improvements on the Pavilion site.

Shortly after the Steering Committee was chartered, President Bush signed Public Law 103-393 ordering GSA to abandon construction on the Pavilion site, and approving the appropriation of up to \$3 million to finance the modification of the Pavilion site and appropriate memorialization of the African Burial Ground. (Jorde 1993: 6-7).

Ironically, the “disrespect for a segment of this community” of which GSA was accused by Congressman Savage at the July 27 field hearing in New York may in fact have helped galvanize public resolve to uphold the dignity of the cemetery. With the

collaboration of community activists and the LPC, the site became a New York State and National Historic Landmark. Collaboration between private citizens and the National Park Service brought about the site's nomination to the United Nation's World Heritage Site list. It is the only African-American heritage site on that nomination list. The United Nations Human Rights Commission sponsored briefings in Geneva on preliminary African Burial Ground Project (ABGP) research findings in 1995 and 1996 (Blakey 1998) after New York and Los Angeles black human rights organizations (Malik Shabazz Human Rights Institute and Lift Every Voice, Inc.) brought the site to their attention. There had not been such public outcry about the desecration of an African-American cemetery's desecration since the Doctors Riots' at the NYABG and its adjacent pauper's field in 1788. The cemetery is of intense cultural and spiritual concern for many people of African descent in the United States and elsewhere.

Significance of the Project's Analytical Approach

Many aspects of the project are novel, not the least of which is the large number of skeletons (419) from the site constituting the largest colonial archaeological sample of any ethnic group available for study in the Americas and the earliest African cemetery in the United States. The human skeletal remains of the ABG provide a uniquely substantive body of primary evidence on eighteenth century colonial North America. It is a window that faces most directly toward the presence and conditions of Africans enslaved to build the English colonial foundations of the United States. This research also examines facts of life in other parts of the Americas to which these once living individuals and colonial New York's economy were closely connected.

These “intrinsic” qualities of the age and size of the ABG hold particular value for exploring the earliest phases of American history and for making statistical inferences from archaeological populations to a broader, contemporaneous community that requires the large sample of individuals found here. During the research team’s first involvement at the site, in March of 1992 by invitation of the ACHP and Mayor Dinkins’ liaison, it was clear that “intrinsic” archaeological value is subjective (Figure 1.7). Whatever the number or quality of the material evidence in the ground, the knowledge derived from it



Figure 1.7: Mayor David Dinkins (center), Peggy King Jorde (Mayor’s Liaison), and Howard Dodson (Chief, Schomburg Center) (front) are briefed on the excavation by Michael Parrington (Principal Archaeologist for HCI and John Milner Associates).

is conditioned by the theoretical framework used to interpret data. The significance of data will depend partly on those interpretations as well as upon the ethical procedures (or lack there of) by which the data were obtained, affecting how people will or will not choose to relate to and use the information from an archaeological site.

The research project sought to maximize the significance of the information available from the site. New York's ABG clearly was and is a site of unique potential. Recognizing this fact, the research team drew from experts, first-hand experiences and benefited from their problems and /or limitations with previous studies. The research design also drew from compelling ideas under discussion by specialists in physical anthropology, archaeology, African Diasporic studies, epistemology, and ethics. The team believed that there were fundamental problems with the way in which smaller African-American bio-archaeological sites had been studied in the past, and this project provided an opportunity and obligation to reformulate the research approach to reflect what the team had learned about those mistakes. The team would apply the alternative approaches that it considered to be appropriate for this kind of site. The praxis of applying these new approaches would lead to better and more exciting kinds of information (including a clearer elucidation of technical and theoretical problems) than was obvious initially. Chapters 2 and 3 examine these past problems, our reformulation of research procedures in light of those problems, and the new avenues over which we were led by logic and circumstance in the course of the ABGP.

The research team's combination of academic and contract archaeology departs from previous contract work, and represents a particular trajectory in the practice of anthropology that is necessarily critical of previously acceptable standards. The ABGP's alternative approaches seek to represent new and better standards of anthropological practice. The project has embraced the commitment that this important site, and the humane community interests to which it relates, deserve the best alternative to

dehumanizing (objectifying) interpretations of African-American identity and history that the team is able to advance. The project competed to direct burial ground research at the end of excavation. The research team encountered forensic anthropologists (cum bioarchaeologists) and contract archaeologists, some of whose typical approaches were acceptable to perhaps most of our colleagues (See Epperson, 1999 and “Comments on the Draft Research design for Archaeological, Historical, and Bioanthropological Investigations of the African Burial Ground and Five Points Area”), yet were unacceptable to the team. The research team strives still to pursue alternate research practices and methodologies thus, some explanation is warranted since the team encountered many colleagues who were either strongly opposed or strongly in favor of its approach. The team asserts that its alternative approach enhances the scientific rigor, humanistic meaning, and societal significance of New York’s ABG research.

By the 1990s two tendencies of African Diasporic bioarchaeology had become well defined. First, a biocultural approach utilizes the demography and epidemiology of archaeological populations in order to verify, augment, or critique the socioeconomic conditions and processes experienced by human communities. In its latest form, political economic theory structures the interpretation of biocultural relationships. The second, a forensic approach, utilizes in part the descriptive variables used by police departments for individual identifications (race, sex, age, and stature) along with pathology assessments in order to analyze human remains from archaeological sites. Yet the bioarchaeological context is not the appropriate place for the application of forensics, which tends to reveal archaeological samples in descriptive rather than historically dynamic ways. While the majority of the procedures for the technical assessment of the skeleton is the same for

both approaches, they differ in the extent to which a descriptive approach or forensics work relies on the objectified categories of biological race identification, without relying upon (or constructing) social, cultural, and historical information that is at the core of the biocultural approach. The result of descriptive/forensic work is the construction of an acultural and ahistorical group of individuals; the result of biocultural work is a biological reflection of the historical processes that bring about the social condition of a community of people. The forensic or descriptive approach, we maintain, is appropriate for police identifications, not for the interpretation of the ways of life in past human communities. Forensics is not bioarchaeology or paleopathology. An example of continued and increasing confusion on this point is the common use of the term “forensic anthropology” by students or contractors interested in bioarchaeology, perhaps due to the prominence of forensics in the American media.

A public struggle took place in New York that illustrates the contrast between these two approaches. The initial excavation teams at the site (Historic Conservation and Interpretation and the Metropolitan Forensic Anthropology Team) included only one senior anthropologist who had had experience studying African American populations. This person had no relevant academic training and their legally mandated research design was glaringly absent historical knowledge of New York’s African-American past and was twice rejected by the Federal and city agencies that were responsible for its evaluation. Forensic methods of race estimation were presented throughout debates at the site as representing an objective approach to the construction of the identity of the colonial population. These anthropologists’ emphasis on racial traits, their obvious lack of knowledge of the study population’s culture and history, coupled with the efforts of

some GSA officials, to fend off the African-American influence on the cemetery's disposition were responded to with deepening indignation by the descendant community members who witnessed the excavation.

Michael Blakey, at that time still a faculty member of the Howard University Department of Social Anthropology, assembled a team of physical anthropologists, archaeologists, and historians in the spring of 1992. This team prepared a design that began to establish the full scientific and historical significance of the site. The majority of these researchers were African Americans, and the team was more ethnically diverse than those assembled for previous bioarchaeological projects. The scholars who were selected held advanced and terminal degrees from leading university programs, were established leaders in their fields, and had a track record of research on the African Diaspora. They were also willing to apply biocultural approaches and inclined toward various forms of publicly-engaged scholarship (Blakey et al 1994) and activist scholarship, or, minimally, respected the rights of descendant communities to influence the disposition of their ancestral remains at archaeological sites. These sensibilities to public accountability stemmed largely from influences of African-American "vindicationist" scholarship (see Chapters 2-3 on the critical and corrective approaches to history, so labeled by the pioneering anthropologist, St. Clair Drake) and by the heightened dialogue with indigenous peoples (some of us had participated in discussions of the World Archaeological Congress and Native American Rights Fund, when many anthropologists were resistant even to meeting with indigenous peoples on the issue) that had recently led to the Native American Graves Protection and Repatriation Act of 1990. The research team assumed that the African-American public should have the right to

determine the disposition of the site as, indeed, that community insisted on using the more general imprimatur of the National Historic Preservation Act of 1966 (as Amended) to assert its right of influence over “cultural resources.” The research team has continued to develop upon the idea that these ethical demands and those of scientific rigor are not mutually exclusive and that the quality of knowledge can be enhanced by humane principles. The team invoked both the ethical principles of the American Anthropological Association and the Vermillion Accords of the World Archaeological Congress in support of community empowerment as a professional standard (La Roche and Blakey 1997).

By late June of 1992, the Congressional Sub-Committee on Transportation and Grounds (chaired by Hon. Gus Savage) in support of the Mayor of New York (Hon. David Dinkins) found that the GSA not in compliance with the National Historic Preservation Act and stopped excavation. The sub-committee turned over the decisions about what should be done with the excavated remains to a Federal Advisory (“Steering”) Committee. The Steering Committee was chaired by Howard Dodson, Chief of the Schomburg Center for Research in Black Culture, and consisted mainly of African-American activists and cultural workers. The project was then assigned to Howard University after a Congressional review showed that its Cobb Laboratory was best suited for the technical demands of the remaining analysis (see Figure 1.8). At that time, the Howard research project included the archaeological contract firm that had recently taken over the excavation (John Milner Associates, Inc.) for an extended period of transition. The Howard researchers regarded the descendant community as their ethical client and



Figure 1.8: Night Procession of the Ties That Bind Ceremony at Howard University marking the transfer of the African Burial Ground ancestral remains to an African Diasporic cultural and research institution in November of 1993 (photograph by Roy Lewis).

entered into intensive dialogue with this community about the possibility of anthropological research. Decisions regarding the kind of research to be done (if any were to be done at all) would depend on community acceptance of an evolving research design that would include methods to address lay people's questions (see Appendix A). The accepted research design document (Howard University and John Milner Associates 1993) proposed the most comprehensive interdisciplinary study then attempted, with studies that ranged from molecular genetics to African art history. Included on the team were specialists in the archaeology and history of relevant African, Caribbean, and North

American diasporic populations, all leading scholars and their most energetic students. The full range of the latest techniques for skeletal recordation and assessment (using as a guide a manuscript of the “Standards” of Buikstra and Ubelaker 1994, then in final preparation would be used. The problems presented for research included: the cultural origins, the physical quality of life, the transformations, and the resistance to slavery that could be gleaned from the data.

The current report responds to many of these problems in all of its chapters. After completion of the approved research, the skeletons were to be returned for reburial, and thereafter a monument and interpretive center were to be constructed. The vast majority of the proposed research goals have been achieved by the present research, although some hoped for objectives, particularly in ascertaining more fully the origins of the ABG sample, were not realized.

This study seeks to advance the biocultural approach in physical anthropology that resonated with living African-Americans rather than to engage in descriptive racialization and cursory history. The approach is amenable to synthesis with diasporic studies that both the African-American researchers and lay community leaders found intuitive. The ample involvement of humanists (historians, cultural anthropologists, and even artists involved in facial reconstruction and the interpretation of mortuary art) along with biologists is also consistent with the interdisciplinary approaches of African American Studies as conceived since the turn of the century. The study’s focus was on revealing the diasporic experiences of the enslaved New York Africans, the history and identity of their descendants, and their descendant’s empowerment in telling their own story and memorializing their own ancestors.

The team's facilitation of such African-American perspectives and concerns for the past led to accusations of "reverse discrimination," even though the project director in this instance had for the first time brought together a uniquely ethnically diverse team of physical anthropologists, archaeologists, and historians. Nonetheless, critics raised objections from the vantage point of their traditional theoretical and methodological perspectives. Indeed, attention given to the initial problem of black exclusion at the ABGP was also followed by a small but noticeable increase in outreach to black students by archaeological projects. It may simply have been the case that the debate about the consideration of race at the ABG site and in the research was contemporary with the wider debate then taking place throughout United States society.

During the 1990s, the NYABGP began developing a synthesis of biocultural anthropology with the African American tradition of diasporic studies. The signatories to the Memorandum of Agreement [U.S. General Services Administration, (GSA), New York Landmark Preservation Commission (NYLPC) and the President's Advisory Council on Historic Preservation (ACHP)] initially expressed discomfort with the incorporation of African-American traditions of critical and corrective history and anthropology (earlier termed "vindicationist") in a draft of the Research Design, but the research plan was technically sound despite the lack of "multicultural" approaches that others insisted would make a more appropriate alternative, although such an alternative did not exist. The review of the April 1992 Research Design by the ACHP, for example, expressed concern that the local anthropologists did not have sufficient say in how the site would be treated and that too little attention was given to the spiritual significance of the site. They also stated that "In reviewing the research designs ...we note a particular

tone in several statements describing the historic context for the proposed research. While we appreciate that the African Burial Ground site is of particular importance to African-Americans, we believe that such statements represent an ethnocentric perspective rather than the multicultural one appropriate for a document presented for federally sponsored scientific analysis, education, and public outreach” (Robert D. Bush to Robert Martin, 28 May 1993). The GSA’s instructions to the Project’s Scientific Director, who was responsible for the Research Design’s content, were as follows:

As to the political or ethnocentric overtones in the Research Design described at page 3 of the ACHP comments, please understand that the United States Government may not be a party to, or engage in, any form of discrimination, either in acts or language. Accordingly, please review the entire Research Design, deleting any discriminatory references, inferences or attributions, etc., in the document (Lydia Ortiz to Michael Blakey, 13 September 1993).

In fact, no changes would be made because no discriminatory content existed. The passages to which the ACHP referred were simply definitive of the concerns and critical perspective of African Diasporic scholarship. It seemed that to affirm the vindicationist or corrective value of the site made our work more meaningful to some and more threatening to others. This is not to lay blame, as indeed the ACHP would give key support to efforts to complete the research and memorialization of the site. It is to say that misunderstanding and philosophical differences related to America’s racial divide emerged essentially around the fact that the research was being organized by blacks who were distinct in more ways than pigmentation. Many anthropologists expressed fears that the project supported the notion that only blacks could study black sites, which was a position never put forward by the project; indeed, our research team consisted of racially diverse scholars. These “ethnocentric” concepts were sufficiently resonant with the

descendant community's perceptions of the site's archaeological significance that whole paragraphs of the Research Design were incorporated in the Memorialization Proposal of the Steering Committee as a public expression without reference to the Research Design. Presented below is a key paragraph from the allegedly "ethnocentric" portion of the Research Design, which is quoted in the first case and paraphrased in the second:

Due to the circumstances that have brought about their presence, these material remains of African ancestors present themselves during a time of social and emotional strife when inspirational uplift is most needed in the African-American community; during a time when evidence of the significance of racism in America needs desperately to be brought to bear on the minds of Euro-Americans; and during a time when there is a thirst for knowledge about African heritage that has propelled heated debates about the adequacies of American education. These African ancestral remains have presented both a challenge and opportunity to simultaneously address these issues (Research Design Subcommittee, 6 August 1993/ also see Appendix A).

Today the remains of our ancestors present themselves, literally risen from their graves, during a time of social and emotional strife, when inspirational uplift is most needed in the African community, when evidence of the significance of racism in the United States needs desperately to be brought to bear in the minds of all persons, and during a time when knowledge about the African heritage is both distorted and inadequate. The memorialization of the African ancestral remains presents an opportunity to address these issues (International Reinterment Subcommittee, 6 August 1993).

This is one of many examples of widely differing views, often along racial lines, of the research effort. In this instance, the ACHP raised formal objections to African Americans defining the significance of the ABG for themselves, and for addressing their research effort to their own traditions of critical scholarship. Why, one might ask, are nationally or ethnically-specific schools of thought such as "British social anthropology," "the Boasian school" or "French structuralism" acceptable avenues to follow, while

influences of an African-American school of thought are not? Perhaps the problem was one of simple lack of familiarity regarding black intellectual traditions. The research team drew from the tradition of corrective scholarship (vindicationism), synthesizing what seems useful in these and other ideas, taking a progressive approach to knowledge. As Chapter 3 will make clear, this is quite different from the classical orientation of what is often represented as Afrocentrism and Afrocentricity (see critiques by Blakey 1995).

These ideas, in the context of the earliest, largest, and most publicly visible site of its kind, put African-American bioarchaeology in the forefront of anthropological research for the first time (Blakey 2000). Furthermore, this is not simply an African-American site or, as many continue to imagine, one whose interpretation simply is led by African Americans. Rather, the ABG, a major American archaeological site whose analysis is informed by African-American intellectual traditions as well.

The site's visibility was also a result of the public's struggles that were required to stop excavation. The ensuing controversy was viewed by the descendant community as a continued refutation of African-American humanity and dignity. This attention to the site has also resulted from the powerful revelations that the excavation and the research team's initial findings produced about a past of African enslavement and African contributions to nation building that had been buried and hidden from the American consciousness (Blakey 1998). Indeed the educated public had long been taught that there had been few blacks and no slavery in the American North. Now the undeniable contradictory evidence confirmed the African-American vindicationist critique of pervasive Eurocentric distortion of American and world history.

Report Scope, Limitations and Future Directions

Much has been accomplished with the approximately \$6 million in Federal funds awarded to Howard University for the ABGP research. This document is the skeletal biology component of three reports, the others covering the written history of these New York Africans (*History Final Report*) and the mortuary archaeological evidence (*Archaeology Final Report*, in preparation). Together, these reports will provide insight into how these people once thought and lived. Initially, the research design envisioned the incorporation of chemical and DNA research that would result in ancillary genetics and chemical studies reports. These five disciplinary reports were to serve as interim deliverables whose multidisciplinary data would be merged as an interdisciplinary, integrated report.

The research team's plan was to defer the complete DNA, chemistry, and histology research that it was proposing for support, because it would involve cutting samples of bone and teeth, and schedule it for the last two years of the project. Although GSA funded initial pilot studies (DNA, bone chemistry, histology and amino acid analysis), it declined to fund the other proposed studies. Also, the team's efforts to obtain extramural support from other sources were unsuccessful.

Hence, those components of the anticipated research were not undertaken. Because the complete DNA and chemical studies were not performed, several key areas of research that depended on such data, including origins/cultural affiliation, individual geographical migrations, sub-adult sex determinations, ethnic and familial burial and social relationships, stasis and transformation in ethnic and familial spatial clustering, and studies of disease specificity—such as genetic anemia or specific treponemal diseases for

which the spirochete's DNA can be tested—could not be pursued. However, these determinations by DNA and chemistry were not possible for most twentieth century paleopathology, and thus this research project is not unusual in these respects. The proposed research design, however, laid out a feasible plan for the use of these new technologies that would have placed the project at the vanguard in the use of what are now increasingly common twenty-first century molecular and chemical techniques. Nonetheless, the researchers believe that the results in other related aspects of this study have laid the groundwork and positioned them to pursue funding for the exploration of future genetic research.

The researchers in the skeletal biology component of the ABGP remain committed to the preparation of the integrated report. The regular sharing of data across disciplines has produced an interdisciplinary dialogue; especially, the four-day Sankofa meetings, of which there were three, where two dozen project specialists participated, producing an interdisciplinary dialog and common organizing themes and research questions (see Chapter 3 for the latter) that influence each disciplinary report. The organizing themes include origins and arrivals, life in New York, death in New York, and the meaning of ancestors to the descendant community. The present chapter focuses on those perceptions of ancestors and the remainder of Section I covers origins and arrivals. Section II is dedicated to the assessment and documentation of living conditions and Section III turns to the conditions of life and death. Thus, the present Skeletal Biology Report is not meant to achieve the goals of interdisciplinary integration by itself, but has multidisciplinary influences that become evident. Because of the common organization of themes and questions, as well as 10 years of dialog among specialists, the disciplinary

reports such as this one are primed for integration into a single narrative about the NYABG.

Organization of the Report

The report is organized as four sections and 15 chapters. Following this introduction, Chapter 2 provides a broad comparative context for the analysis of the remains from the New York site. The major reports on skeletal remains from African Diasporic archaeological sites in the Americas are reviewed. That chapter also develops a social historical and critical perspective on previous studies as background for the present study and its innovations. Chapter 3 describes the theoretical orientation of the project as a newly evolved program that is served by adherence to public accountability, a critique of the politics of history, publicly-engaged scholarship, and aspirations toward rigorous multidisciplinary interrogation of the material data of the site within a broad geopolitical context. The complementarity of ethical principles and high quality information is emphasized as a benefit of this approach, which is catholic in its open-endedness for the application of many different theories that may be found useful for the diverse methods and research questions of the project. Finally, Section I describes the practical methods and work organization required for data collection in the laboratory. The analysis and interpretation of those data are taken up in the three remaining sections of this report.

Section II focuses upon the origins and arrival of Africans in eighteenth century New York City. Chapter 5 examines the available biological information that verifies the African genetic backgrounds of the archaeological population. Fatimah Jackson and her colleague's advance theory, methods, and results related to estimation of the societal

origins of the African Diaspora. The results of the morphological, chemical, and molecular studies they report are more extensive than usually found in reports on sites of this kind (see Chapter 2) and give us a good idea of the range of origins of this sample. Yet, this chapter also demonstrates the much greater potential for DNA analysis that the theoretical development of this project continues to point toward. The ABGP has stayed on the routes mapped out in the Research Design. Members of the research team, along with our students and interested colleagues, plan to continue on this course in our academic institutions over the coming years, supported by funding that we will seek at various intramural and extramural sources for proposed research. Bone and dental samples were prepared by the project with permission of the descendant community for these purposes. Therefore, for components of the research plan that were not funded, we report on some of the project's contributions to theoretical and methodological development toward goals such as, for example, the utility of DNA and chemical methods for estimating African-American origins, the interest in which continues to grow among scholars and the public. Chapter 6 takes another approach to origins applying new methodology to ascertaining the places of birth and geographical movements of the individuals who were been buried in New York.

Chemical sourcing data derive from exposure to different proportions of chemical elements characterizing the different environments to which individuals were exposed during their lifetimes. Alan Goodman and his associates have discovered some of these 'chemical signatures' in the teeth of the ABG sample that suggest where in the world individuals' childhoods were spent. Modest alternative funding, the time of volunteers, and in-kind facilities partially supported important studies. Though their potentials are

not fully realized, these DNA and chemical studies of the origins of the people in the burial ground have provided very useful information. Although doubted by many, (see “Comments on the Draft Research Design for Archaeological, Historical, and Bioanthropological Investigations of the African Burial Ground and Five Points Area,” New York, New York, General Services Administration, Region 2, 1993) when first proposed, these chapters, we believe, make it clear in a material way that our proposals advanced ten years ago were on the cusp of a wave of technology and hence our ideas have been used to good purpose.

Bridging Sections II and III is Chapter 7 that reconstructs the structure of the New York African population using data on the sex and age estimates on more than 300 well preserved skeletons. These data constitute the first and only systematic information on death rates among enslaved Africans in New York City. Information about migration and population growth – with implications for fertility – is generated on the basis of census and other historical sources. In Chapter 13, these patterns of life and death described by Lesley Rankin-Hill, Michael Blakey and their colleagues, are explained as resulting from political and economic forces, not only in New York, but throughout the Atlantic world. Michael Blakey and the coauthors of Chapter 8 analyze dental enamel defects due to the disrupted growth of teeth, which resulted, not from local problems in the mouth, but from generalized diseases and malnutrition. These results show high stress during childhood. These authors begin to explore comparisons of those known to be born in Africa and those of unknown natality (probably a mix of African and American born).

Dental pathology is examined in Mark Mack’s study of caries and abscesses in Chapter 9. These pathologies represent the infectious effects of carbohydrate-rich food,

sugars, and poor dental care. These indicators also provide dietary information based on the local effects of food affecting the mouth during the consumption of meals. However, oral diseases may also burden the immune system's responses to other diseases in the body.

Chapter 10 also shows remarkable similarity between the bony indicators of infectious disease rates and nutritional deficiency found in New York and the small series of skeletons from Rathbun's South Carolina site (1987). In addition, Christopher Null and his coauthors examine active and healed periosteal lesions representing generalized infection to show differences by age and sex. Special attention is given to treponemal diseases that connect New York to other regions and populations in the wake of European colonialism. Comparisons are also made with Nineteenth century Philadelphia and post-Reconstruction wage laborers.

Section III continues the examination of "Life and Death in New York" with Chapter 11 focused on the musculoskeletal effects of the mechanical forces of work and trauma. Cynthia Wilczak and her group have found patterns of work stress evidenced by spinal and limb joint degeneration among men and women in the ABG community. Enlarged muscle attachments and other MSMs (musculoskeletal stress markers) also demonstrate that arduous labor had characterized the lives of both men and women. Some evidence points to different kinds of work, perhaps, among some individuals within these groups although it is not materially clear just how different had been the work of many men and women. Traumatic fractures that occurred near to the time of death are common in the population. Comparisons are made with studies of African-American

archaeological sites in different work settings that show a number of associations between the effects of work in New York and on a South Carolina plantation.

In Chapter 12, Susan Goode-Null and colleagues examine childhood growth, using dental development as a proxy for chronological age. They find evidence for slowed, disrupted, and stunted growth in long bones among the NYABG sample when the results are compared against a model of current growth standards. These researchers reference a broad range of pathology, nutritional, and mechanical factors that relate to delays they find in the physical growth and maturation of the enslaved children interred in the NYABG. The thirteenth chapter, as previously mentioned, returns to demographic analysis, but this now considers the data within a broader political-economic scope. Comparative analysis confirms the presence of unusual and previously unrecognized patterns of early death among the captive African community of early New York. Mortality data on the contemporaneous English slave-holding population are from Trinity Church burial records organized and formatted for analyses by the NYABG Office of Public Education and Interpretation (OPEI) in New York. There are some stunning comparisons of the massive population-wide effects of slavery. Slave holders and African captives exhibit opposing demographic trends of privilege and devastation. This section ends with a synthesis of the report's findings in Chapter 14.

Section IV consists entirely of descriptions of individual burials by Rankin-Hill and her associates at the University of Oklahoma and William and Mary, rendering a brief profile of each individual's case from data contributed by the various studies undertaken in this project.

New York's enslaved African population was highly stressed by all accounts. Specific variations in the skeletons have provided insight into certain aspects of the living experience of this otherwise poorly documented community of America's founders. The skeleton mainly imparts to us the physical quality of life against which an individual's social and psychological struggles and accomplishments may be appreciated. There is much that paleopathology cannot reveal, but skeletons offer leads to patterns and details of this human story that are absent in other lines of evidence, and it is the combination of different lines of evidence that makes the ABGP most exciting. This report constitutes the final step in the skeletal biology research team's study prior to its participation, along with leaders of the two other project research components, in collaboration with Howard University's ABGP management, in the preparation of a single interdisciplinary academic volume, which will integrate skeletal biological, historical, and archaeological findings. Also, the proposed *Integrated Report* will be written for a broader audience than are the three technical, disciplinary reports. Thus, in this chapter, we have established the material evidence for this report's conclusions and also outlined the processes by which the evidence was observed, analyzed and interpreted.

CHAPTER 2

History and Comparison of Bioarchaeological Studies in the African Diaspora¹

Michael L. Blakey

This chapter surveys the full range of bioarchaeological studies conducted on African diasporic sites in the Americas, thus providing a comparative context for the New York African Burial Ground (NYABG). Skeletal data on people of African descent living under diverse conditions throughout the Americas are described to serve as a basis for comparisons with the burials that are researched in the African Burial Ground Project (ABGP). These earlier studies used theoretical approaches different from those we employ. This history of diverse, evolving theoretical approaches is examined as a basis for understanding the scientific and societal implications of the research team's particular synthesis of theory (described in Chapter 3).

The review undertaken here is organized as a social history, emphasizing the interaction of diverse traditions of scholarship with the societal forces that have molded bioarchaeological interpretations of the African Diaspora. It is through the application of such an emphasis that our distinctive synthesis of analytical approaches will be clarified and placed in historical context. This chapter also surveys the major research findings of bioarchaeological studies of the diaspora in North and South America and the Caribbean. In addition, by simultaneously examining the societal influences of analytical approaches and the data these approaches have generated, social perspectives and scientific limitations become more apparent. It is also hoped that the advantages of the present

study's perspectives, affording more dynamic interpretations of data and unusual public involvement, will thus be made more obvious.¹

No condition has influenced the ABGP more than the unique relationship that developed between this project and the African-American public. Subsumed within this relationship is the infusion of 'mainstream' bioarchaeology with the approaches to African diasporic studies that had been developed by diasporans themselves. In order to illustrate differing perspectives and the ultimate synthesis promulgated here, the tradition of diasporan scholarship is summarized and then followed by a social history and survey of bioarchaeological investigations that have run parallel to diasporan scholarship. These disparate ways of explaining black history form the basis of controversy at New York's African Burial Ground (ABG). Our project seeks to resolve those differences with a synthesis of the compatible aspects of diasporan and bioarchaeological theory and method. We begin with definitions of key concepts.

The African Diaspora in the Americas encompasses the populations, societies, cultures, and states created by enslaved Africans and their descendants. As these broadly dispersed legates of forced migration came to conceive of themselves as recipients of a coherent set of historical experiences and affiliated identities, "Diaspora" took on common meanings; both as lived reality and as a subject of scholarship. The African Diaspora, as currently conceived, is more a concept than either a technical specialization or geographical area of study. According to Harris (1993), the African Diaspora concept subsumes the global dispersion (voluntary and involuntary) of Africans throughout history, the emergence of a cultural identity abroad based on origin and social conditions;

¹ The present chapter follows and extends the article by Michael L. Blakey, "Bioarcheology of the African Diaspora in the Americas: Its Origin and Scope," published in the *Annual Review of Anthropology* (2001, 301:387-422).

and the psychological or physical return to the homeland, Africa. Thus viewed, the African Diaspora assumes the character of a dynamic, continuous and complex phenomenon stretching across time, geography, class, and gender. African Diaspora or Black Studies programs in today's universities emerged as interdisciplinary area studies with the above foci and motivations.

African-American biohistory "has evolved into the study of both the biological and sociocultural factors that have affected and/or influenced the health, fertility, morbidity and mortality of African-Americans in the New World within an historical context. African-American biohistory is a meeting ground for the many disciplines that focus on the health and disease of African slaves and their descendants in the Americas" (Rankin-Hill 1997). Principal among these disciplines are history, archaeology, and biological anthropology. While Rankin-Hill uses the term to encompass both historical and historical archaeological studies, I prefer to consider "biohistory" as research that relies primarily upon written records or anatomical collections, reserving the term, "bioarchaeology" for studies that focus upon excavated archaeological populations. Overall, the traditions of American history, archaeology, and physical anthropology have continued to merge for the development of these specializations.

By the above definitions, African-American bioarchaeology and biohistory might have been subsumed under the broad umbrella of diasporic studies, but for various reasons that has not happened. During the last 20 years, these fields have evolved as distinct research traditions. Juxtaposed and periodically cross-fertilizing, these separate venues also reflect different ethnic and social vantages on the Black experience, emphasizing distinctive ranges of methodology and motivations. Diasporic studies

developed directly from the history of African American and other diasporic scholarship and rarely incorporated the tools of archaeology and biology. Bioarchaeology developed from two anthropological disciplines that, like biohistory, had evolved from Euro-American and other traditions of “white” scholarship that rarely incorporated the social science, humanistic, and activist understandings of diasporic studies. Both traditions, however, developed within a common world of intellectual, social, and political change that connected and divided them.

These segmented trends, fostered by a “racially” segmented American society, have recently been merged in our study of the Eighteenth century African Burial Ground (ABG) in the City of New York. This merger might not have been possible were it not also for the recent emergence of biocultural and publicly-engaged anthropologists whose liberal-left formulation achieved a new compatibility with diasporic intellectual traditions. In contrast, there remains a distinctive forensic tradition that racializes and dehistoricizes the African Diasporic experience. We examine next the history of each of these traditions and the data they generated on the African diasporic past.

Origins of African Diaspora Studies

The first studies of the African Diaspora were initiated by Catholic priests, commissioned by the Spanish Crown, who deviated from their assignment of investigating Native Americans and developed initial reports of the cultures and languages of Africans enslaved in the West Indies. At the end of the legal British trade in human captives from Africa, British studies were also commissioned (Drake 1993, Herskovits 1941) which, taken with the detailed commercial data on enslaved Africans throughout the Americas, serve to anchor our knowledge of the diaspora during slavery.

For example, an important new database has amassed many of the diverse colonial records on the American slave trade at Harvard University.

Yet the accounting of chattel is an incomplete human history. The record of the human experience of Africans in the Americas during slavery is sparse, afforded mainly by the initial writings of people who had been enslaved. These writings beginning 1772-1815 were primarily narratives about slavery (with comments on life in Africa), which focused on the humanity of blacks and the inhumanities foisted upon them by whites in the works of freed and escaped captives, such as Marrant, Gronniosaw, Cugoano, Equiano, and Jea, (Gates and Andrews 1998; also see Harriet Jacobs 1861) often arguing their cases with moral fervor. Later, the narratives of abolitionist Frederick Douglass (1855) reported his life in slavery and damned the institution in a more analytical vein. In 1854, he also attacked Morton's, Agassiz's, Nott's and Gliddon's craniometry and racist Egyptology with sophisticated biocultural analyses, to which we will later return. With the publication of Douglass's "The Claims of the Negro Ethnologically Considered," an African-American genre of critical, vindicationist, and activist scholarship had begun that would form a fundamentally distinctive diasporic scholarship. He raises his environmentalist argument against the contrasting Euro-American racial reductionist scholarship at the origin of American physical anthropology (see also Hrdlicka 1918 on Morton's significance). Meanwhile, Antenor Firmin (1885) of free Haiti authored a scientific rebuttal to French racial reductionism with a holistic analysis (biological and cultural) in support of racial equality. The Parisian academy appears to have completely ignored or disregarded his 600 pages of elegant thought (Fluehr-Lobban 2000), but it remained part of the Haitian cannon for a century.

By 1861, Martin Delany, an African-American motivated by missionary interests and African repatriation, reported on the Niger Valley Exploring Party and the relation of its findings to “the Coloured People of the United States,” interests and African repatriation. In the same year, Alexander Crummell, expressed a nascent Pan-African vision of *The Relations and Duties of the Free colored Men in America and Africa*. The American Negro Academy, which he founded in 1897, served as a think tank for African-Americans interested in the uplift of a global black race. W.E.B. Du Bois, a charter member of this Academy, would publish the first empirical urban ethnography in 1899, *The Philadelphia Negro*. Du Bois served for more than seven decades as the dean of African-American social historical research, emphasizing to Pan Africanist, civil rights, and socialist organizing. The Atlanta University Studies, which Du Bois began in 1898, were a comprehensive program of sociological and historical research on blacks, and his editorship of the NAACP’s *Crisis* applied social science to the civil rights effort at the beginning of the Twentieth century (see Harrison 1992 and others in this special issue of *Critique of Anthropology* devoted to Du Bois’ influence in anthropology). His Jamaican-American contemporary of the early Twentieth century, Marcus Garvey, a student of African and Biblical history and head of the Universal Negro Improvement Association, was far more concerned with building an ideology and organizing diasporic unity and African repatriation.

African-American research was nearly always critical for it began from the observation that white racism had distorted the historical record. Du Bois begins an early study of Africa and its Diaspora stating that the “time has not yet come for a complete history of Negro peoples. Archaeological research in Africa has just begun, and many

sources of information in Arabian, Portuguese, and other tongues are not fully at our command; and too it must frankly be confessed, racial prejudice against darker peoples is still too strong in so-called civilized centers for judicial appraisal of the peoples of Africa” (1915). The problem of an ideologically-distorted Africana past continued to inspire a search for information by diasporic scholars, creating a large body of “vindicationist” literature (Drake 1980, 1993).

During the first part of the Twentieth century, Zora Neal Hurston (Hemenway 1977; Mikell 1999) conveyed the complexity of African-American and Caribbean cultures through literary works based on ethnology and folklore. The Haitian Marxist ethnologist, Jacques Roumain (Fowler 1972) helped found the Negritude movement which paralleled the “Harlem Renaissance” in Francophone Africa and the Caribbean, writing about Haiti in a humanistic vein similar to Hurston’s. Another Haitian scholar activist, Jean Price Mars, founded the Society of African Culture and helped found *Presence Africaine*, the scholarly organ of black Francophone intellectuals, located in Paris. It was there in 1955 that Senegalese scholar Cheikh Anta Diop first published portions of what would become the most influential classical archaeological and linguistic analysis of the Africanity of ancient Egypt among African and diasporic readers (Diop 1974). Another African-American anthropologist, Katherine Dunham, through the vehicle of dance, studied and performed the common and deviating threads of African Diasporic culture and religion in Brazil, Haiti, Cuba, and the United States. African-American anatomist and physical anthropologist, W. Montague Cobb focused on issues of evolution, race, racism, and health care in the U.S. in the middle third of the century, also combining his biology with humanism and politics. Fernando Ortiz conducted

ethnographic work and a bioarchaeological study on the African influences of Cuba (1929, 1947). Black anthropologist Irene Diggs, having worked both with Ortiz and Du Bois, covered a broad range of U.S. and Latin American subjects (see Bolles 1999). African American historian William Leo Hansberry had been the first person to receive a degree in African Studies at Harvard before taking a faculty position at Howard, although it was Melville Herskovits who would start the first African studies program at Northwestern University following a two year visiting position at Howard where he studied “race crossing” (Herskovits 1928). In 1916, historian Carter Woodson, also at Howard University, established the *Journal of Negro History*. The organization for which the Journal was the principal organ, the Association for the Study of Negro Life and History (today the Association for the Study of African American Life and History) began “Negro History Week” (today Black History Month) in order to disseminate the history of peoples of African descent. The Fisk and Harvard educated historian, John Hope Franklin’s seminal work, *From Slavery to Freedom: A History of Negro Americans* (1947), should also be noted among these pre-1960s contributions to diasporic studies.

This is but a small sample of the contributors of that period, suggestive of the breadth and focus of domestic and international work toward diasporic studies. With the exception of the enigmatic Hurston, all were involved in political activism, and many were involved in the Pan Africanist movement that sought to free the continent of colonialism and to unite its diasporic peoples. Their scholarly efforts were to preserve and report on African cultural persistence and creativity on the continent and in the Americas, to revise what they saw as Eurocentric distortions of the Africana world, and

to foster an understanding of common cultural identity, albeit at times, incorporating an essentialized racial identity not unlike contemporary European romanticists.

White archaeologists and physical anthropologists had initiated no such journals and research organizations by the 1960s, nor did they publish in black journals. But some Euro-American social and cultural anthropologists and historians did use the *Journal of Negro History* and *Phylon* (edited by Du Bois at Atlanta University).

Franz Boas's interest in African cultures provided an important foundation for American scholarship in this area. His empirical and cultural determinist approaches were both welcomed by and in conflict with African-American scholarship, based on how the Boasians did and did not relate to civil rights goals (Baker 1998). Colonial European anthropological research in Africa was quite abundant, but had limited the involvement of American anthropologists until the post-colonial and Cold War era breached the proprietary wall (see Mwaria 1999: 280; an example of this change point is a meeting between Evans Pritchard, Melville Herskovits, and a young Elliot Skinner at Oxford). Boas's student, Melville Herskovits (1930, 1939, 1941), along with Roger Bastide (1967) were among the first non-African Americans to take an interest in a "hemisphere-wide synthesis" of black life in the diaspora. In the Boasian vein, their work focused on the persistence of African culture, acculturation, and miscegenation without devoting serious study to social and economic discrimination (Drake 1993).

Herskovits, like many diasporan scholars, poignantly recognized that the major corpus of existing popular and scholarly literature on African Americans constituted a "myth of the Negro past." In sum, this mythology conspired to present blacks as "a man without a past" who, being without cultural contributions of his own, had been readily

and completely acculturated by Europeans. He intended to expose and correct the myth by undertaking the study of “Africanisms” among Diasporic peoples (1941).

Yet the liberal white tradition of scholarship represented by Boas and Herskovits was also distinguished by a patronizing and instrumental approach to black scholars who were often already advanced in their Diaspora interests. While Boas took the conventional approach of using Hurston to gain access to data from black communities (Willis 1969; Drake 1980), Herskovits apparently discouraged African-American students from pursuing diasporic subjects. Tellingly, some very prominent black scholars who had studied with Herskovits at Northwestern University (Johnnetta Cole and Joseph Harris, personal communication, 1989) sought out other mentors because they had the distinct impression that Herskovits did not view blacks as the equals of whites. He also deterred black students from studying in Africa because it was too similar to their own culture (Mwaria 1999: 280). A counterintuitive rationale from the perspectives of most African Diasporan intellectuals, the anthropological characterization of the etic (outsider’s) perspective as objective had served to empower the voices of white anthropologists concerning the non-white world where they worked. The sense that Boas (see Willis 1968; Baker 1998) or his most renowned former student, Mead (see Rankin-Hill and Blakey 1994) were patronizing toward and unaccustomed to the black world, punctuates the history of African-American relations with these relatively anti-racist scholars. Despite these American social constraints, some major Euro-American cultural anthropologists and historians referred to the publications of the African Diasporic intellectuals, and vice versa.

These conflicts of liberal racism might explain partially why intellectual cross-fertilization between Northwestern and Columbia (see Sanday 1999, p. 248 on William Willis's experience at Columbia) tended to proceed through literary interaction, while the collective use of primary data by black and white scholars occurred at the University of Chicago during the same period. It is also important that the sociologists and social anthropologists at Chicago were willing to examine social and economic inequality, unlike the cultural focus of Northwestern. The exposure of the "Myth of the Negro Past," however, was meant to undermine the ideological legitimization of social and economic inequity as its contribution to Myrdal's study, *American Dilemma*, coordinated at Chicago. Rankin-Hill (1997) suggests that Boas's motivations were similar to those of Herskovits.

Arguably, the Boasians and Chicagoans were each emphasizing different aspects of the same problem in segmented and competitive ways. The diasporic scholars were involved to varied degrees in both camps. But the diasporans had a long established interest in culture on their own, which Herskovits's program overlapped. The diasporic scholars, being structured into a single "racial" intellectual community, drew upon each other and all of the scientific, humanistic, artistic, and political aspects of their subject, crossing the lines of disciplinary segmentation and camp competition that were hardening in white academia. The "Harlem Renaissance" from which this work got its energy is well named, not only because it ushered in a cultural rebirth and the "New Negro," but for the pre-Enlightenment sensibility manifested in the breadth of interdisciplinary synthesis openly advocated and developed in the work of individual scholars. Du Bois' seminal work, *Souls of Black Folk* (1903), is an equally influential example, as is the

corpus of Montague Cobb's physical anthropology (Rankin-Hill and Blakey 1994). The "Harlem Renaissance" had taken New York and other major cities by storm in the 1920s, attracting masses of whites to its elevated and seemingly exotic African-American culture. Surely this movement had stimulated the interests of the Columbians, as did the rise of anti-lynching campaigns that were visibly associated with Harlem life. Yet whites did not participate in the prolific writings of this Renaissance, and blacks did not publish in the leading (white) anthropological and historical journals.

By the 1960s, some Euro-American cultural anthropologists were beginning to expand their thinking to include both a diasporic scope and critique of inequality. Norman Whitten (with a degree from North Carolina) and John Szwed (with a degree from Ohio) organized the first anthropological symposium on the diaspora that included white and black contributors. This led, three years later, to the publication of *Afro-American Anthropology: Contemporary Perspectives* (1970). Along with the work of Sidney Mintz (with a degree from Columbia) in the Caribbean (1951, 1974) and Marvin Harris and others who undertook the State of Bahia-Columbia University community Study Project in Brazil (Hutchinson 1957), one began to see studies of the economic aspects of diasporic subordination conducted by Euro-American anthropologists three generations down the Boasian lineage.

From 1930 through 1960, the University of Chicago was frenetically engaged in the social anthropology and the sociology of African Americans. This "Chicago school" emphasized the study of the problems of socioeconomic inequality, mostly in urban settings. Here sociology and social anthropology merged in a way seldom seen in the United States. The participation of African-American graduate students was more

pronounced at Chicago than at Northwestern, and included such luminary graduates as St. Clair Drake (see Bond 1988, Baber 1999), E. Franklin Frazier (1939, see Edwards 1968), Charles Johnson, Mark Hanna Watkins, and Allison Davis (who would join the Department's faculty as "the first African American with a Ph.D. to hold a tenure-track position at a predominantly white university in U.S. history," receiving tenure at Chicago in 1947 (Browne 1999). Drake and Clayton's *Black Metropolis* (1945), about a black Chicago community, is essentially a Du Boisian hybrid of the "Chicago school" and cites mainly the African American authors in urban studies of the previous 50 years. Most of these graduates pointed to the mentorship of W. Lloyd Warner (both at Harvard and Chicago) as the senior faculty member under whom they had worked. The Chicago school was not Boasian, but rather a synthesis of British social anthropology, sociology, and African-American traditions of scholarship. It may have been the most collaborative academic program of white and black scholars in the white world either before or after its moment. From it, Drake would expand upon his scope to include a broad sweep of diasporic space and time, and became a framer of the concept of an African Diaspora. His last treatise, *Black Folk Here and There* (1987 and 1990) was more than a nominal tribute to Du Bois's *Black Folk Then and Now*; it was a synthesis of global data on the social significance of color for African descent groups, beginning in ancient Egypt and ending in the twentieth century.

Throughout the early development of research on the African Diaspora, the members of that diaspora who framed that research approached the subject with both interdisciplinary and activist perspectives, whether missionary, integrationist, Marxist, or Pan Africanist. Drake (1980) describes this African-American intellectual tradition as

“vindicationist,” as meant to correct the omissions and distortions of the mainstream Eurocentric tradition. The research of some Euro-American anthropologists in the Boasian lineage was useful in those efforts. The inter-ethnic collaboration at Chicago had policy implications most clearly evident in the governmental use of Myrdal’s *American Dilemma* (1945) (funded by the Carnegie Foundation). Yet, black scholars, as they had done since the anti-slavery movement, maintained a front line stance by asserting the need to increase this work against the prevailing denigration of the black experience that was systematically perpetrated by Western education. Frederick Douglass had elucidated an ideological myth of the Negro past nearly 100 years before Herskovits, and African-American efforts to destroy the myth continued to evolve intellectual, organizational, and activist dimensions within the future black world.

Those mentioned above are small and prominent examples of the major sources of in-depth research on people of African descent between the mid-Nineteenth century to 1960. Their research, humanistic expression, and political activism attended the global emergence of the African Diaspora from slavery, colonialism, and segregation. It deliberately contributed to an understanding of people of African descent and their relationship to the world that would empower those transitions and adjustments. A formal concept of diasporic studies, according to Harris (1993), achieved momentum in 1965 when the International Congress of African Historians convened in Tanzania and included in its program a session entitled, “The African Abroad or the African Diaspora” and continued as a recurring theme of UNESCO publications in several languages. By that time the emergent Pan Africanist Congresses of African, Caribbean, and African American scholars, humanists, and political leadership were influencing the immediate

post-colonial realities of the United Nations. The civil rights, black power, and black consciousness movements of the United States during the period between World War II and the end of the Vietnam War were fueling and fueled by diasporic Black Studies. While many others should be credited, the intellectual leadership of anthropologists St. Clair Drake (Stanford) and Elliot Skinner (Columbia) and historian Joseph Harris (Howard) should be mentioned in the emergence of an academically-grounded concept of the African Diaspora. During the late 1960s and 1970s, scores of black studies programs and departments sprung up at recently desegregated North American colleges and universities as black students physically took over campus buildings for that purpose. Although there are many Euro-American and other scholars working in African-American Studies programs at predominantly white institutions in the United States, those programs nevertheless remain the most likely academic home for black faculty and sociocultural refuge for black students to be found in those majority institutions.

The articulation and disarticulation between these developments and the field of bioarchaeology is a major theme addressed below. This summary of intellectual history provides a reference point against which to contrast the development of an African diasporic bioarchaeology which, while recently impacted by black and cultural scholarship, began along a segmented trajectory of white ecological and racial scholarship that has structured the study of black people very differently. That structuring has taken place in fact, virtually without recognition of the older and deeper intellectual traditions described above. Archaeology and physical anthropology have experienced even less interaction with the black intellectual traditions than did American sociocultural anthropology. Now I turn to the mainstream traditions of physical

anthropology and archaeology whose branches will also penetrate African diasporic research during the 1970s.

Physical Anthropology and the Negro

African American bioarchaeology as it has usually been practiced combines skeletal biology (principally the specialization in paleopathology or the study of health and disease in ancient populations) and historical archaeology (the archaeology of the post-Columbian era in the Americas). Skeletal biology has a longer history of concern with people of African descent in the Americas than has archaeology, and for most of that time physical anthropology followed a different trajectory from diasporan research, mainly because physical anthropology had little if any concern for culture during its first 100 years. Its focus upon racial differences meant that African descent populations, constructed as Negroes, Negroids, or biologically black, were considered an important group for comparisons with Caucasoids, Caucasians, or whites who in turn were regarded as a biological standard of normalcy.

This racist nineteenth and early twentieth century history of physical anthropology has been extensively critiqued (Gould 1996 [1981], Blakey 1996 [1987], Smedley 1993, Armelagos and Goodman 1998, and others). It is now sufficient to state that, apart from specific differences, physical anthropologists classified human populations racially and created hierarchical rankings of races. Whether these were evolutionary or pre-evolutionary rankings, European descent groups (Caucasoids) were placed at the top and Africans (Negroids) at the bottom, with Asians and Native Americans (Mongoloids) usually intermediate. While racial classifications were at times more diverse, from Linnaeus' eighteenth century taxonomy until the issuance of

UNESCO Statement on Race in 1951, this hierarchy was characteristic of Euro-American and European physical anthropology. It was typical of the thinking and policies of the general white population of which these physical anthropologists were part.

The emphasis on race was part of a broader conceptualization of objective science defined by natural historical explanations of variations in presumed natural biological categories (e.g., race). The goal was to develop a science of “man” grounded in the same principles that were applied to zoology, biology, anatomy, and medicine, the fields from which most physical anthropologists initially emerged. The resulting science, however, was clearly not objective. It served as a means of ideological production that naturalized and thus justified colonialism, racial segregation, eugenics, class, and gender inequity. Viewed through this racial lens, human populations had a phylogeny from which culture and history were mere adaptive byproducts. The lower the type, the less interesting were its nearly extinct behaviors. The highest types received romantic eugenical characterizations as was the case for certain sub-races of Western Europe (Ripley 1899, Grant 1916, Stoddard 1921).

African diasporic cultures and history held no interest for physical anthropologists and archaeologists. This was especially true during the nineteenth and early-to-mid twentieth centuries in the U.S., which had no African colonies to understand and manage, but instead sustained a system that maintained the subjugation of a black racial caste. “American Negro” was synonymous with former slaves who were thankful for the opportunities that Christianity and acculturation had afforded them to emerge above their assumed absence of prior civilization, as in Douglass’ and Herskovits’ American myth. There were no contradictions between this myth and physical anthropological study of

the Negro because the naturalized category of race is conceived of as acultural and ahistorical. Physical anthropology was the primary author of the myth.

Skeletal research on African descent populations (as racially black or Negroid) began with Samuel Morton's craniometry in the 1830s, which was popularized in 1854 by *Types of Mankind*, the work of Josiah Nott and George Gliddon. Gould (1981) makes the point that Morton's racial ranking was taken as evidence that then enslaved African-Americans had the mentality of children who were better off under white authority. As mentioned earlier, this work initiated an immediate counter argument from the leading African-American activist intellectual of that time, who added that the book's characterizations of Egyptians as Caucasoid were meant to deny the existence (and possibility) of civilized accomplishments among African peoples (Douglass 1954). *Types of Mankind*, which interprets crania, is a nascent bioarchaeological interpretation in a classic racial-deterministic vein. The book was the first to popularize the American field of physical anthropology. Its use of archaeology initiates the sad fact that from the nineteenth century until the present, the Nile Valley has been the only area in Africa on which a body of bioarchaeological literature has developed (Armelagos et al. 1971; Aufderheide and Rodriguez-Martin 1998) perhaps because dynastic Egypt continued to be viewed as Caucasoid with Nubia as its Hamitic ("brown Caucasoid"), slave-bearing neighbor (Bernal 1987). Exceptions to this are the study by Armelagos (1968), which although it had a paleopathology focus reflected a prescient bioarchaeological orientation, and the work of Greene (1972); these show African continuity in the Nile Valley. While most of the research has centered in the Nile Valley, there is presently work in southern Africa. (3) (4).

Measurements of the skull meant to show a racial evolutionary basis of social inequality (having evolved from pre-scientific phrenology) continued as the focus of the physical anthropology of the Negro until World War II. Craniometry would continue as the focus for descriptive racial taxonomic studies in colonial Africa (Tobias 1953; Oschinsky 1954; de Villiers 1968), as in American studies of racial admixture (Pollitzer 1958) and in forensic studies for the identification of crime victims and missing persons. The Smithsonian's leading physical anthropologist, Ales Hrdlicka, was assigned the task of reviewing "all of the work on the Negro" in 1927 for the National Research Council Committee on the Negro (Hrdlicka 1927). His bibliography included sociological works of Du Bois and Frazier, and the historical work of Woodson and other African-American writers. In addition, an extensive list of work by white scholars was included that analyzed what was then termed, "the Negro Problem." Hrdlicka (1927:207) viewed the previous work as shoddy, not rigorous, and "tinged with more or less bias for or against the Negro." He proposed that future research should focus on the Negro brain (an organ he studied) which, after all was the "real problem of the American Negro." He then continued work on measurements of the skulls of 26 living African Americans found at Howard University and fudged his data so that "the Full-blood Negro" appeared to be of inferior "mentality" (Hrdlicka 1928; Blakey 1996). In fact, since Morton's time, the study of the Negro had been focused upon recently diseased anatomical collections or on living populations (Davenport and Steggerda's eugenical research in Jamaica in 1929 for example, claiming to show the deleterious effects of miscegenation). (5)

Beginning in 1930, Earnest Hooton (Harvard) would follow Hrdlicka as America's most influential physical anthropologist. Hooton's Pecos Pueblo study (1930),

also initiated what has variously been called the statistical (Armelagos et al. 1971), paleoepidemiological (Buikstra and Cook, 1980) or demographic (Aufderheide and Rodriguez-Martin 1998: 7) approach to which initiated the development of modern paleopathology, thus starting a research trajectory that continues today. During this time, however, the “Harvard-Washington [Smithsonian] Axis” (Spencer 1979) was at the core of a physical anthropology that was emphatically racially and biologically determinist (Blakey 1996). A substantial body of publications in modern paleopathology would not begin to emerge until the 1970s, and “1930s-type case reports” would persist even then (Lovejoy et al. 1982: 334). Paleopathological data would characterize the core of African American bioarchaeological studies that emerged during the 1980s. Although a biocultural approach to paleopathology would begin then, the racial typological approach has continued.

The persistence of racial taxonomy has been most noted among forensic anthropologists who “in particular find the phenotypic criteria associated with race to have practical applications because they are frequently called on by law enforcement agencies to assist in the identification of human remains” (Jurmain et al. 2003: 396). Furthermore, according to that prominent physical anthropology textbook, such classification “is viewed as no longer valid given the current state of genetic and evolutionary science” while “[o]bjections to racial taxonomies have also been raised because classification schemes are *typological*” and are “inherently misleading because there are also many individuals in any grouping who do not conform to all aspects of a particular type” (Jurmain et al. 2003: 396; also see Armelagos and Goodman 1998). Racial inequality is ostensibly no longer the point of current racial classification, but

when racial attributions substitute for specific cultural affiliations and historical contexts, inequality is implied. When researchers involved in forensics choose to apply the same descriptive approaches to African American bioarchaeological sites (as in MFAT's work on the NYABG or other research discussed later), their interpretations are then loaded with the 150 year legacy of the objectification and generalization of African diasporic identities. African-Americans are consequentially dehistoricized and dehumanized. As will be shown later, the ABGP chose to vary from that legacy and offers a historicized interpretation even of biological data used to track geographical origins and cultural affiliations.

There were also alternatives to the dominant racial deterministic trend in the early years of physical anthropology. Franz Boas, the liberal socialist anthropologist examined living populations and argued for the plasticity of human biology and behavior. His actual focus (and direct target of critique) was the study of European sub-races (Boas 1911, see Blakey 1996). His general critique of racial determinism was used by African-American activist scholars such as Du Bois for their anti-racist efforts (Baker 1998).

Studies of the new documented anatomical collections (macerated cadavers from the dissecting rooms of medical schools) gained momentum during the 1930s. As it happened, the largest series was completed at [Case] Western Reserve University by T. Wingate Todd, a liberal Scottish physical anthropologist, who had been an officer among Colored troops in Canada (Cobb 1939). Todd's analysis of the Hamann-Todd collection's crania showed environmental causes of differences in black and white cranial development. In a presentation which Todd delivered at a meeting of the National

Association for the Advancement of Colored People (1937), he deduced that an equal potential for achievement existed in these “races.”

T. Wingate Todd’s liberal environmental analyses were furthered by W. Montague Cobb (his former student and an African American physical anthropologist who was professor of anatomy at Howard University from 1932-1969) who used data from skeletal collections and living populations to show that biology did not determine the athletic acumen of blacks or whites (Cobb 1936). Furthermore, Cobb was one of the first physical anthropologists to use demographic data, within a synthesized evolutionary and social historical paradigm, to show high adaptability of the Negro against the adversities of slavery and racial segregation in the U.S. (Cobb 1939; see Figure 2.1).

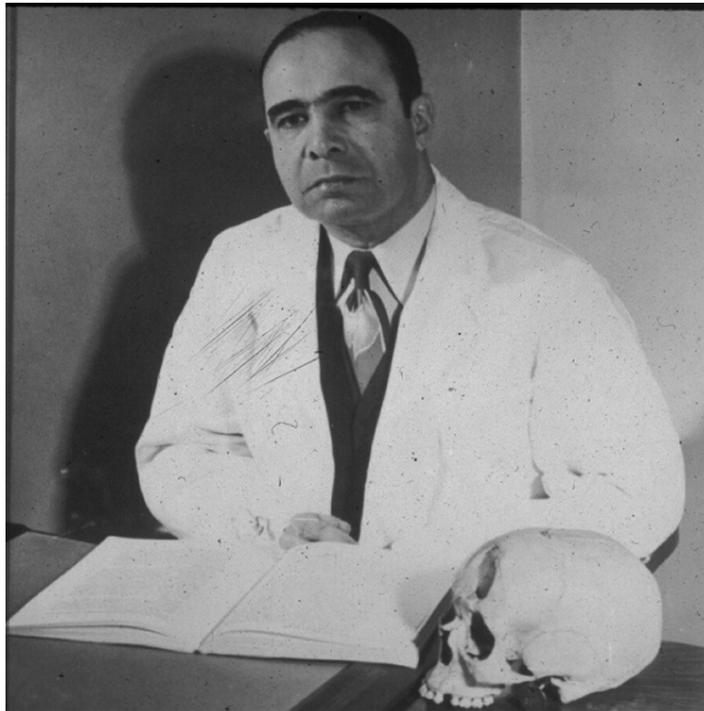


Figure 2.1: W. Montague Cobb with a pathological cranium from his documented anatomical collection at Howard University.

Cobb would later put his approach to physical anthropology and social medicine to service in the U.S. Civil Rights movement and the NAACP in the tradition of activist scholarship (Rankin-Hill and Blakey 1995). These studies, however, seem to have had very little impact on the development of physical anthropology.

Boas was opposed by mainstream physical anthropologists until after World War II when anti-eugenical concerns swept the world and elevated the Boasian approach an advantage (fostering mainly cultural and biocultural anthropology). Todd remained based in anatomy, rather than physical anthropology. Cobb was best known for his medical and civil rights work in the black world, although interest in Cobb's anthropological approaches was rekindled at Howard during the 1990s.

Conception of African Diasporic Archaeology

Physical anthropology slowly began to incorporate modern paleopathology during the 1930s. The field remained steeped in its long tradition of the racial classification of African-descent groups, using this to explain/justify their social status. African-American bioarchaeology would begin during the 1930s. But African-American scholarship was not involved, nor was a keen interest in the Africana world. Instead, it would grow from the interest of many physical anthropologists of that era in race and evolution, particularly as applied to African Diasporic skeletons that were being discovered by archaeologists who were actually looking for extinct pre-Columbian Indians.

In 1938 a team of Oxford archaeologists (funded by Northwestern and Columbia universities) excavated among the first bioarchaeological sites in the African diaspora (Buxton, Trevor, and Julien 1938). In 1939, T. Dale Stewart, who had long been

Hrdlicka's assistant curator at the Smithsonian Institution, responds to the article by Buxton and colleagues and to correspondence by E. M. Shilstone who had made a related find in the British colony of Barbados (Stewart 1939). Stewart's position at the U.S. National Museum made him a likely expert on the racial identification of the curious remains of the one male African-looking skull found in an apparently Arawak (Taino) midden in Barbados and the two "Negro" skulls that were found on Water Island, St. Thomas, U.S. Virgin Islands. These were believed to be intrusive to indigenous deposits that had been of interest to the archaeologists. Stewart argued that the Water Island remains were "Negro instead of Negroid" on cranial morphological grounds and concluded that they were therefore intrusive. The Barbados Negro showed a craniometric association with Stewart's Gabon data. While the measurements showed some inconsistencies with African comparative data in both cases, they were "more in the direction of the Negro" (1939: 50). Buxton et al. (1938) comment on a similar situation reported by Duerden for a Jamaican site in 1897, in which the craniometric methods seemed unreliable for explaining the presence of Africans among the remains of the Arawak.

With these studies, the physical anthropology of race assessment in diasporic archaeological populations had begun. Antemortem loss of mandibular incisors in Burial 40.1.2 and wedge-shaped filing of the maxillary incisors in Burial 40.1.1 from St. Thomas were consistent with distinctly African esthetic practices; the unmodified cranial shapes at both sites were unlike the customary practice of shaping the skull in Tainos from Hispaniola. From these facts, Stewart concluded that these were not the remains of indigenous people. (Indeed, given the problems of determining population affiliation

with only one or two skulls, the cultural data exhibited the most convincing qualitative distinction) (6).

There was, however, no serious consideration by Stewart or the archaeologists of the possibility of cohabitation of Africans and Tainos. The St. Thomas individuals (an adult male and female) were buried in association with red ochre mounds, stone artifacts, and with a pot over the face of one of the individuals. They were amongst 19 Taino burials. The site had been disturbed by previous archaeological excavation and was difficult to assess, yet there might have been historical reasons for two Africans to have been among a group of Tainos. It is not at all clear from these publications why the site is assumed to be pre-Columbian (the authors actually refer to pre-1700) simply because there were Taino artifacts because Tainos were actually present in the Caribbean in early colonial and genocidal times. The remains were curated at the University Museum at Oxford, but the temporal relationships might never be resolved. There would not be another such study until 30 years later and under similarly accidental circumstances.

A notable comparison is found in the work by Ortiz (1927) followed by Rivero de la Calle (1973) on several cases of dental modification (“*mutilacion*”) in Cuban skeletal remains. Although the general assessment of the skeleton is limited, the historical, ethnographic, and folkloric context is extensively revealed with the analysis of the significance of this practice. The practice was associated with Maroons (cimarrones) and religious enclaves. These are also the only examples of dental modification that have been evaluated as a possible local practice, rather than having occurred among Africans brought to the Americas subsequent to the modification of their teeth.

In 1974 two skeletons were found at site 2-AVI-1-ENS-1 at Hull Bay, St. Thomas, which Smithsonian physical and forensic anthropologists also assessed to be “Negroid” (Ubelaker and Angel 1976). Skeleton A (a 33-41 year old man with 5'7" stature) had only slight tibia periostitis (indicating infection) but showed extensive dental decay and abscesses. Skeleton B (a 30-38 year old man with 5'8" stature and a morphology remarkably similar to skeleton A) was shown to have extensive spindle-shaped periostotic tumor-like lesions of the upper right leg and left middle arm, accompanied by active cloacae associated with blood-borne infection. He had a partially healed fracture of the left humerus (upper arm) near the lesion and a healed fracture of the left clavicle, both of which caused significant shortening of these elements. Skeleton B also had very extensive tooth loss and abscesses. Skeleton B was associated with coffin nails and therefore reasonably of the colonial period. But, Skeleton A was definitely associated with an indigenous pottery fragment (Elenoid period, dated 800-1200) and no colonial artifacts. Radiocarbon dating only resolved that the skeletons were not recent, important for the forensic concerns of the investigation. In this example of another accidental bioarchaeological encounter with an African skeleton, the race, age, sex, and stature methodology continues to be important for forensic identification, yet the assessment of pathology marks a more modern approach than the earlier St. Thomas study. None of these examinations attempts to explore the population, history, or social condition of Afro-Caribbean people.

Another Smithsonian publication by Angel in 1976 examined “Colonial to Modern Skeletal Change in the U.S.A.” The study compared 82 archeological skeletons (1675-1879) with 182 modern forensic and donated skeletons. Angel anticipated

increased body size in both European American and African American populations due to increased genetic heterosis and “improvements in disease-control, diet, and living conditions” (p. 727). This is a traditional study in its reliance upon physical anthropological and anatomical literature, early military data on stature, and evolutionary interpretations. The study showed remarkably little skeletal change, albeit greater in the black population than in whites. Life expectancy does increase as does a pelvic indicator of nutritional adequacy, while poorer dental health and the increased frequency of traumatic fractures were seen to reflect modern stresses.

Angel’s study was flawed by the nature of skeletal collections. The continuing dearth of middle and high status Euro-American skeletal collections meant that comparisons of the physical differences relating to socioeconomic variation and change among Euro-Americans could not be adequately made (p. 7). Class analyses, especially for the European American population of the past, also cannot be made on the basis of existing skeletal collections because these have practically no class variation. Comparisons with historical African-American or Native-American populations with Euro-Americans also cannot be accurately made unless these are strictly meant to show relationships among the Euro-Americans who were desperately economically poor and/or institutionalized. The fact that physical anthropologists had focused upon the analytical category of “race” meant that the socioeconomic character of these populations was seldom viewed as important, since a Caucasoid was a Caucasoid, whatever his or her class. The political economy of collections acquisition is also evident, given that the poor and the “other” could readily be dug up or dissected, preserving the burial rights of financially stable whites. An increased interest in the biological effects of

socioeconomic environment during the 1970s is certainly apparent in the Angel paper, despite his continuing reliance upon the use of evolutionary principles. With Angel, the Smithsonian had taken a significant step forward from an earlier preoccupation with the racial evolution of “Old American” whites during United States history (Hrdlicka 1925).

In 1977 the skeletons of two enslaved African American men (Burial #3 was 30-40 years of age and Burial #5 was 40-45 years of age) were reported from a 3000 year old burial mound on St. Catherine’s Island of the Sea Islands off the Georgia coast (circa 1800). These skeletons, too, were found accidentally during a long term study of the island’s native archaeology by the American Museum of Natural History. The analysis (Thomas et al. 1977) was, however, less forensic and more pertinent to historical interpretation than were the Smithsonian studies. Racial identification was made, as in the other studies, along with a modern paleopathological assessment. One man (Burial #3) had a recently fractured leg that had become infected and which probably led to his death. The other “was probably shot to death by a military-type weapon” (1977: 417). Both men had evidence of arduous labor by virtue of their robusticity and muscle development and had “abysmal” dental health. David Hurst Thomas and his associates also encountered the fancy burial of the slave holder’s son in a separate location, showing him to be physically young, gracile, and lacking in evidence of hard work. His evidence of childhood illness and poor dental health was similar to the African-American skeletons. These comparisons were used to examine the relative quality of life and condition of the two plantation groups, bringing to bear both written and oral historical sources. The researchers could not determine why the burials had been made in a Native

American burial mound, and they left open the question of relations with native people after considering the generalization of an historian:

If the [African American] emphasis on burial with one's family spirits was as strong in the early nineteenth century as Combes suggests it was later, the fact that burials were placed in Cunningham Mound D - isolated as they seem to be - becomes a relevant factor for interpretation (1977: 418).

With such a small number of burials (N=3), there was no statistical analysis and there was only a rudimentary historical and cultural analysis. But this study does engage historical analysis and is therefore more advanced than previous reports on accidentally encountered African American sites by suggesting new motivations in addition to its use of the new paleopathology. These authors were examining people, not a race, and probing the conditions of slavery. They re-interred the remains, rather than curating them, and made recommendations about historic burial sites that were considerate of both public sensibilities and scientific concerns for improved rigor and cultural interpretation:

We do not of course, advocate wholesale archaeological investigation of historic graveyards. Prevalent social and religious customs are to be respected in matters of this sort. But we do urge that as graveyards are required to be moved to make way for progress, archaeological mitigation should include adequate research designs to raise some of the germane questions regarding past human behavior and belief systems (1977: 418).

These are the only African Diasporic bioarchaeological studies prior to 1980. After this time, sample sizes and geographical ranges would increase, historical and cultural interpretations would become more sophisticated, and "customs...respected in matters of this sort" will overwhelm bioarchaeology. What would be responsible for these dramatic changes?

The emergence of an active research interest in African-American sites developed as a result of the National Historic Preservation Act of 1966. This Act required the funding of archaeological work to mitigate the effects of all Federal construction projects, including buildings and highways, in order to preserve cultural heritage. These Cultural Resources Management (CRM) projects caused the growth of private archaeological consulting firms, which quickly became the main source of archaeological employment in the United States. CRM also meant that contract funding was available for site excavation and descriptive reporting for sites that were encountered accidentally. Federal road and building projects across the United States produced a number of sites, some of which resulted from encounters with African-American cemeteries. While acknowledging that mitigation is a form of cultural resources preservation, that ideally sites are protected, projects halted or impacts mitigated, it also is the case that, potentially here was a target of opportunism for unethical contract archeologists, but also of opportunity for the launching of African-American archeology.

The first work at an African-American site, however, was not on a cemetery, but rather on a plantation site, the Kingsley Plantation in Florida was excavated by Douglass Fairbanks in 1967. Departing from the new archaeology's emphasis upon ecological determinants, Fairbanks took an historical approach. According to Ferguson (1992), "Fairbanks was not bowing to professional pressure or pleas for a new and more objective archaeology; he was addressing black demands for more attentiveness to black history, and without that political pressure African-American archaeology would have developed much more slowly, if at all" (p. xxxviii). I agree with Ferguson that this new specialty resulted from a combination of the structure of the law, together with the

pressure of black political and social protest.” African-American archaeology increased funded because such sites were repeatedly found in the way of U.S. Government roads, buildings, levies, parks and other construction projects.

Black protest had created both an interest in and market for black history for which archaeologists (and bioarchaeologists) showed little or no interest during the final decade of the 20th century. Archaeologists did not take courses in African-American Studies departments that were multiplying during the period between the 1970s-90s, a time when an archaeological shift took place. These departments remained marginal to the university education of whites. Nor did most archaeologists excavating black sites collaborate with African Americanists, most of whom were black, who had the most extensive knowledge of African Diasporic history and culture. Furthermore, archaeologists did not participate in the Association for African American Life and History or any other scholarly associations African-Americans had long ago established for purposes similar to these that archaeology was just beginning to serve.

This lack of regard for the intellectual fundamentals of African-American Studies reflects the continued segmented social relations (legal and defacto segregation) between U.S. whites and blacks, respectively, comprising the archaeologists and African Americanists. For two more decades, this situation would continue to produce important limiting effects on African-American archaeology and African-American Studies. Notably, plantation archaeologist Theresa Singleton (Smithsonian and Syracuse University) and African-American Studies specialist Ronald Bailey (Northeastern University) organized a week-long meeting at the University of Mississippi in 1989, which had as its goal to bring practitioners of both fields together in dialogue. It is not

sociologically surprising that as the only black Ph.D. archaeologist working on plantation sites, Singleton would be the one to notice that something was wrong and to try to bring African American Studies and archaeology together to talk (8).

In the most extensive review of “The Archaeology of the African Diaspora in the Americas,” Singleton and Bograd (1995) found that African-American archaeology had expanded since the 1960s to include greater regional and industrial diversity of southern sites, to address issues of race and ethnicity, acculturation, inequities, and resistance. Moreover, their exhaustive survey also revealed that most of the literature is largely descriptive, relies too heavily upon flawed analytical techniques or very narrow perceptions of ethnicity, and has been slow to incorporate African-American perspectives in developing this research (p. 30). Continuing, these authors observe, “[t]hat race predominates in discussions of plantation life or defines the presentation of blacks’ lives following emancipation may in part reflect white archaeologists’ and white America’s preoccupation with race. There is a tendency to presume that race, or ethnicity, is significant, which is not to say that race is not important. Rather it is to assert that white preoccupations are not always the same as black preoccupations” (p. 31). The authors argue that it is best to consider ethnicity as a process that is both forced upon and creatively utilized by African Americans, rather than creating an archaeology of “the other,” consisting of static typologies that identify a group with objects. In most cases, the absence of type objects comes to constitute evidence of acculturation and assimilation when other plausible interpretations exist. I suspect that this typological approach is tethered to both the American myth of the Negro past and Herskovits’ search for Africanisms. According to Singleton and Bograd (1995), “The tenor of many ethnicity

studies is problematic. One problem is that they tend to take a perspective from the outside, how archaeologists and others define ethnics or cultural groups, rather than how ethnics define themselves” (pp. 23-24). Similar issues have been raised in a critique of African archaeology (Andah 1995).

Historical archaeologists’ publications rarely reflect African Diasporic scholarship, which has been the most prolific literature on this subject for more than a century. What is most often evident in their work, however, is the influence of the new historiography of plantation life that had also been fostered by the social changes of the 1960s. After, 1980, physical anthropologists would also draw from this important literature, central to the maturation of African-American bioarchaeology. Although space will not allow extensive discussion of the emergence of African-American research in mainstream historiography, a few examples seem essential to understanding its emergence and influence upon bioarchaeology.

The same sociological phenomena that spurred African-American archaeology fostered historical research on the subject, but the marketing and funding venues for history were different from those of contract archaeology. The Black Consciousness Movement had succeeded in producing a market for history books and lectures while the Civil Rights Movement had stimulated interest in both blacks and American racism. The historical works of van Woodward (1968), Jordan (1968), and Genovese (1976) followed the early work of the left-leaning Aptheker (1943) and are examples of an emerging Euro-American interest in African-American historiography that explained the origins of American racism and the condition of blacks. Herbert Gutman’s historical and demographic study of *The Black Family in Slavery and Freedom* (1976) opposed Senator

Daniel Moynihan's influential report, *The Negro Family in America: The Case for National Action* (1965). Moynihan had attributed urban black poverty to a typically "dysfunctional" slave family, which Gutman showed to have little historical basis. But it was Fogel's and Engerman's economics treatise, *Time on the Cross* (1974), that stirred a major debate about whether or not working class whites were similarly oppressed as enslaved blacks whom the authors claimed were more than adequately nourished. Like Moynihan, *Time on the Cross* raised the specter of apology when blacks were found to have been worse off in many respects after the Reconstruction than during slavery. The critiques of this work by Gutman (1975) and David et al. (1976) were quite devastating. This new historiography drew heavily upon the prior work of black scholars. Add to these Phillip Curtin's *Atlantic Slave Trade: A Census* (1969), which estimated the death toll of the middle passage in the millions -- millions more perhaps than most whites wanted to acknowledge and millions fewer than estimated by some black scholars -- and became a major historical grist for the mill of scholarly and politicized debate.

Physical anthropologists began to use data about the demography, nutrition, and health of enslaved African Americans to address questions regarding the quality of life among the enslaved. Curtin's article on the slave trade and Steckel's (1977, 1986) work on problems of nutrition, disease, and mortality on plantations followed Stamp's *The Peculiar Institution* (1956) in showing the dire demographic and health consequences of American slavery. Higman's extensive Trinidadian data on the demography of the slave trade represents an early example of how this type research uniquely found its way to the *American Journal of Physical Anthropology* (1979). Kiple and Kiple's (1977) and Savitt's (1978) apologetic theories attributing chattel slavery and racism to black genetic

immunities to disease also resonated with the evolutionary bent of physical anthropology. The biological data generated by these biohistorical debates interested physical anthropologists who were poised to enter the discussion with the bones and teeth of the enslaved people themselves. Nonetheless, these historians, Rankin-Hill (1997:12) seems correct in saying that “little has been accomplished in expanding the conceptual limits of [biohistory]. In fact, much of the emphasis has been on the intricacies of quantification and data manipulation, and not on different approaches to interpreting and/or examining the data generated.”

The stage for the nascent bioarchaeology of the 1980s was set. Political events spurred a broader societal interest in blacks. Government funding options and markets opened for research and publications in African-American archaeology, in particular, and historical archaeology, in general. Accompanying these trends, a biohistorical literature came to prominence that spoke to the biological anthropologists who had seized upon epidemiological and demographic approaches.

As interest in racial studies, apart from forensic anthropology waned, physical anthropologists were looking for new ways to apply their methods to societal issues (Blakey 1987; Armelagos and Goodman 1998). Biocultural approaches which sought to use biological stress indicators as evidence of societal variation and change began to emerge during the 1970s (Goodman and Leatherman, 1998). Biohistorical approaches, if applied to bioarchaeological contexts, were ideal for biocultural studies. The students of George Armelagos and others at the University of Massachusetts in the forefront of biocultural anthropology will later be shown to have had particular impact on the evolving shape of African American bioarchaeology. Finally, the hurricane-like sweep

of successful efforts by Native-Americans in the 1980s to control the disposition of their skeletal remains and sacred objects (Thomas 2000) culminated in the passage of Federal preservation legislation (Native American Graves Protection and Repatriation Act, NAGPRA, 1990). By 1985, objections were focused upon the Smithsonian by the Native American Rights Fund and the U.S. Congress. The writing was on the wall. American physical anthropologists were losing access to their main source of professional reproduction—Native-American bioarchaeological research. The field of African-American bioarchaeology loomed, therefore, to some as an open niche.

The Birth of African American Bioarchaeology

The first extensive African-American bioarchaeological study was conducted by Jerome Rose and his colleagues at the University of Arkansas in 1982. The Cedar Grove cemetery site (3LA97) in Lafayette, Arkansas, was in the path of the U.S. Army Corps of Engineers construction of a revetment on the Red River. This African-American cemetery had been used during the Post Reconstruction period, 1890-1927, when freed blacks in Arkansas were engaged mainly in tenant farming. Yet, it was the prehistoric site that lay beneath Cedar Grove that had initially been found significant, and for which “mitigation” of the adverse impact of revetment construction was necessary, according to the Advisory Council on Historic Preservation that oversees the National Historic Preservation Act of 1966. Although the Advisory Council would later accept the African-American cemetery on the National Register as significant and deserving mitigation, little time and few resources were available for the study of the effects of the revetment construction on the sites. The Cedar Grove Baptist Church gave the anthropologists permission to conduct research during a 24 hour period prior to relocation

and reburial. The University of Arkansas team excavated and analyzed the 79 remains extremely rapidly, salvaging an extraordinarily sophisticated set of paleopathological data, given the limited amount of available time. The analysis (Rose 1985) also utilized the biohistorical literature and thus entered into the ongoing debates.

The Cedar Grove burial sample was shown to have been highly stressed by all indications. Neonatal mortality (always underestimated using skeletons due to the deterioration and loss of small bones) was 20 percent, and 55 percent of all individuals died before reaching 15 years of age. Only a single individual, 15-19.9 years of age, died, while most of the remaining members of the sample died between the ages of 30 and 50. Ninety percent of the remains had evidence of infectious disease and nutritional problems, which is very high. Among infants and children there were high frequencies of anemia, rickets, scurvy, and protein malnutrition. For adults, the evidence was mostly of healed or chronic infection, degenerative arthritis, healed fractures in men, and one male and one female with bullet wounds. Evidence of poor nutrition, high disease loads, and arduous work regimens was further supported by the bone histological study of Martin et al. (1987). Rose (1985:v) surmised that the work regime for these freed men and women “had not changed since slavery” and that the “general quality of life for southwest Arkansas Blacks had deteriorated significantly since emancipation due to the fall in cotton prices and legalized discrimination.”

In 1985, there was sufficient African-American research among physical anthropologists for Rose and Ted Rathbun (University of South Carolina) to organize the first symposium on “Afro-American Biohistory” at the Annual Meeting of the American Association of Physical Anthropologists. Reference at these meetings to blacks in ethnic

and historical, rather than racial, terms alone was novel. The symposium was published as a special issue of the journal in 1987 (volume 74), with one paper appearing later (Blakey 1998). Rose co-authored the histological study of Cedar Grove with Debora Martin and Ann Magennis. Also, there were bioarchaeological studies of a South Carolina plantation near Charleston showing evidence of childhood malnutrition and disease in a sample of 27 individuals who died circa 1840-1870 (Rathbun 1987). Dental and skeletal growth disruption was found to be highest for male children, 80 percent of whom had evidence of anemia and infection. Most men and women (69 percent and 60 percent, respectively) presented bone reactions to infection, with relatively high exposure to lead and strontium concentrations indicative of a diet high in plant foods. No clear evidence of syphilis was found (Rathbun 1987). This study contains a useful review of the biohistorical and archaeological literature, again showing the close connection to debates in history and archaeology at that time. Also, this site was being removed due to the development of private land for which the law did not require mitigation. The research team was able to convince the landowner to allow research prior to reburial.

The demography and pathology of 16 individuals from the eighteenth and early nineteenth century St. Peter Street Cemetery in New Orleans give evidence of arduous labor among younger males, and comparatively less such evidence among the many females and older adults interpreted as house servants (Owsley et al. 1987). The further racial analysis of this study that attributes lower life spans to racial admixture, along with the dearth of social and historical analysis, shows continuity with older racial traditions. This paper also describes a deeply infected distal right tibia, which Blakey and Ortner

had diagnosed as osteomyelitis, the result of chronic infection of an ankle shackle (see plate, p. 191, for this extraordinary example).

Another study (Owsley et al. 1990) compares the 149 black and white skeletons from Cypress Grove Cemetery (1849-1929) of Charity Hospital of New Orleans with burials at other sites. Excavation at this site also had been mitigated in the course of a Federal highway project. Similarities were found with the St. Peter's sample; also, the infection rates paralleled those of a New York State pauper's cemetery used by whites. The cut bone findings indicated that both blacks and whites who died at Charity were often dissected prior to burial. Consistent with the forensic approach frequently used in CRM bioarchaeology, the descriptive data were not integrated with community history. The accompanying volume prepared by archaeologists provides historical description (Beavers et al. 1993) dealing mainly with the city health and medical context of the hospital.

Several biohistorical studies appeared during the final decades of the 20th century that also show clear anthropological influences. Hutchinson (1987), using Harris County, Texas, slave schedules of 1850 and 1860 in combination with a credible range of biohistorical literature, explains marked regional population growth as a function of importation, rather than natural increase. She shows that enslaved persons who were recorded as "black" tended to have higher life expectancies on small farms, while those termed "mulattoes" were on average older on large plantations; this possibly was due to more mulatto house servitude on large plantations where black field hands were exposed to the worst conditions. Alternatively, mulattoes might have more often been native to the Harris County plantations and therefore younger, on average, than the blacks who

most likely included imported Africans; also, immunities to yellow fever (following Kiple and King, 1981) might have contributed to differences in life expectancy between the blacks and mulattoes (Hutchinson 1987).

Also, Wienker (1987) combines traditional evolutionary and biodeterministic tendencies with a new bioculturalism in his study of an early twentieth century logging company town in Arizona. While acknowledging health care inadequacies for blacks in the town's deeply segregated context, Wienker considers the possibility that dark pigmentation might have had deleterious effects in the temperate Arizona highlands.

A clearer break toward a non-biodeterministic view, as seen in Rose (1985), Martin et al. (1987) and Rathbun (1987), is also found in the symposium paper by Blakey (1988). This paper traces ethnogenesis and demographic change in an Afro-Native American ethnic group (Nanticoke-Moors) in rural Delaware from the colonial period until 1950. The study uses a political economic analysis of 406 cemetery headstones, archival data, and oral history. It proposes that community responses to racial policies and industrialization brought about a single community's segmentation into different socially-constructed races. Although genetically similar, Nanticoke-Moors experienced different educational and economic options depending on their "racial" affiliations. Increased isolation was required to maintain Indian identity, with increasingly higher life expectancy among the industrializing African-American identified kin, than among Indian identified kin, who maintained a farming economy. Notably, this study considered few biohistorical debates, with the exception of Eblen (1979), and focused instead upon historical and ethnographic literature that examined African-American/Native American relations in the region.

During the mid-1980s, a collaboration was initiated between the Smithsonian Institution and John Milner Associates (a CRM firm), that led to excavation of the First African Baptist Church (FABC) cemetery in downtown Philadelphia and, as a consequence, also contributed to the Afro-American Biohistory symposium. The FABC had been used primarily by free, freed, and escaped African-Americans between 1823 and 1841. Because it was in the path of subway expansion, the site required archaeological mitigation. John Milner Associates excavated 140 skeletons, by far the largest African-American archaeological sample to that date. The FABC was also unique as a northern black bioarchaeological site, and a rare urban example, with St. Peter in New Orleans the other urban exception. The fact that the analysis was led by J. Lawrence Angel, a preeminent physical anthropologist at the Smithsonian Institution, raised the status of African-American bioarchaeology as surely as had the Rose-Rathbun symposium. Angel who had first established his reputation on the social biology of ancient Greece, had turned to the study of secular change in the European and African American skeletons from the colonial period to the present (Angel 1976). Along with his assistant, Jennifer Kelley, the principal archaeologist, Michael Parrington, and the on-site collaboration of Lesley Rankin-Hill and Michael Blakey (who coordinated and completed the project following Angel's death), J. Lawrence Angel personally conducted the core research and also made the collection available to other researchers. This combination of researchers, we believe, may have helped the FABC work evolve even further beyond the descriptive approaches that Angel typically had employed.

Of the 75 adult skeletons, males had a higher average age of death (44.8 years) relative to females (38.9 years), which compares favorably with most other nineteenth

century African-American sites. The burial sample appeared to have been stressed by inadequate nutrition, arduous labor, pregnancy and childbearing, unsanitary conditions, limited exposure to the sun, and extensive exposure to infectious diseases. Nutritional and growth indicators showed little better conditions than for enslaved blacks of the Catoclin Iron works of Maryland, 1790-1820 (Kelley and Angel 1983), although arthritis and violence-related fractures were fewer in Philadelphia (Angel et al. 1987). Consistent with the tradition of physical anthropology, the studies of ancestry were also of interest, with the resultant observation that 30 percent of individuals with os acromiale (non-union of part of the shoulder joint) being interpreted as a familial trait, when it might have been evaluated as the result of persistent mechanical, labor-induced stress during adolescent development (Rankin-Hill 1997: 152; Stirland, 2000:118-130).

The comparative analysis of Angel and Kelly was further developed in a second symposium paper (Kelley and Angel 1987) for which they had assembled 120 colonial African and African-American skeletons from 25 sites in Maryland (Catoclin), Virginia, and the Carolinas, as well as forensic cases of the Smithsonian's collections. Nutritional stresses were very evident in many skeletons, including anemia, which these authors incorrectly attribute to sickle cell anemia. Adolescents and many adults (male and female) showed exaggerated development of skeletal features associated with lifting muscles, including the deltoid and pectoral crests of the humeri. They also noted degeneration of the vertebral column and the bones of the shoulder at relatively young ages. Evidence of skull trauma and "parry" fractures of the lower arm suggested that violence had been especially common at Catoclin Furnace. In these examples, historical references are rarely used.

The First African Baptist Church skeletons were reburied in Eden Cemetery, Philadelphia, by the modern congregation in 1987. At a time when Native Americans were calling for reburial of 18,000 remains at the Smithsonian, the Institution's initial interest in announcing the FABC ceremony was administratively quashed. And, little more than marginal interest was expressed by the church congregation. The attitudes of African-Americans regarding this research, little of which had been made available to them, were mixed. In contrast, five years later, the New York community would explode over a similar project.

John Milner Associates continued to develop the preliminary work of Parrington and the foundation study of Angel (Parrington and Roberts 1984, 1990). Blakey and his associates at Howard's Cobb Laboratory published articles on childhood malnutrition and disease using a detailed analysis of dental developmental disruption, enamel hypoplasia (Blakey et al. 1992, 1994, 1997). Dental defect frequencies in the FABC sample were at frequencies similar to those found in the Maryland and Virginia collections that Angel had described, pointing to a similar degree of childhood malnutrition and disease in the recently free north as in the plantation south (Blakey et al., 1994). Both reported hypoplasia frequencies between 70 and 100, percent which were among the highest in any human population studied by anthropologists (10), thus demonstrating the capability of paleopathology to render this type of comparison across a broad span of human experience. In Philadelphia, these stresses occurred during fetal development as well as throughout the first seven years of life. The advantage of historical records for some FABC individuals included documented causes of death. These causes prominently

included infectious diseases, while 10 percent of Philadelphia's children had reportedly died of marasmus (starvation) (Blakey et al. 1994).

Lesley Rankin-Hill published the first book that synthesized a breadth of African American bioarchaeological and biohistorical data for the interpretation of the FABC, *A Biohistory of 19th-Century Afro-Americans: The Burial Remains of a Philadelphia Cemetery* (1997). Based upon her 1990 Ph.D. dissertation, this extensive treatment of modern paleopathological and demographic methods and the use of general and site-specific historical sources is commendable. Particularly important is her use of a basic model of biocultural stress developed at the University of Massachusetts by Goodman et al. (1984). This general model, which places culture in the role both of stress adaptation and stress inducer, is elaborated by Rankin-Hill as an organizing scheme for the particular historical stressors and effects of nineteenth century urban African-American life (1997, pp. 164-165). She did, in fact, present the most developed theoretical formulation for African American bioarchaeology, which includes the political and economic factors interacting with the physiology and health of early African Americans. She describes the multiple stressors, cultural buffers, and skeletal effects of physiological stress in the lives of Philadelphia laborers and domestic workers whom we will subsequently compare to the earlier skeletal record of New York City. The emphasis on adaptation anchors this work to the evolutionary tradition of the field.

While there are other influential centers, the influence of the University of Massachusetts is tangible, having been the graduate institution of Rose, Martin, Magennis, Rankin-Hill, and Blakey, as well as Robert Paynter in African-American archaeology. It can be distinguished from the other centers of the development of this

specialty by its unabashed advocacy and development of biocultural theory (Goodman and Leatherman 1998; Rankin-Hill 1997). Early biocultural models were developed from the synthesis of the human adaptability interests of R. Brooke Thomas, the biocultural paleopathology of George Armelagos, and the historical demography of Alan Swedlund during the late 1970s and early 1980s at Massachusetts. These models were honed and evolved by their students in order to incorporate political and economic factors that would expose the biological effects of oppression. The influence of faculty in cultural anthropology economics and African-American studies influenced the physical anthropologists and archaeologists, all of whom were exchanging information at a time when walls were being erected between subdisciplines at many other anthropology departments.

The involvement of African-Americans was also unusual, with one faculty member -- the influential Johnnetta Cole -- and one third of the black physical anthropology students in the United States (Rankin-Hill and Blakey) during this crucial period. More importantly, they were steeped in African-American traditions of scholarship, which they inserted into the departmental discourse. The progressive intellectual developments of the 1960s and early 1970s were well recognized at Massachusetts, as was the abysmal record of physical anthropology regarding race. Research on the political history of physical anthropology was exceptionally active there, and the emphasis was on the development of new theory. The core of ABGP skeletal biologists come from this background. They also have been influenced by African Diasporic scholars, prominently including Montague Cobb of Howard.

During that period, many of the forensics-oriented academic and museum programs that also conducted bioarchaeological investigations, in contrast, still were hampered by approaches reflective of the racial-descriptive tradition. In places like the Physical Anthropology Division of the Smithsonian Institution or forensics-oriented physical anthropology at the University of Tennessee, a technical emphasis on human identification appeared to grow in isolation from social, cultural, and political theory, or African-American studies. Despite their then embrace of less progressive traditions, these and other institutions and their graduates have been much involved in the shaping of bioarchaeology in the diaspora and during the 1960's and early 1970's were perhaps the most influential institutions for forensic anthropology.

The racial-descriptive approach rather than a biocultural one, dominated the Metropolitan Forensic Anthropology Team's initial field analyses of skeletons at the NYABG site. Their apparent efforts to define the population racially, with little regard for its cultural and historical interpretation, appeared in awkward contrast to the critical, humanistic, and diasporic sensibilities of the descendant community and to the biohistorical research orientation of the new Project leadership that took charge of the laboratory and analytical phases of research described in this final report and its two companion reports.

The distinctions between these approaches are recognized by many practicing paleopathologists. Scholars from any of the specializations and institutions described above are, of course, diverse and individual in the ways that they have developed expertise and should not be stereotyped by the examples or general trends explicated earlier herein. The goal of this chapter is to clarify the difference that each historical,

intellectual trajectory makes for the study of African-American bioarchaeology. The clashes between these approaches in the 1990s, highlighted by the African Burial Ground phenomenon in New York City, are understandable from this vantage (see Epperson 1999; La Roche and Blakey 1997). The ABGP chose its epistemological path among these available avenues.

Some very interesting diasporic bioarchaeology work was also conducted by researchers outside the United States by the end of the 1980s. The most sophisticated is the work of Mohamad Khudabux, sponsored by the Universities of Surinam, Kuwait, and Leiden (1989 and 1991). His studies refer extensively to much of the recent United States skeletal literature and to Higman's (1979) archival data on statures of different African ethnic groups enslaved in the Caribbean (1979). A study of the 38 African skeletal remains (57 burials) of the Waterloo Plantation (1793-1861) in coastal Surinam is striking for its combination of modern paleopathological methods (from the Workshop of European Anthropologists), its use of historical documents, and political economic analysis (akin to the most advanced stage of North American biocultural theory as represented in Goodman and Leatherman 1998). The overarching question of the study is whether the skeletal data would confirm the eighteenth and nineteenth century chronicles pointing to poorer health and quality of life among the enslaved Africans of the Caribbean than among those of the United States. The data generally does confirm, but the detailed analysis is all the more interesting.

Mortality on this cotton plantation was highest among 0-5 and 35-60 year olds, producing a life expectancy at birth of approximately 40 years. This life expectancy, higher than at sugar plantations, was attributed to the less extreme arduousness of cotton

work. The study makes skeletal statural comparisons to those from Caribbean and North American sites, and considers the influences of both genetics and diet. Unusually and especially significant, it includes descriptions of variation in African cultural origins during the course of the trade, including Ewe, Fon, Yoruba, and Akan (Gulf of Guinea), thus giving a cultural texture to bioarchaeology that racial assessment otherwise obscures.

This study's evidence demonstrates the skeletal effects of heavy work, poor housing, and poor nutrition as does the contemporary research on North America. A distinct pattern for Surinam, which the authors effectively generalize to much of the Caribbean during the active slave trade period, is the small proportion of women on Surinam plantations. There were approximately twice the number of skeletons of enslaved men as there were of women at Waterloo, and historical documents report a less extreme but consistently low sex ratio for Surinam as a whole. They also present convincing evidence for syphilis in 27 percent of the population (with vault stellate lesions); eight of whom were diagnosed with the acquired venereal form. "Saber shin" (sword-shaped tibiae associated with syphilis and yaws) was present in six individuals between 5 and 15 years of age who were thought to have contracted late congenital syphilis, a total of 14 or 56 percent of those showing treponemal infection. Skeletal manifestations at this level point to a heavily treponema-infected group, most of which appears to be syphilis. Treponemal diseases in the ABG Ground sample occurred at dramatically lower rates than were found in the Surinam sample and included no examples of stellate lesions.

What stands above most U.S. observations of this colonial disease in blacks is the incorporation of a dynamic historical context by the Surinamese researchers.

Documentation shows that venereal syphilis was introduced to Africans by the frequent rape and abuse of women on slaving ships, and the widespread concubinage of female house servants which spread contagion. Since the sex ratio was so low, as was the woman's control of her own body, the clear inference would be that European and African males would have been sexually active with the same women. A relatively large proportion of males were instrumental to the cotton industry, as with the even more labor intensive sugar industry. Under conditions of slavery, the Caribbean sex ratio contributed to the spread of treponemal disease. Fertility in the Caribbean was noted as being flat or below replacement, similar to what the History Final Report documents for Eighteenth century New York. During the period of intensively active transatlantic trade, Africans could simply be replaced when made to work beyond the physiological requirements of fecundity. Khudabux and his associates show that when the transatlantic trade was outlawed and Surinam needed to foster fertility among the Africans enslaved there, the ravages of syphilis had become so great that it would be a long time before its population could grow, which ironically hindered Surinam's economic development (11).

United States anthropologists were also examining Caribbean bioarchaeological data during the late 1980s and 1990s. The historical archaeological report of Handler and Lange (1978) spurred many subsequent skeletal studies of Newton Plantation in Barbados. Since the archaeological excavation of the skeletons had been less than systematic, skulls predominated the collection and hence dental studies were emphasized. These studies revealed high frequencies of enamel hypoplasia, indicating high nutritional and disease stresses in early childhood (Corruccini et al. 1985). Three individuals with Moon's molars and Hutchinson's incisors were reported, which was extrapolated to a 10

percent syphilis rate for the living plantation population (Jacobi et al. 1992). Studies of trace elements isolated very high lead contents, which, if not the result of contamination, suggested a high intake of rum distilled in leaded pipes (Corruccini et al. 1987a). They also reported dental modification (“tooth mutilation”), high frequencies of tooth root hypercementosis associated with chronic malnutrition and periodic, seasonal rehabilitation (Corruccini et al. 1987b) and high childhood mortality. One of the important generalizable findings of the study involved infant mortality, which these authors found to be about 50 percent of mortality reported in archival records. Less than half this percentage, 16 infant deaths in a total population of 104 skeletons, was observed from infant skeletons, which were disproportionately destroyed by taphonomic processes (Jacobi et al. 1992). These differences of archival and skeletal data for estimates of infant mortality will be important to recall when ABGP comparisons are made between skeletal data on African captives and Trinity Church burial records on the English slave-holding population.

The work of the physical anthropologists discussed earlier is modestly integrated with the more cultural and historical work reported elsewhere in other, specialized articles (e.g., Handler 1997). This common limitation of disciplinary and specialist journals leaves biological assessment in isolation and thus limits biocultural interpretations. Site reports can overcome this segmentation; for example, Armstrong and Fleischman (1993) evaluated four African skeletons from the Seville Plantation, Jamaica, combining paleopathology, history, and archaeological analysis. The elegant simplicity of these house burials, which show cultural continuity between the Asante, plantation laborers and Maroons, and their symbolic goods, accentuates their evocative

individual biological characterizations. The sample is, however, inadequate for statistical analysis.

A good example of decontextualized, descriptive approaches is also found in the Caribbean, the Harney Site Slave Cemetery, on private land in Montserrat. The site was being destroyed by swimming pool construction when archaeologist David Watters obtained the owner's cooperation in salvaging some of the skeletal remains. The site was so much disturbed that artifacts could not be established as grave goods, although a few pottery sherds were found, including imported and "Afro-Montserratian" unglazed wares. Like Newton Plantation and the NYABG site, graves were in west-east/head-foot orientation (Watters and Peterson 1991). The remains of 17 black slaves were discovered during construction (only 10 of which were *in situ* burials) and were sent to the University of Tennessee for study (Mann et al. 1987). There were six adult males (average stature 5'11"), six adult females (5'1"), one probable male and four subadults, but no infant or young child remains.

The study is forensic in that its purpose was to estimate "age, race, sex, and stature" and is highly descriptive. The authors also reported that 17 of 92 teeth exhibited caries, two showed pipe notches, and root hypercementosis and hypoplasia "similar to those described by Corruccini et al. (1982, 1985) in Barbados. Anemia (porotic hyperostosis) was frequent but periostitis (representing infectious disease) was low. Three women had fractures, one of the right fibula (lower leg), one of the left thumb, and one of the right ankle that had become severely infected. Degenerative joint disease was moderate and related mainly to aging. The authors point to a harsh lifestyle with periodic severe malnutrition and common illnesses, leading to early death.

While the size of the sample is small, the lack of local historical context is striking. West Indies shipping data from one historical source is mentioned along with two comparisons with the Newton Plantation skeletal study. The remaining literature is solely forensic or skeletal biological. There is no discussion of the conditions of life on the Bransby Plantation (or of Montserrat as a whole) where the interred had previously lived and worked. The repeated references to their study of the “Negroid traits” of the “Black slaves” (Mann et al. 1987; and Watters”) and Peterson’s recapitulation of Mann et al. in 1991) showed a remarkable similarity to the outmoded typological approach of an earlier era in which “racial” identification substituted for the construction of a human cultural and historical identity (12). Indeed, these same criticisms have been raised regarding initial forensic field studies of the NYAGP.

The bioarchaeology of the African Diaspora in the Americas has today developed several different trajectories. The biocultural and forensic approaches represent polar opposites of a continuum. Our project has made use of the biocultural approaches that emphasize the need for substantial historical background and analysis of the political and economic relations upon which a population’s biological condition depends. The Boasian cultural environmentalist tradition can be found at the root of biocultural anthropology, yet a theory of the impact of social “circumstances” upon the “physical man” is also found a half century prior to Boas’ work in the diasporan writings of Frederic Douglass, followed by Firmin and Cobb. Douglass’ dialectic of social action and biology (e.g., “a man is worked upon by what he works on”) was pit against racial reductionism of the founding fathers of American physical anthropology (Douglass 1854, pp. 304-5). As with the biocultural and historically-grounded bioarchaeological studies

that began to appear in the 1980s, our research project is interested in the dialectical relations of biology, culture, and history. The relationship among these fields tells a human story of the bones of a past community. The ABGP, furthermore, utilizes the kinds of broad interdisciplinary syntheses, diasporic concept, and geographical scope, critique, and public engagement that are consistent with the intellectual traditions of diasporic people. The following chapter describes how these aspects of theory further advance the effort to reveal dynamic, human history while striving to resolve some of the ethical and epistemological dilemmas of non-reductionist research.

Studies that substitute racial identification for culture and pathological assessments for history remain antithetical to these approaches. Their narrowness of scope appears to be consistent with the European Enlightenment's reductionist notions of objectivity in which "parts" (especially biological parts) become important to understand as abstractly separable from the larger 'whole' of their interaction. It is clear nonetheless that these descriptive studies are not without political messages and biased characterizations of the populations under study. Looking back at the development of African Diasporic bioarchaeology, it becomes apparent that a lack of interest in and understanding of the social, cultural, and historical dimensions of "the black" often allowed researchers to be satisfied with very narrow interpretations of bioarchaeological sites. The experiences of the people buried at these sites were dehumanized by the ostensible objectification of racial classification and ahistorical pathology assessments. Opportunities to explore the complex human dimensions of each skeletal biography, to know a population's cultural identity and societal origins, or to examine the local and international political and economic "circumstances" of a now-skeletal population were

lost. Studies that fail to examine such human dimensions of African diasporic skeletal data ultimately create the impression of people without a history.

Notes

[1] I am very thankful for the research assistance of David Harris who, with the help of Tomlinson, obtained copies of all of the literature in African diasporic bioarchaeology for my review. Thanks also to the many helpful colleagues who sent site reports and articles in the less accessible journals.

[2] Blacks took what they could use at Northwestern's African Studies Program, and moved on to develop their own segregated turf. Joseph Harris, as an example, would ultimately extend his scope from Ethiopia to West and Eastern African "Return Movements" (1993). He organized a conference on the diaspora in 1979 (mainly involving historians from the diaspora), which would lead to the seminal volume *Global Dimensions of the African Diaspora* (1993, [1982]). His scholarship helped mold a diasporic focus for the History Department at Howard where he devoted his career.

[3] The most influential work on ancient Egypt among diasporans themselves, is Cheik Anta Diop's *The African Origin of Civilization: Myth or Reality* (1974), first published as an article in *Presence Africaine* in 1955. Anta Diop's evidence interprets Egypt as the racially-black classical center of African culture (also see Holl 1995 on Diop). His work continues to fuel Afrocentric (or Afrocentricity) scholarship popular within the African- American community (Blakey 1995).

[4] Recently, researchers at the University of Capetown have used isotopic analysis to demonstrate dietary change in the African victims of the wreck of the Portuguese slaving brig, Pacquet Real (Cox and Sealy 1997). Morris (1998) examines dental modification in southern Africa from the early Iron Age onward. Perhaps these and other recent Cape Town studies will initiate an emergence of African bioarchaeology apart from the Nile Valley or the paleoanthropology of East African hominids. Human origins studies in Africa, like Nile Valley research, have traditionally sought to understand the origins of non-Africans. Textbooks and museum exhibitions usually shift from Africa (Australopithecines) to Asia (*H. erectus*) to Europe (*H. sapiens*) attesting to the use of Africa (where evolution continues today) as only a precursor of modern Europeans. Historical archaeology on non-colonial whites in Africa is rare. I was unable to identify a single bioarchaeological study in West or Central Africa, the regions most directly related to the origins of the American Diaspora.

[5] An interesting twist is found in the work of Caroline Bond Day, an African American whose first degree was earned at Atlanta University. Afterwards, she attended Radcliffe College where she wrote a masters thesis on mixed race families in her native Georgia (Ross et al. 1999). Earnest Hooton of Harvard, her Radcliffe advisor, introduced Day in the resulting book as a “proximate mulatto.” *In A Study of Some Negro-White Families in the United States* (Day 1932), she takes up a more sociological analysis of racial intermarriage than Hooton had expected. It was an uneven book, without an analysis of the relationship between the extensive biological and sociological observations; physical anthropologists made no use of it and blacks were uncomfortable with it. Ross and associates (1999, p. 45) attribute this in part to the fact that “Hooton’s

goals were different from Day's.... Day wished to stress the sociocultural similarities between a black middle-class population and a white middle-class population, while Hooton wished to stress the biological differences between these two populations...Day attributes differences in lifestyle to racial segregation rather than to any innate biological differences.” Day was also a humanist who devoted much of her energy to dramatic and fictional writing, and did not continue to conduct physical anthropological research.

When the sociologists and anthropologists at Chicago were investigating the social causes of urban violence and crime, Earnest Hooton (1939) conducted a nationwide investigation of the racial and anatomical bases of different types of crime that included a black genetic propensity for rape.

[6] Paleopathology had first focused on individual specimens, not populational structure and dimensions of health. Traumatic lesions and syphilis, trephination (evidence of pre-scientific brain surgery), dental “mutilation” (esthetic modification of the shape of anterior teeth), and deliberate cranial “deformation” (esthetic modification of skull shape) provided exotic and sensational single specimens on which to report (Armelagos et al. 1971). Yet, many of the individual cases reported were probably essential to the development of type specimens for diagnosis that would be needed for later paleoepidemiological work. Reports of individual cases, racial taxonomic studies, and descriptive research with vague ties to evolutionary theory (and which were uninformed by social history) continued throughout the 1970s (Armelagos et al. 1982). By that time a modern statistical paleopathology and bioarchaeology had also become well established. Not until the 1980s, forty years after its application to Native American and other cultural groups, would the paleodemographic or statistical approach come to be

used for the study of people of African descent in the Americas. African-American physical anthropologists would also participate in that work for the first time during the 1980s, bringing their intellectual traditions with them.

[7] Angel did what was probably the only means of addressing the problem of the very low economic status of individuals comprising modern skeletal collections by using donated skeletons and crime victims that included the non-impooverished. Angel's sampling probably came closer to a proper comparison than usual. El-Najjar et al. (1978), for example, studied secular change in dental enamel hypoplasia frequencies (evidence of childhood malnutrition and disease) in U.S. blacks and whites without addressing these biases. The fact that both the perpetrators and victims of violent crime tend to be among the desperate poor, however, means that some class bias likely remained in Angel's study. The extent of class continuity among these temporally differentiated groups should be considered when the modesty of change observed by Angel is considered.

[8] It should be noted that Merrick Posnansky (UCLA), who would introduce Theresa Singleton at the first session ever on historical archaeology at the tenth Congress of the Pan African Association for Prehistory and Related Studies in Harare in 1995, as the "mother of African American archaeology," had been an important mentor to many of the new Africanists and diasporic archaeologists who emerged from UCLA in the 1980s. Professors DeCorse and Agorsá represent Professor Posnansky's influence within the ABGP. Perry, Howson, and Bianchi of our project, furthermore, had studied or worked with Schuyler and others at the forefront of African-American historical archaeology in the Northeast United States.

[9] Although Rathbun at South Carolina also studied with Bass, his work stands out as exceptionally informed by an appreciation for the biohistorical debates. Rathbun and Scurry (1991) also compare the evidence of infection, malnutrition, mortality, and lead content in skeletons of enslaved Africans and slave holders from the Belleview Plantation (1738-1756) near Charleston, South Carolina. These authors indicate that the Africans clearly had harder work and lower status than the English plantation owners. The health of the two samples was similarly very poor, although the owners had twice the exposure to lead as did workers due to food preparation and storage differences.

[10] Rathbun's results on a South Carolina plantation were very similar, as was the mutual finding of significantly higher hypoplasia frequencies in male than female children (Guatelli-Steinberg and Lukacs 1999). The Howard study also first showed that the dietary stresses of weaning were not the primary cause of hypoplasia (see review of Katzenberg et al., 1998) in African Americans, raising questions about this assumption of Rathbun (1987) and Corruccini and coworkers (1984).

[11] The incisiveness of a political economic approach to bioarchaeology was developing well outside of the U.S. It may also be worthy to note that although African Diasporic studies were not undertaken, the Mexican tradition of physical anthropology spurred by Juan Comas has been well ahead of the U.S. in the use of a political economic analysis (Marquez-Morfin, 1998). A recently discovered sugar plantation cemetery for enslaved Africans in Oaxaca (Hacienda de San Nicolas Ayotla) was reported by historian Arturo Mota and anthropologists Abigail Meza and Socorro Baez at the X Coloquio Internacional de Antropología Física, Juan Comas. The site, on which excavation began in 2000, is the first African diasporic bioarchaeological project in Mexico.

[12] The study of the Mt. Pleasant Plains (1850-1900) in Washington, DC, is highly descriptive and shows a similar disregard of known history. Although a census of local migration is discussed and there is an extensive review of old Washington cemeteries, little is said of the people who used them. The 13 African-American skeletons showed apparent good health, which may indicate a more affluent black urban population or a rural existence during the pre- and early industrial period, a time before a rapid decline in dental health and relative physical health. Such interpretations would be very much enhanced by some details about the social and economic situation of the people who used this cemetery. Notably, recent community activity has focused on this site. Once owned by the Colored Benevolent Association, much of the cemetery was purchased by the Smithsonian's National Zoological Park in 1890 and another portion (from which the 13 skeletons originated) was sold to a developer in 1959 who was supposed to have relocated the remains. Recent public objections grew out of the Zoo's attempt to convert part of this land into a dump while claiming that the Smithsonian was not bound by the National Historic Preservation Act (Coates in *Washington City Paper* 3 April 1998).

[13] Since these specialties differ much in theory but little in method, the specialty of "forensics" (which is the more recognizable of the two to the public ear) has often been used as a catch-all for crime-scene and archaeological research involving skeletons, although the term forensic actually refers to the identification of recently disposed (usually no older than 100 years) human remains for the police and courts. The required training for forensics has to do with the identification of individuals, not the analysis of populations that must be understood in a social and historical context. When skeletal remains are first discovered, forensic anthropologists are the proper specialists for

establishing whether the remains are crime-related (therefore falling under their purview) or whether they are older, archaeological remains (requiring demographic and epidemiological analysis as well as knowledge of the specific historical context of the remains under study). The increasingly sloppy usage of a “forensics” expertise in government contracting for bioarchaeological research, beyond first discovery, would tend to reinforce ahistorical interpretations of skeletal populations. These differences are especially important when, in the interest of objectification, race substitutes for the history of African diasporic sites when there is no “Negroid” culture or history. Thus, what this research team considers an overextension in use of forensics consultation instead may simply be a utilitarian and convenient approach for contractors and clients, the frequent use of which occurs not in order to deliberately undermine the construction of African-American history and identity, but rather as the unconscious residual of a “bottom line” orientation, naïve scientism, insensitivity of the potential for historical context, or social distance from black people who might be more inclined to question its application.

Chapter 3

Theory: An Ethical Epistemology of Publicly Engaged Biocultural Research

Michael L. Blakey

The approach taken to the organization and interpretation of data from the African Burial Ground (ABG) involves four main elements. The ways in which these elements have guided the research are discussed this chapter. These theoretic principles can be generalized and extended to a broader range of research projects than our study of the New York African Burial Ground (NYABG).

1. While seeking sociocultural and ideological influences of research, critical theory in the vindicationist vein allows the interpretations to be scrutinized, empowering factual information through scientific and other scholarly research. The fundamental principle rests upon acknowledging that political and ideological implications are intrinsic to science and history, and that choices about these are unavoidable (Douglass 1950 [1854]; Blakey 1996, 1998b). The pervasive incorporation of African diasporic intellectual traditions of this kind into the dialog around New York's ABG opened a special opportunity for applying this long-standing critical view of historical knowledge to a bioarchaeological study. Many brands of "critical theory" have emerged in recent decades including neo-Marxist and postmodernist thought in American and European archaeology. The synthesis of criticism that emerges in this case was referenced previously (Chapter 2) as part of the evolved understandings of the social and political embeddedness of history and anthropology among African diasporans. Yet as

participants in the intellectual development of a broader ‘Western’ world, such critical thought connects with other intellectual traditions whose experience has led to similar insights.

2. Public engagement affords the communities most affected by a research program a key role in the design and use of research results. A respect for pluralism and the ethics of working with groups of people who historically were placed at risk of social and psychological harm recommends an acknowledgement of this community’s right to participate in research decisions. Scholars balance accountability to such communities with responsibility to standards of evidential proof or plausibility that defines the role of scholars. The goal of this collaboration is not simply ethical: Public engagement affords opportunities for advancing knowledge and its societal significance by drawing upon broader societal ideas and interests. The democratization of knowledge involved here is not predicated on the inclusion of random voices, but on democratic pluralism that allows for a critical mass of ideas and interests to be developed for a bioarchaeological site or other research project, predicated on the ethical rights of descendant or culturally affiliated communities to determine their own well-being.

3. Multiple data sets facilitate cross-validation of the plausibility of results. Results may be rejected, accepted, or recombined into newly plausible narratives about the past based on how diverse results of different methods compete or reconfigure as a complex whole. The required multidisciplinary experts engage in a ‘conversation’ that produces interdisciplinary interpretations of the archaeological population or sample. Diverse expertise provides for recognition of a subject matter that might otherwise go

unnoticed in the individuals and communities under study. By revealing multiple dimensions of human subjects, this approach can characterize even skeletal individuals that more nearly resemble the complexities of human experience than are possible in simple, reductionist descriptions.

4. An African diasporic frame of reference for the New York population provides a connection both to an Atlantic world political economy and a transatlantic cultural history that is more reflective of the causal conditions existing throughout the life cycle of members of this eighteenth century community, than was the local Manhattan context of enslavement. The broader diasporic context of their lives also adds to an understanding of the population as more fully human than is afforded by a local context of enslavement. Non-African diasporic research might also circumscribe, differently, the scope of time and space required to examine a sufficiently large political economic system and social history to begin to explain how, what, and why its subject came to be.

Critical Theory

African diasporic intellectuals have, since late slavery, acknowledged the intrinsically political implications of anthropology and history with which they were confronted. Indeed, the historical record of American physical anthropology has continued to demonstrate that the physical anthropologists with the most emphatic interest in “objectivity” have nonetheless participated in the creation of racial and racist ideology (Blakey 1987, 1996; Rankin-Hill and Blakey 1994; Gould 1981). The previous chapter has shown how even highly descriptive studies can represent political ideology. White supremacist notions are supported when representations of blacks are so shallow

and biological as to denude them of human characteristics and motivations. As racialized ‘black slaves,’ African diasporic populations may be removed from culture and history, an objectification that some view as consistent with the ideals of Western science. Here it is both the biological categorization of identity (race) and the omission of history and culture that deny humanity to these historic populations. While this process dehumanizes the black past, Euro-American history is also transformed to one in which Africans are not recognizable as people. They become instead a category of labor, the instruments or “portmanteau organisms” of whites (see Crosby 1986), that are therefore not readily identified with as the subjects of human rights abuses. These aspects, even of description, transform American history.

Douglass asks scholars to simultaneously take sides *and* be fair to the evidence (Douglass 1950 [1854]). This contrasts with differences from Enlightenment notions of objectivity because it is accepted that science and history will always be subjective, influenced by current biases and interests. How can one take a position and be fair to the evidence? One conceptualization of the purpose of historical research that may not violate either of these goals is the assumption that research into the diasporic past is not simply the pursuit of new knowledge. Indeed, diasporic traditions of critical scholarship have assumed that the search is for the re-evaluation of old, politically distorted and conveniently neglected knowledge about black history. The research design of the African Burial Ground (ABG) project asserts that the motivation to correct these distortions and omissions will drive the research effort in part. This understanding of the ideological nature of the constructed history allows our team to scrutinize data more critically than were the research team to assume ownership of special tools for neutral

knowledge. We need be more circumspect and aware of how our interpretations may be used and influenced by societal interests beyond the academy walls. In the tradition of vindicationism and activist scholarship, our criticism holds as an assumed goal the societally useful rectification of a systematically obscured African-American past. The fact that NYABG should not have existed from the standpoint of the basic education of most Americans supports the need for a vindicationist approach. The history of the northern colonies and of New York is characterized as free and largely devoid of blacks. That of course is untrue. The history that denies the presence of blacks and of slavery in places where these actually did most certainly exist is not accidental. Such a history must be deliberately debated. Yet societal interests also influence our alternative interpretations, and they may influence policy and social action. We are tinkering with other people's identities. Who are we as individual scientists to decide how to formulate our research plans relative to such potentially powerful societal effects?

Public Engagement

While we are responsible for our epistemological choices, it is perhaps inappropriate for researchers to make those choices in isolation. The epistemological choices – i.e. the choice of ways of knowing the past by virtue of the selection of research questions, theories and analytical categories – are also the justifiable responsibility of the broader communities whose lives are most affected by the outcome of research. This recognition of the potential for a democratization of knowledge merges epistemological concerns with ethical ones. The community with which we work – living descendants or culturally-affiliated groups – has an ethical right to be protected from harm resulting from the conduct of research (the American Anthropological Association's Statement on

Professional Responsibility and Ethics, World Archaeological Congress's Ethical Statement, and the new ethical principle of the American Association of Physical Anthropologists, which largely recapitulates the former, are key examples of this ethical standard). Community members have a stake in how research is conducted if it might impact them negatively or positively. The National Historic Preservation Act allows the public a say in whether research will be done at all and NAGPRA legislation gives Federally-recognized Native Americans and Pacific Islanders rights to determine the disposition of their ancestral remains and sacred objects.

Many archaeologists and physical anthropologists have resisted these ethical and legal obligations, arguing that the autonomous authority of researchers needs to be protected for the sake of objectivity and the proper, expert stewardship of knowledge about our past. That position is based on assumptions that are inconsistent with our critical theoretical observations of intrinsic cultural embeddedness of science that have informed the activist scholarship in the diaspora. If science is subjective to social interests, it seems fair, at least, in the American cultural ethos, to democratize the choice of those interests that scientists will pursue. Since the people most affected are also to be protected, it is least patronizing for anthropologists to enter into a research relationship with descendant communities by which those communities protect themselves by participating in the decisions regarding research design. Indeed, a "publicly-engaged" anthropology of this kind has been proposed by a panel of leading anthropologists who have linked the practice to American values of democratic participation and pluralism (Forman 1994 and Blakey et al. in Forman 1994). Useful and exciting paths of inquiry, as well as elevated scrutiny of evidential proof, are revealed when naïve objectivity is

replaced by ethics. It is very interesting to consider that the idea of objective methods capable of revealing universal truths may have served to obscure the need for ethics of accountability to non-scientific considerations in the pursuit of knowledge.

Our project has conceived of two types of clients, the descendant community most affected by our research (the ethical client) and the GSA that funds the research (the business client). While both clients have rights that should be protected, the ethical requirements of the field privilege the voices of descendants. Descendants have the right to refuse research entirely, and the researcher's obligation is to share what is known about the potential value of bioarchaeological studies. Our project received permission to present a draft research design to African Americans and others interested in the site. Our purpose was to elicit comment, criticism, new ideas, and questions that the descendant community was most interested in having answers. The result of this public vetting process is, we believe, a stronger research design with more interesting questions than would have likely come from researchers alone. A sense of community empowerment, in contrast to the pre-existing sense of desecration, was fostered by our collaboration. Permission to conduct research according to the resulting design was granted by both clients. Public pressure in support of a more comprehensive research scope than usually afforded such projects resulted from the fact that research questions interested them and that they claimed some ownership of the project. Thus, research directions, an epistemological concern, were fostered by public involvement, an ethical concern. The queries produced by the engagement process were condensed to four major research topics:

1. The cultural background and origins of the population.
2. The cultural and biological transformations from African to African-American identities.
3. The quality of life brought about by enslavement in the Americas.
4. The modes of resistance to slavery.

In applying this approach to an ethical epistemology, experience has shown that social conflict is an inherent possibility of public engagement, as are bonds of common meaning and interest between scholars and the public that would not otherwise have been possible. In 1993, while vetting the Research Design in a Harlem State Government auditorium the panel of researchers was confronted by some African Americans who objected to our references to slavery in Africa, insisting that slavery had never existed there. We were able to convey familiarity with what we considered to be a reflection of the concern of some African-Americans that the Euro-American community's frequent references to African slavery were often meant to suggest that Africans were responsible for the slave trade. That apologetic spin abdicates the responsibility of Europeans and Euro-Americans (the 'demand' side of the trade) for American slavery. We were also sensitive to the frequent misconception that those brought to the Americas were "slaves" in Africa, rather than free people who had been captured and "enslaved." With recognition of this understanding and of differences and similarities between chattel and African household slavery, our requirement as scholars was, nonetheless, to indicate that we would refer to slavery in Africa because of the material evidence for its existence there. It was the community's right to decide whether or not it would engage scholars to conduct research on the ABG or to have only religious practitioners or some other

treatment. If we were to be involved, it was to be as scholars and that meant standing on evidence. It is significant too that the diasporic scholars on the panel knew the critique that had informed the community concern about African slavery and understood it to be more than a matter of emotional sensitivity. They responded that we would attempt to maintain an awareness of the misuses of the fact of slavery in Africa in the course of our work, which we did.

The researchers were strongly urged to refer to the Africans of colonial New York as “Africans” or “enslaved Africans,” rather than slaves. This recommendation upon deliberation and discussion seemed cogent and not inconsistent with material facts. The critical consideration of the community representatives was that “slave” was the objectified role that Europeans and American whites had sought to impose. The Africans themselves, while clearly subject in large part to the conditions of the role of “slave” had often both previous experience and self concepts that were as complex human beings “who had their own culture before they came here” as community activist and artist Adunni Tabasi puts it (New York Beacon, August 23, 1995), and who resisted slavery psychologically, politically, and militarily according to material facts. Thus, we agreed that we represented the perspectives of slaveholders by using the dehumanizing definition of the people we were to study as slaves, when “enslaved African” reasonably emphasized the deliberate imposition of a condition upon a people with a culture. Similarly, we accepted, as did the state and Federal agencies, the naming of the “Negroes Burying Ground” the African Burial Ground for similar reasons to the use of “enslaved Africans.” Sherrill Wilson found, in the course of background research for the National Historic Landmarks designation of the site, that Africans named their institutions

“African” in New York City as soon as they obtained the freedom to put such nomenclature on record in the early nineteenth century.

This case exemplifies the value of the process of public engagement and the deliberation, potential conflict, and reasonable compromise that was often involved in this process. The purpose was to find a synthesis of scholarship and community interests, if a synthesis could be achieved. Such deliberations rely upon trust, and that is as well established by a demonstration of the integrity of scholarship as it is by the researcher’s recognition of the community’s ultimate right to determine the disposition of its ancestral remains.

Choice of language was one of the most emphatic contributions of the community that did not seem as comfortable with questioning some of the methodological techniques that were under consideration for study of the remains from the ABG. Invasive methods were discussed and accepted as required to answer the important question of origins that has long been keenly important to African Americans. Family roots and branches had been deliberately severed by the economic expediencies and psychological control methods of slavery. Another community emphasis of importance to the course of the research project was the insistence on including African and Caribbean research in our geographical and cultural scope and on extending the temporal parameters back to the Dutch period when, despite the lack of historical reference, the cemetery might have been used for the burial of Africans and their descendents. These ideas helped to define the project’s research questions and choice of expertise that expanded to an African and diasporic scope, which has proved to be essential for recognizing the specific artifactual, genetic, and epidemiological effects of the cemetery population throughout its history and

at different points in the life cycles of the persons buried there. Furthermore, our team's recognition of African suppliers for a Euro-American driven transatlantic trade in human captives positioned us properly to receive a senior delegation of the Ghanaian National House of Chiefs. They acknowledged regretfully the involvement of some past African leaders in this practice.

Especially during the earlier stages of the research, there were attempts to contain or reduce the project by limiting project and community input into aspects such as the memorialization plans, the interpretive center, and others. Whenever the project was burdened by apparently intractable bureaucratic procedures, the leadership returned to the public forum and was brought as community advisors to local, state and national legislators to make these efforts transparent to the public. Congressmen and community members were able to reiterate their support by letter and verbally to the GSA, which over time became more responsive and supportive of the project, but ongoing challenges to sustained and smooth operations still occurred at times. Although some proposed aspects of the Research Design (Howard University and John Milner Associates 1993) were not funded, the integrity of the researchers' relationship to the ethical client -- the descendant community -- was maintained by standing steadfast with the community's insistence that GSA carry through with its commitments. The GSA was not allowed to disregard its obligations or promises to the black community. After its building was completed, the agency approved for funding additional aspects of the research design and engaged in interactions with the community related to memorialization, reinterment, and interpretation, among others. This project's leadership sought always to give GSA its best and honest advice.

Were this project not linked to community interests, there might have been fewer conflicts with the federal agency. On the other hand, community engagement defined much of the significance of the project that would represent descendant community empowerment. Harrington (1993) maintains that part of that empowerment was shown by the community's resolve and effective opposition to desecration by the insensitive leadership of a large federal agency. On the other hand, the project's ability to withstand and negotiate prevailed as a result of having a strong base of support in the general public and among concerned legislators. Funding, even under these conditions, was adequate for the broad scope of work, which is described in this Skeletal Biology Report and the project's two companion reports.

Finally, the project was designed to utilize a biocultural and biohistorical approach and rejected race estimation in favor of culturally salient categories of ethnic origin using DNA, craniometry, archaeological artifacts and features, as well as, the available historical record. We had no need to reinforce the concept of race through our research, especially when that concept obscures the cultural and historical identity of those who are made subject to its classification. Moreover, new molecular technologies and specialists in African mortuary data could put us on the trail of ethnic groups with discernable histories.

Over 50 physical anthropologists wrote to the GSA, generally supporting the forensic approach to racing (Cooke 1993; Epperson, 1996). Indeed, a number of these letters and comments suggested that the use of DNA, chemistry, and cultural traits such as dental modification could be of no value in determining origins. However, the backing of the descendant community that was far more interested in social and cultural history

than racial classification enabled the project to maintain its programmatic thrust despite the opinions expressed by these physical anthropologists.

The essential point here is that the questions and approaches that have driven the research of the NYABGP were produced by a public process of empowerment that involved distinct supporters and detractors. What we have been able to accomplish for present evaluation and future development has been the result of protracted struggle with those researchers who customarily have expected to control this kind of contracted study in order to create a research enterprise that is not repugnant to the American-American community. It is also a project of unusual epistemological complexity. As a result, the project has had an impact upon both the scientific community and public discussions of human rights and reparations for slavery (see La Roche and Blakey 1997; Blakey 1997; Blakey 1998; Blakey 2001). Six documentary films and frequent and lengthy textbook references to the New York African Burial Ground Project (Thomas, 1998; Pearson, 1999, and others) also suggest that the project has raised interesting issues for a broad range of people.

Multiple Data Sets

Multidisciplinary expertise was repeatedly shown to be essential in our attempts to answer the project's major questions regarding the origins, transformations, quality of life, and modes of resistance. Examining a question such as the origin of the population with different sets of data such as genetics, anthropometry, material culture, history, and chemistry was valuable.

1. Cross-validating the plausibility of findings on the part of a particular specialized method or set of data is provided in the form of complementary or conflicting

results from an alternative data set. Contracting results were at least as useful as complementary data because these would raise new questions and possibilities about interpretation or the need for methodological development. Biological data (such as molecular genetics) have often been privileged over cultural and historical data. We found genetics data, read in isolation of other information, to lead to erroneous conclusions relative to more verifiably accurate cultural and historical evidence. We do not privilege the biological data, but benefited from the discussion among the differing results that led us to mutually plausible conclusions. Metaphorically, one voice allowed the floor with impunity can easily make false representations without there being any means of evaluation or accountability. Where there are several voices in a dialogue about facts, the standards of plausibility are elevated by the accountability that the facts generated by each method have to one another. This sort of “discussion” among different data sets become a means, if not of objectivity, of raising standards of plausibility and of fostering a dialectical process by which new research directions would emerge.

2. Multidisciplinary research allows us to recognize more diverse dimensions of the individual biographies and community histories than any one discipline could allow us to “see” in the data. By assessing layers of origins data, for example, we construct the population in terms of its demography, pathology, genetics, cultural influences on burial practices, environmental exposures in teeth, religious history, and art that allow the construction of a more complexly human identity at the site. A fraction of these disciplines would have produced only a portion of these richer human qualities we worked to understand because observations are largely limited to the specialized knowledge and research tools required to make them.

3. This disciplinary breadth, inclusive of biology, culture, and history makes possible the kind of political economic analysis in which we are interested as biocultural anthropologists. The biological data are interpreted in relation to the population's social, political, and economic history. Yet some studies, such as those found in Chapter 5, will rely on evolutionary theory while remaining historical in its attempt to discover cultural origins with biological evidence. There needs to be a "tool kit" of theories for purposes of different research questions. The break with tradition here is that such an approach is not in search of a unifying theory; that physical anthropology and human evolution are not synonymous.

Diasporic Scope

The descendant community had been forceful in its insistence upon our examination of the African backgrounds for the New York population. Their idea was that these were people with a culture and history that preceded their enslavement and which continued to influence them even in captivity. We found the African and Caribbean connections important for understanding the site in many ways. We therefore engaged archaeologists, historians, and biologists with expertise and experience in research in all three areas. Similar to the value of multidisciplinary resources of the project, the diasporic scope of expertise allowed us to find meaningful evidence where narrower expertise could not have "seen" it. The use of quartz crystals as funerary objects required an African archaeological background, because Americanist archaeologists might have assigned them no meaning (see Perry 1999); the heart-shaped symbol believed to be of Akan origin and meaning (see Ansa 1995) was assumed to have a European, Christian meaning in the absence of anyone who could recognize an Akan

adinkra symbol. Thus the geographical and cultural connections to the site are enlarged by the diasporic scope of the researchers.

The previous chapter showed how bioarchaeological projects are often limited to very localized special and temporal contexts of interpretation. Were this project to have limited its scope of interpretation to New York City's history (or to the cemetery itself), the ABG would have revealed a colonial New York population understood for the immediate conditions of its member's enslavement, or less. A larger international context reveals a cultural background for captives and their descendants, an ebb and flow of migration between different environments and social conditions, shifting demographic structures related to a hemispheric economy, and the interactions of people and environments that changed over the course of the life cycle to impact their biology in multiple unhealthy ways. By understanding these African captives as people from societies of their own and who were thrust into enslavement in an alien environment, perhaps, their human experience can be more readily identified. This, at least, was the expressed goal in meetings of descendant community members that informed the Research Design. The desire to reach back and critically examine that experience is motivated by the scope of interests of an African diaspora "concept" that has traditionally included a vindicationist approach to black history that stands against Euro-centric historical apologetics.

A variety of other, specific theories (or explanations relating observations to systems that can be generalized within which they have meaningful implications for us) have been applied in explaining particular phenomena observed at the ABG. The above approaches, however, form the most general framework of our analyses. The meta-

theoretical approach described above comprises a process for generating the questions we ask, for assessing the reasons why we are asking those questions, the choices of theory with which the information is organized to answer those questions. They are also perhaps the most unique to our situation in which these approaches emerged as special opportunities to resolve problems and contradictions met with at the site. These are, nonetheless, procedures that can be generalized for bioarchaeological work in many kinds of situations, not limited to this site or to African diasporic bioarchaeology.

The three separate disciplinary reports for the ABGP modestly represent the potential for interdisciplinary integration of data. The three Sankofa Conferences that involved 24 of the project's multidisciplinary specialists (1995, 1998, and 2002), and the exchanges of ideas that have proceeded over the intervening years in a decade of research have influenced substantively most of the biological analyses of this report. Moreover, this report as well as the *History Final Report* and the forthcoming *Archaeology Final Report* are meant as the last stage prior to synthesis of these into an *Integrated Report*, which we look forward to developing in the future. That latter report is projected to be less technical and more accessible to the general public.

The *Skeletal Biology Final Report*, therefore, is one major achievement in an ongoing research program that the researchers expect to continue beyond the current contract with the GSA. It nonetheless represents the results of an exhaustive skeletal recordation on 419 human skeletons from the largest and oldest colonial archaeological population in the Americas that has been studied to date. The extensive methods of cleaning, inventorying, reconstructing, data gathering, and documentation for this and

future studies – an enormous amount of careful work of more than 100 professionals, technicians, and students – are reported in the following chapter.

CHAPTER 4

Laboratory Organization, Methods, and Processes

M. L. Blakey, M. E. Mack, K. Shujaa and R. Watkins

Laboratory Organization

This chapter describes the organization of skeletal recordation in the laboratory. This work requires specialized personnel, task teams, and processes that convert fragile fragments of soil-encased bone into skeletal elements that reveal accurate anatomical structure and observable effects of physiological processes that can be assessed for genetic, demographic, and pathologic information. That information is then coded and entered into a computer database where all information on each individual can be tracked and statistical data on sample groups of skeletons can be manipulated. Skeletal recordation was completed in 1999 resulting in an estimated 250,000 observations on the 419 human remains. Photographic and radiographic documentation and sampling of bone and dental tissue were also undertaken for future research. A collection containing more than 55,000 photographs (mainly slides and digitized images) and over 2,000 x-ray radiographs, and a small sample of cranial CAT scans has been assembled.

Skeletal recordation (processing and data collection) was conducted in The W. Montague Cobb Biological Anthropology Laboratory of Howard University. The Cobb Laboratory consists of approximately 3,000 square feet of space. Three laboratory rooms, a storage room and hallway, and two offices comprise the laboratory, which is equipped with electronic security and environmental controls throughout. During the study, room

Facilities and Environment



Figure 4.1: Work space in the main “blue” laboratory

temperature was maintained as 70-72° F and 50% relative humidity. Three free-standing back-up dehumidifiers were used during summer rains, when humidity briefly exceeded the desired level. Humidity was monitored by hygrometers in each laboratory room, and a hand-held hygrometer was used to monitor the interior environment of skeletal storage boxes. Only once was there an observed distortion of bone due to humidity, involving slight expansion of a postmortem humeral fracture that had been out on an examination table during a roof leak. The airtight interior steel cabinetry in which remains were stored further limited the effects of environmental fluctuations in bone.

Exterminators eliminated pests annually. Moth crystals are regularly used inside cabinets of the laboratory’s permanent anatomical collection (The Cobb Human Skeletal Collection) but were not required of the African Burial Ground (ABG) remains. No evidence of insect or mammal infestation was observed in this collection during skeletal recordation.

Fungi were observed in 25 skeletons, and two additional skeletons were isolated with the 25 infested cases because of their close proximity to one of them. Procedures for handling these cases will be discussed in Chapter 4.0. All skeletons were sampled for fungus identification and stored in airtight interior steel cabinets labeled with OSHA-required biohazard signs.

The laboratory is equipped with benches, tables, stools, clean bench, fume hood, proper lighting, sinks, refrigerators, photography equipment, small x-ray machine, computers, mechanical and digital calipers, microscope, and other necessary research tools.

Personnel

The following Cobb Laboratory personnel were involved in skeletal recordation and related administration of the African Burial Ground Project (ABGP).

Project and Scientific Director:

The Scientific Director had responsibility for all project administration and scientific design, research, and reporting as well as public and client relations. The Scientific Director organized, controlled quality, and directed all research activities and wrote all research designs, cost proposals, and reports with the assistance of senior personnel. This position coordinated all components of research within and apart from The Cobb Laboratory. A Ph.D., experience, and scholarly productivity in bioarchaeological research were requirements for this position.

Laboratory Director/Osteologist:

The Laboratory Director was responsible for laboratory management including relevant organization, technician training and quality control, supervision, and

maintaining adequate laboratory supplies. The Director was also responsible for dental data collection and contributed to research analysis, reporting, and public and client relations. The Director managed the flow of information and materials exchange with other laboratories; scheduled and conducted public tours, and reported to the Scientific Director. An M.A. and experience in bioarchaeology were requirements for this position.

Office Manager/Administrative Assistant:

The Office Manager had oversight of office management including the laboratory's payroll, bookkeeping, purchasing, travel arrangements, communications, records keeping, and assisted the Scientific Director in all administrative tasks of the project while supervising clerical staff. A B.A. in management and clerical experience were requirements for this position.

Osteologist:

The Osteologist conducted assessments of bone pathology with the Scientific Director's supervision and assisted the Laboratory Director and Scientific Director in technician training and quality control. The Osteologist supervised assisting technicians, advised photography as needed, and contributed to analysis and reporting. An M.A. and experience in paleopathology were requirements for this position.

Osteological Technicians (OT), four simultaneous positions:

Osteological Technicians conducted age and sex assessments and anthropometric measurements, supervised processing staff and quality control at their work stations, supervised or conducted photography and radiology as needed, assisted curation, and

conducted public tours. The most experienced Osteological Technicians conducted bone pathology and dental assessments under supervision of the Scientific Director and Laboratory Director and contributed to analysis and reporting. Osteological Technician Assistants reported to the Lab Director (except those persons conducting bone pathology assessments), who also reported to the Scientific Director. A B.A. in anthropology and experience in skeletal biology were requirements for these positions.

Osteological Technician Assistants (OTA), up to 12 simultaneous positions:

Osteological Technician Assistants assisted in all technical tasks of recordation, especially processing which includes pedestal reduction, cleaning and reconstruction of skeletal elements, photography and its organization, inventory radiology, and public tours. The most advanced OTAs were also involved in supervised anthropometric measurement, dental casting, sectioning and sampling of bone, and curation. OTAs mainly reported to the OTs, and were assigned to the Laboratory Director and Osteologist as needed. OTAs were graduate and undergraduate students of anthropology, anatomy, human development, history and those fields, who had completed a course in human osteology and had specialized training in recordation techniques in the Laboratory.

Medical Photographer:

The Medical Photographer undertook photographic documentation of skeletal observations and inventory, manages the photography laboratory, and assisted in purchasing photographic equipment and supplies, and kept the log of photographs. This position reported to the Laboratory Director and was advised by Osteologists and OTs.

The Medical Photographers were required to have experience in skeletal recordation photography or a related subject of medical photography.

Data Systems Manager:

The Data Systems Manager was responsible for maintaining the relational and statistical data bases, computer hardware and software, and produced statistical analyses for the Scientific Director. This position reported directly to the Scientific Director and required an individual with at least a B.A. and experience in database management.



Figure 4.2: Data Systems Manager Douglas Fuller, and Project Director Michael Blakey discuss organization of the database

Botanist, two positions:

The Project Botanists sampled and identified fungi (molds), determine their genera, advised the Scientific Director regarding any potential biohazards, and recommended biocides and safety procedures. These Botanists reported to a Senior Botanist with a Ph.D. Enrollment in a doctoral program in botany was a requirement for this position.

Conservators, two positions, as needed:

Conservators were contracted as consultants to work as needed to stabilize artifacts found during skeletal processing. They reported to the Scientific Director.

Consultants and Specialists, several positions:

Consultant positions were filled by specialists in bone and dental chemistry, DNA, and histology, and the Associate Director for Biological Anthropology and other senior researchers. These consultants, in general, held the Ph.D. and were recognized nationally or internationally as leading scholars in their areas of specialization.

Secretary:

The Secretary reported to the Office Manager, was responsible for communications, and assisted with all clerical work.

The above positions comprise the technical, management, and administrative staff of the Cobb Laboratory. All laboratory staff collectively contributed to the interdependent processes required for all data collection and analysis. Weekly meetings and periodic training sessions facilitated staff development and the integration of laboratory tasks. Respect for specialized skills and responsibility for productivity was part of a laboratory

philosophy that also emphasized training. Each member of the team was expected to teach others how to perform the member's work (to make that individual "redundant") as a means of continual improvement of the laboratories resources and opportunities for individuals.



Figure 4.3: Cobb Laboratory staff

Burial Processing and Methodology

Cleaning and Reconstruction

During burial processing, osteological technicians (OTs) and osteological technician assistants (OTAs) wore latex (or non-allergenic) examination gloves, dust masks and laboratory coats as a barrier to contagion and the contamination of bones with the researcher's DNA. All sachets (acid-free tissue packets with bones) were wrapped for shipment and storage.



Figure 4.4: Safety while unwrapping burials

In addition to wearing the protective clothing mentioned above, respirators replaced dust masks when sachets were opened for the first time, because of the unknown nature of fungi that had infested some of these remains in New York. If no molds appeared to be present, the technicians proceeded with cleaning, reconstruction, and data collection. If molds did appear to have infested the remains, the entire burial was immediately isolated in airtight cabinets until Project Botanists could sample these molds for identification. After the application of ethanol as a biocide, some fungal infested remains would later be processed under conditions specified by the University Biohazards Committee guidelines. Two remains infested with nonhazardous levels of the harmful and enigmatic fungus, *Blastomyces* (and three individuals located near to them which shared the same cabinet) were to remain quarantined.



Figure 4.5: OTA Joseph Jones involved in cleaning and reconstruction.

Each skeleton was cleaned of the surrounding soil matrix in order to observe bone surfaces for information. In many instances the remains were encased in soil blocks or “pedestals” which had to be reduced by excavating away as much of the soil as was practical in order to remove or reveal bones. The Scientific Director Lab Director or Osteologist advised the OTs and OTAs on the extent of possible reconstruction, efficient techniques for cleaning and reconstruction under different circumstances, and made decisions about immediate photography or data collection to prevent data loss when bones seemed in jeopardy of collapse. It was often not feasible to spend many hours or days completely reducing soil pedestals or reconstructing tiny fragments of bone when they could ultimately reveal little information due to very poor preservation. Frequently the block of soil matrix was all that prevented a bone from disintegrating, making it advisable to expose as much informative bone as possible while keeping it partly encased and maximally intact. Photographs were regularly taken before and after the pedestal reduction process for full documentation, since some friable bones and important

observations will inevitably disintegrate when removed from soil that reinforced their integrity. The vast majority of skeletal elements, however, were removed from their matrices and observed complete.

Cleaning was accomplished with small dental tools, brushes, and cotton applicators used to apply a 75 percent ethanol/ 25 percent water solution in order to soften soil that had become dehydrated and hardened in New York. Measures were taken to minimize the application of ethanol to the bone itself, however, in order to limit destruction of DNA-bearing proteins. Bones earmarked to be sectioned were flagged with colored tape to be sampled for later genetic, histological, radiographic, and chemical analyses. When archeological artifacts such as floral and faunal remains, beads, shroud pins or coffin nails were recovered, they were stabilized by conservators, recorded on individual artifact location maps for each skeleton and sent to the archaeological laboratory for curation and analysis.

Whenever practical, fragmented skeletal elements were reconstructed using polyvinyl acetate (PVA) as an adhesive so that anthropological measurements, observations, and assessments would be maximized. The application of PVA was also minimal. Bone surfaces were not coated in order to reduce contamination of chemical studies and to leave the bone surface un-obscured. After the skeletal elements of an individual were cleaned and mended, initial data collection (inventory, age and sex estimation) was performed by the Osteological Technician responsible for that burial with the advisement of the Laboratory Director and/or the Osteologist.

Data Collection and Skeletal Assessment

An inventory of all complete and fragmented skeletal elements was conducted for each burial to ascertain the relative state of preservation for each individual and the number of skeletal elements and their aspects that could be used as “populations” for group comparative purposes. For example, a research question concerning the knee joint might refer to the number of arthritic distal anterior femora (the upper part of the knee joint) as a percentage of all observable distal anterior femora, not as a percentage of skeletons from the Burial Ground. Therefore, keeping careful records of the preservation status of every significant bone by aspect (proximal third, middle third, <25% present, etc.) provides an important statistical control. The inventory was conducted according to Standards for Data Collection from Human Remains (Buikstra and Ubelaker, 1994) hereafter referred to as the Standards.

A skeletal inventory was taken of every observable bone and tooth with the following preservation scores:

blank = missing data
1= >75% present = complete
2= 25% - 75% present partial
3= <25% present = poor

The preservation of vertebra bodies and neural arches were recorded separately. Long bones were given separate scores for proximal end, proximal third, middle third, distal third, and distal end. An accounting of the preservation status of this archaeological sample is provided as Appendix C.

An anthropometric record was compiled for each measurable cranial dimension and postcranial element whose measurement bore potentially useful information.

Measurements were not taken if damage, incomplete preservation, warpage, or limited reconstruction made accurate measurement improbable. Occasionally, measurements were approximated for bone elements with minimal alteration of size (as in some cases in which exfoliated cortical bone produces a 1-2 mm difference in length), and in which we estimate where the landmark had been and the degree of error involved. Any approximated measurements were specifically noted.



Figure 4.6: Allison Davis and Keisha Hurst take anthropometric measurements

Measurements were taken bilaterally and in the metric system, using the following instruments as appropriate: a) digital sliding caliper; b) spreading caliper, c) osteometric board, d) measuring tape, and e) mandibulometer.

Separate forms were used to record measurements for immature (<20 years) and adult remains. All measurements for “infants” (fetal-3 years) were taken according to standards recommended for immature materials. Postcranial measurements for children

(3-12 years) and for adolescents (12-20 years) were recorded according to the same standards; however, when sufficiently complete, cranial and mandibular measurements were taken according to the more extensive adult anthropometric standards. Adolescent bone elements with fused epiphyses were considered adult and measured as such.

Quality control was maintained by recording two sets of measurements for each skeleton, taken by different technicians or on different dates. The two sets of measurements were then compared in order to assess the degree of difference between them. When the degree of difference was greater than five percent of the average value of two measurements, then a third measurement was taken and compared to the previous two. This process continued until two measurements remained with a degree of difference of less than five percent. These two measurements were then averaged for analytical purposes. The five percent rule was applied as an alert to serious error. In fact, acceptable measurements were always much closer together than 5 percent of the size of the bone. We are confident of the accuracy of the final mean measurement used in our studies. The last two sets of measurements taken are available for examination as part of the permanent record of the project.

Sex Determination

Determination of sex was based on observed skeletal variations in shape and size known to differ between males and females. Each of ten cranial, seven pelvic, and seven other postcranial characteristics were assigned a score on a scale of one to five, with one demonstrating typical female configuration, five marking male morphology, and three indeterminate. In most cases, a sex determination was achieved by finding the average score for all attributes. Commonly, however, skeletons with average scores denoting one

sex also exhibited some characteristics indicative of the other sex. In such cases, greater weight was given to the most reliable sex determinants (elaborated below). When poor preservation eliminated all reliable sex indicators, sex was estimated as undetermined. Rationales for sex determination were recorded in the section reserved for comments in addition to the 24 item score sheet. Age was always a consideration when estimating sex, as many older skeletons may undergo degenerative changes, such as bone resorption or remodeling, which, if not accounted for, can complicate a sex assessment and sex assessment in children is questionable categorically. We consider our sex assessments to be reliable for individuals who were 15-19 years of age and older. While there are currently no widely accepted standards for determining sex in younger juveniles, a specialized study was conducted using an experimental approach that will be included in a subsequent chapter of this report.

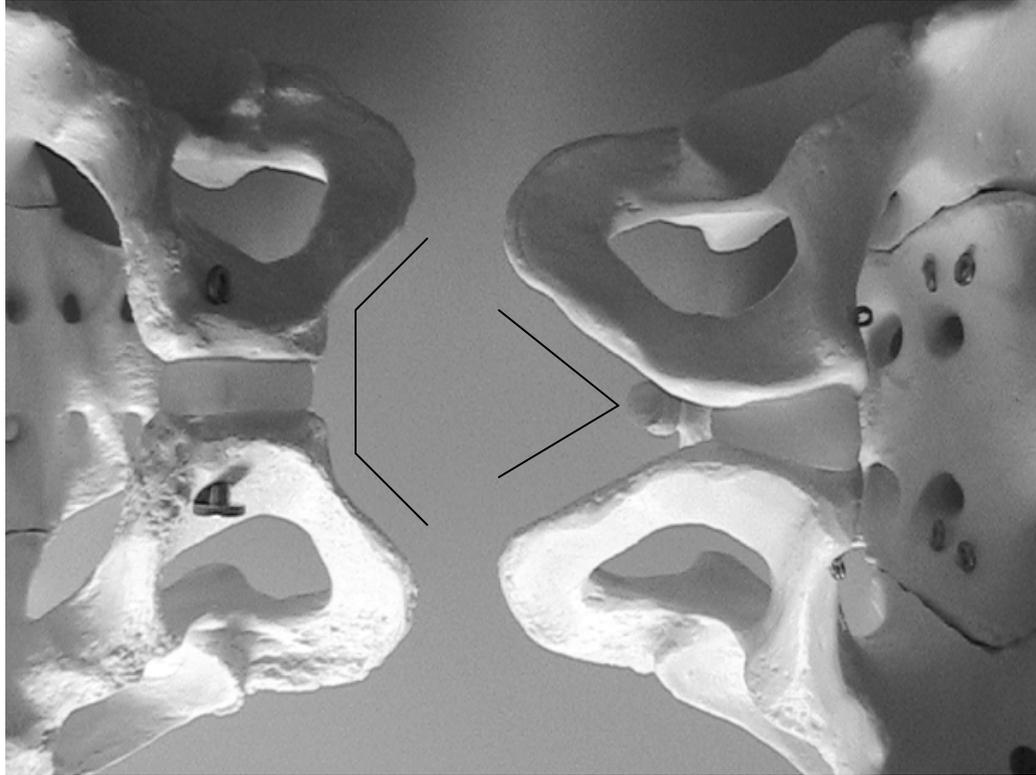


Figure 4.7: Comparative male and female pelvic shapes. Note the wide subpubic angle in the female (left) in relation to the male (right)

When sufficiently complete, the pelvis is the most reliable indicator of sex. The subpubic angle, the ventral arc (Phenice 1969), and the presence or absence of the preauricular sulcus is particularly useful. Each trait was evaluated independently according to standards delineated by Phenice (1969) and Sutherland and Suchey (1991) and others. Older adolescent individuals whose pelvic bones showed qualitatively distinct female characteristics were generally assessed as female. An adolescent pelvis exhibiting-male patterns, however, was considered ambiguous, as this could have also represented a female skeleton that had not yet reached full maturity (Buikstra and Ubelaker 1994:16). Considerable additional data would be needed to establish the sex of such a person.

Though not so reliable as the os coxae, estimation of age based on cranial morphology was also very useful for sex determination, especially in cases involving “typically” robust or gracile features. Each trait was scored according to standards described by Bass (1971, 1987), Krogman (1955, 1962), and Buikstra and Ubelaker (1994). For adolescents, in the absence of convincing pelvic indicators, a robust cranium was interpreted as an indication of overall maleness, while a gracile skull often resulted in an ambiguous overall diagnosis. Older age was also a consideration when determining how much influence to assign to cranial features in an overall sex assessment, as many adult skulls of either sex may exhibit a more masculine morphology with increasing age (Meindl et al., 1985). Additionally, with tooth loss, the mandible may undergo remodeling, which can also complicate sex determination.



Figure 4.8: Geriatric left mandible for which long-standing toothlessness has obliterated most evidence of dental ‘sockets’ (Burial 209)

Post-cranial dimensions proved highly variable with this sample. Measurements were taken and applied to the guidelines for sex determination in Dittrick (1979) and

Thieme (1957). Many of the measurements conflicted with more accurate indicators such as pelvic morphology; therefore, they were often of less value in sex estimation. Except in cases of denoting “typical” maleness/ femaleness, postcranial measurements (length of long bones, for example) were usually assigned less weight in sex determination than reproductive anatomy (pelvic characteristics). Given the robusticity of many of the ABG females, sexual characteristics that were not heavily influenced by biomechanical factors were favored over those that were most influenced by muscularity.

Age Determination

Estimation of age-at death involves the observation of numerous indicators of growth, development, and age-related degenerative changes. The desired “composite age” for each individual consists of an estimated age-range and mean age (mean of age range) obtained by an evaluating and weighing the age estimates derived from several different aging criteria (such as epiphyseal closure and dental attrition). The estimates of each criterion are also usually based upon age scores or estimates from a variety of bones or teeth. Although efforts were made to provide a mean age and age range for each skeleton assessed, advanced age and/or poor preservation sometimes rendered this impossible. In such cases, only a minimal age was given (e.g. $x > 55$).

When it was impossible even to calculate a minimal age, an attempt was made to assign the skeleton to one of the age classes listed in *Standards for Data Collection from Human Remains* that include perinatal, infant, child, juvenile, adolescent, or adult. We were successful in estimating reliable upper and lower age ranges on three quarters of the skeletal population without resorting to these general categories. The demographic analyses of the project rely solely upon this large group of accurately aged individuals.

Rationales for ages were provided in the section reserved for comments on the Age Determination form, and photographs were taken as supporting evidence for these estimates.



Figure 4.9: Cranium of infant 1-2 years of age (Burial 252)



Figure 4.10: Child 5-7 years of age (Burial 39)



Figure 4.11: Elderly woman 50 - 60 years of age (Burial 40)

For immature remains, composite age was determined by evaluating dental development, epiphyseal and primary ossification center fusion/union, and/or long bone diaphyseal length. When possible, tympanic plate development was also evaluated for infants. Because of its high variability, long bone diaphyseal length (and iliac width) was used as a primary age indicator only when no other elements were sufficiently preserved. Dental development, being little influenced by environmental factors, is the most accurate indicator of subadult age. Dental development was evaluated according to sequences of tooth formation and eruption compiled by Ubelaker (1989; 1986), Gustafson and Koch (1974), and Moorrees, Fanning, and Hunt (1963a, 1963b). Up to 75 different developmental indicators were evaluated in estimates of the ages of immature individuals. Of these indicators, 32 are observations of epiphyseal union and primary centers of ossification, each of which was scored in 3 stages that include non-union, partial union, and complete union of the epiphyses and metaphyses of bones that correspond to different developmental ages.

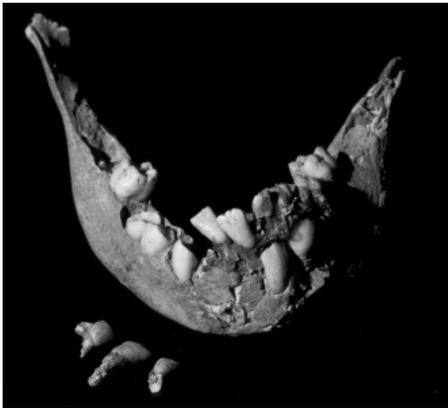


Figure 4.12:
Mandible of 9-10 year old child with permanent teeth in various stages of eruption compared with a dental aging chart (Ubelaker 1989) showing ages associated with different eruption stages

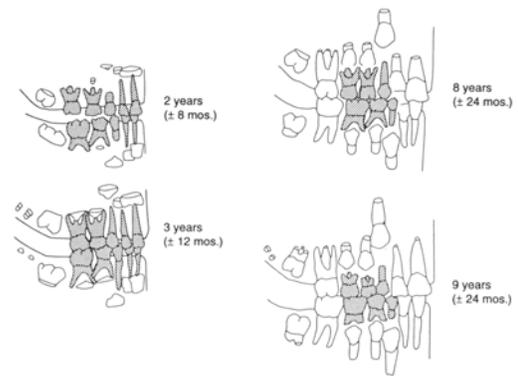


Figure 4.13:
Deciduous teeth are shown in grey; permanent teeth are shown in white. The arrow points to a 9-year-old's development

Degree of fusion for epiphyses and primary centers of ossification was also a valuable age indicator, yet, there were a number of cases in which ages reached by assessing union were inconsistent with those determined by observing dental development. When this occurred, greater weight was given to dental development because of the greater environmental influences on bone growth and development. Fusion of primary ossification centers was evaluated for the vertebrae, os coxae better, and the basilar portions of the occipital bones. Epiphyseal union was assessed for long bone epiphyses, clavicles, and scapulae. For older adolescents, degrees of fusion were also assessed for bones of the hands and feet.



Figure 4.14: Unfused epiphysis comprising the immature head of the femur of a 3-5year old (Burial 138)



Figure 4.15: Unfused epiphysis of a juvenile distal femur compared to a fully fused adult epiphysis

For adults, age-at-death was estimated by evaluating age-related degenerative changes occurring on the pubic symphysis and auricular surfaces of the os coxae (see Lovejoy et al. 1985), cranial sutures (Meindl and Lovejoy 1985), and sternal rib ends (Iscan and Loth 1986), and dental attrition. Osteoarthritic change (eburnation, erosion, lipping, and various manifestations of osteophytosis) was also assessed for vertebrae and for the articular surfaces of various long bones. Late fusing skeletal elements such as the

sacral vertebrae, basilar synchondrosis, and the medial epiphysis of the clavicle were also useful for distinguishing young adults from older remains, although there were a few cases in which skeletons that demonstrated advanced age-related changes in other features had incompletely fused sacral vertebrae. Delayed development of this kind, when not consistent with several other reliable age indicators, was considered an anomaly and was noted, but discounted for age estimation. Evidence of delayed development has been considered however, in relation to load-bearing and other stressors that might reasonably have interfered with the development of particular bones. The potentially high skeletal stress of forced labor may also have brought about premature degeneration of bones of the spine and true joints relative to chronological age. We believe that a conservative and reasonable accounting was given to each of these considerations.

The auricular surfaces of the *os coxae* were more frequently preserved than pubic symphyseal surfaces. Age-related changes in auricular surfaces were evaluated in accordance with phases delineated by Lovejoy et al., (1985). Changes in the morphology of pubic symphyseal faces were documented according to the Todd (1921), and with consideration of methodological issues raised by Brooks and Suchey (1990), Katz and Suchey (1986), and Katz and Suchey (1989). By comparison with standard casts. For both features, differences between the left and right sides were noted and recorded. Sternal rib change was evaluated according to phases defined by Iscan, Loth, and Wright (1984), and osteoarthritic variation was scored based on standards devised by Stewart (1958).

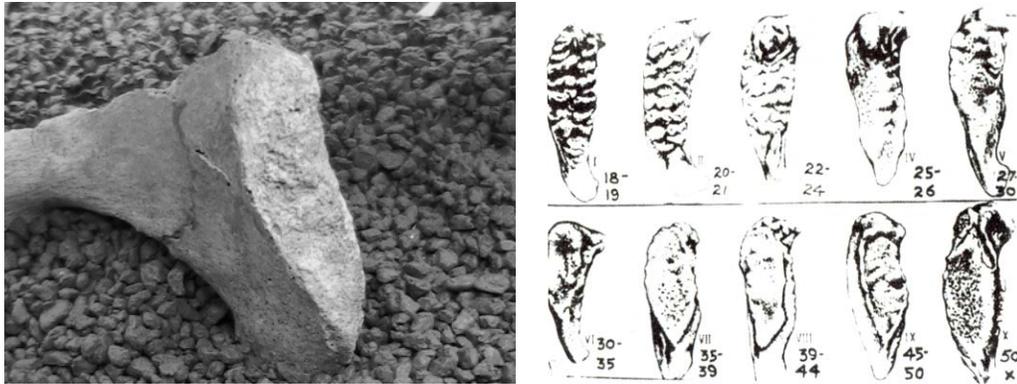


Figure 4.16: Pubic symphysis of a 45 – 50 year old male (Burial 20, left) and Todd's ten typical phases of age in the pubic symphysis

Various degrees of cranial suture closure were evaluated, according to the scoring system devised by Meindl and Lovejoy (1985). When possible, suture closure was scored bilaterally, since asymmetry in fusion rates was noted frequently. We were pleased to find that, while the age ranges estimated by this method tended to be very widely distributed, the mean age based on suture closure tended to be consistent with those of other aging methods. This method is clearly superior to earlier aging methods using this criterion. A maximum of 65 degenerative indicators of aging were scored for each individual.

After all available indicators had been evaluated, a composite age range and mean were determined. When ages ascertained from various features clustered tightly (usually within 6-24 months for sub-adults, within 5-10 years for well preserved adult skeletons), every indicator was included in the composite age range, defining the low and high possible ages for the individual. In some cases, however, the age range estimated from, perhaps, one criterion (usually cranial suture closure, according to the method of Meindl

and Lovejoy (1985), produced unusually broad age-ranges, whose medians, however, were very consistent with those of other methods) differed widely from the others. When this occurred, more weight was given to indicators whose ages clustered than to outlier ages such as cranial suture age-range scores. Such outliers were recorded but did not become part of the composite age. A mean of the resulting composite age has been used for all analyses for ease of statistical manipulation. Wider age ranges, however, are especially useful when considering an *individual* skeleton because it will describe the likely error (the possible ages of that person at his or her death). The Burial Descriptions in Section IV of this report use such broad age ranges. When *samples or groups* of individuals are evaluated, especially the sizable archaeological population reported here, the single, average age for each individual becomes an adequate operational summary of their ages for statistical manipulation. Having many individuals within each analytical cell or field (such as the five or even one year age categories we have used) means that they will represent the range of error (randomly biased above and below the true age) by virtue of the diversity and number of individual's age estimates that, when large, begin to approach theoretical probability in which the biases cancel each other. In other words, the errors of bias are reduced in statistical treatments of groups by having sizable numbers of age-estimated individuals whose biased ages will be randomly too low for some and too high in others. Since these random, but small, errors in each direction will cancel each other out, the narrow age range in which their means fall (the one or five year interval around their mean ages in the above histogram in Figure 4.17, below) constitutes a reasonable operational summary age for the age *group* in question. One solution to the problem of smaller archaeological populations is to use very broad temporal groupings to

accommodate the random errors of small populations so that one is reasonably certain an individual lies within the category of say, “adult” or “infant.” We believe that our sample is sufficiently large and the data set is extensive enough to use one-year age intervals for the demographic analysis of subadults whose developmental ages are the most accurately assessed and five-year intervals for adults under 55 years of age. The idiosyncrasies of skeletal variation in older individuals are too great for more a more reliable age estimate than 55+.

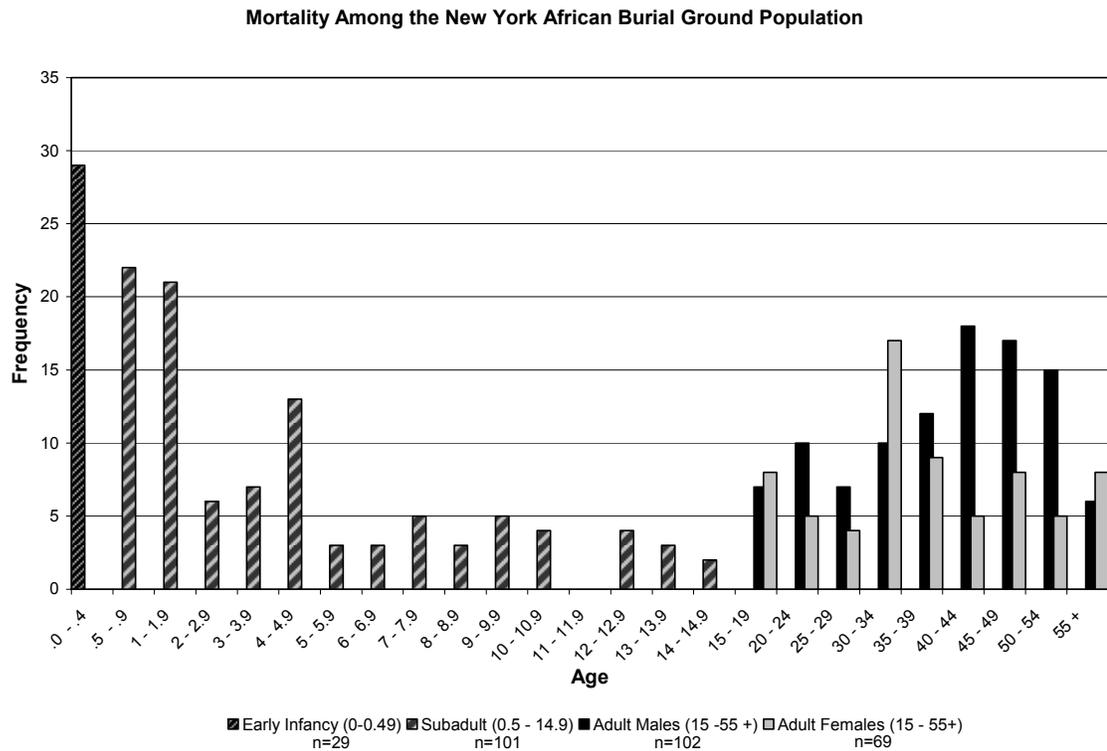


Figure 4.17: Bar Graph representing sex and age at death using average ages

Dental Assessment

After the skeletal remains of each burial were cleaned and reconstructed the dentition for each burial (permanent and/or deciduous) was cleaned, identified, assessed and curated separately by the laboratory director and his assistants. Data collection was performed under the guidelines set forth in *Standards for Data Collection for Human Remains*, *Arizona State University Anthropology System*, and the methodological considerations of Goodman and Rose (1990), Blakey and Armelagos (1985), Rose et al. (1983), Rudney et al., 1983), Scott (1979), Smith (1984) and others. Recordation for the deciduous and/or permanent teeth included dental inventory, measurements, morphological traits, attrition rates, enamel defects, culturally induced alterations and pathological observations. A complete photographic record was constructed for each tooth, the overall dentition and the maxillary and mandibular alveoli. If all teeth were present a maximum number of 96 measurements, and 231 coded observations of morphology and developmental pathology would be made. Additional descriptive assessments of dental pathology were also numerous.



Figure 4.18: Laboratory Director Mark Mack conducts dental recordation

Assessment of Bone Pathology

An experienced Osteologist and an Osteological Technician, with assistance of an OTA, in consultation with the Scientific Director assessed each set of skeletal remains for pathologies, anomalies and non-metric genetic traits in bone. For consistency the same Osteologist carried out most of these assessments. Where staffing changes were made for pathology assessment and coding, care was taken by the Scientific Director to establish comparability among researchers. Assessment methods included the descriptive classifications of abnormality of shape, abnormality of size, abnormal bone loss, abnormal bone formation, fractures and dislocations, porotic hyperostosis, vertebral pathology, and arthritis, and epigenetic traits used in the *Standards*. More specific descriptive sub-

categories of the *Standards* and traditional diagnostic interpretation (such as “meningitis,” not included in the *Standards*) were included in these assessments. Pathology assessments were made as narrative descriptions as per earlier approaches than the *Standards* (such as the Paleopathology Associations guidelines for assessment) yet with the *Standard’s* coding method in mind. The project’s use of “slight” versus a “moderate” to “severe” degrees of pathology, for example, is equivalent to the use of the *Standards’* categories of “barely discernable” and “clearly present,” respectively. Having begun this research while *Standards* were still in development, we had the benefit of our colleague’s generous provision of the early manuscripts, the researchers developed an approach that bridged (and included) the traditional diagnostic and new, more descriptive methodologies. Chapter 10 will address the pathology codes in greater detail.

Subsequently, an OT coded these descriptions with input from the Scientific Director and Associate Director for Biological Anthropology. The project’s own coding method utilized a spread sheet format that encompassed virtually all useful information of the *Standards’* coding scheme in one third of the time required to use the latter code. As one of the first projects to test the *Standards*, we consider our approach to coding to be advisable, since difficulties in coding have often been noted by those attempting to use the new protocol. Additionally, a complete photographic record was developed of all pathologies by continuous consultation between the photographers and osteological staff.

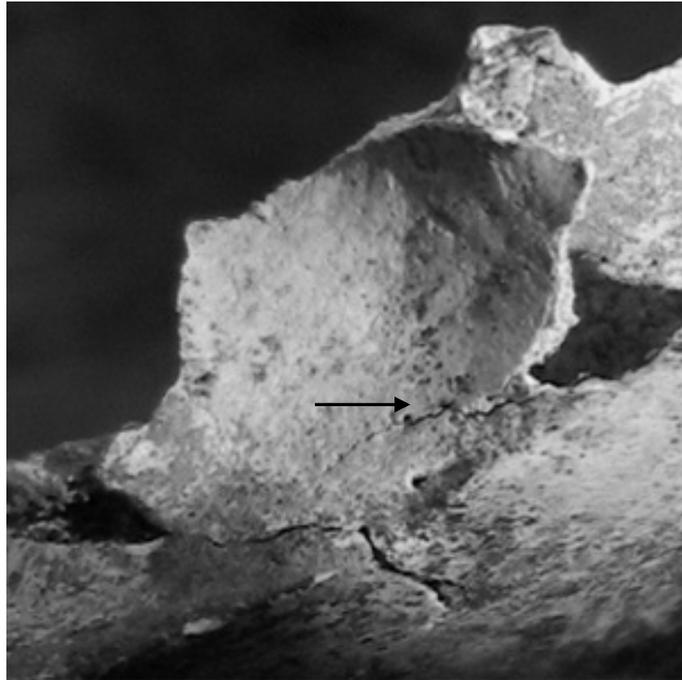


Figure 4.19: Barely discernible porotic hyperostosis

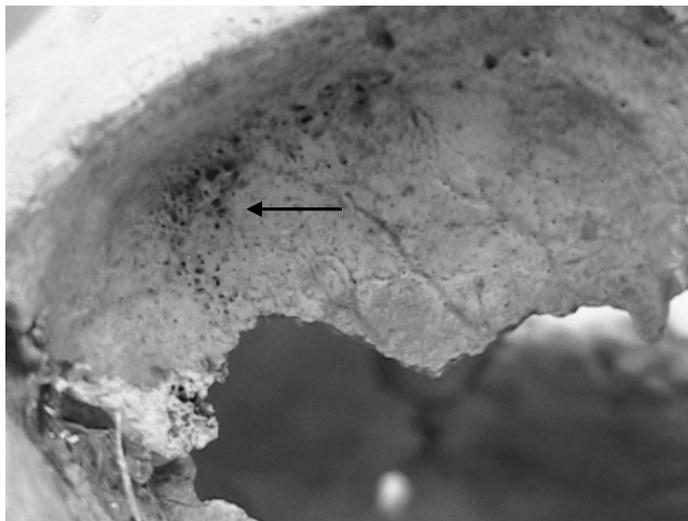


Figure 4.20: Clearly present porotic hyperostosis

Detailed descriptions of pathologies will be found in later chapters of this report. The project's database contains approximately 12,000 coded pathologies observed in the NYABG Population.



Figure 4.21: Photographer Jerome Otto Edwards and Osteologist M. Cassandra Hill photographing cranium

A photographer trained and experienced in the photographic documentation of skeletal remains was enlisted to carry out this task with the assistance of one OTA. The skeletal remains were photographed from a number of orientations to fully document each bone that contained information, as called for by the *Standards*. Photographic documentation is essential because the remains will be reburied, and photographs will provide the only visual evidence for future researchers. Osteological Technicians and OTAs contributed to photography as their experience increased over the life of the

project. Photographs were later digitized at the Institute for Historical Biology, College of William and Mary and the Cobb Laboratory.

Additionally, as a means of documentation, radiographs were taken of useful crania and long bones to discover pathologies that were not readily apparent by visual observation. Inventory radiographs made by the Department of Radiology, Howard University Hospital and the Department of Orthopedics, College of Dentistry utilized x-ray settings recommended by the *Standards*. Specialized radiographs made with a portable machine of The Cobb Laboratory provided immediate images that aided assessments of age and traumatic fracture.

Sectioned Bone Samples

Samples of right femora, humeri, and fibulae, and a rib sample were taken according to the *Standards* protocol for sectioning. Sectioning was done after all other work was completed. Bone and dental tissue samples are to be used for histology, chemistry, DNA, histomorphometry, and curation. DNA samples (right fibulae) were cut using a clean bench with reverse airflow and handsaws were bathed in ethanol and chlorine to remove all proteins between cuts in order to eliminate inter-individual DNA contamination (mixing). Gloves and dust masks were worn at all times. All other samples were obtained with a band saw, using steel mesh gloves for personnel safety. A total of eight centimeters of bone was removed from each skeleton when possible. Appendix B contains an example of a file for a well preserved adult (Burial 101), showing the specific methods or observations mentioned in this chapter.

The New York African Burial Ground (NYABG) sample database is too large to be rendered as tables in this volume and is to be made available in electronic media.

Skeletal Curation

After photography and radiography, the bones from each individual were carefully stored in airtight metal cabinets under the controlled conditions described in the previous chapter of this report. The skeletal remains were routinely monitored, and we have taken curation and protection of these ancestral remains as an important, traditional, custodial duty. Public care for the remains has taken other forms including religious observances. Provision was made for a shrine at the laboratory entrance that has been kept by Ife (Yoruba) cultural practitioners.



Figure 4.22: African-American Ife Shrine in the Cobb Laboratory

SECTION II:
Origins and Arrival of Africans in Colonial New York

CHAPTER 5

Origins of the New York African Burial Ground Population: Biological Evidence of Geographical and Macroethnic Affiliations Using Craniometrics, Dental Morphology, and Preliminary Genetic Analyses

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Introduction and Theoretical Perspectives

Origins are central to understanding the past and present identity of a people. Origin studies provide, under optimal conditions, a context for all other assessments, such as archaeological, biomedical, and nutritional evaluations. Characterizing the phenotypic status and determining the origins of the eighteenth century New York African population and those individuals interred in the New York African Burial Ground (NYABG) were among the project's major goals. Towards that end, our craniometric, dental morphology, and genetic teams collaborated extensively with project historians and archaeologists to develop a biocultural, interdisciplinary research strategy for a historically and ethnographically informed interpretation of the ancestral origins of the people disinterred from the NYABG. Our research strategy addressed the inquiries of the descendant African-American community with the professional scientific rigor demanded by our disciplines.

At this point in our investigations, the craniometric and dental morphology data are the most complete and well-developed lines of evidence for establishing relationships between the African Burial Ground (ABG) individuals and other world groups. Craniometric evaluations for the purpose of ancestral origin determinations have been

applied to anthropological populations for a very long time and have a rich history. Classically such studies were focused on typological racial assessments. This was not the case in the studies by Froment and Keita and Shujaa that quantify craniometric diversity and then compare this variability with a broad range of historical and modern African and non-African groups. Dental morphology studies are a well-established basis for assessing presumable genetic relationships between skeletal populations. This chapter contains a dental morphology study by Mayes and Mack that addresses the biological diversity in dentition observed among the NYABG individuals and the historical population affiliations associated with this variability. Both the craniometric and dental morphology studies confirm the African regional backgrounds of the New York population and probe the current limits for establishing greater ethnic specificity using such traditional methodology and comparative statistics.

Molecular genetic assessment, our third approach to determine ancestral origins, is a rapidly emerging and extremely precise set of techniques to match individuals with specific geographical regional groups, often with a high degree of reliability. Preliminary genetic studies by George and Kittles suggest that, based upon DNA analysis, much of the genetic diversity characterizing a subsample of NYABG individuals is decidedly West and Central African in origin. In a few cases, these preliminary results could localize specific individuals to precise geographical regions of West and Central Africa and suggest macroethnic affiliations. These preliminary studies, with a subset of the NYABG individuals, clearly point to the feasibility and utility of continued research effort in this area. Jackson's initial work provides a roadmap for these future studies.

Database limitations, research strategies, and historical and evolutionary contexts

Despite this focus, all four bioanthropological lines of evidence, dental morphology, non-metric phenotypic traits, craniometrics, and molecular genetics encountered problems in the comparative analysis of the data. The most significant problem encountered was the dearth of appropriate, non-racialized studies of African, Native American, and European population biology diversity for comparative assessments with the individuals of the ABG. Of particular note is the continued paucity of data on intra-African diversity. For example, substantive non-metric trait studies that include African populations are not available in the published literature. This important limitation in the database is being partially addressed at a number of levels, including the development in 2002 of the first human DNA bank in Africa by Jackson and her colleagues (Mbah 2003). The aim of this project, as a direct response to the needs of the NYABG analyses, is to have a full representation of and public access to continental African molecular genetic diversity that can be linked to geographical region, ecological setting, national identity, and ethnicity. Similar efforts are underway to characterize the genetic diversity among East Coast Native American groups (Smith, personal communication 2003).

Another limitation of our sample for broader extrapolations is that the Africans and African Americans enslaved in New York represent a distinct minority of North American captives. In 1790, there were nearly half a million Africans and African Americans enslaved in the United States. Of these 491,157 individuals, only 21,193 (approximately 4.3 percent of all enslaved persons) resided in New York State. The majority of these individuals were in New York City. Therefore, the representativeness

of this subset of North America's enslaved population is likely problematic. The origins of the NYABG individuals may not reflect the origins of enslaved Africans elsewhere in the Americas.

A third limitation in extrapolating our studies is the size of the subset of retrieved individuals from the NYABG. The approximately 400 individuals retrieved from an estimated 15,000 interred represent less than 3 percent of the estimated total number of buried individuals. The representativeness of this subset for all of New York City's enslaved persons is likely problematic. The retrieved individuals come from a limited area of the actual Burial Ground and may represent a clustering of genetically related and/or phenotypically affiliated individuals. Indeed, a preliminary analysis of mtDNA based interrelationship in a small group of interred individuals suggests close maternal affiliations between particular burials. Additional genetic tests based on Y-chromosome haplotypes and autosomal genes are warranted to further illuminate the genetic interrelationship of the individuals recovered from the NYABG along with molecular sex determinations of all individuals.

Finally, for a number of historical and evolutionary reasons, it is very difficult to reconstruct the exact modern or historical African ethnic group(s) to which a specific NYABG individual belongs, since New World Africans (including African Americans) are highly heterogeneous and represent an amalgamation of genes from diverse African ethnic groups in addition to highly variable genetic contributions from non-Africans (primarily Europeans and Native Americans). Many of the European slaving vessels would pick up shipments of captive Africans from various points on the coasts of Africa. In gathering captives in this manner, the vast majority of shipments contained a rainbow

of ethnicities that eventually found their way to the docks, households, and plantation work sites of the Americas. This created a plethora of African ethnicities with maximal opportunities for gene flow between individuals that had, on the continent of Africa, remained distinct. On the small island of Dominica alone, there were captives from diverse areas in Africa such as Old and New Calabar, Gambia, Cape Mount, Angola, Bonny, Cameroon, and Anamaboo (Carrington, personal communication, 2002). These names only refer to the regions from which the Africans were acquired for shipment, not their specific ethnic groups. A similar scenario is anticipated for New Amsterdam/New York City, thus complicating the efforts to link specific Burial Ground individuals to particular African ethnic groups. As the specificity of the African databases improves, we should be able to detail regional and macroethnic levels of genetic nuance. Indeed, our preliminary molecular genetic studies have already allowed this level of sophisticated assessment.

The Atlantic trade in 10-50 million enslaved Africans and the interactions of the survivors and their descendants in the Americas provide the ancestral foundations for the individuals of the NYABG. Both the geographical extensiveness of the trade in enslaved Africans, often deep into the interior of the continent, and the diversity of their interactions with each other and with non-Africans (Europeans and Native Americans) warrant that a broad array of regional groups be included for origin reconstruction studies. This is reflected in the research strategies implemented for the craniometric, dental morphology, and molecular genetic components of our study; comparisons were made with available African, Native American, and European groups. However, the dominant African origins of NYABG individuals became evident early in our analyses.

Once the primacy of African origins was obvious from craniometric, dental, and molecular genetic data, we sought to further refine our studies to identify where in Africa these individuals may have had their strongest ancestral ties.

The historical record indicates ten major geographical regions as sites from which enslaved Africans were likely exported to New Amsterdam/New York during the time frame of the NYABG (Figure 5.1 and 5.2). Additionally, the origin, number, initial entry points and subsequent re-exportation routes of enslaved Africans to the Americas (e.g., Caribbean trade to New York) have been identified (History, Report Chapters 2, 6, and 7). These historical data help us better understand the potential for genetic and phenotypic variations among the NYABG individuals, based upon the likelihood of gene-flow among previously diverse Africans, gene-flow with non-Africans, possibilities of genetic drift and bottleneck effects, and various types of selection at particular points in the historical record. The historical information also suggests the ethnic and regional identities of potential reference ancestral groups (e.g., which specific groups of Native Americans may have biologically interacted with the Africans of New York) as well as the characteristics of the databanks (e.g., distinctive morphological traits) necessary to ascertain the origins of New York Africans interred in the Burial Ground.

The larger context for reconstructing the origins of the NYABG individuals is within the current paradigm of modern human origins. The available molecular and skeletal information on recent human evolution favors a recent African origin of modern humans who spread out of Africa approximately 100,000 to 200,000 years ago (Ayala and Escalante 1996). In this context then, non-African diversity represents a subset of African heterogeneity, complicating somewhat our search for continental and population-

specific phenotypic and genotypic markers. However, for all of the useful polymorphic traits studied, African levels of diversity have exceeded those observed in non-Africans, and much of the African diversity appears to be clustered geographically and/or ethnically. Theoretically, this implies that genetic and phenotypic assessments of the NYABG individuals should be able to identify whether they are of predominantly African or non-African origin and, if they are African, which regions of the continent they share ancestral affinities. Furthermore, existing craniometric, dental morphology, and molecular genetic variation allows us to characterize these individuals in relation to themselves and to address questions of kinship within the group.



Figure 5.1: Major African exit points for enslaved individuals bound for New York in the 17th and 18th century. Additional exit points (not shown) include Mozambique and western Madagascar as well as the Atlantic islands off of West Africa (e.g. Cape Verde).

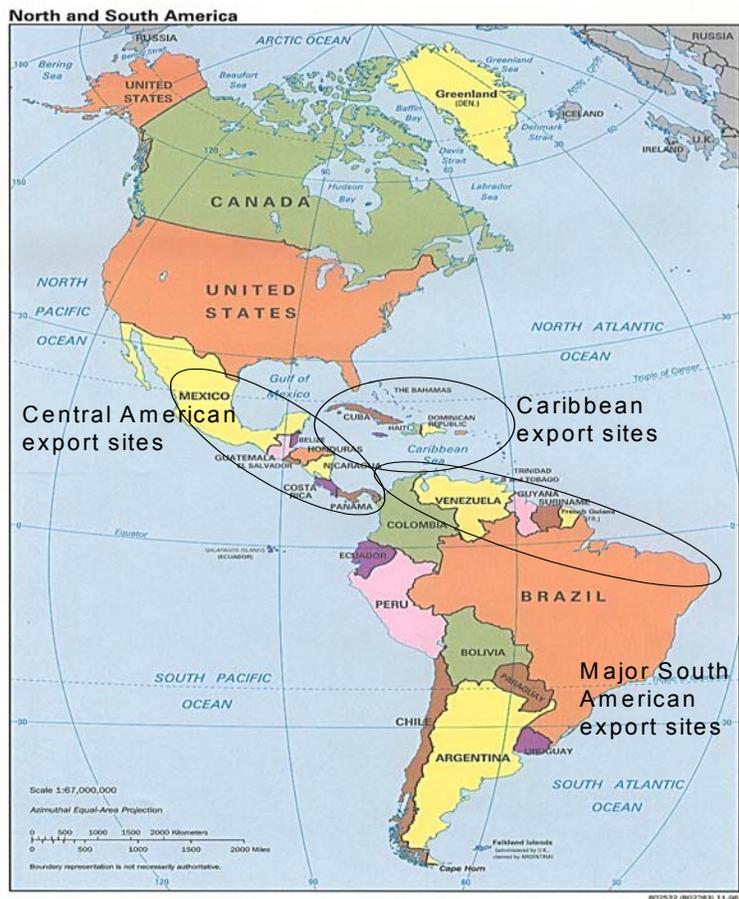


Figure 5.2: Exit regions for enslaved Africans bound for New York, Central and South American and the Caribbean in the seventeenth and eighteenth century.

RESEARCH QUESTIONS

The four major questions to be addressed in using genetics and phenotype to reconstruct the ancestral origins of the NYABG population are:

1. Is it possible to differentiate between continental groups (Africans, Europeans, Native Americans as a subset of Asians) at the genetic and/or phenotypic levels?
2. Is it possible to differentiate genetically and/or phenotypically in the ABG sample, among the ancestral Africans, ancestral Europeans, and ancestral Native Americans

- coming from various historically relevant geographical areas and germane ethnic groups within a specific continent?
3. Is it possible to differentiate sex-linked differences in ancestral origins and biological affinity among those interred in the NYABG?
 4. Most importantly, is it possible to differentiate among the Africans, who most likely contributed disproportionately to the ancestral backgrounds of those interred in the NYABG, from various regions of Africa and between different macroethnic groups of Africa?

In other words, we are especially interested in the complex relationships of this sample population to each other and to the larger world. These distinct but complementary levels of assessment are critical for ascertaining the origins of those interred in the NYABG. The New York African Burial Ground Project (NYABGP) research team has begun to notably contribute to the existing databases.

RESEARCH BACKGROUND SYNOPSIS

The importance of integrating phenotypic and genotypic variation in our assessments of biological lineage and ancestral origins is evident from the wealth of such studies in the published literature. There is considerable variation between and within populations (e.g., with regard to such traits as tooth size, congenitally missing teeth, crown morphology, mtDNA haplogroups, etc.). These differences are a reflection of the ongoing process of evolution and can be used to accurately reconstruct ancestral origins in specific populations when contextualized by an appropriate understanding of history and the environment.

Craniometric Assessments

Assessments of craniometric variation from Africa, Europe, and Asia basically support the dominant African-centered genetic and archaeological models of human origins and microevolution (Relethford and Jorde 1999). The average heterozygosity is significantly higher among Africans indigenous to the sub-Saharan areas of the continent than among non-Africans. An early study (Relethford and Harpending 1994) of worldwide variation in within-group phenotypic variation applied to a large set of craniometric data representing major Old World geographic regions involved 57 measurements for 1,159 cases in four regions: Europe, Sub-Saharan Africa, Australasia, and the Far East. Relethford and Harpending predicted a linear relationship between variation within populations (the average within-group variance) and variation between populations (the genetic distance of populations to pooled phenotypic means). If this prediction continues to hold true, craniometric data should also facilitate our hypothesis testing of ancestral origins of individuals retrieved from the NYABG.

Dental Trait Variants

The study of teeth has historically been an informative means of demonstrating patterns of human dispersals (Shields 1999). The multivariate analysis of worldwide dental phenotype microevolution suggests that world patterns are also broadly in accord with the dominant interpretation of genetic, archaeological, and other dental data. Like these data, dental morphology suggests an African (i.e., San, Western Africans, and Bantu) origin and subsequent dispersal for extant humanity. According to a prevailing interpretation of dental trait variation, the first modern human African emigrants not to become extinct were Southeast Asian Negritos. All Eurasians then emerged and

expanded through a series of extinct antecedent populations branching from the short lineage extending from Negritos to Australian aborigines. Proto Europeans were the first group to fission from this lineage. Under this dental morphology-generated hypothesis of modern human origins and subsequent differentiation, the next groups to have emerged were antecedent Southeast Asians, from which present Southeast Asians and then antecedent east Central Asians then diverged. Independently, people from the region of Mongolia and all Native Americans arose as daughter populations from antecedent East Central Asians (Shields 1999). Given this scenario, we should be able to find dental variants that distinguish between various continental groups of contemporary humans as well as high dental morphology diversity within Africa.

Fortunately, the study of European genetic diversity has been quite extensive, and the characterizations of the relevant groups for our intracontinental comparisons are more advanced. Of greatest relevance to our testing of hypothesis two is evidence of genetic and phenotypic diversity among the Dutch, Spaniards, Portuguese, English, Scots, Irish, French, Danes, Germans and others since these groups were the most active in the transatlantic trade in enslaved Africans and/or maintained the greatest potential (due to proximity) for contributing to the gene pool of the New York population.

Molecular genetics

Applied genetics is of increasing relevance in our efforts to reconstruct the origins of long deceased populations. New methods, new techniques, and the increased ease at which sophisticated assessments can be made have provided new ways of knowing the long buried histories of individuals and, by extension, their groups. In a recent article by senior geneticists Cavalli-Sforza and Feldman (2002), they note that the past decade of

advances in molecular genetic technology has heralded a new era for all evolutionary studies, but especially the science of human evolution. Data on various kinds of DNA variation in human populations are rapidly accumulating, particularly markers from mitochondrial DNA (mtDNA) and the Y chromosome. The evolution of the human mitochondrial genome is characterized by the emergence of geographically distinct lineages or haplogroups. Significant differences between the three African, nine European, and seven Asian (including Native American) haplogroups make it now possible to confirm or reject an African genetic origin from studies using mtDNA. Indeed, the analysis of nucleotide sequences of the D-loop of mtDNA derived from the aDNA of a small sample of NYABG individuals has been very informative in confirming the continental origin (Africa) and in its subsequent elaboration of the geographical region, within-continent identities of nearly 50 NYABG individuals.

Methods, Data, and Results

Craniometrics

The scope of the present study is not about human variation in general, and therefore does not include populations from all around the world; the issue is to assess the origins of the people buried in the cemetery as they represent the New York African community of the time. These origins combine three roots:

1. The geographical origin in Africa (according to the historical analysis the primary sources of the enslaved population was from Central and Western Africa, with a minor Madagascan and Southern African components)
2. Some admixture with the European colonists in America and traders in Africa
3. Some admixture with Native Americans

To undertake such a comparative study, it was necessary to first build a reference collection of European, African, and Native American populations, ideally of the same period (circa 1650 to 1769). Two decisions were made: consider only adults, and limit comparisons to skull measurements. The first decision was based on the fact that there are virtually no studies on subadult skeletons, due to the under representation of subadults in cemetery populations (due to preservation and/or cultural processes), the disarticulated nature of subadult crania, and the difficulty in determining sex until late adolescence (unless performing DNA testing).

The second decision, to study only crania, was based on the status of this type of research and not the potential utility of the post-cranial skeleton for assessing ecological variation. Unfortunately, most skeletal biological research concerning anatomical variation focuses on stature, race, and sex assessments; while the primary research on anatomical variation has been developed within human adaptability research on living populations. These data have not been correlated with skeletal analyses. Therefore, the cranial element of the human skeleton remains the most studied element for comparative analysis and is still highly racialized.

A literature review for intercontinental and intracontinental crania variation was undertaken. The literature review revealed that there was a paucity of individual level data, and sample variation reported primarily by means and standard deviations only. In addition, limited standardized measurements (usually 6 to 15) were published, thus producing a loss of biologically relevant information. No reference to any “racial” definition was made as the multivariate analysis does not require it and the scatter plots speak for themselves to express the resemblance between individuals, without the use of

closed biological categories. Table 5.1 identifies the populations used in this study and the sources they came from.

Statistical Analysis

A stepwise discriminant function analysis was undertaken using the statistical software package, “Statistical Package for Social Sciences (SPSS).” The purpose of the analysis was to classify a series of unknown origin objects, the NYABG skulls, into groups defined on a geographical basis, by using simultaneously multiple variables (cranial measurements). A preliminary, univariate statistical analysis verified that the variables studied display a normal distribution. Then canonical discriminant functions are generated, each function expressing a part of the total variance and displaying, more or less, an important correlation with some of the discriminating variables. Distances between individuals are calculated and crania are plotted in a hyperspace of the same dimension as the number of variables considered. The Mahalanobis metric, a generalized Euclidean metric, is employed to measure the distance between two points in this hyperspace because it adequately accounts for correlated variables.

Associated with each group in a sample is a point called the group centroid, which represents the means for all variables in the hyperspace defined by variables in the model. A case is said to belong to a group if the Mahalanobis distance of the case from the group’s centroid is smaller than the Mahalanobis distance from any other group’s centroid.

Table 5.1: Population Sources for Craniometric Analysis by Froment

# Individ.	Population	Reference
59	NYABG	Present study
	EUROPE	
271	City of Lyon (France)	Buyle-Bodin 1982
785	Valais (Switzerland)	Pittard 1911
131	City of Firenze (Italy)	Florence Museum collection
110	Norse (Norway)	Howells 1989
264	Grodek, Poland, 13-17 th century	Belniak et al., 1961
	WEST AFRICA	
114	Ashanti (and other Ghanaians)	Shrubsall 1899a
71	Ibo and Calabar area (Nigeria)	<i>in</i> Ribot 2002
96	Senegal (Seerer and Iron Age)	<i>in</i> Ribot 2002
127	Dogon (Mali)	Howells 1989
134	Tellem (early Mali)	
22	Togo & Benin	<i>in</i> Ribot 2002
	CENTRAL AFRICA	
133	Cameroon (mainly Grassfields)	Drontschilow 1913
155	BaSuku D.R.Congo	<i>in</i> Ribot 2002
68	Various D.R.Congo (Zande, Kongo)	<i>in</i> Ribot 2002
82	Tetela, D.R.C.	Benington 1912
141	Bantu from Gabon	Benington 1912
	SOUTH AFRICA	
125	Zulu	Howells 1989, Shrubsall 1899b
27	Nguni	<i>in</i> Ribot 2002
48	Xhosa	<i>in</i> Ribot 2002
19	Various Bantu South Africa	<i>in</i> Ribot 2002
36	Ovambo	Hrdlička 1928b
	EAST AFRICA (just for comparison)	
30	Dschagga Kilimandjaro	Wide 1896
29	Teita (Kenya)	Kitson 1931
	NATIVE AMERICANS	
111	Algonquin (mainly Virginia)	Hrdlička 1927b
53	Connecticut, Delaware, Maine	Hrdlička 1927b
24	Huron	Hrdlička 1927b
41	Massachusetts	Hrdlička 1927b
115	Manhattan, Long Island, Rhode Island	Hrdlička 1927b
120	Central California	Breschini & Haversat 1980
89	Labrador “Indians”	Steward 1939b
43	Guadeloupe slave cemetery (French West Indies)	Courtaud <i>personal communication</i> 2002

NB: the study by Ribot (2002) is a large compilation of available literature, where complete references can be found; many series have been measured by Ribot, or M. Lahr, or G. Thilmans; unpublished studies by Froment have also been included.

The number of variables included for analysis must be smaller than the size of the sample; this condition was met in this study. The number of individuals in each subsample (n= 20-28) was greater than the number of variables which varied from 5 to 12 based on the completeness of the crania. When a cranium is incomplete, the number of variables is reduced; and no missing measurement attempt was replaced by an estimate. An individual with a missing variable was excluded from the analysis, thus explaining the variation in sample size. Therefore, the strategy was to maximize the number of individuals without minimizing the number of variables for analysis.

Results

Although the New York sample is heterogeneous craniometrically, this analysis indicates that a majority of NYABG individuals can be considered African. Four individuals (n= 20 to 28 complete skulls) are closer to Europeans than to Africans, yet are within the overlapping ranges of both geographic populations (Figure 5.3). Since the greater proportion of West and Central African crania are clustering closely, they are not distinguishable. Most NYABG crania are clearly primarily Central and West African, although four to five individuals are within the range of South Africa.

When comparing NYABG with a sample from a Guadeloupe, French West Indies cemetery, that has only enslaved Africans, both NYABG and Guadeloupe cluster with Africans (Figure 5.4). The Native American component in the NYABG sample could not be definitively confirmed; in fact only one individual was close to a Native American and both of these individuals were in the overlapping range with Europeans (Figure 5.4).

In any world population, there is considerable individual variation. In a sample of heterogeneous origin, such as the NYABG sample, variation is even greater. Yet, this

analysis demonstrates that those individuals interred in the burial ground were of African origin; what this analysis can not do is identify the specific geographic areas narrowly, nor can it identify specific African ethnic groups. Based on adaptation and ecological theory and lines of evidence, this should be possible, but only substantive, relevant reference populations would provide a means to test hypotheses and undertake these analyses.

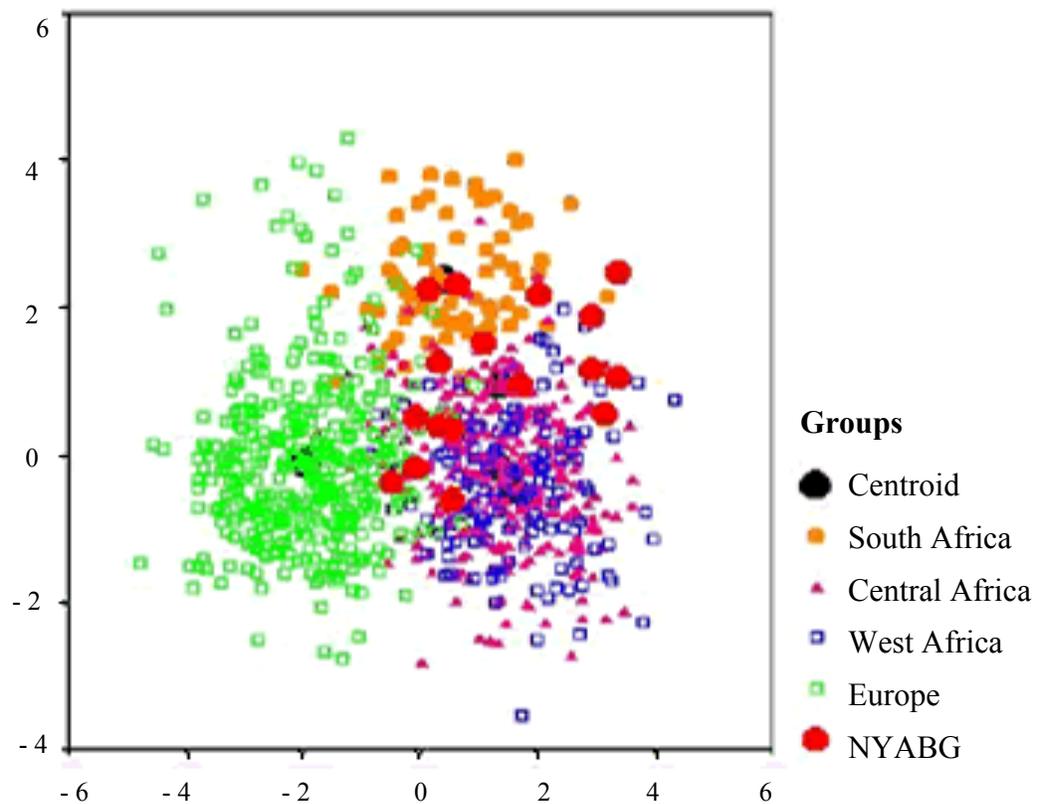


Figure 5.3: New York African Burial Ground Skull Shape Analysis (Mahalanobis Distance) NYBG population (red dots) compared to Southern and Northern Europe (green squares, n=357), West Africa (blue squares, n=115), Central Africa (pink triangles, n=342), South Africa (brown dots, n=59). Centroids are in black.

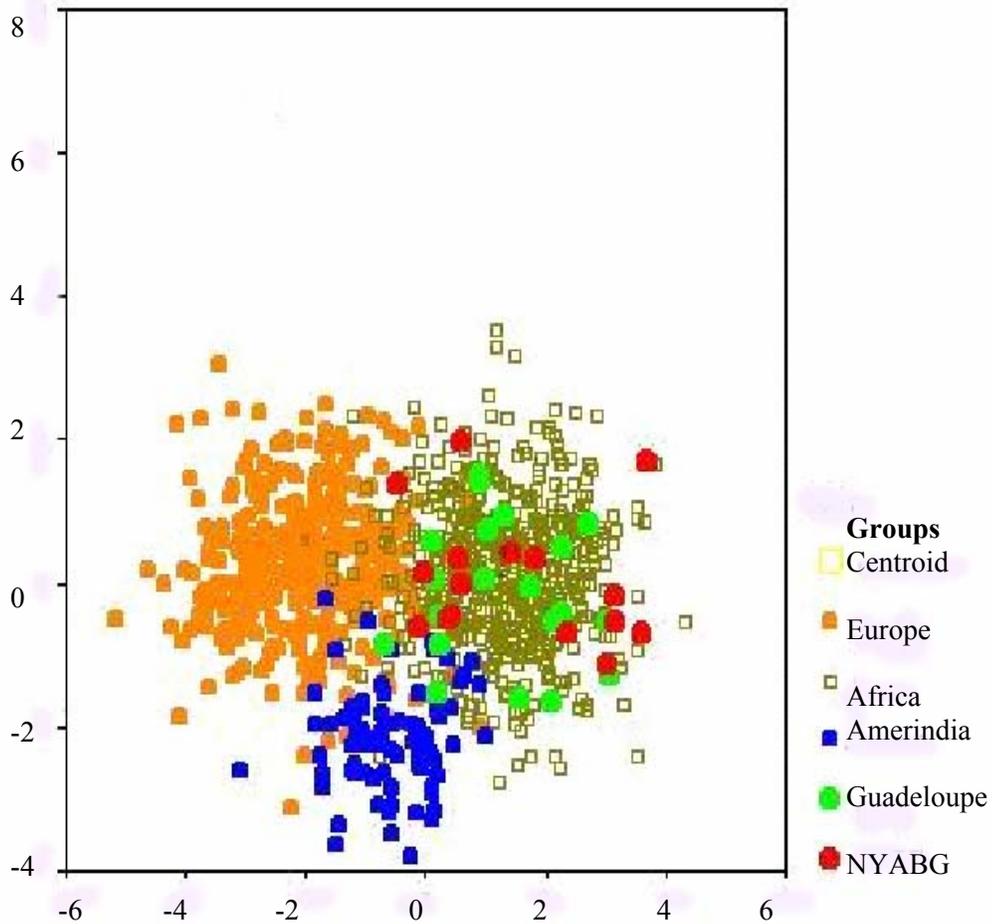


Figure 5.4: Scatter Plot of Craniometric Distance

New York African Burial Ground Population (Red Dots) Compared To All Europe (Orange Squares), All Africa (Olive Squares), Native Americans (Blue Squares), and a Xvii-Xix Century Cemetery from Guadeloupe, French West Indies (Green Dots).

In another craniometric analysis done by Keita and Shujaa, exclusively male crania were used to assess population affinities using the requirement of at least 10 measurements per skull because more of these were intact or sufficiently reconstructed (n=26 with at least 10 standard measurements) than female crania for the required sex-specific analysis. These crania are from burials distributed across the site. The comparative material is from Howells, (1973) study (Table 5.2), and measurements of crania from Gabon taken by Keita, and crania measured by Shujaa at the American Museum of Natural History (AMNH) for the ABGP researchers (Table 5.3).

Ten craniometric variables were taken: maximum breadth, biauricular breadth, basibregma height, maximum length, upper facial height, nasal breadth, nasal height, bizygomatic breadth, basion-prosthion length, and basi-nasion length. Using the Statistical Package for the Social Sciences, the ABG cranial series was analyzed with the others using canonical discriminant functions (Table 5.4). The centroid values place the New York crania nearest series from the Akan-speaking Ashanti (Asante) and Gold Coast series of the AMNH which form the modern nation of Ghana. Statistical proximity to populations that are historically unlikely to have had an opportunity to contribute genes to the New York population may exhibit morphological similarity that is unrelated to any close lineage affiliations. Thus Gold Coast individuals may be considered relevant candidates for a parental population to the NYABG, while others, such as the Tolai of New Guinea, are historically implausible.

The first two functions account for 54 percent of the variance, with eigenvalues of 2.03 and 1.05, respectively. The results of this study are consistent with known historical data. Many Africans were brought to English colonial America from what are now the

modern nations of Ghana, Angola, Democratic Republic of Congo, and the Senegambia Region [modern day Senegal and Gambia] (Curtin 1969; Inikori 1982; Gomez 1998).

Future research should include an analysis that only uses skeletal series from the regions of Africa that “contributed” most heavily in the seventeenth through eighteenth centuries to the Africans who were captured and enslaved in New York. The ABGP collected primary data on Ghanaian populations at the AMNH, which enabled a more diverse array of ethnic affiliations than was previously available from the published data on historical populations. Previous genetics and physical anthropological research has not focused on the question of African-American ethnic origins and thus has not over time produced a body of literature and appropriate comparative series for such analyses to be readily undertaken. Where African affinities or admixture have been studied, “racial” composites of diverse “sub-Saharan” or at best “West African” groups were constructed for analysis. The discussion of dental morphology below raises similar issues to these. There is a clear need to collect metric data on culturally-specific, historically relevant comparative populations in order to fully examine the range of NYABG origins.

In fact, much the same can be said of colonial English and Dutch populations. The closest Western European groups available in the Howells series (the most extensive series, generously provided to us by its author) are Scandinavian. The American Museum of Natural History collections (also graciously made available by Dr. Ian Tattersall) do not have a European series. Alternate collections that include the appropriate populations have been identified, and every effort will be made to include them in future studies. The current study, nonetheless, contributes substantially to the

search for origins of New York's earliest Africans by pushing the limits of current reference collections and showing the general craniometric affinities of the ABG sample. This study has demonstrated statistical relationships to specific ethnic populations to the extent available, although these statistical relationships need always to be measured in relation to historical plausibility. Furthermore, this examination has pointed to problems and their likely solutions if more robust ethnically-specific research on diasporic origins is to be conducted in the future.

Table 5.2: Howells Cranial Series

Population Source		Population Source	
1.	Norse (Norway)	16.	N. Japan
2.	Zalavar (Hungary)	17.	S. Japan
3.	Berg (Sweden)	18.	Hainan
4.	Teita (Kenya)	19.	Atayal
5.	Dogon (Mali)	20.	Philippines
6.	Zulu (South Africa)	21.	Guam
7.	Australia	22.	Egypt (Ancient, Late Period)
8.	Tasmania	23.	Bushman
9.	Tolai (New Guinea)	24.	Andaman Islands
10.	Mokapu (Hawaii)	25.	Ainu
11.	Easter Island	26.	Buriat (Siberia)
12.	Moriori	27.	‘Eskimo’
13.	Ankara (Plains Indians)	28.	Anyang
14.	Santa Cruz	29.	S.Maori
15.	Peru	30.	N.Maori

Table 5.3: AMNH and Keita’s Cranial Series

31.	Angola	36.	New York City
32.	Ashanti (Ghana)	37.	Staten Island
33.	Congo	38.	Gabon
34.	“Gold Coast”(Ghana)	39.	NYABG
35.	New York City		

Table 5.4: Centroid Values, Functions 1 and 2
 Canonical discriminant functions evaluated at group means (group centroids)

Group	Function 1	Function 2
1	.49289	-.81395
2	.66661	-.28289
3	2.00005	-1.33064
4	-1.83911	-.47633
5	-1.07939	-.80471
6	-1.56471	-.25812
7	-2.47642	-.62274
8	-1.31698	-.54909
9	-2.02165	.46116
10	.52011	1.54096
11	-1.39044	2.25476
12	1.09593	.72961
13	1.83141	.32525
14	.69772	-.77958
15	.76860	-.81823
16	.80924	.35667
17	.36571	.73132
18	.76538	.61597
19	.23183	.21099
20	.61612	.47115
21	.65600	1.76339
22	.24024	-5.6196
23	-1.62934	-2.49426
24	-1.8969	-.99949
25	-.21452	.18726
26	3.69605	-.63395
27	-.28503	1.58377
28	.61646	1.41405
29	1.02113	1.25171
30	-.26710	1.21620
31	-1.91646	.08740
32	-2.30512	.17624
33	-1.05963	-.37668
34	-2.02701	.17210
35	.23124	1.27807
36	1.81689	.18109
37	.15982	2.97094
38	-.82579	.50584
39	-1.50629	.52638

Dental Morphology

Analyzed in this section are dental trait frequencies and their intra and inter-population differences. Different populations appear to have similar ranges of dental cusp variation. As with other inherited traits, however, some distinct shapes of dental crowns (cusp patterns, for example) occur more often in particular regions, ethnic groups, and families than in others. This section examines an extensive range of dental variation in more than 200 individuals from the NYABG site. This part of the chapter explores the possible origins of the Africans in colonial New York City by comparing the frequencies of different dental shapes (morphology) found in the NYABG sample to those of historically relevant, potentially paternal populations in Africa, Europe, and North America. Using specific dental traits, several pertinent questions arose: how does the NYABG sample compare to other world populations? How does this sample compare to other African populations, based on the dental evidence? What is the relative degree of relationship within the population? Given the history of slavery on the African continent, can we determine the region of Africa in which this population originated, based on dental morphology?

Dental Comparison of New York African Burial Ground Individuals with Populations of the World

Variations in the degree and type of expression of dental morphology can be shown for different regional groups. These geographical and cultural patterns of frequency distribution are used to generate hypotheses about historical population relationships. This fact and the archaeological sturdiness of enamel make dentitions valuable repositories of information on migration. Scott and Turner (1997) have recently provided an in-depth and detailed review of discrete dental variation among modern and

recent human populations. This analysis incorporates data collected by many researchers during the past few decades. However, while extensive in scope, it should be noted that data for certain traits we have noted are not included for many of the populations presented by Scott and Turner.

In their analyses of biological distance, Scott and Turner used Nei's distance statistic and the hierarchical clustering algorithm known as the unweighted pair-group method using arithmetic averages (UPGMA) to produce trees or dendrograms. As with most multivariate clustering techniques, there is no direct way to evaluate significance or error. They did find, with their rather large samples, that they would get essentially the same dendrograms no matter what combination of a standard distance measure and clustering algorithm they employed (Scott and Turner 1997: 288). Turner's analysis is based on single-trait frequencies on a single tooth on one side of the dental arcade. This is true even for traits that potentially can be exhibited across dental fields, as well as bilateral occurrences. This technique is favorable for a more complete collection, which is taphonomically in good shape and which enables the researcher to control for large amounts of data. The dendrogram in Figure 5.5, below, shows the relationship between worldwide populations based on twenty-three crown traits (Scott and Turner 1997). It contains five clusters of world groups: Western Eurasia, Africa, Sunda-Pacific, Sahul-Pacific, and Sino-American. The African cluster is made up of two sub-groups, West Africa and South Africa. This larger world classification of Africa is more closely aligned with the Sunda-Pacific populations than with the Western Eurasia populations. In Scott and Turner's analysis, North Africa finds itself clustered with Western Eurasia. The same twenty-three dental traits used by Scott and Turner were compared to the data

set from the NYABG sample (Table 5.5). The SPSS average lineage (UPGMA) with Euclidean distance as the distance statistic was used to produce our dendrograms (SPSS 1997) (Figures 5.6-5.8).

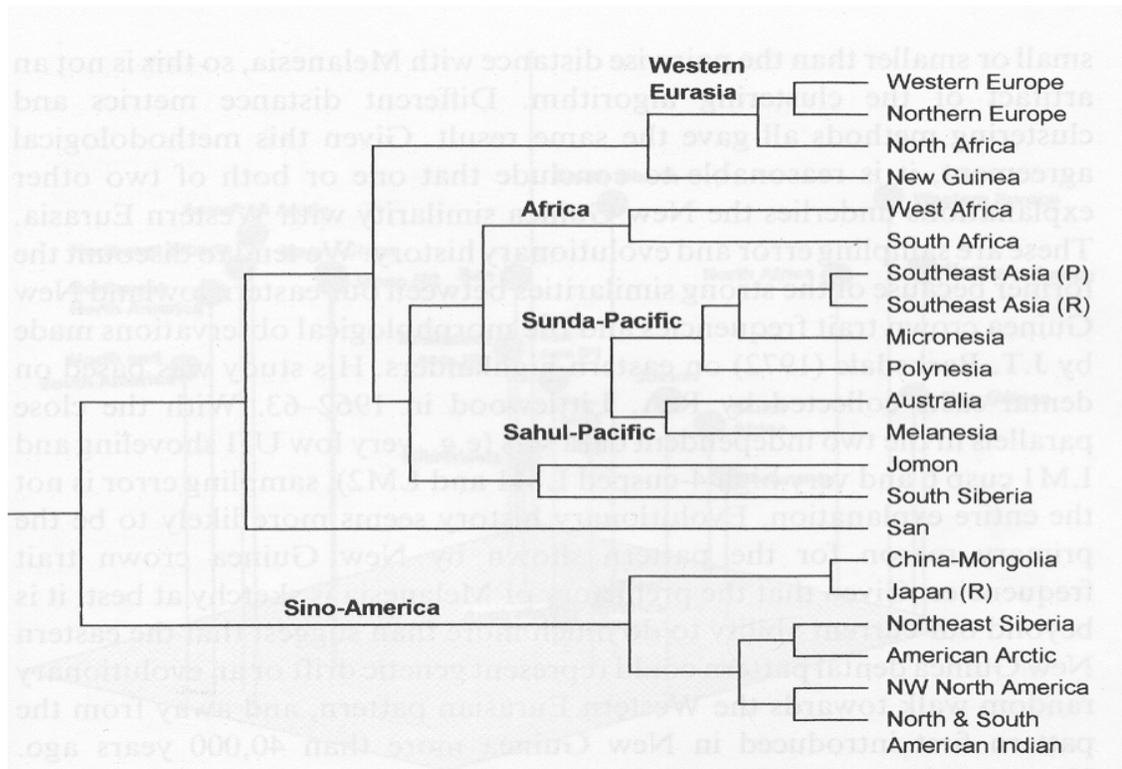


Figure 5.5: Worldwide populations based on 23 crown and root traits (Scott and Turner 1997)

Table 5.5: New York African Burial Ground Dental Traits Distribution

Dental Trait	Observations/ Total Sample
Winging/left	2/117
Shoveling ULI1	6/117
Double Shoveling ULI1	5/140
Interruption Groove LI2	15/136
Canine Mesial Ridge Left (Bushman)	19/122
Odontomes	1/117
3-cusped UM2	8/106
Carabelli's Cusp ULM1	18/123
Cusp 5 LUM1	24/120
Enamel Extensions ULM1	6/108
4-Cusped LM1	4/92
4-Cusped LM2	51/87
Y-Groove Pattern LLM2	26/95
Cusp 6 LLM1	7/95
Cusp 7 LLM1	11/102
Deflecting Wrinkle Lt	6/94
2-Rooted LUP1	42/76
3 Rooted LUM2	70/73
2-Rooted LC	0
Tome's Root Lt	32/84
3-Rooted LM1	0
1-Rooted LM2	1/63
Distal Trigonid Crest Lt	2/80

Based on Euclidean distance, the NYABG data are clustering closely to Scott and Turner's South African population data. Both, in turn, group closely to a second cluster involving Western Europe, Northern Europe, North Africa, and New Guinea. Interestingly, West Africa and the San population cluster together and distant from the other African populations (see Figure 5.6).

When the same distance analysis compares only the African populations and Western Europe, the NYABG clusters closely to North and South Africa, and then Western Europe. The West African and Khoisan populations fall farther from the previous groups (Figure 5.7). Lastly, when compared to only the African populations, the NYABG clusters closely to North Africa, followed closely by South Africa, and clustering farther from Western Africa (see Figure 5.8).

Scott and Turner's classification of North, South, and West Africa can, however, be misleading. The category labeled South Africa in this data set is made up of populations from South, East, Central, and West Africa (Table 5.6). Within this framework, the NYABG sample is actually clustering closely to a pooled sample of Africans south of the Sahara and some populations north of it.

Table 5.6: Scott and Turner Population Descriptions

WESTERN EURASIA:	
Western Europe	Lapps, Reindeer Is., Karil Peninsula, England (Poundbury), Netherlands (Dorestad de Heul), Lent, Danish Neolithi
Northern Europe	Medieval Norway, Greenland, Iceland
North Africa	Algeria, Bedoin, Canary Islands, Carthage, Chad, Christian (Sudan), El Hesa, Kabyle, Kharga, Lisht, Meroitic, Mesolithic Nubians, Soleb, X-Group, North Africa (Algeria, Chad)
SUB-SAHARAN AFRICA	
West Africa	West Africa, Nubia #117, Nubia #67/80
South Africa	Congo, Gabon, Ghana, Nigeria/Cameroon, Pygmy, South Africa, SeneGambia, Sotho, Tanzania, Togo/Benin, Tukulor
San	San, Khoi khoi
(1997: 318)	

From the above analysis we can determine that the individuals from the NYABG sample are most biologically similar to individuals in West, Central, North, and South Africa. This trend continues as individual frequencies for each dental trait are partitioned. The **farthest** population clusters – thus the least biologically related to the NYABG – are from Northwest North America, North and South American, the American Artic (*ergo* Native Americans) China-Mongolia, Recent Japan and North East Siberia (Figure 5.6). As noted in our earlier discussion of craniometry, lumping diverse populations into arbitrary categories limits our ability to examine greater ethnic specificity with these methods. These data are, nonetheless, generally consistent with

regional origins of New York Africans reported by the African Burial Ground Project's historians.

Another problem of comparative databases might be resolved in future studies. As previously discussed most dental traits are measured in terms of grades, with the realization that scoring different levels of a grade is just as, if not more, relevant as simply noting its presence or absence. Even so, Scott and Turner (1997), when comparing world frequencies, analyzed a trait as either present or absent, or only considered the most prominent form of a morphological trait. For comparative purposes, we chose the same twenty-three dental traits and followed the same methodology. For example, Carabelli's Cusp is a dental trait found on the mesiolingual cusp of a maxillary molar. Carabelli's cusp can be exhibited in different grades ranging from a groove or pit to a free standing cusp in the same location. Following Scott and Turner's methodology, only grades 5-7 were considered in trait frequencies for comparison to other world populations. Here only 7 percent of the individuals from the NYABG (with observable dentition) exhibit this trait. However, if the lower grades (1-4) are considered unto themselves, then, 33 percent of the individuals exhibit Carabelli's. When all scores are considered (present or absent) 40 percent of the NYABG individuals exhibit some form of Carabelli's Trait. An increase in world-wide sample sizes has led to a more comprehensive understanding of how to interpret patterns of trait expression, through grades, rather than simply as present or absent.

Multivariate cluster analysis on the same twenty-three dental traits was used to determine genetic affinity within the NYABG sample. While small clusters are apparent, no major groupings are visible. However, a variation in methodology to include all

gradients of dental morphology may clarify this point. These data are consistent with the historical expectation of the NYABG sample as highly diverse, even if it consists of the expected range of African populations.

Tooth morphology is part of the biological heritage that humans carry with them when they migrate, much like their blood group genes, fingerprint patterns, PTC taste reactions, and other biological traits. When human groups are isolated from one another for a period of time, their crown and root trait frequencies diverge to varying degrees, depending on population size and the extent and temporal duration of isolation. When divergent populations come in contact and interbreed, the resulting populations possess convergent morphological trait frequencies. In other words, these polymorphic features of the dentition behave like other biological variables that are used to assess population history and evolutionary process.
Scott and Turner, 1997

Following Turner's theoretical perspective, the analysis of discrete dental traits strongly indicates that the NYABG sample is biologically similar. Multivariate analysis indicates a close degree of relationship between the NYABG and other African populations, particularly, West, Central and South Africa. Of note, is the consistent clustering of the NYABG with Scott and Turner's Western European population, which includes a sample from the Netherlands. There is a degree of relationship that is worth further investigation given the population history of New York City. These data add to an expanding database on world population dentition and demography. The use of dental morphology in the discussion of population movement is not unique. However, the NYABG provides an opportunity for investigating such techniques to shed light on a population of widely displaced individuals. That situation and the fact that teeth are visible in the living and the dead offer an opportunity to assess biological relationships between living populations, their relatives, ancestors and descendants. The NYABG as we have approached it also allows corroboration of these results against other biological

traits, and historical, cultural and artifactual evidence. Indeed, we have been guided by the preliminary archaeological data showing evidence of African cultural continuity in some funerary decorations at the site.

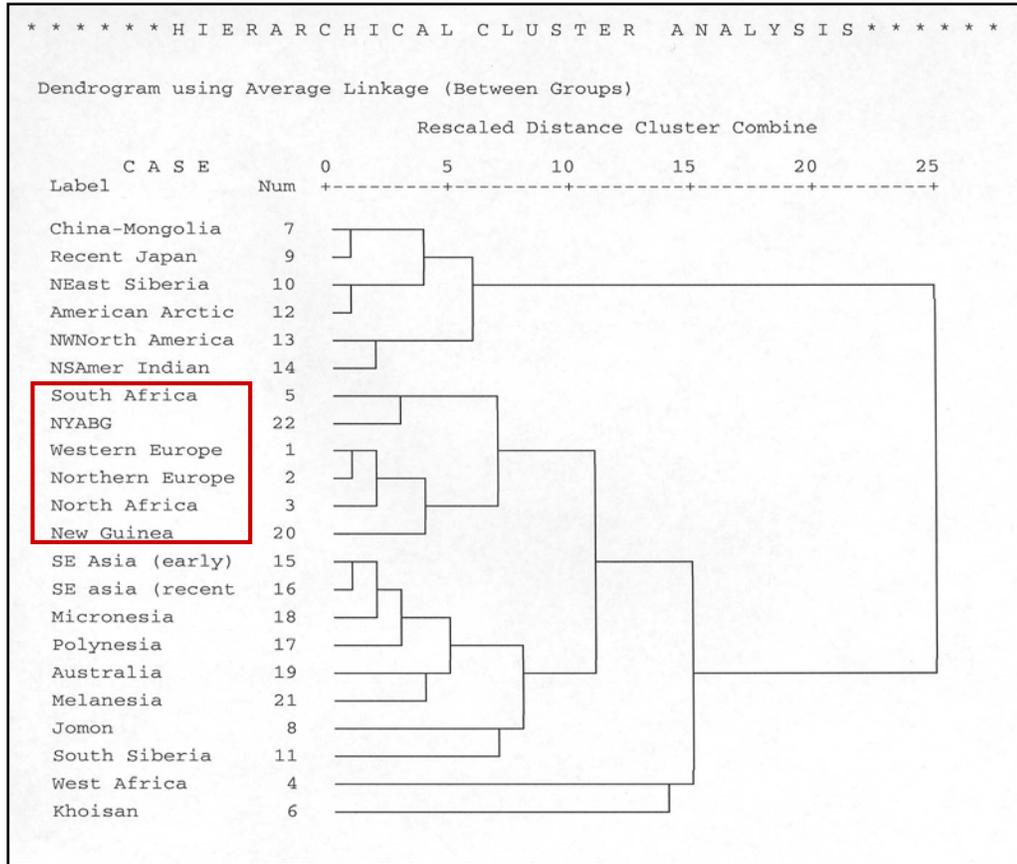


Figure 5.6: New York African Burial Ground compared to other world populations based on 23 crown and root traits (Scott and Turner 1997)

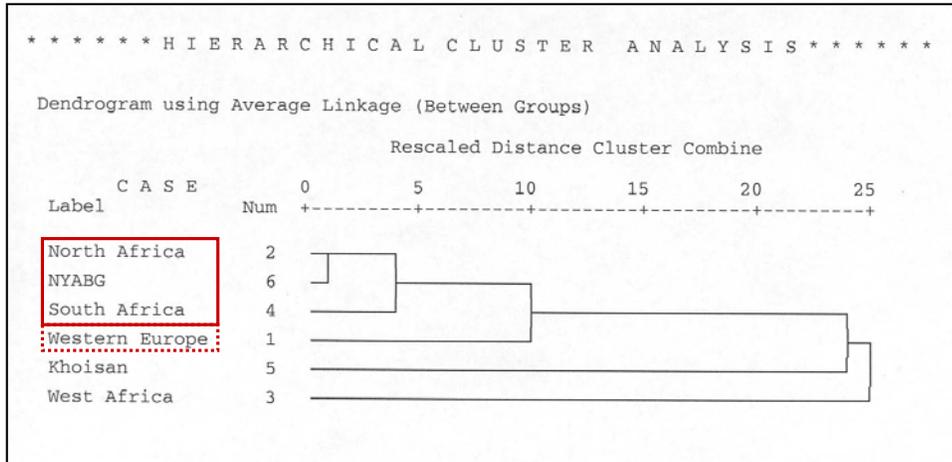


Figure 5.7: New York African Burial Ground compared to other African populations and Western Europe based on 23 crown and root traits (Scott and Turner 1997)

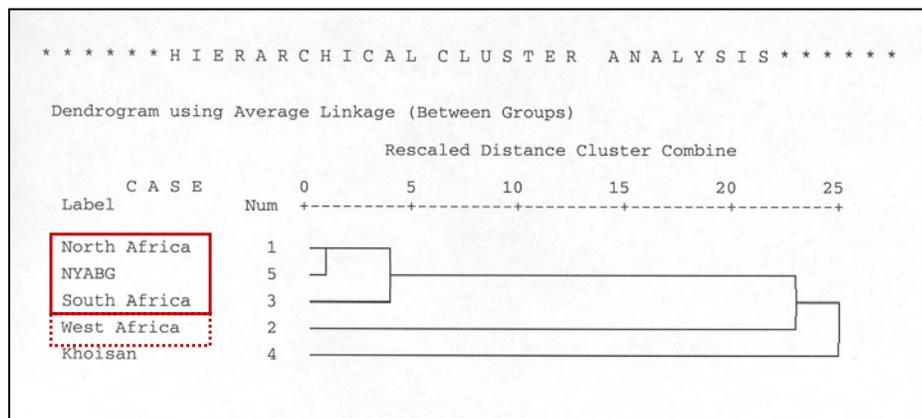


Figure 5.8: New York African Burial Ground compared to other African populations based on 23 crown and root traits (Scott and Turner 1997)

Molecular Genetic Assessments

Introduction: Overview, Limitations, and Approach

The genetic analyses of the NYABG samples provide an unparalleled opportunity for understanding the population origins and demographic structure of this unique group. Unfortunately, DNA extracted from these samples suffers from a fragmented genome and presence of PCR inhibitors, some of which were co-mingled with the extracted DNA. Critical to our analyses has been the quality of the aDNA. The quantity and quality of aDNA is dependent upon the interment conditions as well as the excavation specifics at the archaeological site. Therefore, we used the best standardized and established methods for aDNA analysis available at the time of analysis 1995-1999, so as to maximize genomic yield.

In 1995, GSA funded a small feasibility study with the following aims and objectives:

- a. To isolate nucleic acids from bones and/or hair samples
- b. Amplify specific mtDNA sequences via the PCR technique
- c. Sequence the amplified products
- d. Clone the amplified sequences for further study and provide a reservoir of these fragile sequences, and
- e. Perform a phylogenetic analysis of the sequences to determine possible kinships and sites of origins for a small number of these individuals.

Initial work on this small feasibility study was lead by George and this feasibility study was then extended by Kittles. The details of our methods and materials are reported below.

1995-1997 Protocol for genetic analyses of the New York African Burial Ground

The initial subsample was identified in 1995. We were able to extract and isolate nucleic acids from nine 200-year old hair and bone samples by mid-June 1995. NYABG individuals at burial numbers 233, 274, 619, and 840 were amplified with primers L15,997 and H16,321. Burial Ground individuals 219, 267, 797, 253, and 274 were not amplified. Ancient DNA (aDNA) from the NYABG sample was done using the following standard methods:

Contamination control was maintained by providing separate rooms for extraction, amplification, and sequencing. All glassware, solutions, chemicals, instruments, and bones were rendered sterile either by autoclaving or by UV irradiation. The bones were further subjected to filing of a 1-2 mm layer of outer material to reduce the risk of surface contamination.

Pre-extraction processing techniques included breaking the cleaned and resurfaced bone into small pieces, wrapping it in previously autoclaved heavy duty aluminum foil, placing the wrapped bone in liquid nitrogen, and placing this between sterilized metal plates wrapped in heavy duty aluminum foil. The treated bone was then pounded into a fine powder using the metal plate. Liquid nitrogen was not required for the pre-extraction processing of the hair root samples.

DNA extraction and isolation involved subjecting 0.25 g of powdered bone to the silica/guanidinium thiocyanate extraction protocol of Bloom and colleagues (1990) and Hoss and Paabo (1993). In this protocol (discussed in more detail below), the

strategy was to release nucleic acids by enzyme digestion, bind these to a silica column, and later elute them for quantification.

PCR amplification was prepared for 5 μ L of the 65 μ L of nucleic acid extraction volume. Using specific oligonucleotide primer pairs, in which one of the pair had a biotinylated 5' end, the DNA is subjected to 35 cycles of PCR amplification (Hoss and Paabo 1993). The results were examined on a 2 percent NuSieve agarose gel.

Results

Results of the initial molecular genetic results were partially successful. aDNA was obtained from 9 of the 15 NYABG samples studied. Four of these nine samples were successfully amplified using specific mtDNA primers. The amplified mtDNA sequences from the skeletal remains were not successfully cloned using the TA cloning vector and the sequences were not subjected to phylogenetic analysis.

1998-1999 Protocols for Genetic Analyses of the New York African Burial Ground

The second subsample consisted of seven NYABG bone samples, some of which had been initially studied by George. Kittles was able to bring an updated methodology to the project. These studies included the following individuals identified by burial numbers: 219, 233, 274, 310, 383, 619, and 843.

Contamination prevention was maintained by extensive autoclaving (of all buffers and water), regularized filtration purification (of these buffers and water), exclusive use of disposable lab coats, gloves, sleeves, masks, and caps, and bleach wipes of equipment followed by UV light irradiation. All pipette tips contained filters, and all PCR reagents were separated into aliquots to reduce the risk of cross-contamination. The

mortars and pestles used to grind the bone to a fine dust were treated with 1N HCl, rinsed with double-distilled water, and subjected to UV radiation before each use.

Pre-treatment of bone for DNA extraction and isolation consisted of cutting off about 2 mm of the entire bone surface with scalpel blades. The resulting internal bone fragments (300-500 mg) were ground in a specimen dedicated mortar and pestle to a fine dust.

DNA extraction and isolation continued using a silica-based protocol. In this procedure, silica powder was introduced to the digested sample, DNA bound under the influence of guanidinium thiocyanate, and this allowed the remainder of the contents of the digest to be washed away. In following this established technique, the ground bone was incubated in 1000 μ l of guanidinium thiocyanate (GuSCN) extraction buffer overnight at room temperature resulting in the release of nucleic acids by enzyme digestion. The extraction buffer consisted of 4.7M GuSCN, 20 mM EDTA, 46 mM Tris (pH 8.0), and 1.2 percent Triton X-100. After incubating the solid tissue remains in the buffer, a pellet was produced by several centrifugations. The supernatants were then added to a silica suspension and nucleic acids were isolated, eluted in 30 μ l aliquots, and quantified. As our experimental control, a blank extraction containing all reagents, but no tissue, was included in every set of extractions.

PCR amplification and sequencing was based on the amplification of the hypervariable segment I (HVS-1) of mtDNA and Y-chromosomal and autosomal microsatellite amplifications. Four sets of primers produced overlapping fragments of a 300 base pair segment of the HVS-1. Primers were also included which amplified highly

variable microsatellite markers of the Y-chromosome specific locus (DYS390) and the autosomal DNA locus (D5S471).

Amplification of mtDNA was performed in 30 μL reaction volumes of 150 μM dNTP's 10 mM Tris-HCl (pH=8.3), 50 mM KCl, 1.0-2.0 mM MgCl_2 , 0.6 units of AmpliTaq polymerase, 3.0 μl of 5 μM primer mix and 7.5 μl of the DNA extract. The PCR conditions consisted of 40 cycles at 95°C for 50 seconds, 55°C for 50 seconds, and 72°C for 50 seconds. Amplification products were visualized on 3 percent agarose gels. Both DNA strands were then sequenced using fluorescent-labeled dideoxy terminator cycle sequencing chemistry using the ABI 373A DNA sequencer (ABI, Foster City, CA). The *Seq A* and *AutoAssembler* programs (ABI, Foster City, CA) were used to align and overlap both sequenced strands of DNA, allowing for the visual inspection of any ambiguities in the sequence.

Amplification of the Y-chromosome and autosomal microsatellites used 10 μL of DNA added to 200 μM of dNTPs, 10 mM Tris-HCl (pH=8.3), 50 mM KCl, 1.0-2.0 mM MgCl_2 , 0.6 units of AmpliTaq polymerase (Perkin Elmer), and 0.33 μM of primers. The PCR cycling conditions were 93°C for 3 minutes, 10 cycles at 94°C for 15 sec, 55°C for 15 sec, and 72°C for 30 sec. Then samples were run at 20 cycles at 89°C for 15 sec, 55°C for 15 sec, and 72°C for 30 sec. The final extension cycle was at 72°C for 10 minutes.

Results

Results of the molecular genetic analyses of the second subsample indicated a strong West and/or Central African ancestral presence in the studied NYABG individuals. Only three of the mtDNA from sampled individuals exhibited unknown

molecular variants of mtDNA. Even in these cases, an African maternal ancestral origin may be present, as the background database on African mtDNA diversity is still in an early stage of development.

Analysis of the third subsample included 48 bone and two hair and/or tissue samples from the NYABG. Analyses were completed in 1999.

Contamination prevention was maintained by autoclaving and purification by filtration of all buffers and water. Disposable lab coats and gloves were used during all steps. Benches and equipment were treated with bleach and irradiated by UV light. All pipette tips contained filters. PCR reagents were separated into aliquots. The mortar and pestle (used to grind the bone into a fine dust) was treated with 1N HCl, rinsed and double-distilled (dd) water, and UV irradiated before each use.

Pre-extraction practices involved small samples of bone being cleaned by cutting off about 2 mm of the entire bone surface with sterile scalpel blades.

DNA extraction and isolation used internal bone fragments (300-500 mg) ground into a fine dust using a project-dedicated mortar and pestle. The ground bone was then incubated in 1000 μ l of guanidinium thiocyanate (GuSCN) extraction buffer overnight at room temperature. The extraction buffer consisted of 4.7M GuSCN, 20 mM EDTA, 46 mM Tris (pH=8.0), and 1.2 percent Triton X-100. After incubation, the solid tissue remains were pelleted by centrifugation and supernatants added to a silica suspension. Nucleic acids were isolated and eluted into 30 μ L aliquots. A blank extraction containing all reagents but no tissue was included in every set of extractions, as a control.

PCR amplification and sequencing used four sets of primers to amplify the hypervariable segment 1 (HVS-1) of mtDNA. The primers produced overlapping fragments of a 300 base pair segment of the HVS-1. Amplification of mtDNA was performed in 30 μ L reaction volumes of 150 μ M dNTP's 10 mM tris-HCl (pH=8.3), 50 mM KCl, 1.0-2.0 mM MgCl₂, 0.6 units of AmpliTaq polymerase, 3.0 μ L of 5 μ M primer mix and 7.5 μ L of the DNA extract. The PCR conditions consisted of 40 cycles at 95°C for 50 sec, and 72°C for 50 sec. Amplification products were visualized on 3 percent agarose gels. Both DNA strands were then sequenced using fluorescent labeled dideoxy terminator cycle sequencing chemistry (ABI) and the ABI 373A DNA sequencer (Foster City, CA). The *Seq A* and *AutoAssembler* programs (ABI, Foster City, CA). The *Seq A* and sequenced strands of DNA allowed for the visual inspection of ambiguities in the sequence. Sequence comparisons were accomplished using *PAUP Version 4.0* (Swofford 1999). Due to the large data set, an exact search was unfeasible, so extensive branch swapping was performed in order to find optimum trees.

Results

Results from the molecular genetic analysis of the third subsample allowed the comparison of our results with a database of published mtDNA sequences from around the world. Currently 1,800 sequences have been entered in the database. Accessible Native American and European sequences were represented among the published mtDNA sequences; however, of the 48 mtDNAs sequenced, 45 evidenced mtDNA haplogroups found in West and Central African populations and their recent descendants. The remaining three sequences were unknown, as previously noted. In the published mtDNA database, the number specific to African populations is about 849. Among these

849, those observed in West and Central Africa includes a total of 520 populations. The database includes individuals sampled from the following countries: Benin, Burkina Faso, Cameroon, Central African Republic, Guinea, Mali, Morocco, Niger, Nigeria, Senegal and Sierra Leone. For each country, we noted the geographical region and nearest probable historical export site for enslaved Africans bound for the Americas during the seventeenth and eighteenth centuries (Table 5.7):

Table 5.7: Countries, Geographical Regions, and Historical Export Sites for Enslaved Africans

MODERN COUNTRY Represented in the 1999 Database	GEOGRAPHICAL REGION Represented in the 1999 Database	NEAREST PROBABLE HISTORICAL SLAVE EXPORT SITE(S)
Benin	West Africa	Bight of Benin
Burkina Faso	West Africa	Gold Coast
Cameroon	West Central Africa	Bight of Biafra
Central African Republic	Central Africa	Bight of Biafra
Guinea	West Africa	Senegambia/Upper Guinea
Mali	West Africa	Senegambia
Morocco	Northwest Africa	Moroccan west coast
Niger	West Africa	Senegambia
Nigeria	West Africa	Bight of Biafra/Bight of Benin/Calabar
Senegal	West Africa	Senegambia
Sierra Leone	West Africa	Windward Coast

At the time of our analyses, no samples were included on the published database from Ghana, Angola, Gabon, Congo, Liberia, or other areas known historically to have included important catchment areas or export sites for the transatlantic trade in enslaved Africans to the Americas.

Nucleic acids were extracted from all 48 of the bone samples provided in this subset of the NYABG. Extractions from the two tissue samples, burials numbered 23 and

97, failed to yield adequate DNA. For the successful 48 DNA extractions, mtDNA control region sequences (<300 bp) were amplified by PCR and the products visualized using ethidium bromide stained agarose gels. Direct sequencing of the products revealed several polymorphic sites among the samples.

The level of genetic diversity observed in subsample three from the NYABG was quite high. Forty-five of the 48 sequences were unique and the haplotype diversity closely approached 1.0 ($0.997 + 0.01$). This high level of haplotype diversity is common for populations of African descent (Watson et al 1997; Vigilant et al. 1991). Countries, geographical regions, and macroethnic groups are listed when haplotypes appear restricted to such units. Sequences that are phylogenetically related to West or Central African sequences, but are not observed in any particular geographical region or among a specific macroethnic group are designated West/Central AFRICAN. Haplogroups are also noted. Although there has been limited and sporadic sampling of Africans for genetic studies, by 1999 many studies had identified at least three mtDNA haplogroups in African populations: L1, L2, and L3. Table 5.7 details the genetic affinity of samples as they relate phylogenetically to the published data (as of 1999).

All three haplogroups were observed in the third subsample from the NYABG individuals. Not surprisingly, the L1 haplogroup is observed in the least sampled geographical area of Africa; so we expect that it may be more common than reported. Haplogroup L2 is common among the Niger-Kordofanian speakers from the Senegambia and Gold Coast regions of West Africa. The L2 haplotypes, which may represent the descendants of migrants of Bantu speakers into West Africa, constitute 69.5 percent of the studied ABG individuals.

The third mtDNA haplogroup, L3, is quite common in East Africa and in the Horn region of Africa. While the L3 group is more common in East Africa, it is observed at an appreciable frequency in West Africa, particularly among Afro-Asiatic speakers. Since many of the enslaved Africans were derived from more inland areas of West and Central Africa, such as northern Nigeria, northern Cameroon, and southern Niger, for example, this may explain our observation of the L3 haplogroup in 21.7 percent of the NYABG individuals. Table 5.8 summarizes the molecular genetic affinities of the NYABG sample.

Table 5.8: Molecular genetic affinities of 48 individuals of the NYABG

Burial #	Catalog #	Tissue Site Sampled	mtDNA Haplo-group	Geographical, Country, And Macroethnic Genetic Affinity
1	93	R. Radius	L2	West/Central AFRICAN
6			L2	West Africa, Benin (Fulbe peoples)
7	Not Indicated	Not Indicated	L3	West Africa, Niger
9	233	R. Radius	L2	West Africa, Benin (Fulbe peoples)
11	267	R. Ulna	L2	West/Central AFRICAN
12	Not Indicated	Not Indicated	L2	West/Central AFRICAN
16	326	R. Ulna	L2	West/Central AFRICAN
20	310	R. Fibula	L2	West/Central AFRICAN
25	358	R. Ulna	L3	West/Central AFRICAN
32			L3	West Africa, Niger
37	460	R. Fibula	L2	West/Central AFRICAN
40	489	R. Fibula	L3	West Africa, Niger
47	619	R. Ulna	L2	West Africa, Benin (Fulbe peoples)
49	641	R. Fibula	L2	West/Central AFRICAN
51	700	R. Fibula	L2	West/Central AFRICAN
56	793	R. Radius	L3	West Africa, Niger
58	Not Indicated	Not Indicated	L2	West/Central AFRICAN
63	Not Indicated	Not Indicated	L2	West/Central AFRICAN
67	810	R. Radius	L2	West/Central AFRICAN
71	813		L2	West/Central AFRICAN
73	815	R. Radius	L2	West Africa, Nigeria (Yoruba peoples)
76	819	R. Fibula	L3	West Africa, Niger
89	830	R. Ulna	L1	West/Central AFRICAN
97	840	R. Ulna	L2	West Africa, Nigeria (Fulbe peoples)
101	843	Not Indicated	L3	West Africa, Niger
105	Not Indicated	Not Indicated	L1	West/Central AFRICAN
107	850	R. Fibula	L2	West Africa, Nigeria (Hausa peoples)
115	858	R. Fibula	L3	West Africa, Niger
122	867	R. Ulna	L2	West Africa, Nigeria (Hausa peoples)
135	878	R. Fibula	L2	West//Central AFRICAN
138	883	R. Fibula	L2	West Africa, Senegal (Mandinka peoples)
144	Not Indicated	Not Indicated		West/Central AFRICAN
151	896	R. Ulna	L2	West/Central AFRICAN
154	899	R. Fibula	L3	West Africa, Niger
158	903	R. Fibula	L2	West Africa, Senegal (Mandinka peoples)
171	931	R. Ulna	L1	West/Central AFRICAN
176	Not Indicated	Not Indicated	L2	West/Central AFRICAN
180	960	R. Radius	L2	West Africa, Senegal (Mandinka peoples)
194	Not Indicated	Not Indicated	L2	West Africa, Nigeria (Fulbe peoples)
219		R. Fibula	L3	West Africa, Niger
226	Not Indicated	Not Indicated	L2	West/Central AFRICAN
233	Not Indicated	Not Indicated	L2	West Africa, Benin (Fulbe peoples)
242		R. Fibula	L2	West Africa, Nigeria (Fulbe peoples)
310		R. Rib	L2	West/Central AFRICAN
335		R. Ulna	L2	West/Central AFRICAN
340	Not Indicated	Not Indicated	L2	West Africa, Nigeria (Fulbe peoples)

Genetic Initiatives and Protocols for 2000 – 2004

When 219 NYABG samples were transferred to the Bioanthropology Research Laboratory at the University of Maryland in 2000, our initial assessment identified four major problem areas:

1. Inadequate database on contemporary and archaic African genetic
2. Diversity High levels of intra-African genetic variability
3. Complex ethnic histories and demographic patterns
4. Difficulty in extracting sufficient quantities (and quality) of archaic skeletal DNA for multiple analyses

Our solutions were to:

1. Establish an International Advisory Board of senior anthropological geneticists
2. Identify historians and anthropologists with specific regional expertise
3. Utilize pooled regional samples to recreate regional clusters of marker genes (possibly using DNA microarrays)
4. Apply advanced biotechnological techniques to recover ancient DNA and test against regional pools
5. Set up a National African DNA Bank(s) for future reference

Our initial focus was to address the serious lapses in the existing database on African genetic diversity on the continent and throughout the Atlantic diaspora. For some time we had known that the limitations in the existing comparative database posed a significant hindrance to the reliable placement of NYABG individuals in particular geographical regions of Africa and among specific contemporary African macroethnic

groups. In an effort to begin to tie particular genetic variants to specific regional areas of the world, we began several important initiatives.

In 2000, several senior geneticists agreed to serve on an advisory board related to genetic analyses for the NYABG. They were Dr. Kenneth Kidd (Yale University), Dr. Kenneth Weiss (Pennsylvania State University), Dr. Michael Crawford (University of Kansas), Dr. Robert Ferrell (University of Pittsburgh), Dr. Alain Froment (Orleans University) and Dr. Robert Murray (Howard University).

Information from the ABGP historians suggested that West Central Africa was an important source of the Africans of Eighteenth Century New York. Therefore, we recruited and worked closely with the following regional experts:

- Dr. Paul Nkwi, Executive Secretary, Cameroon Academy of Sciences, Editor of *African Anthropologist*, and internationally known social anthropologist
- Professor Victor Ngu, President, Cameroon Academy of Sciences, noted physician and inventor
- Dr. Peter Ndumbe, Dean, Medical School, University of Yaounde 1, physician, specialist in infectious disease, and director of the Research Institute associated with the Medical School
- Dr. Ugo Nwokeji, Professor of History, University of Connecticut, expert on the export of West and Central Africans during the transatlantic slave trade
- Dr. Charles Dimintyeye, Cultural Attaché, Embassy of the Republic of Cameroon, Washington, DC, professor of French and expert on francophone West and Central Africa

- Professor Joseph-Marie Essomba, Professor of Archaeology, University of Yaounde I, expert on archaic evidence for human occupation in West and Central Africa.

In 2000-2002 efforts were underway to develop the first human DNA bank in Africa. Dr. Fatimah Jackson made two critical collaborative contacts: Dr. Jeanne Beck, Vice President of Coriell Institute for Medical Research, Camden, NJ and Dr. Peter Ndumbe, Dean of the Medical School, University of Yaounde I, Yaounde, Cameroon. After a series of meetings and working sessions with scientists at Coriell Institute for Medical Research (New Jersey Medical and Dental School) and the University of Yaounde I College of Medicine (Yaounde, Cameroon, West Central Africa), plans were implemented to lay the foundations for this bank. Cameroon's central location in Africa, highly genetically diverse population, as well as the presence of an adequately developed infrastructure and enthusiastic and supportive scientific and political communities made the country an ideal choice for housing this bank. Coriell Institute for Medical Research offered to train Cameroonian technicians in DNA banking techniques. The University of Yaounde I offered its Research Institute as a permanent site for the bank. With the permission and support of the Cameroonian Academy of Sciences, the Cameroon Prime Minister's Office, and the Ministry of Health, the bank was formally begun in July 2002. In November 2002 an international workshop was held in Yaounde, Cameroon where the goals and objectives of the bank were outlined, its direct relationship to the ABGP indicated (Dr. Michael Blakey was among the participants at the workshop), and the plans were laid for a collaborative grant proposal to the National Institutes of Health to support the bank. To date, the bank has already collected and extracted DNA samples

from over 400 West and Central Africans and is officially linked, through the Ministry of Tourism, with UNESCO's "Route of the Slaves" Project.

In 2002, Dr. Jackson began discussions with technical experts at Affimetryx Corporation to develop a DNA microarray that would provide rapid assessments of African regional markers. At that time, each gene chip could contain 2,000 single nucleotide polymorphisms (SNPs). Our plan is to identify, through the literature and through direct collections, regional African variation in SNPs. SNP variation among specific African regions will then be used to design custom-made DNA microarrays for target testing, analysis (bioinformatics), and interpretation. The geographical regions identified as major sources of genetic polymorphism for Eighteenth Century New York Africans include: Central Africa, Bight of Biafra, Mozambique, Senegambia, Upper Guinea, Bight of Benin, and the Gold Coast. We continue to concentrate our research on groups from these geographical regions as they provide the strongest baseline information on the NYABG ancestral template; these regions provide insights into Eighteenth Century levels of African-American genetic sequence polymorphisms. Further, these regions most powerfully permit reconstructions of African and non-African origins. Our methods for these ethnogenetic reconstructions include the following:

1. Archaic Map Analysis
2. Regional Ethnic Reconstructions
3. Group Displacement Tracking
4. Ethnic and Regional Verification using Alternative Documentation
5. Geographical Information System (GIS) Mapping using Vector and Raster Maps

6. Contemporization of the findings (i.e., determining the modern equivalents)
7. Statistical Analysis

In 2003-2004 Dr. Jackson received Institution Review Board (IRB) clearance to initiate genetic studies among the African-descended student, faculty, and staff population at the University of Maryland. The aims of this project were to:

1. Attract 100 to 200 African, Afro-Caribbean, and African-American students currently enrolled at the University of Maryland to a workshop-dinner on genetics and health;
2. Provide these students with an opportunity to extract DNA from various fruits, to learn about some of the latest advances in the genetics of disorders disproportionately affecting peoples of African descent; and
3. Collect and analyze buccal cell samples from each student for the presence of genes associated with specific regional origins. This DNA will become part of a database for future comparative analyses with the NYABG individuals.

To date, we have collected 183 DNA samples from individuals from all over the world, including Europe (Scotland, Ireland, Denmark, Germany, Italy, Spain), South America (Brazil, Colombia, Peru), Asia (Nepal, India, Butan, Pakistan, China, Korea) and Africa (Ghana, Nigeria, Cameroon, Liberia, Congo, Guinea, Ethiopia, Senegal, Kenya, Tanzania), as well as the United States. In April 2004, our first paper was presented at the annual meetings of the American Association of Physical Anthropology entitled “African-American lineage markers: determining the geographic source of mtDNA and Y chromosomes” (Lorenz et al. 2004).

Future Genetic Studies of the New York African Burial Ground Samples Specific Genomic Segments to be Evaluated

Continuation of the mtDNA Studies

Over the last 9 years, our research team has clearly demonstrated the ability to successfully extract, isolate, sequence, and analyze mtDNA from 200-300 year old skeletal material. Using the improved techniques now available, our continued studies of MtDNA present an excellent opportunity to make within-group delineations, particularly among Africans. The mtDNA haplogroup **L3e**, which is identified by the restriction site +2349 MboI within the Afro-Eurasian superhaplogroup **L3** (-3592 HpaI), is omnipresent in Africa but virtually absent in Eurasia (except for neighboring areas with limited genetic exchange). **L3e** had previously been poorly characterized in terms of HVS-I motifs, as the ancestral HVS-I type of L3e cannot be distinguished from the putative HVS-I ancestor of the entire **L3** (differing from the CRS by a transition at np 16223). However, recently Bandelt and colleagues (2001) undertook the MboI screening at np 2349 of a large number of Brazilian and Caribbean mtDNAs (encompassing numerous mtDNAs of African ancestry), and revealed that **L3e** is subdivided into four principal clades, each characterized by a single mutation in HVS-I, with additional support coming from HVS-II and partial RFLP analysis. Apparently the oldest of these clades (transition at np 16327) occurs mainly in central Africa and was probably carried to southern Africa with the expansions of the Bantu peoples. The most frequent clade seems to be prominent in many Bantu groups from all of Africa. In contrast, a second clade is essentially restricted to Atlantic Western Africa (including Cabo Verde). This should permit us to distinguish between Senegambians and Central Africans within the NYABG sample. Our most recent work on mtDNA compares Cameroonians, Senegalese, and African

Americans and suggests significant differences in **L1/L2**, **L3d**, and **L3e** among the three groups: (see Table 5.9)

Table 5.9: Distribution of Haplogroups in the African and African-American Populations

Population	L1/L2	L3b	L3d	L3e	Non-L	Unknown
Cameroon	43.2%	7.4%	3.7%	19.8%	9.9%	16%
Senegal	61.1%	9.7%	6.2%	9.7%	10.6%	2.7%
African American	50.6%	7.1%	9.4%	14.1%	18.8%	0%

Of particular note are the 16 percent unknown (meaning samples that did not amplify for one or more haplogroup markers) among the Cameroonians (compared with 2.7 percent among the Senegalese and 0 percent among the African Americans) and the 18.8 percent non-L among the African Americans (probably an indicator of past maternal gene flow from non-African individuals).

Continuation of Y-Chromosome and Autosomal Studies

In addition to the mtDNA studies, we plan to return to our investigations of the Y-chromosome. The Y-chromosome DNA polymorphisms have been studied extensively and found to be useful in distinguishing between major continental groups as well as detecting within group variability. At least 13 years ago, Torroni and colleagues (1990) observed that several Y-specific TaqI fragments are recognized by 49a and 49f probes in human male DNA digests. The occurrence of polymorphic variations in six of these fragments (A, B, C, D, F and I) has already been well reported in the published literature, and these provide a potentially powerful tool for the study of the population genetics of the Y chromosome. The 49a-49f/TaqI polymorphisms were studied recently in 121

Africans from Senegal and Cameroon, two important origins sites for the Africans of the NYABG, and 125 Europeans from Italy. Four new bands were observed, of which, three (new) patterns were found. In each of these patterns, bands were consistently present in which (G, O and H-P-R) were missing. However, among the Africans tested, all lacked C and D fragments. Moreover, a band, A1, characterized about 80 percent of the Senegalese and Cameroonians, but was not present in the Italian group. The combination of A1C0D0 could therefore be a powerful genetic marker of paternal West or West Central African ancestry. This combination occurs in five haplotypes, one of which, haplotype IV, accounts for 68 percent of the African sample. In contrast with the results of the mtDNA analysis on the same population samples, the degree of variability displayed by these (and other) Y chromosome sequences appears to be much lower in Africans than in Europeans. For example, Watkins and colleagues (2001) analyzed 35 widely distributed, polymorphic Y-chromosome Alu loci in 715 individuals from 31 world populations. The average frequency of Alu insertions (the derived state) was lowest in Africa (.42) but higher and similar in India (.55), Europe (.56), and Asia (.57). A comparison with 30 restriction-site polymorphisms (RSPs) for which the ancestral state has been determined shows that the frequency of derived RSP alleles is also lower in Africa (.35) than it is in Asia (.45) and in Europe (.46). Neighbor-joining networks based on Alu insertions or RSPs are rooted in Africa and show African populations as separate from other populations, with high statistical support. Correlations between genetic distances based on Alu and nuclear RSPs, STR polymorphisms, and mtDNA, in the same individuals, were high and significant. Y-chromosome data are important in our biological affinity reconstructions in that we anticipate that we will encounter non-African Y-chromosome

haplogroups in some proportion of the NYABG individuals born outside of Africa (e.g. in the Americas) and interred during the Eighteenth century in particular.

Given the limitations of aDNA, we plan also to study the distributions in the NYABG of the following tetrameric short tandem repeat (STR) polymorphisms: STR loci D3S1358, VWA, FGA, D8S1179, D21S11, D18S51, D5S818, D13S317, D7S820, CSF1PO, TPOX, TH01, and D16S539.

Application of Specific Genomic Segments to Particular Research Questions

The three applied genetics topics that will be investigated will be ancestral origin, biological affinity, and molecular sex. We propose to test hypotheses that revolve around four central questions:

1. What geographical regions of Africa are represented in the NYABG individuals?
2. What degree of biological affinity exists among closely interred individuals in various sections of the NYABG?
3. What is the relationship between molecular sex and anthropometric sex in the ABG population?
4. Can we distinguish molecular sex-linked differences in various sources of stress (age, infection, nutrition, biomechanical) in the NYABG individuals?

mtDNA analysis is central to our ancestral origins and biological affinity analyses because of the anticipated low level of admixture in the earliest burials of the NYABG. Following these analyses in importance are our assessments of the Y-chromosome STRs. The importance of these data in biological affinity studies and molecular sex determinations is reflected in the initial sex ratio disparities in importation of enslaved

Africans into New York City's enslaved population base. Both mtDNA and Y-chromosome STR studies however must be supplemented with other autosomal genetic information (STRs) as discussed above. These nuclear DNA based data are essential for two major reasons. They fill in the biological lineage reconstructions by including the non-gender based ancestral genetic contributions, and they are necessary to begin to localize geographically the probable historical ancestral origins of studied individuals. Recent studies have found that fragments of up to 800 bp in length can be reproducibly amplified from aDNA extracts (Haack et al. 2000). In particular, we plan to amplify the short tandem repeat (STR) locus HUMVWA31A, and use this to address, in part, the biological affinity and grave location questions as well as address the development of individualized allelic profiles. Authentication of the amplified fragments will be carried out by measures of expectancy.

Ancestral Origin Studies: Research Hypotheses and Analytical Methods

From our previous studies of various subsamples of the NYABG, it is clear that it is possible to identify the ancestral origin of NYABG individuals and to determine, for an important proportion, their likely geographical regions within West and Central Africa (and even their probable macroethnic affiliations). These intriguing results revealed in 1999 suggest that even further refinements are possible using the expanded databases (public and private) to which we now have access. The geographical regions of West and Central Africa on which we are focusing our DNA microarray efforts are elaborated in Table 5.10.

Table 5.10: African Geographical Regions Currently Under Investigation as Sources of Genetic Polymorphisms

Geographical Region (based on historical slave export sites)	Inclusive Modern Countries	Status of Genetic Investigations (as of June 2004)
Central Africa	Angola, Republic of Congo, Democratic Republic of Congo, Gabon, Equatorial Guinea, Cameroon, Central African Republic, northern Namibia	Contact made with Embassies of Angola, Gabon, Cameroon. Establishment of National human DNA bank in Cameroon. Formal collaborative relationship with Cameroon Academy of Sciences, UNESCO "Route of the Slaves" project.
Bight of Biafra	Western Cameroon, Eastern Nigeria	DNA collections made in western Cameroon
Mozambique	Mozambique, Madagascar	Contact made with Embassy of Mozambique, official correspondence with colleagues in Madagascar
Senegambia	Senegal, Gambia, Northern Guinea, Southern Mali, Southern Mauritania, Guinea Bissau	DNA collections made in Senegal. Contact made with Embassy of Mauritania, correspondence with colleagues in Guinea
Upper Guinea	Southern and Western Guinea northwestern parts of the Windward Coast (Sierra Leone and Liberia)	DNA collections made in Liberia. Limited genetic collections from Sierra Leone
Bight of Benin	Benin, Western Nigeria, Southeast Niger	
Gold Coast	Ghana, Burkina Faso, Eastern Cotê d'Ivoire, Southeast Niger	DNA collections from Ghana
Other	Western Morocco	Contact with Embassy of Morocco

Basically, our earlier genetic studies of subsamples of the NYABG have begun to address both of the two major research questions we considered when we began our investigations in 1995:

1. Can we distinguish between continental groups (Africans, Europeans, and Native Americans as a subset of Asians) at the genetic (and/or phenotypic) level(s)? If this is possible, then the second issue is:

2. Can we distinguish genetically (and/or phenotypically) among Africans, among Europeans, and among Native Americans coming from various historically relevant areas and germane ethnic groups within a specific continent? Most importantly, since the individuals of the ABG appear to be Africans, can we distinguish among Africans from various geographical regions and between different localized macroethnic groups of Africa?

The continued ancestral origins analysis of the NYABG individuals is aimed at determining where in Africa they likely came from and, when possible, from among which local and regional groups. These data will make an important contribution to anthropological genetics, African diasporic history, US colonial history, and our understanding of the peopling of Eighteenth Century New York.

Biological Affinity Studies: Research Hypotheses and Analytical Methods

The burial locations of interred individuals and the biological lineage relationships among co-interred and closely interred individuals are the foci of our first cluster of null and alternative hypotheses. There are numerous shared graves in the NYABG of women with infants and older children buried with younger children. In burials 326 and 374 there is evidence of an adult male of about age 50 co-interred in the same grave shaft with an infant under six months of age. Molecular analyses should indicate to what extent these two individuals were biologically related. Another application of the molecular testing of inter-individual biological affinities addresses the interrelationships of closely interred individuals as well as the affinities of all 400 studied

NYABG individuals. Were the various sections of the excavated burial ground a final resting place for related individuals, for one gender versus both, for infants, children and subadults and not adults? Was the total excavated section of the NYABG a familial or ethnically delineated portion of the overall Burial Ground and thus housed family groups? Or, were the burial sites, in general, the final resting places of biologically unrelated individuals? In terms of kinship and biological lineage affinity, does the placement of deceased individuals in the NYABG have any significance?

For addressing these questions, we have developed the following cluster of specific null hypotheses:

- *H_{oI}*: Interred individuals of the NYABG show no evidence of overall or sectional structured burial placement by molecular sex identity and/or by age.
- *H_{oII}*: Co-interred individuals of the NYABG show no greater evidence of biological affinity as measured by molecular genetics than that seen among the NYABG residents in general.
- *H_{oIII}*: Geographically closely interred individuals of the NYABG show no greater evidence of biological affinity than that seen among the NYABG residents in general.
- *H_{oIV}*: Burial placement is uninfluenced by various indices of stress, including infection, nutritional deficiency, or biomechanical stress.

The alternative hypotheses regarding the intra-group biological affinity of the NYABG sample include:

- *H_{aI}*: Interred individuals of the NYABG show evidence of overall patterned interment by age, molecular sex, and familial groups including sectional sex groupings, sectional age groupings, and sectional familial groups (based on evidence of structured biological lineage affinities).
- *H_{aII}*: Co-interred individuals of the NYABG show greater biological affinity to each other than that seen in general among NYABG residents.
- *H_{aIII}*: Geographically closely interred individuals of the NYAGB show stronger biological affinity than do the individuals of more distantly placed burials.
- *H_{aIV}*: Among interred individuals, burial placement is influenced by osteological evidence of infectious disease but not by evidence of nutritional deficiency or biomechanical stress.

We plan to study the burial ground by initially partitioning it into sections based upon the designations of the NYABG archaeologists, noting the arrangements of coffins, existing barriers on site, and the timing and vertical placements of burials. Next, we will merge these sections to do comprehensive overall assessments. We will be looking for clusters of STRs, mtDNA, and Y-chromosome haplotypes that correspond to geographic proximity of burial site. We are particularly interested in the genetic analyses of the following co-interred burial dyads and triads: 12 and 14; 25 and 32; 72, 83, and 84; 79 and 90; 89 and 107; 94 and 96; 121 and 202; 142, 144, and 149; 146 and 145; 159 and 161; 225 and 252; 226 and 221; 255 and 265; 263 and 272; 268 and 286; 219 and 235; 311 and 316; 314 and 338; 318 and 321; 320 and 334; and 326 and 374.

To test the hypotheses (I-IV) presented above, the molecular genetic profiles (aDNA-based) of all interred individuals will be studied and correlated with geographical proximity of interment site. Correlation coefficients and multi-way analysis of variance will be determined for extensive within-group comparisons, both in the archaeologically designated sections and for the overall burial ground area. An alpha value of 0.05 will be considered significant at both levels of assessment (within section and overall).

Due to the extensiveness of the NYABG area, we will use Geographical Information Systems software (GIS), discussed below, to plot the burial ground (using a raster maps) and then superimpose upon these raster maps the genetic and osteological information. The sections will be merged using GIS to produce general and specific maps; this should permit faster, better-integrated, 3-dimensional assessments of the interrelationship of geographical proximity and biological affinity. This approach is particularly important since biological affinity may be evident in some sections of the burial ground but not in other sections. Furthermore, the use of GIS will permit easily visualized evidence of any patterning or substructuring with respect to burial position and biological lineage affinity as well as its statistical assessment.

Application of Geographical Information Systems (GIS) to New York African Burial Ground

GIS will be used to effectively depict multi-tiered information on the NYABG by transforming geographic, historical, osteological, and molecular data into vector and raster maps using either AutoCAD (AutoDesk), ArcView (ESRI) or Arc/Info (ESRI). Vector maps will be produced for demarcated sections of the burial ground as well as for the burial ground as a whole. The locations of clustered coffins and multi-person burials

will be noted by defining each feature of the NYABG by a point in space. We will then connect the points to draw lines and area outlines. Image data will be added to our vector data to provide general geographical points of reference. The analysis of vector data involved summarizing the attributes in the layers of molecular sex, age, infectious disease, nutritional deficiency, biomechanical stress, and molecular genetic markers data tables. Raster maps will be used for continuous numeric values (such as intensity of infectious disease) using the age clusters as our cell size. ArcView's Spatial Analyst will allow us to sample, model, and grid raster based data (reclassification, interpolation, creation of surfaces).

Molecular Sex Determinations: Research Hypotheses and Analytical Methods

We plan to study the molecular sex of the NYABG individuals, focusing first on the unsexed infants, young children, and subadults among the interred. Dr. Jackson has taken the lead in writing a proposal to the National Science Foundation seeking support to identify the molecular sex of all individuals recovered from the NYABG and then comparing these results with their anthropometric sex, when available. With this unique database in place, we hope to test a number of hypotheses aimed at exploring gender bias in mortality by age, by osteological evidence of infection, nutritional deficiencies, and biomechanical stress, and by physical location within the section of the NYABG excavated. As mentioned in the previous section, we also seek to identify the molecular sex of co-interred individuals as well as individuals buried in close proximity within various sections of the excavated NYABG.

All molecular sex determinations will be based on standardized aDNA analyses while all anthropometric sex determinations, as well as evidence of osteological infections and biomechanical stress, will derive from recently completed assessments of the skeletal biology research team of the NYABG.

Since sex identity has an important influence on so many other variables, constructing the sex composition of the sample is an essential component in fully characterizing the NYABG individuals. Morphological and morphometrical analyses of skeletal remains usually give reliable access to the gender of mature individuals while the analyses of skeletal remains of immature individuals allocate only 70-90 percent of the individuals (Lassen et al 1997). In the NYABG, 65 infants, 44 children, 24 subadults, and X adults remain unsexed. For these individuals, molecular sex data will be invaluable.

Therefore, the second cluster of specific null hypotheses includes the following:

- H_oV : Molecular sex determinations correspond with (are identical to) anthropometric sex determinations.
- H_oVI : No molecular sex bias is evident in the pooled sample; overall, the number of genetic males equals the number of genetic females in the NYABG sample.
- H_oVII : No molecular sex bias is evident at any age group among infants, children, subadults, and adults in the sample.
- H_oIX : No molecular sex bias is evident by osteologically-evident infection in any age group among infants, children, subadults, or adults in the sample.

- H_oX : No molecular sex bias is evident by osteologically-evident nutritional deficiencies in any age group among infants, children, subadults, or adults in the sample.
- H_oXI : No molecular sex bias is evident by biomechanical stress in any age group among children, subadults, or adults in the sample.

The second cluster of alternative hypotheses regarding molecular sex includes:

- H_aV : Molecular sex determinations do not correspond with anthropometric sex determinations; molecular sex determinations indicate more females than were evident anthropometrically.
- H_aVI : There is evidence of molecular sex bias among pooled interred individuals, and the number of genetic males is greater than the number of genetic females.
- H_aVII : There is evidence of molecular sex bias by age with more genetic males than genetic females at each age group among infants, children, subadults, and adults in the sample.
- H_aIX : There is evidence of molecular sex bias by osteologically-evident infection in each age group with genetic females showing more osteologically-evident infection than genetic males.
- H_aX : There is evidence of molecular sex bias by osteologically-evident nutritional deficiencies in each age group with genetic females showing more osteologically-evident nutritional deficiencies than genetic males.

- H_{aXI} : There is evidence of molecular sex bias by biomechanical stress in each age group with genetic males showing more biomechanical stress than genetic females.

To test the above-referenced null hypotheses (H_0 -XI), we will use extracted aDNA from each interred individual to characterize and identify molecular sex from bone samples from the NYABG individuals, which have already been collected from different skeletal elements. Ancient DNA (aDNA) will be isolated from these skeletal elements by a combination of automated phenol/chloroform extraction and precipitation with silica powder. A combination of manual Chelex extraction and a purification kit will also be used to perform an extraction (as per Lassen et al. 2000). Finally, the aDNA extracts will be amplified with a primer system that amplifies a part of the amelogenin gene located on the human sex chromosomes. These characterizations will be performed double-blind; that is, we will not be aware of the previously done anthropometric sex determinations while the molecular sex identities are being determined. Further, the anthropometric sex determinations will have been made without knowledge of the molecular sex identities. These latter molecular sex identities will then be compared statistically to determine the correspondence between molecular genetic and anthropometric results. We will then return to the molecular sex identities and partition the interred individuals by their molecular sex and osteologically determined age groupings. Molecular sex determinations will be especially important for the interred NYABG infants and young children for whom it was often impossible to determine anthropometric sex. An alpha level of 0.05 will be considered statistically significant. This strategy will also allow us to effectively consider the alternative hypotheses associated with this first cluster.

Summary of Planned Future Analyses and Proposed Timetable

The genetic analysis of the NYABG provides a unique opportunity to explore and understand human biology and biodiversity at a very technologically sophisticated level. To our knowledge, our studies represent the first attempt to characterize an African/African-American historical population at the molecular genetic level of assessment. With full access to the NYABG samples and adequate time to complete these analyses, we feel that a major contribution can be made to the knowledge base, with positive effects for the entire nation. Table 5.11 summarizes the planned future analyses, the timetable for these analyses, and the support structures already in place to address these analyses.

Table 5.11: Anticipated Future Genetic Analyses of the NYABG Samples

Type of Analysis	Relevant Genomic Segments for study	Project Initiation Date	Anticipated Project Completion Date	Project Support Status as of June 2004
NYABG Ancestral Origins (African, European, Native American)	mtDNA haplogroups, Y-chromosome and autosomal STRs	2002	2009	Funding received from David C. Driskell Center for Diaspora Studies (UM) and Nyumburu Cultural Center (UM). Currently working on NIH proposal with colleagues at Coriell Institute for Medical Research
Biological Affinities among NYABG individuals	mtDNA haplogroups, Y-chromosome and autosomal STRs	2003	2007	Critical feedback received from NYABG archaeologists for “in progress” NSF grant proposal
Molecular Sex of NYABG individuals	Amelogenin gene located on the human sex chromosomes	2004	2008	NSF grant proposal in advanced stage of development

Chapter 6

Isotopic and Elemental Chemistry of Teeth: Implications for Places of Birth, Forced Migration Patterns, Nutritional Status, and Pollution

**A. Goodman, J. Jones, J. Reid, M. Mack, M. L. Blakey,
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Introduction

Concerns about individual and group origins are central to the study of the New York African Burial Ground (NYABG). A key goal of the project is to provide scientific insights into the geographic origins of individuals. Enslaved Africans came from different regions of Africa. Can we determine more precisely the geographic area where individuals and groups come from and what were their ethnic affinities? At what ages were enslaved individuals forced to involuntarily leave their homelands? Which individuals came to New York via the Caribbean or some other destination in North America? Who was first generation enslaved, and who was born into slavery?

Although origin questions are central to this project, providing insights into origins is difficult. To date, few methods provide clear answers. Historical documents such as slave ship manifests and auctions provide an overall and indispensable source of information on geographic origins, ethnicities, demographic patterns, and even names (e.g., see Gomez 1998; Hall 1992; Lovejoy 1997, 2003). However, there is no method we are aware of that can link these historical records to individual burials.

Archaeological information such as artifacts and burial position may suggest an individual's natal home (geographic place of birth), possible ethnic affinity, or status within an enslaved community (Corruccini *et al*, 1987a; Handler 1997; Samford 1994).

However, because cultural practices, such as placing a burial in extended position or facing east, are generally without fixed temporal and spatial boundaries, suggestions as to geographic and ethnic origins must be appropriately broad and speculative (DeCorse 1999) and sensitive to the fact that such practices potentially convey multiple messages (Perry and Paynter 1999).

Information derived from bones and teeth, that is, bioarchaeological information, may similarly provide insight into geographic and ethnic origins. Genetic information derived from bone and tooth size and shape, and more directly, from mitochondrial DNA (mtDNA) provide a means to compare an individual or group with values from contemporary “ethnic groups” (see Chapter 5; Watson et al. 1996; Jackson 1997). The resulting data provide insights into genetic, and by extension, ethnic affinities. While extremely powerful, these methods are also limited. Because humans historically do not live in closed communities, genetic traits and frequencies are fluid, open, and not culturally bounded. As well, the relationship between genetic affinity and ethnicity may change over time because of group fissioning, exogamy, and the fluidity of ethnic categories (Goodman 1997).

Other types of bioarchaeological information may provide insights into natal homes and ages at forced migration. For example, death in the first decade of life suggests that an enslaved child was born in the Americas versus Africa or the Caribbean because historical documentation shows that enslaved African New Yorkers were most often “*young adults from whom the buyer could expect many years of service*” (McManus 2001[1973]: 36; see also Lydon 1978). Corruccini et al. (1987b) suggest generalized tooth root hypercementosis associated with seasonal “rehabilitation” following cycles of

poor nutrition throughout most of the year may distinguish Caribbean-born from African-born individuals among an enslaved population in Barbados.

Conversely, Handler (1994) has suggested that culturally modified teeth (CMT), teeth that have been intentionally and decoratively chipped, filed or otherwise modified, in enslaved Africans in the Americas, is a marker of African natality. Permanent teeth begin to erupt after about six years (Smith 1991), and historical documentation of CMT in Africa consistently shows that the practice was most often performed on individuals approaching their teens and older (van Rippen 1918). More important still, Handler (1994) makes a strong case for the assumption that this cultural practice was discontinued under enslavement in the Caribbean and the Americas. In this chapter, we provide two pilot chemical tests of the hypothesis that young individuals were born into slavery and individuals with culturally modified teeth were enslaved in Africa.

One of the most exciting technical developments in analytical chemistry is the maturation of multiple techniques for analysis of the geographic origins of humans and other organisms with sequentially calcifying tissues such as fish otoliths and human teeth (Campana et al. 1994; Cox et al. 1996; Evans et al. 1995; Lee et al. 1999; Lochner et al. 1999; Outridge 1996; Outridge et al. 1995). At the time of rediscovery of the burial ground, chemical ecology studies were just beginning to show that strontium and oxygen isotopes in hard tissues reflect landscapes during their calcification and that each landscape has a somewhat unique elemental and isotopic signature (Ambrose 1991; Blum et al. 2000; Ericson 1985, 1989; Larsen 1997; Price et al. 1994a, 1994b; Schwarcz et al. 1991; Schwarcz and Schoeninger 1991; Sealy et al. 1991, 1995; White et al. 1998; see Figure 1). Emerging with the development of studies of enamel, which forms in early

life, these new techniques provided the first unambiguous methods for reconstructing human landscapes at the time of birth and through the first decade (Cox *et al.* 2001, Cox and Sealy 1997; Grupe 1998; Gulson *et al.* 1997; Sealy *et al.* 1995).

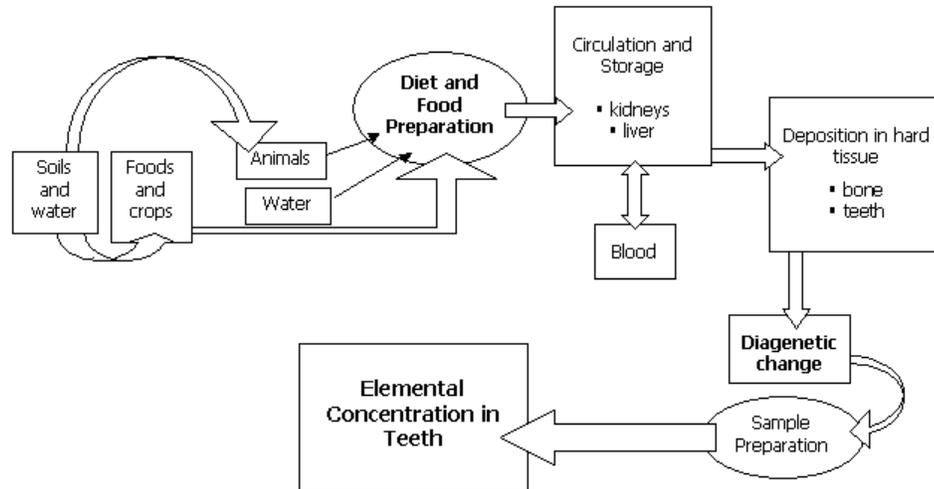


Figure 6.1: Elemental Uptake/Deposition Model

The ability to track individuals’ natal homes and then their ages at movement from their places of birth is based on the fortunate co-development and intertwining of three advancements:

- Better understanding of the geology and chemical ecology of landscapes.
- Better understanding of patterns of calcification of dental enamel, dentin and cementum.
- The development of chemical analytical methods that allow for the “microsampling” of enamel and other hard tissues.

The hard tissue samples provide a chemical signature of individuals at different ages at development. With samples taken from sequentially developing areas, one can track

changes over the life of an individual. Cementum provides information on annual changes (Evans et al. 1995; Hals and Selvig 1977; Tsuboi et al. 2000), whereas primary enamel and dentin can provide a chronology of change in early years and months.

The purpose of this chapter is to present results from our ongoing research on the use of multiple chemical methodologies to provide insights into the geographic origins and ages at migration of individuals from the NYABG. The first part of the chapter provides an overview of chemical methods that are relevant to a full study of geographic origins, ages at migration, nutritional status and pollution exposure. In the second section, we provide detailed methods and results of research that has been completed thus far on strontium isotope ratios and variation in multiple elemental concentrations, or elemental signature analysis (ESA). We then compare the chemical signatures of individuals assumed to be African born via the presence of modified teeth with individuals assumed to be born around New York because of their young age at death. We highlight an unexpected finding: that lead concentrations are significantly elevated in the individuals who were born in New York and that these elevations appear to begin in the first years of life. Finally, we discuss the implication of the completed research and the benefits that would accrue from additional research.

Tooth Development and Chemistry

Teeth contain unique information about past environmental and physiological conditions. The pattern of formation of enamel and dentine is clearly demarcated and ring-like, much like the rings of trees (Kreshover 1960; Goodman and Rose 1990) or more so, the leaves of an onion or artichoke. Furthermore, once formed, the dental hard tissues, and especially enamel, which is acellular and nearly totally mineralized, are

essentially inert (Carlson 1990). Earlier in this century, Massler et al. (1941: 36) confidently stated: "enamel and dentin in the formative and calcifying stages of their growth serve as kymographs on which are permanently recorded physiologic or pathologic changes in metabolism."

The potential of the dental hard tissues continues to be echoed through the second half of the twentieth century. In 1988, Sharon advocated for a scientific "tooth bank" because "*Teeth are storehouses of invaluable information for biological, physical, and medical sciences. . . . Teeth can provide keys to provenance, development. . . . exposure to pollutants and provide a permanent cumulative, qualitative, and quantitative record of insult*" (1988:124). In a commentary in *Science* on the developing field of biogeochemistry, Kohn (1999:335) notes that "enamel retains an exquisite microstructure produced when the animal precipitated its tooth and is the material of choice for terrestrial studies." All authors assert that with further research, teeth will yield information applicable to a wide variety of environmental and biological questions.

Indeed, teeth have begun to yield insights about life conditions during their formation. Starting with the work of Massler and colleagues (Sarnat and Schour 1941), many researchers have evaluated variations in enamel's external morphology and histological structure in relationship to histories of disease and other conditions that might disrupt development (see chapter 9). These studies have shown that linear enamel hypoplasias, lines or bands of decreased enamel formation, are linked to a wide variety of conditions that are sufficiently severe and long lasting to disrupt ameloblasts, the enamel forming cells (Goodman and Rose 1990). Furthermore, the location of these defects on tooth crowns reflects the timing of the physiological disruption (Sarnat and Schour 1941;

Goodman and Song 1999). The sensitivity of ameloblasts to physiological conditions, enamel's inertness once formed, and the ability to discern the timing of disruption from their location make linear enamel hypoplasias biological records of past physiological statuses (see Chapter 8).

In a prior study of the burial ground, Blakey (1998a) used enamel hypoplasias recorded on the teeth of adults as an index of childhood conditions (permanent tooth crowns develop from ~birth to ~seven years of age). They found a moderate rate of enamel defects compared to Caribbean slaves (Corruccini et al. 1985), suggesting less stress in childhood. However, these preliminary results are complicated by the fact that many of the adults may have grown up in Africa, rather than as enslaved Africans in New York. Tooth chemistry may be able to resolve who grew up in the New York area, somewhere in Africa, or a third location such as the Caribbean. Furthermore, taking advantage of the different times of calcification of different teeth and regions within a tooth, it may be possible to estimate the age of individuals at the time of forced migration or any other geographic relocation.

Indeed, analyses of the chemical composition of dental tissues may provide new and complementary insights into (1) hard tissue chemistry and development, (2) diet and nutritional physiology, (3) the movement and migration of individuals, and (4) diverse environmental conditions such as industrial lead production. For example, paleonutrition, the study of the diet and nutrition of past peoples, emerged in the 1970s from developments in the chemical analysis of bone, combined with an understanding of ecological and physiological processes governing the deposition and retention of elements in calcified tissues (Aufderheide 1989; Price et al. 1985). The promise of this

field is that isotopic and elemental concentrations in preserved hard tissues would reflect aspects of dietary intakes or nutritional status. Recent developments are just now beginning to suggest that the potential of chemical studies of teeth may be reached. Relative to morphological and histological analysis, this delay in maturity of this field is based on at least three factors.

- First, **bone was initially the preferred hard tissue for study**. However, as results accrued, many researchers began to realize that the processes governing elemental and isotopic incorporation and turnover of bone (and in the case of archaeological bone, postmortem changes) were more complex than previously realized.
- Second, until recently, **methods were not widely available to chemically relate areas of enamel to known periods of development** (prenatal, early infancy, childhood, etc.). The development of microsampling methods, and in particular laser ablation analysis, which is keyed to the ring-link development of enamel and dentine, is now solving this second problem (Outridge 1996).
- Third, interpretations of bone elemental values are limited because of **lack of background information and lack of controlled studies** of ecological, physiological and biochemical processes. Although enamel offers important advantages of highly regulated calcification geometry and inertness once formed, our understanding of the significance of its elemental concentrations remains rudimentary for the same reasons.

The Histology and Development of Dental Calcified Tissues

Human teeth consist of three hard tissues: enamel, dentine, and cementum (Figure 6.2). Enamel forms the exterior of the crowns of human teeth; dentine

comprises the interior of the crown and roots, and a thin layer of cementum covers the roots. In addition to the “primary” cementum and dentine, which is formed during early in life, secondary (circumpulpal) dentine and secondary cementum are continuously deposited.

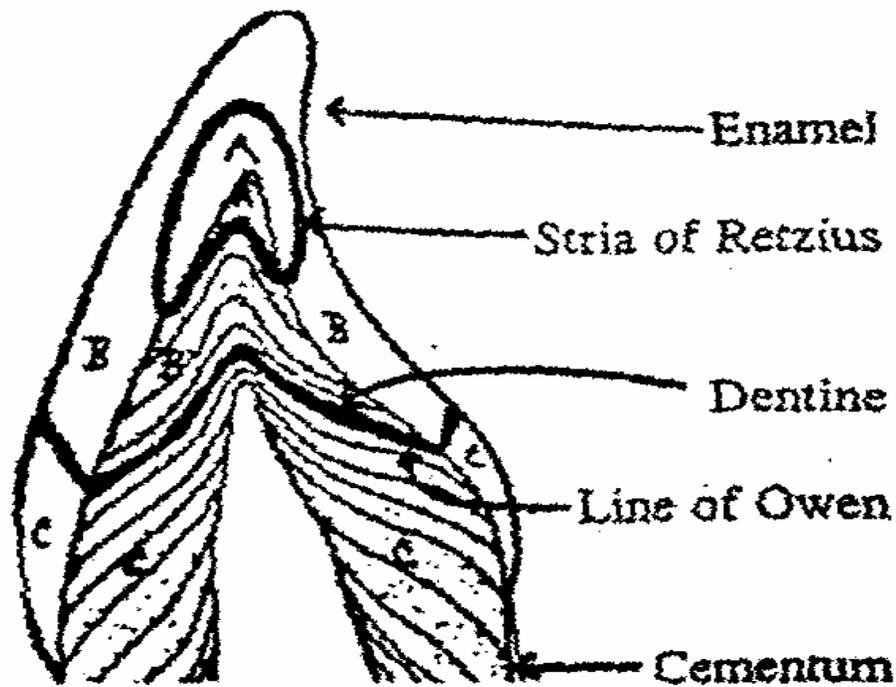


Figure 6.2: Longitudinal cross section of a deciduous incisor tooth showing enamel dentine and cementum. Zones A, B, and C in enamel and dentine represent the earlier to later calcifying portions of the tooth crown. The pattern of formation is reflected in contour lines of Owen in dentine and stria of Retzius in enamel. The accentuated growth line between zone A and B is the approximate division between the second and third prenatal trimester, and the line between zones B and C represents the approximate location of the birth line. Acid dissolution may sample zones of "dome" enamel whereas laser ablation samples finer areas of enamel and dentine.

A summary of variations among the dental hard tissues and bone is presented in Table 6.1. Some key differences are the hardness of enamel and its lack of regenerative (turnover) abilities.

Table 6.1: Comparison of Dental Hard Tissues and Bone.

	<u>Enamel</u>	<u>Dentine</u>	<u>Cementum</u>	<u>Bone</u>
Origin	Ectoderm	Ectomesenchyme	Mesoderm	Mesoderm
Organic framework	Pseudokeratin	Collagen	Collagen	Collagen
Crystal	Apatite	Apatite	Apatite	Apatite
Internal space	None	Dentinal tubule	Canaliculi	Canaliculi
Turnover Ability	None	Odontoblast	Cementoblast	Osteoblast
<u>Chemical Composition (Ave.)</u>				
Organic	0.3%	15%	23%	21%
Inorganic salt	97.2%	75%	65%	65%
Water	2.5%	10%	12%	14%

Enamel

The hardest and one of the most specialized tissues in the body, enamel covers the crowns of teeth (Figure 6.2). The thickness of the enamel layer ranges from less than 0.1 mm near the cervical border of deciduous teeth to a few millimeters on the crowns of permanent molars. Enamel is formed from ameloblasts that derive from the inner enamel epithelium. After odontoblasts begin secreting the dentine matrix, adjacent ameloblasts quickly begin secreting enamel matrix. Once the full thickness of enamel matrix is

reached, ameloblasts change morphology and physiology consistent with a change in role from matrix secretion to absorption of protein and water and calcification. After enamel is fully calcified, ameloblasts become senescent; mature enamel is an acellular and essentially dead, 97 percent calcified tissue. The temporal record of past physiology and chemistry may be seen to follow the enamel growth lines, stria of Retzius (Figure 6.2). Enamel is the tissue of choice for our research because its formation is well understood and it is acellular, nonvital, and nearly completely composed of apatite crystals (Cleymaet et al. 1991).

Dentine

Tooth formations begin with the secretion of predentine by odontoblasts, dentine forming cells. Dentine formation is highly regulated and occurs in layers or sheets, as odontoblasts are recruited to secrete dentine matrix. The pattern of formation of dentine is visible in growth lines called contour Lines of Owen (Figure 6.2). Dentine calcification occurs relatively quickly after the collagenous dentine matrix is formed. Like all other calcified tissues, apatite is dentine's main crystal component (Ten Cate 1985).

A small amount of secondary (or circumpulpal) dentine is continuously deposited after eruption. Chemical characterization of this dentine is useful as a referent for average conditions over a long span of time, such as long term lead exposure (Needleman and Bellinger 1991).

Cementum (or cement) is a thin covering of the roots of teeth. It is relatively similar to bone in a number of respects, including embryological origin, basic structure and degree of calcification. Its apatite crystals are similar in size and structure to bone and dentine,

about 200-1000 angstroms in length and 30 angstroms in width (Carlson 1990). One notable feature of cementum is that in addition to a primary layer in mammals, it is continuously deposited in annual rings, which has been used in wildlife biology and bioarchaeology as a method for determining age at death (Charles et al. 1986, Condon et al. 1986; Kagerer and Grupe 2001). Because of its continued deposition, cementum chemistry provides a means of tracking annual life history changes until death. Outridge et al (1996) have shown that lead varies by cementum layers (Figure 6.3).

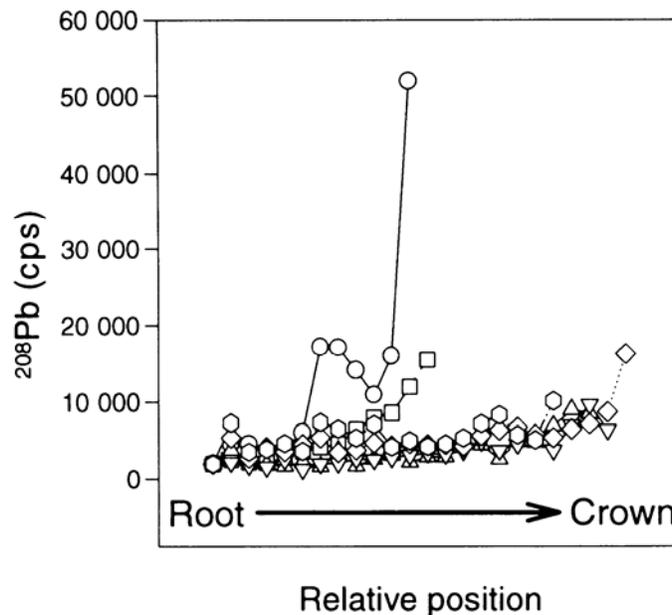


Figure 6.3: Outridge and co-workers (1996) were the first group to use LA-ICP-MS to study chemical changes in teeth. In this figure (Outridge *et al.*, 1995: 167) they illustrate changes in ^{208}Pb content of six adjacent annual cement rings of a walrus tooth (Pb is estimated as counts per second). Each layer is represented by a different symbol, with 11 to 20 ablation areas per layer. A spike occurs in one layer; however, the lead content is quite variable. Because human cementum is very thin and more vital than enamel and dentine, we have not chosen to focus on it. However, if time permits, we will pilot a laser ablation study of human cementum.

Instrumentation and Methods of Analysis

One of the challenges of hard tissue chemical studies is to be minimally destructive and at the same time provide chemical information based on the pattern of development and calcification of enamel and dentine. Until the last few years, two general methods have been used to analyze lead and other elements in dental samples: digestion of whole teeth or major portions for wet analysis and surface profiling. Neither method provides much needed time-specific information. However, in recent years, techniques that do so have come to maturation. These involve either ‘ablating’ or microdrilling small areas of hard tissue. We have employed laser ablation to provide elemental information and drilling to provide information on isotopes. The following is a brief description of the instrumentation, coordination of activities, the utility of each methodology, and an overview of the main questions to be addressed.

Instrumentation and Coordination of Samples

Elemental analyses have been carried out utilizing Hampshire College’s Inductively Coupled Plasma Mass Spectrometer (ICP-MS; Perkin Elmer Elan 6000A; Shelton, CT) and attached Laser Ablation system (CETAC LSX 100, Omaha, NE). The marriage of the high precision, high sensitivity, and multi-element capacities of a state-of-the-art ICP-MS with the spatial resolution capabilities of laser ablation (LA-ICP-MS) provides us with a unique opportunity to construct detailed maps of elemental concentrations in teeth with minimal sample preparation and minimal destruction. The method is particularly ideal for chronologically developing tissues such as trees, shells, and teeth (Outridge 1996). Our laser ablation system was obtained to study hard tissues.

Tooth samples have also been prepared at Hampshire College and then are sent to other laboratories that specialize in isotopic analyses. In the early stages of research, samples were removed using a Dremel Drill (see Figure 6.8). The results presented below on strontium isotopes are based on enamel and dentin removed by this method and analyzed at the University of Kansas by Doug Walker. In May 2002, we obtained a precision micromill (New Wave Research), allowing us much better control of the location and size of the sample. For example, the micromill allows us the potential to sample multiple isotopic systems at dozens of locations within a single tooth.

The Chemical Tool Kit

The major dietary methods are presented first: elemental strontium, barium, zinc, iron and carbon and nitrogen isotopes. These are followed by methods for evaluating environmental change: elemental signature analysis (ESA), oxygen isotopes and strontium isotopes, and finally, methods that indicate pollutant exposure and ingestion (lead, arsenic, mercury, etc.) that might also imply location via anthropogenic sources. We wish to eventually employ multiple chemical methods in order to obtain multiple confirmations of origins and nutrition. However, due to funding limitations, here we focus on results obtained thus far for three methodologies that relate to origins and anthropogenic pollution: elemental signature analysis, elemental lead, and strontium isotope ratios.

Strontium and Barium

Studied relative to calcium concentrations, strontium and barium concentrations provide a means for evaluating the trophic level of diets. Strontium (Sr) and barium (Ba) substitute for calcium (Ca) in hydroxyapatite, the major inorganic component of all hard

tissues. However, calcium is “favored” or enriched over the other two divalent cations because of its smaller size. An enrichment or fractionation step occurs as food moves through trophic levels (Figure 6.4). Therefore, herbivores have more strontium and barium relative to calcium than primary carnivores, which have more strontium and barium than secondary carnivores. Thus, ratios of strontium and barium to calcium have become well established as indicators of the relative portion of meat in diets (Ambrose 1993; Blum *et al.* 2000; Burton and Price 1990; Gilbert *et al.* 1994; Runia 1987; Sealy and Sillen 1988; Sillen and Kavanagh 1990).

Because breast-feeding is a higher trophic level than weaning, an increase in strontium/calcium and barium/calcium ratios in teeth may also be used to pinpoint the age at weaning (Katzenberg *et al.* 1996). Here, LA-ICP-MS is a particularly excellent methodology. It is one of just a few instruments that can measure strontium and barium in small, targeted samples with the needed sensitivity and can evaluate change in elemental ratios virtually by week (LA spot size can be as small as 10 μm , which is equal to about 2-3 days of enamel development.)

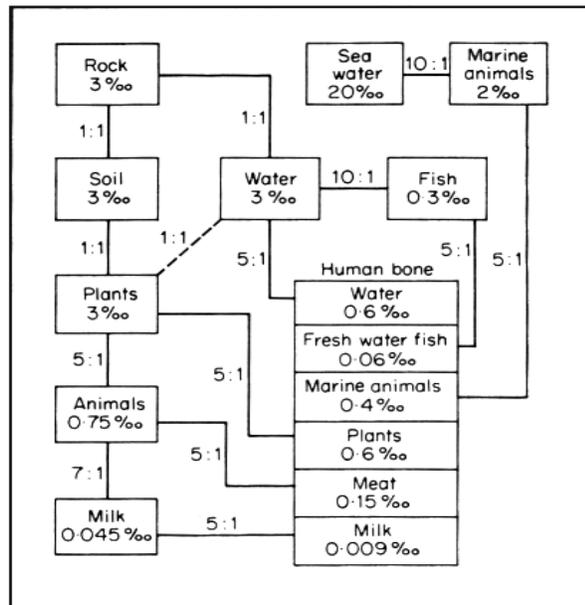


Figure 6.4: Diagram from Price *et al.* (1985: 423) showing the five-fold fractionation of Sr/Ca occurring during human digestion, and the contributions to the composite Sr/Ca of bone from various diet components. With knowledge of environmental levels of Sr and Ca and of fractionation dynamics, one can balance the relative input of Sr and Ca into bone or other calcified tissues. Ezzo (1994a; 608) suggests that strontium “is the only firmly established elemental model in bone chemistry analysis.” Yet, this is not a simple system, nor has it been fully tested for either bone or dental hard tissues. We propose to test various links in the Sr system and also to use this diagram as a model for study of other systems such as Fe, Ba, Sr and Pb.

Zinc and Iron

Zinc and iron are essential elements that are frequently deficient in diets. Their deficiency may cause a wide spectrum of functional consequences. Both nutrients are key to maintaining linear growth and resistance to infectious disease. Iron also affects cognitive development and work capacity. Although the consequences of these micronutrient deficiencies are often masked by protein energy malnutrition, deficiencies in these two elements can have severe consequences for the individual, the family and the social group (Allen 1993; Anonymous, 1979; Golden 1988; Scrimshaw 1991). Contemporary diets are frequently deficient in one or both of these micronutrients

(especially when dietary diversity is low, and meats and fresh fruits and vegetables are limited).

It is highly likely that zinc and iron deficiency were prevalent and consequential to the lives of the enslaved Africans, and it is also likely that their consequence may have been masked by gross protein-energy deficiency. Thus, direct measurement of iron and zinc concentrations will supplement prior analyses of porotic hyperostosis (an indicator of iron deficiency anemia) and bone growth (reflecting overall nutritional status).

Since the 1970s, these elements have been studied in bones and, more recently, in teeth. Ezzo (1994b) warns that interpretations are not unambiguous. We have studied zinc concentrations in deciduous teeth of contemporary Mexican children with known diets during their tooth formation. Our main finding is that enamel zinc concentrations are not related to total zinc intake, but they are strongly associated with factors affecting bioavailability such as phytate and calcium intake (Goodman et al. 2003).

Carbon and Nitrogen Isotopes

The combined analyses of stable carbon isotopes on enamel carbonate, bone carbonate, and bone collagen (respectively, mineral and organic fractions of bone), and nitrogen isotopes on bone collagen, provide data on the macronutrient components of diets, as well as, the degree of herbivory versus carnivory. This method can provide distinctions between consumption of different plant groups (e.g., maize vs. most other plants), terrestrial, freshwater, and marine resources, and legumes versus other plants. This analysis will: (1) help to refine understanding of nutritional (and possibly infectious) diseases in individuals, (2) provide a means of looking at social differences within and between groups, and (3) document major dietary shifts which can be caused by

geographic relocation. As well, paralleling the analysis of oxygen isotopes (described below) and changes in strontium and barium relative to calcium, nitrogen isotopes can distinguish nursing infants who are one level higher in the food chain than their mothers (Katzenberg et al. 1993; Schurr 1997). Lastly, this isotopic data will be integrated with the elemental data (iron, zinc, strontium, barium, etc.) from the same tissues to refine our reconstruction of food consumption and nutritional status.

Elemental Signature Analysis (ESA)

The ICP-MS allows for the simultaneous analysis of a wide suite (~ 90) of elements and their isotopes in semi-quantitative mode (Table 6.2). This methodology provides a rapid assessment of the presence of pollutants and additional elements of possible interest, especially those that might be useful to discriminate subgroups (such as those who grew up in New York versus elsewhere). For example, results from this mode of analysis may be analyzed with discriminant function or cluster analysis to identify groups of individuals and outliers who may be migrants. ESA will complement more specific methods noted below for evaluating migration and change in environment.

Table 6.2: Range of Element Concentrations in Human Dental Enamel. Elements in bold are research foci. A suite of elements will be used in some studies.	
<u>Concentration range in ppm</u>	<u>Elements</u>
> 1000	Na, Cl, Mg
100-1000	K, S, Zn, Si, Sr
10-100	Fe, Al, Pb , B, Ba
1-10	Cu, Rb , Br, Mo, Cd, I, Ti, Mn, Cr, Sn
0.1-0.9	Ni, Li, Ag, Nb, Se, Be, Zr, Co, W, Sb, Hg
<0.1	As, Cs, V, Au, La , Ce , Pr, Nd, Sm, Tb, Y
Modified from Curzon (1983: 5).	

Strontium Isotopes

The isotopic composition of strontium is widely used in the earth sciences to discriminate between differing geologic terrains and, as a result, may be valuable in tracing the places of birth and early life of the enslaved African. Strontium, which has chemical affinities to calcium and concentrates with calcium in hard tissue, occurs as four stable isotopes, ^{84}Sr , ^{86}Sr , ^{87}Sr and ^{88}Sr . ^{87}Sr is the decay product of the long-lived radioactivity of ^{87}Rb ; with time, the proportion of ^{87}Sr to total Sr grows at a rate dependent on the available Rb. Geologic environments rich in Rb relative to Sr will undergo large increases in the ratio $^{87}\text{Sr}/^{86}\text{Sr}$, while regions of the earth with low Rb/Sr ratios will retain low values of $^{87}\text{Sr}/^{86}\text{Sr}$ for long periods of geologic time. Since Rb is a particularly weak bonding element in the high temperatures of the earth's interior, it has been flushed to the surface through volcanic activity over time and has been concentrated in the continental crust. Stronger bonding Sr is less fractionated and remains in higher concentration in the earth's interior. As a result, old continental rocks have developed high $^{87}\text{Sr}/^{86}\text{Sr}$, while volcanic islands recently formed by partial melting of the Rb-poor mantle of the earth have dramatically lower $^{87}\text{Sr}/^{86}\text{Sr}$. The $^{87}\text{Sr}/^{86}\text{Sr}$ ratios in teeth and bones of humans whose food and water are locally obtained should reflect the $^{87}\text{Sr}/^{86}\text{Sr}$ ratios of their environment.

Continents typically consist of regions of ancient rock (cratons) stitched together by zones of younger mountains created during relatively more recent continental collisions. West Africa is typical in that a zone of approximately 600 million year old mountains (in Nigeria) lies between very old (more than 2 billion years) cratons to the west and to the south. $^{87}\text{Sr}/^{86}\text{Sr}$ in the cratons will be very high, while the mountains

As with the other “provenance” methods, analysis will focus on a life span perspective with separate analyses of bone and different teeth and parts of teeth that calcify at different times in life. Thus, it may be possible to pinpoint the age of any individual at time of movement from one location to another, and any subsequent movement.

Oxygen Isotopes

Oxygen isotope analysis has recently been developed for bone and enamel phosphate (Wright and Schwarcz 1998; White 2002). In contrast to carbon isotopes, which are based on the premise that “you are what you eat,” oxygen isotope analysis is based on the premise that “you are what you drink.” Values in our body fluids reflect those of the water we drink, and the values of environmental water are a function of complex physiographic and climatic variables including temperature, humidity, rainfall, distance from the ocean and altitude. By analysis of teeth that have formed at different ages in life, it is possible to estimate the age at which individuals moved from one environmentally distinct region to another. As in other analyses, bone values reflect more recent and last locations.

This methodology has been employed on ice cores from Greenland to plot annual changes in the earth’s temperature. Oxygen isotope ratios are sensitive to minor changes in ambient temperature. White et al. (2002) have employed this isotope to discriminate individuals who grew up at Teotihuacán, in the Valley of Mexico, versus those who may have grown up at Monte Alban, Oaxaca and in the Maya highlands further to the south. Oxygen isotopes should distinguish with great fidelity individuals who grew up in a tropical area (West Africa and Caribbean) from those who grew up in a more temperate

zone (New York). In trying to pin down the possibilities of a two-step migration from Africa to the Caribbean to the United States, this method perfectly complements the analysis of strontium isotopes.

Because nursing infants are one level higher in the food chain than their mothers, their oxygen isotopic ratios are enriched. Because the balance of protein, fat, and carbohydrate is unique in nursing children, the difference between the collagen and carbonate values is much smaller than it is in adults in the same population. These techniques allow us to tell how long the nursing period lasted and how prolonged the weaning period was.

Environmental controls, that is, water and tooth samples from current or historical inhabitants of New York and areas where the enslaved African may have lived, are crucial to take maximum advantage of oxygen isotope results. Oxygen isotopes without environmental controls can identify outliers and the number of movements (useful information in itself). But without control data, it cannot identify location of origin. To establish a baseline for the location of an individual, a contemporary or archaeological bone or tooth sample (either human or animal) can be used, along with water samples. Suspected locations of origin would be similarly sampled.

In summary, oxygen isotope analysis, when combined with insights from analyses of ethnohistorical information and other chemicals and DNA analyses, may provide a powerful tool for locating regions from which individuals may have moved. Oxygen isotope analysis can be used to specifically test hypotheses derived from other analyses.

Lead, Lead Isotopes and Heavy Metal Pollution

Lead has frequently been studied in deciduous teeth to track current lead exposures and in bones to provide a history of pollution exposure (Aufderheide et al., 1988; Budd et al. 1998; Fergusson and Purchase 1987; Gulson and Wilson 1994; Purchase and Fergusson 1986; Shapiro et al. 1972). Based on bone lead levels and historical documentation, Corruccini et al. (1987a) suggest lead poisoning from rum intake and inhalation of fumes during sugar manufacturing was an “unrecognized epidemic” in the Caribbean during the seventeenth and eighteenth centuries that would have affected enslaved African and white health and mortality.

By using LA-ICP-MS we can pinpoint the age and chronological nature of exposure to pollutants (Evans et al. 1995; Outridge 1996; Outridge et al. 1995). Such data provide insights into maternal exposure (via analysis of deciduous teeth), occupations, and movement. The analysis of lead isotopes provides a means to evaluate the potential source of lead (as each source has a unique isotopic signature), and this method, too, may be used to evaluate change in location. Gulson *et al.* (1997) found that differences in lead isotope ratios ($^{207}\text{Pb}/^{206}\text{Pb}$ and $^{206}\text{Pb}/^{204}\text{Pb}$) of permanent and deciduous teeth enabled distinction between immigrants and long-term residents in Australia, and hypothesized that observed differences in blood-enamel and blood-dentine isotope exchange rates may be used to estimate individuals' residence time in Australia.

Methods and Results

In this section, we first review the working hypothesis that individuals with culturally modified teeth were African born. This hypothesis sets up the expectation that individuals with modified teeth might chemically cluster differently than individuals who

died in the first decade of life and are assumed to be New York born. We then test this hypothesis by elemental signature and strontium isotope analysis.

African Cultural Modification of Teeth

The practice of intentionally modifying teeth spans thousands of years and is geographically widespread. Morris (1998) notes that dental chipping and intentional removal was observed among Early Iron Age (ca. 1500 years B.P.) skeletal remains from southern Africa. Britain, India, China, Southeast Asia, Japan, the Malay Archipelago (including the Philippines and New Guinea), Australia, Oceania, the Americas, Hawaii, Grenada and the Virgin Islands have also produced excavated, culturally altered dentitions (Milner and Larsen 1991). With declining prevalence, members of some societies – notably in Africa, although elsewhere – continue to alter their physical appearances by decoratively filing, chipping, ablating or otherwise modifying dentitions (Milner and Larsen 1991; Inoue et al. 1992, 1995; Jones 1992; Morris 1998). Although culturally (i.e., intentionally and non-therapeutically) modified teeth “indicative of different ways of life” have long interested anthropologists, Milner and Larsen (1991: 357) note that studies tend to be “particularistic, frequently focusing on single specimens or skeletal series from a certain site,” and reflective of the discipline’s “descriptive phenomenologically oriented tradition.” Recent work, however, considers dental modification as a “biocultural attribute” possibly linked to “social distinction” and “cultural integration” at pre-Hispanic Mayan archaeological sites (Tieslerbos and Frausto 2001) and social status among pre-contact Guamanians (Ikehara-Quebral and Douglas 1997).

Anthropologists have offered different explanations linking cultural dental modification and African natality. Stewart and Groome (1968) suggest dental modification would have seemed “hostile” to European slaveowners, who, as a result, would have prohibited its practice whenever possible. Handler and co-workers’ (1982) analysis of the late seventeenth to early nineteenth century Newton sugar plantation cemetery in Barbados includes a more complex explanation based on integrated archaeological, bioanthropological and ethnohistorical data. While European traders in West Africa regularly commented on African cultural practices as “heathenish” or “savage,” Handler and co-workers (1982) suggest scarce documentary reference to dental modification in colonial settings makes it difficult to reliably assess slaveowners’ perceptions of the practice as “hostile” or otherwise problematic. In fact, where dental modification is mentioned, i.e., in runaway advertisements, it is for the purpose of enhancing descriptions of African escapees in order to facilitate their recognition and recapture.

Handler and co-workers (1982), note that runaway attempts were frequent in the Caribbean and other parts of the New World, during this period. Interestingly, they further note that posters to help find the runaways with modified teeth invariably include reference to African natality in the form of cultural attributes such as cicatrization (or “country marks”) or through ethnic distinctions (of varying precision) such as “Ibo” or “Coramantine.” Handler (1994) offers further support for this hypothesis in the form of similar findings from British colonial North America, noting that contemporaneous runaway advertisements from Georgia, Maryland, Virginia, and North and South Carolina also mention dental modification only with respect to individuals whom slave

owners believed to be African born. Like Stewart and Groome (1968), Handler and co-workers (1982) and Handler (1994) suggest African dental modification indicates African natality, as the practice was most likely discontinued in the Americas. However, following Price and Price's (1972) discussion of cicatrization in Suriname, Handler and co-workers (1982) and Handler (1994) argue that, unlike more easily hidden or coded African cultural practices, dental modification was voluntarily discontinued due to its highly visible, "immutable and indelible" results – i.e., as "an adaptive response" enabling greater anonymity during escape efforts.

If fleeing enslavement was central to cultural reasoning that concluded dental modification was maladaptive in the New World, one might still expect this practice to be more visible in the bioarchaeological record. This is due to the prevalence of dental modification in those areas from which most enslaved Africans were extracted during the period of the trans-Atlantic Trade (see Table 6.3), as well as the fact that *most* enslaved persons apparently did not attempt escape. While Handler and co-workers (1982) correctly note that many did, the majority of enslaved Africans engaged in (often more subtle) forms of resistance such as working slowly, intentionally breaking tools to disrupt production, *or maintaining African cultural practices*. In such contexts, dental modification may have taken on importance as a marker of social identity in the Americas perhaps even more acute than seen generally in Africa, where its meanings were sometimes sacred, but sometimes superficial (van Rippen 1918).

Table 6.3: African Dental Modification Patterns: (Gould et al., 1984)

- A. Filing mesial maxillary central incisors (Guinea, Togo, Angola, Democratic Republic of the Congo, Uganda, Kenya and Tanzania)
- B. Filing mesial and distal of maxillary central incisors (Guinea, Central African Republic, Democratic Republic of the Congo, Angola)
- C. Filing six maxillary anterior teeth to pointed shape (Democratic Republic of the Congo, Zimbabwe)
- D. Filing four maxillary and four mandibular incisors to pointed shape (Guinea, Cameroon, Republic of the Congo)
- E. Horizontally filing maxillary central incisors (Guinea, Democratic Republic of the Congo)
- F. Centrally notched incisors (Sierra Leone)
- G. Serrated incisors (Mozambique)
- H. Mesial triangular notch cut in gingival one-third of central incisors (Republic of the Congo, Sudan)
- I. Concave filing of maxillary incisor, convex filing of mandibular incisors (Tanzania, Mozambique)
- J. Extracting maxillary central incisors (Zambia)
- K. Extracting mandibular central incisors (Uganda, Kenya)
- L. Extracting primary mandibular canines (Democratic Republic of the Congo, Sudan, Uganda)
- M. Extracting four maxillary incisors (South Africa)
- N. Extracting four mandibular incisors (Sudan)
- O. Extracting four maxillary and four mandibular incisors (Democratic Republic of the Congo, Uganda)
- P. Extracting single lateral incisor (*note: maxillary in diagram*) (South Africa)
- Q. Artificial prognathism with facially flared maxillary central incisors (Senegal, Kenya)

The ethnohistoric component of Handler's (1994) hypothesis obscures this possibility and limits the practical relevance of his analysis to those members of the enslaved population that anticipated escape. Thus, runaway advertisements, while useful, are not directly relevant for testing connections between African natality and dental modification for most archaeologically recovered African Diasporan remains. As well, early ethnographic accounts, occupied primarily with describing modification patterns, are of limited use for estimating natality since those patterns often are not geographically confined. Table 6.4 makes this point with respect to modification patterns observed at the ABG. Chemical analyses should more reliably assess the nature of such connections for a greater number of individuals and possibly provide clues for understanding dental modification's limited presence among Diasporan populations.

Geographic natality among enslaved Africans with culturally modified teeth has been chemically estimated before, with low skeletal lead content relative to age interpreted as an indicator of African birth at the Newton Plantation (Corruccini et al. 1987a). More recently, Sealy and colleagues (1995) analyzed bones and teeth to shed light on an understudied dimension of the Transatlantic Slave Trade: Africa's *internal* diasporas produced through involuntary migration. Strontium, carbon, and nitrogen isotopic variation proved useful for establishing non-local origins and dietary patterns of individuals some enslaved and bearing dental modifications, buried during the eighteenth and nineteenth centuries along the coast of Cape Town, South Africa (Cox and Sealy 1997; Cox et al. 2001).

Table 6.4: NYABG Modification Patterns With African and African Diasporan Reference Populations.			
<u>Modification Pattern</u>	<u>Burial Number(s)</u>	<u>Referenced Population(s)</u>	<u>Reference(s)</u>
Wave (Incisors and Canines)	47	None	None
Wedge (Central Incisors)	23	Cuba via Congo (Bakongo); SW Angola (Ngumbi); Cape Town via SE Africa (Makua, Maravi and Yao)	Ortiz 1929; Wentzel 1961; Cox and Sealy 1997
Mesial (Incisors)	Filing 6, 114, 326, 366, 377	S Angola (Owampo) and N Namibia (Damara); Virgin Islands	von Jhering 1882; Buxton et al., 1938
Distal Chipping/Filing (Incisors)	101, 241, 367, 397	Barbados	Handler et al., 1982
I ¹ , I ² Mesial, Distal Chipping/Filing	68, 194, 243, 403	Grenada; Cuba via Congo (Loango)	Stewart and Groome 1968; Ortiz 1929
I ¹ , I ² Mesial, Distal with C ¹ Mesial Chipping/Filing	115, 384	None	None
Point (Incisors)	9, 106, 151, 192	Barbados; Cuba via Congo (Calabar); Gold Coast (Ashanti, Aksin)	Stewart 1939; Ortiz 1929; AMNH
Blunt (Incisors)	Point 266, 270, 340	Southern Dem. Republic of Congo	Torday 1919
Hourglass (Incisors)	281	Dem. Republic of Congo; Barbados	Lignitz (1919 – 1920); Handler et al., 1982
General (Occlusal) Chipping/Filing (Incisors)	165	None	None
Modified from Blakey (1998b).			

We combine LA- ICP-MS ESA and Sr isotopic analysis to analyze permanent first and third molars (and one central incisor) from a total of 40 “modified” or “non-modified” subadults from the excavated portion of the ABG. ESA is based on the incorporation into enamel of elements that are not nutritionally essential and not directly bioregulated. These nonessential elements may be used to estimate the relative geographic relatedness of individuals during tooth formation and to identify possible clusters among and between modified and non-modified individuals. Since they are not actively physiologically regulated, elements such as lead reflect anthropogenic landscape interactions and patterned pollutant exposure. By comparing early- and later-developing enamel, we are able to more directly consider natal age as well as identify possible migration patterns observed as shifting first and third molar elemental signatures.

This study provides chemical evidence for the estimation of modified and non-modified individuals’ natality at the NYABG while piloting the bioarchaeological application of LA-ICP-MS ESA. Cultural dental modification is considered here in biohistorical context, as an archaeologically retrievable biocultural practice. That is, dental modification is viewed as “one of the many ways human populations manipulate and reshape physical features to convey cultural meaning and expression” (Blakey 1998b). Where such practices affect the bones and teeth, they take on added importance for the reconstruction of lived experience.

The NYABG sample is unique in that the number of observable modified dentitions (n = 26) produced by its excavation is the largest associated with an African diasporic population to date. The site is also a window onto colonial Africans’ under explored northern experiences. Chemical estimation of natality addresses the first of four

primary questions developed by researchers in collaboration with the skeletal population's descendant (i.e., New York's African American) community: what are the geographic (and/or) ethnic origins of the population? We also implicitly test Handler's (1994) conclusions, based largely on ethnohistorical data, with biochemical analytical methods that are potentially applicable to other African diasporic skeletal populations.

Beyond its absence or presence as a cultural "retention" or "survival," dental modification observed among African diasporans' may provide direct evidence of African natality and childhood and a means of assessing African and American health environments. To date, Handler's (1994) work at the Newton Plantation in Barbados has most thoroughly explored the meaning of African dental modification in the Americas, concluding its presence likely indicates African natality. However, Handler's (1994) hypothesis is limited by its emphasis on escape from enslavement as an impetus to discontinue dental modification. We employ chemical analysis in the form of LA-ICP-MS ESA to estimate African natality among modified and non-modified individuals from the NYABG in an effort to further understand this population's origins and to establish a more widely applicable means of testing Handler's (1994) findings.

Materials and Methods

Sample selection and preparation. LA-ICP-MS ESA was applied to 40 teeth. Thirty-seven from NYABG individuals included a permanent first molar from 13 modified adults and 19 non-modified subadults; a permanent first incisor from 1 modified adult (Burial 101); and a third molar from 4 modified adults. Additionally, an intrusive pig tooth found with Burial 137 was analyzed for its presumably New York values, as were 2

permanent first molars from individuals excavated in coastal Ghana in order to provide possible examples of “West African” trace elemental profiles (see Table 6.5) As we show below, our assumption that the pig tooth came from a local pig is no longer justified based on its high strontium isotope ratio, which suggest that the tooth came from an African born pig.

Table 6.5: NYABG Chemical Analysis Sample.					
NYABG modified adult		NYABG non-modified subadult		Ghanaian and other	
<u>ID (age, sex)</u>	<u>Tooth</u>	<u>ID (age, sex)</u>	<u>Tooth</u>	<u>ID</u>	<u>Tooth</u>
Burial 6 (30, M) Burial 9 (40, M)	LLM1	Burial 7 (4, N/A)	LRM1	CREGEG	LRM1
Burial 23 (21, M)	URM1	Burial 22 (3.5, N/A)	LRM1	CREGDO	LLM1
Burial 47 (40, M)	LLM1	Burial 35 (9, N/A)	ULM1	Pig molar associated with Burial 137	Molar
Burial 101 (32.5, M)	LRI1	Burial 39 (6, N/A)	LRM1		
Burial 106 (30, PF)	LRM1	Burial 43 (3.5, N/A)	LRM1		
Burial 115 (30, I)	LRM1	Burial 45 (3.5, N/A)	LRM1		
Burial 165 (35, F)	LLM1	Burial 55 (4, N/A)	URM1		
Burial 266 (30, I)	URM1	Burial 126 (4.5, N/A)	LLM1		
Burial 270 (35, M)	LLM1	Burial 138 (4, N/A)	URM1		
Burial 281 (35, PM)	ULM1	Burial 160 (4.5, N/A)	LLM1		
Burial 340 (19, F)	LRM1	Burial 167 (10.5, N/A)	LRM1		
Burial 366 (35, F)	LLM1	Burial 169 (7.5, N/A)	LRM1		
Burial 367 (30, PF)	ULM1	Burial 180 (12, F)	ULM1		
		Burial 219 (4.5, N/A)	LRM1		
		Burial 236 (4.5, N/A)	LLM1		
		Burial 244 (7, N/A)	LLM1		
		Burial 286 (6.5, N/A)	LLM1		
		Burial 304 (4, N/A)	LRM1		
		Burial 405 (8, N/A)	URM1		

Burial 9 (40, M)	LRM3				
Burial 47 (40, M)	LRM3				
Burial 101 (32.5, M)	LLM3				
Burial 340 (19, F)	LRM3				
Note that individuals in bold were analyzed for early- and later-forming enamel. Age is given in years. F (female); PF (probable female); I (indeterminate); PM (probable male); M (male); N/A (not applicable).					

Burial 101 was included despite his lack of a permanent first molar because his analysis offers the opportunity to compare chemical findings with skeletal biological data

suggestive of time spent in Africa, i.e., possible evidence of yaws in the form of platycnemia and striated lesions observed for the tibiae. Also, the presence of what appears to be an Akan Adinkra (“Sankofa”) symbol tacked to Burial 101’s coffin lid reflects perhaps the most ethno-linguistically specific material culture evidence recovered from the site. The Ghanaian individuals were excavated in Eguafu (CREGEG) and Dominase (CREGDO) villages during the summer of 2000 as part of ongoing archaeological research into the dynamics of early West African and European “culture contact” in coastal Ghana’s Central Region (see DeCorse 2001).

Sample preparation proceeded as follows. Teeth were first soaked for two days in distilled, deionized water and brushed for removal of loose debris. Organic material was removed with a two-day soak in a 1 percent papain solution, after which teeth were thoroughly rinsed with distilled, deionized water. Following a 30-second, 3 percent (v/v) hydrogen peroxide bath for removal of inorganic material, teeth were rinsed and soaked again for two days in distilled, deionized water. Upon drying, teeth were embedded in Buehler Epoxide Resin with the procedure detailed by Marks et al. (1996). However, teeth were secured in plastic containers with glue instead of copper wire. Two bucco-lingual thin sections approximately .20 – .25 mm in thickness were secured with a diamond-coated copper blade affixed to a low-speed Buehler Isomet cutting unit for histological analysis. The exposed surface of the embedded tooth and the thin sections were etched with 1 M hydrochloric acid. Embedded teeth were polished, cleaned with acetone, and rinsed with distilled, deionized water just prior to ablation. All glassware was cleaned with 50 percent (v/v) nitric acid and rinsed three times with distilled, deionized water.

Sample Collection and Analysis

Selected teeth were ablated with a 266 nm UV pulsed Nd:YAG laser (CETAC, LSX 100, Omaha, Nebraska). Trace elemental intensities (counts per second, or cps) were determined by ICP-MS (Perkin-Elmer Sciex, Elan 6000a, Norwalk, CT). Semiquantitative analytical software (TotalQuant II, Perkin-Elmer, Norwalk, CT) was employed to determine intensities of 64 elements across a mass range of 40.078 (Ca) to 204.383 (Bi), and including 232.038 (Th) and 238.029 (U).

Before laser ablation of each tooth, response factors stored in TotalQuant II were updated to reflect instrument sensitivity under current operating conditions by external calibration with National Institute for Standards and Technology (NIST) standard reference material (SRM) trace elements in glass (612). SRMs are matrices containing certified or known major and trace elemental compositions for a given material used in the development of chemical methods of analysis for trace elements. Certified and known values are both used for calibration in semiquantitative analysis, but only certified values necessarily reflect agreement between two or more methods or laboratories, and thus are more reliable (NIST 1992). The glass matrix (NIST SRM 612) was used because currently there is no enamel hydroxyapatite SRM, which would more closely approximate human tooth elemental composition.

Following optimization of the operating conditions of the ICP-MS for TotalQuant II analysis, calibration and sample collection were performed as follows. First, an argon blank was run as a procedure blank. Next, NIST SRM 612 was ablated as an external standard, with certified/known concentration values of Fe, Ni, Rb, Sr, La, Pb and Th used to construct a calibration curve covering the desired mass range. The NIST SRM 612

was then ablated as a sample, and found and certified/known values were compared in order to evaluate the calibration (Table 6.6).

Table 6.6. ICP-MS external calibration results for NYABG Burial 6 LM₁. Percent of error for elements in bold are below semi-quantitative range ($\Delta E\%$ +/-30 – 50).

<u>Element</u>	<u>NIST SRM 612 concentration (ppm by weight)</u>		
	<u>Found</u>	<u>Certified/Known</u>	<u>$\Delta E\%$ error</u>
Ti	0.083	(50.1 ± 0.8)	-99.83
Mn	30.175	(39.6 ± 0.8)	-23.8
Fe	46.099	51 ± 2	-9.6
Co	29.121	(35.5 ± 1.2)	-17.969
Ni	33.331	38.8 ± 0.2	-14.095
Cu	33.205	(37.7 ± 0.9)	-11.923
Rb	29.061	31.4 ± 0.4	-7.449
Sr	75.738	78.4 ± 0.2	-3.395
Ag	5.642	22.0 ± 0.3	-74.36
Ba	56.424	(41)	37.620
La	32.249	(36)	-10.419
Ce	35.407	(39)	-9.213
Nd	29.498	(36)	-18.061
Sm	26.344	(39)	-32.451
Eu	28.616	(36)	-20.511
Gd	20.648	(39)	-47.056
Dy	19.722	(35)	-43.651
Er	19.931	(39)	-48.895
Yb	23.701	(42)	-43.569
Au	0.146	(5)	-97.08
Tl	12.025	(15.7 ± 0.3)	-23.408
Pb	32.957	38.57 ± 0.2	-14.553
Th	13.12	37.79 ± 0.08	-65.282
U	4.557	37.38 ± 0.08	-87.809

$\Delta E\%$ error = (Found concentration–certified or known concentration)/certified or known concentration * 100.) = known, but uncertified, value. Certified/known range of concentrations equals larger of entire range of observed results or those within 95% confidence interval (NIST 1992).

Upon verifying accuracy, teeth were ablated as samples. At least two 2.5- to 3-minute raster-pattern ablations were conducted for most teeth, and whenever possible from earliest-formed enamel (i.e., from the cuspal/occlusal area) in order to increase the likelihood of analyzing natal landscape interaction (Figure 6.6). Another calibration was then performed prior to ablation of the next tooth. Counts per second (or intensities) for non-essential, non-bioregulated elements measured within semiquantitative range – Rb, Sr, La, Ce and Pb – were averaged and interpreted with Statistical Package for the Social Sciences (SPSS) 11.0 hierarchical cluster analysis as representations of individuals' relative relatedness. For a detailed discussion of calibration and other theoretical and methodological issues concerning semiquantitative ICP-MS analysis, see Amarasiriwardena et al. (1997), (although their research involved liquid nebulization sampling).

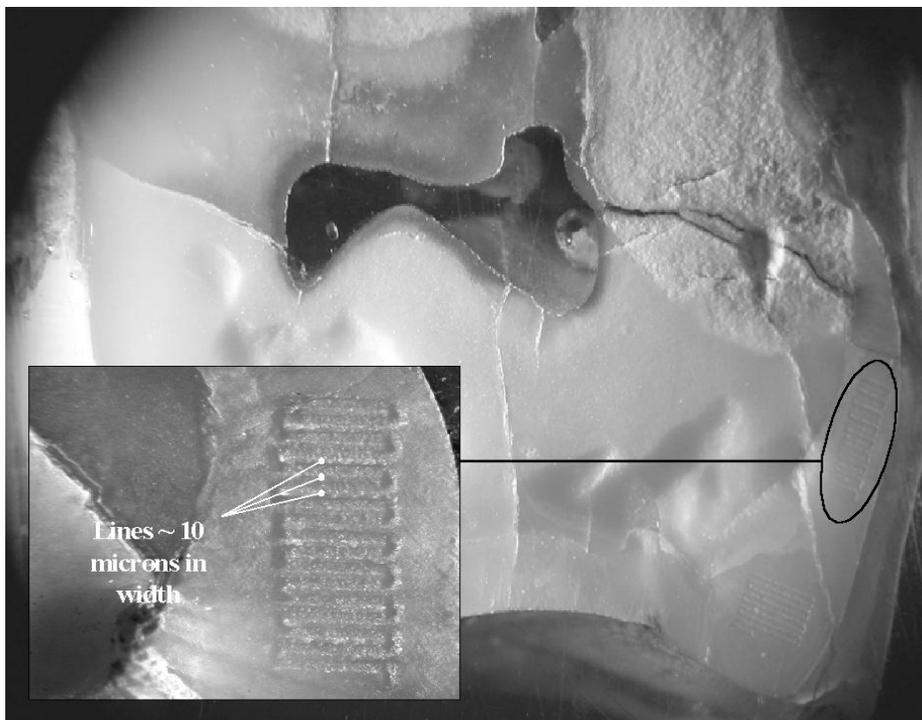


Figure 6.6: Raster ablation (Burial 23, URM1)

Results

The cluster diagram (Figure 6.7) includes the following information from left to right: (a) four main clusters or statistical grouping (C1, C2, B1, A), (b) burial number or sample and tooth sampled, (c) sex, (d) estimated age in years, (e) presence and type of dental modification and (f) finally the cluster-linkages. The lengths of the arms linking the clusters represent the estimated geochemical distance between individuals or groups (clusters). For example, the greatest distance is found between Burial 165 and the remaining individuals.

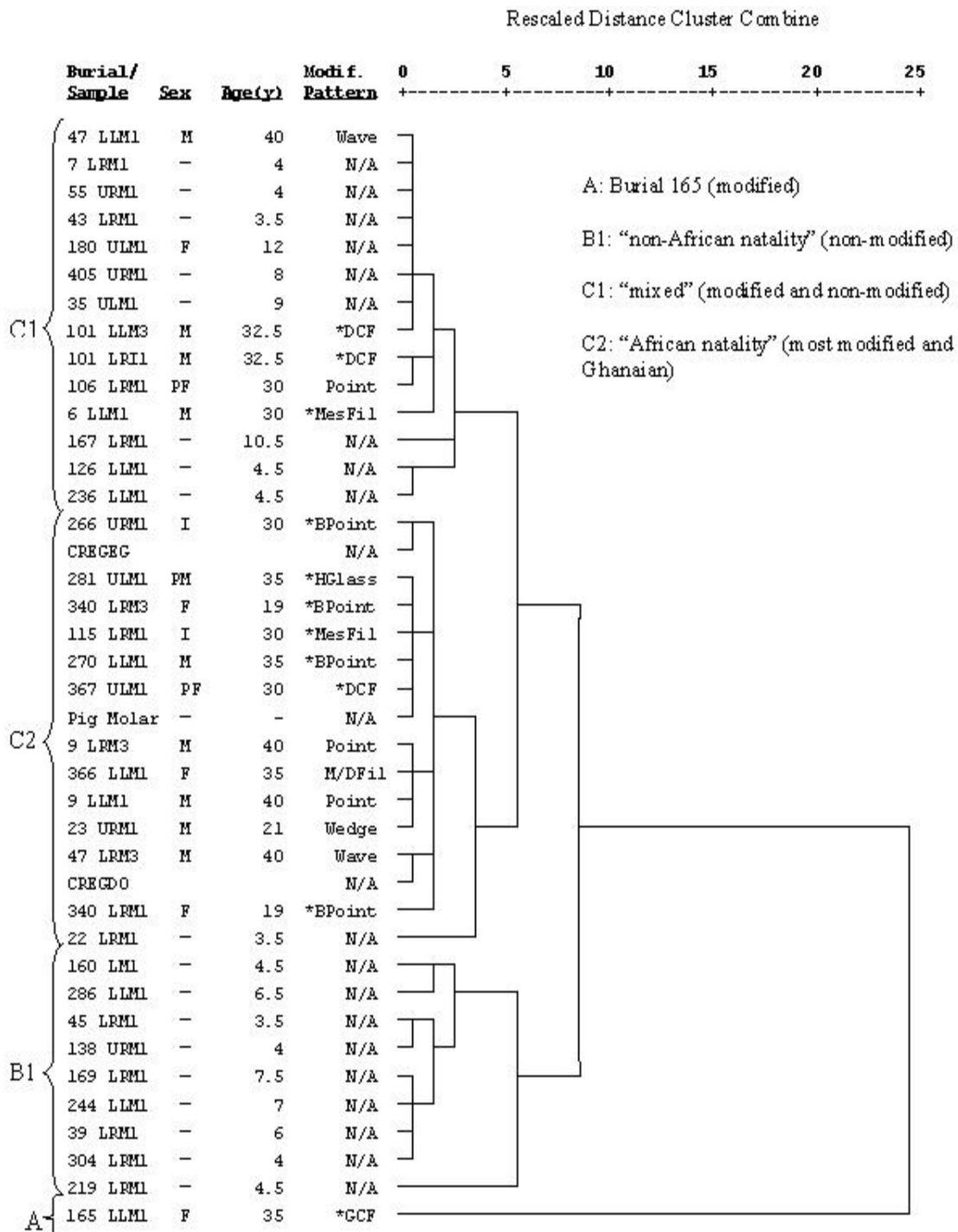


Figure 6.7: ESA Cluster Diagram based on concentrations of five trace elements: Rb, Sr, La, Ce and Pb. BPoint (blunt point); DCF (distal chipping and filing); GCF (general chipping and filing); HGlass (hourglass filing); M/D Fil (mesial and distal filing); MesFil (mesial filing)

As just noted, the analysis produced a first division between Burial 165 (labeled cluster A, bottom) and the remaining individuals are subsequently divided, first separating cluster B1 from the remaining individuals, then subdividing cluster C1 from C2.

The interesting result concerns which individuals were designated to each cluster. Cluster B1 consists of nine teeth/individuals, from Burial 160 to Burial 219. All of these individuals died before eight years of age. Cluster B1 appears to be a natal New York cluster.

Cluster C2 includes fourteen individuals and sixteen teeth starting with Burial 266 and ending with Burial 22. The sixteen teeth include two teeth from Ghana, the intrusive pig molar, and thirteen teeth, and eleven individuals from the burial ground. Two individuals, Burial 9 and Burial 340 are represented by both an M1 and an M3 and with the exception of Burial 22 at the bottom of the cluster; all of the other twelve ABG individuals display dental modifications. These results suggest that this is an African natality cluster.

Cluster C1 is more mixed than the others. There are fourteen teeth and thirteen individuals in this cluster (Burial 101 is represented by two teeth). The majority of the teeth, nine individuals/teeth, are from children without dental modifications. Five other teeth are from four individuals (Burial 47, Burial 101, Burial 106 and Burial 6) with CMT. Finally, Burial 47 is represented in this cluster by its first permanent molar and in the C2 (African natal) cluster by its third permanent molar. This cluster switch is intriguing as it suggests a movement from a yet unknown area.

In summary, ESA, a first methodology, has successfully separated the majority of individuals/teeth into coherent clusters. This helps affirm the utility of the method, on one hand, and that young individuals were indeed born near New York while the majority of individuals with modified teeth were African born.

A key implication of these data is that, depending on how they cluster, it may now be possible to determine the broad geographic natality of older individuals without modifications. However, some interesting questions remain before we can take this next step with confidence. Why does Burial 22, an individual that died at 3.5 years of age, cluster with African born individuals? And why do four individuals with dental modifications cluster with nine young individuals without modifications? One complication is that the chemistry of a first molar may partly reflect the chemistry of the mother's environment if the mother loses bone apatite during breast-feeding. Another hypothesis is that dental modification continued in New York. Our hope is that another method will help resolve alternative hypotheses.

Strontium Isotope Ratios

As previously noted, the ratio of ^{87}Sr to ^{86}Sr has emerged as a powerful method to distinguish the age of landscapes. Because the isotopes are not fractionated in biological tissues, the tissues of animals living on these landscapes reflect the landscapes.

Methods and Materials

As in the ESA analysis, for this pilot or testing study we selected teeth from dentally modified individuals as well as teeth of young individuals from the NYABG. In most cases, analyses focused on the first permanent molars, which develop during the first few years of life. All samples were obtained by drilling dentine and enamel using a

Dremel tool and stainless steel bits (Figure 6.8). The bit was thoroughly cleaned with water in an ultrasonic bath and visually inspected under a microscope for contamination between samples. Analyses of replicate drill samples from the same tooth suggest contamination by the bit and cross-contamination between samples was negligible. Powder was collected and placed in an ultraclean teflon beaker with approximately 1 mL of 7M HNO₃. The beaker was sealed and placed on a hotplate at 100°C overnight for dissolution. After cooling, the beakers were opened, returned to the hotplate and evaporated to dryness. The sample was cooled and dissolved again in 600 µL 3.5M HNO₃ in preparation for isolation of Sr. All samples were centrifuged prior to column chemistry; however, no solid residue was ever observed. Strontium was separated using standard, Sr-specific crown-ether resin chromatographic techniques. Columns used had a

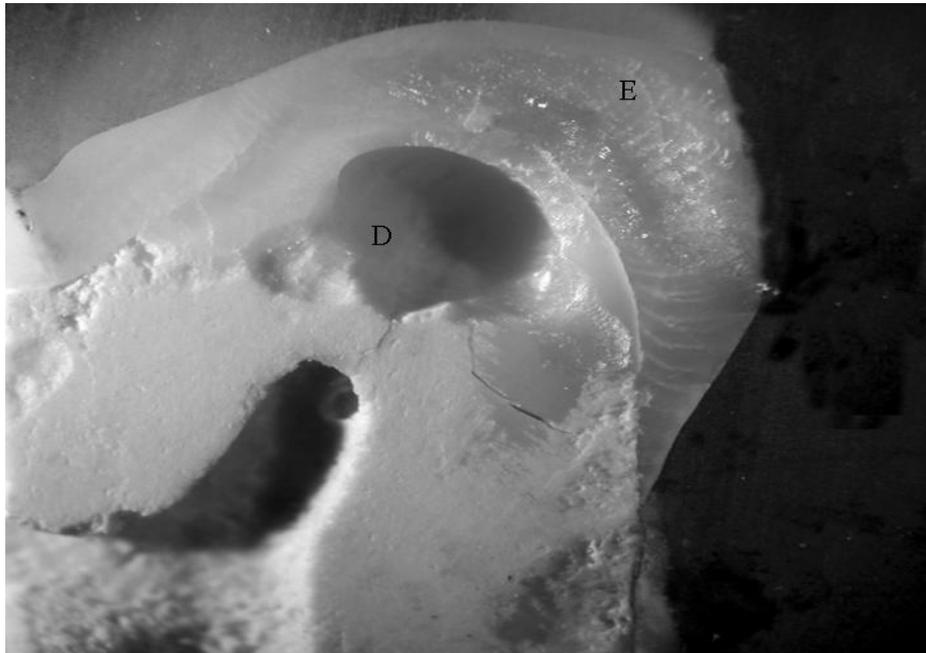


Figure 6.8: Dremel Drill drilling (Burial 266, LRM1). D = dentine, E = enamel.

total column volume of approximately 35 µL. Rinsing was done with 3.5M HNO₃, and Sr was eluted with water. Total procedural blanks during analysis were less than 100 pg

Sr and comprise a negligible portion of the Sr analyzed. Separated Sr was dried in H₃PO₄ and loaded onto single Re filaments using a TaCl₅ emitter solution for analysis. Analysis was accomplished on a VG Sector (University of Kansas analyses) and Sector-54 (University of North Carolina, Chapel Hill analyses) thermal ionization mass spectrometer. Both labs use identical 3-cycle dynamic Sr analysis routines and all data are normalized to $^{86}\text{Sr}/^{88}\text{Sr} = 0.1194$. Replicate analyses of NIST-987 yield $^{87}\text{Sr}/^{86}\text{Sr} = 0.710262 \pm 0.000009$ (2σ).

Results

Results are reported as the ratio of ^{87}Sr to ^{86}Sr (Figure 6.9). Although results appear to tightly cluster around 0.710-0.720, the method is accurate to six significant figures. Thus, it may eventually be possible to suggest that a difference as small as 0.710450 to 0.710460 is meaningful.

Figure 6.9 provides a summary of results. The $^{87}\text{Sr}/^{86}\text{Sr}$ ratio is plotted on the y-axis and individuals span across the x-axis. Approximate ages are at the bottom and in boxes are the individuals' $^{87}\text{Sr}/^{86}\text{Sr}$ ratios with enamel represented by open circles and dentine represented by dark diamonds. Individuals lacking decorative modifications are on the left; individuals with decorative modifications are toward the center, and the Ghanaian teeth, Ghanaian well water, and the intrusive pig molar are located on the right.

Sr isotopes in NYABG and Ghanaian teeth

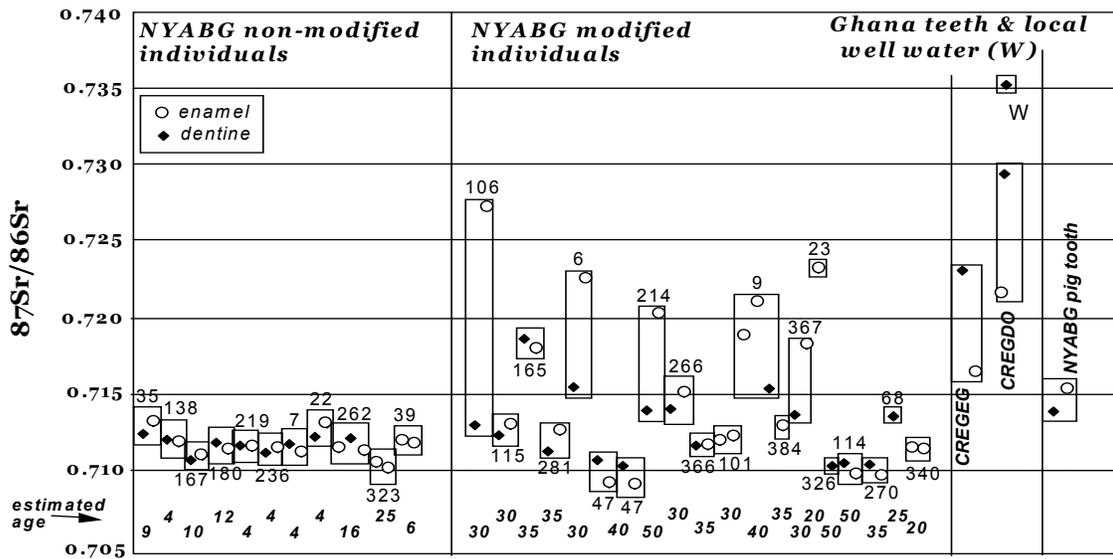


Figure 6.9: Strontium Isotopes Chart: Ratio of ^{87}Sr to ^{86}Sr in samples of enamel and dentine of individuals from the New York African Burial Ground, plus two individuals from Ghana; water from Ghana; and an intrusive pig molar (recovered with Burial 137).

Enamel

Based on prior geological studies and the clustering of young individuals, the “local” Manhattan $^{87}\text{Sr}/^{86}\text{Sr}$ value is likely to be ~0.711-712. And, in fact, most young and non-modified individuals (left side of figure) have both enamel and dentine values that cluster around in this range.

On the other hand, the Ghanaian teeth and waters and the intrusive pig have much higher $^{87}\text{Sr}/^{86}\text{Sr}$ values. The highest $^{87}\text{Sr}/^{86}\text{Sr}$ found was from a river sample collected in Ghana (value over 0.735). All of these samples have significantly higher strontium isotope ratios than those found in the New York born and suggest a wide range of values in Africa. These results are consistent with prior findings.

The individuals with decoratively modified teeth seem to divide into two or even three groups. Many individuals have high enamel values (Burials 106, 165, 6, 214, 266,

9, 267 and 23). Others such as Burial 47, Burial 114 and Burial 270 may be below the Manhattan value and others (Burials 115, 281, 366 and 101) are at the moment indistinguishable from the Manhattan value.

Dentine vs. Enamel

Dentine values relative to enamel values provide some potential insights. In all of the young individuals without dental modification, the dentine values are close to the enamel values, suggesting little movement or migration during life. On the other hand, the Ghanaian dentine values are high relative to the enamel values, suggesting possible movement to the African interior.

Most interesting is that all individuals with enamel ratios above the suggested “Manhattan range” have dentine values that are *closer* to the Manhattan range. This suggests that dentine may be chemically equilibrating to the lower Manhattan range. Possible explanations for this movement of dentine toward the Manhattan range might be either postmortem diagenesis, the incorporation of vital secondary dentine, or changes in primary dentine chemistry during life. In the future we intend to test among these different explanations because they have different implications for the interpretation of dentine chemistry.

Enamel Strontium Isotopes Ratios compared to ESA

The combined results of two independent sourcing methods suggest the following. First, the vast majority of young individuals cluster together in both methods. This suggests that they indeed spent all of their short lives in and around New York.

Similarly, most individuals with modified teeth cluster together in both the ESA and strontium isotope studies, suggesting that they spend their early lives in Africa.

A few individuals particularly require further study by more detailed examination of sequentially developing enamel and dentine by the above methods and new methods. For example, Burial 101 falls within the range of the New York-born on both methods, suggesting the possibility that this individual's teeth were modified in the Americas. On the other hand, Burial 106 clearly appears to be African born based on strontium isotopes, but not based on ESA.

Enamel Lead Content

As part of the collection of data for ESA, data were collected semi-quantitatively for nutritionally significant elements such as strontium and iron and heavy metal pollutants such as lead. Here we provide a brief note on lead variation within the ABG teeth.

Figure 6.10 presents lead intensities for samples with dental modifications (dark bars) and other individuals. Intensities are ordered from lowest to highest and vary from near nonexistent (less than 100 counts per second) to over 50,000 counts per second. The average intensities of lead in non-modified teeth are over 30,000, compared to an average of fewer than 5000 counts per second for modified individuals.

NYABG ESA Average Pb (82) Intensities

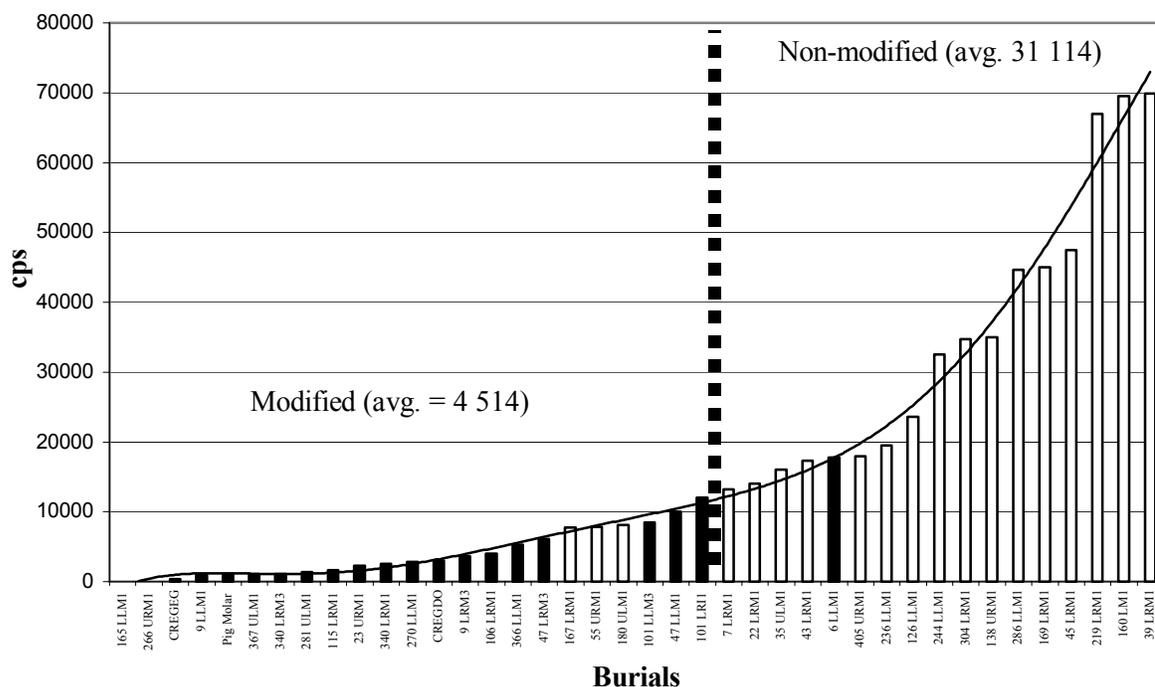


Figure 6.10: Lead Variation. Ranking of intensities of lead in teeth studies for ESA. Teeth from individuals with dental modifications (dark bars) tend to have low lead levels compared to individuals without dental modifications (white bars).

Without doubt, lead is significantly high in the teeth of some individuals from the ABG. As part of a broader study, six individuals were analyzed quantitatively for lead concentrations by liquid nebulization-ICP-MS (Webb et al., 2003). Despite the small sample size, it is worth noting that two non-modified children's (Individuals 304 and 405) whole tooth lead levels were significantly higher than those of four modified adults (Individuals 47, 266, 340 and 367). Lead levels ranged from 1.2 to 112.2 $\mu\text{g/g}$ (ppm), observed in Individuals 405 and 367, respectively. While it is as yet unclear precisely how lead levels of (different regions in) teeth relate to blood levels, 10 $\mu\text{g/dL}$ in blood is above the Centers for Disease Control (CDC) threshold for unsafe lead levels. A

concentration in whole teeth of over 100 ppm is undoubtedly unsafe and would have neurological and behavioral consequences (Purchase and Fergusson 1986).

Lead burden variation observed in the ABG sample underscores the need to assess the distribution and biohistorical impacts of elevated lead burden within and across populations. For example, enslaved African bone lead levels were apparently more variable and generally higher in Barbados than in at least some parts of southern mainland North America. Corruccini *et al.* suggest that many enslaved Africans buried at the Newton Plantation experienced “*only mild, intermittent symptoms of lead intoxication...[while others] probably suffered moderate to severe symptoms*” (1987a: 238). Aufderheide *et al.* (1981, 1988) associate high bone lead values from the Clifts Plantation in eighteenth century Virginia primarily with wealthy white slaveowners who ingested “very substantial” quantities of lead via foods stored in relatively expensive, pewter containers. Likely also affected, however, were domestic laborers whose access to such foods and subsequent lead burden would have been greater than that of other enslaved Africans; possibly the explanation for high lead content observed for an 18 year-old female (Aufderheide 1988). Rathbun (1987) reports mean bone lead values intermediate to those from the Caribbean and Virginia studies for African American remains excavated from a nineteenth century plantation cemetery in Charleston, South Carolina.

As lead is found in enamel formed during the first year or two of life, the public health significance of better understanding the social and biocultural etiology and consequences of lead poisoning becomes even clearer. It is highly likely that lead is transmitted from mother to child through breast-feeding and may even be transmitted

prenatally (Schell 1991, 1997). Thus, the distribution of elevated lead levels is in part a reflection of maternal lead burden—a “multigenerational experience” (Schell 1997: 72) historically and organically linked to race, residence and economic status in the United States. Hence, lead poisoning is no longer an “unrecognized” epidemic affecting primarily white landowners. Today, lead poisoning constitutes a “silent” epidemic disproportionately affecting African Americans “hypersegregated” in low-income, urban areas where malnutrition, old housing and prolonged exposure due to low social mobility maximize lead levels (Lanphear et al. 1996; Needleman 1998; Reed 1992; Weintraub 1997).

This finding of unusually high lead levels among first-generation African Americans, especially in individuals who died at an early age in New York, provides important historical context and leads to a number of important questions. We would like to know the prevalence of lead pollution, the source of the pollution, the age of individuals who are ingesting high lead levels, and whether lead is implicated in their early deaths. Expanded lead analysis may help to distinguish other groups within the NYABG sample whose work environments or status placed them at higher risk for lead poisoning. These would include domestic workers, mine workers, and possibly freed people; some of whom would have had greater access to pewter items (see Aufderheide et al., 1985; McCord, 1953).

Conclusions

Preliminary studies of teeth from individuals buried in the NYABG confirm that most individuals who died at an early age spent their lives in and around Manhattan and most individuals with culturally modified teeth appear to have spent their first decades

somewhere in Africa. Strontium isotopes also suggest that a few individuals may have spent time in the Caribbean. High lead level in teeth of individuals who lived their lives around Manhattan and died at an early age is an entirely new finding.

These pilot studies have significantly furthered our understanding of the lives of the individuals who are buried in the NYABG. The results strongly hint at the capability to tell the geographic histories of individuals along with individual histories of nutrition and pollution exposure. Combined with historical, archaeological, and other bioarchaeological information, additional studies modeled on the ones conducted here will lead to the clearest understanding of enslaved Africans.

Therefore, based on the outcomes obtained in these pilot studies and the experience gained from research on the ABG sample, the ABGP Skeletal Biology team intends to pursue additional funding for the conduct of future studies that would explore, among others, the following:

- Extension of studies to bone to better understand chemical conditions nearer the time of death.
- Establish the cause of variation in chemistry between enamel and dentine of the same tooth.
- Extensive analysis of soils and fauna from New York and possible other natal homes (West Africa, Caribbean) in order to better establish values at possible source locations.
- Extension of analyses to other teeth and a finer grained analysis of teeth.
- The addition of new methodologies such as oxygen isotopes to further resolve natal homes.

Acknowledgements

We owe a great degree of gratitude to the descendant community for allowing scientific analyses of the lives of their ancestors. A variety of individuals helped along the way, including, but not limited to, Lesley Rankin-Hill (University of Oklahoma), Douglas Walker (University of Kansas), Chris DeCorse and Samuel Spiers (Syracuse University), Edward Carr (University of South Carolina), Rhan-Ju Song and Alexis Dolphin (University of Massachusetts) and Christina Spaulding, Ellen Webb, Stephanie Allen and the class of “Archaeology of Enslaved Africans” (NS 134/334; Spring, 2003) from Hampshire College. The additional financial support for the research presented in this chapter came from a grant to Dr. Alan Goodman from the NSF-CRUI program (9978793).

CHAPTER 7

Demographic Overview of the African Burial Ground and Colonial Africans of New York

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The origins of Africans in colonial New York, and some conditions encountered upon their arrival, have been explored in the two preceding chapters. The objective of the current chapter is to reconstruct who these diverse Africans became as a single population/community (that used a common cemetery) once in New York City. This chapter serves as both an historical demographic (based on documents) and paleodemographic (based on skeletal assessments) overview of the structure of the African population of colonial New York.

The overview is based on the synthesis of the research outcomes that is presented in the New York African Burial Ground Project (NYABGP) *Final History Report*, which are related mainly to municipal censuses, and the analyses and interpretations of the skeletal biological research team that are concerned primarily with mortality. The goals of the analyses presented herein are to: 1) establish population profiles and demographic trends for the New York African Burial Ground (NYABG) skeletal sample that integrate these two data sets; 2) reveal the New York African population in relation to its surrounding, temporal, political, economic, and sociocultural landscape; 3) place the NYABG skeletal sample within the biohistorical framework of the African diaspora in America; and 4) provide a conceptual framework for the archaeological research work.

The research presented in this chapter is not based on a set of hypotheses but instead begins to track relationships among demographic variables and between the demography and historical attributes of this sample. This sample is unique compared to the other African Diasporic skeletal series, differing in such features as sample size, time period, and a regime of urban enslavement. The only ubiquitous demographic trait identified in all series is that of high infant mortality rates. The political economic, environmental, and socio-cultural context of each sample produces a variety of patterns that will be discussed near the end of the chapter. A more comprehensive and etiological discussion of demographic political economy is presented in Chapter 14 of this report. The current chapter is to provide a sufficient demographic background to facilitate the reader's evaluation of the health effects discussed in chapters 8-13.

This chapter is organized into three sections; the first presents a brief discussion on paleodemography and its limitations followed by the paleodemographic data including the age and sex composition of the NYABG sample, mortality patterns of subadults and adults, life expectancy, and sex ratios. The second section summarizes the historical demographic data within an historical context. This includes population size, age and sex composition, sex ratio, and mortality trends shown in living people for the colonial period. The third presents comparative population parameter assessments from the African diaspora and colonial New York.

The sum of demographic research of the ABGP consists of data on migration, fertility, mortality, and population structure. Demographic profiles can reasonably document the movements of Africans into and out of colonial New York City, the proportions of men, women, and children of different ages who comprised its African

community, their frequency of death and life expectancy at different ages, and changes in population size and composition. Therefore, these population profiles provide a means of determining who constituted the African community during the historical development of the city. Changes in population profiles reflect changes in the social, economic, political, and environmental conditions that shaped the Colonial African experience in New York.

Taking into consideration that investigating the African presence in the archaeological and historical record is a “search for the invisible people” (Rankin-Hill 1997), the quantity and quality of data available for this study is sufficient for an accurate reconstruction of the larger living African community of colonial New York City, including those persons interred in the African Burial Ground. For the colonial period, there are two main data sources: historical archival/documentary evidence and paleodemographic evidence.

Census data and other historical documentation are available for colonial New Yorkers, primarily Euro-Americans and to some extent Africans. These data are useful for understanding migration, fertility, and population structure although there are also significant limitations with these sources. These limitations include: a lack of detail in the available historical and archival documents; changing categories between censuses and other sources (e.g., the age when a child becomes an adult); undercounts of Africans due to smuggling, under-reporting cargo and property subject to tariffs and taxation. For example, in the Spanish slave trade “Piezas de India” (Curtin 1969) were recorded as cargo; this could refer to one or a hundred enslaved Africans. The available census data are less useful for assessing mortality than is the paleodemographic accounting of the dead themselves. The strengths of each data source can compensate for the weaknesses

in the other. The synthesis of skeletal and historical/archival sources provides a window into the life and death in the colonial city. Furthermore, the comparison of historical/archival and paleodemographic analyses provides a means of exploring critical questions and complex biocultural interactions.

An extensive discussion of documentary evidence for New York's demography is provided in the *History Final Report* of the ABGP. However, some of the key data from the historical work will be integrated throughout the demographic discussions and in skeletal biological chapters. Some answers are already possible from the available, integrated data. In other cases, questions have been directed to the historians' work for possible resolution.

Paleodemography

Paleodemography is the study of archaeological populations based on skeletally determined age and sex. Paleodemographic analyses provide a means for assessing mortality and are less effective with some other demographic variables. For example, estimates of and discussions concerning fertility are generally limited in general from skeletal remains; factors such as high levels of forced and/or voluntary migration and trading of enslaved African people would only further complicate assessment.

In the last 30 years since Angel's (1969) article "The Bases of paleodemography," there have been several phases of intense criticism followed by discourse and proposed solutions to the intrinsic problems of paleodemographic studies. In the 1970's the major focus was on the uses and problems of utilizing life tables with skeletal populations (e.g., Moore et al. 1975; Buikstra 1976).

In the 1980s, there were two major critiques of paleodemography, the most significant by Bocquet-Appel and Masset (1982) stating that paleodemographic techniques were so flawed that the field should be abandoned, and they heralded their “farewell” to its “death.” Their criticisms were based on two major points; they maintained that: (1) the age structures of skeletal samples reflect only the age structures of reference populations by which skeletal aging criteria have been established; and (2) age estimates of adults lack sufficient accuracy to allow for demographic analysis. Age estimates, then, are seen as mere “random fluctuations and errors of method” by these authors. This launched extensive debates into the early 1990s by numerous authors, for example: Van Gerven and Armelagos 1983; Buikstra and Konigsberg 1985, and Greene, Van Gerven, and Armelagos 1986, dispelling the idea that age assessment was so flawed it rendered paleodemography as a dead area of research.

The second major critique in the 1980s by Sattenspiel and Harpending (1983) and Johansson and Horowitz (1986) brought to the forefront the concept that the fundamental assumption of nonzero population growth of life tables and other demographic models/analyses could actually distort age at death distributions so that they reflect fertility more than mortality (Milner, Wood and Boldsen 2000).

In the early 1990s, Wood et al. (1992) document three critical problems in paleodemography using archaeological data sets and models to establish their argument. These three problems are: demographic non-stationary (that populations are not stable/stationary as previous models assume); selective mortality, only those that succumb at any given age are represented in a skeletal population; and, hidden

heterogeneity in risks, unknown mix of individuals with mixed susceptibilities makes aggregate data almost impossible to interpret.

These changes and developments lead us to a variety of possible solutions, questions, and modeling to explore in paleodemographic studies, according to Wood et al. (1992). Others have begun to explore both methodologically and theoretically the direction of paleodemographic research in the future (e.g., Sanders and Hoppa 1993; McCaa 2002). Notwithstanding the limitations of paleodemographic assessments, cautious and substantive inferences from the population structure of the dead to that of the living can be developed.

New York African Burial Ground Skeletal Sample

The NYABG sample consisted of 419 recovered burials of which 301 were available for study based on preservation (see Appendix C). Determinations of age and sex were based on multiple methods of aging and sexing for adults and aging methods for subadults, as discussed in Chapter Four. Therefore, paleodemographic assessments are based on these 301 individuals. The adult skeletal remains available for study totaled 171 individuals for whom age and gender could be determined, including 102 males and 69 females. In addition there were 130 ageable subadult skeletons. Therefore, subadults were 43.2 percent of the total sample and adults were 56.8 percent. In this chapter, five year age interval groups are used for demographic analyses (see Chapter 4 for the detailed discussion on aging).

Mortality

New York African Burial Ground overall mortality, based on the total demographic skeletal sample (N=301), was elevated in the first two years of life. This

was followed by a decreased mortality until late adolescence/early adulthood (with a slight increase at age 4-5 that may or may not be relevant), mortality remained elevated throughout adulthood. Mortality was highest for infants 0-6 months (9.6%), adults in the 30-34 age group (9.1%) and 45-49 year olds (8.3%) (Figure 7.1).

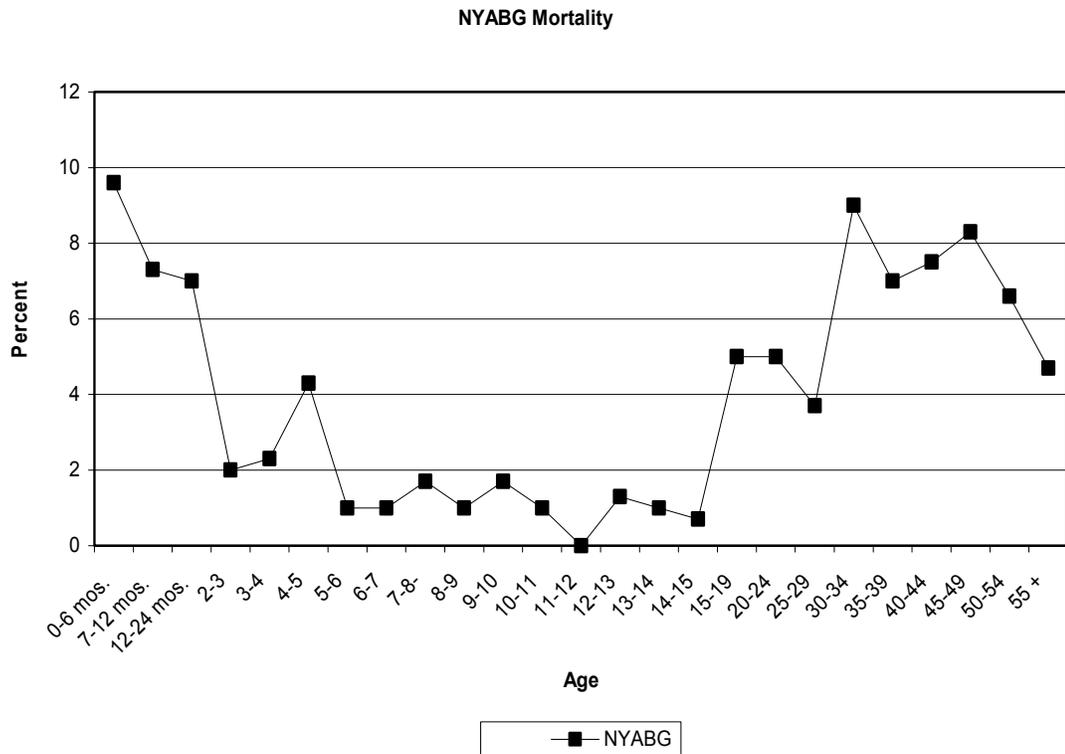


Figure 7.1: New York African Burial Ground Mortality

Adult Mortality

Adult mortality was highest in the third and fourth decades of life where 28.1 percent of adults died in each decade. Female mortality (37.6%) was highest in the 30-39 age group, close to double the rate of males (21.6%). Male mortality was highest (34.3%) in the fourth decade (40-49), while female mortality was lower almost by half (18.8%). Thus a differential mortality trend by sex can be observed with approximately two-thirds of the females (62%) dying by the end of the fourth decade, compared to 45

percent of the males. Notably, many young adults aged 15-19 are present in the burial ground, which is usual.

In general, females entering their reproductive years have higher biological risks than males under “non-stressful” socio-economic/environmental circumstances. In the ABG, both groups have similar and high rates. In general demographers consider age 12-35 a “trauma bump” in mortality especially for males both in historical and contemporary populations (Bogue 1969). Therefore, the apparent death rates for 15-19 and 20-24 year old males may be a typical phenomenon with other factors such as interpersonal violence, accidents, and high risk behaviors contributing to young adult mortality. Yet, these data indicate that females were under “stress” during a period of their lives when they should have been reproducing, not dying (see Figure 7.2 and Table 7.1). Several explanations can be proposed here: 1) similar mortality rates for young men and women may result from their being a greater proportion of the captives imported to New York and are therefore represented in the skeletal sample in greater numbers; 2) these young adults may have represented newly arrived captives who were unsuccessful in adapting to a new environment and the lifestyle of enslavement; 3) possible bias in the skeletal sample; 4) that enslaved Africans entered into young adulthood biologically compromised and were at greater risk of susceptibility; or 5) an interaction of all the above factors.

NYABG Adult Mortality by sex and Age

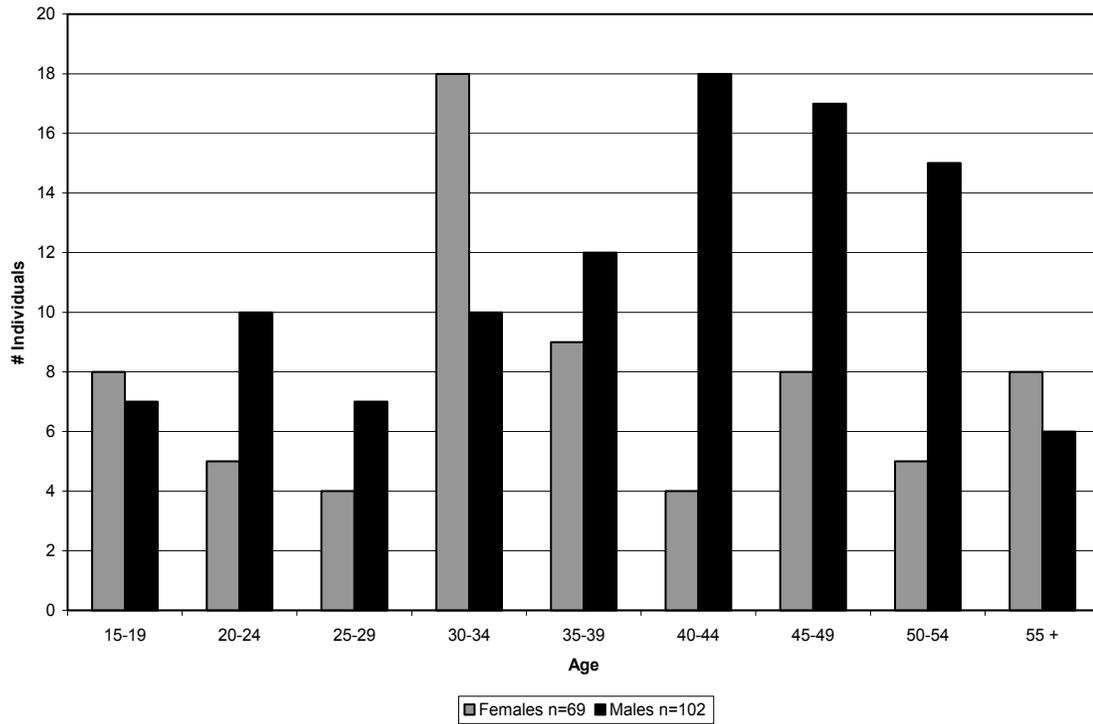


Figure 7.2: New York African Burial Ground Mortality by Sex and Age

Table 7.1: New York African Burial Ground Adult Mortality

Age Group	Male			Female			Adults		
	N	% Male	% Total	N	% Female	% Total	N	% Total	% Adult
15-19	7	6.9	2.3	8	11.6	2.7	15	5.0	8.8
20-24	10	9.8	3.3	5	7.2	1.7	15	5.0	8.8
25-29	7	6.9	2.3	4	5.8	1.3	11	3.7	6.4
30-34	10	9.8	3.3	17	24.6	5.6	27	9.0	15.8
35-39	12	11.8	4.0	9	13.0	3.1	21	7.0	12.3
40-44	18	17.6	6.0	5	7.2	1.7	23	7.5	13.5
45-49	17	16.7	5.6	8	11.6	2.7	25	8.3	14.6
50-54	15	14.7	5.0	5	7.2	1.7	20	6.6	11.6
55+	6	5.9	2.0	8	11.6	2.7	14	4.7	8.2
	102	100	33.9	69	100	22.9	171	56.8	100

Subadult Mortality

Subadult mortality is an important factor in overall population stability and viability eventually affecting natural population growth. If indeed as Sattenspiel and Harpending (1983) argue, subadult skeletal remains actually represent subadult birth rates rather than deaths, and then birth rates can be inferred as being high; yet overall African population growth in New York City was low and gradual. The majority of subadult deaths (39.2%) occurred during the first year of life, followed by another 16.2 percent in the second year. Therefore, 55.3 percent of all the subadults died by age two. A sharp decline between ages two and four, with a doubling at age 4-5 is followed by a radically decreased mortality until adulthood (Table 7.2).

Table 7.2: New York African Burial Ground Subadult Mortality

Age Category	N	% Subadults	% Total
0-6 months	29	22.31	9.6
7-12 months	22	16.92	7.3
12-24 months	21	16.1	7.0
2 - 3	6	4.6	2.0
3-4	7	5.3	2.3
4-5	13	10.0	4.3
5-6	3	2.3	1.0
6-7	3	2.3	1.0
7-8	5	3.8	1.7
8-9	3	2.3	1.0
9-10	5	3.8	1.7
10-11	4	3.1	1.0
11-12	0	0	0
12-13	4	3.1	1.3
13-14	3	2.3	1.0
14-15	2	1.5	.7
	130	100	43.0

Historical Demography of Africans in Early New York

It has been estimated that at a minimum, 6800 Africans were imported into New York colony between 1700 and 1774, with approximately 2800 coming directly from Africa and 4000 from the Caribbean and Southern colonies. Perhaps one-fifth to one quarter of them remained within the city of New York (Lydon 1978: 382-383, 388). Many lived there for the rest of their lives, had children, and were eventually buried in the African Burial Ground. Some gained legal freedom, gradually building a free African population (which nevertheless had to fight to attain basic civil liberties), but most died enslaved.

The county of New York did not maintain official death records prior to the early nineteenth-century. The quantitative data available, therefore, are from church records, and are for the European rather than the African community; only nine deaths of Africans appear among thousands recorded in the surviving colonial New York church records. Most of these available church records provide limited information. Age at death, is given by only a few denominations, and for limited time periods. For example, the Dutch Reformed Church only provided categories (male, female, child, and infant) thus rendering the records unquantifiable. Overall demographic research on the Middle Atlantic colonies is severely limited and does not provide a broad basis for comparative studies.

New York County's population grew steadily between 1698 and 1800, actually, increasing almost twelve-fold. The African population only grew eight fold during the same period. The proportion of Africans in New York fluctuated throughout the period, actually declining between 1786 and 1800. The Euro-American population remained

fairly constant (around 80-85% of the total population) until 1786 when it increased to 90 percent (Table 7.3).

Table 7.3: Population of New York County, 1698 - 1800

Year	Total	Black	% Black	White	% White
1698	4,937	700	14.2	4,237	85.8
1703*	4,391	799	18.2	3,592	81.8
1712	5,841	975	16.7	4,886	83.3
1723	7,248	1,362	18.8	5,886	81.2
1731	8,622	1,577	18.3	7,045	81.7
1737	10,664	1,719	16.1	8,945	83.9
1746	11,717	2,444	20.9	9,273	79.1
1749	13,249	2,368	17.9	10,926	82.1
1756	13,046	2,278	17.5	10,768	82.5
1771	21,863	3,137	14.3	18,726	85.7
1786	26,614	2,107	7.9	21,507	92.1
1790	31,225	**3,092	9.9	28,133	90.1
1800	57,663	***5,867	10.2	51,796	89.8

Source: Foote (1991:78) and White (1991:26), except 1703. Both Foote and White have corrected the raw figures. See also Kruger (1985:131), though there are some discrepancies in the percentages for 1786, 1790, and 1800.

* From census of households in New York City (see below). These figures differ from those given in the 1703 census of the colony of New York, which listed only 630 blacks.

** Includes 1,036 free and 2,056 enslaved blacks

*** Includes 3,333 free and 2,534 enslaved blacks

Age and Sex Structure

The proportion of men to women (sex ratio) is utilized for assessing a population's "stability". Relatively equal numbers between the sexes within each age group often suggest that the population has been in place long enough to effect the equilibrium produced through natural fertility. An equal sex ratio (presented as 100 on a scale in which lower numbers represent an under representation of males) also indicates a favorable availability of marital partners for the establishment of families. There are no standards for "normal" or "abnormal" sex ratios per se; it is the relationship of sex ratios with birth and death rates that are significant to population growth and age-sex structure. For example, a sex ratio of 110 would indicate that there is a preponderance of males; a sex ratio of 89 would indicate a shortage of males in the population. Of course the sex ratio in reproductive age group would have the greater short term impact on overall population growth. In many enslaved sugar, coffee, and/or tobacco plantations of the Caribbean the lower sex ratios combined with birth, death rates, and health care quality led to declining enslaved populations (e.g., Higman 1991; Friginals 1977).

Historically the earliest phases of voluntary migration often produce sex ratios far in excess of 100, due to the initial large migration of men prior to the migration of women. Recent immigrants also tend to have fewer children, and the elders tend not to migrate. Essentially, the majority of first wave in-migrants tend to come from the most economically productive age groups.

These populations tend to grow rapidly as time goes on and as women arrive in large numbers and children proliferate, especially in agrarian communities. A population's growth and fertility are more dependent upon the number of reproductive

females than on the number of reproductive males. When considering enslaved populations in many cases, these historically and contemporary identified trends occur in the early phases of capture and trade, as trade in human cargo escalates the needs of the prevailing political economy shapes the age-sex composition and sex ratio of the enslaved population. Several of the same population trends associated with voluntary migration are also observed in the New York African population, despite the fact that involuntary migration of enslavement was based on a selective process external to the captive men, women, and children. In 1626, the Dutch Colony of New Netherlands initially imported 11 men followed by the first three enslaved African women in 1628 (McManus 1966). This selection process of captors focused on able bodied, economically productive males and eventually females, and excluded those segments of low labor value; namely, the very young, the old, and the infirm. This phenomenon also had an impact on African demographic patterns by establishing a pattern of under population and under development of the African continent.

Eighteenth century censuses identified by project historians provide a source for New York inhabitants including Africans. As in all historic documents, the potential for inaccuracy is recognized, understanding that undercounts of both enslaved Africans and European Americans is probable. The selective nature of the slave trade is further substantiated in the New York 18th century censuses where the proportional rates of African adults relative to children (excluding 1731 and 1737 where adults = 10 years of age and older) were highest (Table 7.4). New York's African adult population was fairly consistent around 60-65 percent; in 1746 it decreased to 56 percent followed by a return to the earlier higher rates.

Table 7.4: African Population by Age and Sex, 18th Century Censuses

Year	Adults Male	Adults Female	Children Male	Children Female	Age Cutoff	Label in Census	Notes
1703	298	276	124	101	≤16	negroes	
1712	321	320	155	179	≤16	slaves	
1723	408	476	220	258	not given	negroes and other slaves	presumed 16
1731	599	607	186	185	≤10	blacks	
1737	674	609	229	207	≤10	black	
1746	721	569	419	735	≤16	black	black adult males includes 76 males over 60
1749	651	701	460	556	≤16	black	black adult males includes 41 males over 60
1756	672	695	468	443	≤16	black	black adult males includes 68 males over 60
1771	932	1085	568	552	≤16	black	black adult males includes 42 males over 60
1786	896	1207				slaves, negroes	

Source: *Century of Population Growth*, checked against *Docs. Rel. Col. Hist. NY*. Some discrepancies in the Kruger and Foot numbers have been corrected.

Sex Ratio

Throughout the eighteenth century based on historical documents and contemporary literature (Kruger 1985) sex ratios tended to indicate an excess of females, or numbers equivalent to males (Table 7.5). A substantially greater number of males are reported only for 1746 (126.7%) and 1737 (110.7%). The proportion of males (but not their absolute numbers) decreased most markedly following periods of political upheaval in the Americas (Table 7.5, see Chapter 14 for further discussion). Low sex ratios have been observed as an urban phenomenon during enslavement and antebellum periods in several states and the Caribbean. For example, Higman (1991, 1984) observed low black sex ratios in West Indian towns and Morgan (1984) in Charleston, South Carolina, that also had a preponderance of women in many years. Since females were of great value as domestics within towns and cities, women were actively sought by slaveholders and by early urbanites in non-slaveholding states. Domestic work was not an easier work regime; domestics were engaged in strenuous physical labor, as evidenced by skeletal biological and paleodemographic assessments of the First African Baptist Church cemetery, nineteenth century urban “free people of colour” (Rankin-Hill 1997).

Table 7.5: Sex Ratio New York City County 1703-1819

YEAR	SEX RATIO	NOTES
1703	107.9	
1712	100.3	
1723	85.7	
1731*	98.7*	*Note that in 1731 and 1737, the censuses counted persons over or under 10 years of age; thus “adults” were not all of childbearing years. The overall sex ratio for these years was 99.1 for 1731 and 110.6 for 1737.
1737*	110.7*	*ibid.
1746	126.7	
1749	92.9	
1756	96.7	
1771	85.9	
1786	NA	State census did not count blacks by sex
1790 1800 1810	NA	Federal censuses did not count blacks by sex
1805	72.3	local censuses for the early 19th century (Kruger 1985:370)
1819	65.8	
		Source: <i>Century of Population Growth</i> . Discrepancies were found in Foote’s and Kruger’s numbers, and have been corrected. The numbers in <i>Century of Population Growth</i> were checked in <i>Docs Rel. Col Hist NY</i> .

Comparison with the New York Colonial European-American Community

Historical records provide few contemporary comparative populations, European–American or African for the eighteenth century. The best potential source for mortality was the Trinity Church and burial ground records. Trinity Church, an Anglican Church near the ABG site, is one of the oldest churches in New York City. Many of the cemetery residents were most probably the actual owners of those interred in the ABG. The data set was compiled from a publication of existing church records (Corporation of Trinity Church 1969) by the project’s Office of Public Education and Information covering the period from 1700 to 1777. Although records and epitaphs were available for

a greater length of time, these were excluded due to the turmoil and subsequent evacuation of New York City during the Revolutionary War. These church records, as any historical document, can have intrinsic flaws and/or biases; these can include non-recording, interment elsewhere or religious, social and/or political exclusion from the cemetery among other reasons. The Trinity church burial population sample consists of 327 interments, 187 adults and 140 children; of these, there were 100 male and 87 female adults.

Adult mortality patterns between the two populations differ somewhat dramatically; to some extent they are inverse images of each other (Figure 7.3). In comparing adults by age and sex and subadults, a differential pattern between European and African New Yorkers can be observed. The Trinity Church males have moderate death rates during the “middle” ages and are primarily dying in later life (with great longevity into the 80’s and 90’s). The only age group where Trinity mortality exceeded African Burial Ground males was in the 25-29 and 55+ age groups (Figure 7.4). This higher rate of death in the mid 20s may be explained by the in-migration of young men, who would then be present in greater numbers in death or interpersonal violence. Other reasons for the early mortality of English men are still under investigation by historians. African male mortality was the highest at 35-49 followed by ages 20-24. Therefore NYABG males were experiencing significantly higher mortality rates in early adulthood.

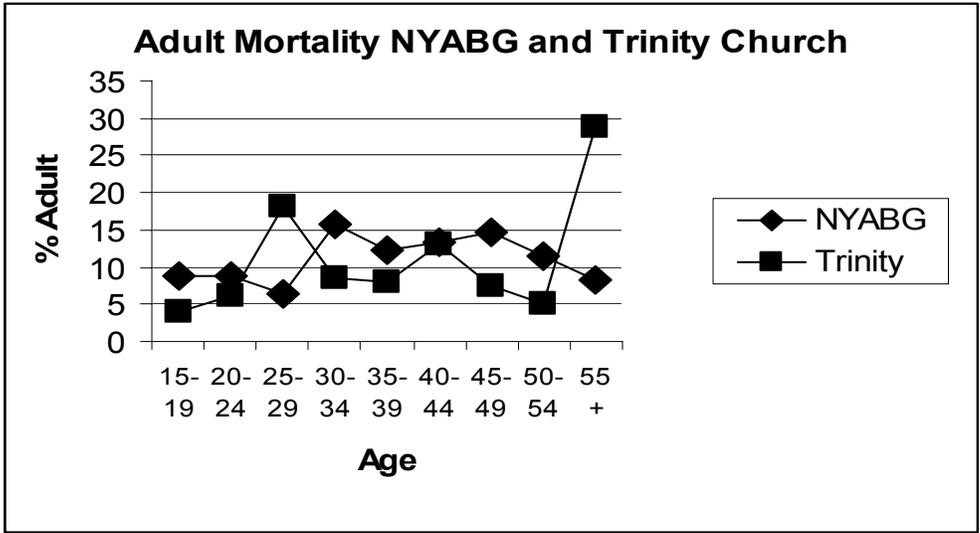


Figure 7.3: Adult Mortality NYABG and Trinity Church

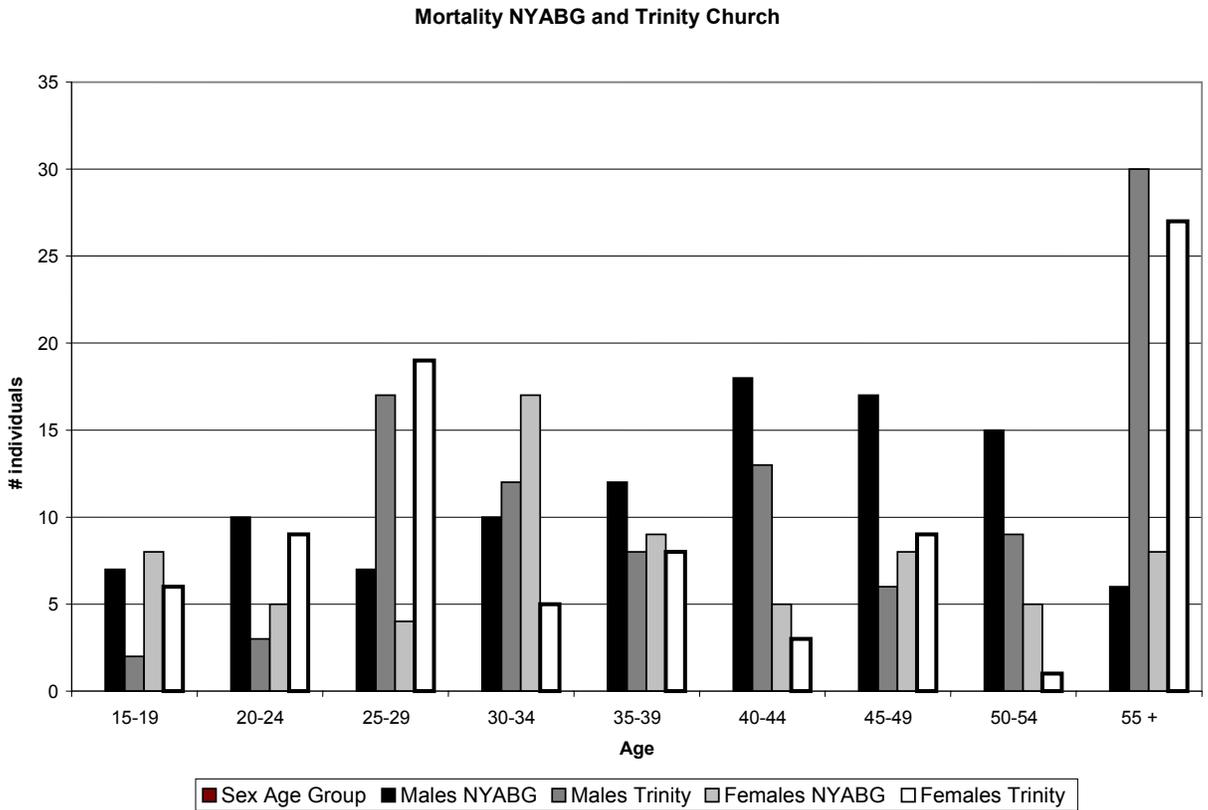


Figure 7.4: Mortality NYABG and Trinity Church by Sex and Age

Female mortality for Trinity Church peaks at ages 55+ and 25-29; the longevity of English women is only slightly less than that of males and, of course, much higher than the ABG women. High mortality in the 25-29 age group is a repeated pattern throughout the eighteenth and nineteenth centuries in America, primarily based on the stresses of reproduction; this pattern does not decline until the early twentieth century. The NYABG women are proportionately dying at higher numbers throughout early adulthood; by age forty, 62 percent of ABG women and 54 percent of their European counterparts have died. Yet the women of Trinity Church have a reduced mortality regime after the 25-29 peak and go on to live to older ages; very few African women made it to old age (Figure 7.4).

Subadult mortality for Trinity Church was slightly higher in the first year of life, exceeding the ABG in the second year of life, 10 percent and 4 percent respectively (Table 7.6). The overall mortality regime for the NYABG and Trinity Church were almost identical in pattern with high early childhood mortality and a dramatic decline for ages 5-9 and 10-14 (Figure 7.5).

Table 7.6: NYABG and Trinity Church Subadult Mortality

Age	NYABG	% Subadults	Trinity	% Subadults
0-5	98	75.4	119	85.0
5-9	19	14.6	15	10.7
10-14	13	10.0	6	4.3
	130	100.0	140	100.

Subadult Mortality New York African Burial Ground and Trinity Church

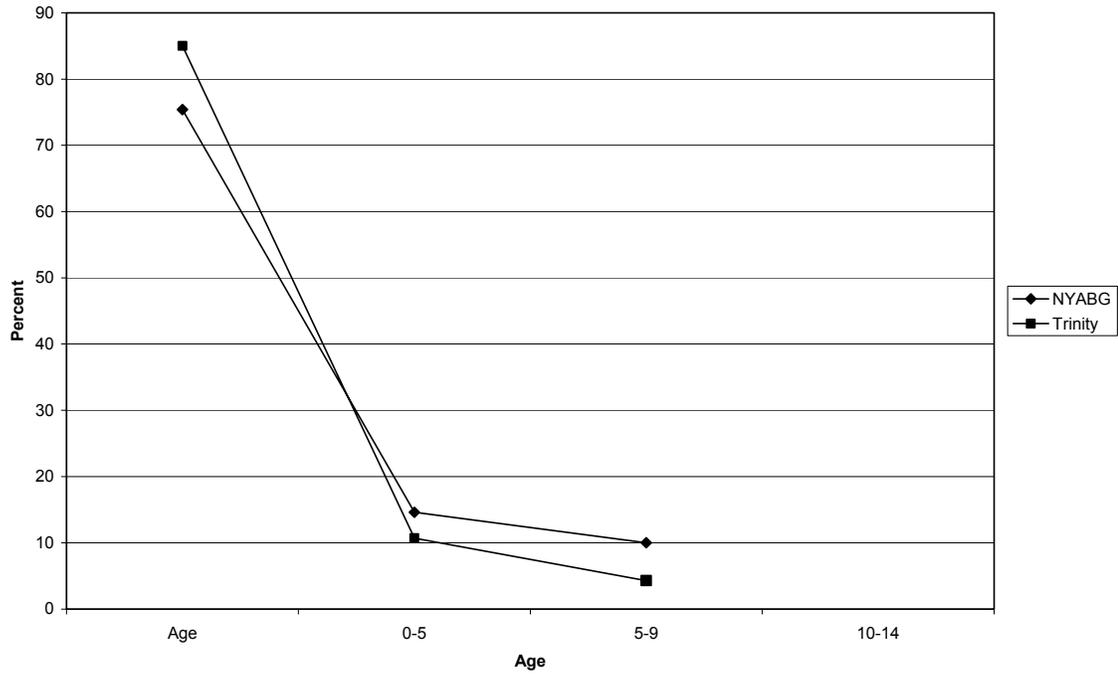


Figure 7.5: Subadult Mortality NYABG and Trinity Church

Young children and infants are always underrepresented in historical cemetery populations but the under representation in archaeological cemeteries with varied preservation conditions (such as the ABG) tend to be dramatically higher. Most of the Trinity Church mortality data used here derive from archival records and Corruccini et al. (1982) clearly show that such records of infant mortality in contemporary (eighteenth century) Barbados are several times greater than the numbers of infant skeletons they observed (better preserved adults skeletons were comparable to archival figures). Hence, the pattern of mortality fits what is known about the colonial period characterized by epidemics and unhealthy sanitary conditions that affected the morbidity and mortality of all colonial Americans. The overall impact on this enslaved population was more dramatic.

It is very clear from these data that the factors affecting age at death were very different among enslaved Africans and the prominent English parishioners of Trinity Church who held them in bondage. Both English men and women lived to old age up to 10 times more often than did Africans.

Comparative Skeletal Biological Studies of the African Diaspora

The limited skeletal series of Africans in the Diaspora that have been studied represent a broad spectrum of life styles and biohistory throughout the eighteenth, nineteenth, and early twentieth centuries (Table 7.7). These skeletal biological series include: South Carolinian plantation enslaved (Rathbun 1987); Maryland industrial enslaved (Kelley and Angel 1983); ex-slaves and their descendants from rural Arkansas (Rose 1985); urban slaves from New Orleans (Owsley et al. 1987); poor and destitute urban dwellers (Blakey and Beck 1982) from reconstruction period Atlanta; slaves from several small (1–9 burials) southern farms or plantations (Angel et al. 1987); Philadelphia urban “free people of colour” (Angel and Kelly et al. 1987; Rankin-Hill 1997; Crist et al. 1999) and the only Caribbean series, Barbadian sugar plantation enslaved (Handler and Corrucini 1986). Availability of the majority of these Afro-American skeletal populations for analysis has been limited (two weeks to several years) due to their historical status and/or exhumation conditions. Only one skeletal series has been curated, that of Catoctin Furnace (Kelley and Angel 1983); the remainder have been reburied or scheduled for reinterment.

There are three general trends observed in all African diasporic skeletal series, which concur with biohistorical life style and health analyses (see, for example, Kiple and Kiple 1980; Rankin-Hill 1997): (1) high infant and child mortality; (2) periods of malnutrition and

disease indicated by linear enamel hypoplasias and nonspecific infectious lesions; and, (3) high incidence of degenerative joint diseases and muscle attachment area hypertrophy, evidencing the physically strenuous lives of Africans in the New World. Differential patterns are observed among and between these African diaspora skeletal series in longevity by sex, general health status, type, and incidence of trauma. These studies demonstrate the need for regionally, temporally, historically, and culturally focused studies of Africans in the new world. Comparisons and conclusions regarding African diasporic skeletal biological studies have varied based on several factors: the preservation of the skeletal remains, which affects the types of analyses possible; the methodologies undertaken by different investigators; and the presentation of data. The following section encapsulates provenience and demography of the major African diasporic skeletal series. These skeletal series provide comparisons for the NYABG where data was available and appropriate.

Newton Plantation, Barbados, West Indies

Corruccini and coworkers (1982) have undertaken the only large study of an Afro-American enslaved population from the Caribbean. This series represents a population involved in an intensified sugar plantation economy. This slave cemetery, associated with the Newton plantation in Barbados, consisted of 103 individuals interred between 1660 and 1820. These analyses indicated a mean age at death of 29.3 years; due to poor preservation not differentiated by sex. Historical data available on Newton plantation's captives aided the evaluation of the demographic patterns determined from the scarce skeletal remains. These data “show vastly greater infant and child mortality, stability with relatively low mortality ages 10–35, then consistently greater mortality by age 40 than is indicated by skeletal aging” (Handler and Lange 1978: 286).

St. Peter Street Cemetery, Louisiana

The St. Peter Street Cemetery in New Orleans, Louisiana, dating circa 1720 and 1810, was studied by Owsley et al. (1987). St. Peter's served as New Orleans' principal cemetery during the city's first seventy years under both Spanish and French rule. Until the discovery of the NYABG, this cemetery represented the earliest urban African-American skeletal population that had become available for study.

The sample consisted of twenty-nine individuals, twenty-three adults aged twenty and over, and six subadults (one infant, two aged 5–9, and three aged 15–19); of these, thirteen (45%) were identified as African Americans and were most probably enslaved people. Females appear to have had a shorter life span than males, with peak mortality at 20–24 years of age and slightly higher rates of death, while male peak mortality was at 40–49 years. But Owsley and coworkers caution that an “inherent sample bias may misrepresent the actual mortality curve of the colonial population” (1987, p.10) due to small sample size and the under-representation of infants and children.

Catoctin Furnace, Maryland

The Catoctin Furnace Cemetery in Frederick County, Maryland, dates from the late 1790s to 1820. The skeletal population studied represented only one-third of the cemetery population, since the rest of the cemetery had been covered by a state highway. This skeletal material became available during the widening of the highway and constitutes a small sample of thirty-one individuals (fifteen adults, fourteen children under age twelve, and two teenagers). These individuals were members of an iron working enslaved community, and primarily represented kin (Kelley and Angel 1983). Females were at greater risk of early death in this industrial slave community, as indicated by a mean age at death of 35.2 years for

females and 41.7 for males, a pattern of earlier female mortality comparable to post-Reconstruction Cedar Grove.

38CH778, South Carolina

Inadvertently discovered during construction-related ground leveling, site 38CH778 was the slave cemetery associated with a plantation outside of Charleston, South Carolina (Rathbun 1987). Thirty-six individuals, interred between 1840 and 1870, were recovered and subsequently reinterred. Skeletal remains consisted of twenty-eight adults (thirteen male, fifteen female) and eight subadults. Males appear to have been at greater risk of earlier mortality, with a mean age at death of 35 years, versus 40 years for females.

First African Baptist Church (1821-1843), Philadelphia, Pennsylvania

The First African Baptist Church (FABC) Cemetery, located in what is today known as Center City Philadelphia, was discovered in November 1980, during the excavation of the Philadelphia Commuter Rail tunnel. The cemetery was in use circa 1821-1843 until the Board of Health closed it down. The members of the FABC congregation buried in the cemetery represent a community of ex-enslaved and freeborn African Americans. The FABC cemetery consisted of 144 burials; of these, 135 skeletons were recovered. There were 75 adult and 60 subadult skeletons. The adults consisted of 36 males and 39 females. The majority of subadults (55%) were infants (0-6 months). Females, in general, died earlier than males. The mean age at death for FABC females was 38.9 years and 44.8 years for males (Angel and Kelley 1987; Rankin-Hill 1997).

Cedar Grove, Arkansas

The Cedar Grove Baptist Church Cemetery (Rose 1985) was the burial site of a post-Reconstruction (1890–1927) rural African-American population that consisted of descendants of the local plantation freedmen. The revetment of the Red River by the Army Corps of engineers led to the salvage excavation of burials scheduled for destruction. The seventy-eight burials excavated comprised 73.6 percent of the total cemetery population and represented 40 percent of the cemetery's usage time since its founding in 1834.

Demographic patterns suggested that the Cedar Grove sample represented a highly stressed population. Females and infants constituted a high percentage of the cemetery population, an indication of high infant mortality (27.5%) and of a life expectancy of fourteen years at birth. Adult (above age 20) mean age at death was 41.2 years for males and 37.7 years for females. Thus, females had an earlier and higher mortality rate than males, a pattern opposite to that of the enslaved at 38CH778, South Carolina, but similar to that of other African diasporic skeletal series (e.g., Catoclin Furnace).

Table 7.7: Skeletal Series of the African Diaspora

Site/Location	Time Periods	Total No. Burials	Life Style	Preservation	Analysis/Status
Newton, Barbados	1660–1820	103	plantation slaves	fragmentary	months/reinterred
New York African Burial Ground	1694-1794	419	urban slaves	fragments-excellent	7 years - reinterred 2003
Colonial sites	1690–1820	29	plantation slaves	poor-good	indefinite/available ¹
St. Peter's Cemetery, New Orleans	1720–1810	13	urban slaves	Poor	3 years/reinterred
Catoctin Furnace, Maryland	1790–1820	31	industrial slaves	poor/fragments	indefinite/available ¹
FABC 8 th Street, Philadelphia	1821–1843	144	ex-slaves/freeborn	poor-good	3 years/reinterred
FABC 11 th , Street - Philadelphia	1810–1822	89	ex-slaves/freeborn	poor-good	5 years/reinterred
38CH778, South Carolina	1840–1870	36	plantation slaves	poor-good	1 year/reinterred
Oakland Cemetery – Atlanta, Ga.	1866–1884	17	poor and indigent	fragments-excellent	? /reinterred
Cedar Grove Cemetery Arkansas	1890–1927	78	rural farmers	poor-excellent	2 weeks/reinterred

Source: Rankin-Hill 1997, 2001

1 = Remains available Smithsonian Institution, Museum of Natural History.

Mean Age at Death

The mean age at death for the NYABG sample was 22.3. The low mean age at death reflects the high childhood mortality in the New York population. The NYABG mean age at death by sex was 38.0 for males and 35.9 for females. The slight advantage of males is common in many African diasporic skeletal populations (Table 7.8), with the

Table 7.8: Mean Age at Death for Afro-American Skeletal Populations

AFRO-AMERICAN SKELETAL POPULATIONS	MEAN AGE AT DEATH		
	Males	Females	Total
New York African Burial Ground	38	35.9	22.5
First African Baptist Church Cemetery*	44.8	38.9	41.3
Cedar Grove, Arkansas**	41.2	37.7	39.5
38CH778, South Carolina***	35.0	40.0	37.5
Catoctin Furnace, Maryland****	41.7	35.2	38.4
St. Peter Street Cemetery, Louisiana ***** +AGE RANGE	20-24 ⁺	40-49 ⁺	-
Newton Plantation, Barbados, West Indies*****	-	-	29.3

Angel et al. 1987, Rankin- Hill 1997*
Rose1985**
Rathbun 1987***

exception of enslaved plantation South Carolinians and New Orleans urban enslaved; however, this may be an artifact of the small skeletal sample and preservation status. An independent samples *t*-test was run in SPSS using the composite ages for adult NYABG males and females to test for difference in the mean age at death; no significant difference was found $t=1.190$, $p>.05$ ($p=2.36$).

NYABG women have a lower mean age at death than the women from the iron working Maryland Catoctin Furnace site where women were devalued as workers since they only contributed domestic chores. In each of the comparisons, the maximum age of 55+ was used,

therefore making the comparisons possible and avoiding one of the potential biases of this calculation. All of the skeletal series with the exception of the Newton plantation had a range of preservation status that allowed for multiple methods of aging and sexing (in order to increase accuracy and reliability), as did the NYABG sample. In attempting to test whether there was a statistically significant difference among sample mean age at death considering the difference in sample size, a one-way ANOVA was undertaken in SPSS for NYABG, FABC and Catoctin Furnace. The analysis was limited to these three samples because composite ages were not available for the others and mean ages were based on published data. The ANOVA yielded no significant differences of mean age of death among the three populations, $F(2, 260) = .791, p > .05$ ($p = .454$). In addition, population size has no significant effect on mean age of death, $F(2, 260) = .791, p > .05$ ($p = .454$).

In determining whether there was a statistically significant difference between male and female means at death within populations, an independent samples t-test was run to see if there were sex differences across all samples for mean age at death. This test yielded significant sex differences in mean age at death across all samples, $t(261) = 2.964, p < .05$ ($p = .003$). This was followed by individual independent samples t-test for within sample differences by sex for the three samples. As reported above for the NYABG sample, there was no significant differences; for Catoctin Furnace, there were also no significant sex differences in mean age of death, $t(13) = 1.285, p > .05$ ($p = .221$); and for the FABC, there were significant sex differences in mean age of death, $t(75) = 3.160, p < .05$ ($p = .002$).

Mortality

The NYABG infant mortality rate (under 12 months) is low at 15.18 percent compared to FABC at 25 percent. Since the New York population only represents a segment of a large cemetery population, and FABC represents the entire cemetery, the under representation of infants due to excavation selection and poor preservation associated with site conditions may partly explain the lower infant mortality. Other possibilities could include burial of infants outside of the cemetery or that a greater number of infants survived; eventually dying in later childhood or early adolescence.

NYABG early childhood mortality did not appear to have a bimodal tendency as observed in both the Cedar Grove post-Reconstruction African-American population (Rose 1985) and FABC nineteenth century free African Americans in Philadelphia (Rankin-Hill 1997). In both populations, there was a high infant mortality rate during the first six months followed by a decline, and then an increase again during the second year, which may have been associated with a weaning period. In the NYABG sample, however, early childhood mortality remained high throughout the first two years of life (Table 7.9).

Table 7.9: NYABG, FABC and Cedar Grove Subadult Mortality by Age Group

Age in Years	NYABG		FABC		Cedar Grove	
	N	% Deaths	N	% Deaths	N	
0-6 mos	29	22.3	26	43.3	17	38.6
7-12 mos.	22	16.9	8	13.4	5	11.4
< 2	21	16.2	11	18.3	11	25.0
3-5	26	20.0	4	6.7	1	2.3
6-15	32	24.6	11	18.3	10	22.7
	130	100.00	60	100.00	44	100.00
< 1	51	39.2	34	56.7	22	50.0

Survivorship and Life Expectancy

Life table data, such as age-specific probability of dying and life expectancy, may be compared to other unsmoothed life table data for other regionally, temporally, and/or socio-culturally comparable populations or to the patterns observed in model life tables. Examples of commonly used model life tables are those developed by Weiss (1973), based on both ethnological and skeletal populations, and those developed by Coale and Demeny (1966) for isolating abnormal characteristics in mortality profiles (Moore et al. 1975). Through these demographic analyses, population parameters can be generated, and long-term trends in adaptation, health, and disease can be examined.

As discussed earlier, life tables in particular have generated severe criticism in recent years because of the inherent problems of reduced accuracy in aging skeletons and whether the skeletal samples meet the fundamental assumptions of model life tables; 1) a stable static population, 2) that mortality is not selective, and 3) that risk is constant throughout the population (Wood et al. 1992). In actuality, very few if any prehistoric, historic or contemporary populations would meet these criteria. In prehistoric and historic skeletal populations, one or more of these criteria is either violated or unknown to the researcher. In the NYABG sample and most African diasporic collections, all of the criteria are not met (whether working historical documents or skeletal data). In recent years, sophisticated statistical modeling techniques have been undertaken in order to ameliorate problems created by failure to meet criteria. In the case of samples that do not meet the criteria, there are also greater issues. These issues are primarily associated with their biological heterogeneity and whether they are actually a biological population simply because they had similar life experiences and ended their lives interred in the

same cemetery. This discussion is not appropriate for a contract report such as this. Therefore, with clear knowledge of the limited “value” of life table analysis, some basic observations will be presented herein.

A life table using unsmoothed data was constructed for the NYABG sample using an Excel database computerized life table (Table 7.10).

Table 7.10: New York African Burial Ground Life Table

TOTAL Age Interval (in years) (x)	No. of Deaths (Dx)	% of Deaths (dx)	Survivors Entering (lx)	Probability of Death (qx)	Total Years Lived Between X and X+5 (Lx)	Total Years Lived After Lifetime (Tx)	Life Expectancy (e0x)
0-5m	29	8.50	100.00	0.0850	9.575	2409.545	24.10
6-12m	22	6.45	91.50	0.0705	8.827	2399.971	26.23
1-2	27	7.92	85.04	0.0931	92.757	2391.144	28.12
3-4	20	5.87	77.13	0.0760	370.968	2298.387	29.80
5-9	19	5.57	71.26	0.0782	342.375	1927.419	27.05
10-14	13	3.81	65.69	0.0580	318.915	1585.044	24.13
15-19	32	9.38	61.88	0.1517	285.924	1266.129	20.46
20-24	21	6.16	52.49	0.1173	247.067	980.205	18.67
25-29	17	4.99	46.33	0.1076	219.208	733.138	15.82
30-34	34	9.97	41.35	0.2411	181.818	513.930	12.43
35-39	31	9.09	31.38	0.2897	134.164	332.111	10.58
40-44	20	5.87	22.29	0.2632	96.774	197.947	8.88
45-49	26	7.62	16.42	0.4643	63.050	101.173	6.16
50-54	19	5.57	8.80	0.6333	30.059	38.123	4.33
55+	11	3.23	3.23	1.0000	8.065	8.065	2.50
Total::	341	Crude Mortality Rate:		41.50			

In addition, life tables generated for FABC and Cedar Grove were utilized for comparisons (Rankin-Hill 1997). Survivorship was higher for the ABG sample compared to Cedar Grove until age 45, although paralleling FABC and MT30–60.0 in adulthood. The ABG sample had higher survivorship in early childhood than Cedar Grove, FABC, and both model

tables. Nevertheless, survivorship (l_x) for NYABG, FABC, Cedar Grove (MT15.0–45.0), and MT30–60.0 clearly demonstrate the impact of infant mortality on the overall pattern (Figure 7.6).

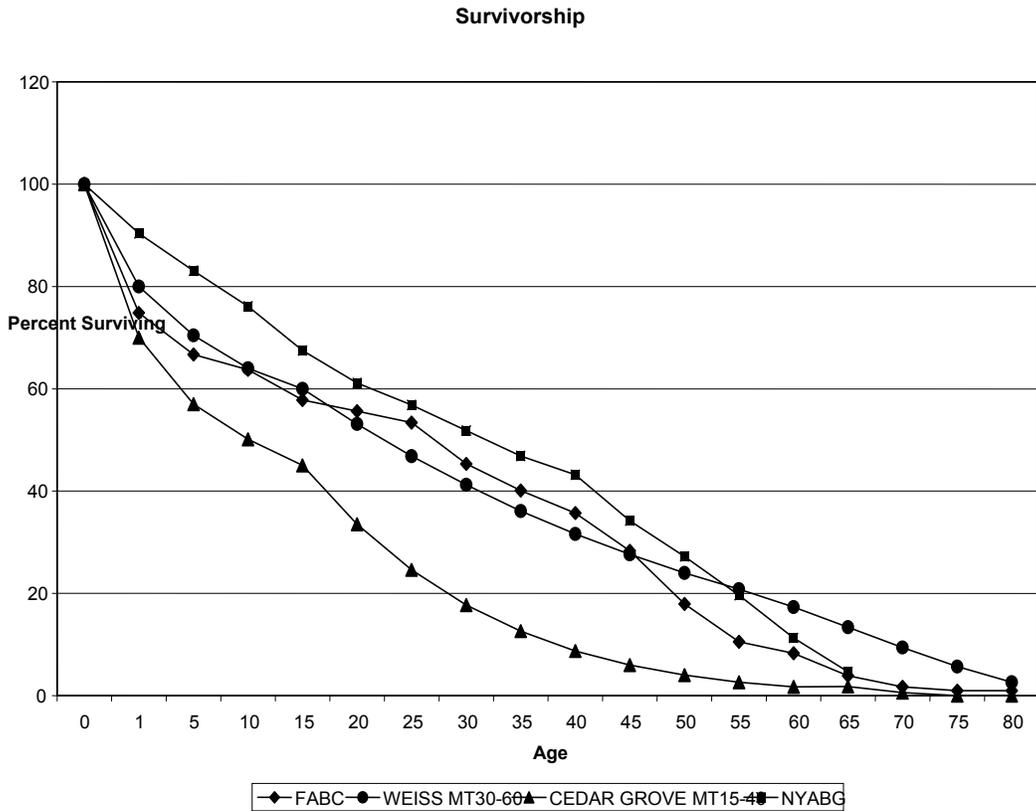


Figure 7.6: Survivorship

An independent samples t test yielded no significant sex differences in survivorship within the ABG sample, $t(16) = .339$, $p > .05$ ($p = .739$). A one-way ANOVA was run for NYABG, FABC, and Cedar Grove, but the analysis yielded no significant differences in survivorship among the three groups $F(3, 68) = 1.282$, $p > .05$ ($p = .288$).

Life Expectancy

Life expectancy (E^0x) at birth for the NYABG members was 24.2 years. By ages 3-4, life expectancy rose to 30.38 years reflecting the higher incidence of death for subadults under two years old, therefore the impact of higher risk of dying. Two life tables for adults by sex were also generated for the NYABG. A comparison of these tables indicates different trends based on sex. Males at age 15-19 and 20-24 had a life expectancy of 24.1 and 21.03, respectively. By age 25-30, male life expectancy was 18.21 (Table 7.11).

Table 7.11: New York African Burial Ground Male Life Table

Males Age Interval (in years) (x)	No. of Deaths (Dx)	% of Deaths (dx)	Survivors Entering (lx)	Probability of Death (qx)	Total Years Lived Between X and X+5 (Lx)	Total Years Lived After Lifetime (Tx)	Life Expectancy (e^0x)
15-19	7	6.86	100.00	0.0686	482.843	2441.176	24.41
20-24	10	9.80	93.14	0.1053	441.176	1958.333	21.03
25-29	7	6.86	83.33	0.0824	399.510	1517.157	18.21
30-34	10	9.80	76.47	0.1282	357.843	1117.647	14.62
35-39	12	11.76	66.67	0.1765	303.922	759.804	11.40
40-44	18	17.65	54.90	0.3214	230.392	455.882	8.30
45-49	17	16.67	37.25	0.4474	144.608	225.490	6.05
50-54	15	14.71	20.59	0.7143	66.176	80.882	3.93
55+	6	5.88	5.88	1.0000	14.706	14.706	2.50
Total :	102	Crude Mortality Rate:		40.96			

At ages 15-19 and 20-24, females had a life expectancy of 22.07 and 19.63, respectively; by age 25-30, female life expectancy was 16.16 (Table 7.12).

Table 7.12: New York African Burial Ground Female Life Table

Females

Age Interval (in years) (x)	No. of Deaths (Dx)	% of Deaths (dx)	Survivors Entering (lx)	Probability of Death (qx)	Total Years Lived Between X and X+5 (Lx)	Total Years Lived After Lifetime (Tx)	Life Expectancy (e^0_x)
15-19	8	11.59	100.00	0.1159	471.014	2221.014	22.21
20-24	5	7.25	88.41	0.0820	423.913	1750.000	19.80
25-29	4	5.80	81.16	0.0714	391.304	1326.087	16.34
30-34	17	24.64	75.36	0.3269	315.217	934.783	12.40
35-39	9	13.04	50.72	0.2571	221.014	619.565	12.21
40-44	5	7.25	37.68	0.1923	170.290	398.551	10.58
45-49	8	11.59	30.43	0.3810	123.188	228.261	7.50
50-54	5	7.25	18.84	0.3846	76.087	105.072	5.58
55+	8	11.59	11.59	1.0000	28.986	28.986	2.50
Total:	69	Crude Mortality Rate:		45.02			

An independent samples *t* test in SPSS was run that indicated no statistically significant sex differences in life expectancy within the NYABG sample, $t(16) = .051$, $p > .05$ ($p = .960$).

New York African Burial Ground life expectancy (24.2) was considerably higher than the 14 years reported by Rose (1985) at Cedar Grove and slightly lower than the 26.59 years reported for FABC (Rankin-Hill 1997) (Figure 7.7). NYABG life expectancy was compared to Weiss's (1973:175) model life table MT30.0–60.0 and to MT15.0–45.0 (1973:118), reported by Rose as the most comparable table to the Cedar Grove mortality experience. The MT15.0–45.0 table exemplifies a highly stressed subadult population, although infant mortality was actually higher. The NYABG life expectancy curve fits closely to the FABC from ages 10-45. Subadult life expectancy clearly points to the perils of surviving early childhood in New York. The initial

childhood years from birth to age 10-15 are lower than the Weiss MT30.0–60.0 and

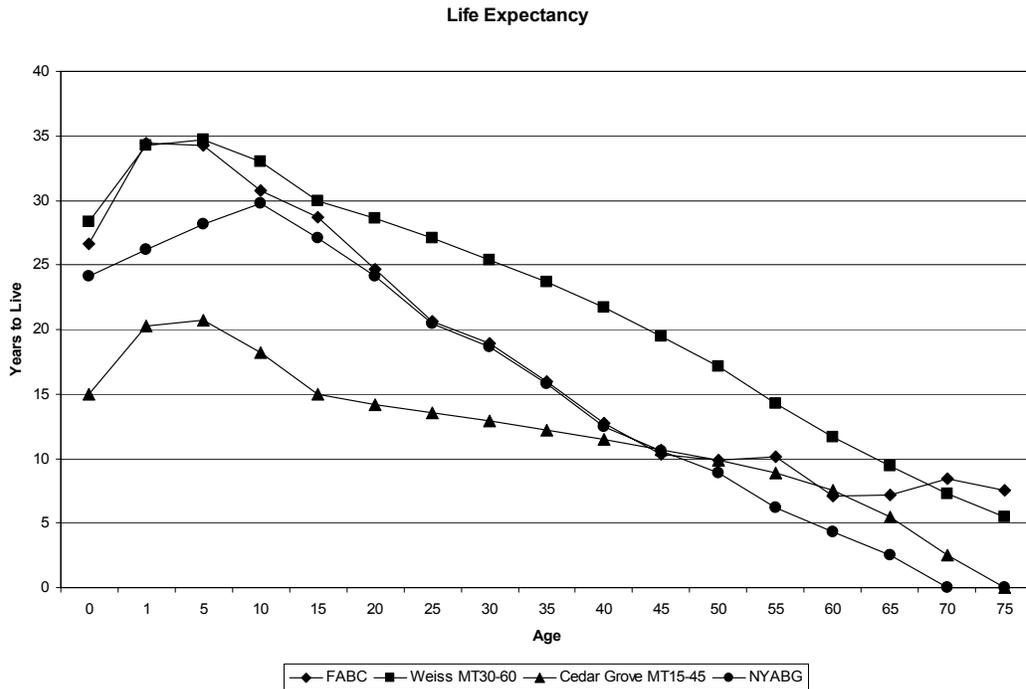


Figure 7.7: Life Expectancy

FABC, but higher than that for Cedar Grove. NYABG and FABC are similar from age 20, declining at comparable rates. NYABG life expectancy declines even more rapidly than for the “highly stressed” Cedar Grove group after age 45. The differences between NYABG, Cedar Grove, and FABC life expectancy and mortality experience are significant. Clearly, post-Reconstruction Cedar Grove rural Arkansas African-Americans were at highest risk of dying earlier. However, at the end of the life span, life expectancy was dramatically reduced for the NYABG sample.

Summary of Findings for the NYABG Sample

Paleodemography:

- Mortality was highest for:
 - Infants 0-5 months (9.6%).
 - Adults 30-34 year olds (9.1%).
 - Adults 45-49 year olds (8.3%).
- Young adults aged 15-19 comprised 8.8 percent of the sample.
- A differential mortality trend by sex was observed:
 - 62 percent of the females died by the end of the fourth decade.
 - 45 percent of the males died by the end of the fourth decade.
 - Female mortality (37.6%) peaked at age 30-39.
 - Male mortality (34.3%) peaked at age 40-49.
- Subadult mortality was 43.2% for the NYABG (N=301).
 - 39.2 percent died during the first year of life.
 - 16.2 percent died in the second year.
 - 55.3 percent of all the subadults died by age two.

Historical Demography:

- Age-sex composition and sex ration were shaped by the prevailing political economy.
- New York Africans had a low sex ratio and slow population growth, similar to the Caribbean plantation pattern.
- Sex ratios indicate either more females or equal numbers of males and females.
- The proportion of African males decreased markedly following periods of political upheaval in the Americas.

European-American Comparison

- High mortality in women 25-29 based on reproductive stress is an ubiquitous American pattern throughout the eighteenth and nineteenth centuries declining in the early twentieth.
- Observed is a differential pattern between European and African New Yorkers.
- Trinity Church males have moderate death rates during “middle” ages and great longevity.
- Trinity male mortality exceeded ABG males at 25-29 and 55+.
- Trinity female mortality peaked at 55+ and 25-29, with longevity slightly less than that of males and higher than that of ABG women.
- NYABG women are proportionately died at proportionately higher rates.
 - 62 percent of ABG women died by age forty.
 - 54 percent of European women died by age forty.
- Trinity Church women had a reduced mortality regime after the 25-29 age peak.

Skeletal Biological Comparisons

- Mean age at death for the NYABG cemetery sample was 22.5, including all ageable adults and subadults (N=301).
- Low mean age at death reflects high childhood mortality.
- ABG mean age at death was 38.0 for males and 35.9 for females.
- The bimodal tendency of childhood mortality observed in Cedar Grove and FABG is not present at the NYABG. Both had high infant mortality rates during the first six months, followed by a decline, then followed by an increase again during the second year. The ABG early childhood mortality remained high throughout the first two years of life.
- NYABG women have a lower mean age at death than the women from the iron working Maryland Catocin Furnace, who were devalued as workers.

- Life expectancy (E^0x) at birth for the NYABG was 24.2 years by ages 3-4 and life expectancy rose to 30.38 years.
- NYABG life expectancy (24.2) was considerably higher than the 14 years reported for Cedar Grove, and slightly lower than 26.59 for FABC.
- The differences between NYABG, Cedar Grove, and FABC life expectancy and mortality experiences are significant:
 - Cedar Grove post-Reconstruction rural Arkansas African-Americans were at highest risk of dying earlier.
 - At the end of the life span, life expectancy was significantly reduced for the NYABG sample.

SECTION III:
Life and Death in Colonial New York

Chapter 8

Childhood Health and Dental Development

M.L. Blakey, M. Mack, A.R. Barrett, S.S. Mahoney and A.H. Goodman

Dental enamel hypoplasias are defects in crown development that appear as a transverse groove or series of pits that are partially or entirely around the circumference of the tooth. Hypoplastic defects, while they manifest in the teeth, result from metabolic disturbances of malnutrition and disease elsewhere in the body. Enamel hypoplasias thus provide evidence of general stress that may have been brought about by many different kinds of stressors. Like other “general stress indicators” such as life expectancy, infant mortality, or growth retardation rates, frequencies of hypoplastic defects can be compared among different populations as a gross index of physical well-being and the adequacy of societal resources upon which the physical quality of life may depend. Of particular value, enamel hypoplasia develops in childhood and adolescence when both the deciduous and permanent teeth are formed.

The evidence of these early stresses remains apparent in adult skeletons in which teeth have been retained. The defects occurring on different teeth and in different locations on teeth represent stresses at differing ages during childhood and adolescent growth, similar to the analysis of tree rings for a record of droughts during the lifetime of a tree. These defects have been observed in archaeological collections and living populations representing a very broad range of human experiences, from those of early hominids to industrial nations. Included among these are a number of studies from

African-American and Afro-Caribbean archaeological sites (Blakey and Armelagos 1985; Blakey et al. 1994; Goodman et al. 1984; Goodman and Armelagos 1985; Condon and Rose 1992; Corruccini et al. 1985; Clarke 1982).

This chapter puts forward an analysis of hypoplasia frequencies in the African Burial Ground (ABG) sample. Comparisons are made of enamel defect frequencies in different age groups and sex/gender groups. We compare individuals with culturally-modified teeth who were probably born in Africa and those with unmodified teeth whose origins are unknown. We also compare the New York sample with skeletal collections from other diasporic archaeological sites. Questions regarding the physical quality of life in childhood are central as is our assessment of these data for evidence of health differences or transitions among Africa, the Caribbean, and New York, which take place at different points in the life cycles of New York Africans.

Deciduous dental enamel begins to develop during the fifth month in-utero, completing development by the end of the first year of postnatal life. Permanent dental enamel begins formation at birth and continues into the sixteenth year of age. General stress indicators are visible in dental enamel due to the process of enamel formation. Ameloblastic (enamel producing) activity involves cellular production of a protein rich matrix that mineralizes, forming the crystalline enamel of teeth. If the development of the enamel crown is interrupted by physiological insult, a transverse groove or series of pits (hypoplasia) or discolored enamel (hypocalcification) results in the 'rings' of enamel being laid down at that time (see Figure 8.1 and Figure 8.2).

Hypoplasia results from differential thickness in the enamel, whereas hypocalcification occurs during interruption within the final stages of ameloblastic

activity, and results in discoloration of the tooth enamel (Blakey et al., 1994, p. 372). Dental enamel is acellular and, therefore, lesions and discolorations due to physiological stress are permanent and are not obliterated through cellular renewal. In

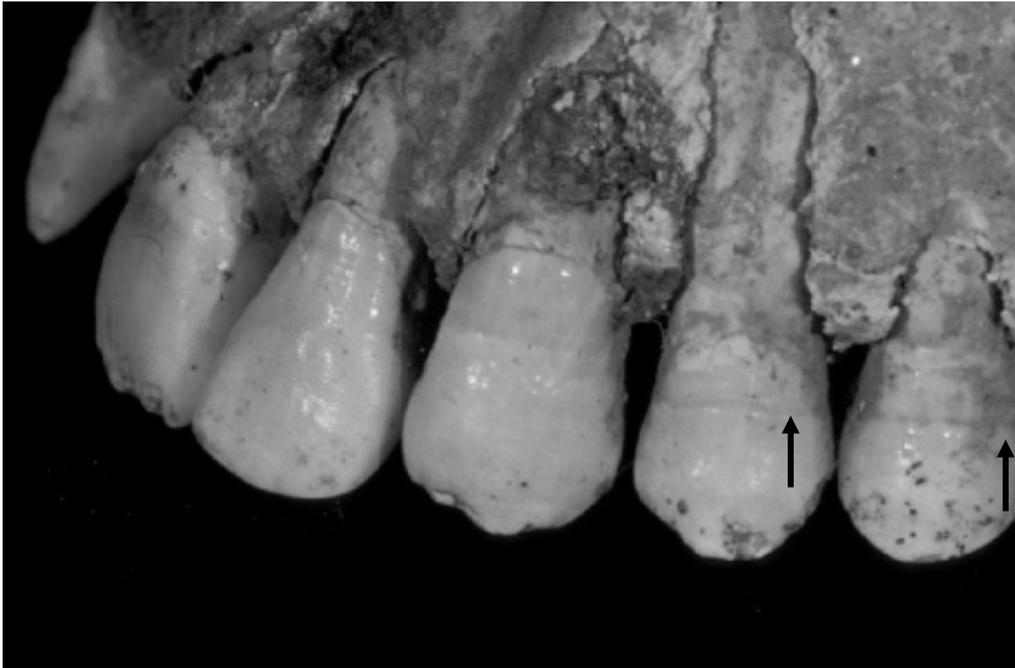


Figure 8.1: Linear enamel hypoplastic lesions in the anterior maxillary permanent dentition in a female aged 20 – 25 years (Burial 1)

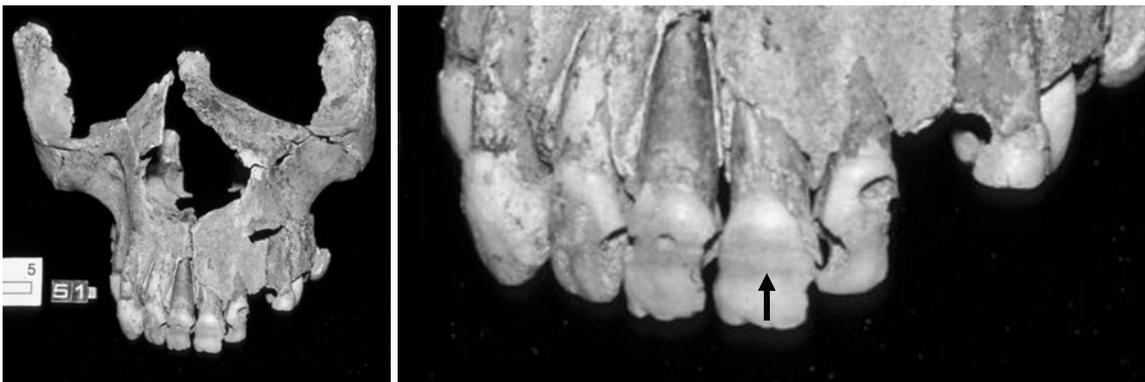


Figure 8.2: Bands of discoloration caused by hypocalcification in the anterior maxillary permanent dentition in a 24 – 32 year old female (left), magnification (right) (Burial 51)

addition to general identification of stress incidence during enamel formation, the rate of enamel matrix formation provides a mechanism for estimating the developmental stage at which the growth arrest occurred (Blakey et al. 1994:372; Goodman and Armelagos 1985). Hypoplasia provides an estimation of stress severity and/or duration by the size of the malformation. With rare exception, dental enamel hypoplasia is a result of systemic metabolic stress associated with infectious disease, insufficient calcium, protein, or carbohydrates, and low birth weight, characterized together as “general stress” (Goodman et al. 1988; Blakey et al. 1994).

Materials and Method

A subsample was selected from the ABG sample to study the occurrence and frequency of hypoplasia within adults and children (see Table 8.1). Within this study, the presence of hypoplasia within an individual was defined by the presence of linear or non-linear hypoplasia in one of the teeth selected for analysis. The absence of hypoplasia was

Table 8.1: Summary of Study Samples

Study description	Dentition	Samples Size	
Hypoplasia and Hypocalcification	Canines and Incisors - Permanent	65	99
Hypoplasia and Hypocalcification	Canines and Incisors - Deciduous	34	
Hypoplasia Controlled for Attrition	Canines and Incisors - Permanent	48	
Hypoplasia Controlled for Attrition	Third Molars	97	
Canine Chronology for Hypoplasia	Canines - Permanent	23	
Hypoplasia and Hypocalcification	Third Molars	111	

defined by the absence of hypoplasia in all teeth selected for analysis. According to research conducted by Goodman and coworkers, secondary canines and incisors display

95 percent of enamel hypoplasia observed where all available dentition is represented (Goodman et al. 1980). The current study employed this “best tooth” method in selecting individuals with the presence of a permanent left or right maxillary central incisor and a left or right mandibular canine. The presence for permanent teeth was defined according to codes 2 and 7 within *Standards* (Buikstra and Ubelaker 1994) indicating that teeth are fully developed, in occlusion and observable. A total of 65 individuals within the ABG were selected for analysis of permanent dentition which represents the developmental period between birth and 6.5 years of age. A separate selection was conducted for individuals with permanent third molars, left or right, mandibular or maxillary, where presence was defined by codes 2 and 7 within *Standards* (Buikstra and Ubelaker 1994: 49). One hundred and eleven individuals are included within this third molar analysis, which represents the developmental period in life from nine years to approximately sixteen years of age.

A subsample was selected from the permanent canine and incisor study and from the third molar study to control for age- or sex-related differences in dental attrition that might affect hypoplasia frequencies. Individuals with moderate to severe dental wear and individuals for whom dental wear could not be scored (including inability to score due to cultural modifications such as filing and pipe notches), were removed from the canine and incisor sample and from the third molar sample. Individuals with a dental wear score of five or greater, according to Smith (1984), were removed from the permanent incisor and canine sample, resulting in 48 observable individuals. Individuals with a dental wear score of seven or greater, according to Scott (1979), were removed from the third molar sample, resulting in 97 observable individuals.

Deciduous dentition was studied by selecting individuals older than one year with one left or right central maxillary incisor, one left or right mandibular canine, and one second molar (see Figure 8.3). The presence for deciduous teeth was defined by codes 1, 2 and 7 within the *Standards* where the teeth were fully developed and observable. Thirty-four subadults were selected to assess hypoplasia in deciduous dentition. Developmental stages spanning approximately five months in-utero to sixteen or seventeen years of life are represented by the dentition selected for analysis within this study. Statistical analysis for each study employed SPSS software version 11.5.



Figure 8.3: Deciduous mandibular dentition with a single non-linear hypoplastic pit in the right canine of a subadult aged 3 – 5 years. This individual also appears to have been anemic (Burial 7)

Twenty-three individuals were assessed for the chronology of physiological stress episodes resulting in hypoplastic lesions. Chronology was determined for defects in the

left permanent mandibular canines; however, right mandibular canines were used when the left was absent or unobservable. Measurements for the hypoplastic lesion's beginning and ending had been recorded by members of the ABGP in the late 1990s (see Figure 8.4). The distance from the dental cervix to the onset of the incisal (beginning) aspect of the lesion was recorded, followed by the measurement of the cervical (latest developing) aspect of the lesion. A midpoint for this episode was calculated, and this measurement was used in conjunction with the total crown height measurement to estimate the age at which each episode occurred.



Figure 8.4: Permanent mandibular canine and lateral incisor with linear Hypoplasia in a male aged 35 – 45 years (Burial 9)

Total crown height was divided by the number of years the mandibular canine develops (6 years), and this figure served as an index representing an increment of growth in one year. The midpoint measurement was divided by the yearly incremental

growth index, which provided the number of years prior to the end of enamel development (6.5 years of age) at which the incident occurred. Next, this figure was subtracted from 6.5 to arrive at the age of occurrence for each episode. For analysis within this study, the midpoint of the canine, representing the developmental period of 3.5 years, was calculated for each tooth. Episodes were coded as occurring before 3.5 years and after 3.5 years (see Table 8.2). Three and a half years is also the age at which central incisal crown development ends, providing a comparison of frequencies represented between the incisor and canine and between the correspondent ages of crown development within the canine.

**Table 8.2: NYABG Canine Chronology Formula and Example Calculation:
 $CH/6 = YGI \quad 6.5 - (MID/YGI) = \text{Age of Occurrence}$**

Crown Height (CH) (mm)	Total Years of Development	Yearly Growth Increment (YGI)	Crown Midpoint at 3.5 years	Hypoplastic Lesion Midpoint (mm)	Formula	Age of Occurrence (years)
12.71	6	$12.71/6=2.12$	6.36	3.93	$3.93/2.12=1.85$	$6.5 - 1.85=4.65$

Results

Among the 65 individuals with permanent dentition, 70.8 percent were hypoplastic. Frequencies for hypoplasia in permanent dentition are higher in the ABG sample than those observed in the enslaved populations of Catoctin Furnace, Maryland (Kelley and Angel 1987) or Newton Plantation in Barbados (Corruccini et al. 1985). The New York frequencies are lower than the total frequencies observed in the largely free and freed nineteenth-century Philadelphia First African Baptist Church (FABC) sample (Blakey et al. 1994) or enslaved African Americans buried in nineteenth-century Charleston, South Carolina, 38CH778 (Rathbun 1987). The difference in hypoplasia frequencies may reflect the time trajectories and geographic locations represented within

these populations. A greater number of people within the ABG and Barbados sites more likely would have been born in Africa than would have been the case for the nineteenth-century African-Americans in Philadelphia and the South. The latter group spent their lives within the conditions of slavery or as free people living under conditions of economic and social inequality.

The difference in hypoplasia frequencies for men and women in the ABG was not statistically significant [62.5% of the women (n=15) and 74.3% of the men (n= 26)], indicating that male and female children experienced similar frequencies of stress episodes from birth to the age of 6.5 years. However, the New York ABG sample does fall into the general pattern established by previous studies (mentioned earlier and here) indicating that the men have consistently higher percentages of hypoplasia than females (Rathbun 1987; Owsley et al. 1987; Khudabux 1991). Blakey and coworkers (1994) report 86 percent hypoplasia in women and 92 percent in men among 54 individuals from the FABC sample. Angel and coworkers report 71 percent of men and 43 percent of the women at Catoctin Furnace, Maryland, had hypoplasia. The Blakey et al. (1994) study of the Catoctin site indicates that women had higher frequencies of slight linear enamel hypoplasias; however, men had a greater frequency of moderate to severe hypoplasias [68 percent males (n=17) and 37.9 percent females (n=11)]. Among the populations compared within this study, Rathbun (1987) reports the highest frequencies in men and women at the Charleston, South Carolina site (71 percent in women and 100 percent for men). Tables 8.3 and 8.4 provide comparative frequencies and other data for the studies just discussed, while frequency data for the NYABG sample are presented in Table 8.5.

**Table 8.3: Frequency of Hypoplasia in Males and Females at NYABG
N=59***

Males n=35		Females n=24	
Present	Absent	Present	Absent
74.3% (n=26)	25.7% (n=9)	62.5% (n=15)	37.5% (n=9)

*6 of the 65 individuals with adult dentition were too young to determine sex. Therefore, these individuals are not represented in the total number of males and females.

Table 8.4: Comparison of Frequencies Reported in Skeletal Populations
*frequencies were not reported for this category

Site/ Location	Region	Rural/ Urban	Historical Period	Hypoplasia Frequency/ secondary dentition (%)	Hypoplasia in Females (%)	Hypoplasia in Males (%)	Hypoplasia in Subadults/ deciduous dentition (%)
NYABG, New York	Northeast, North America	Urban	17 th and 18 th centuries	70.8 (n=46)	62.5 (n=15)	74.3 (n=26)	85.3 (n=34)
Newton Plantation, Barbados	Barbados, West Indies	Rural	1650s - 1834	54.5 (n=56)	*	*	*
FABC, Pennsylvania	Northeast, North America	Urban	1800 - 1850	89 (n=54)	86 (n=29)	92 (n=25)	92.5 (n=30)
Catoctin Furnace, Maryland	Southeast, North America	Urban	1790 - 1820	46 (n=7)	4 3	71	Slight 68* (n=17)
							Mod-Sev 68 (n=17)
Charleston, S. Carolina (38CH778)	Southeast, North America	Rural	1840 - 1870	85 (n=27)	71 (n=14)	100 (n=13)	*

Sources: Newton Plantation site frequencies from Corruccini et al. (1985), First African Baptist Church frequencies reported from Blakey et al. (1994) with frequencies in children cited from Rankin-Hill (1997). Catoctin site frequencies reported from Kelley and Angel (1987) for overall frequencies. Frequencies by sex for Catoctin Furnace are from Angel et al. (1987) and Blakey et al. (1994). Frequencies reported by Blakey et al. (1994) have an asterisk (*) and represent frequencies of slight hypoplasia or moderate to severe hypoplasia within the Catoctin Furnace site. Frequencies for males and females in the South Carolina 38CH778 site from Rathbun (1987). Combined secondary dentition frequency calculated from male and female frequencies reported by Rathbun.

**Table 8.5: NYABG Frequency of Hypoplasia by Age Group
(N=99)**

Age Group	Within Age Group		
		Men (n=35)	Women (n=24)
1 – 14* (n=37)	86.5% (n=32)		
15 – 24 (n=17)	76.5% (n=13)	83.3% (n=5)	75.0% (n=6)
25 – 55 + (n=45)	66.7% (n=30)	72.4% (n=21)	56.3% (n=9)

*Three children within this age category had permanent dentition

Among the 99 ABG individuals within the canine and incisor study, 37.4 percent (n=37) died before the age of 15 years, 86.5 percent (n=32) of whom had hypoplasia. Young adults who died between the ages of 15 and 24 years of age represent 17.2 percent of the population, 76.5 percent of whom had hypoplasias. A total of 45.5 percent of the people died after the age of 25 years (n=45), 66.7 percent (n=30) of whom had hypoplasia. The frequency of childhood growth disruption is lowest in the oldest age-at-death groups.

Most of this sample experienced generalized stress in their childhood years. Individuals with permanent dentition (n=65) representing the period of childhood between birth and 6.5 years of age had hypoplasia in 70.8 percent (n=46) of the cases, overall. Notably, this frequency is about 20 percent lower than that for the Philadelphia FABC remains. Among children with deciduous dentition, 85.3 percent of the children (29 of 34) had hypoplasia, representing disrupted development between the fifth month in-utero through the end of the first year of life. In contrast with the permanent dentition findings, this frequency is more than 20 percent higher than for the FABC.

If the FABC can serve as an operational reference point, one can ask why it is that the childhoods of those who died as adults in New York are relatively less stressed, while those who died as children in New York are relatively more stressed, in comparison with the Philadelphians who died in the 1830s and 1840s. The interpretation of this issue bears on the specific histories of in-migration in the two cities that will be addressed later in this chapter.

The foregoing data suggest that the individuals who experienced early stress episodes resulting in enamel hypoplasia were more likely to have died in childhood and that enslaved children in colonial New York experienced high levels of stress. The lower frequency of individuals with hypoplasia among those who were older than age 25 at death may reflect the forced migration of enslaved men and women arriving in colonial New York. These individuals seem more likely to have experienced childhood stress episodes in Africa than in New York, and their lower defect frequencies might reflect childhood experiences elsewhere. The brisk importation, low fertility, and high child mortality of eighteenth-century New York meant that an African who lived there as an adult was more likely to have been born in Africa (or possibly the Caribbean) than to have been born and survived to adulthood in New York. Although some children were imported, those who died as children in New York seem more likely to have been born there than those who died there as adults. Hypoplasia frequencies in the dead children, therefore, seem most likely to reflect the conditions of New York. The data on lead and strontium content in teeth (see Chapter 6) are supportive of those assumptions about the nativity of young children.

Those who died between 15-24 years of age have intermediate frequencies of defects in the teeth that developed during early childhood, as shown in Figure 8.5. We also examined frequencies of hypoplasia in third molars that developed between 9 and approximately 16 years of age. The late childhood and adolescence stress represented by hypoplastic third molars was present in 44.4 percent (n=12) of those who died between 15-24 years and was present in only 10.7 percent (n=9) of those who died at 25 years of age and older in whom we could observe third molars. These differences were

statistically significant (Pearson chi-square with Yates Continuity Correction = 13.035, 1 df, $p < .0005$). Interestingly, the 15-24 year olds would have died quite close to the time when these late stresses were occurring. The analysis of 111 individuals with third molars was conducted apart from our usual analysis of incisors and canines. The third molars are less sensitive to hypoplasia than are the anterior teeth and cannot be directly compared with them, although the hypoplastic lesions may represent more severe episodes of stress (Goodman and Armelagos 1985).

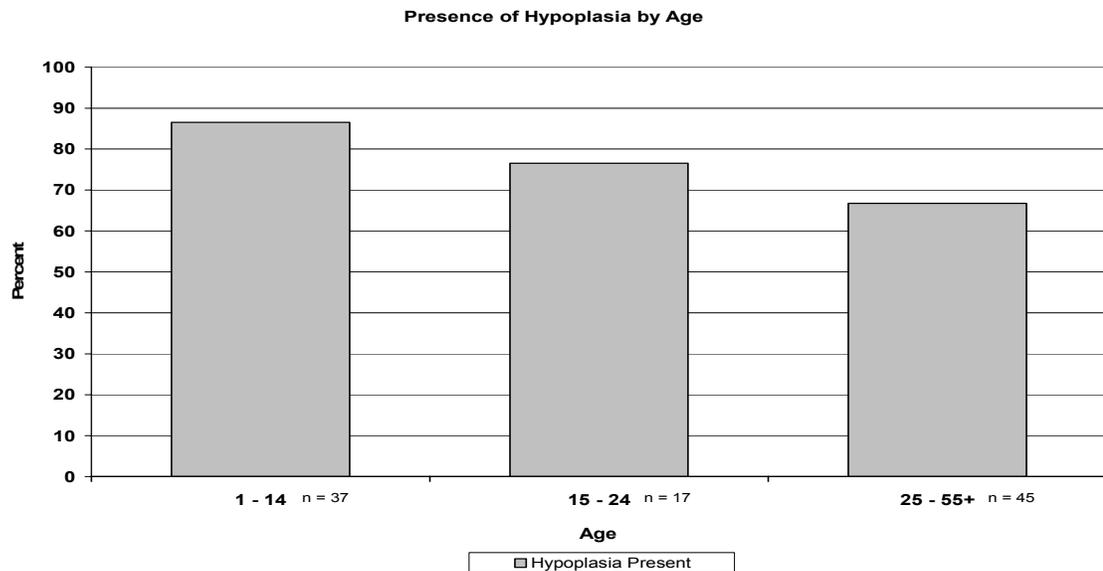


Figure 8.5: NYABG Presence of Hypoplasia by Age (n=99)

A comparison of only third molar data is considered next (see Figure 8.6). We suspect, based on historical documentation of importation ages, that many of the 15-24 year olds are likely, because of age, to have been new arrivals through the trade in human captives, with the Middle Passage constituting another plausible stressor for them. Fifteen years of age was also the beginning of adulthood in most eighteenth-century censuses in New York (10 years of age was the criterion of adulthood less frequently

used). Studies of active periosteal lesions in this group show more new infection in the 15-24 year age range than among the older individuals who exhibit a preponderance of sclerotic and healed lesions. Mortality is also very high among the 15-24 year old males and females, as is detailed in other chapters. Changing conditions of life either through forced migration or/and adult status may be involved in these effects.

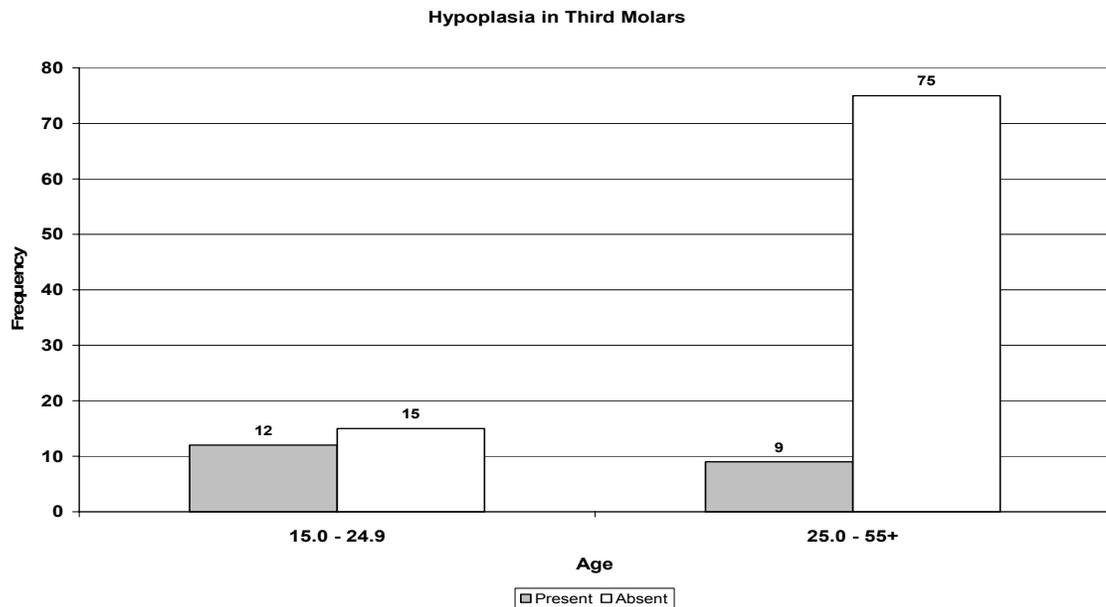


Figure 8.6: NYABG Hypoplasia in Third Molars (n=111)

The skewing of subadult nativity toward New York as the place of birth, and the skewing of adult nativity toward West and Central Africa may help explain low frequencies of hypoplasia in adults and high frequencies in subadults, when compared to nineteenth-century Philadelphians. The FABC, conversely, shows relatively low frequencies in subadults and high frequencies in adults. This may also be related to different places and conditions of childhood for those who died as children and those who died as adults in Philadelphia, since African births probably were not a major factor in mid-nineteenth-century Pennsylvania. Among the FABC sample, subadult nativity

should be skewed toward Philadelphia, as similarly those who died as children in New York were also often born there. Philadelphia in the mid-nineteenth-century can be characterized as having a free, disenfranchised, predominantly impoverished, unskilled wage laboring black community. There was mobility toward greater economic stability among some blacks in the early part of that century, but this was halted during a peak period of Irish immigration into the city at about the time the FABC cemetery was in use (Du Bois 1899; Rankin-Hill 1997). These conditions were stressful, yet hypoplastic stress effects in these dead Philadelphian children were less frequent than in the enslaved children of colonial New York City.

The FABC adults, however, contained a large number of persons who were born and raised in bondage both in late eighteenth-century slave-holding Pennsylvania and on the eighteenth and nineteenth-century Southern plantations from which they were given manumission, bought their freedom, or escaped to Philadelphia (Rankin-Hill 1997). For these FABC adults, their hypoplastic indicators of childhood stress were higher, relative to those who died as New York Africans but whose childhoods were frequently spent in Africa. This interpretation of the data is assisted by the facts that the same researchers (and methodological training) were involved in both studies, both archaeological samples are sizable, both primary and secondary dentition were observed, and both sites are in of the urban Northeast, thus greatly improving the reliability of comparisons.

Since much of this interpretation relies on the relation of hypoplasia frequency to age, one should examine the extent to which age-related occlusal wear might play a role in reducing our ability to observe hypoplasias, thus reducing the count of defects in

older individuals. Subsets of the permanent dentition samples were created to control for the possible effect of dental attrition on hypoplasia frequencies between age and sex groups due to loss of observable data through tooth wear. The incisor and canine study, as well as the third molar study, displayed the previously reported pattern of hypoplasia frequencies when attrition was controlled. The highest frequencies were found in individuals aged 15 – 24 years and lower frequencies were found in individuals who lived to be 25 years of age and older. These differences were statistically significant in the third molar analysis only (Pearson chi-square with Yates Continuity Correction = 10.678,1 df, $p < .002$). Men continued to have higher frequencies of hypoplasia than women within both age groups in the canine and incisor study. These gender differences were not statistically significant. Table 8.6 and Table 8.7 provide a summary of hypoplasia frequencies within each study. These findings show that the observed decrease in hypoplasia frequencies for older age groups and the differential frequencies between men and women were not a result of lost data due to tooth attrition.

**Table 8.6: NYABG Frequency of Hypoplasia by Age and Sex
Canines and Incisors (controlling for attrition)
(N=48)**

Age Group	Frequency within Age Group		
		Men (n=24)	Women (n=21)
15 – 24 (n=16)*	81.3% (n=13)	100% (n=5)	75.0% (n=6)
25 - 55 + (n=32)	71.9% (n=23)	65.2% (n=15)	34.8% (n=8)

*Three individuals with adult dentition were too young to determine sex. Thus, these individuals are not represented in the total number of males and females.

**Table 8.7: NYABG Frequency of Hypoplasia by Age Group
Third Molars (controlling for attrition)
(N=97)**

Age Group	Frequency within Age Group
15 – 24 (n=26)	46.2% (n=12)
25 - 55 + (n=71)	12.7% (n=9)

Hypoplasia chronology was calculated for the canines of 23 individuals for whom measurements of hypoplasia lesions were available in the permanent dentition study. Differential frequencies of hypoplasia within permanent canines and incisors were observed, indicating the greater occurrence the experience of life stressors across the age ranges. While 27 individuals showed hypoplasia in maxillary central incisors and 40 showed hypoplasia in mandibular canines, variability in sensitivity made direct comparisons questionable.

Canine chronology indicates that of the 23 individuals for whom chronological assessment was possible 87 percent (n=20) experienced stress episodes between 3.5 and 6.5 years of age, versus 21.7 percent (n=5) who experienced episodes in the first 3.5 years of life. Four children (17.4%) exhibited evidence of multiple episodes between birth and 6.5 years of age. The difference in hypoplasia frequencies displayed for the incisors and canines was 21 percent, whereas the difference for hypoplastic occurrence from birth to 3.5 years and 3.5 to 6.5 years is over 50 percent if the incidents occurring in both developmental periods are pooled (see Table 8.8 and Table 8.9). The differential stress pattern between birth to 3.5 years and 3.6 to 6.5 years represented by an individual tooth analysis corresponds to the differential frequencies assessed using chronology within the canine. However, the canine chronology provides a more precise understanding of the ages at which stress episodes occur and of differential stress levels

experienced within the first 3.5 years, versus 3.5 – 6.5 years of age, and is therefore methodologically preferable to the between tooth method.

Table 8.8: NYABG Occurrence of Hypoplasia by Age Range

Age Range	% Hypoplastic
.5 – 3.5 years	21.7% (n=5)
3.6 – 6.5 years	87% (n=20)
0 – 3.5 and 3.6 to 6.5	17.4% (n=4)

Table 8.9: NYABG Occurrence of Hypoplasia by Age Intervals

Age	% Hypoplastic
.5 to 1 year	0
1.01 to 2 years	0
2.01 to 3 years	21.7% (n=5)
3.01 – 4 years	26.1% (n=6)
4.01 – 5 years	87% (n=20)
5.01 – 6.5 years	21.7% (n=5)

Another factor that must be considered in interpreting the chronology is variability of susceptibility within tooth types. The study of the Dickson Mound Population conducted by Goodman and Armelagos (1985) indicates that incisors are more likely to display hypoplasia between the period representing ages 2 to 2.5 years, whereas canines are more likely to display hypoplasia in the fifth to sixth year of development. This suggests that the within-tooth chronological pattern of hypoplasia frequency differences is at least partly a reflection of canine sensitivity patterns.

The individuals within the age category of 1 to 14 years are more likely to have been born in New York than individuals who were older at the time of death. Their early deaths and high levels of stress indicators, such as hypoplasia, support an interpretation that these children were born into the arduous conditions of enslavement and therefore experienced greater levels of diseases and illnesses, possibly a consequence of being

forced to work at young ages. The peak frequencies of hypoplasia between the ages of 3 to 4 years in secondary dentitions observed by Corruccini et al. (1985) were attributed to weaning at ages 2 to 3. Blakey et al. (1994) tested the weaning hypothesis within African-American enslaved groups to argue that enslaved children experience physiological stress from multiple sources, and that weaning does not account for the peak in hypoplasia frequencies. Furthermore, Blakey's study suggests the need for historical and cultural contexts to be considered within a biocultural interpretation. The high frequencies of hypoplasia occurrence during the fifth year demonstrate that this stage was a vulnerable and stressful age for children who survived early infancy and who died as adults. This window on childhood appears to be most pertinent for those who were born in Africa, while childhoods in the Caribbean, New York, and other locations are doubtlessly mixed into our adult sample. How much more stressful the fifth year of age was compared to earlier ages, however, has not been confirmed using enamel defects due to variation in hypoplastic sensitivity across different parts of the crown. Moreover, these data represent the experiences of survivors, while the high death toll of infants clearly represents vulnerability and stress among those who did not survive to exhibit developmental defects in secondary teeth. Those deaths (see Chapter 7) clearly resulted from conditions in New York City, albeit precipitated partly by the poor health of captured mothers whose own experiences of childhood stress were relatively less frequent.

The project has used a political-economic framework for explaining biological variations in the ABG sample. For example, Susan Goode-Null's (2002) study of childhood health and development in the NYABG sample found that the enslaved people

brought into New York between the years of 1664 to 1741 were largely from the Caribbean. Following McManus' *A History of Negro Slavery in New York* (1966), Goode-Null explains that from 1741 to 1770, due to the cessation of slave trading between the British and Spanish colonies and the fear that a slave revolt aborted in 1741 might repeat the events of the 1712 slave revolt in New York, enslaved Africans were imported directly from Africa, rather than via the Caribbean, and were largely young women ages 13 to 40 years and children preferably of nine to ten years of age, rather than adult males. Adult enslaved men from the Caribbean were considered the strategists behind the successful and aborted revolts (Goode-Null 2002: 28; see also chapter thirteen in this volume and the History Final Report for further reference to these factors).

These historical data suggest at least two additional interpretations. One explanation assumes that many children experiencing stress episodes during the ages of 3.5 to 6.5 years, and who lived to adulthood, were born within the colony of New York. Goode-Null's study reports that enslaved children in New York were frequently sold by the age of six years (History Final Report, 2004; Goode-Null 2002: 37-38). Advertisements indicate domestic skills promoting the marketability of enslaved children. Therefore, it is likely that children approaching the age of six years may have experienced trauma related to separation from their parents, differential nutrition provisions provided by non-parental custodians or slaveholders, or stresses and increased exposure to disease due to induction into domestic or other labor duties. Children under the age of 15 were highly stressed, and approaching the age of six may have been a significant stage within the life histories of children born within the legal status of "slave" in colonial New York. Furthermore, legal definitions of "adult" were applied to children

over the age of ten years in the 1731 and 1737/8 censuses, and at sixteen years in the census data prior to 1731 and after 1737/8, including the 1810 census (Chapter 13; Goode-Null 2002; Blakey 1998: 62). This legal status as “adult” would most likely have effected the character of labor expected of young enslaved Africans under the age of 15 and within the age group of 15 to 24. These data further suggest that a child approaching the age of nine or ten may be prepared for an occupational position through entry into labor training and work. Substantial third molar defect frequencies, especially for those who died between 15 and 24 years of age, characterize stresses of older children and adolescents whether or not they were born in New York.

A second interpretation assumes the inclusion of children imported from Africa to New York, again around the age of nine or ten, as enslaved laborers. These children may have experienced high levels of physiological stress during their earlier childhood related to shifts in political power and socioeconomic upheaval within the Atlantic slave trade networks that may have factored into their enslavement. Also, children under the age of 15 years could likely have experienced the middle passage prior to their arrival in New York. Any of a host of other possible inadequacies of the large, stratified agrarian societies from which they derived may have contributed to moderately high hypoplastic frequencies in the childhoods of those who died as adults in New York. Consistent with other findings of this study, most of the stresses shown by adult teeth were likely produced by factors within their native African environments with a minority of the adult teeth developing during childhoods in New York. The high third molar frequencies for those who died between 15 and 24 years of age also suggest effects deriving from arrivals in New York between 9 and 16 years of age in at least 44 percent of the individuals.

Those who lived to old age showed far less stress during 9-16 years of age than those who died shortly after arrival in New York.

Our observation that those who lived the longest also had the lowest evidence of childhood stressors may suggest that higher chances of survival to adulthood are associated with having lower stress in childhood, irrespective of where the childhood took place. An attrition of hypoplastic individuals that is associated with age has been postulated elsewhere (Blakey and Armelagos 1985). These are not mutually exclusive propositions; those born in Africa may have had fewer childhood stressors and survived to older ages at death in New York than those who were born in New York City.

One approach to this question has been to compare hypoplasia frequencies for individuals with culturally-modified teeth to those without such modifications (see Figure 8.7 and Table 8.10). Handler's historical study (1994) and our chemical research (see Chapter 6) strongly suggest that modified teeth most frequently indicate African birth. Individuals without cultural modification (probably both African and non-African born) had higher frequencies of hypoplasia than individuals without [Modified 66.7% (n=6); Unmodified 72.9% (n=40)].

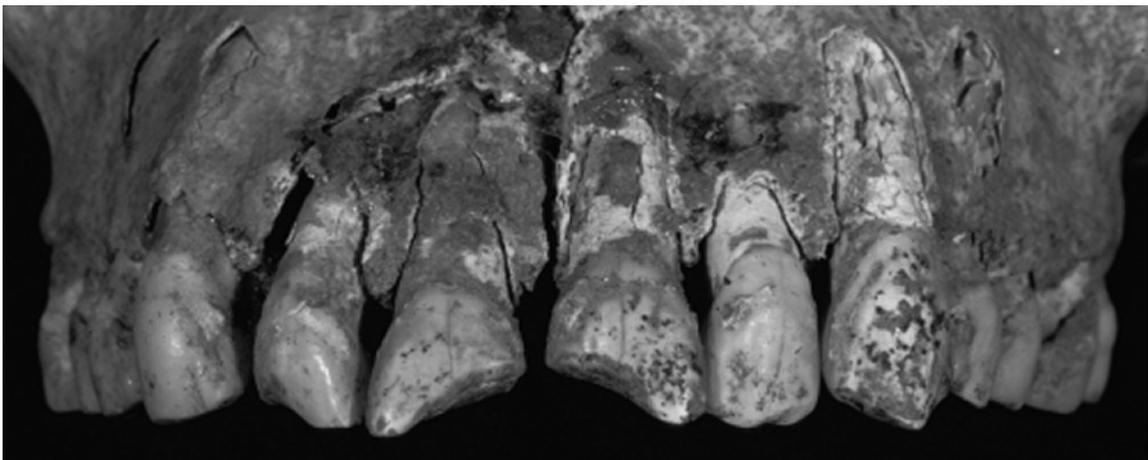


Figure 8.7: Dental Modification

The mean ages at death for individuals with modified and unmodified teeth were comparable, though slightly older for individuals with modified teeth (34 years for individuals with modified teeth and 31 years for individuals with unmodified teeth). While consistent with the association between African birth and lower defect frequencies, these differences are not statistically significant at the $p < .05$ level. Chemical and mtDNA analyses will provide greater insight into these interpretations. Indeed, chemical sourcing data would add greatly to the conclusiveness of these tests by providing an independent method of identifying place of birth in at least two hundred ABG individuals; this should be done in a future study.

Table 8.10: NYABG Hypoplasia in Culturally Modified and Unmodified Permanent Teeth

Culturally Modified (n=9)	Unmodified (n=56)
66.7% (n=6)	71.4% (n=40)

The highest levels of hypoplasia are found within the individuals with deciduous dentition and may therefore represent effects of prenatal stress experienced by the mother during pregnancy. Furthermore, the decreasing frequencies of hypoplasia exhibited by individuals who lived longer suggest a relationship between stress episodes indicated by hypoplasia and a decreased life span.

Dental Enamel Hypocalcification

A study of dental enamel hypocalcification was conducted to assess frequencies within a subsample of 99 individuals. This subject had permanent dentition, including a left or right maxillary central incisor and a left or right mandibular canine, and included children with deciduous left or right maxillary incisors, left or right mandibular canines, and a second molar.

Within this study of the ABG sample, 67.6 percent (n=29) of the 34 children with deciduous dentition had hypocalcification. Among the 65 individuals with permanent dentition, 18.5 percent (n=12) had hypocalcification (see Table 8.11). Women had a higher frequency of hypocalcification than did men (72.7% of the 24 females versus 27.3% of the 35 males).

Within this subsample, 60.5 percent (n=23) of the 38 children under the age of 15 years had hypocalcification, whereas only 10 percent (n=2) of the 20 young adults aged 15 to 24.9 years and 28.6 percent (n=10) of the adults aged 25 and older had hypocalcification (see Table 8.11). This difference was statistically significant (Pearson chi-square = 19.84, 2 df, $p < .0005$) and mainly reflects the change from predominantly primary to secondary teeth by age 15. The difference between hypocalcification frequencies found in individuals with deciduous dentition (67.6% n=23) and permanent dentition (18.5% n=12) should not be considered in the same manner in which this age-related pattern in hypoplasia has been considered.

Deciduous dentition is more likely to become hypocalcified than to exhibit hypoplasia, and deciduous dentition typically displays higher frequencies of hypocalcification in comparison to permanent dentition (Blakey et al. 1997). Thus, the observed low frequency of hypocalcification in permanent dentition follows the expected pattern due to suspected intrinsic differences between deciduous and permanent dentition that may have nothing to do with stressor prevalence. Comparisons of hypocalcification across primary and secondary dentition are therefore inappropriate.

Table 8.11: NYABG Comparison of Hypocalcification and Hypoplasia Frequencies by Age Group (N=99)

Age Group	Within Age Group	
	Hypocalcification	Hypoplasia
1.0- 14.9	60.5% (n=23)	86.5% (n=32)
15.0-24.9	10% (n=2)	80.0% (n=16)
25.0-55 +	28.6% (n=10)	66.7% (n=30)

Comparison of the two defect types within deciduous dentitions is of interest. Deciduous dentition forms in-utero and continues into the first year of life and therefore represents early childhood development and a measure of prenatal health and the health status of the mother. Hypocalcification and hypoplasia frequencies were both highest in children dying prior to the age of 15 years, demonstrating high physiological stress and vulnerability during the prenatal and early childhood years. The higher levels of hypoplasia (86.5%) versus hypocalcification (65.7%) within deciduous dentition (n=34) is unexpected, however, given the tendency of deciduous teeth to preferentially exhibit hypocalcification. Hypoplasia frequency in this case is extraordinarily high compared to other deciduous dental studies using similar methods (Blakey and Armelagos 1985; Blakey et al. 1995; 1997; Rankin-Hill 1997). Both defect frequencies indicate the extremely high levels of stress experienced in-utero and during the first year of life among the ABG children who died before the age of fifteen.

Conclusions

Historical data on the ages of children who were in various stressful contexts have been applied to explain developmental defect frequencies that occurred at different ages in the childhood and adolescent periods of the life cycle. Children, likely born in colonial New York within the condition of slavery, were more vulnerable to health risks and early

death due to nutritional deficiencies and illness than is evident for the childhoods of those who were likely to have been born in Africa. The findings of this study suggest disparity between early childhood health and nutrition for individuals more likely to have been born in colonial New York and individuals likely to have been born as free people in the agricultural villages of the war-torn states of West and Central Africa (see *History Final Report*, section I). The fact that higher frequencies of enamel defects were shown to exist among children under the age of fifteen and among individuals without dental modification, than among individuals who were most likely to have been born in Africa (older individuals and those with modified teeth), supports this hypothesis. The chronology of physiological insults resulting in hypoplasia further supports the vulnerability of childhood and adolescence for enslaved Africans in New York.

The third molar data reflect the trajectory of life experience for individuals, most of whom were likely to have been born in Africa and enslaved in the Americas. Significantly higher hypoplasia frequencies found in the third molars representing the developmental period of 9 through 16 years correspond with historical data indicating high levels of importation of older children, adolescents and young adults in the eighteenth-century. These findings indicate that the quality of life for Africans was greatly compromised upon entry into the New York environment of enslavement through the processes of either birth or forced migration.

Chapter 9

Odontological Indicators of Disease, Diet, and Nutrition Inadequacy

M.E. Mack, A.H. Goodman, M.L. Blakey, and A. Mayes

The dentition is usually the best-preserved element of the skeleton. Hydroxyapatite, an inorganic calcium matrix, comprises approximately 97 percent of the chemical composition of enamel (Carlson, 1990). This crystalline structure makes dental enamel hard and dense and useful to resist the abrasive nature of mastication. Also, as a result of their hardness, teeth are often all that remains of a long-deceased individual. The abundant presence of dentition in archaeological contexts has led to the intensive exploitation of teeth for information about the past. Chapters 8 and 6 of this report have addressed the systemic effects of nutrition in dental development and of ecosystem relationships that changed dental chemistry, respectively. In addition, the relative presence or absence of pathological conditions, such as tooth loss, caries (cavities from dental decay) and associated abscesses of the alveolar bone surrounding the dental root and cervix also provide evidence of the general level of biological well-being and accessibility of dental care, as well as biological effects of foods commonly eaten.

In order to further understand the diets and living conditions of individuals from the African Burial Ground (ABG), in this chapter, we summarize traditional odontological methods for assessing the local effects of different foods within the oral cavity itself. We specifically focus on dental caries, dental abscesses, and tooth loss. Subsections include discussion of the frequencies of subadult and adult dental diseases as well as the differences found in adult males and females. Finally, comparisons of

infectious dental pathologies (caries, associated abscesses and antemortem tooth loss) will be made between the ABG population and other skeletal samples that may have experienced similar life conditions. We also briefly discuss a few cases of micro and macrodontia.

Sampling

For a variety of reasons, sample sizes for each pathological observation will vary. Much of the variation centers on not only the relative state of preservation of the teeth, but also the condition of the surrounding alveoli. In many cases, teeth were recovered while the surrounding alveoli were too poorly preserved for observations of pathology. Likewise, many dentitions were part of, and encased in, cranial pedestals, often obscuring a complete side of the dental arcade in cases where teeth were too friable to remove in an observable state. Additionally, many teeth were covered with organic or diagenetic staining due to the local soil conditions, water seepage and damage, and the time elapsed since interment (Figure 9.1). This discoloration is not to be confused with enamel hypocalcification; it often affects dental roots and the surrounding alveoli which were exposed as a result of postmortem deterioration, as well as dental enamel. Calculus deposits built up on tooth surfaces, and although these deposits were usually removed, calculus sometimes prevented pathological observations.

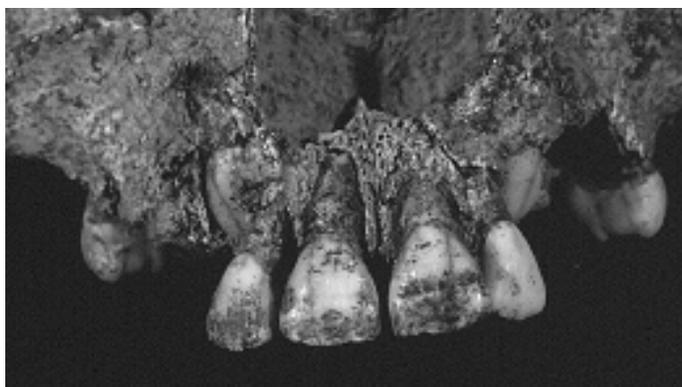


Figure 9.1: Diagenetic staining affecting dentition in a 55 – 65 year old female (Burial 241)

Finally, antemortem tooth loss and traumatic fractures, especially of the molars, precluded some diagnoses, and in the cases of the twenty six individuals exhibiting dental modification, along with enamel being lost due to filing/chipping, some pathology information was lost as well (**Appendix 9.1**).

After the skeletal remains of each burial were cleaned and reconstructed, the dentition for each burial (permanent and or deciduous) was cleaned, identified, assessed and curated separately by the Laboratory Director and his assistants. Data collection was performed under the guidelines set forth in *Standards for Data Collection for Human Remains* (Buikstra and Ubelaker 1994). Pathological recordation for the deciduous and/or permanent teeth included dental inventories and tooth loss with alveolar resorption, caries reporting by surface and number of caries by tooth, abscess presence and location (buccal, lingual or exudative), and other pathological observations (molar agenesis, dental crowding, etc.) (Appendix 4.6). Dental caries is defined as a progressive tooth demineralization resulting from localized fermentation of food sugars and carbohydrates by bacteria (Mandel, 1979). Dental caries formation, periapical abscessing and antemortem tooth loss are all evidence of a disease process (Larsen, 1997). A complete

photographic record was constructed for each tooth, the overall dentition and the maxillary and mandibular alveoli (Figure 9.2).

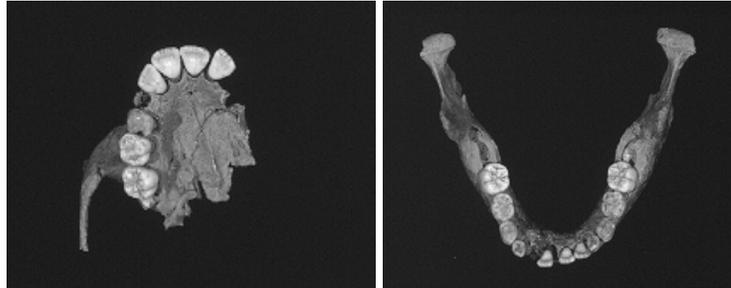


Figure 9.2: Examples of the photographic record (Burial 95, a subadult aged 7 – 12 years)

For example, the plate on the left displays the occlusal surface of the maxillary dentition and alveoli, while the plate on the right provides an occlusal view of the mandibular dentition of Burial 95, providing photographic evidence of dental observations.

Only dentitions from individuals with known sex and age (both adult and subadult) are used for the following dental pathology analysis. For these purposes, adults are defined as 15-60+ years of age, while subadults are defined as younger than 15 years (14.99 and below). The rationale supporting these definitions and the use of only individuals with known sex and ages has been outlined above (Chapter 7). It is a bit troublesome to have multiple definitions of “adulthood” – one for demographic purposes and another for other studies.

Infectious Pathology

Tables 9.1 and 9.2 contain, respectively for males and females, dental pathologies – caries and abscesses – frequencies identified in the New York African Burial Ground (NYABG) sample. Caries is present in all tooth types. However, as expected the highest frequencies of caries are found in molars followed by premolars and single cusped incisors and canines. The highest frequencies found in males are in the lower left first molar (37.74 percent), the lower left second molar (31.03 percent), and the upper right third molar (30.43 percent). The least carious tooth is the right lower second incisor (2.67 percent). No tooth type is caries free. Whereas just three teeth reached caries prevalence of over thirty percent in males, thirteen teeth reach a similar threshold in females, including eleven of twelve molars and two premolars. As it did in males, the lower left first molar displays the highest frequency of caries in females (55.17 percent).

The prevalence of dental abscesses is also greatest in molars. In males, the highest prevalence of abscessing is found on the upper right first molar (19.70 percent) followed by the contralateral upper left first molar (17.19 percent). Interestingly, in females, the highest frequency of abscessing is found in the lower left first molars (24.14 percent) and right first molars (18.75 percent).

Table 9.1: Dental Pathology Frequency - Males – Permanent Dentition

Tooth #	Present	Absent	Total	% Absent	# Caries	% Caries	# Abscess	% Abscess
1) RM ³	69	8	77	10.39%	21	30.43%	7	10.14%
2) RM ²	68	9	77	11.69%	17	25.00%	7	10.29%
3) RM ¹	66	15	81	18.52%	19	28.79%	13	19.70%
4) RP ²	71	9	80	11.25%	14	19.72%	8	11.27%
5) RP ¹	73	10	83	12.05%	17	23.29%	8	10.96%
6) RC ¹	77	5	82	6.10%	11	14.29%	1	1.30%
7) RI ²	72	6	78	7.69%	9	12.50%	0	0.00%
8) RI ¹	70	10	80	12.50%	10	14.29%	1	1.43%
9) LI ¹	71	8	79	10.13%	10	14.08%	3	4.23%
10) LI ²	75	8	83	9.64%	7	9.33%	2	2.67%
11) LC ¹	72	8	80	10.00%	12	16.67%	5	6.94%
12) LP ¹	64	13	77	16.88%	14	21.88%	4	6.25%
13) LP ²	64	14	78	17.95%	12	18.75%	6	9.38%
14) LM ¹	64	14	78	17.95%	12	18.75%	11	17.19%
15) LM ²	64	14	78	17.95%	13	20.31%	10	15.63%
16) LM ³	66	9	75	12.00%	15	22.73%	10	15.15%
17) LM ₃	58	27	85	31.76%	15	25.86%	6	10.34%
18) LM ₂	58	25	83	30.12%	18	31.03%	7	12.07%
19) LM ₁	53	28	81	34.57%	20	37.74%	8	15.09%
20) LP ₂	72	9	81	11.11%	12	16.67%	0	0.00%
21) LP ₁	81	5	86	5.81%	6	7.41%	3	3.70%
22) LC ₁	80	5	85	5.88%	8	10.00%	2	2.50%
23) LI ₂	78	5	83	6.02%	4	5.13%	0	0.00%
24) LI ₁	70	10	80	12.50%	2	2.86%	1	1.43%
25) RI ₁	70	7	77	9.09%	3	4.29%	1	1.43%
26) RI ₂	75	7	82	8.54%	2	2.67%	0	0.00%
27) RC ₁	79	6	85	7.06%	5	6.33%	2	2.53%
28) RP ₁	79	7	86	8.14%	15	18.99%	2	2.53%
29) RP ₂	82	9	91	9.89%	13	15.85%	2	2.44%
30) RM ₁	56	31	87	35.63%	11	19.64%	2	3.57%
31) RM ₂	64	23	87	26.44%	19	29.69%	6	9.38%
32) RM ₃	63	23	86	26.74%	14	22.22%	3	4.76%

Table 9.2: Dental Pathology Frequency – Females – Permanent Dentition

Tooth #	Present	Absent	Total	% Absent	# Caries	% Caries	# Abscess	% Abscess
1) RM ³	40	12	52	23.08%	12	30.00%	3	7.50%
2) RM ²	48	6	54	11.11%	16	33.33%	3	6.25%
3) RM ¹	40	13	53	24.53%	14	35.00%	5	12.50%
4) RP ²	47	9	56	16.07%	13	27.66%	2	4.26%
5) RP ¹	43	16	59	27.12%	14	32.56%	3	6.98%
6) RC ¹	55	4	59	6.78%	11	20.00%	2	3.64%
7) RI ²	47	7	54	12.96%	14	29.79%	2	4.26%
8) RI ¹	46	4	50	8.00%	11	23.91%	3	6.52%
9) LI ¹	47	6	53	11.32%	10	21.28%	3	6.38%
10) LI ²	49	6	55	10.91%	13	26.53%	2	4.08%
11) LC ¹	53	3	56	5.36%	6	11.32%	4	7.55%
12) LP ¹	45	11	56	19.64%	11	24.44%	3	6.67%
13) LP ²	46	7	53	13.21%	12	26.09%	2	4.35%
14) LM ¹	41	11	52	21.15%	15	36.59%	7	17.07%
15) LM ²	51	5	56	8.93%	19	37.25%	6	11.76%
16) LM ³	44	11	55	20.00%	15	34.09%	2	4.55%
17) LM ₃	38	19	57	33.33%	12	31.58%	3	7.89%
18) LM ₂	41	19	60	31.67%	12	29.27%	7	17.07%
19) LM ₁	29	25	54	46.30%	16	55.17%	7	24.14%
20) LP ₂	51	7	58	12.07%	8	15.69%	3	5.88%
21) LP ₁	57	4	61	6.56%	7	12.28%	0	0.00%
22) LC ₁	59	4	63	6.35%	9	15.25%	2	3.39%
23) LI ₂	54	5	59	8.47%	8	14.81%	1	1.85%
24) LI ₁	57	4	61	6.56%	1	1.75%	1	1.75%
25) RI ₁	52	5	57	8.77%	2	3.85%	0	0.00%
26) RI ₂	56	5	61	8.20%	9	16.07%	1	1.79%
27) RC ₁	56	7	63	11.11%	9	16.07%	2	3.57%
28) RP ₁	52	5	57	8.77%	20	38.46%	5	9.62%
29) RP ₂	49	9	58	15.52%	8	16.33%	1	2.04%
30) RM ₁	32	27	59	45.76%	12	37.50%	6	18.75%
31) RM ₂	40	20	60	33.33%	12	30.00%	2	5.00%
32) RM ₃	39	17	56	30.36%	15	38.46%	3	7.69%

Table 9.3: New York African Burial Ground Total Number Carious Teeth by Sex

# of Carious Teeth	Male	Female	Total
0	27.1% (n=26)	15.7% (n=11)	22.3% (n=37)
1	11.5% (n=11)	10.0% (n=7)	10.8% (n=18)
2	6.3% (n=6)	10.0% (n=7)	7.8% (n=13)
3	5.2% (n=5)	5.7% (n=4)	5.4% (n=9)
4	6.3% (n=6)	12.9% (n=9)	9.0% (n=15)
5	10.4% (n=10)	10.0% (n=7)	10.2% (n=17)
6	12.5% (n=12)	7.1% (n=5)	10.2% (n=17)
7	7.3% (n=7)	2.9% (n=2)	5.4% (n=9)
8	2.1% (n=2)	7.1% (n=5)	4.2% (n=7)
9	2.1% (n=2)	1.4% (n=1)	1.8% (n=3)
10	1.0% (n=1)	4.3% (n=3)	2.4% (n=4)
11	3.1% (n=3)	1.4% (n=1)	2.4% (n=4)
12	1.0% (n=1)	4.3% (n=3)	2.4% (n=4)
13	2.1% (n=2)	0.0% (n=0)	1.2% (n=2)
14	0.0% (n=0)	0.0% (n=0)	0.0% (n=0)
15	1.0% (n=1)	1.4% (n=1)	1.2% (n=2)
16	0.0% (n=0)	2.9% (n=2)	1.2% (n=2)
17	1.0% (n=1)	0.0% (n=0)	0.6% (n=1)
18	0.0% (n=0)	1.4% (n=1)	0.6% (n=1)
18+	0.0% (n=0)	1.4% (n=1)	0.6% (n=1)
Total	100% (N=96)	100% (N=70)	100% (N=166)

Most adults (72.9 percent of males and 84.3 percent of females) had at least one carious tooth (Table 9.3). Historical data show that the average diet for anyone living during the Colonial Period was high in carbohydrates such as corn or wheat flour and sugar, either refined, in its raw state or in the form of molasses, which often led to caries formation (History Report, Chapter 10).

Some caries is so severe that the entire tooth is affected with inflammation and infection of the surrounding alveolar bone. The fact that many of the abscesses were untreated reflects the paucity of dental and overall medical care available to the individuals comprising the NYABG sample (Figure 9.3). Table 9.4 summarizes the mean and standard deviations for the number of carious teeth, abscessed, and lost teeth, and

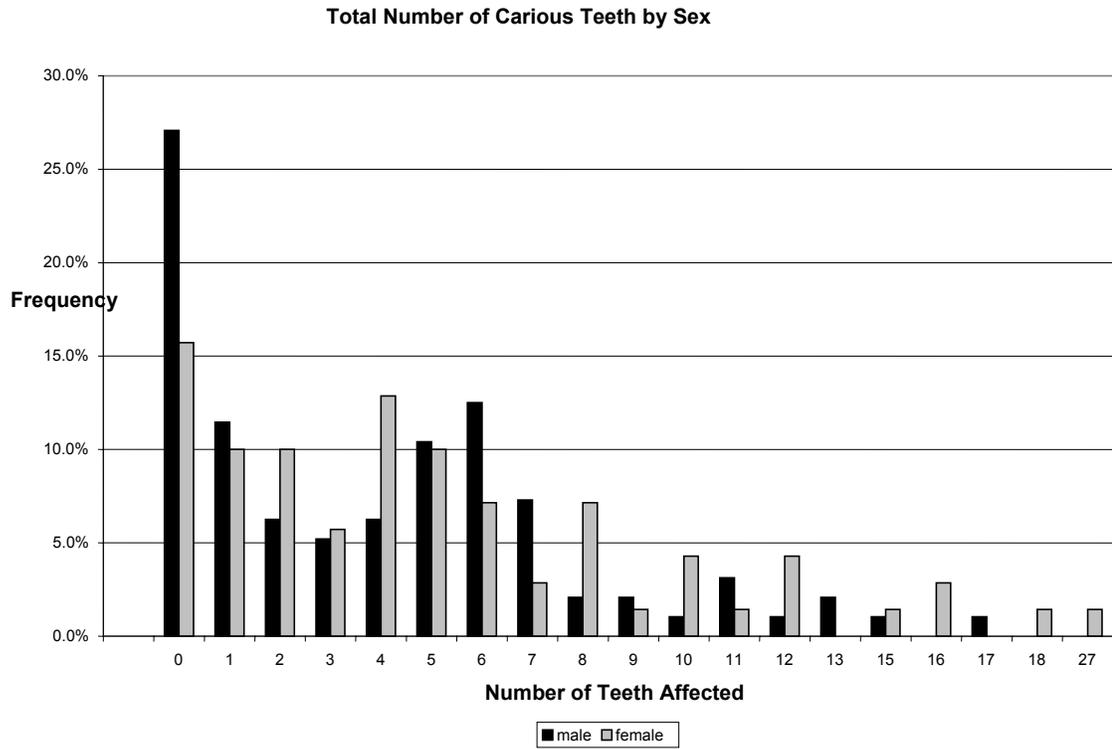


Figure 9.3: Total Number of Carious Teeth by Sex



Figure 9.4: Molar caries in a male aged 26 – 35 years (Burial 101)

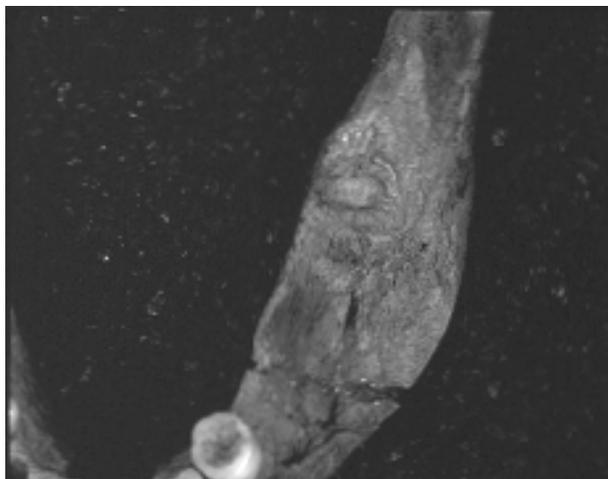


Figure 9.5: Abscessing in a female aged 25 – 35 years (Burial 266)

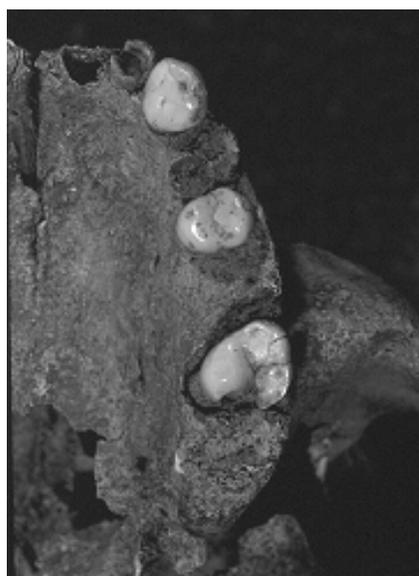


Figure 9.6: Caries formation in a female aged 35 – 40 years (B 107)

total pathologies, that is, the total chances of having at least one of these three conditions. As was suggested by individual tooth percents in tables 9.1 and 9.2, females have a higher average rate of carious teeth (5.2) compared to males (4.0). Females also have more lost teeth than males (4.3 vs. 3.7, respectively) and thus females have higher rates of total pathology (10.9 vs. 9.1 teeth). On average, nearly ten teeth (9.9, sd = 9.1) per permanent dentition are either lost, carious or abscessed.

Table 9.4: Dental Pathology Frequency by sex for the permanent dentition of individuals from the New York African Burial Ground

Males and Females – Permanent Dentition					
Sex		No. Teeth Lost	No. Caries	No. Abscesses	Total Pathology
Male	Value	3.7	4.0	1.5	9.1
N=96	St. Dev.	(5.4)	3.9	2.6	9.0
Female	Value	4.3	5.2	1.4	10.9
N=70	St. Dev.	6.2	5.1	2.7	9.1
Total	Value	4.0	4.5	1.4	9.9
N=166	St. Dev.	5.7	4.5	2.7	9.1

Table 9.5: Dental Pathology Frequency – Deciduous Dentition

Tooth #	Present	Absent	Total	% Absent	# Caries	% Caries	# Abscess	% Abscess
1) rm ²	67	1	68	1.47%	7	10.45%	1	1.49%
2) rm ¹	71	2	73	2.74%	9	12.68%	0	0.00%
3) rc ¹	64	1	65	1.54%	7	10.94%	0	0.00%
4) ri ²	62	3	65	4.62%	5	8.06%	0	0.00%
5) ri ¹	59	5	64	7.81%	7	11.86%	0	0.00%
6) li ¹	56	5	61	8.20%	6	10.71%	0	0.00%
7) li ²	60	2	62	3.23%	1	1.67%	0	0.00%
8) lc ¹	64	0	64	0.00%	3	4.69%	0	0.00%
9) lm ¹	72	1	73	1.37%	13	18.06%	0	0.00%
10) lm ²	71	0	71	0.00%	11	15.49%	0	0.00%
11) lm ₂	75	0	75	0.00%	10	13.33%	0	0.00%
12) lm ₁	83	1	84	1.19%	10	12.05%	0	0.00%
13) lc ₁	68	1	69	1.45%	3	4.41%	0	0.00%
14) li ₂	60	5	65	7.69%	1	1.67%	0	0.00%
15) li ₁	56	6	62	9.68%	0	0.00%	0	0.00%
16) ri ₁	52	6	58	10.34%	0	0.00%	0	0.00%
17) ri ₂	57	5	62	8.06%	2	3.51%	0	0.00%
18) rc ₁	63	2	65	3.08%	4	6.35%	0	0.00%
19) rm ₁	78	1	79	1.27%	11	14.10%	1	1.28%
20) rm ₂	80	0	80	0.00%	12	15.00%	0	0.00%

As young children are weaned onto solid foods they lose the immunological and nutritional advantages of mother's milk, which can be significant for marginally nourished populations in which the solid food diet is composed mainly of carbohydrates in the form of breads and cereal grains and either raw or processed sugars. Weaning and poor nutrition, coupled with little access or knowledge of dental care, initiates the disease process of caries and abscess formation, along with tooth loss (Figure 9.8). The frequency of dental caries and abscesses in the deciduous dentition is presented in table 9.5. Because these teeth are in the mouth for a shorter length of time, the rates of dental pathology are much lower compared to the permanent teeth. For example, only two cases of dental abscessing were found. However, many teeth do display dental cavities, including 18 percent of the upper left first deciduous molars. As with the permanent teeth, deciduous molars are more carious than single cusped deciduous teeth.

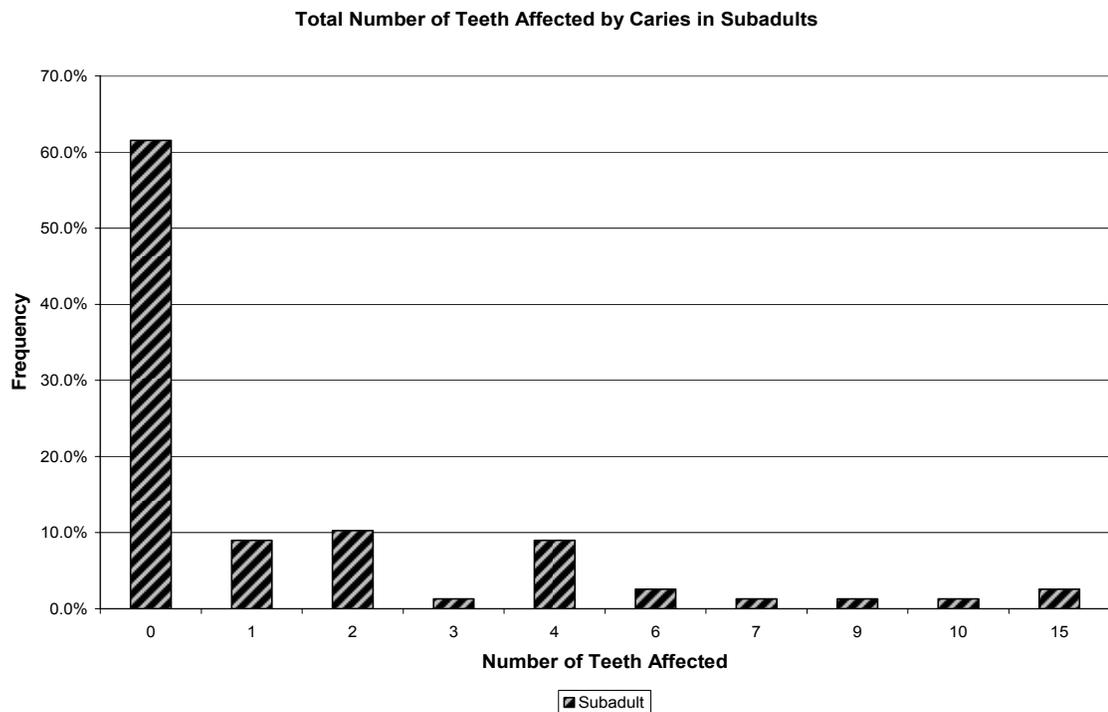


Figure 9.7: Total number of teeth affected by caries in subadults

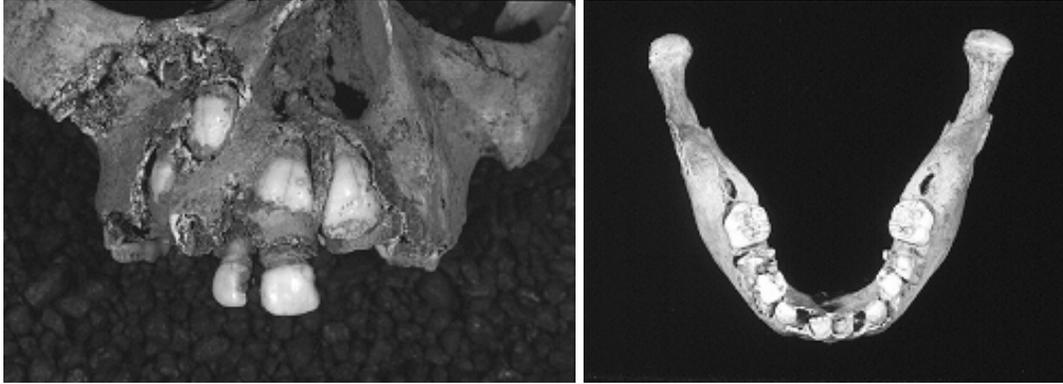


Figure 9.8: Caries, abscessing and enamel hypoplasia in a subadult aged 5 – 7 years (Burial 39)

Table 9.6: New York African Burial Ground Dental Pathology Mean Comparison with Other 18th and 19th Century Samples (Steckel and Rose 2000)

Site	No. Teeth Lost	No. Carious Teeth	No. Abscesses
African Burial Ground, NY			
Male	4	4	1.5
Female	4	5	1.4
Remley Plantation			
Male	7	2	0.5
Female	12	4	0.1
Belleview Plantation			
Male	5	6	0
Female	6	3	0.3
Charleston Elites			
Male	0	0	0.3
Female	2	1	1
FABC, Philadelphia			
Male	7	7	1
Female	5	9	1
Black Soldiers			
Male	1	2	1
Blacks, Arkansas			
Male	6	5	0.6
Female	8	4	0.4
Blacks, Texas			
Male	3	4	0.1
Female	3	4	0.1
Rochester Poorhouse			
Male	5	5	1
Female	5	6	0.9

Table 9.7: New York African Burial Dental Pathology Mean Comparison with Other 18th and 19th Century Samples (Kelly and Angel 1987)

Dental pathologies per mouth	18th Century	Catoctin	19th Century	Forensic 20th Century	NY African Burial Ground
Female	11.8 (9.8) F	11.0 (9.6) F	9.1 (11.3) F	10.3 (8.5) F	10.9 (9.1) F
	N = 12	N = 8	N = 16	N = 27	N = 70
Male	8.0 (7.7) M	14.4 (10.0) M	9.6 (8.4) M	14.1 (7.8) M	9.1 (9.0) M
	N = 16	N = 7	N = 25	N = 46	N = 96
	F + M = 9.6		F + M = 9.4	F + M = 12.8	F + M = 9.9
	N = 28		N = 41	N = 73	N = 166

The following section will compare dental pathologies in the NYABG sample with other contemporary and modern samples. Tables 9.6 and 9.7 provide a comparison of the rates of dental pathologies found in the present study compared to previously published results. Statistical comparisons are not made because of variation in methods and low sample sizes. As is true for the ABG, the general trend appears to be greater dental pathology in females than males. Caries rates are highest in the FABC sample from Philadelphia but also high in many of these samples (Table 9.6). The ABG results fall toward the high end of the middle of the range. Tooth loss is also highest in the FABC and free blacks from Arkansas, with the ABG results falling toward the middle of the range. Finally, abscess rate is greatest in the ABG (Table 9.6), which may be a reflection of poor dental care when compared to later populations, as well as a lack of access to any dental care due to the social inequalities.

The mean number of pathological teeth per mouth in the ABG versus select other samples is presented in Table 9.7. These data also suggest that the prevalence of dental pathologies in the NYABG is near the average of frequencies found at other archaeological sites. New York frequencies are high compared to other eighteenth century samples, however.

Genetic Dental Pathology

Genetic dental pathologies are inherited in the form of one or more alleles, although environmental stressors play a supporting role in their expression (Scott and Turner 1997). These include hypodontia (tooth agenesis), hyperdontia (supernumerary teeth), dental crowding, cleft palate, and abnormal tooth retention or exfoliation. Amelogenesis imperfecta, which produces distinctively severe enamel developmental defects, is a form of hypoplasia and hypocalcification (see Chapter 8). The following section contains examples of dental genetic anomalies from the NYABG, including dental hypodontia, dental crowding, and hyperdontia.

Subadult Dentition

One subadult, Burial 17, exhibits hypodontia of the deciduous left maxillary central incisor. Although this may be interpreted as exfoliation, there is no corroborating evidence that the tooth was ever present. This child is also afflicted with craniosynostosis, rickets, enamel hypoplasia and hypocalcification, and a cleft palate. Radiographic analysis of the maxilla and mandible also indicates substantial dental crowding of the permanent dentition.



Figure 9.9: Radiograph of incisor hypodontia in a subadult aged 4 – 6 years (Burial 17)

Dental crowding is the only genetic pathology that affects subadults with any appreciable frequency. Among subadults with intact dental arcades, 8 (9.9 percent) exhibit crowding of the deciduous teeth, especially the mandibular incisors. Additionally, through radiographic observations all but one of the eight subadults affected also exhibit dental crowding of the permanent maxillary and mandibular incisors.

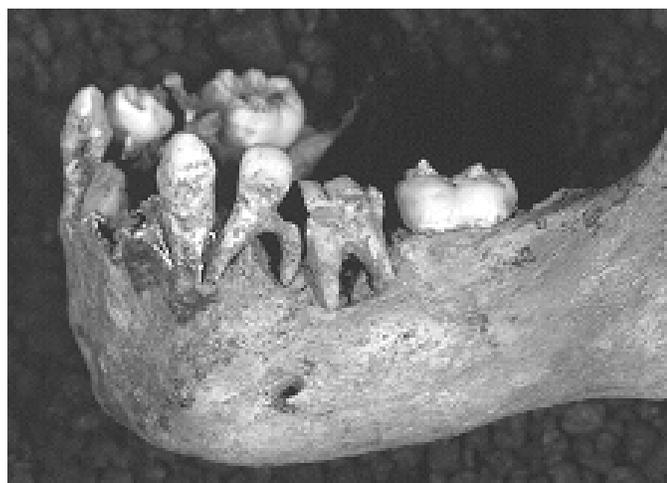


Figure 9.10: Dental crowding in a subadult aged 5 – 7 years (Burial 39)

Adult Dentition

Observable genetic dental pathologies are extremely rare in adults. Only one individual exhibits hypodontia; Burial 376, a 20-25 year old male, exhibits alveolar resorption, and his relatively young age with no tooth loss or caries formation confirms the assessment of tooth agenesis.

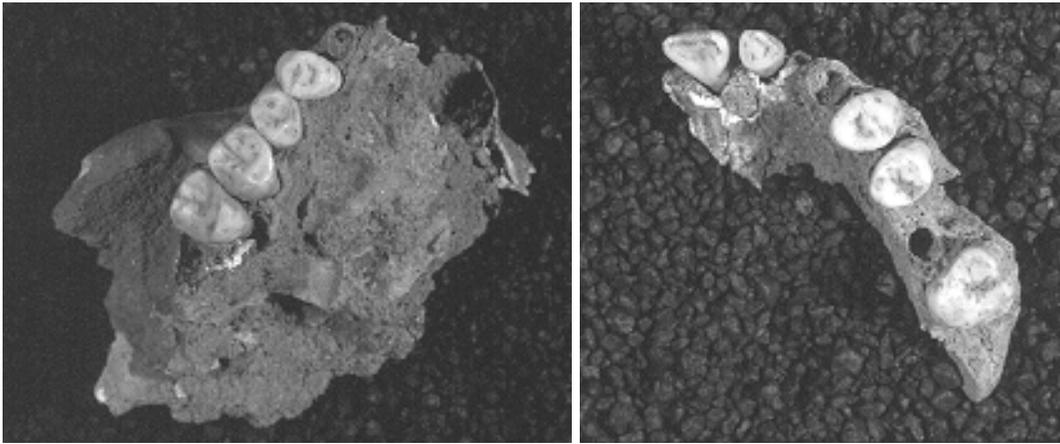


Figure 9.11: Maxillary molar agenesis in a male aged 30 – 40 years (Burial 379).

Only two individuals exhibit hyperdontia. Burial 12, a 35-40 year old female, has a supernumerary tooth at the location for the mandibular right first premolar, thereby obstructing its eruption. Burial 176, a 20-25 year old male, has a supernumerary tooth lingually adjacent to the maxillary left second premolar. The only other genetically caused dental pathology present in adults is dental crowding. Dental crowding is exhibited among 5 (0.5 percent) of the adults, specifically of the mandibular incisors.



Figure 9.12: An example of a supernumerary tooth in a female aged 35 – 45 years (Burial 12)

Conclusions

Overall, we found a high rate of tooth loss, caries and abscessed teeth. The rates of pathology, especially of dental abscesses, are high in comparison to other groups of the same period. Females generally have a higher rate of dental pathologies than males.

In addition to other hardships, it appears that individuals from the ABG had to endure the pain of dental pathologies and possibly changes in diet due to decreased ability to masticate. The overall high rate of dental pathology may reflect deficiencies in diet and dental hygiene. These results provide additional evidence of poor dietary regimens, unhealthy living conditions and lack of dental care that characterizes the quality of life for the majority of those who lived in bondage.

CHAPTER 10

Osteological Indicators of Infectious Disease and Nutritional Inadequacy

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Introduction

The present chapter investigates the prevalence of infectious diseases and nutritional inadequacies in the New York African Burial Ground (NYABG) sample, as represented in bone. A broad range of skeletal indicators of pathology was assessed in the Cobb Laboratory. Diagnoses of specific diseases represented by skeletal indicators were usually attempted, as per the long-standing standards of paleopathologists. Data were also gathered in accord with the more strictly descriptive criteria of the new *Standards for Data Collection from Human Skeletal Remains* (Buikstra and Ubelaker 1994). Indeed, the pathology coding section of the *Standards* is clearly the most novel and complex feature of the guide, and we think it constitutes a significant forward step in paleopathologic methodology. Yet, as one of the first projects to utilize and test the *Standards* in their entirety, we found the strict pathology coding approach to be somewhat cumbersome and time consuming. To mitigate this problem, we developed pathology codes for computerization that saved time and effort without the loss of useful information. Therefore, the skeletal pathology and non-metric trait computer database developed at the New York African Burial Ground Project (NYABGP) is a simplified version of the pathology portion of the *Standards* (Buikstra and Ubelaker 1994:107-158).

The modifications of the African Burial Ground (ABG) pathology database simply improved efficiency for coding complex descriptions of the type, appearance, severity, and location of pathologies and interesting anatomical features for computerization and statistical manipulation. The information captured by these codes was consistent with the *Standards* as well as with the previous protocol of the Paleopathology Association and our own and other researchers' earlier approaches to data collection. For example, we established that severity descriptors such as "trace" (Kelley and Angel 1987) or "slight" (Blakey et al. 1994) are close to the standard's use of "barely discernable," as a descriptor, while observations of greater magnitude such as "moderate, severe, or extreme" easily fell within the "clearly present" category of the standards. Indeed, this simple two tier severity (or clarity) rating of the *Standards*, barely discernable compared to clearly present, accomplishes its goal of classifications that many specialists can agree on and that can be compared across many studies, including those conducted before the creation of the new standards. Since our project developed during this methodological transition, data were gathered deliberately to bridge the old and new methodologies. Pathology assessments were rendered as text that includes many diagnoses as well as descriptors that were converted into four-letter codes. In the future these bench-top diagnoses should be of interest while the descriptive coding will provide the nearly raw data from which alternative diagnoses may be made. In this chapter, we have relied principally on the use of our coded data.

This adapted coding system facilitated direct synthesis of pathology assessments, especially the ability to combine nominal, observed characteristics of an individual or group and combine these to create more complex diagnoses. This allowed us to produce

clinically meaningful categories of pathology from the wealth of descriptors in our database (16,635 observations of pathology). Care was taken to retain the level of specificity, clear terminology, and emphasis on description (rather than specific pathological diagnoses) that was emphasized by the *Standards* (Buikstra and Ubelaker 1994:107-108).

It should be noted that some distinctions such as those made between active and healed, “reactive woven bone” and “sclerotic,” lesions require considerable subjective evaluation (Figures 10.1, 10.2, 10.3, and 10.4). As with other qualitative descriptions, we feel that the large numbers of observations made in this study substantially reduce the effects of errors due to possible misidentification/miscoding of marginal cases. The statistical associations found between plausibly associated variables are supportive of a swamping effect on any marginal errors.

Three hundred and six of a total of 419 individuals in the NYABG exhibit at least one identifiable pathology or non-metric skeletal trait. A further 52 individuals were assessed though no abnormalities were observed. It must be noted, however, that this number includes individuals who were very poorly preserved but whose “observable” skeletal elements or fragments did not present evidence of abnormalities.¹ Sixty-one of 419 individuals were not assessed for pathologies or non-metric skeletal traits; the majority (n = 55) were too poorly preserved to be evaluated.² Of these 61, five individuals were quarantined due to potentially harmful fungi found in pedestal soil and therefore could not be assessed. Burial #100, a young subadult in poor condition who remained in an earthen pedestal intermingled with its badly decayed coffin, was also not assessed.

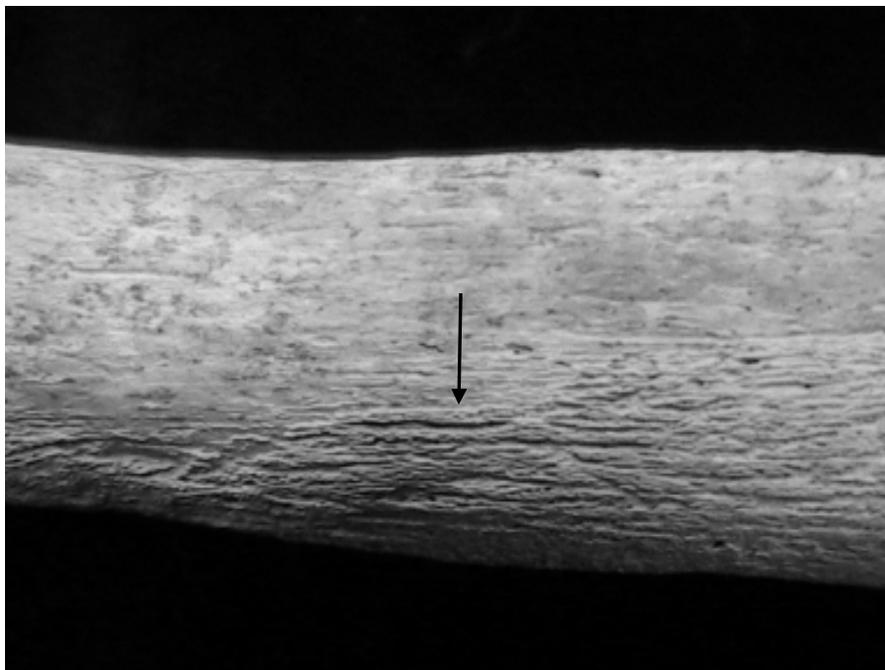


Figure 10.1: Active periostitis on left posterior ulna of a 35-45 year old male (Burial 70)

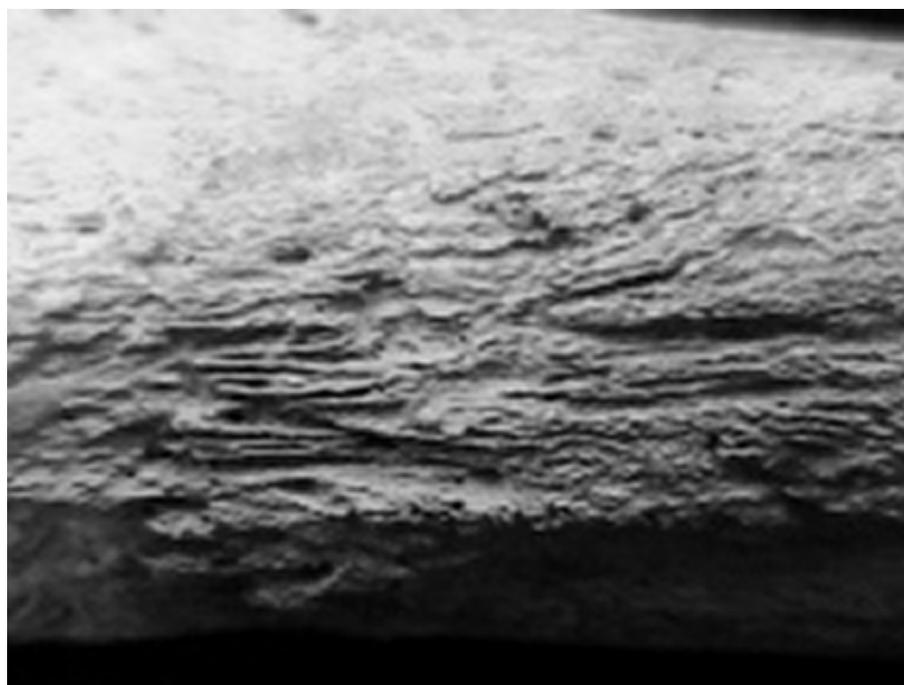


Figure 10.2: Active periostitis on left posterior ulna of a 35-45 year old male, magnified (Burial 70)



Figure 10.3: Healed, sclerotic periostitis on right lateral tibia of an adult male (Burial 69)

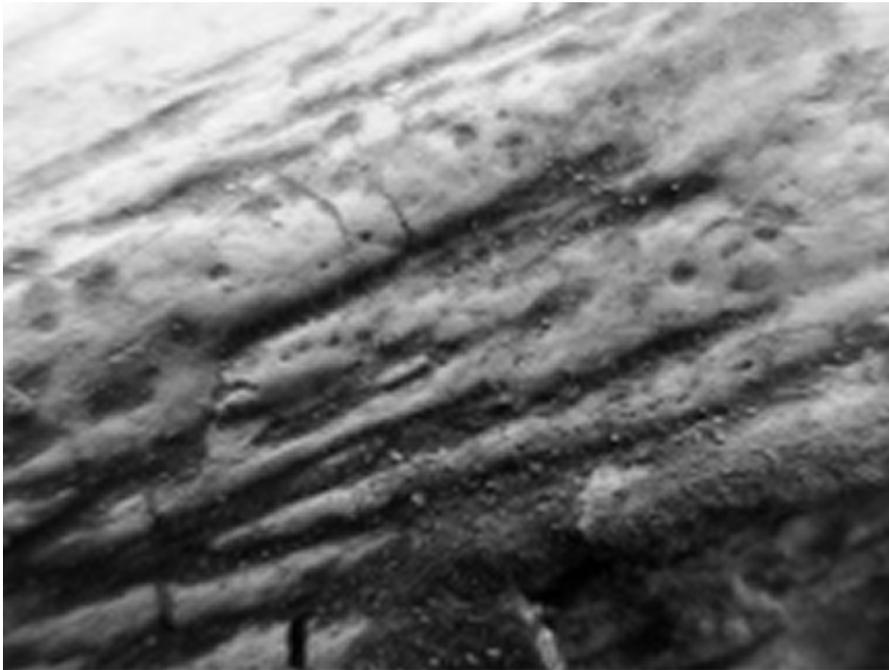


Figure 10.4: Healed, sclerotic periostitis on left lateral tibia of a 45-50 year old male, magnified (Burial 20)

Therefore, for purposes of this study a total sample size of 358 individuals will be utilized in analyzed (Table 10.1). This sample includes 105 subadults younger than 15 years old, 237 adults 15 years old or older (115 males, 85 females), and 16 individuals for whom age and sex were undeterminable.³ While these sample sizes will be used in general statements regarding disease prevalence, in cases where a more restricted sample size was warranted (e.g., numbers of investigated crania for porotic hyperostosis), sample sizes were generated with the aid of the skeletal inventory database.

The central focus of this chapter is the prevalence of general and specific infectious disease and nutritional inadequacy indicators observed in the NYABG skeletal sample. General infectious periostitis is considered first. We report prevalence of cases, healed versus active lesions, age and sex distributions of those affected. These data are followed by comparative analysis with data from the First African Baptist Church (FABC), a nineteenth-century free urban sample (Rankin-Hill 1997); 38CH778, a southern plantation population, 1840 - 1870 (Rathbun 1987); and Cedar Grove, a post-reconstruction rural population (Rose and Santeford 1985) (Table 10.2). Following discussion of general infectious disease, the occurrence of specific disease indicators, especially treponemal disease, will be considered. We then combine the NYABG skeletal data with historical information and thus discuss the potential type, and/or types, of treponemal infection present in this sample. These findings will be compared to the high rates of syphilis found at the Waterloo Plantation population from Suriname (Khudabux 1991).

Table 10.1: Age Structure of Assessed Sample

Age	Sex			Total
	Male	Female	Unknown	
.00 - .49			23	23
.50 - .99			14	14
1.0 - 1.9			12	12
2.0 - 2.9			3	3
3.0 - 3.9			6	6
4.0 - 4.9			10	10
5.0 - 5.9			3	3
6.0 - 6.9			2	2
7.0 - 7.9			5	5
8.0 - 8.9			3	3
9.0 - 9.9			5	5
10.0 - 10.9			3	3
11.0 - 11.9			0	0
12.0 - 12.9			4	4
13.0 - 13.9			3	3
14.0 - 14.9			2	2
“Subadult”			7	7
15.0 - 19.9	7	8	4	19
20.0 - 24.9	10	5	1	16
25.0 - 29.9	7	4	2	13
30.0 - 34.9	10	16	2	28
35.0 - 39.9	12	9	0	21
40.0 - 44.9	18	5	0	23
45.0 - 49.9	17	8	2	27
50.0 - 54.9	15	5	1	21
55+	6	8	0	14
“Adult”	13	16	25	54
“Undetermined”	0	1	16	17
Total	115	85	158	358

Table 10.2: African Diaspora Skeletal Series Discussed in this Chapter
(Adapted from Rankin-Hill 1991)

Site/Location	Time Periods	Total Number of Burials	Life Style	Reference
Newton, Barbados	1660 - 1820	104	plantation enslaved	Jacobi et al., 1992
New York African Burial Ground	1697 - 1794	419 (358 assessed for pathology)	urban enslaved	
St. Peter's Cemetery, New Orleans	1720 - 1810	31	urban enslaved	Owsley et al., 1987
Catoctin Furnace, Maryland	1790 - 1820	31	industrial enslaved	Kelley and Angel 1987
Waterloo Plantation, Suriname	1793/1796 - 1861	25	plantation enslaved	Khudabux 1991
FABC - 8 th and Vine, Philadelphia	1821 - 1843	144	ex-slaves/freeborn	Rankin-Hill 1997
38CH778, South Carolina	1840 - 1870	36	plantation enslaved	Rathbun 1987
Cedar Grove Cemetery, Arkansas	1890 - 1927	78	rural farmers	Rose and Santeford 1985

The potential for metabolic disruption resulting from nutritional inadequacy, as exhibited by the presence of porotic hyperostosis, will be addressed in the second section. The rates of porotic hyperostosis exhibited in the individuals of the ABG will once again be compared primarily to those encountered within the Cedar Grove, 38CH778, and FABC samples. The possible presence of rickets or vitamin-D deficiency will be considered based on the presence of bilateral medial/lateral bowing of long bones of the lower limbs. The third and final section will assess the interaction of infection and nutritional inadequacy by investigating the co-occurrence of porotic hyperostosis and periostitis. Information from the NYABG will be compared with available data from Cedar Grove and FABC.

Overall, this chapter relates the NYABG paleopathology and the New York historical documentation. Therefore, the chapter tests the historical conclusions (History Report, Chapter 10) concerning the exposure of enslaved Africans to infectious pathogens in New York and prior to their involuntary transport to the New World.

Infectious Disease

Assessment of skeletal pathology observed in the individuals from the NYABG yielded numerous cases of boney response to infectious agents. The most common of these lesions were associated with abnormal bone found on the outer, periosteal surface of skeletal elements. This abnormality, commonly termed periostitis or periostosis,⁴ can be the result of specific disease (e.g. direct bone infection or trauma) or as part of a broader expression of infectious disease (e.g. treponemal infection) (Ortner 2003:207-208). With the possible exception of traumatic periostitis,⁵ the case can be made that most periostitis is associated with an infectious agent. For the purposes of this chapter, the presence of periostosis will be initially discussed as a general indicator of infectious disease. In the subsequent discussion of treponemal disease, periostosis will be considered a specific expression of this disease.

Over half, 200 or 55.9 percent, of the individuals in the ABG were affected by generalized infectious disease or periostitis (Tables 10.3 and Table 10.4). All but 15 of these individuals, 92.5 percent, exhibited more than one infectious locus, including 44 subadults and 153 adults, or 41.9 percent and 64.6 percent of these age groups. Among subadults, femora were the most common element affected, followed by the humeri and

tibiae. In contrast, among adults, the tibiae were the most commonly impacted, followed by the femora and fibulae.

Regarding severity, among those that exhibited periostitis, 74 (37.0 percent) individuals had at least one lesion that was assessed as "clearly present" (as opposed to "barely discernable" or no severity determined). Among subadults, three of the 44 (6.8 percent) exhibited at least one periostitic lesion that was assessed as clearly present. Adults displayed a significantly⁶ higher proportion of individuals with clearly present lesions, 68 or 44.4 percent of those with periostitis. Periostitis prevalence varied little between males and females – 81 or 70.4 percent in males and 60 or 70.6 percent in females. However, males do have a statistically significantly higher incidence of individuals with lesions classified as clearly present. Forty-four, or 54.3 percent of the males with periostitis, showed clearly present lesions, compared to 21 or 35.0 percent of the females.

Of the 200 individuals with periostitis in the ABG, 126 or 63.0 percent exhibited only healed lesions, 18 or 9.0 percent displayed only active lesions, and 34 or 17.0 percent had a combination of both active and healed lesions. Among adults the distribution of lesion status was: 113 or 73.9 percent healed periostitis, 2 or 1.3 percent active lesions, 30 or 19.6 percent both active and healed lesions. Differentiated by sex, adult males and females displayed only slight differences (not statistically significant) in the status of periosteal lesions: healed - 62 or 76.5 percent for males, 42 or 70.0 percent for females; active - 1 or 1.2 percent in males, 0 in females; and both active and healed - 16 or 19.8 percent for males, 13 or 21.7 percent for females. In subadults, of those who had periostitis, 10 or 22.7 percent exhibited healed lesions, 16 or 36.4 percent displayed

active lesions, and 4 or 9.1 percent had a combination of both healed and active lesions. Not surprisingly, those under one year of age expressed only active periostitis, having died before observable healing could have occurred. Compared to adults ($p < .001$), children were prone to dying during their first active infection that was sufficiently severe to leave bony evidence. The dental developmental defects discussed in Chapter 12 suggest that the majority of older children had experienced bouts of

Table 10.3: Occurrence and Status of Generalized Infectious Disease

	n[†]	Total %	Clearly Present %	Active %[‡]	Healed %[‡]	Both %[‡]
Subadult	105	41.9	6.8	36.4	22.7	9.1
Adult	237	64.6	44.4	1.3	73.9	19.6
Female	85	70.6	35.0	0.0	70.0	21.7
Male	115	70.4	54.3	1.2	76.5	19.8
Total	358	55.9	37.0	9.0	63.0	17.0

[†] “n” equals the number of individuals assessed for pathology.

[‡] Status values represent the percentage in each group of those with evidence of generalized infectious disease; “missing” percentages represent those whose lesions were unassessed/unassessable for status.

Table 10.4: Generalized Infectious Disease Statistical Testing: Intra-Population

	Generalized Infectious Disease Presence/Absence		Clearly Present Presence/Absence		Status of Lesions	
	x²	P	x²	P	x²	p
Subadult/Adult	15.288	<.001	20.988	<.001	73.473	<.001
Male/Female	.001	.981	5.178	.023	.084 [†]	.772

[†] Conditions for 2X3 contingency table not met, x² reflects the collapsing of “Active” and “Both” categories.

disease and nutritional stress earlier in their lives that left evidence in the disrupted development of teeth, if not in the bone. As subsequent discussion explores, these pathology indicators in bone represent the ‘tip of an iceberg’ of disease and ill health that for various reasons will often leave the skeleton unaffected.

When compared with periostitis rates for the FABC (Rankin-Hill 1997), 38CH778 (Rathbun 1987), and Cedar Grove (Rose and Santeford 1985), the NYABG sample exhibits similar, slightly lower infection frequencies (Figure 10.5, Table 10.5).⁷ However, differences in rates found between 38CH778 and the ABG were not found to be statistically significant. When differentiated by age category, it was found that the NYABG subadult infection frequency was intermediate between the high rates reported in Cedar Grove and 38CH778 – though not statistically significant – and the lower rate observed in FABC. Among adults, rates of infection at the ABG are similar to the high prevalence found at Cedar Grove and in 38CH778. Females in the Cedar Grove and the ABG samples have nearly identical periostitis prevalence figures (approximately 71 percent).

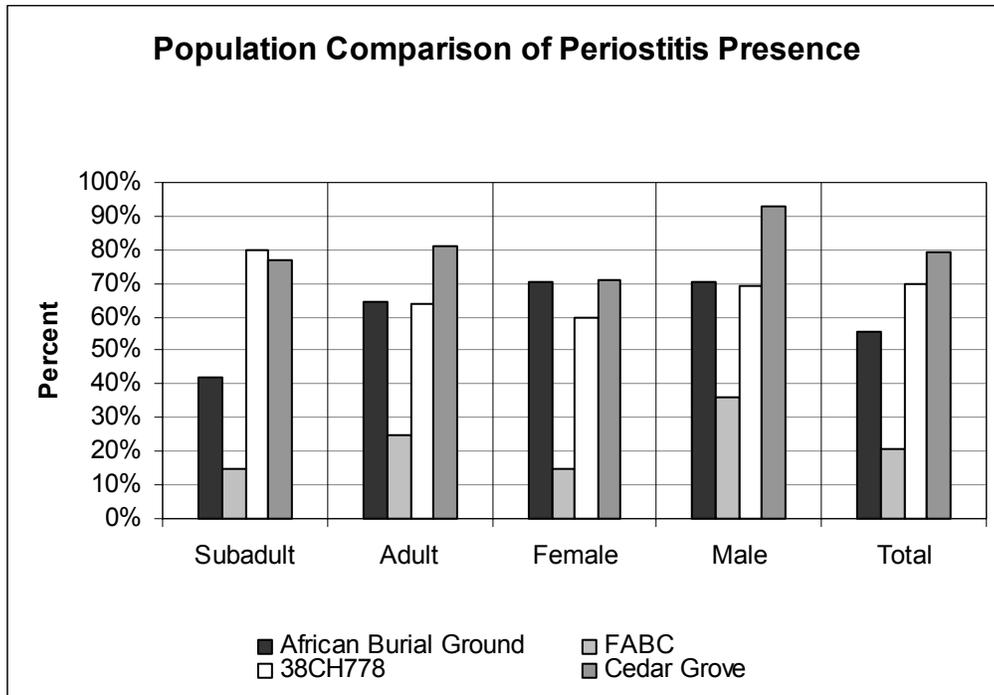


Figure 10.5: Population Comparison of Periostitis Presence

Table 10.5: Generalized Infectious Disease Statistical Testing: Inter-Population

	All Populations		African Burial Ground/FABC		African Burial Ground/Cedar Grove		African Burial Ground/38CH778	
	χ^2	p	χ^2	p	χ^2	p	χ^2	p
Subadult	43.722	<.001	12.676	<.001	15.549	<.001	1.480 [†]	.224
Adult	48.116	<.001	35.443	<.001	3.600	.058	.033 [†]	.857
Female	38.788	<.001	32.724	<.001	.037 [†]	.848	.265 [†]	.607
Male	22.856	<.001	13.746	<.001	2.468 [†]	.116	.053 [†]	.818
Total	>50	<.001	48.654	<.001	14.273	<.001	2.359	.125

[†] Yeats Correction for Continuity utilized due to small “expected” cell values.

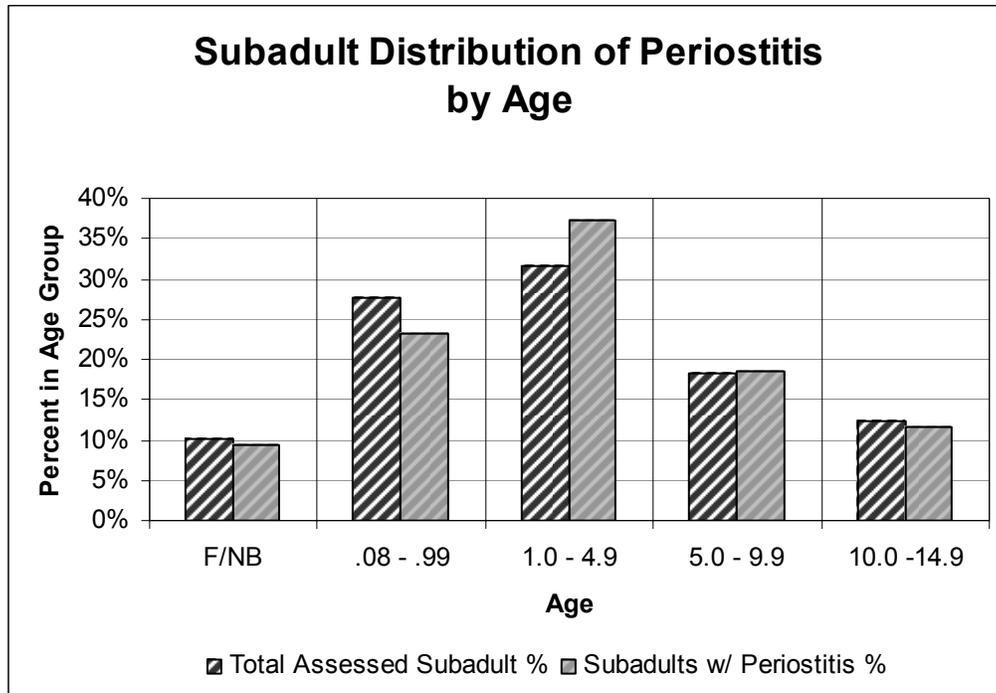


Figure 10.6: Subadult Distribution of Periostitis by Age

While not statistically significant, incidence figures for males from Cedar Grove (93 percent) exhibit a 22 percent higher incidence of periostitis than males from the ABG (70.4 percent). The periostitis rate among males from the ABG is most comparable to the rates observed in the 38CH778 South Carolina plantation population (69 percent).

The distribution of subadults from the ABG sample displaying generalized infection closely mirrors the overall age structure for this subgroup (Figure 10.6). The disparity observed in the two age distributions may reflect older individuals that survived previous episodes with infectious disease versus younger individuals who may have perished before skeletal involvement occurred. Interestingly, all individuals (9) younger than one year exhibited only active lesions. It is in the older 1.0 – 4.9 age group in which the first cases of healed lesions are encountered (2 with only active lesions, 5 with only healed lesions, 2 with a combination of healed and active lesions). Comparing

individuals with periostitis in different age groups, an increase in prevalence encountered after the first year (Figure 10.7) may reflect individuals who survived earlier insults. The rate of infection appears to decrease once again in subadults after five years of age. Indeed, our mortality data show a decline and stabilization in age-specific deaths among older children. Having weathered the vulnerable circumstances of infancy and weaning, older children usually will not see a major wave of new stresses until adolescence and young adulthood.

Subadult periostitis rates for the NYABG sample fall between those from Cedar Grove and FABC in most age categories (Figure 10.8). The proportions of periostitis in the ABG are consistently higher than those found in FABC, and considerably lower than Cedar Grove. However, in the oldest age group the trend

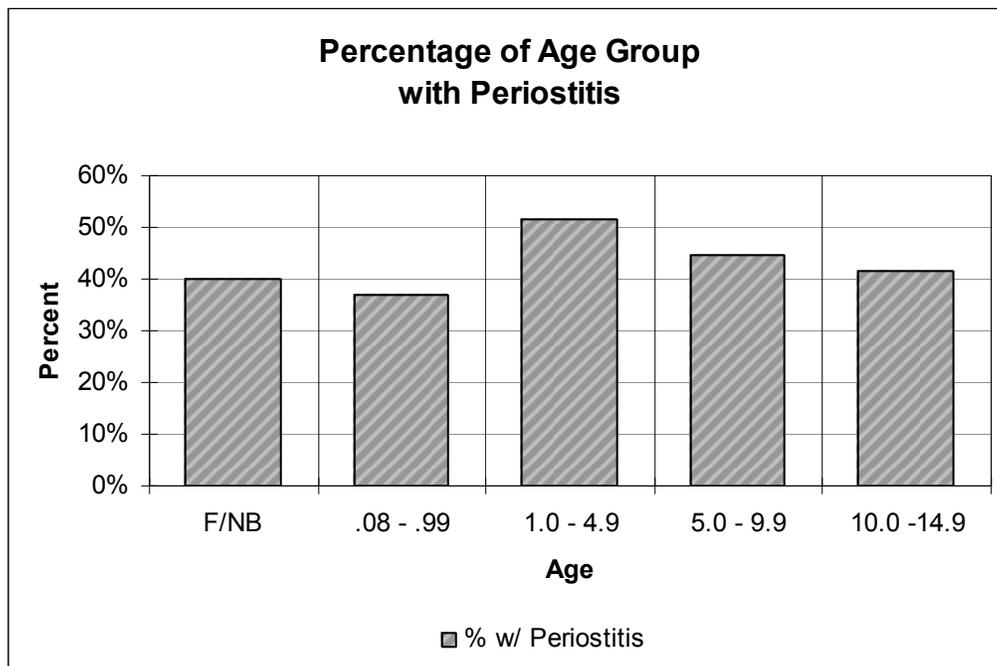


Figure 10.7: Percentage of Age Group with Periostitis

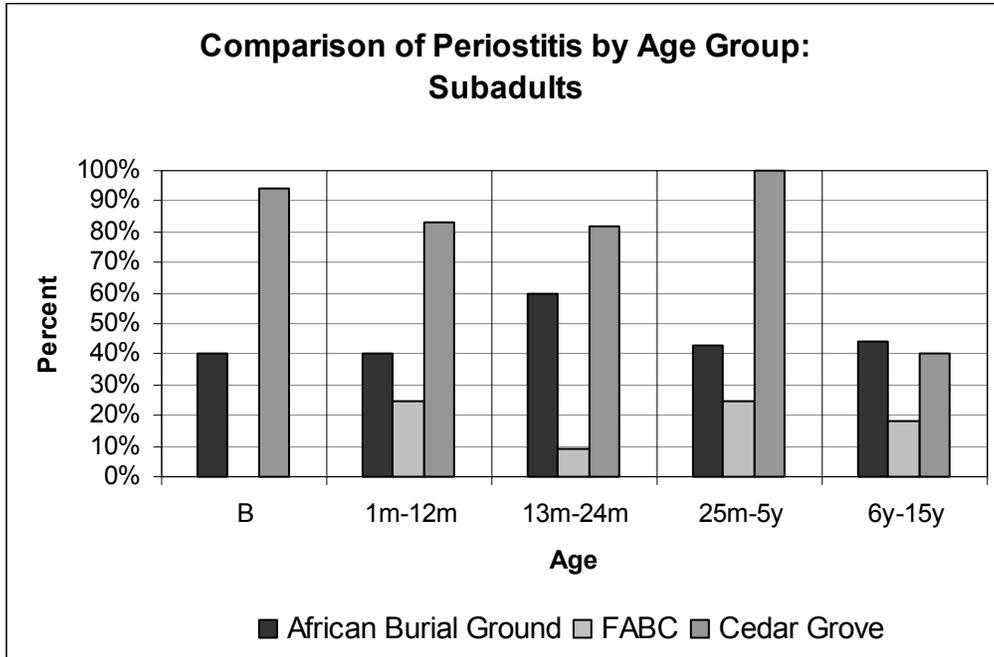


Figure 10.8: Comparison of Periostitis by Age Group: Subadults

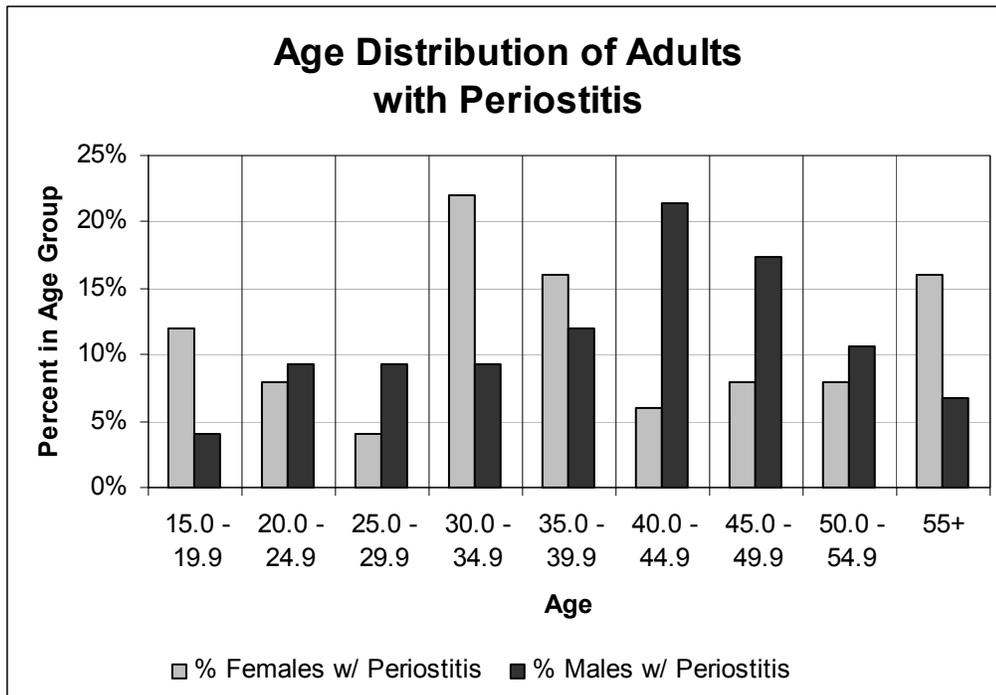


Figure 10.9: Age Distribution of Adults with Periostitis

changes slightly, with the ABG 6 to 15 year olds having a 4 percent higher rate (44.4 percent) of periostitis than individuals in the same age group from Cedar Grove (40 percent).

Males and females in the ABG sample present generalized infection patterning (Figure 10.9) that mirrors their sex-specific mortality profiles. The occurrence of periostitis is greater than 50 percent in most male and female age groups throughout the adult segment of the population (Figure 10.10). Interestingly, both males and females seem to exhibit a bi-modal distribution of affected individuals: males with peaks in 25.0 – 29.9 and 44.0 – 44.9 age groups, females with peaks in 20.0 – 24.9 and 35.0 – 39.9 age groups. Both males and females display another peak at 55+, though this would not be unexpected given that this age group represents the potential accumulation of a lifetime of skeletal indicators of generalized infection.

When comparing these adult proportions to those of FABC and Cedar Grove, it is observed that, like the subadult pattern, the New York adults exhibited frequencies of infectious disease indicators that are intermediate of these two examples (Figures 10.11 and 10.12). Once again the rates of periostitis among the adults at the ABG are higher than FABC, however, not as extreme as the rates found in Cedar Grove population for most age groups.⁸ Only in the female 30.0 – 39.9 age range did the rate of periostitis in the ABG (76.0 percent) exceed the extraordinary rates reported for Cedar Grove (55 percent).

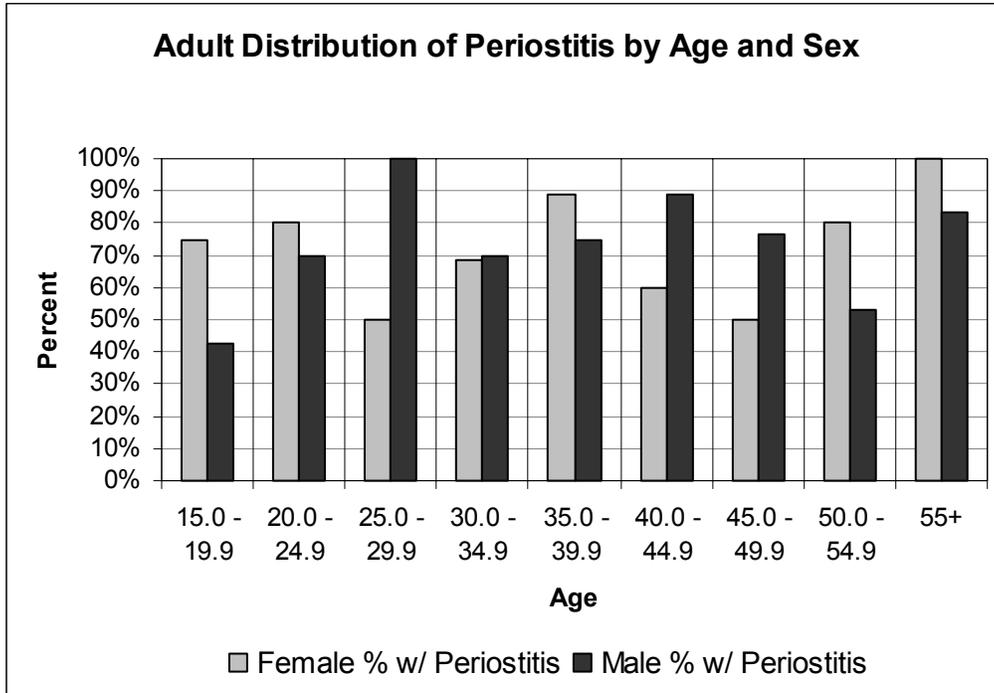


Figure 10.10: Adult Distribution of Periostitis by Age and Sex

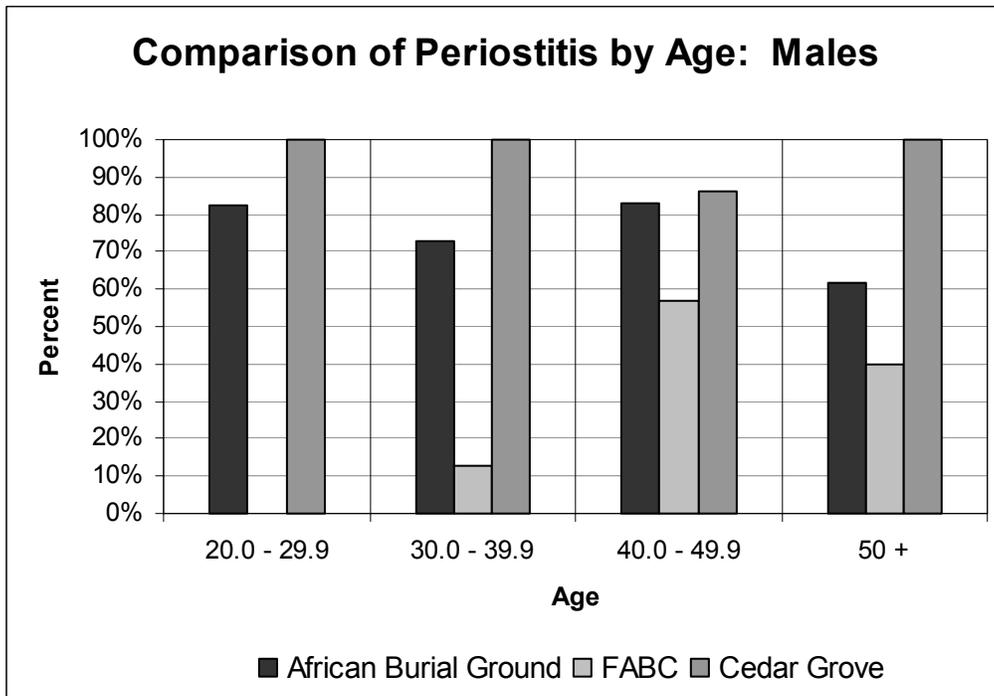


Figure 10.11: Comparison of Periostitis by Age: Males

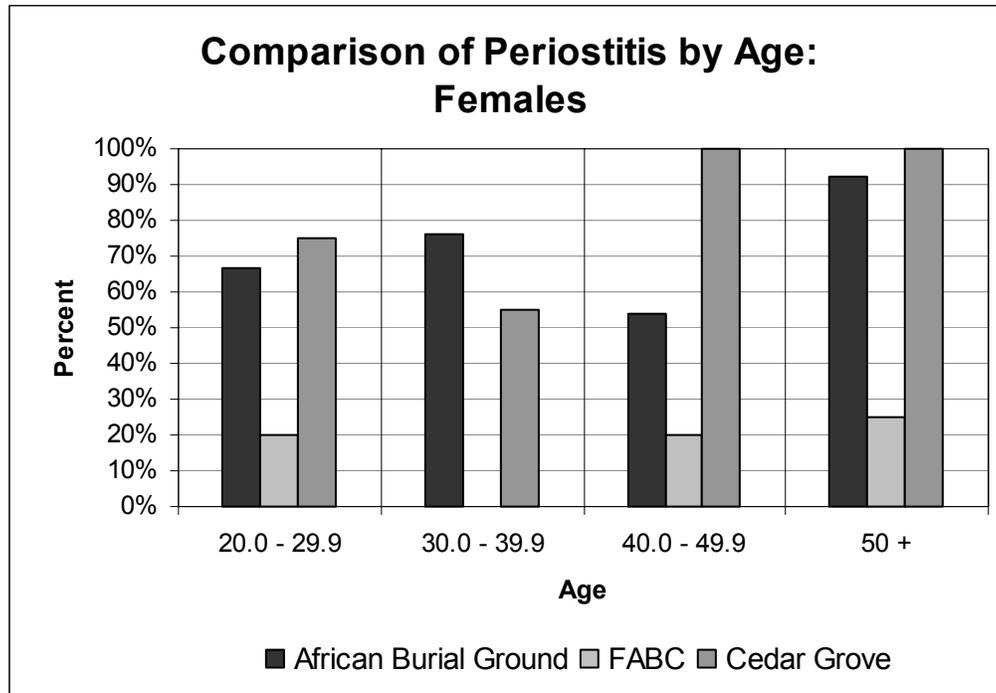


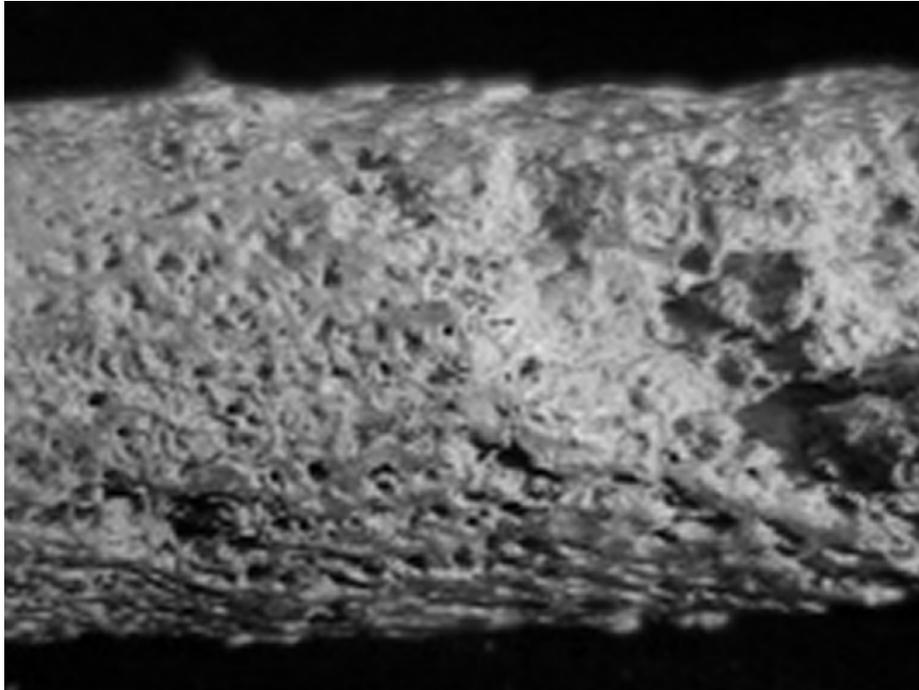
Figure 10.12: Comparison of Periostitis by Age: Females

Other infectious processes observed in the NYABG series include meningeal reactions. Meningeal reactions, as utilized in this study, refer to both hemorrhagic and inflammatory meningeal reactions (Schultz, 2003:93-94). We would like to underscore at this time no diagnoses of specific meningeal diseases have been made. The generalized diagnosis of meningeal reaction was made in seven individuals: 6 were subadults younger than 6 years old and one 25 - 35 year old female. The occipital most commonly affected, though lesions were also found on the parietals and the frontal.

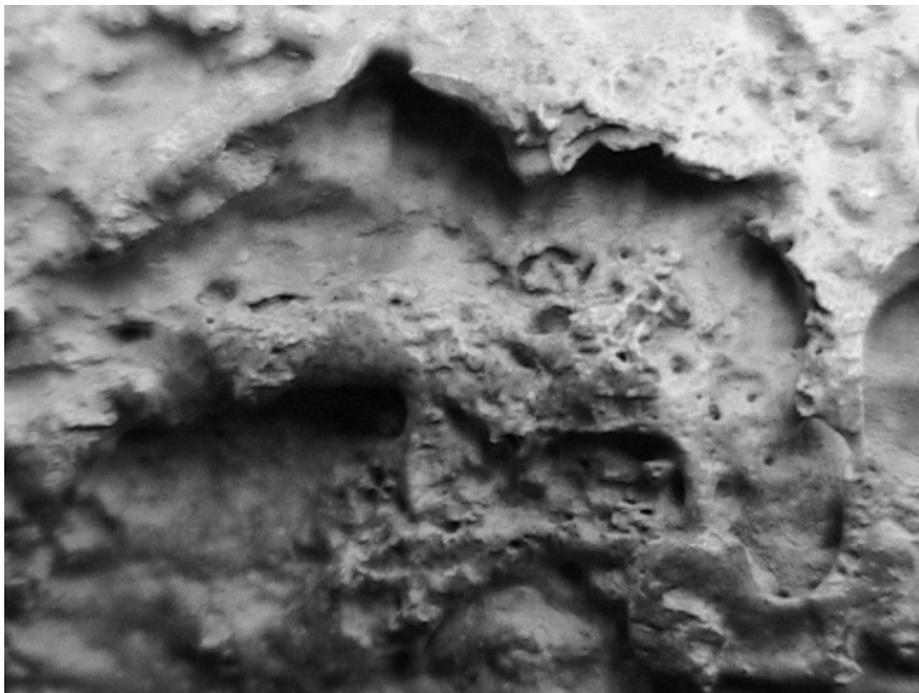
Osteomyelitis, abnormal bone formation possibly associated with bacterial infection, (Ortner 2003:181) was also observed within the NYABG series. This infectious process was identified in five adults: two females (17 - 21 and 50 – 70 years old), two males (40 - 50 and 50 – 60 years old), and one individual of indeterminate sex and age. At least two elements were affected in all five individuals; however, no clear

patterning of lesion locations suggestive of a specific pathogen was evident in these individuals. The most severe case was found in Burial 32, a male 50 – 60 years old, who displayed systemic osteomyelitis (Figures 10.13 and 10.14).

A third example of specific infection is a constellation of pathologies that may reflect treponemal infection (Figure 10.15), including “saber shin,” a feature associated with congenital syphilis and bejel (Ortner and Putschar 1981:210; Ortner 2003:278,294; Steinbock 1976:102) or “boomerang leg” yaws (Ortner and Putschar 1981:180; Ortner 2003:275; Steinbock 1976:145).⁹ We observed no obvious evidence of “stellate scars” (“caries sicca”), frequently associated with the gummatous cranial lesions of venereal syphilis (Steinbock 1976:129) or yaws (Ortner 2003:276) in the NYABG sample. In total, eleven individuals (4 percent of those with observable tibiae) presented evidence of saber shin (Table 10.6). All but one of these were adult males; eight between the ages of 30.0 and 54.9 and two of unknown adult age. The remaining individual was a skeleton of unknown sex and undeterminable age.



**Figure 10.13: Osteomyelitis in the right anterior distal femur
(Burial 32, 50-60 year old male)**



**Figure 10.14: Osteomyelitis in the right anterior distal femur, magnified
(Burial 32, 50-60 year old male)**



Figure 10.15: Left femoral midshaft of Burial 101 (26-35 year old male, top) showing ‘saber shin’ bowing in comparison to a healthy femur from the Cobb collection (CC2, bottom)

Table 10.6: Occurrence of Treponemal Infection Indicators

	n [†]	Saber Shin		Suite of Tibial Pathologies		Total	
		n [‡]	%	n [*]	%	n ^{**}	%
Adult	181	10	5.5	28	15.5	38	21.0
Female	69	0	0.0	7	10.1	7	10.1
Male	89	10	11.2	18	20.2	28	31.5
Total Series	249	11	4.4	29	11.6	40	16.1

† “n” equals the number of individuals with observable tibiae

‡ “n” equals the number of individuals diagnosed with saber shin

* “n” equals the number of individuals exhibiting a suite of tibial pathologies indicative of treponemal infection

** “n” equals the total number of individuals observed with these pathologies

From this baseline information, a database script was created to search for additional individuals that were not initially diagnosed with “saber shin” explicitly but whose skeletal changes were consistent with this diagnosis. The suite of descriptors we sought included: periostitis, anterior bowing, medial/lateral flattening (platycnemia), and/or fusiform expansion of the diaphysis/anterior crest. This combination of indicators (with the possible exception of the fusiform diaphysis) is definitive of “saber shin” and may be taken as an exhaustive sample of possible cases. This search yielded an additional 29 individuals that could possibly have treponemal infection, increasing the total to 40 or 16.1 percent of individuals with assessable tibiae. None of these individuals appears to be under the age of 15; however, two are of unknown sex and undeterminable age. This would correspond to 21.0 percent of the being affected. This number includes 7 females (10.1 percent) and 28 males (31.5 percent). Statistical testing found this difference to be significant ($\chi^2 = 10.241$, $p = .001$). The age profile for these individuals exhibits the highest frequencies of those affected between 30.0 and 54.9 years (males), and 30.0 – 34.9 years (females) (Table 10.7). These frequencies mirror the mortality curve of the population and may reflect age-specific risk.

These 40 individuals were then assessed for the presence of lytic and blastic lesions to evaluate lesion patterning and to assist in differential diagnosis between various treponemal infections. The tibiae were by far the most commonly affected element, followed by the femora and fibulae, sequentially. Overall, in most individuals ($n = 30$, or 75.0 percent) the lesions appeared healed, one person (2.5 percent) exhibited only active infection, and 9 individuals (22.5 percent) had a combination of active and healed lesions. Possible evidence of involvement in the facial area, which may be expressed in yaws,

venereal syphilis or congenital syphilis (Ortner 2003:277, 283, 293), was detected in seven individuals (17.5 percent). However, as noted previously, no stellate scars were detected on their cranial vaults.

Table 10.7: Demographic Profile of Occurrence of Treponemal Infection Indicators

	Male	Female	Unknown	Total
15.0 - 19.9	1	1	1	3
20.0 – 24.9	1	0	0	1
25.0 – 29.9	1	0	0	1
30.0 – 34.9	4	4	0	8
35.0 – 39.9	3	0	0	3
40.0 – 44.9	3	1	0	4
44.0 – 49.9	5	0	1	6
50.0 – 54.9	4	0	0	4
55 +	1	1	0	2
“Adult”	5	0	1	6
Total Series	28	7	3	38

While the identification of specific treponemal diseases cannot be made with any certainty, some inferences can be made, based on 1) the region where these individuals were living both prior to and during their enslavement in New York, 2) lesion patterning, and 3) historic documents. The location of New York, as well as the African locations from which these people originated, seems to effectively rule out the presence of endemic syphilis (bejel) and pinta. Endemic syphilis, while found in Africa, is typically located in arid climates in the Old World (Ortner and Putschar 1981:180; Steinbock 1976:138).

Pinta, which only impacts the skin of the affected individual, is found in tropical areas of the New World (Ortner and Putschar 1981:180; Steinbock 1976:91). This would limit possible sources of treponemal infection to yaws, venereal syphilis, and congenital syphilis.¹⁰

The apparent absence of stellate scars, often associated with venereal syphilis, would seem to argue against the presence of this form of treponemal infection (Ortner and Putschar 1981:188-190; Steinbock 1976:129). This paucity of classic evidence of venereal syphilis is especially telling, given the large size of the observable sample. One individual, Burial 230 (55 - 65 year old female), exhibited a cranial lesion similar to a stellate scar; however, the lesion lacked some of the diagnostic characteristics of such lesions (Figure 10.16). Another individual, Burial 418 (30 - 55 year old male), exhibited lytic lesions that could be interpreted as cloacae associated with venereal syphilis (Figure 10.17). Furthermore, while most if not all individuals discussed here are of sexually mature age, the presence of the saber shin anomaly would seem to suggest involvement during their earlier growth and development.

Thus, the occurrence of the saber shin anomaly would suggest either congenital syphilis or yaws (Ortner and Putschar 1981:180,210; Ortner 2003:275,294; Steinbock 1976:102,145). Furthermore, if congenital syphilis and yaws are considered the primary possibilities, it can be argued that onset occurred prior to arrival in New York. The historic documentation for this period suggests that venereal syphilis was rare in the regions of Africa where persons were being enslaved for transportation to the Americas (History Component Report, Chapter 10). This reality, in conjunction with the fact that most women were brought directly from Africa to New York, may reduce the frequency

of venereal syphilis in this segment of the population. The high proportion of females to males in New York, a marked contrast to the Caribbean, would also reduce the accelerated contagion found in the Caribbean where a small proportion of females, often sexually exploited by slave holders while sexually active with African men, could rapidly spread venereal disease to African compatriots (see Chapter 7 for discussion of sex ratios). However, New York males were often being brought from the Caribbean where venereal syphilis was known to have spread to substantial numbers of enslaved Africans.

These two trends together may help explain the disparity of treponemal infection that is seen in the sex distribution in the population of the ABG. If the dearth of lesions indicative of sexually acquired syphilis suggests a limited number of individuals in the population with this disease, then infection by congenital syphilis (from mothers at or before birth) may be coming from an affected external population. Fundamentally, congenital syphilis in a community requires venereal transmission of the disease in the community where its members were born in order for it to persist. This possibility would point mainly toward adults who were born in the Caribbean. Furthermore, if there was substantial venereal syphilis in colonial New York, the rates of the congenital disease among African adults would have been much attenuated by the very high mortality of infants that constituted a barrier to the proliferation of congenital disease.



Figure 10.16: The cranial lesion (arrow) in the left parietal of a 55-65 year old female (Burial 230) is more similar to stellate scars than any other lesion observed in the African Burial Ground population, yet it lacks the billowing of its margins and other typical characteristics of such scars (Most probably a depression fracture).

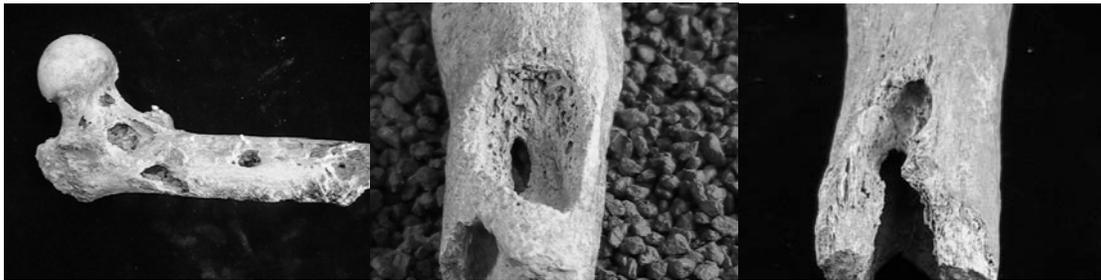


Figure 10.17: Cobb Collection (CC101) Left femur showing cloaca in a person who died while diagnosed with syphilis in 1937 (left). An adult male 30-55 years of age in the African Burial Ground population (Burial 418) was found to have similar resorptive lesions in the right posterior proximal ulna (center) and left posterior proximal femur (right). Such diagnostic evidence of syphilis was otherwise not observed among the skeletal remains of New York Africans.

On the other hand, this pattern of treponemal indicators may also point directly to yaws among African-born individuals. Yet, the temperate climatic zone of New York would not have been conducive to the transmission of this tropical disease. The fact that captives are being imported continuously, coupled with mortality and low fertility (see Chapter 14), supports the inference that high levels of yaws could have been sustained in New York.

Most of these infections may well be yaws. The presence of yaws in North America is noted in historic documentations (History Component Report, Chapter 10). Yaws was also the focus of a court case in New York in which an enslaved African was found to have the disease after her purchase (History Component Report, Chapter 10). Still, if the presence of yaws was used as a reason against purchase, then it is conceivable that this undesirable condition could lead to a slave owner avoiding afflicted individuals, thus possibly creating a reduction in the rates of disease in the population.

Whatever the nature of treponemal disease in the ABG, it is clear that the associated infection rates are neither as severe nor pervasive as those found in the Waterloo Plantation sample from Suriname (Khudabux 1991), where 56 percent were diagnosed as having treponemal infection, specifically venereal and congenital syphilis. This rate is much higher than the possible 16.1 percent found overall in the ABG sample, or the 21.0 percent observed in the adults. The vastly different sample sizes, 25 individuals at Waterloo Plantation versus the 249 individuals with observable tibiae discussed here, may influence the overall prevalence of infected persons. However, it

must be noted that three individuals in the smaller Waterloo Plantation exhibited diagnostic stellate scars on the crania while the NYABG, a much larger series, had no definitive evidence of these lesions.¹¹

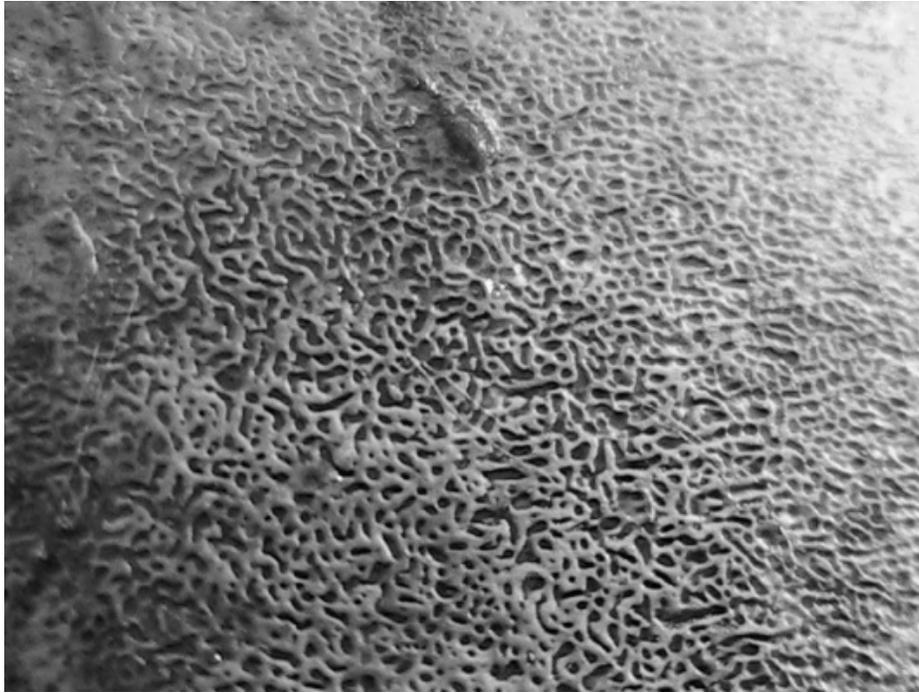
Nutritional Inadequacy

The presence of porotic hyperostosis and diploic thickening were commonly found in the individuals of the NYABG. The *Standards* operationally defines porotic hyperostosis as cranial pitting; however, evidence of thickened diploe was also included in this study as an important characteristic of porotic hyperostosis. While often associated with anemia, particularly with iron deficiency anemia, current practice cautions against a direct correlation between anemia and porotic hyperostosis (Ortner 2003:55). Other disease processes that are implicated as possible causes of porotic hyperostosis include the nutritional disorders of scurvy and rickets, and infection (Ortner 2003:56, 383-418). At this time, radiographic data has not been investigated for the purpose of differential diagnosis. Furthermore, cranial cross sectional data, while potentially informative in this regard, was not collected at the NYABG.

An association of porotic hyperostosis observed in the ABG sample with metabolic dysfunction due to inadequate nutrition (e.g. iron deficiency anemia, rickets, and scurvy) is not unexpected, given the stresses associated with enslavement. Genetic anemia, while potentially present, should be limited in expression. The high rate of mortality associated with sickle cell anemia, particularly prior to modern medical intervention, would preclude an individual's representation in this population past adolescence. Also the low prevalence, 2-3 percent, of sickle cell anemia in Afro-

Caribbean and West African populations (Serjeant 1981) would suggest a similar low incidence in the NYABG. Infection as a possible source of porotic hyperostosis serves as the most likely confounding factor. Future study, incorporating radiographic data will aid in the differential diagnosis of cases of porotic hyperostosis. For the purposes of this study, porotic hyperostosis is used as a general indicator of nutritional inadequacy.

The occurrence of nutritional inadequacy, as represented by porotic hyperostosis observed in crania, is presented in Figures 10.18, 10.19, and 10.20 and Tables 10.8 and 10.9. Almost half, 130 (47.3 percent), of the observable crania exhibited at least one occurrence of porotic hyperostosis. Adults (93, or 50.5 percent) had a higher, though not statistically significant, incidence of this pathology than the subadults (35, or 39.8 percent). Adult males displayed a higher proportional rate of porotic hyperostosis (55, or 57.9 percent) than females (32, or 43.8 percent), though this was also not statistically significant.



**Figure 10.18: Porotic hyperostosis in right posterior parietal
(Burial 138, 3-5 years old)**

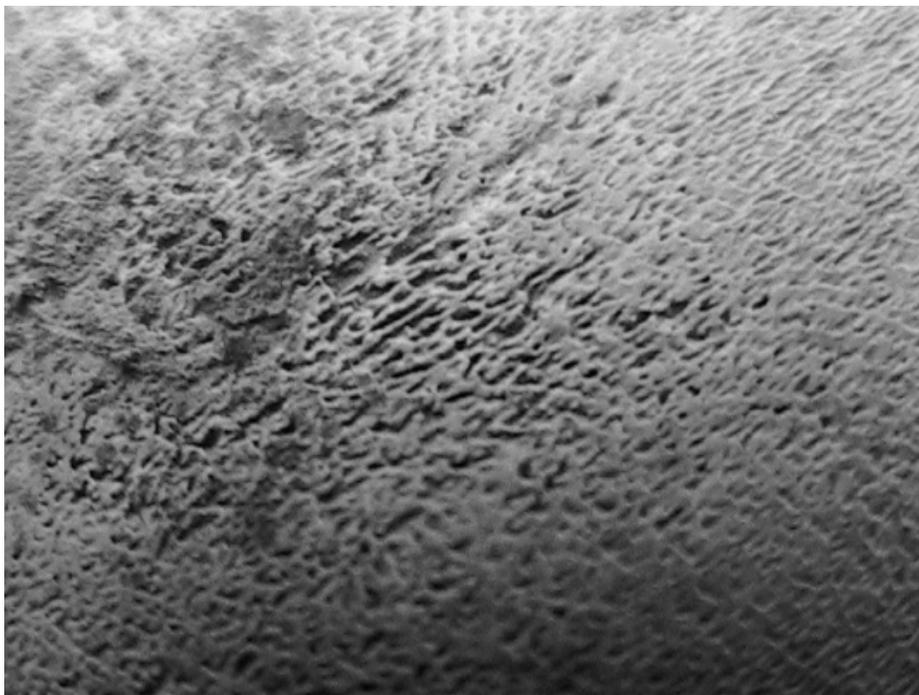


Figure 10.19: Porotic hyperostosis (Burial 64, 4.5-10.5 months old)



Figure 10.20: Thickened diploe of occipital adjacent to lambda, compared with a normal specimen at the same location (Burial 151, 35-45 year old male)

Table 10.8: Porotic Hyperostosis: All Cranial Locations

	N [†]	Total %	Active % [‡]	Healed % [‡]	Both % [‡]
Subadult	88	39.8	16.7	83.3	0.0
Adult	184	50.5	1.5	89.4	9.1
Female	73	43.8	0.0	94.7	5.3
Male	95	57.9	2.3	86.4	11.4
Total	275	47.3	4.8	88.1	7.1

[†] “n” equals number of individuals with observable cranial elements.

[‡] Status values represent the percentage of those in each group with evidence of porotic hyperostosis; cases of thickened diploe have been removed.

Table 10.9: Porotic Hyperostosis Statistical Testing: Intra-Population

	Porotic Hyperostosis Presence/Absence		Status of Lesions	
	χ^2	p	χ^2	p
Subadult/Adult	2.772	.096	.086 [†]	.769
Male/Female	3.268	.071	.285 [†]	.593

[†] Conditions for 2X3 contingency table not met, χ^2 reflects the collapsing of “Active” and “Both” categories. Yeats Correction for Continuity utilized due to small “expected” cell values.

Healed lesions were observed in 74 (88.1 percent) individuals with porotic hyperostosis. Adults (59, or 89.4 percent) were marginally more likely than subadults (15, or 83.3 percent) to have only healed lesions, while subadults had a higher number of individual with only active lesions (3, or 16.7 percent) than adults (1, or 1.5 percent). However, the difference in status between subadults and adults was not statistically significant. Though also not statistically significant, adult males exhibited a higher proportion of individuals with both active and healed lesions (5, or 11.4 percent), and included the only adult instance of solely active porotic hyperostosis. Females, correspondingly, had a higher incidence of individuals with only healed porotic hyperostosis (18, or 94.7 percent).

As illustrated in Figures 10.21 and 10.22; Tables 10.10 and 10.11, rates were generally lower for the presence of porotic hyperostosis in the orbits than the rest of the cranium: an overall rate of 23.7 percent (54 individuals) for assessed orbits. Subadults (18, or 28.6 percent) had a higher rate of involvement in the orbits than the adults (36, 22.0 percent), contrary to what was observed for grouped cranial locations. However, it was found that this difference was not statistically significant. The pattern encountered

with status of lesions of cribra orbitalia is similar to that found in with porotic hyperostosis. Interestingly, all individuals that exhibited solely active porotic hyperostosis were found to have the location of the lesion in the orbits (one adult male, three subadults).

When compared with FABC (Rankin-Hill 1997), Cedar Grove (Rose and Waterford 1985), and 38CH778 (Rathbun 1987), the ABG sample (47.3 percent) has a higher overall rate of porotic hyperostosis (Figure 10.23, Table 10.12). Interestingly, the ABG sample rates of porotic hyperostosis are very similar to Cedar Grove among the subadults, however more similar to FABC in adults. Focusing solely on pathology encountered in the orbits (Figure 10.24, Table 10.13), the ABG shows a similar population incidence as that found at Cedar Grove though less than that observed at

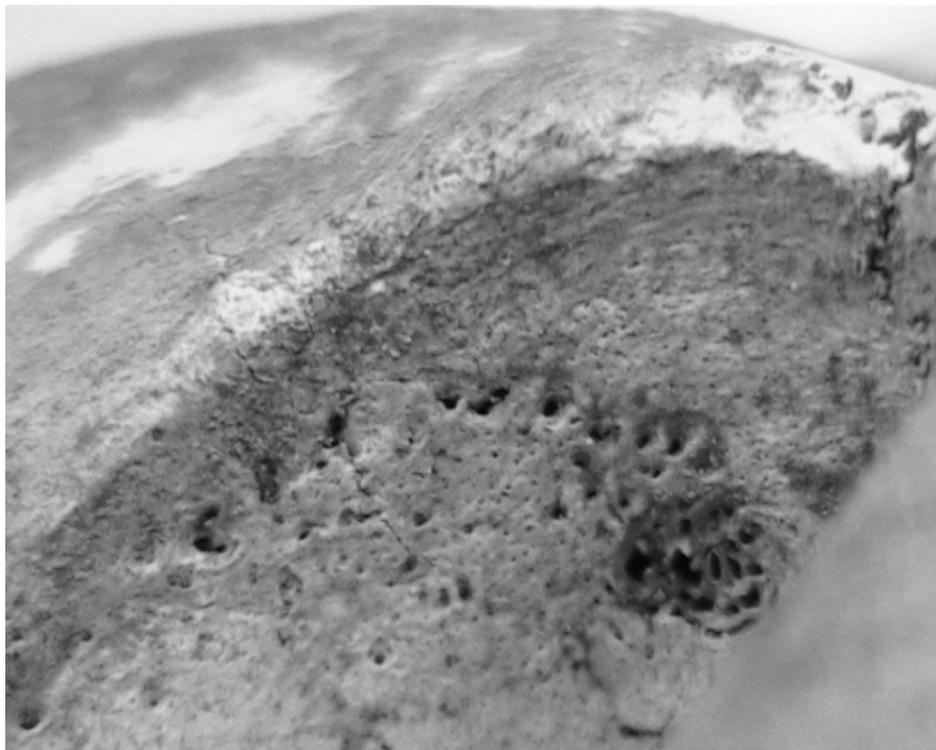


Figure 10.21: Cribra orbitalia of the left eye orbit (Burial 6, 25-30 year old male)



Figure 10.22: Cribra orbitalia of the right orbit (Burial 39, 5-7 years old)

Table 10.10: Porotic Hyperostosis: Cribra Orbitalia

	n[†]	Total %	Active %[‡]	Healed %[‡]	Both %[‡]
Subadult	63	28.6	21.4	78.6	0.0
Adult	164	22.0	2.9	91.4	5.7
Female	66	18.2	0.0	91.7	8.3
Male	86	26.7	4.5	90.9	4.5
Total	228	23.7	8.2	87.8	4.1

[†] “n” equals the number of individuals with observable eye orbits

[‡] Status values represent the percentage of those in each group with evidence of cribra orbitalia; cases of thickened diploe have been removed.

Table 10.11: Cribra Orbitalia Statistical Testing: Intra-Population

	Porotic Hyperostosis Presence/Absence		Status of Lesions	
	χ^2	p	χ^2	p
Subadult/Adult	1.100	.294	.575 ^{†‡}	.448
Male/Female	1.545	.214		.432 ^{†*}

[†] Conditions for 2X3 contingency table not met, χ^2 reflects the collapsing of “Active” and “Both” categories.

[‡] Yeates Correction for Continuity utilized due to small “expected” cell values.

* Fishers Exact Test.

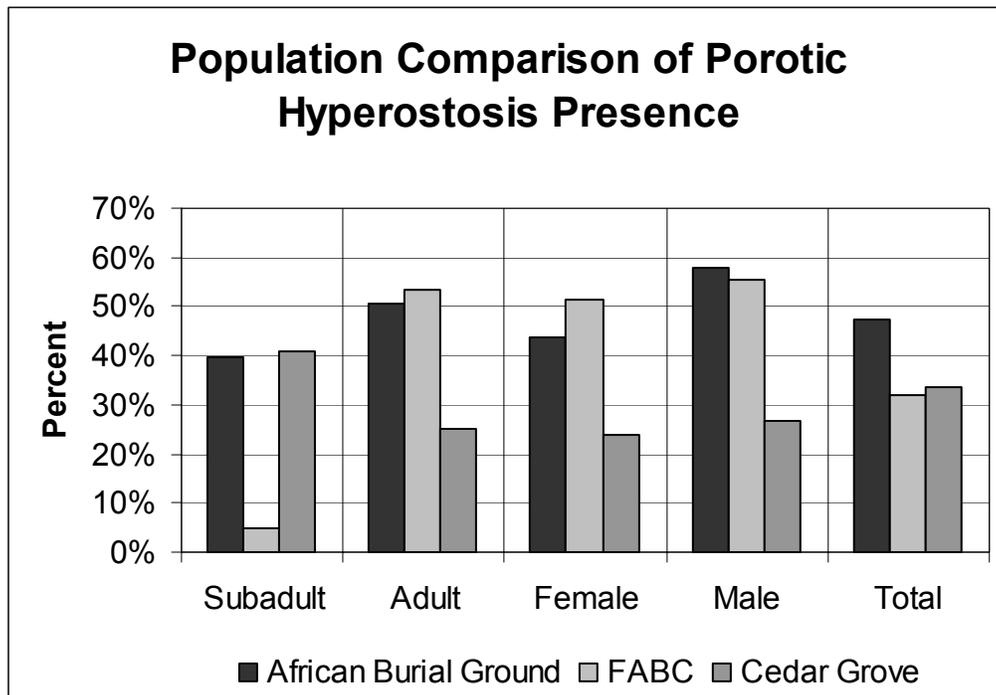


Figure 10.23: Population Comparison of Porotic Hyperostosis Presence

Table 10.12: Porotic Hyperostosis Statistical Testing: Inter-Population

	All Populations		African Burial Ground/FABC		African Burial Ground/Cedar Grove	
	x ²	p	x ²	p	x ²	P
Subadult	24.689	<.001	22.605	<.001	.016	.900
Adult	8.957	.011	.166	.6384	7.900	.005
Female	4.270	.118	.567	.452	1.965 [†]	.161
Male	5.128	.077	.058	.809	3.902 [†]	.048
Total	10.890	.004	8.828	.003	4.594	.032

[†] Yeats Correction for Continuity utilized due to small “expected” cell values.

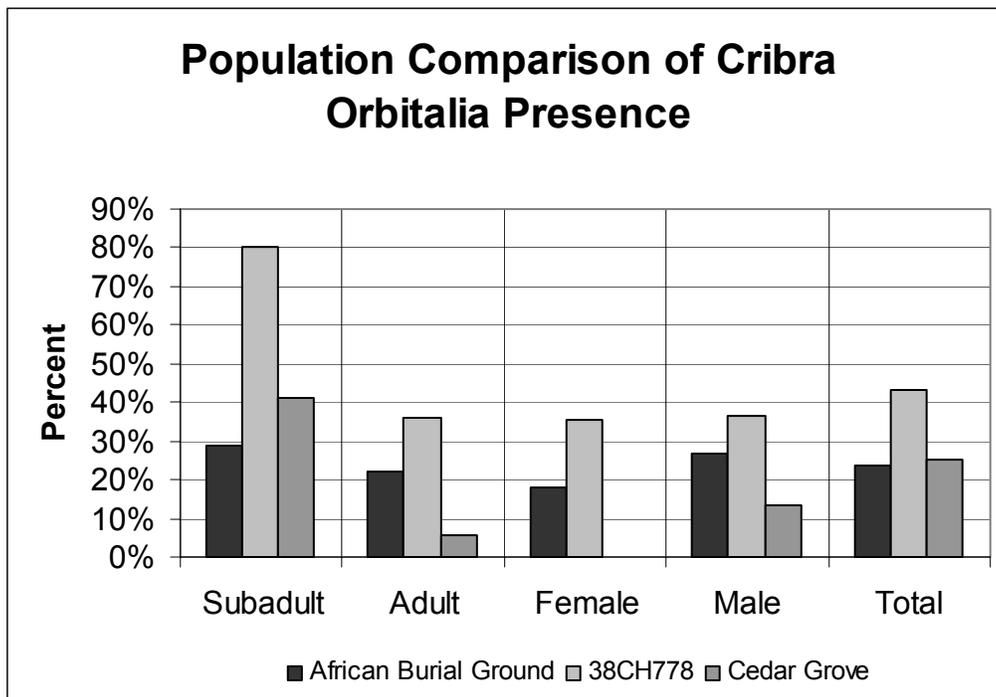


Figure 10.24: Population Comparison of Cribra Orbitalia Presence

Table 10.13: Cribra Orbitalia Statistical Testing: Inter-Population

	All Populations		African Burial Ground/Cedar Grove		African Burial Ground/38CH778	
	x ²	p	x ²	P	x ²	p
Subadult	‡	‡	1.766	.184	3.495 [†]	.062
Adult	8.688	.013	4.146 [†]	.042	1.649 [†]	.199
Female	7.902	.019	3.032 [†]	.082	1.203 [†]	.273
Male	1.894	.388	.618 [†]	.432	.098 [†]	.754
Total	5.385	.068	.056	.813	4.351 [†]	.037

[†] Yeats Correction for Continuity utilized due to small “expected” cell values.

[‡] Conditions not met for 2X3 contingency table.

38CH778. The 38CH778 population displays higher cribra orbitalia rates in all categories however, only the total population comparison is statistically significant. The similarity between the ABG and Cedar Grove diminishes when the samples are partitioned by age: higher comparative rates found among subadults at Cedar Grove, conversely higher rates in adults at the ABG (the latter is statistically significant).¹²

Porotic hyperostosis (all locations) in subadults is found most frequently in the 1.0 – 4.9 and 5.0 – 9.9 age groups (Figure 10.25). This pattern is also apparent when considering the prevalence of the disorder within age grades (Figure 10.26). The disproportionately lower rates in the first year seem to suggest, similar to the periostitis rates, that the individuals in the older age grades may have survived earlier insults and that the younger individuals are dying prior to skeletal involvement of the pathology. Interestingly, all subadult cases of active porotic hyperostosis (cribra orbitalia,) occurred in the first year. Older subadult age groups displayed only healed lesions.

When the subadult distribution of porotic hyperostosis is compared with other populations, rates observed in the ABG samples are consistently higher than those from

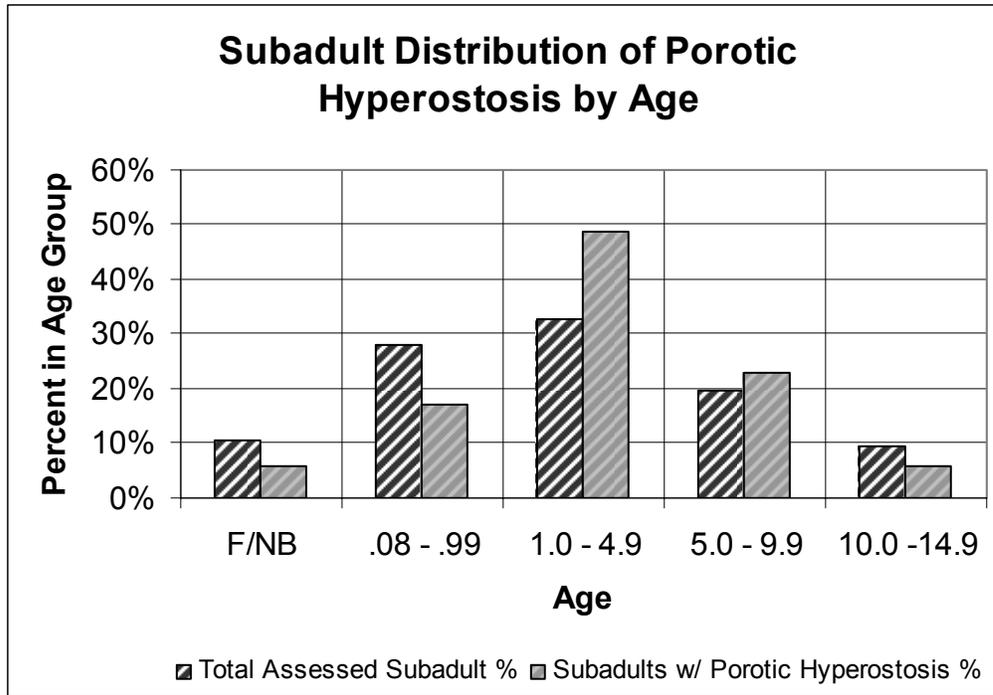


Figure 10.25: Subadult Distribution of Porotic Hyperostosis by Age

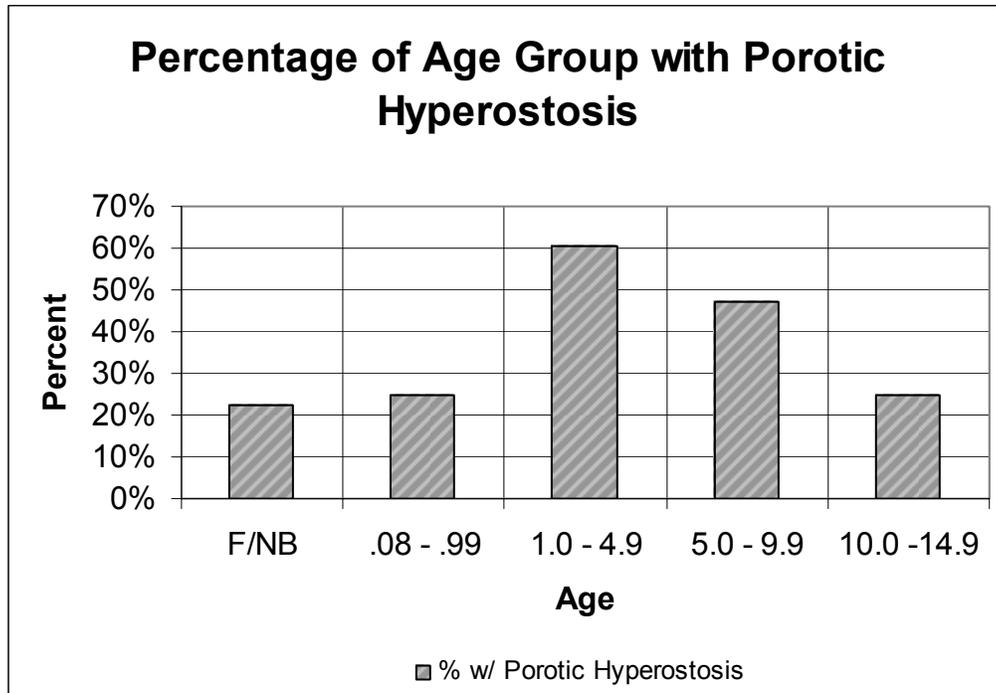


Figure 10.26: Percentage of Age Group with Porotic Hyperostosis

FABC (Figure 10.27). Rates of porotic hyperostosis are lower in the first two years at the NYABG than those found at Cedar Grove. However, the ABG subadults do display a higher rate than Cedar Grove subadults in the 6 – 15 year range. The apparent disparity seen in the 25 months – 5 year age range may be attributable to the sample size in the FABC and Cedar Grove populations.

Among adults, porotic hyperostosis is higher overall, except in the 20.0 – 24.9 and 50.0 – 54.9 year age groups (Figure 10.28). Disparities between males and females are not as great in the younger adult age groups, from 15.0 to 29.9 years. Both male and females experience peaks in porotic hyperostosis frequencies in the 25.0 – 29.9 and 35.0 – 39.9 year age groups. In comparisons with other populations, no clear pattern emerges (Figures 10.29 and 10.30). Female rates for porotic hyperostosis in the ABG are higher in all adult age categories except in the fifth decade where both FABC and Cedar Grove

have higher rates. Male rates of porotic hyperostosis at the ABG are more consistent throughout the adult age ranges than those found in the Cedar Grove and FABC populations, though this difference is possibly a factor of sample sizes within these age groups in the latter two populations.

Another possible example of metabolic disruption due to nutritional inadequacy is long bone bowing. Medial/lateral bowing of the lower limb was observed in a number of individuals, possibly indicative of metabolic disruption due to vitamin-D deficiency (rickets) (Table 10.14 and 10.15). Only individuals who expressed bowing bilaterally were included in this analysis thus limiting the confounding effect of post-mortem distortion. Approximately 11.9 percent of individuals with observable lower limb bones exhibited medial/lateral bowing. Adults (14.4 percent) had a higher rate than subadults (6.5 percent), though this difference was not statistically significant.

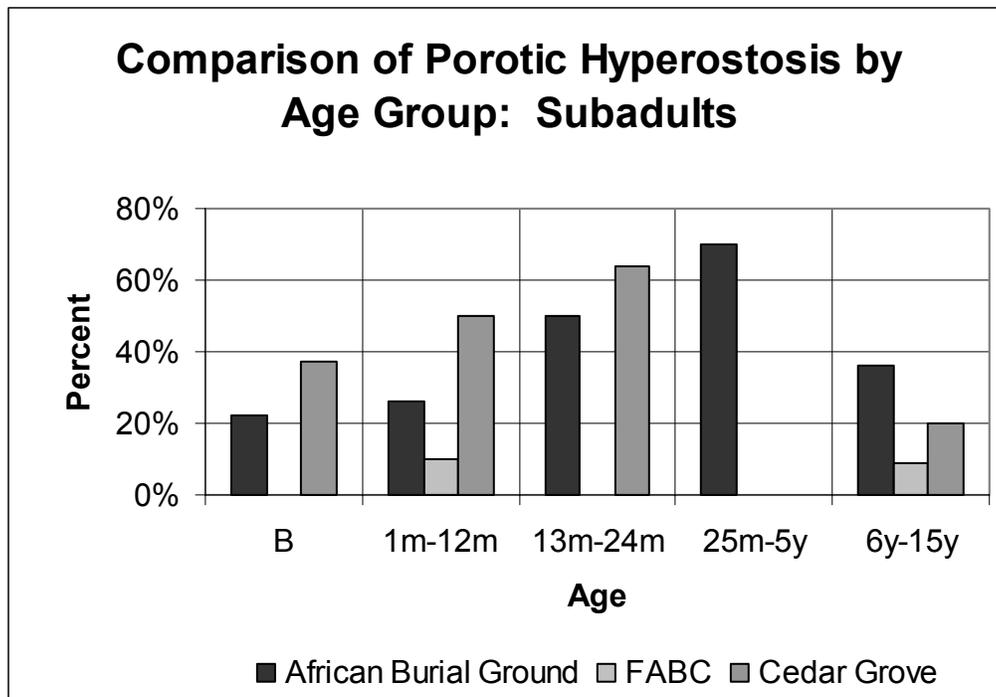


Figure 10.27: Comparison of Porotic Hyperostosis by Age Group: Subadults

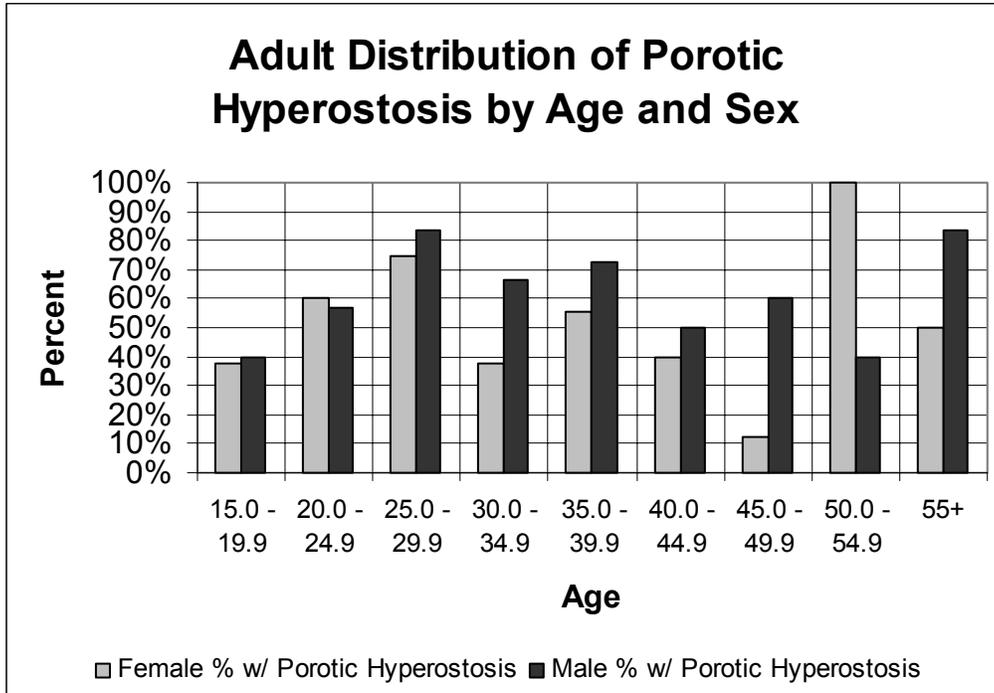


Figure 10.28 Adult Distribution of Porotic Hyperostosis by Age and Sex

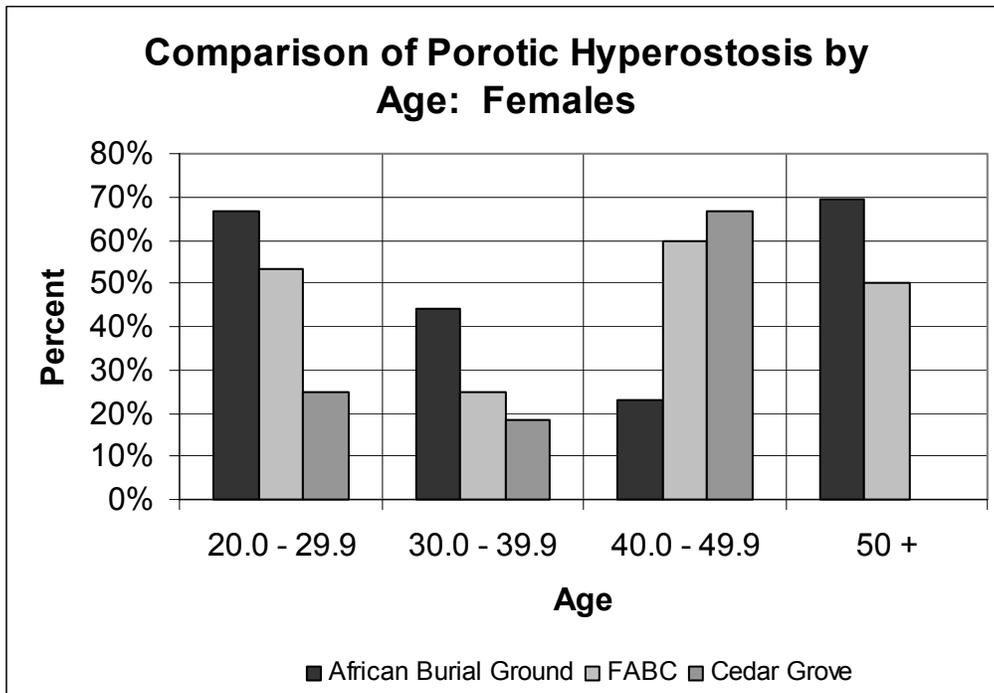


Figure 10.29: Comparison of Porotic Hyperostosis by Age: Females

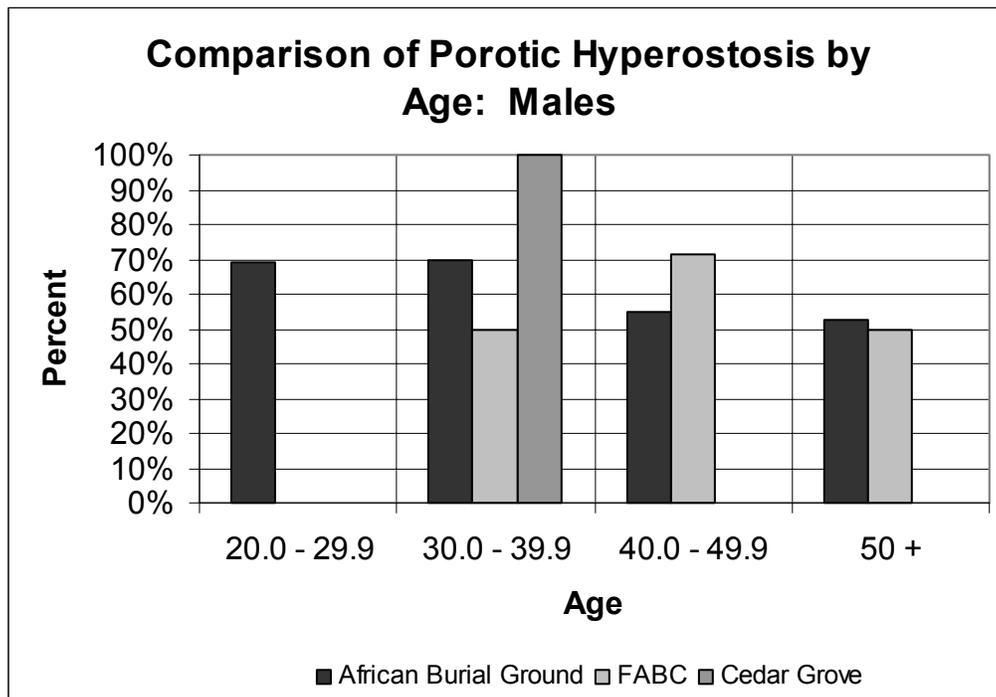


Figure 10.30: Comparison of Porotic Hyperostosis by Age: Males

Table 10.14: Medial/Lateral Bowing of the Lower Long Bones

	n [†]	Total N [‡]	Total %	Clearly Present n [*]	Clearly Present %
Subadult	77	5	6.5	2	2.6
Adult	202	29	14.4	5	2.5
Female	77	13	16.9	1	1.3
Male	102	15	14.7	4	3.9
Total	285	34	11.9	7	2.5

[†] “n” equals the number of individuals with observable long bones of the lower extremities

[‡] “n” equals the number of individuals with bilateral medial/lateral bowing of the elements.

^{*} “n” equals the number of individuals with “clearly present” bilateral medial/lateral bowing of the elements.

Table 10.15: Medial/Lateral Bowing Statistical Testing: Intra-Population

	Medial/Lateral Bowing Presence/Absence		Clearly Present	
	x²	p	x²	p
Subadult/Adult	2.528 [†]	.112	.137 [†]	.711
Male/Female	.158	.691	.356 [†]	.551

[†] Yeats Correction for Continuity utilized due to small “expected” cell values.

Among adults, females (16.9 percent) display a slightly higher frequency, though not statistically significant, of medial/lateral bowing than males (14.7 percent). When cases of medial/lateral bowing that were determined “clearly present” (as opposed to “barely discernable” or no severity determined) were considered, fairly consistent rates were observed throughout the sample. While not statistically significant, males (3.9 percent) did exhibit a higher rate than females (1.3 percent). In comparison with FABC, which contained only one diagnosed case of rickets, the data may suggest a higher potential rate of this disorder at the ABG. The rate of rickets in the ABG sample, on the other hand, was not as great as that found among the Catoctin Furnace sample of enslaved industry workers from Maryland, where 50 percent of females and 75 percent of males exhibited tibial bowing (Kelly and Angel 1987:206). While this disparity in rates may be in part due to differential scoring of tibial bowing, the greater prevalence at Catoctin Furnace seems to indicate that vitamin-D deficiency was more common in that sample than at the ABG.

The presence of scurvy (vitamin-C deficiency), another nutritional disorder that could potentially be present among the individuals of the ABG, was not investigated at this time. Research related to the skeletal expression of scurvy by Ortner et al. (1999)

and others will provide a useful framework for future investigation of this nutritional disorder in the ABG.

Interaction of Infectious Disease and Nutritional Inadequacy

The interaction of infectious disease and nutrition is of particular concern, especially in enslaved people such as, those interred at the ABG. Interestingly, historical research has found that the synergistic relationship between these two issues was also a concern in the past (History Component Report, Chapter). To investigate this synergism, frequencies of porotic hyperostosis and periostitis were considered together (Table 10.16 and 10.17). As can be seen in Table 10.16, over one third (34.2 percent) of the individuals from the ABG exhibited skeletal indicators of both porotic hyperostosis and periostitis.

Adults (40.8 percent) were almost twice as likely as subadults (20.5 percent) to have both pathologies. Of the adults, males (48.4 percent) had an 11 percent higher, though statistically not significant, proportion of individuals with periostitis and porotic hyperostosis than the females (37.0 percent). Upon examining the co-occurrence of individuals with porotic hyperostosis who also had periostitis, we found that almost three-quarters (72.3 percent) of those in the population with porotic hyperostosis also had infectious disease. Once again subadults (51.4 percent) exhibit lower rates than adults (80.6 percent); however, males and females have very similar incidences of periostitis among those with porotic hyperostosis.

Upon comparing rates of individuals that have both porotic hyperostosis and periostitis, we found that the ABG exhibits higher overall percentages than the values for

Cedar Grove (Rose and Santeford 1985) and FABC (Rankin-Hill 1997), though this difference is not statistically significant (Figure 10.31 and Table 10.18). Subadults at the ABG present-intermediate rates: is lower than Cedar Grove, yet higher than FABC. Among adults, the ABG exceeds the co-occurrence incidence of porotic hyperostosis and periostitis in both Cedar Grove and FABC. This pattern maintains when sex-specific

Table 10.16: Co-occurrence of Porotic Hyperostosis with Periostitis

	N [†]	Porotic Hyperostosis		Porotic Hyperostosis with Periostitis		
		n‡	%	N*	% of Group	% of PH
Subadult	88	35	39.8	18	20.5	51.4
Adult	184	93	50.4	75	40.8	80.6
Female	73	32	43.8	27	37.0	84.4
Male	95	55	57.9	46	48.4	83.6
Total Population	275	130	47.3	94	34.2	72.3

† “n” reflects the number of individuals with a pathologically assessed cranium, removing the potential of including individuals in the sample that could not be investigated for porotic hyperostosis

‡ “n” equals the number of individuals with observable porotic hyperostosis

* “n” equals the number of individuals with observable porotic hyperostosis that also have observable periostitis

Table 10.17: Co-occurrence of Porotic Hyperostosis with Periostitis Statistical Testing: Intra-Population

	Within Population Presence/Absence		Within Porotic Hyperostosis Presence/Absence	
	χ^2	P	χ^2	P
Subadult/Adult	10.909	.001	9.505 [†]	.002
Male/Female	2.197	.138	.045 [†]	.832

† Yate's Correction for Continuity utilized due to small “expected” cell values.

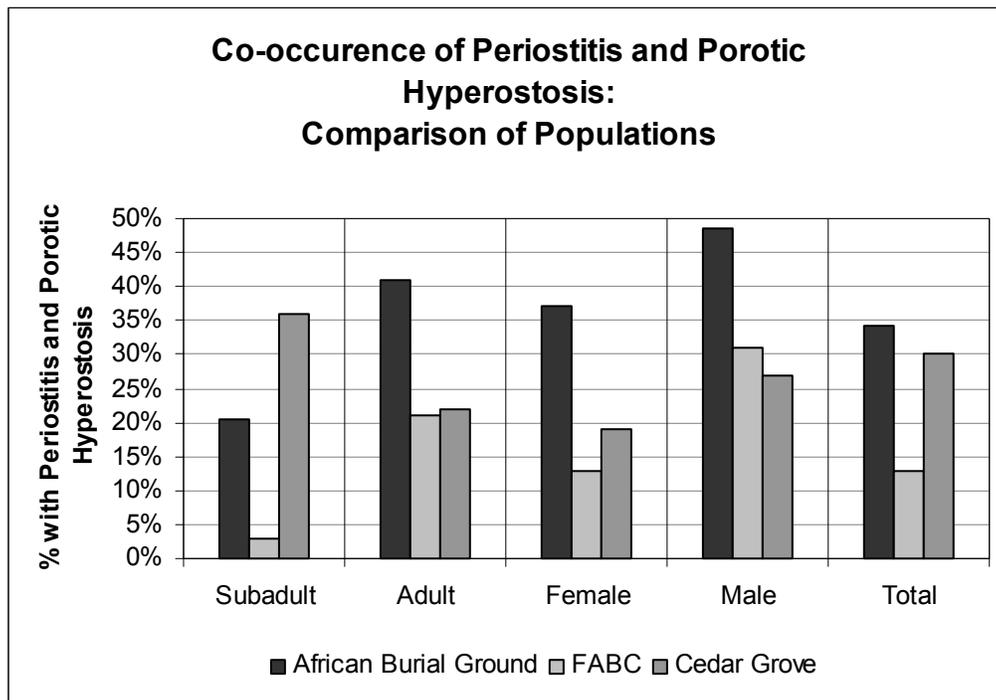


Figure 10.31: Co-occurrence of Periostitis and Porotic Hyperostosis: Comparison of Populations

Table 10.18: Co-occurrence of Porotic Hyperostosis with Periostitis Statistical Testing: Inter-Population

	All Populations		African Burial Ground/FABC		African Burial Ground/Cedar Grove	
	χ^2	p	χ^2	p	χ^2	p
Subadult	18.489	<.001	7.543 [†]	.006	3.882	.049
Adult	11.383	.003	8.824	.003	4.405	.036
Female	8.332	.012	7.274	.007	1.632 [†]	.201
Male	4.996	.082	3.390	.066	1.673 [†]	.196
Total	19.869	<.001	19.823	<.001	.488	.485

[†] Yeats Correction for Continuity utilized due to small “expected” cell values.

rates are considered, though the only statistical difference that exists in this case is between females in the NYABG and FABC populations.

These results suggest that while Cedar Grove may indeed have experienced higher overall frequencies of periostitis than that found at the ABG, the interactive patterning for porotic hyperostosis and periostitis is similar at population level. However, this interaction appears to have affected age groups differently, greater among adults in the ABG, and greater in subadults at Cedar Grove. The similarity in adult rates for porotic hyperostosis in the ABG and FABC populations is not replicated in the co-occurrence rates of porotic hyperostosis and infectious disease. This would suggest a greater interaction of the two disorders in the ABG sample. Further investigation of co-occurrence rates of porotic hyperostosis and periostitis among these populations should be a productive venue for future research.

Conclusion

This chapter has focused on the indicators of infectious disease and nutritional inadequacy in the enslaved African population of colonial New York City as represented in the ABG. The rates of generalized infectious processes observed in this investigation were high regardless of age or sex. Adult infectious disease was found to be more comparable to Southern plantation (Rathbun 1987) and post-reconstruction rates (Rose and Santeford 1985), when compared to the similar urban environment of free “people of colour” in early nineteenth century Philadelphia (Rankin-Hill 1997). Rates of porotic hyperostosis were less consistent: NYABG subadults were found to be closer to the post-reconstruction Cedar Grove subadults, while the adults are more similar to adults in

Philadelphia's First African Baptist Church. However, the rate of cribra orbitalia was not as extreme as that found in the nineteenth century 38CH778 Southern plantation population. The interplay of infection and porotic hyperostosis was evident in the high numbers of persons with indicators of both pathologies.

The presence of treponemal infection is well documented in this study. While diagnosis of a specific treponemal form was not possible, at least some individuals were apparently infected prior to their arrival and that venereal syphilis was not a common treponemal infection in the particular case of colonial New York. This is significant because of the high prevalence of venereal syphilis associated with European colonialism throughout the Americas. Thus the plausibility of higher rates of the tropical disease, yaws, and lower rates of venereal syphilis may substantiate other evidence of the continuous importation and high mortality of African captives in eighteenth-century New York. The duration of exposure to venereal syphilis among these individuals may not have been adequate for the manifestation and expression of severe symptoms. Groups coming here from a region of endemic yaws may have been provided vaccine-like immunity to other treponemal strains. Furthermore, the rates of infection were not nearly so high nor as severe as those of widespread infection of venereal syphilis found in Suriname (Khudabux 1991).

As discussed in Chapter 13, the only infectious disease whose rates were documented for New York Africans is smallpox, in connection with one of the several epidemics that ravaged New York, Boston, and Philadelphia in the eighteenth century. The 'vindicationist' work of Cobb (1981) has called attention to the Akan, West African use of smallpox inoculation and their introduction of this medical practice to the English

colonies, including nearby Boston. Smallpox infection may have contributed to the periostitis observed in skeletal remains, but specific skeletal indicators of this disease were not studied here. A slightly lower mortality for Africans than for Europeans was recorded for the epidemic. That result would seem counterintuitive, assuming that the enslaved population had lived under worse conditions for the spread of epidemic diseases than did free persons. Inoculation should be considered as a factor in the relationship between disease prevalence and death rates (see Chapter 13).

The information presented here suggests that infectious disease, in conjunction with inadequate nutrition, was another source of chronic stress for the enslaved population of the NYABG. ABG studies of disrupted growth and development and of early mortality are consistent with these findings.

Notes

¹ We refer to *observable* remains as the precise technical category of bones well enough preserved to give clear evidence of the presence or absence of pathology. Observable bones in the 52 individuals showed no pathology. Yet, these were skeletons with few observable bones, and many bones were in such poor conditions as to provide no information, possibly hiding additional pathologies. We treat them nonetheless as the sample of non-pathological or reasonably healthy persons.

² As entirely *unobservable* these individuals cannot be shown to be healthy or pathological and are removed from our statistical treatment altogether.

³ For purposes of this study, individuals whose sex determination was uncertain, i.e. identified as “possible male” or “possible female,” were included in the “male” and “female” categories. One individual, Burial 358, was identified as a female; however, an age was undetermined. This individual was included as an adult female for purposes of generating a population size, but was not included in any assessments of pathologies discussed in this chapter.

With respect to age, five-year demographic age groups (see Table 10.1) were utilized when discussing population prevalence of a particular anomaly. However, when sample sizes warranted, e.g., subadults, larger groupings were utilized. Different groupings were also utilized in inter-population comparisons due to inconsistent age grouping strategies. The only difficulty encountered was individuals with a composite age of 15. In this chapter, individuals with a composite age of 15 are included as adults, and as such are not included in the subadult comparisons. It was found that while this exclusion had an effect on the frequencies generated, it did not change overall conclusions made in this chapter.

⁴ Ortner notes that periostosis, rather periostitis, is the “more appropriate term” for such conditions; however, he continues to utilize the more common periostitis in his most recent volume due to less common usage of periostosis in the medical literature (Ortner 2003:51-2).

⁵ However, it could be argued that many cases of trauma related periostitis may be the result of secondary infection.

⁶ A “p” value of .05 was utilized in all statistical tests to determine significance.

⁷ While the attempt was made to ensure that similar skeletal lesions were being compared in all pathological conditions discussed in this chapter, possible inter-observer variation between populations in the identification of these conditions can not be completely discounted. The possible effect that this could have on the analyses discussed in this chapter are unknown at this time.

⁸ In the St. Peter's Cemetery population from New Orleans six adults were found to have post crania periostitis, generating a population prevalence of between 13.0 percent and 4.5 percent depending on the element considered (Owsley et al.1987). Unfortunately, the small sample size and mixed ethnic background of this population limits any comparative statements that could be made.

⁹ These two similar conditions, saber shin and boomerang leg, will be referred to singularly as saber shin for the remainder of the chapter.

¹⁰ While the potential for congenital transmission of yaws has recently been discussed (Ortner 2003:277), it is unclear at this time how this form of congenital treponemal infection can be differentiated from non-congenital yaws or other treponemal infections.

¹¹ Jacobi et al. (1992) report three cases of possible congenital syphilis (based on dental criteria) in the Newton Plantation population. Based on sample size, these three cases equated to 3.8 percent of the population, from which the authors estimated an actual congenital syphilis rate of approximately 10 percent for the population (1992:153-154). See the dental pathology chapter (Chapter 11) for a thorough discussion of possible dental indicators of treponemal infection.

¹² Two cases of cribra orbitalia, both adult females, were present in the St. Peter's Cemetery population equating to a population rate of 12.5 percent, or a sex specific 33.3 percent rate among females (Owsley et al. 1987:190). Once again, however, these conclusions are limited by small sample size and mixed ethnic composition in the population.

CHAPTER 11

Skeletal Indicators of Work: Musculoskeletal, Arthritic and Traumatic Effects

C. Wilczak, R. Watkins, C. Null, and M. L. Blakey

The types of bony changes studied in association with mechanical stress include: osteoarthritis, pressure facets, cortical thickness, fracture, and hypertrophy of tendinous and ligamentous attachment sites. While age is one component in the development of many of these markers, we believe that they mainly reflect the cumulative effects of mechanical stress rather than senile degeneration alone. This influence is supported by extensive experimental evidence of bone remodeling with increased osteogenesis and decreased bone resorption in response to mechanical loading (see reviews in Boyde 2003, Knüsel 2000, Wilczak and Kennedy 1998). The empirical evidence of Wolff's 1892 theory of bone transformation provides the research rationale for studies of activity-induced bone hypertrophy (Derevenski 2000; Hawkey and Merbs 1995, Weiss 2003, Wilczak 1998). In the case of osteoarthritis, which involves both cartilage and bone, current studies of repetitive loading on isolated cartilage tissue and individual chondrocytes indicate that biomechanical factors do contribute to degenerate joint disease onset, although the precise nature of the relationship has yet to be defined (Shieh and Athanasiou 2002).

It is also important to note that some researchers have argued against normal levels of habitual activity as a factor in the distribution of these markers, particularly in the case of osteoarthritis but do consider traumatic injury or extreme forms of labor

plausible candidates for early and severe forms of development (Jurmain 1999; Knüsel 2000). Trauma or acute stress is a generally accepted causative factor in the development of osteoarthritis, and clinical studies in sports medicine show that enthesial disorders can also be initiated by injury (Benjamin et al. 2002; Ortner 2003). There are two significant etiological possibilities in terms of assessing the labor intensity of a population: direct responses to loading that was experienced during normal levels of activity or initiation due to traumatic injury.

Skeletal indicators of work stress are of particular interest for the African Burial Ground Project (ABGP) because physical labor is the principle purpose for which Africans were enslaved. We expect a diverse expression of markers among individuals from this sample due to anticipated differences in cultural practices and genetic susceptibility, as well as variability in labor patterns. Slave labor in the city would include work in fisheries, industry, transportation, shipping, small shops, construction, and domestic work. A study of an urban enslaved population from New Orleans (1720-1810) found that skeletal indicators of labor stress were more variable than in rural enslaved, reflecting this wide range of activities (Owsley et al. 1987). While many of the urban enslaved had pronounced skeletal changes associated with manual labor, others, possibly free Blacks or domestic enslaved, exhibited very few signs of physical stress. Similar patterns should be observed in the African Burial Ground (ABG) population.

Sample Analyzed

Incidence rates for mechanical stress markers were calculated using only individuals of 15 years of age or greater. Enslaved children were often put to work at an early age, but there are several reasons to limit the analyses of markers of biomechanical stress to late adolescents and adults: 1) continuous bone remodeling associated with growth may confound the analysis; 2) stress markers can require repeated stress over a period of time to develop; and 3) most studies of occupational markers have been limited to adults and little is known about their development in subadults.

The excavated New York African Burial Ground (NYABG) remains included 419 burials; 187 individuals were suitable for this analysis. Two hundred and twenty-nine individuals were excluded because they were either less than 15 years of age, too incomplete for analysis, or fungal contamination prevented analysis. Three males with bilateral sacroiliac fusion were also excluded based on a possible differential diagnosis of a spondyloarthropathy or DISH, which can confound stress marker analyses (Arriaza 1993; Ortner 2003). Two of the excluded males were in the age range of 35 to 49 years while the third was a male in the 50+ age category. The demographic distributions of the individuals used in this portion of the study are presented in Table 11.1. Sample size for analysis of specific markers varies from these maximum numbers due to differential preservation of various skeletal elements.

Table 11.1: Demography of the Sample used in Stress Marker Analysis

Age Categories	Males	Females	Unknown sex
15-24	15	12	8
25-34	17	18	3
35-49	40	20	0
50+	16	13	0
Adult	10	15	0
Totals	98	78	11

Degenerative Changes of the Joints

Scoring

Osteoarthritis of the synovial joints was scored as changes including porosity of the articular surface, lipping at the joint margins, and eburnation or grooving of opposing surfaces. Spinal osteophytosis (spondylosis deformans) of vertebral body synchondral joints was scored based on marginal spicule (osteophyte) development. Initial analysis included a determination of severity for each type of degenerative change scored on a scale as either absent = 0, mild = 1, or moderate to severe = 2.

For osteoarthritis, a composite score for each joint or joint complex was created, which included both the individual severity scores and the type of degenerative changes. Porosity and osteophyte scores were classified as mild when one or both scores equaled 1, moderate when one score equaled a 2, or severe if both scores equaled 2. Eburnation is usually considered an end stage of cartilage

breakdown and joint destruction, so its presence was always scored as severe. If more than one articular surface was present for a joint, the higher composite score was used. In some cases, such as the hands and feet, functional areas included multiple synovial joints comprising a joint complex. Osteoarthritis was assessed as present for such a region when any one of the joints showed degenerative changes. Since more than 90 percent of the sample showed identical composite osteoarthritis scores on the right and left side, no analysis of asymmetry is presented.

Results of the Vertebral Analysis

Figures 11.1 and 11.2 illustrate severe vertebral osteoarthritis and osteophytosis development. Sample sizes and the frequency of degenerative changes by sex for osteoarthritis of the vertebral synovial joints and osteophytosis of the vertebral bodies are listed in Tables 11.2 and 11.3. Since there is a known age component in the development of osteoarthritis and osteophytosis, frequencies are given with the total sample age range from 15-50+ and excluding the oldest and youngest for a sample age range of 25-49 years. Thirty-four males and twenty-nine females have evidence of osteoarthritis in at least one vertebral region. There is little evidence for sex differences in the distribution of vertebral osteoarthritis. Lumbar vertebrae show the greatest difference with 58.3 percent of females and 42.5 percent of males affected for the age range of 25-49 years, but this difference is not statistically significant (chi-square test, $p=0.22$).

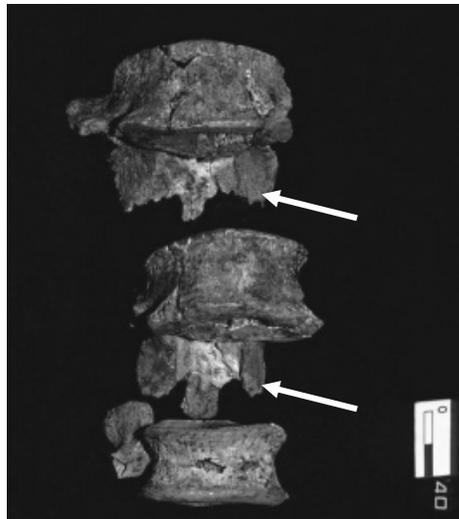


Figure 11.1: Severe osteoarthritis of the vertebral articular processes in a female aged 50-60 years old. (Burial 40)

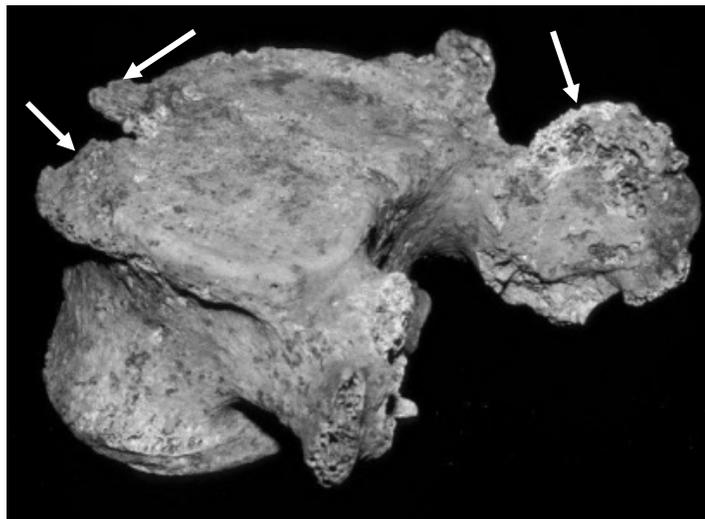


Figure 11.2: Severe osteophytosis (left arrows) and osteoarthritis (right arrow) of a lumbar vertebra in a male aged 35 - 45 years (Burial 63)

Vertebral osteophytosis is present in 23 males and 21 females in at least one vertebral region. Cervical osteophytosis rates are similar to osteoarthritis rates in individuals

25-49, but thoracic and lumbar osteophytosis occurs about half as frequently as osteoarthritis. There is no evidence for significant differences between the sexes in the rates of osteophytosis for individuals aged 25-49.

Table 11.2: Distribution of moderate to severe vertebral osteoarthritis by sex

	Males		Females	
Age in yrs	# affected¹	%	# affected¹	%
	Cervical			
25-49	11 (39)	28.2	7 (23)	30.4
15-50+	18 (59)	30.5	10 (47)	21.3
	Thoracic			
25-49	12 (30)	40.0	9 (23)	39.1
15-50+	19 (52)	36.5	13 (41)	31.7
	Lumbar			
25-49	17 (40)	42.5	14 (24)	58.3
15-50+	26 (63)	41.3	26 (45)	57.8

¹Numbers in parentheses are sample sizes (n)

Table 11.3: Distribution of moderate to severe vertebral osteophytosis by sex

	Males		Females	
Age in yrs	# affected¹	%	# affected	%
	Cervical			
25-49	12 (39)	30.8	6 (24)	25.0
15-50+	20 (60)	33.3	15 (47)	31.9
	Thoracic			
25-49	6 (32)	18.8	3 (22)	13.6
15-50+	13 (52)	25.0	8 (40)	20.0
	Lumbar			
25-49	7 (43)	16.3	3 (23)	13.0
15-50+	12 (68)	17.6	11 (43)	25.6

¹Numbers in parentheses are sample sizes (n)

Comparisons among age categories and regions are most clearly seen in Figures 11.3 and 11.4. Males, females and individuals of unknown sex are combined into one sample for this analysis since neither osteophytosis nor osteoarthritis rates show significant sex differences, and sample sizes are as low as eight individuals when the sexes are considered separately by age. Total sample sizes for the individual vertebral regions by age categories range from 18 to 44 individuals. The general trend for both osteophytosis and osteoarthritis is toward increased frequencies of affected individuals with age. Nonetheless, a fairly large proportion of the youngest age group has moderate to severe degenerative changes. The most striking example is seen in osteoarthritis of the lumbar vertebrae with 45.0 percent of individuals aged 15 to 24 affected. Also in this age category, the frequency of

moderate to severe cervical osteoarthritis is 11.0 percent and cervical osteophytosis is 10.5 percent.

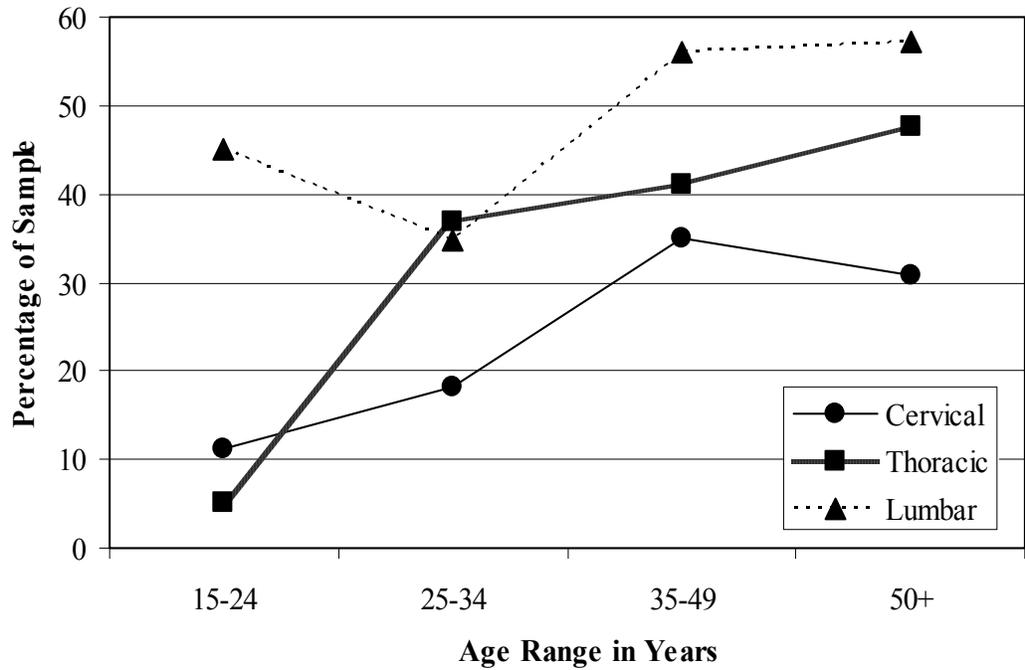


Figure 11.3: Age and incidence moderate to severe vertebral osteoarthritis

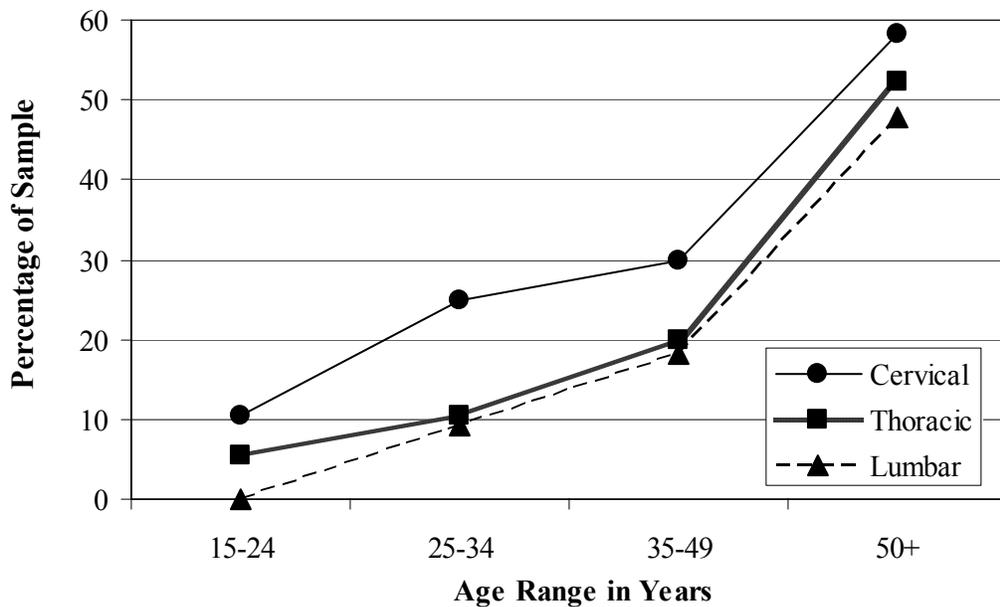


Figure 11.4: Age and incidence of moderate to severe osteophytosis.

In this sample, cervical osteophytosis is more frequent than in the thoracic and lumbar regions in all age categories (Figure 11.5). When the thirty-two cervical osteophytosis cases with preserved thoracic or lumbar vertebrae are examined individually, twenty (nine females and eleven males) or 62.5 percent do not have these severe changes in one or both of the other two vertebral regions. For these twenty cases, cervical osteoarthritis is absent in four (20 %), mild in four (20 %) and moderate to severe in twelve (60 %). The corresponding ages of these cervically affected individuals are: two, 15 to 24; four, 25-34; eight, 35 to 50; and six, 50+. By the sixth decade, 58.4 percent of the individuals (14 of 24) show clear evidence of cervical osteophytosis. Osteoarthritis shows the reverse regional distribution with the lumbar vertebrae most affected and the cervical vertebrae least affected.

The general correlation of osteophytosis and osteoarthritis with age is expected since both develop as part of the natural aging process. However, they are also multifactorial conditions that can be affected by genetics, metabolism, and nutrition (Wilczak and Kennedy 1998). Mechanical stress can also accelerate the age at onset as well as the severity of degenerative changes. The presence of moderate to severe osteophytosis and osteoarthritis in the youngest age group suggests causative factors in addition to normal age degenerative changes. The high frequency of cervical osteophytosis compared to that in the lower back, is also compelling evidence for the impact of strenuous labor on the vertebral column. Environmental factors such as nutrition are systemic, and while they may increase susceptibility to cartilage and joint breakdown, they would not be expected to affect the pattern of degeneration within the vertebral column. In relation to both age and mechanical



Figure 11.5: Severe osteophytosis of the cervical vertebrae in a male aged 35-45 years (Burial 63)

effects, osteophytosis generally affects the lumbar region first with the cervical about half as affected and the thoracic least (Bridges 1992; Jurmain 1999). The reversal of the normal pattern provides evidence for labor that resulted in mechanical strain to the neck. Further evidence is present in seven individuals with unambiguous pre- or peri-mortem fractures to the cervical vertebrae (Table 11.11). All but one also has modifications consistent with osteophytosis, osteoarthritis, or both in the cervical region.

The similar rates of cervical osteophytosis do not necessarily mean that males and females were performing the same types of labor, but only that both were

subjected to repeated and severe stress of the neck. Diverse activities have been suggested as contributing factors to the development of cervical osteophytosis, including compression of the neck during milking, extension of the neck during fruit picking, and use of a tumpline for carrying loads on the back (Bridges 1994; Olin 1982; Wienkler and Wood 1988). Correlations between carrying loads on the head and cervical osteophytosis have also been suggested for Bronze Age Harappans (India) and prehistoric Native Americans from Alabama, as well as for contemporary grain porters from Zambia and South Africa (Bridges 1994; Levy 1968; Lovell 1994; Scher 1978). Loading of the shoulders as well as the head can place stress on the neck, particularly when the lower cervical and thoracic vertebrae are involved. In the ABG sample, four individuals have moderate to severe cervical and thoracic osteophytosis without involvement of the lumbar vertebrae: one female 25-34 years, one male 15-24 years, and two males of 50+ years old.

Sixty percent of individuals with cervical osteophytosis also had at least moderate cervical osteoarthritis. Theoretically, stress on the disks and vertebral bodies is primarily due to compression, while the apophyseal joints are stressed with rotation and bending. Many activities will result in both compression and bending stresses; for example, when carrying objects on the head the weight of the load may shift during walking causing lateral stresses in the head and neck. However, a substantial portion of individuals had osteophytosis without osteoarthritis, reflecting perhaps the diversity of the individual activities within the population, differences in anatomy, genetic predispositions, nutritional stresses, or disease. Certainly, the

distribution of stress across the vertebral segments will vary among individuals and may influence the onset and progression of degenerative joint disease.

Unlike osteophytosis, the distribution of osteoarthritis in previous studies does not present as clear a pattern of regional distribution among the three vertebral segments. There is some bias toward lumbar involvement, but it is not uncommon for peak values to occur in either the thoracic or lumbar segments (Bridges 1994; Derevenski 2000). Biomechanically, this is not surprising since the apophyseal facets have less of a weight-bearing role than the vertebral bodies and disks. High levels of osteoarthritis in this sample suggest participation in labor involving bending and rotation of the spine or indirect stress to the back through limb muscles that directly attach to vertebrae. This is particularly true for the lumbar region where the early age for onset for severe osteoarthritis is striking. Stress in the lower back occurs during many general types of arduous physical labor including carrying, bending and lifting, as well as dragging heavy objects.

Schmorl's nodes

Schmorl's nodes are shallow, depressed pits occurring on the superior and/or inferior endplate of the vertebral bodies resulting from the pressure of cartilaginous protrusions of damaged intervertebral discs. (Figure 11.6)

The general pattern of spinal distribution for 22 affected males and 11 affected females (Table 11.4) is similar with the greatest occurrence in the lumbar region and the lowest occurrence in the cervical region for both sexes. Lumbar frequencies are equal, but male frequencies are more than double those of females in the thoracic

vertebrae and triple those of females in the cervical vertebrae. Two females and six males have Schmorl's nodes in multiple vertebral regions.

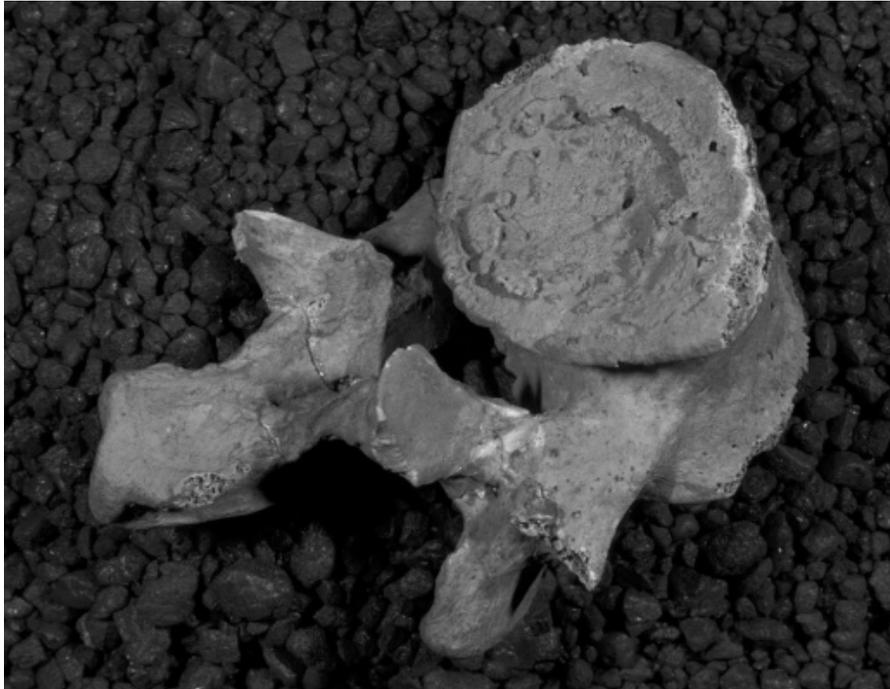


Figure 11.6: Schmorl's node depression of a lumbar vertebra in a male aged 35-45 years (Burial 70)

Table 11.4: Regional Distribution of Schmorl's nodes

	Males		Females	
	Number¹	Percent	Number¹	Percent
Cervical	6 (60)	10.0	1 (47)	2.1
Thoracic	10 (51)	19.6	4 (40)	10.0
Lumbar	14 (67)	20.9	9 (43)	20.9

¹numbers in parentheses are sample sizes (n)

Age-related degenerative change is often considered the primary reason for Schmorl's node development (Aufderheide and Rodriguez-Martin 1998), but

mechanical stress may be a contributing factor as appears to be the case in this population. The relative rarity of this condition in younger persons suggests that it only occurs earlier in life under conditions of extreme physical stress (Capasso et al. 1999). In the combined male and female sample, the most frequent occurrence of Schmorl's nodes is in the age range of 25-34 for all three vertebral regions (Table 11.5). The frequencies are over two times those found in the oldest sample of 50 years or greater. As with vertebral osteoarthritis and osteophytosis, the presence of Schmorl's nodes in younger individuals suggests factors other than age-related disc degeneration. While one might expect to see increase in the incidence with age when mechanical stresses are a factor, the higher frequency in younger individuals may simply reflect sampling bias in the labor history or genetic susceptibility (in conjunction with stress) of the individuals within each age group. Percentages of individuals with Schmorl's nodes in the cervical, thoracic and lumbar regions also affected with osteophytes in the same vertebral region are 28.6 percent, 42.9 percent and 21.7 percent respectively.

Table 11.5: Percentage of Individuals with Schmorl's nodes by Age¹

Age	Cervical	Thoracic	Lumbar
15-24	0 (0)	16.7 (2)	15.0 (3)
25-34	12.5 (3)	31.6 (6)	36.4 (8)
35-49	7.5 (3)	8.6 (3)	22.7 (10)
50+	4.2 (1)	14.3 (3)	13.0 (3)

¹numbers in parentheses are number of individuals with Schmorl's nodes

Spondylolysis

Unilateral or bilateral fracture of a vertebral neural arch and subsequent separation from the vertebral body constitute the defect of spondylolysis (Figure 11.7). Although technically considered a type of fracture, it is discussed here because it can be due to fatigue fracturing when presenting as typical spondylolysis. Typical spondylolysis is a fracture in the lumbosacral region through pars interarticularis with L4 and L5 most frequently affected (Merbs 1996). The etiology of typical spondylolysis suggests both genetic factors, likely related to differences in vertebral morphology, and mechanical stress affecting the lower back such as general heavy labor and in athletics that stress the lower back such as football, gymnastics, and rowing (Merbs 1996, 1989).



Figure 11.7: Vertebral spondylolysis in a female aged 35-40 years (Burial 107)

Complete, bilateral spondylolysis of L4 or L5 was present in four adults from the ABG (Table 11.6). All of the individuals with spondylolysis also have at least

one other pathological change of the vertebrae both within and outside of the lumbar region, including Schmorl's nodes and osteophytosis in three of the four burials. All four individuals show evidence of osteoarthritis of the lumbar apophyseal joints. Osteoarthritis is also present in the cervicals of Burial 37, in the thoraces of Burial 107, and in both the cervical and thoraces of Burial 11.

Table 11.6: Spondylolysis and Associated Vertebral Degenerative Changes

Typical Spondylolysis			Other Degenerative Changes ¹		
Sex	Burial	Age (yrs)	OP	OA	Schmorl's
Male	11	35-49	C, T, L	C, L	
Male	97	35-49		L	T
Female	107	35-49	T, L	T, L	T
Male	37	50+	C, T	T, L	T, L

¹C = cervical, T = thoracic, L = lumbar

Examination of musculoskeletal stress markers (MSMs) and axial osteoarthritis reveals further evidence that the individuals affected by spondylolysis experienced heavy stress. Details of osteoarthritis and MSM scoring procedures are given in the respective sections of this chapter. Burial 11 is a male aged 35-50 who shows hypertrophy or stress lesions at 37 percent of 33 muscle or ligament attachments. These attachments include several associated with carrying or heavy lifting such as the triceps, biceps, deltoid, quadriceps, linea aspera, obturator exturnus/internus, and gluteus minimus/medius attachments. Moderate osteoarthritis of the hip and elbow are also present in the form of peripheral lipping of all articular surfaces. In the

elbow, lipping is particularly prominent on the ulna suggesting bending stress as a greater factor than rotational stress.

Burial 97 is a male aged 35 to 50 years with extensive musculoskeletal stress markers (MSMs) that were scored as moderate to severe for 17 of 30 or 56 percent of the attachments examined, which is over twice the average percentage (25.2 %) of MSMs for all adult males. Moderate to severe osteoarthritic lipping is also present at the hip, elbow, wrist, and hand. The knee, ankle, and foot were not sufficiently preserved for scoring. The only female (Burial 107) with typical spondylolysis was aged 35 to 50 years. Thirty-nine percent of the attachments examined were scored as MSMs as compared to the average of 17.6 percent for all females. Some of the same patterns emerge as seen in Burial 11 with stress lesions at the brachialis, deltoid, linea aspera, quadriceps, and obturator internus/externus attachments. While mild lipping is present at most joints or joint complexes, only the knee was scored with moderate to severe lipping.

Burial 37 is a male aged 50+ years. In addition to the extensive changes in the vertebral column as detailed in Table 11.6, twenty-one percent of the attachments show significant hypertrophy or stress lesions including those of the brachialis, supinator, quadriceps and linea aspera. All of the joints examined in this older individual show at least mild osteophytic lipping, but more pronounced lipping occurs in the hip, ankle, knee, and foot. While all four burials show some correspondence between spondylolysis and other stress markers, there are also differences among the individuals. High levels of mechanical stress are indicated by MSMs for Burial 11,

by osteoarthritis in Burial 37, and by both MSMs and osteoarthritis in burial #s 11 and 97.

Variability in the types of vertebral changes as well as in the degree and patterning of the associated MSMs and axial osteoarthritis, suggests a corresponding variability in the types of labor performed by this urban population. However, individual differences in genetics, nutritional levels and bone density, anatomy, and posture in the performance of similar task are also contributing factors to diverse manifestations of stress in the spine. Susceptibility to spondylolysis in particular has been correlated with anatomical variation in the lower back and preferred posture during the performance of strenuous tasks (Capasso et al. 1999). Merbs (1983) and Stewart (1953) both suggested holding the legs extended when sitting (as in a kayak) or when standing and working with materials on the ground contributed to the high incidence of spondylolysis among Alaskan natives. Even what appear to be very similar sorts of activities may show different skeletal manifestations upon closer examination. Grain porters in Zambia had fractures, herniations and other injuries most commonly in cervical vertebrae C₁ to C₄ while grain porters in Cape Province only showed injuries below C₄ (Capasso et al. 1999). So while there is evidence of general levels of high mechanical stress for the four burials examined here, one must be careful not to over-interpret the specific manifestations for any one individual.

Results of Appendicular Joint Analysis

In the upper limb, 22 females and 43 males have osteoarthritis in at least one of the joints or joint complexes, which included the shoulder, wrist, elbow and hand. For individuals with osteoarthritis and all four joint regions scorable, the average number of joints affected is 2.26 for females and 2.09 for males. If the joint and joint complexes are ranked by relative frequency of osteoarthritis, differences between the sexes are present (Table 11.7). Females have the highest incidences in the wrist for the 25-49 year age range, while males are highest in the elbow (Figures 11.8 and 11.9). The shoulder is least affected in both sexes. The greatest frequency difference between males (32.6 %) and females (19.4 %) is in the elbow.

In the lower limb, 40 females and 58 males have osteoarthritis in at least one joint or joint complex, which included the hip, knee, ankle, and foot. For individuals with osteoarthritis and all four regions scorable, the average number of joints affected is 2.39 per individual for females and 2.17 per individual for males. When the eight joint or joint complexes of the upper and lower limb are considered together, the average number affected in those with osteoarthritis is 4.11 for females (n = 26) and 3.59 for males (n =44). There were six individuals with all eight regions affected. Four of these were males of 50+, and two were females aged 25-34 years.

Table 11.7: Distribution of moderate to severe osteoarthritis in the upper limb

	Males		Females	
Age in yrs	# affected ¹	%	# affected	%
	Shoulder			
25-49	6 (46)	13.0	4 (31)	12.9
15-50+	15 (76)	19.7	12 (55)	21.8
	Elbow			
25-49	16 (49)	32.6	6 (31)	19.4
25-50+	29 (82)	35.4	14 (58)	24.1
	Wrist			
25-49	10 (38)	26.3	5 (21)	23.8
15-50+	18 (66)	27.3	10 (40)	25.0
	Hand			
25-49	8 (48)	16.7	5 (29)	17.4
50+	19 (80)	23.8	12 (55)	21.8

¹Numbers in parentheses are sample sizes (n)

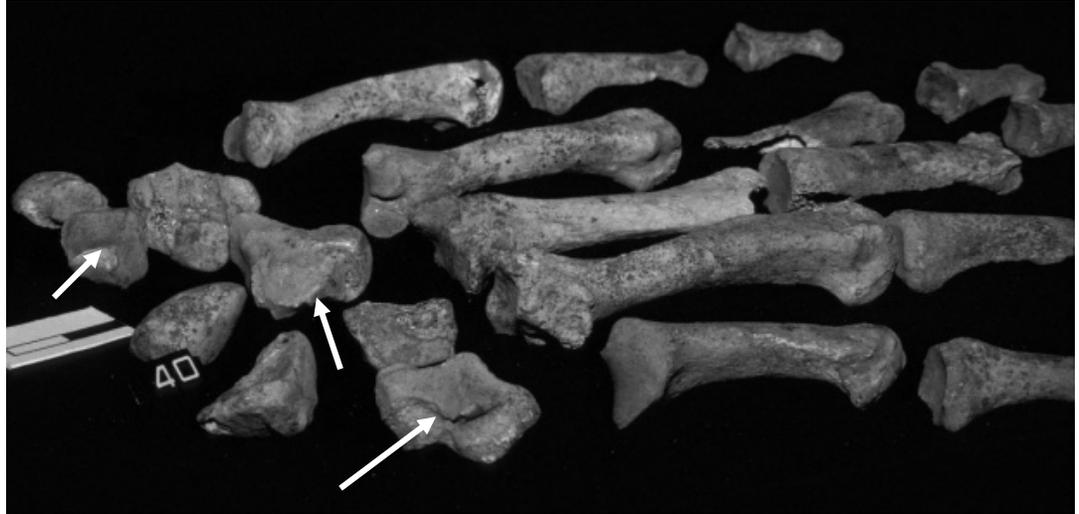


Figure 11.8: Osteoarthritis with marginal lipping in the wrist of a female aged 50-60 years (Burial 40).



Figure 11.9: Mild to moderate osteoarthritis in the humeral articular surface of the elbow in a male aged 30 - 40. A. anterior view, B. posterior view (Burial 11)

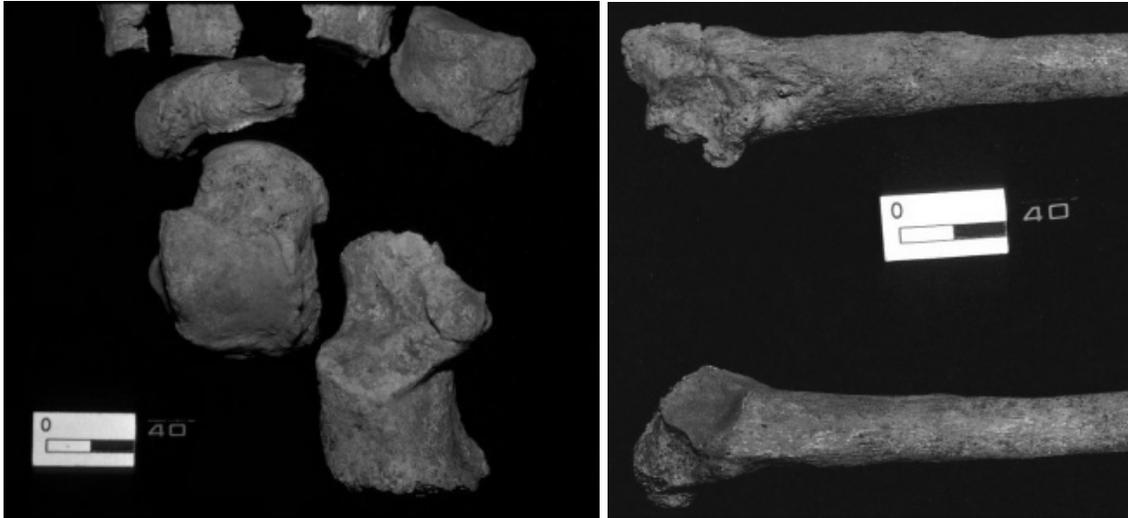


Figure 11.10: Osteoarthritis of the ankle in a female aged 50-60 A. superior aspect of the distal ankle articulations B. the proximal ankle articulation on the fibula (Burial 40)

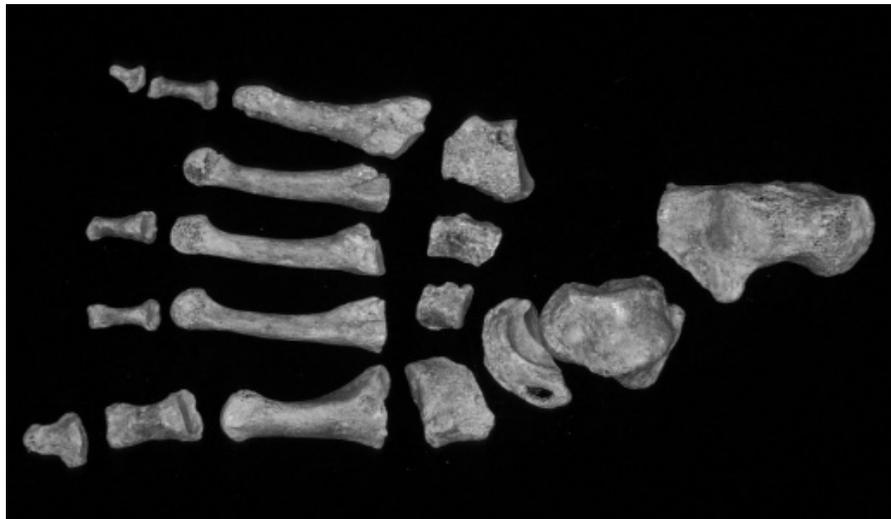


Figure 11.11: Osteoarthritis in the ankle and foot of a male aged 40-50 years (Burial 238)

There is a higher frequency of osteoarthritis in the lower limb than in the upper limb for both sexes (Table 11.8). Only the male elbow, and perhaps wrist, has comparable incidence levels. Both males and females have the highest lower limb

incidence of osteoarthritis in the ankle (Figure 11.10). In females this is followed by the hip and by the knee in males. The ankle joint shows the greatest sex difference with 51.7 percent of females and 42.2 percent of males affected for the age range of 25-49 years, but this difference is not statistically significant.

Table 11.8: Distribution of moderate to severe osteoarthritis in the lower limb¹

Age in Yrs	Males		Females	
	# affected	%	# affected	%
	Hip			
25-49	19 (51)	37.3	13 (31)	41.9
15-50+	33 (82)	40.2	22 (57)	38.6
	Knee			
25-49	14 (49)	38.6	13 (33)	39.4
25-50+	27 (82)	32.9	24 (62)	38.7
	Ankle			
25-49	19 (45)	42.2	15 (29)	51.7
15-50+	39 (75)	52.0	27 (56)	48.2
	Foot			
25-49	15 (45)	33.3	11 (31)	35.5
50+	28 (76)	36.8	20 (56)	35.7

¹Numbers in parentheses are sample sizes (n)

It is difficult to examine age effects independently for males and females because sample sizes are as low as ten individuals when the sexes are considered separately by age. Since the joints or joint complexes do not show statistically significant sex differences, all are plotted as combined samples of males, females and unknown sex initially (Figures 11.12 and 11.13). The elbow is also plotted separately for males and females since the greatest sex differences were found at this joint

(Figure 11.14). Total sample sizes for the combined appendicular joints by age categories range from 17 to 54 individuals. The general trend for both upper limb and lower limb joints is toward increased frequencies of affected individuals with age. Nonetheless, a fairly large proportion of the youngest age group have moderate to severe degenerative changes. This is most apparent in the lower limb where incidences range from 15 percent in the foot to 25.0 percent in the ankle for 15-24 year olds. In the upper limb, the elbow of the youngest age group has the highest incidence of 21.7 percent. The lower limb is clearly more affected than the upper limb, and it is unlikely that incidences in the lower limb are simply a phenomenon of normal weight-bearing and age since moderate to severe osteoarthritis reaches quite high levels in the young adults and is pronounced in those aged 25-49 years as well. The graph also shows the trend for higher incidences in the ankle, with the greatest differences when compared to the hip, knee and foot in the 25-34 year age group. In the oldest individuals (50+), the incidence for all lower limb joints and joint complexes converge with those of the ankle at rates greater than 58 percent.

Sample sizes for osteoarthritis of the elbow range from nine for females aged 15-24 and 50+ to 36 for males aged 35-49 years. The trend for males to exceed females is interrupted in the age range of 25 to 34. In this group of 13 males, none showed significant osteoarthritis. The largest difference is in the 35-49 year age range where the male incidence was 44.4 percent (n=36) and the female was 18.8 percent (n = 16).

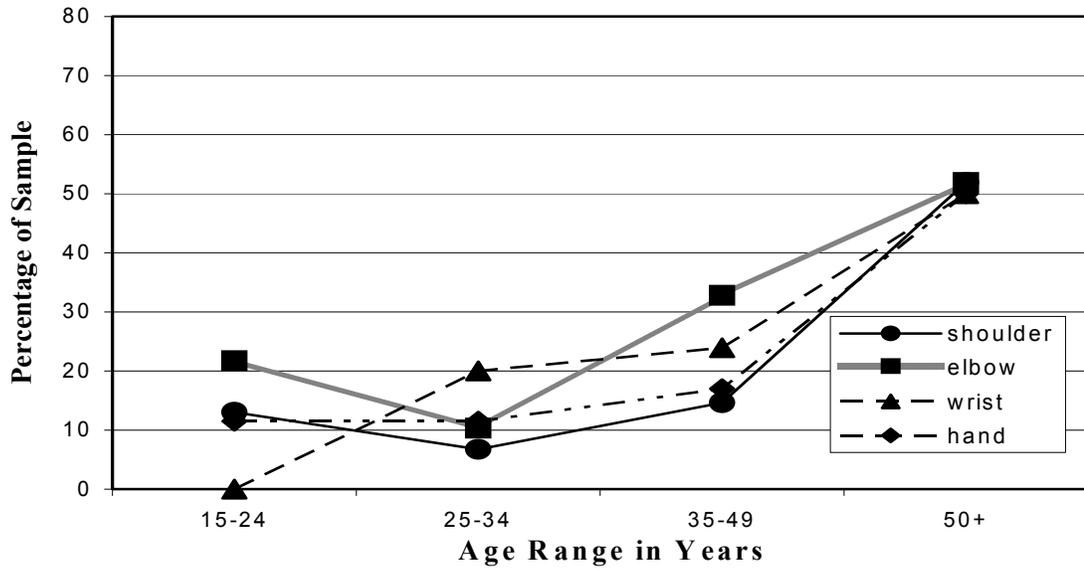


Figure 11.12: Age and incidence of moderate to severe osteoarthritis in the upper limb

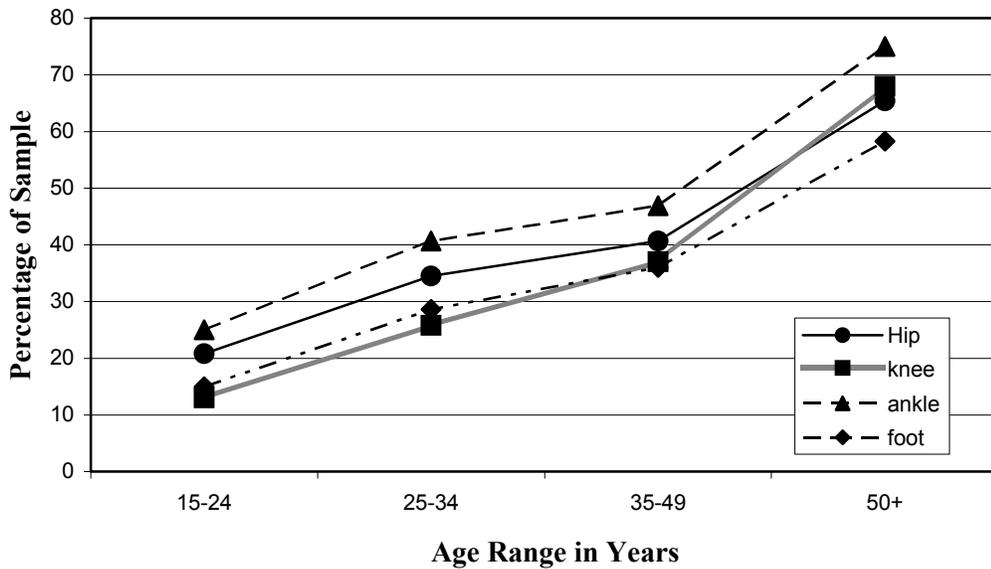


Figure 11.13: Age and incidence of moderate to severe osteoarthritis in the lower limb.

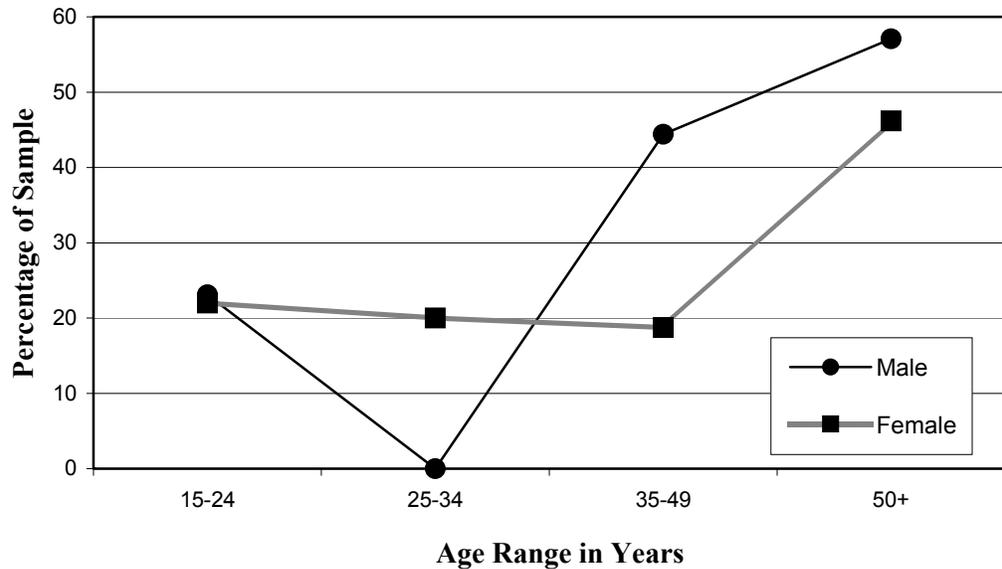


Figure 11.14: Age and incidence of moderate to severe osteoarthritis of the elbow

Incidence of osteoarthritis was higher in the lower limb, suggesting greater stress than in the upper limb. Activities that might be applicable in this population include walking over uneven surfaces, performing activities while squatting, and climbing stairs and ladders. It is not possible to say for certain which of these activities would be most important for this population, and it is likely that different stresses are factors for different individuals. An alternative explanation is that high general stress experienced in this population contributed to osteoarthritis development in both limbs, but rates in the lower limb are highest because of the additional weight-bearing burden. Perhaps this is true, but the pattern in the vertebral column is suggestive of the higher burden in the pelvic girdle. The higher incidence of osteoarthritis in the lower limb is compatible with the high levels of osteoarthritis of the lumbar vertebrae, supporting a difference in the activity loads of the upper and lower limbs. It is of interest that the highest incidence of osteoarthritis was found in

the ankle since it is rare in the archaeological record as well as today (Rogers 2000). When it does occur, it is normally due to traumatic injury or other pathology. Certainly, abrupt trauma cannot be ruled out here.

For the elbow, there is no way to know if males aged 35-49 years with high osteoarthritis rates or males aged 25-34 with lower rates are more representative of the population. Therefore, it would be an over-interpretation to conclude that all males experienced more stress than females at the elbow. This example clearly illustrates the difficulties in making specific statements rather than discussing broad trends in this population where individuals performed a wide variety of tasks. All that can be concluded is that at least some individual males were likely to experience high stress levels at the elbow. This stress level could be due to habitual labor in this age group or traumatic injury, leading to the degenerative changes.

Musculoskeletal Stress Markers

Musculoskeletal Stress Markers (MSM) are distinct marks at the site of ligament and tendon attachments to the periosteum and bone. The types of bony changes include hypertrophic bone development that causes enlargement and the formation of distinct ridges and crests at the attachment, resulting in a rugose appearance. With extreme stress at the attachment non-lytic furrows or pits may develop, resulting in a stress lesion called an enthesopathy at a tendinous attachment or a syndesmoses at a ligament attachment. Both of these terms have been used to describe either hypertrophy and stress lesion or stress lesions exclusively. To avoid confusion, we will follow the terminology of Hawkey and Merbs (1995), referring to

the more extreme furrow or pit development as stress lesions for both enthesial and syndesmosial sites.

Scoring of MSMs

Three attachments were scored in the head and neck, nineteen in the upper limb, and eleven in the lower limb. If hypertrophy or stress lesions were manifest at both the origin and insertion of a specific muscle or ligament the highest score was used. For most of the attachments, the greatest percentage of MSM expression was at the insertion where tensile stresses are most intense. For example, there were seven MSMs scored for the humeral origin of the brachialis muscle and 81 at its insertion on the ulna. Multiple muscles were scored together when they share a common attachment or when the attachments are located too closely for clear discrimination. Therefore, when referring to an attachment site in the singular, it may include several sites such as origin and attachment and/or multiple muscles. MSMs were scored as mild hypertrophy = 1, moderate/severe hypertrophy = 2, mild stress lesion = 3, or moderate/severe stress lesion = 4 (Figures 11.15 and 11.16). In analyses of MSM frequency, only scores of two or greater are considered. Exclusion of mild hypertrophy ensures that only clear cases of MSMs are scored.

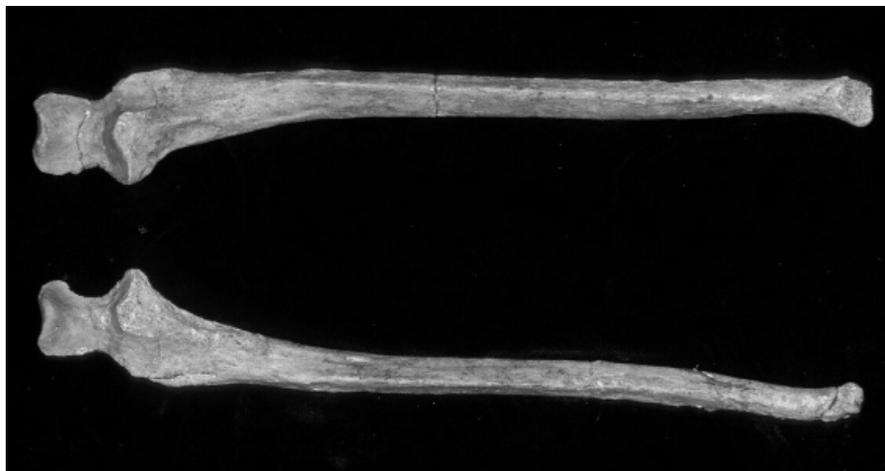


Figure 11.15: Severe Hypertrophy of the Ulnar Supinator Insertions in a male aged 40 - 50 Years (Burial 369)

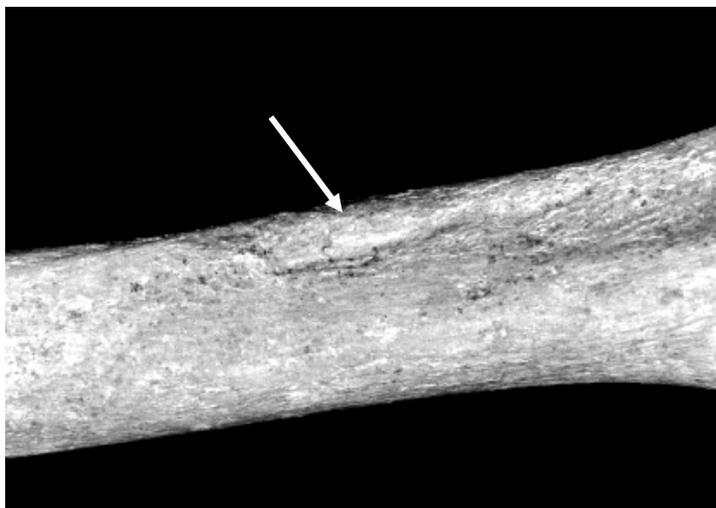


Figure 11.16: Stress Lesion of the Right Humerus in a male aged 20 - 23 years (Burial 181)

Results of MSM Analysis: Percentages of moderate to severe MSMs scored per individual were calculated based on the available number of attachment sites present. For these calculations, only individuals with at least nine scorable sites for the 33 attachments (>25 percent) are included. The average percentage of MSMs per

individual is 25.1 for males and 19.6 for females (Table 11.9). This difference is significant (t-test, $p = 0.03$).

Average percent MSM scores do increase with age for both males and females. Although lower than other age groups, at least some attachments show significant hypertrophy and/or stress lesion even for individuals aged 15-24 years. The difference of 4.8 percent in average MSM scores in females between the two middle age groups are the lowest and correspond to an average of 1.6 insertions per individual (out of the 33 total). The youngest females show a difference of 6.5 percent when compared to females aged 25-34 corresponding to 2.1 few insertions per individual. For males, the difference between the two middle age ranges (7.6 percent or 2.5 insertions) is greater than the difference between 15-24 years and 25-34 year olds (4.1 percent or 1.4 insertions). These results are consistent with a previous study showing smaller average insertion areas for younger males for a sample of twentieth century African Americans and European Americans (Wilczak 1998).

These data suggest that accumulated stresses over time are usually necessary for MSM development, but those attachments under the greatest strain may develop quite rapidly. Alternatively or in conjunction with high stress and rapid development, it may indicate full integration at a very young age for males into the “adult” enslaved labor force, giving amply time for hypertrophy and stress lesion formation. Burial 323 is a male aged 15-24 who has moderate/severe MSM development at 39.4 percent (13 of 33) of his scorable attachments. Ten of these are stress lesions that include the linea aspera, quadriceps, biceps, deltoids and pectoralis/latissimus dorsi

attachments. The large percentage of stress lesions suggests hard labor did begin at an early age for this individual.

Table 11.9: Average moderate to severe musculoskeletal stress marker scores by age¹

Age (yrs)	n	Average # of attachments	Average % MSM	Highest % MSM
Males				
15-24	14	27.5	16.7	39.4
25-34	15	24.6	20.8	38.7
35-49	40	28.0	28.4	57.6
50+	15	28.2	31.4	60.6
All ages	92	26.6	25.1	60.6
Females				
15-24	11	27.7	10.1	27.3
25-34	17	28.0	16.6	39.4
35-49	20	28.3	21.4	41.9
50+	13	29.1	31.5	63.6
All ages²	68	24.9	19.6	63.6

¹All results are for individuals with nine or more insertions present

²All ages includes adults with age indeterminate

Moderate to severe forms of MSMs are present in substantial frequencies. On a per case basis, females have an average of 6.5 occurrences and males 8.3 occurrences for the 33 attachments in the analysis. Since males have higher frequencies of MSMs and the age composition of the two samples varies,

comparisons of specific attachments are presented by relative rank (Table 9.10). Of the ten most frequent MSMs, only two are not common to both males and females. The coracoclavicular ligament is ranked eighth in females (32.7 percent) and eleventh in males (28.2 percent). A much greater difference is seen for the biceps brachii muscle, which is ranked tenth for males (33.8 percent), but 23rd (8.2 percent) for females (Figure 11.17). In the lower limb the highest ranked attachments are the linea aspera and the gluteus maximus (1, 4 males and 2, 6 females; Figures 11.18 and 11.19). In the upper limb the deltoid, pectoralis major/latissimus dorsi, supinator, finger flexors, lateral scapula, and costoclavicular ligament were among the ten most common MSM for both males and females. Hypertrophy of the lateral border of the scapula may be another manifestation of teres major activity. It is also the origin of teres minor and the long head of the triceps, but MSMs of the insertions for these muscles are much less frequent in this population. Within the top ten, the rankings for the brachialis (Figure 11.20) is somewhat higher in females (1 vs. 5) while the Pectoralis major/Latissimus dorsi/teres minor is somewhat higher in males (3 vs. 7).



Figure 11.17: Hypertrophy of the biceps brachii insertion of the radii in a male aged 40 - 45 years (Burial 10)

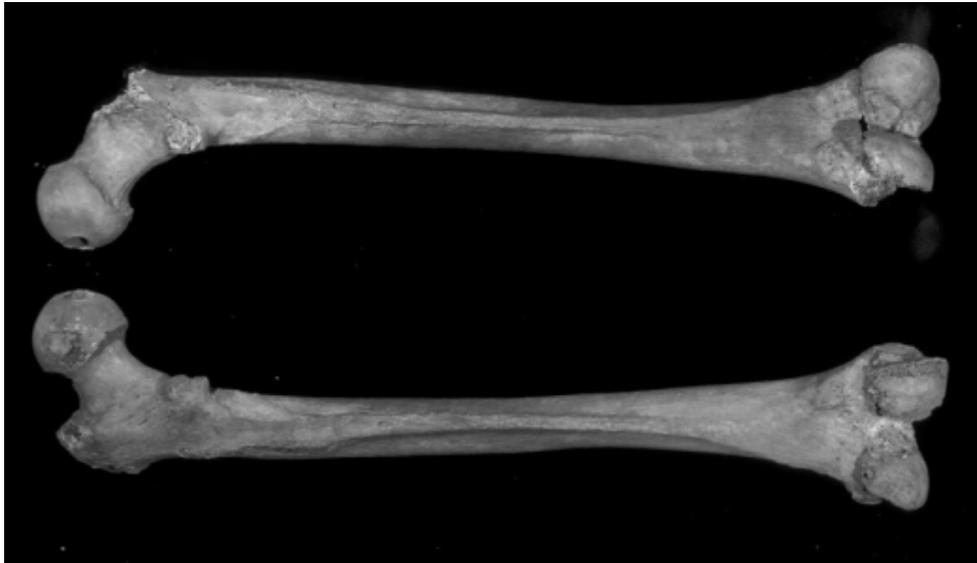


Figure 11.18: Hypertrophy of the linea asperae of the femora in a female aged 40 - 50 years (Burial 328)



Figure 11.19: Hypertrophy of the gluteus maximus insertions of the femora in a male aged 17 -18 years (Burial 174)



Figure 11.20: Hypertrophy of the brachialis insertions of the ulnae in a female aged 25-35 years (Burial 223)

Table 11.10: MSMs frequencies in males and females

	Male Attachment	#	%	Female Attachment	#	%
1	Linea aspera	58	66.7	Brachialis	32	55.2
2	Deltoid	51	62.2	Linea aspera	34	51.5
3	Pect. major, Lat. dorsi, teres major	48	59.3	Supinator	29	50.0
4	Gluteus maximus	49	58.1	Deltoid	30	48.4
5	Brachialis	45	54.9	Fingers flexors	27	44.3
6	Supinator	45	54.2	Gluteus maximus	29	43.9
7	Finger flexors	32	41.0	Pect. major, Lat. dorsi, teres major	25	42.4
8	Lateral Scapula	28	35.4	Coracoclavicular lig	18	32.7
9	Costoclavicular lig	25	35.2	Costoclavicular lig	15	27.3
10	Biceps brachii	26	33.8	Lateral Scapula	16	26.7
11	Coracoclavicular lig	20	28.2	Cranial base-occiput	13	25.5
12	Hamstrings	24	28.2	Quadriceps	13	18.3
13	med epicondyle-hum	22	26.5	Obturator in/ex	11	16.7
14	Cranial base-occiput	15	25.4	Finger extensors	10	16.4
15	Quadriceps	22	25.0	Hamstrings	10	15.8
16	Mastoid process	17	23.0	Rotator cuff	9	15.8

17	Lat epicondyle-Hum	19	22.4	Triceps brachii	9	14.8
18	Rotator cuff	17	20.7	Pronator teres/quad	8	14.3
19	Trapezius/nuchal	15	18.1	med epicondyle-hum	9	13.8
20	Iliopsoas	15	17.2	lat epicondyle-hum	7	10.8
21	Subclavius	12	16.9	Achilles tendon	7	10.4
22	Finger extensors	13	16.7	Gluteus medius/min	5	9.3
23	Triceps brachii	14	15.7	Biceps brachii	4	8.2
24	Obturator int/ext	13	15.1	Subclavius	4	7.3
25	Achilles tendon	12	13.6	Teres minor	4	7.0
26	Pronator teres/quad	7	8.6	Planterflexors	3	6.5
27	Gluteus medius/min	6	8.0	Iliopsoas	4	6.1
28	Dorsiflexors	3	4.2	Trapezius/nuchal	3	4.9
29	Plantarflexors	3	4.1	Dorsiflexors	2	4.5
30	Teres minor	3	3.7	Brachioradialis	2	3.6
31	Anconeus	2	2.4	Mastoid process	1	1.8
32	Brachioradialis	1	1.3	Intercondylar eminence	0	0
33	Intercondylar eminence	1	1.4	Anconeus	0	0

The cutoff point for further discussion of the ten most frequently affected attachments is arbitrary since there is no clear breakpoint between common and uncommon MSMs in this population. There is, however, some pattern in the data with several MSMs related to movement around the shoulder joint found in high frequencies in both males and females. Pectoralis major, latissimus dorsi and teres major insert into the intertubercular groove of the humerus. All three muscles act to adduct, extend and rotate the humerus, the first two medially and the teres major laterally. They are sometimes called “climbing muscles” because they pull the torso up when the arms are fixed. In addition, the pectoralis can assist in flexing the humerus to the horizontal position, at which point the deltoid is necessary through full elevation. Latissimus dorsi is a powerful retractor of the pectoral girdle during activities such as rowing and the down stroke in swimming. The MSMs in the deltoid, which can abduct, flex, extend, and laterally and medially rotate the humerus depending upon which fibers are active and the position of the arm, also suggest circumductory motions or loading of the shoulders and pushing loads up above shoulder height. Stress in the shoulder is also apparent for the costoclavicular ligament, which attaches the medial clavicle to the first rib and limits the clavicle’s anterior and posterior movement. The corococlavicular ligament attaches the clavicle to the coracoid process and limits forward and backward movement of the scapula. This pattern of stress suggests activities including alternating flexion and extension of the arm toward the chest with the elbow bent as has been described in skin scraping among Inuits (Hawkey 1988; Hawkey and Merbs 1995), lifting heavy objects up from the ground, stacking and unstacking materials, and placing burdens upon the

shoulders or head. Overall, the pattern in the shoulder is compatible with many types of general labor involving heavy lifting and carrying as might be expected for this population.

Hypertrophy of the brachialis, which flexes the elbow, supports the presence of repetitive types of back and forth motion of the arm and forearm. While higher in women, both sexes show evidence of stress at this attachment. An additional flexor of the elbow and shoulder, the biceps brachii, shows hypertrophy in men. This could relate to general carrying functions since the biceps brachii opposes extension of the forearm against a load carried with the elbows flexed and the forearms extended in front of the body or when carrying heavy buckets or baskets in the hands with the arms down at the sides of the body (Galera and Garralda 1993). High frequencies of this MSM have been reported in masons, bakers and agricultural populations. Biceps brachii also supinates the forearm and both males and females have stress lesions and hypertrophy of the supinator muscle attachments. Supination occurs during twisting of the forearm, the type of motion used when opening a jar. The biceps is only important in supinating the forearm when the elbow is bent and the supinator muscle acts alone when the elbow is straightened (Kelly and Angel 1987). Supination is required in many skilled crafts such as sewing and weaving that also use alternating extension and flexion of the elbow. These types of activities are of interest since males and female finger flexor MSMs are ranked seven and five respectively. Supinator MSMs have been ascribed to activities that manipulate loads while the elbow is extended for tasks including citrus fruit picking, paddling a boat or canoe, and using heavy tools with a long reach such as furnace irons (Capasso et al. 1999).

High stress in the lower limb at the linea aspera and gluteus maximus attachments also point to heavy labor. The gluteus maximus is an extensor and abductor of the thigh. Its function as an extensor is not important in ordinary walking, but rather in more powerful movements such as climbing, stepping on a stool and raising the trunk from a flexed posture. Muscles directly attached to the linea aspera are the adductors mangus, brevis and longus, and the short head of the biceps femoris. The edges of the origins for the quadriceps muscles, vastus lateralis and vastus medialis, extend to the lateral rim of the linea aspera and may be especially important in the development of the extreme hypertrophy and distinctive “mesa-like” shape seen in pilasterism. The adductors are important in maintaining balance during walking. Adductors mangus also can act to flex an extended thigh and longus can extend a flexed thigh. The short head of the biceps femoris acts to flex the knee. The vastus lateralis and medialis are two of the main extensors of the knee and are active in movements such as stair climbing and squatting. It is possible that they contribute to the MSMs seen in at least some individuals since the quadriceps insertion at the knee is affected in 25.0 percent of males (#15) and 18.3 percent of females (#12). Linea aspera development has been reported in a several groups with strenuous locomotor activities including Canadian fur traders who jogged up steep portage trails, sixteenth century sailors, and horseback riders (Capasso et al. 1999). The combination of linea aspera and gluteal MSMs suggests a greater role for hip/flexion extension stress rather than adduction stress. This new role is consistent with picking up heavy loads both by bending at the hip and lifting up the burden or, as previously suggested, when lifting from a squatting posture (Mack et al. 1995). However, there

is a great range of activities that could produce the pattern seen here, so it is not possible to ascribe these changes to one specific habitual behavior.

The examples from previous studies given in conjunction with MSMs throughout this report are used to illustrate the range of activities suggested as a cause of the lesions seen and not to assign specific tasks to this population. While general load carrying would be expected as part of the labor for many enslaved, some of the same MSMs are most likely caused by different activities among these individuals. It is also important to remember that unlike the culturally distinct and more standardized labor pattern expected in an medieval agriculturalists or in a thirteenth century Inuit population, urban enslaved people would perform many types of labor. As we look at the population and the various MSMs with high frequencies, it must not be forgotten that those particular MSMs do not represent the remains of any one individual. The significance of the high levels of MSMs in the shoulder and femur is suggestive because it would be associated more with heavy forms of labor rather than skilled crafts. It is interesting that males and females show the same general pattern of stress but that there are some differences that may reflect sex differences in the types of work performed. Alternatively, they may reflect sex differences in anatomy and biomechanics.

Comparisons with other Enslaved Populations

There are few studies of enslaved skeletal populations in the Americas, and the type of information and number of individuals available vary considerably (Table 11.11). Poor preservation can also limit collectable data. This is the case for a Barbados, West Indies, enslaved plantation series, where analysis was largely

confined to dental characteristics (Corruccini et al.1982). Thus the number of enslaved populations where MSMs have been studied is extremely limited with just four burial sites documented. In addition, the Kelly and Angel's (1987) plantation sample does not comprise a single cemetery sample but instead scattered burials from across Maryland and Virginia.

Direct comparisons of the incidence of specific markers are problematic due to differences in data collection methodologies across studies. However, it is at least possible to compare general patterns of the types of stresses experienced. Kelly and Angel (1987) give no precise descriptions relating to the occupational markers in the plantation/farm slave sample. They did find overall nutrition and longevity for Catoctin males were greater than for rural enslaved and attribute this to the value placed on skilled workers by the slave-holders, perhaps resulting in better nutrition and living conditions.

Markers of work-stress in the Catoctin industrial enslaved sample are interesting, given the association of these enslaved workers with the ironworks and the relatively well-defined labor pattern. This sample does show some broad similarities to the ABG particularly the early age of onset for MSMs: 1) an 18-20 year old female has well-developed attachments particularly for the deltoid tuberosities and the clavicular attachments, 2) the youngest adult male around 20 years old has marked supinator crest and gluteal development, 3) a male in his late twenties also showed marked arthritis of the knee and right elbow, and 4) a female of approximately 18 years has a Schmorl's node. In general, Kelly and Angel (1987) paint a picture of fairly heavy stress with evidence of heavy lifting inferred from the

frequency of deltoid, pectoral, and teres major MSMs, as well as shoulder and vertebral breakdown. These general patterns are shared with the ABG sample. There are several cases of cervical “arthritis” (osteophytosis?) that they associate with skilled craft persons rather than carrying loads due to its co-occurrence with MSMs in the finger phalanges.

Table 11.11: Skeletal Studies of MSM in Enslaved African Americans

Location	Dates	n¹	Population	Reference
Charleston, SC	1840-1870	28	plantation slaves	Rathbun (1987)
New Orleans, LA	1721-1810	13	urban slaves	Owsley, et al. (1987)
Catoctin, MD	1790-1820	16	industrial slaves (ironworker)	Kelly & Angel (1983, 1987)
MD and VA	1690-1860	76	plantation/farm slaves	Kelly & Angel (1987)

¹includes adult remains only

In their earlier work (1983), Kelly and Angel also suggest a specific link between hypertrophy of the supinator crests in Catoctin males with “manipulating an iron with long reach.” A later paper, however, acknowledges a considerably broader explanation of precision crafts work and use of an axe.

Rathbun (1987) also documents physical stress within a rural enslaved population from South Carolina. Unfortunately, he provides no information on age occurrence of stress markers, but the presence of hip osteoarthritis in 100 percent of the male sample implies at least some individuals in their 20s were afflicted. As

measured by rates of osteoarthritis, stress was most apparent in the shoulder, hip and lower vertebrae. This varies from the results of the ABG where appendicular osteoarthritis was lowest in the shoulder and moderate in the hip in comparison to the knee, ankle and foot. Of interest is the similarity when one examines incidence by sex. At both South Carolina and in our New York City sample, males were more frequently affected by osteoarthritis of the elbow and females at the knee. While the exact physical stresses and labor varied between these two populations, these similarities may be a signature of broad occupational differences with males lifting and carrying more and female stress at the knee associated with bending and kneeling in household labor tasks. Incidence of cervical osteophytosis was similar to lumbar rates in males at South Carolina, but female cervical rates were nearly twice that of the lumbar rates. This suggests greater sex differences in the regional stresses of the neck and back than is found at the ABG. Perhaps this signals greater differences in the types of carrying done by males and females in this rural population versus our urban sample or, as suggested at Catoctin, females bending the neck while performing some types of craft work and/or household work. The only MSM mentioned by Rathbun (1987) is the supinator crest insertion, which was more frequently affected in males than in females. Once again, no significant sex difference in this attachment was found for the ABG.

Owsely et al.'s (1987) sample from New Orleans should be most similar to the one from the ABG since it also consists of an urban rather than rural enslaved population, albeit with a very small sample size of thirteen individuals. It is unclear at what age degenerative joint changes are first observable in this population, but only

one female showed moderate/severe lipping of the glenoid fossae while eight males showed pronounced osteoarthritic changes of various joints. In this study, joint surfaces were scored separately, so it is somewhat difficult to compare with our results. However, the upper limb in general is more often affected than the lower limb, a reversal of the pattern seen at the ABG. Greater similarities are found in MSMs for males with hypertrophy of the deltoid, supinator and biceps brachii insertions. Muscle attachment site changes in the lower limb are “equally profound” for most males. While females had lower overall MSM scores at the ABG, the sex differences in New Orleans seem much greater with only relatively minor hypertrophies in females, suggesting to the authors that they were performing less heavy physical labor than males, perhaps as house slaves. At least two of the older African American males at New Orleans did not show MSM development, again suggestive of variability in the severity of labor within urban enslaved populations and a social hierarchy even among enslaved. Consistent with this finding, the ABG population has incidences of osteoarthritis and MSMs that vary greatly among individuals independent of age. Both urban sites contrast with the more consistently high levels of stress documented in the rural enslaved of South Carolina who presumably would have engaged in plantation and farm work with less variability in the types of tasks performed.

Conclusions

There are no historic documents indicating the occupation or types of forced labor experienced by specific individuals from the ABG. Nor is it a site such as Catoctin Furnace or a hunting and gathering society where a limited number of activities might be inferred from contexts. In a series such as that from the ABG, linking individuals with specific occupations would be imprudent when one considers the wide range of possible activities that might affect a single marker, differences in individual anatomy, and idiosyncrasies in the way a single task may be performed (Capasso et al. 1999; Jurmain 1999; Knüsel 2000 Stirland 1991). The inability to confidently assign specific occupations to individuals does not imply that all analyses of habitual activity markers are meaningless. Information about the general labor conditions and levels of mechanical stress can be assessed. The most consistent results of this study are those that suggest strenuous labor began at an early age for at least some individuals, based on the presence of osteophytosis, osteoarthritis, enthesopathies, and Schmorl's nodes in the youngest age category of 15 to 24 years. Osteoarthritis in the lower limb and especially the ankles of individuals 15 to 35 years old suggests high general stress, perhaps walking on rough terrain, inclines or stairs with loads. Osteophytosis and osteoarthritis of the cervical vertebrae together with hypertrophy of the linea aspera, gluteus maximus and deltoids provides evidence of lifting and carrying loads on the back, shoulders, or head.

Few sex differences are present, so there is little evidence that males and females were specifically involved in activities that would result in large differences

in overall mechanical stress levels. This does not mean that certain labors were not specifically designated to one sex, just that each sex could have performed separate but equally arduous tasks on a regular basis. While sex differences are not common, they do occur. The elbow joint shows somewhat higher frequencies of osteoarthritis among males along with relatively higher hypertrophy for the biceps brachii and pectoralis major/latissimus dorsi/teres minor attachment, all of which are associated with carrying and lifting loads. In females, there is a relatively higher ranking of hypertrophy of the coracoclavicular, supinator crest and brachialis, which are associated with repetitive back and forth motions and forearm supination (these other muscles are also included Pectoralis major/Latissimus dorsi/Teres minor). Variability among individuals in the number and severity of stress markers has been emphasized throughout this chapter. This result is consistent with the labor of both free and enslaved individuals in an eighteenth century urban environment.

Trauma

Dislocation: Only one clear case of a dislocation is apparent in the remains. It is in the left temporomandibular joint of a male aged 25-34 years (Burial #151). Dislocations do not often leave a skeletal signature and when they do, they are usually subtle (Jurmain 2001). It is likely that dislocations are under-diagnosed in all skeletal populations.

Fracture scoring: Premortem fractures were diagnosed when there was any remodeling of the bone (usually extensive healing), indicating survival after the trauma occurred. Perimortem fractures (unhealed fractures in living bone that occurred around the time of death) are those that are clearly not caused by recent

burial/geologic processes, excavation or curation. Because it is often difficult to distinguish perimortem and postmortem fracture, a third category of ambiguous perimortem is included in the analysis.

Evidence of trauma in the skeleton is an indicator of both accidents associated with labor and violence against the individual. One would expect to observe fractures associated with both sources in an enslaved population. Perimortem fractures can be especially informative in the case of violence. While it is not usually possible to associate fractures with cause of death (Burial 25, below, representing such a case), perimortem fractures are almost certainly indicative of the manner of death.

Results of Fracture analysis: A total of 117 fractures in 23 males and 81 fractures in 18 females are present in adults (Tables 11.12). The cranium is the most common site for the fractures in males (23.5 %; Figure 11.21) followed by the ribs (11.4 %). Cranial fracture (11.1 %) is common relative to other elements in females and is similar to the percentage of fractures in the femur (12.4 %). The vast majority of these fractures are either perimortem or ambiguous perimortem for both males (79.5 %) and females (88.9 %). Equal numbers of fractures are found in the upper and lower limbs (Table 11.13). Premortem fractures in females are primarily in the hands and feet (5 of 9), but in males they are found in all regions except the skull.

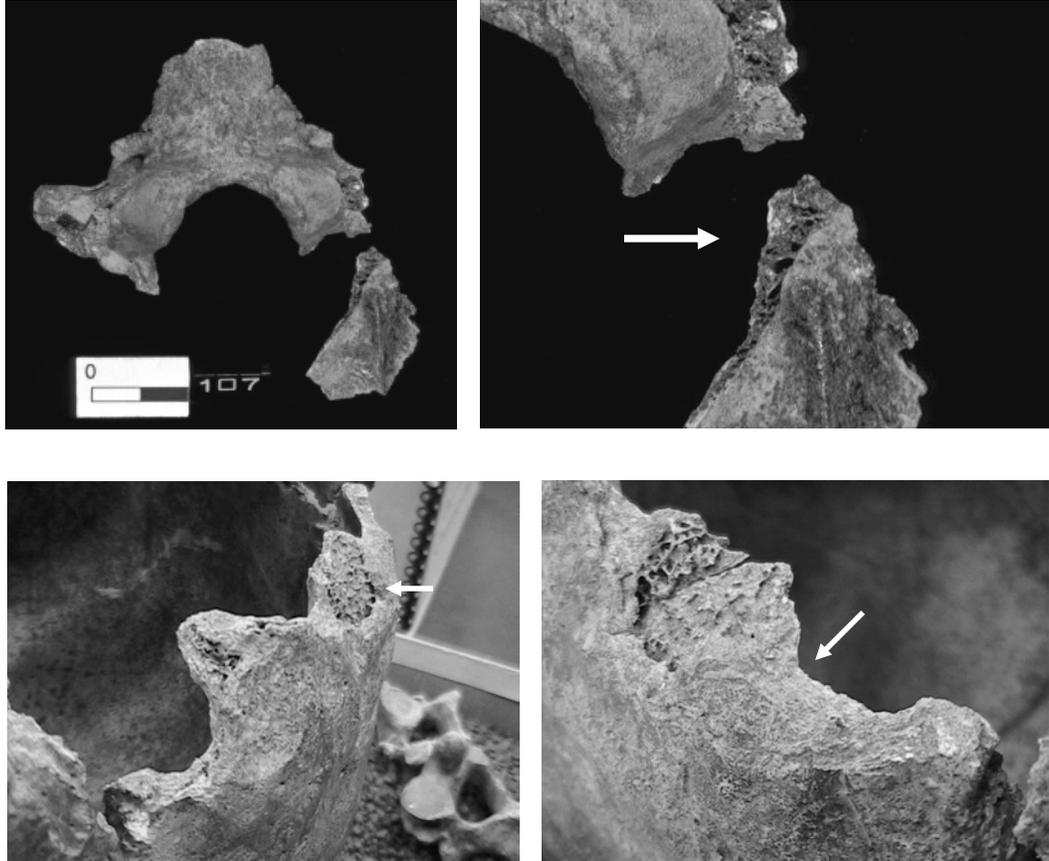


Figure 11.21: Ring fractures of the base of the skull in a female aged 35-40 years (Burial 107) The basilar is shown (top left) with a perimortem fracture (close up, top right). Other fractures are shown in the posterior occipital base (bottom left) exhibiting a beveled shape consistent with perimortem fractures (close up, bottom right). Ring fractures result from collision of the spine and skull base that can result from excessive, traumatic loading on top of the head (axial loading) (See Hill et al. 1995) or accidental or deliberate force to the top of the head such as diving on ones head or being thrust into a wall.

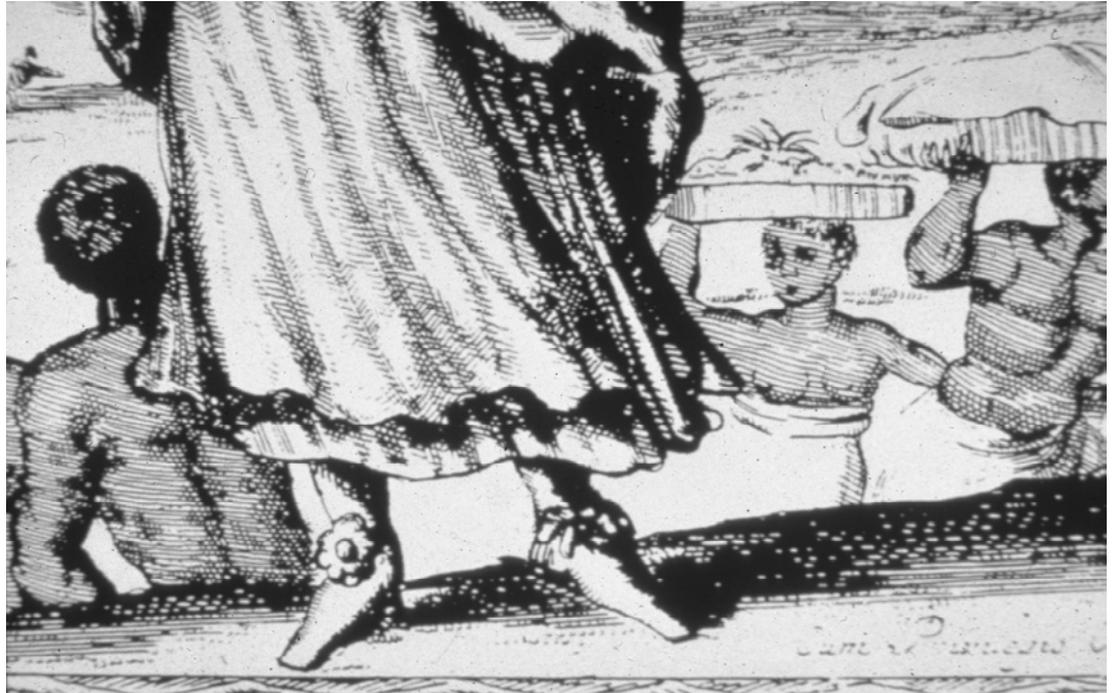


Figure 11.22: Seventeenth Century Drawing of Africans in New Amsterdam showing normal axial loading.

Table 11.12: Number of fractures by skeletal element in adults by sex¹

	Males				Females			
	Pre ²	Peri	Am	%	Pre	Peri	Am	%
Cranium		9	19	23.5		5	4	11.1
Mandible			1	0.9		1	1	2.5
Cervical vert	1	2		2.6	2	2	1	6.2
Thoracic vert	2	2		3.4		1	1	2.5
Lumbar vert		1	1	1.7		3	2	6.2
Rib	3	4	4	9.4	1	2	2	6.2
Clavicle	1	1	1	2.6		2		2.5
Scapula		4	1	4.3		5	2	8.6
Humerus		1	2	2.6		4	1	6.2
Radius	3	2	3	6.8		5		6.2
Ulna	3	1	4	6.8		6		7.4
Pelvis		8	2	8.6		5	1	7.4
Femur		4	6	8.6	1	8	1	12.4
Tibia	1	2	2	4.3		4		4.9
Fibula	4		3	6.0		3		3.7
Metacarpal			1	0.9	2			2.5
Hand phalanx			2	1.7				0
Metatarsal	1			0.9	1			1.2
Foot phalanx	5			4.3	2			2.5
Total	24	41	52		9	56	16	

¹Pre = premortem, Peri = perimortem, Amb = ambiguous perimortem

²Vertebral fractures do not include spondylolysis (see Table 6)

Table 11.13: Number of fractures by skeletal region in adults by sex

	Males				Females			
	Pre ¹	Peri	Amb	%	Pre	Peri	Amb	%
Skull	0	9	20	24.8	0	6	5	13.6
Axial	6	9	5	17.1	3	8	6	21.0
Upper Limb	7	9	11	23.1	0	22	3	30.9
Lower Limb	5	14	13	27.4	1	20	2	28.4
Hands & feet	6	0	3	7.7	5	0	0	6.2

¹Pre = premortem, Peri = perimortem, Amb = ambiguous perimortem

The distribution of fractures among the individuals is especially interesting. The average number of fractures among all individuals with fractures is 5.1 for males and 4.5 for females. If ambiguous perimortem fractures are excluded, the averages are 2.8 for males and 3.6 for females. Averages in this case are misleading as a few individuals account for the majority of fractures (Table 11.14).

A female aged 15-24 (Burial 205) has the greatest number of fractures and all 32 are perimortem. The fractures are distributed throughout the skeleton including the long bones of the arms and legs, the vertebrae, and the skull (Figure 11.23 and 11.24). Burial 89 is a female aged 50+ with 2 premortem fractures of the right hand and 8 perimortem fractures to the right side arms, legs and pelvis. She also has a fracture in the occipital and cervical vertebrae. Of the 23 fractures in a male aged 50+ one is a premortem fracture of the left clavicle. The perimortem fractures are

distributed throughout the body in the long bones of limbs, the pelvis and vertebrae. He has no fractures in the skull. Burial 171 is a male with 4 pre-mortem fractures of the left and right distal radius and ulnae. The perimortem fractures are located in the skull, vertebrae and ribs.

Table 11.14: Number of pre-mortem and perimortem fractures per individual

# of fractures	# of Males	# of Females
1	5	9
2	4	2
3	3	
4		1
6		1
10		1
17	1	
23	1	
32		1

Subadult fractures: Fractures are present in three subadults aged 10-14 of unknown sex. Burial 253 has a pre-mortem fracture of the occipital and left temporal (Figure 11.25). Burial 180 has two pre-mortem fractures of the left clavicle. There are two ambiguous perimortem fractures to both the radii and ulnae. All of the 18 fractures in the child of Burial 180 are perimortem. They are distributed throughout the skeleton including the long bones of all four limbs, the pelvis and the cranium.

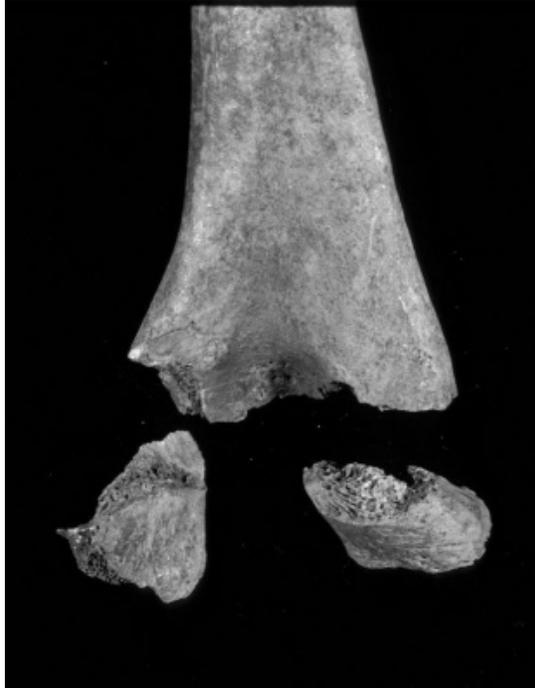


Figure 11.23: Perimortem fractures of the humerii in a female aged 18 - 20 years (Burial 205)

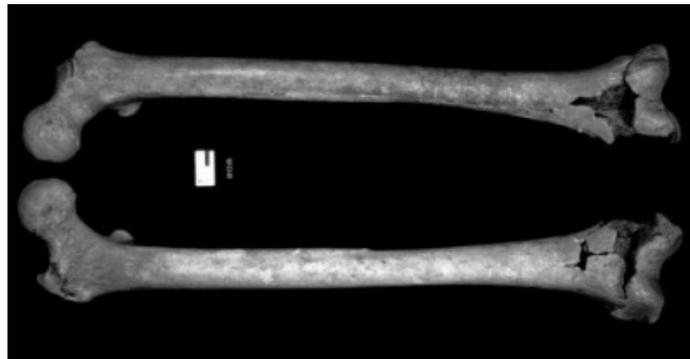
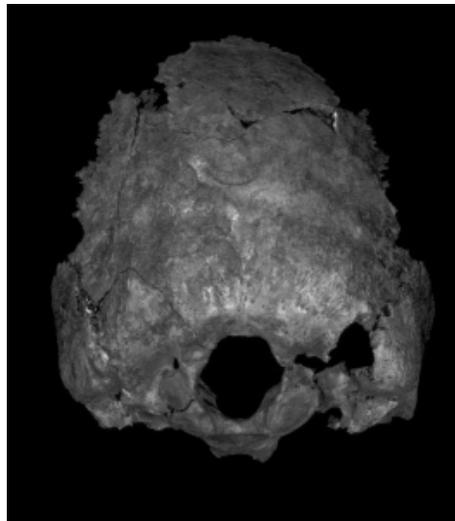


Figure 11.24: Perimortem fractures of the femora in a female aged 18 - 20 years (Burial 205)



**Figure 11.25: Premortem occipital fracture in a subadult aged 13 - 15 years
(Burial 253)**

Numerous individuals in this population have fractures, and it is especially telling that many of them are perimortem. It is certainly possible that at least some of these fractures are related to the cause of death, particularly in cases of perimortem cranial fractures. For individuals with extraordinarily large numbers of perimortem fractures, it is unlikely that they were the result of accidental injury. Captives were subject to being beaten and murdered. It is also possible that the fractures were inflicted shortly after death for unknown reasons.

Burial 25 is the most dramatic case of interpersonal violence in the **ABG** population. A 20-24 year old, 5'1" tall woman, Burial 25 had been found with a lead musket ball lodged in her ribcage (Figure 11.26). In her pathology assessment in the file of Burial 25, Osteologist M.C. Hill writes "smooth, gracile cranium and mandible; maxilla and mandible exhibit old, darkly stained fractures with beveled edges. The patterning of these fractures (restricted to the face) is consistent with a possible La Fort

injury...” With regard to the lower arms, the left radius was shown to be shattered with some of its fractures showing darkly stained and beveled edges. The right radius “has a spiral green bone fracture of the distal metaphysis. There is a large flake of cortical bone missing from the anterior surface in the area of the fracture. Examination of the margins of the flake shows what appears to be a ridge of new bone along the margin and a “web” of new bone inside the flaked area. This area corresponds anatomically to the area of inflammatory periosteal activity on the right ulna.” What is described here is a young woman who had been shot and who had also received blunt force trauma to the face (a rifle butt would customarily have been used to finish a shooting victim), a “spiral” or oblique fracture of the lower right arm just above the wrist (Figure 11.27) caused by simultaneous twisting and pulling. These fractures by virtue of their beveled form and dark color are consistent with the fracture of living bone and were definitely not caused by the excavation. The small trace of new bone and of adjacent inflammatory response suggests that this woman lived for some short period, no more than a few days, after she was beaten. Her left arm also shows evidence of perimortem trauma but with less certainty than her other fractures exhibit.

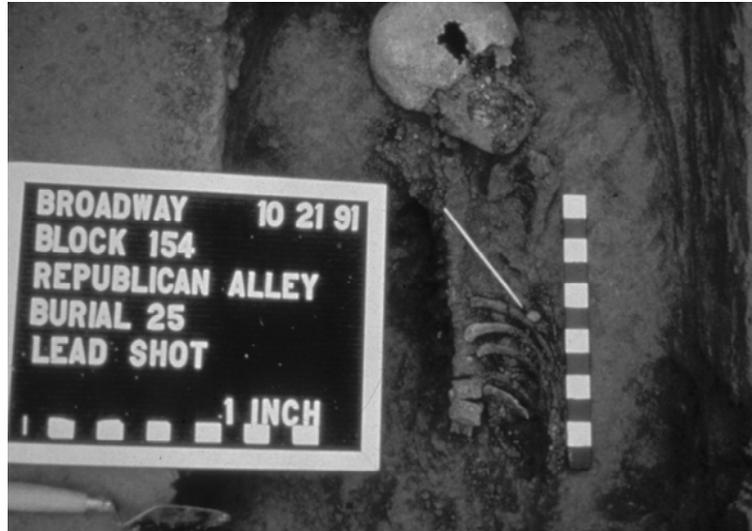


Figure 11.26: Burial 25 is shown in situ with musket ball.

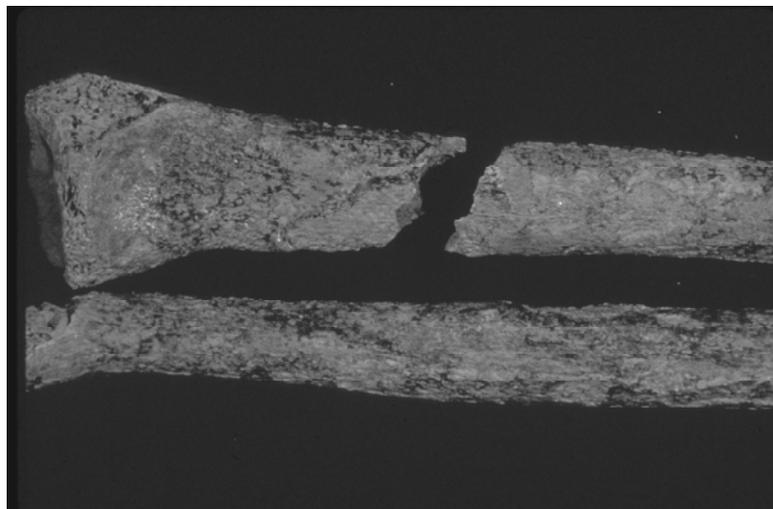


Figure 11.27: Spiral fracture in lower arm of Burial 25

The musket ball was located in the left chest. A large hole exists at the center of the shattered left scapula, suggesting that the projectile had entered through the upper left back. Old fracture surfaces of the ribs were also suggestive of the extent of damage due to the musket ball within the thorax of this young woman. The thinness of the scapula,

however, makes an observation of beveling (expected when living or “green” bone breaks) difficult so that assessment of the point of entry remains plausible though inconclusive. Burial 25, according to Holl’s archaeological report (Holl 2001:116), is part of a “tight group of three burials that seems to constitute a well-delineated unit” that also includes Burial 32 (a superannuated, 55+ years old man) and Burial 44 (a 3-9 year old child). This young woman appears to have died while resisting a person or persons with access to firearms.

Trauma at the ABG shows a unique pattern relative to other sites in the number of perimortem fractures. At Catoctin, there are a few minor antemortem fractures in a wrist (distal radius), ulna, clavicle, metatarsal, and metacarpal plus a dislocation of a hip and perhaps one shoulder that could easily be related to accidental injury although interpersonal violence is not ruled out. Incidence of fracture is not available from South Carolina. At New Orleans, no perimortem fractures are reported, but three males do have antemortem fractures that are more indicative of violence rather than accidental injury. One male has three cranial fractures that the degree of remodeling suggests were inflicted in at least two different episodes. A second male has healed cranial fractures as well as a healed parry fracture of the ulna and a third male also has a single parry fracture. The ABG does show cranial fractures in both males and females as well, suggesting interpersonal violence. The lack of such fractures at Catoctin may indeed reflect better treatment of skilled enslaved laborers in that location than in eighteenth-century New York.

CHAPTER 12

Subadult Growth and Development

S.K. Goode-Null, K. Shujaa, and L.M. Rankin-Hill

Introduction

Growth and developmental status is often used as an indicator of general health status at the population level. A brief review of literature regarding human skeletal growth and development indicates there are several methodologies for assessing these processes in human skeletal remains (Albert and Greene 1999; Flecker 1942; Goode et al. 1993; Gruelich and Pyle 1950; Hoppa 1992; Hoppa and Fitzgerald 1999; Hoppa and Gruspier 1996; Johnston and Zimmer, 1989; Livshits et al. 1998; Miles and Bulman 1994; Saunders 1992; Saunders et al. 1993; Sciulli 1994; Todd 1937). Particularly, adult height may be used as a proxy for an individual's general state of childhood and adolescent nutritional status (Goode et al. 1993; Hoppa 1992; Miles and Bulman 1994). However, Hoppa (1992) and Miles and Bulman (1994) have recently proposed the use of cross-sectional long bone growth profiles in archaeological populations as a means to assess a population's health status, using long bone lengths would stand as a proxy for stature estimates for immature remains. On the other hand, Goode et al. (1993) propose standardizing (see below) all long bone measurements as a method of representing any or all long bones measured in a single graphic plot. This method was promoted as a means of: 1) circumventing situations wherein infant and child skeletons are either fragmentary or skeletal elements are not equally represented, 2) promoting intra- and interpopulation

growth comparisons, and 3) as a means of diagnosing individuals with grossly deviant standardized values for closer analysis of the abnormality (1993:323)¹.

A more thorough discussion of literature that pertains to studies relating long bone lengths to health status can be found in Goode-Null (2002), Hoppa (1999), and Miles and Bulman (1994). Previously, many such analyses of long bone lengths were used to predict the age of unknown individuals (Jantz and Owsley, 1984; Ubelaker 1989). However Hoppa's study revealed that diaphyseal long bone lengths were too variable when comparing four populations across temporal and geographic contexts. His study also illustrated the complex relationship between environment and the biology of growth by comparing age estimates based on humeral and femoral lengths for seven geographically and temporally disparate populations. Hoppa's conclusion was that standards for diaphyseal length were capable of grossly under- or overestimating the age of immature individuals.

The overarching goal of this chapter is to produce an anthropologically-grounded body of information that will broaden our knowledge about the life experiences of enslaved African children in New York City. Specific chapter objectives are to: 1) assess the growth status of individuals; and 2) compare growth status— a) between the sexes, where appropriate and b) with other indicators of health and well being, specifically those associated with physical activity/labor, to achieve a more holistic perspective of childhood under enslavement. These objectives lend themselves to addressing the following more general question about life in the African/African American community of eighteenth century New York City: How did the institution of

slavery affect the overall health and well being of the children in the NYABG population?

Due to the often fragmentary and variable representation of skeletal elements of these individuals, it has been necessary to focus predominantly on growth, osteometric data analysis, in relation to health status and biomechanical stressors. However, development is partially addressed in relation to biomechanical stressors and the high incidence of craniosynostosis (premature fusion of the sutures in the cranium) diagnosed in this population. Given the extensive nature of the New York African Burial Ground Project (NYABGP), skeletal development will be analyzed in future studies and publications related to skeletal developmental asymmetry.

Methodology

The overall condition of the skeletal remains from this site ranges from poor to excellent. The assessment presented in this chapter consisted of the analysis of metric and nonmetric data collected according to the *Standards for Data Collection from Human Skeletal Remains* (Buikstra and Ubelaker 1994). The data include but are not limited to: dental and skeletal age (e.g., epiphyseal closure), sex (adults), pathology, trauma, and osteometrics. These data have been recorded and entered into an SPSS 10.0 Graduate Student Statistical Package database and were used in the analysis presented here.

The methodologies employed in the analysis of growth relied upon building a baseline population sample from which subsamples could be drawn for specific statistical tests. Therefore, the methodological section of the chapter will first delineate how the baseline sample was selected and will be followed by more specific descriptions of how subsamples were drawn.

Criteria for Baseline Sample Size

Several criteria for determining which individuals could be included were employed in the construction of a baseline sample for this study. First and foremost, only those individuals for whom age assessments could be made were included. Secondly, age assignment had to have been based on either dental ages (for individuals less than 15-20 years) or pelvic ages (for individuals 17 years and older), or more than one aging method if the individual was an adult without a pelvic age assessment. Age assessments for infant and juvenile remains were restricted to dental sequences as they exhibit the highest correlation with chronological ages (Lewis and Garn, 1960; Demirjian, 1986; Smith, 1991). Additionally, dental ages are more highly correlated between sexes than either epiphyseal union or long bone lengths. Specifically, skeletal development remains relatively androgynous until the onset of testosterone production in the 6-8 week old male embryo (Pryor 1923; Tanner 1990). At this point the female embryo continues to develop skeletally at a fairly steady rate, while males begin to lag. This sexually differentiated pattern of development progresses from days to weeks during fetal life, and then to months postnatally (Pryor 1923; Pyle and Hoerr 1955). Similar reasoning underlies the preference for utilizing pelvic morphology as the primary indicator of age in older subadults and adults. However, it was deemed appropriate to utilize mean age assessments for two or more aging techniques in the absence of pelvic age indicators. This is predicated upon the higher probability of being able to apply alternative aging methods in a sex specific manner when assessing older subadults and adults.² Due to the criteria used for constructing this baseline sample, there may be some inconsistencies

in the ages reported for some individuals between this and other chapters when results of the analysis are presented and discussed.

Criteria used for baseline selection resulted in a maximum possible sample of 349 individuals from which subsamples for specific analyses could be drawn. Of these 349 individuals, 153 were adults and 194 were less than 25 years of age (172 were 20 years of age or less, and 135 were less than 15 years of age), and thus available as a baseline subsample to specifically assess growth status within the skeletally immature segment of the population.

Growth

Considerable data relating to human growth and development was collected and entered into the project database. These data include dental development, epiphyseal union scores, and long bone measurements, which have been utilized to calculate composite ages for all individuals. This study used the existing ABGP database to meet the objective of assessing overall and differential childhood health and well being of the New York African Burial Ground (NYABG) immature individuals *vis a vis* growth. To achieve this objective, data related to demographic trends in growth status were analyzed separately and in conjunction with data related to pathologies/biomechanical stress indicators, and trauma (see below).

A critique of long bone growth profiles recommends the following methods to assess growth in this population: 1) standardized long bone measurements (Goode et al.1993; Sciulli 1994), and 2) stature estimation. It is generally understood that, for both males and females, skeletal maturity (cessation of growth and union of secondary growth centers) under optimal conditions is usually attained at about twenty years of age

(21 years for males, 18 years for females). Thus, to adequately assess growth status in this population, all individuals under the age of 25 years (n=194) and who are represented by postcranial remains comprised the base sample for data collection. The number of individuals that have sufficient aging criteria and long bones (minimally) that can be included in this portion of the analysis is 130. Of these 130 individuals, 48 are younger than 25 years.

Long Bone Length Standardization

Long bone measurements have been standardized for growth assessment using a very simple ratio calculation. Once age (specifically dental) determination is completed, diaphyseal length of a long bone is divided by the appropriate for age diaphyseal length found in one of the available growth standards. For example: Burial 96 is designated as a male with composite pelvic age of 17 years. His femoral length is 43 cm, while the Maresch (1970, see below) standard indicates an average femoral length of 50.89 cm for males age 17 years. Thus, the resulting proportion, signified by δl is $43/50.89$ or 0.845. Thus, if an individual is represented by a single long bone (δl_i) or by multiple long bones, they can be represented in the plot of δl_i for the population (for additional information on computing δl values see: Goode et al. 1993). For those individuals represented by more than one long bone a mean value of the δl_i for all separate long bones, designated δl_{mean} , can be calculated and plotted. As Goode et al. (1993) indicate, a δl_i greater than unity would represent a bone (or bones if δl_{mean}) that is (are) longer than the standard value, while the opposite is true for δl_i and/or δl_{mean} values less than unity.

The standard used to test this method is derived from the long bone data series collected by the Child Research Council of Denver, Colorado on living children, as

originally reported on by Maresh in 1955 (*cf.* Goode et al. 1993). However, the Denver research group continued to collect data until 1967, and Maresh provided an updated version of the data used by this method in 1970. The updated data reported on by Maresh has recently (Scheuer and Black 2000) been republished and is easily accessible, which promotes the use of this method for interpopulation comparisons, as well as further testing of the method itself to delimit its explanatory power in relation to skeletal growth across time and space.

One such test of the standardization of long bone measurements is provided by Sciulli (1994). Sciulli also utilized the same standard for long bone lengths (Maresh 1955) to calculate δl_i and subsequent δl_{mean} values. However, he substituted Fazekas and Koša's (1978) long bone data at 10 lunar months for Maresh's data for 2 months in the birth cohorts of the populations being tested.

Perhaps the most significant contribution of Sciulli's test, of the standardized long bone measure technique, is his finding that not all δl_i were equivalent, "and therefore the magnitude of the overall measure δl_{mean} depends on which long bone(s) contribute to it" (1994:257). This conclusion is based on two tests he performed. First, Sciulli plotted and compared Maresh's long bone lengths. This resulted in observing that the femur has the greatest growth velocity rate, followed by the tibia and fibula, which were similar. These were followed by the humerus, then the radius and ulna, which were also similar and showed the slowest growth rates. Secondly, Sciulli demonstrated that the five Native American samples in his test of the method "show a significant concordance in relative long bone length" (1994:258). This concordance indicates that, for these samples, elements rank from smallest to largest in length relative to the Maresh standards in the

following manner: femur, tibia, fibula, humerus, radius and ulna (equally large). Sciulli concluded that the pattern found in relative long bone lengths for the five Native American samples can be explained if one accepts the hypothesis that “the most rapidly growing long bones will be the most greatly affected by nutritional and disease stress” (1994:258). Otherwise, he concludes that the patterns observed in his test of the method may be due to inherent differences in growth patterns of the long bones of Native Americans and those of the reference population.

Sciulli’s latter point will be addressed below. However, it is important to note that Maresh’s data on long bone lengths are based on a sample composed of 123 males and 121 females who participated in this longitudinal (1930-1967) health study from birth until at least 18 years of age. These children are of White European descent (primarily Northern European), and are from families whose socio-economic status is characterized as middle-to-upper middle class. The logic behind recruiting children from such families was: 1) to insure that parents had a sufficient understanding of the project goals to maintain a long term commitment, 2) private medical care was available to the participants to reduce the influence of project staff over their health care, and 3) that adequate food resources were not economically dependent (McCammon 1970:6).

The decision to use this reference population in standardizing long bone measurements for the NYABG population was predicated upon several Factors. First, it will facilitate comparisons with previous studies. Second, the genetics of human growth and particularly development are the same for all populations. Specifically, a subset of developmental genes, known as homeobox genes, is essentially “phylogenetic” genes, and thus more highly canalized (under stricter biological control). These homeobox

genes are responsible for controlling segmentation and sequencing of other genes during development (Mange and Mange 1988; Weiss 1993). On the other hand, genes controlling growth are much more plastic, or susceptible to environmental impacts (CDC/NCHS 2001: <http://128.248.232.56/cdcgrowthcharts/module2/text/page5b.htm>). Here it is necessary to be explicit regarding the meaning of the terms growth and development. Acheson (1966:465) notes that growth is “the creation of new cells and tissues” while maturation/development “is the consolidation of tissues into permanent form.” These definitions are reiterated by Bogin (1999) when he notes that growth is a change in size, while development refers to a change in shape.

Consequently, secular trends in growth within and between populations, such as those reported by Sciulli (1994), have a stronger relationship to environmental factors such as political-economic conditions or hypoxic stress. Therefore, this reference population acts as a gold standard, providing an opportunity to assess the level of impact that the political-economy of enslavement had on the growth of the NYABG children. Lastly, this is one of the few longitudinal growth studies undertaken in an environment with a naturally occurring stressor—namely high altitude. In addition to chronic exposure to hypoxic stress, McCammon’s (1970:23-38) description of the population included sufficient background information related to the incidences, types, and timing of illnesses experienced by these children to indicate that there was exposure to short and long term health stressors that could negatively impact the growth of at least some of the children in this study. This, finding then, offsets to some extent the critique that the applications of growth standards derived from homogeneous populations do not adequately reflect the variety of natural and social conditions experienced by populations that do not meet the

same demographic and/or epidemiological composition. This point will be revisited in the following section. In this study the method for calculating standardized long bone measures (δl_i and δl_{mean}) as described by Goode et al., (1993) was followed. However, as outlined by Sciulli, long bone measures provided by Fazekas and Koša (1978) were utilized to calculate the standardized long bone measures in fetal and neonatal remains. Additionally, all individuals under the age of 25 years were included to verify the potential for diagnosing “catch-up” growth with this method when applied to cross-sectional data. Where possible, results from this analysis are compared to those of Goode et al., (1993) and Sciulli (1994).

Stature

Stature estimates for adults were calculated using regression formulae for African-American males and females as developed by Trotter (1970; *cf.* Ubelaker 1989; see Table 12.1). Fazekas and Koša’s (1978:264) non-sex specific regression formulae, as seen in Table 12.2, for fetal and neonatal recumbent length were used to estimate the measurements for fetal remains. It should be noted that Table 12.1 does indicate the standard error of the stature estimate per long bone, while Table 12.2 does not do so. The per long bone standard errors for fetal and neonatal recumbent length estimates are not provided by Fazekas and Koša³.

Table 12.1: African-American Stature Regression Formulae as Developed by Trotter (1970; cf Ubelaker 1989)

MALE	FEMALE
Humerus: Length(cm) $\times 3.26 + 62.10 \pm 4.43$	Humerus: Length(cm) $\times 3.08 + 64.67 \pm 4.25$
Radius: Length(cm) $\times 3.42 + 81.56 \pm 4.30$	Radius: Length(cm) $\times 2.75 + 94.51 \pm 5.05$
Ulna: Length(cm) $\times 3.26 + 79.29 \pm 4.42$	Ulna: Length(cm) $\times 3.31 + 75.38 \pm 4.83$
Femur: Length(cm) $\times 2.11 + 70.35 \pm 3.94$	Femur: Length(cm) $\times 2.28 + 59.76 \pm 3.41$
Tibia: Length(cm) $\times 2.19 + 86.02 \pm 3.78$	Tibia: Length(cm) $\times 2.45 + 72.65 \pm 3.70$
Fibula: Length(cm) $\times 2.19 + 85.65 \pm 3.53$	Fibula: Length(cm) $\times 2.49 + 70.90 \pm 3.80$

Table 12.2: Fetal and Neonate Stature Regression Formulae as Developed by Fazekas and Kosa (1978)

FETAL/NEONATE REGRESSION FORMULAE	
Humerus:	Length(cm) $\times 7.52 + 2.47$
Radius:	Length(cm) $\times 10.61 + 3.95$
Ulna:	Length(cm) $\times 8.20 + 2.38$
Femur:	Length(cm) $\times 6.44 + 4.51$
Tibia:	Length(cm) $\times 7.24 + 4.90$
Fibula:	Length(cm) $\times 7.59 + 4.68$

The utilization of formulae provided by Trotter and Fazekas and Koša provides opportunities for comparative analyses with previous studies of enslaved Africans and African Americans.

Only recently has a study been done using regression formulae for estimating the stature at death for juvenile and subadult remains. In the present study we utilize a sex specific and composite sex linear regression formulae for the calculation of estimated

stature for immature remains (see Tables 12.3, 12.4, and 12.5). The regression formulae were constructed by using the National Center for Health Statistics (NCHS⁴ 2000) recumbent length (infant) and stature data (children two to twenty years of age), as the dependent variable and growth series data for long bones (Maresh 1970), as the predictive or independent variable (Goode-Null, 2002). The utilization of these reference data sets to compute the regression formulae and apply them to the NYABG remains is based upon the fact that secular trends in growth are highly correlated with environmental conditions, as mentioned previously. Specifically, the CDC/NCHS states they “[p]romote one set of growth charts for all racial and ethnic groups. Racial- and ethnic-specific charts are not recommended because studies support the premise that differences in growth among various racial and ethnic groups are the result of environmental rather than genetic influences” (<http://128.248.232.56/cdcgrowthcharts/module2/text/page5b.htm>).

All regression equations were applied in a sex specific manner, if appropriate, to both mean long bone lengths and individual long bone lengths. For individuals of indeterminate sex, the composite regression formulae for birth < 12 months, and ≥ 12 months < twelve years were applied. Individuals over the age of twelve years were assessed by calculating male and female stature estimates; which were then averaged to achieve a mean height at death. Stature was computed for a total of 132 individuals from the NYABG population. Comparisons to the CDC growth standards were then undertaken for stature estimates for all individuals under age 25 years for whom age assessments were made (n = 48).

Development

As noted previously, the extensive nature of the ABGP and the fragmentary and variable representation of skeletal elements did not support an analysis of development at this time. Future studies are planned for such an analysis when additional data can be collected from radiographic films. However, it was possible to undertake a brief qualitative examination and discussion in relation to the presence of craniosynostosis. Craniosynostosis was observed in a total of 15 individuals under the age of twenty-five years. This high rate of occurrence will be examined in relation to primarily potential biomechanical, and to a lesser extent nutritional and genetic, stressors or causes.

Table 12.3: Regression Formulas for Calculating Stature of the Immature Remains of Male Children (all measures are in centimeters)

REGRESSION FORMULAS FOR JUVENILE STATURE ESTIMATION: MALE	
Humerus	
0 < 12mo:	Length \times 7.50 + 1.72 \pm 2.34 (p < .05, r ² = .995)
\geq 12mo < 84mo:	Length \times 4.66 + 26.71 \pm .53 (p < .001, r ² = .999)
\geq 84mo < 150mo:	Length \times 4.54 + 29.66 \pm .80 (p < .001, r ² = .999)
\geq 150mo < 186mo:	Length \times 4.42 + 25.41 \pm 3.93 (p < .001, r ² = .996)
\geq 186mo:	Adult formula
Radius	
0 < 12mo:	Length \times 9.25 + 1.7 \pm 3.29 (p < .05, r ² = .990)
\geq 12mo < 84mo:	Length \times 6.43 + 23.42 \pm .49 (p < .001, r ² = 1.00)
\geq 84mo < 150mo:	Length \times 6.07 + 29.41 \pm .85 (p < .001, r ² = .999)
\geq 150mo < 186mo:	Length \times 5.72 + 28.40 \pm 3.52 (p < .001, r ² = .997)
\geq 180mo:	Adult formula
Ulna	
0 < 12mo:	Length \times 8.88 - 2.87 \pm 2.64 (p < .05, r ² = .995)
\geq 12mo < 84mo:	Length \times 6.07 + 20.23 \pm .54 (p < .001, r ² = 1.00)
\geq 84mo < 150mo:	Length \times 5.68 + 27.41 \pm 1.04 (p < .001, r ² = .999)
\geq 150mo < 186mo:	Length \times 5.23 + 32.23 \pm 2.87 (p < .001, r ² = .998)
\geq 186mo:	Adult formula
Femur	
0 < 12mo:	Length \times 4.59 + 16.27 \pm 2.49 (p < .05, r ² = .990)
\geq 12mo < 84mo:	Length \times 2.97 + 35.85 \pm .39 (p < .001, r ² = 1.00)
\geq 84mo < 150mo:	Length \times 2.85 + 39.19 \pm .57 (p < .001, r ² = 1.00)
\geq 150mo < 216mo:	Length \times 3.14 + 16.13 \pm 3.55 (p < .001, r ² = .995)
\geq 216mo:	Adult formula
Tibia	
0 < 12mo:	Length \times 6.54 + 8.62 \pm 5.93 (p < .05, r ² = .960)
\geq 12mo < 84mo:	Length \times 3.64 + 36.03 \pm .37 (p < .001, r ² = 1.00)
\geq 84mo < 150mo:	Length \times 3.40 + 42.10 \pm .70 (p < .001, r ² = .999)
\geq 150mo < 216mo:	Length \times 3.79 + 13.43 \pm 2.07 (p < .001, r ² = .998)
\geq 216mo:	Adult formula
Fibula	
0 < 12mo:	Length \times 6.77 + 9.08 \pm 4.98 (p < .05, r ² = .971)
\geq 12mo < 84mo:	Length \times 3.59 + 37.38 \pm .43 (p < .001, r ² = 1.00)
\geq 84mo < 150mo:	Length \times 3.56 + 38.92 \pm .71 (p < .001, r ² = .999)
\geq 150mo < 216mo:	Length \times 3.79 + 19.67 \pm 2.75 (p < .001, r ² = .997)
\geq 216mo:	Adult formula

Table 12.4: Regression Formulas for Calculating Stature of the Immature Remains of Female Children (all measures are in centimeters)

REGRESSION FORMULAS FOR JUVENILE STATURE ESTIMATION: FEMALE	
Humerus	
0 < 12mo:	Length \times 7.49 + 0.92 \pm 2.76 (p < .05, r ² = .993)
\geq 12mo < 84mo:	Length \times 4.70 + 25.63 \pm .63 (p < .001, r ² = .999)
\geq 84mo < 150mo:	Length \times 4.63 + 27.68 \pm 1.62 (p < .001, r ² = .998)
\geq 150mo:	Adult formula
Radius	
0 < 12mo:	Length \times 10.45 - 5.05 \pm 3.36 (p < .05, r ² = .992)
\geq 12mo < 84mo:	Length \times 6.57 + 22.99 \pm .81 (p < .001, r ² = .999)
\geq 84mo < 150mo:	Length \times 6.11 + 30.66 \pm 1.30 (p < .001, r ² = .998)
\geq 150mo:	Adult formula
Ulna	
0 < 12mo:	Length \times 10.06 - 10.52 \pm 3.24 (p < .05, r ² = .993)
\geq 12mo < 84mo:	Length \times 6.13 + 19.90 \pm .88 (p < .001, r ² = .999)
\geq 84mo < 150mo:	Length \times 5.60 + 29.70 \pm 1.45 (p < .001, r ² = .998)
\geq 150mo:	Adult formula
Femur	
0 < 12mo:	Length \times 4.49 + 15.90 \pm 1.94 (p < .05, r ² = .994)
\geq 12mo < 84mo:	Length \times 3.01 + 34.15 \pm .56 (p < .001, r ² = .999)
\geq 84mo < 144mo:	Length \times 2.88 + 38.49 \pm 1.16 (p < .001, r ² = .999)
\geq 144mo:	Adult formula
Tibia	
0 < 12mo:	Length \times 6.69 + 6.72 \pm 5.58 (p < .05, r ² = .965)
\geq 12mo < 84mo:	Length \times 3.70 + 34.39 \pm .55 (p < .001, r ² = .999)
\geq 84mo < 144mo:	Length \times 3.34 + 43.68 \pm 1.49 (p < .001, r ² = .998)
\geq 144mo:	Adult formula
Fibula	
0 < 12mo:	Length \times 6.90 + 7.62 \pm 5.71 (p < .05, r ² = .963)
\geq 12mo < 84mo:	Length \times 3.65 + 35.98 \pm .65 (p < .001, r ² = .999)
\geq 84mo < 144mo:	Length \times 3.58 + 38.69 \pm 1.28 (p < .001, r ² = .998)
\geq 144mo:	Adult formula

Table 12.5: Regression Formulas for Calculating Stature of the Immature Remains of Indeterminate Children (all measures are in centimeters)

REGRESSION FORMULAS FOR JUVENILE STATURE ESTIMATION: INDETERMINATE	
Humerus	
0 < 12mo:	Length × 7.51 + 1.17 ± 2.16 (p < .001, r ² = .990)
≥ 12mo < 144mo:	Length × 4.70 + 25.63 ± .63 (p < .001, r ² = 1.00)
Radius	
0 < 12mo:	Length × 9.69 - 0.73 ± 2.58 (p < .001, r ² = .987)
≥ 12mo < 144mo:	Length × 6.57 + 22.99 ± .81 (p < .001, r ² = .998)
Ulna	
0 < 12mo:	Length × 9.32 - 5.67 ± 2.49 (p < .001, r ² = .990)
≥ 12mo < 144mo:	Length × 6.13 + 19.90 ± .88 (p < .001, r ² = .999)
Femur	
0 < 12mo:	Length × 4.54 + 16.08 ± 2.29 (p < .001, r ² = .980)
≥ 12mo < 144mo:	Length × 3.01 + 34.15 ± .56 (p < .001, r ² = .999)
Tibia	
0 < 12mo:	Length × 6.63 + 7.51 ± 3.55 (p < .001, r ² = .967)
≥ 12mo < 144mo:	Length × 3.70 + 34.39 ± .55 (p < .001, r ² = .999)
Fibula	
0 < 12mo:	Length × 6.87 + 8.25 ± 3.17 (p < .001, r ² = .973)
≥ 12mo < 144mo:	Length × 3.65 + 35.98 ± .65 (p < .001, r ² = .999)

These results were also compared to data available in the project database regarding trauma and non-disease pathologies related to biomechanical stressors in an attempt to assess explanatory relationships in an age and sex specific manner. Specifically, long bone fractures were assessed in relationship to individual growth status, as were the non-disease pathologies of arthritic lesions, enthesopathies and hypertrophies. Also, generalized non-specific infectious lesions and anemias were correlated with stature to assess how differential access to nutritional resources may have impacted the growth of individuals in the New York African Burial Ground. All data

analysis was accomplished using SPSS 10.0 Graduate Student Statistical Package for Windows. Specific tests utilized included chi square and correlations, with significance levels set at 5 percent ($p = 0.05$). Power analyses were performed to determine the probability of detecting type II (beta) errors (Hodges and Schell 1988). The power values, provided in Table 12.6, were calculated for small ($w = 0.10$), medium ($w = 0.30$), and large ($w = 0.50$) effects for the specific subsample sizes.

Table 12.6: Power Values for Statistical Chi-square Tests based on sub-sample sizes and magnitude of effect (Effect size is denoted by w)

Sample	N	$w = 0.10$	$w = 0.30$	$w = 0.50$
Total Subsample	48	0.1065	0.5472	0.9337
Males	3	0.0534	0.0815	0.1393
Females	5	0.0557	0.1029	0.2010
Indeterminate	40	0.0969	0.4751	0.8854
0 < 6 years	30	0.0850	0.3759	0.7819
$\geq 6 < 16$ years	10	0.0615	0.1578	0.3526
$\geq 16 < 25$ years	8	0.0592	0.1357	0.2930

Analysis

There is a longstanding recognition of the synergistic relationships between 1) growth, 2) access to nutritional resources, and 3) chronic or acute infectious states (for example see Goodman 1992; Rankin-Hill 1997). However, few assessments of children in the archaeological record have included more than cursory examinations of activity-related skeletal indicators that integrate this triad of health factors. Therefore, the analysis presented below includes biomechanical indicators of stress as a means of

enhancing the overall understanding of children's lives by creating a quartet of interrelated factors and indicators of health. As noted previously, 48 individuals comprise a population subsample in the analysis presented below relating to growth status, health, and labor.

Growth Assessment

Growth assessment provides an entry point for gaining a better understanding regarding what is impacting the distribution of deaths and life expectancies of the young adults, children, and infants from the New York African Burial Ground. The research presented here focuses on standardized long bone lengths and stature estimations. Preliminary growth evaluations for these individuals consist of comparing all individuals represented by the major long bones of the extremities to modern growth standards for height. This was done for both individual long bone elements, as standardized measures, and stature estimates.

Standardized Long Bone Measures

Long bone standardization is a relatively new method for assessing human growth from cross-sectional data that biological anthropologists often investigate. As was presented above, the method of standardization is a simple ratio (δl_i or δl_{mean}) of specific long bones to a corresponding growth standard by element. Table 12.7 provides the δl_i and sex specific δl_{mean} values for the total population subsample (N=48). As can be seen this table also provides the actual number of available elements by sex for calculation of the ratio. This table illustrates that Sciulli's (1994) conclusion that various long bones contribute differentially to δl_{mean} , is correct. When the chart in Figure 12.1 is consulted, it is obvious that this method does not allow the diagnosis of catch-up growth

(accelerated adolescent growth that can greatly compensate for childhood growth retardation) in this population. However, Sciulli's (1994) conclusions that environmental factors will more likely affect the long bones with the most rapid growth velocity may be valid for this population. Table 12.7 indicates that of the sex specific calculations the

Table 12.7: δl_i and δl_{mean} Values for the NYABG Population sub-sample by sex

	Humerus	Radius	Ulna	Femur	Tibia	Fibula	Mean
Male	0.94		0.92	0.84	0.88		0.90
N	1		1	1	1		3
Female	0.98	1.03	1.02	0.97	0.98	0.91	0.98
N	5	2	4	5	2	1	5
Indeterminat	0.94	1.04	0.83	0.96	0.87	0.90	0.92
N	28	15	15	22	13	2	40
Mean	0.95	1.04	0.92	0.92	0.91	0.90	0.94
N	34	17	20	28	16	3	48

femur, tibia, and fibula (but not the ulna) have some of the lowest δl_{mean} values. The relatively high value for the fibulae has more to do with the exceptionally low representation of this element in the remains analyzed here. The fibulae that are present for analysis represent some of the taller (see discussion of stature below) and more mature members of the subsample, thus potentially skewing the value upwards.

Individual δl_{mean} values indicate that 73 percent (n=35) of the total subsample fall below the level of unity. Within this subsample, only one female has a δl_{mean} value in excess of unity, while thirteen indeterminate sex individuals and no males have δl_{mean} values that exceed unity. However, the lowest value for δl_{mean} (0.69) represents an

approximately 6 month old infant (Burial 312). A close scrutiny of the aging and sexing database indicate that there were no discrepancies or errors made in the age assessment.

Overall, 79 percent of the individuals (n=38) have δI_{mean} values that are greater than 0.9. On the surface, this would seem to indicate that most children and young adults in this subsample had at least adequate nutrition to sustain growth. However, how standardized long bone measures influence our interpretation of environmental interactions with growth will be incorporated more fully in the following analyses of stature and pathologies.



Figure 12.1: Mean Standardized Long Bone Measures

Stature Estimates

Stature estimates were calculated in a sex specific manner for all individuals represented by long bones whose biological age could be determined according to the criterion set forth above. Thus, stature estimates were calculated for a total of 129 individuals (males, n=54; females, n=34 indeterminate, n=41). Figures 12.2, 12.3, and 12.4 illustrate individual stature estimates for these NYABG individuals in relation to the select percentiles of the CDC/NCHS stature standards for males, females, and individuals of indeterminate sex, respectively. In these figures, male and female stature estimates are compared to the 25th, 50th, and 75th percentiles of the CDC growth standards, and individuals of indeterminate sex are compared to the male and female CDC male and female 50th percentiles. While all three Figures indicate a "normal" pattern of growth, especially as illustrated in Figure 12.4, they also indicate the presence of moderate-to-severe growth deficits at various points in the life span. Figure 12.2 identifies an overall growth deficit for nearly all the males in this mortuary subsample. When a close examination of males less than 25 years is undertaken by comparing Figure 12.2 and Table 12.8, it becomes apparent that all (n=3) males fall below the 10th percentile and would be classified with moderate-to-severe growth impairment. There are two males (66.7 percent) who do fall below the third percentile. Females younger than 25 years, as represented by Figure 12.3 and Table 12.9, have consistently higher stature estimates for assessed age. Sixty percent of all females (n=3) fall below the 50th percentile, while forty percent (n=2) fall at or above the 50th percentile. Two females (40 %) do fall below the 25th percentile in growth, which includes one female (20 %) who falls at the 10th percentile. However, females have a far greater percentage (n=3, 60 %) of individuals

who fall within and above the range for normal growth, with one of these females (Burial 276) falling above the 90th percentile.

The representation presented in Figure 12.4, is provided as an evaluation of using a composite male/female regression formula for estimating the stature for individuals of indeterminate sex. No calculations of growth percentiles were undertaken for this segment of the population subsample.

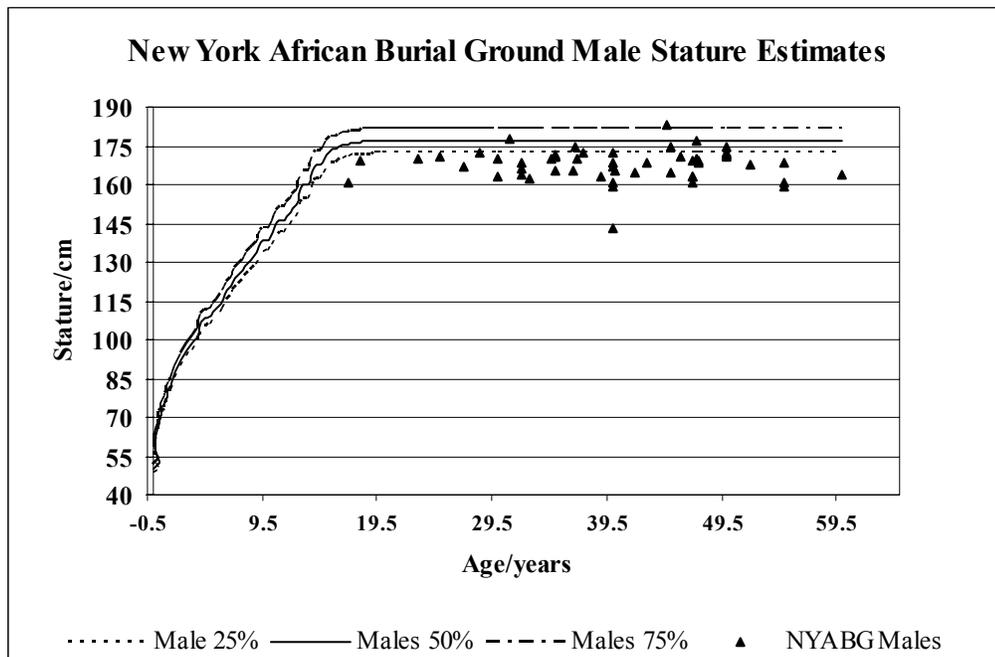


Figure 12.2: New York African Burial Ground Stature Estimates: Male

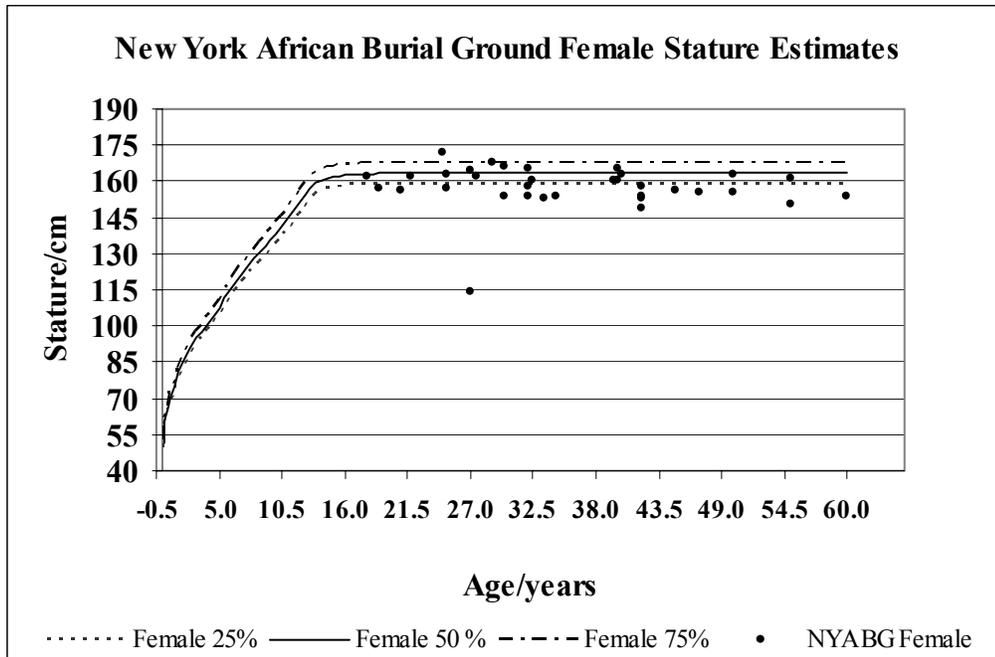


Figure 12.3: New York African Burial Ground Stature Estimates: Female

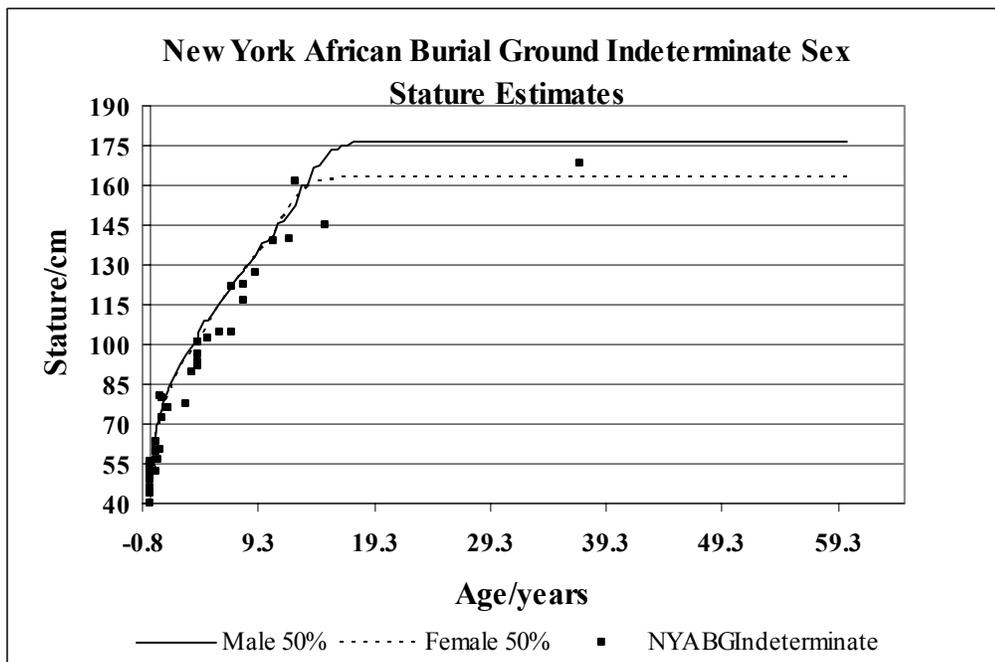


Figure 12.4: New York African Burial Ground Stature Estimates: Indeterminate Sex

However, by looking at the chart it is quite apparent that the individuals (predominantly infants and young children) were experiencing similar patterns in growth as the male and female standards, though the demarcation between those experiencing poor growth and those with normal or close to normal growth are more pronounced. As with the previous two figures, it is apparent that several individuals are falling well below the 25th percentile of growth (male or female standards). Overall, an initial assessment of these data, based on the figures and tables provided above, illustrate that stature, as a gauge of health and nutritional status, indicates females within this mortuary sample were healthier in relation to their male counterparts. Yet, as pointed out by Wood et al. (1992), this conclusion may be precipitous if considered a direct evaluation of individual risk of death due to underlying differences in frailty. A further evaluation of the sex specific stature estimates in relation to health will be taken up below.

Table 12.8: Male Stature Estimates and Growth Standard Percentile Rankings for Individuals less than 25 years of age only.

Burial #	Age	Stature	% Rank
96	17	161.09	2
427	18	163.19	9
343	22.8	170.14	2

Table 12.9: Female Stature Estimates and Growth Standard Percentile Rankings for Individuals less than 25 years of age only.

Burial #	Age	Stature	% Rank
259	18	162.03	49
205	19	156.65	24
122	21	156.35	10
383	21.75	161.69	50
276	24.5	158.17	94

The stature estimates provided above also need to be considered in relation to the standardized long bone measurements and pathology assessment before fully committing to this conclusion.

The relationship between the δl_{mean} values presented above and stature is illustrated in Figure 12.5. The δl_{mean} values are presented by sex and in relation to stature estimates. They further illustrate that on the whole, the population is not reaching its growth potential. Of the 71 percent (n=35) of the subsample that falls below the unity level, 3 (9 percent) are males, 5 (14 %) are females, and 27 (77 %) are individuals of young adolescents and children of indeterminate sex. This finding mirrors the 72 percent of the population subsample which fall at or below the 25th percentile for stature, considering that there were 39 immature individuals of indeterminate sex for which percentile rankings could not be assessed.

Correlations were undertaken to test the relationship between δl_{mean} and stature estimates or their percentile rankings to determine the validity of assessment of growth status based on the visual relationship between these two variables. The two-tailed test of δl_{mean} and stature estimates indicated there was a significant relationship between the two variables, something that could easily be predicted from Figures 12.1 and 12.4. However the test of relationship between δl_{mean} and percentile rankings of stature was significant at the $p < 0.01$ level, with a correlation coefficient of 0.781 and an adjusted r^2 value of 0.601. The high but not perfect correlation between δl_{mean} values and percentile rankings is expected since both methods are founded on a common reference data set. However, the ability of each method to produce results that do not regress to the mean indicates that either or both of these methods can be utilized to probe issues of population health. The

above analyses of growth status using standardized long bone measures and stature estimates indicate that the population was minimally not having its physical needs met. However, physical growth, as measured by stature or long bone growth, is not the only marker of nutritional status or health, nor is nutrition the only factor that influences growth. Therefore, the following section will present an analysis of data that relates to other skeletal indicators of nutritional stress, general infection and indicators of biomechanical stress.

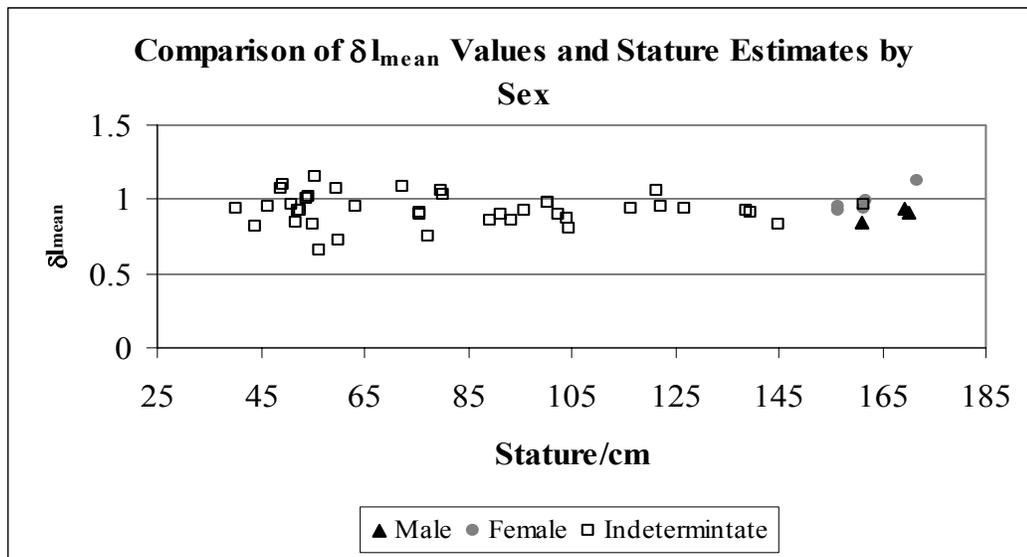


Figure 12.5: Comparison of Individual δI_{mean} Values and Stature Estimates by Sex

Pathological Assessments

The database available for pathological assessment of individuals from the NYABG contains over 16,000 entries related to pathology by type, element, aspect, and severity. Many of these entries are general codes that allow researchers to assess suites of pathologies for differential diagnosis, still a smaller percentage are codes that relate to specific disease or "abnormal" conditions. The analysis presented here relied on a survey of both types of pathological codes. The conditions that will be analyzed below are

indicators of nutritional status, specifically pathologies related to anemias and generalized nonspecific infectious lesions, and biomechanical stress markers. The authors would like to remind readers that information presented in this chapter is restricted to a small subset of biologically immature individuals and may not reflect results presented in previous chapters (i.e., Chapter 10).

Nutritional and General Infection Indicators

Due to the synergy between nutrition and generalized infectious processes, this section will address both sets of pathologies. The first set of data to be considered is those associated most often with nutrition first and disease processes second. These data are related to anemia, specifically lesions found frequently in the craniofacial region known as porotic hyperostosis and their corresponding lesions in the eye orbit referred to as cribra orbitalia. Both orbital and cranial lesions will be referred to as porotic hyperostosis (PH) throughout the remainder of this chapter. Abnormal long bone morphology can also be attributed to nutritional deficiencies, such as anemia, rickets (vitamin D deficiency), and scurvy (vitamin C deficiency) and biomechanically induced stress during growth or over prolonged periods of time. These indicators of either nutritional status and/or biomechanical stress will also be considered below. However, as there are only limited ways in which bone can react to various insults (Ortner and Putschar 1981), infectious and dietary related lesions may be similar in appearance at the gross level of analysis, and can only be diagnosed at the microscopic or radiographic level. Thus, lesions characterized as reactive lamellar bone will be attributed to the category of generalized infectious processes, though undoubtedly some will eventually be diagnosed otherwise.

Nutritional Indicators

Porotic hyperostosis (PH) is most often associated with childhood nutritional deficiencies in iron during peak growth phases or may be attributed to genetic hemolytic disorders such as thalassemia or sickle cell anemia. The purpose of the analysis presented here is not to identify PH as iron deficiency anemia or as a hemolytic disorder; rather, it is to assess the presence of anemia-related lesions in relationship to against the health status of the infants, children, and young adults and its connections to their growth. Also, both nutritionally induced and inherited forms of anemias have negative consequences for growth, *vis a vis* their impact on cellular metabolism.

The individuals diagnosed with PH lesions in the subsample used in the current growth analysis are shown in Table 12.10. The number of PH/ ICH lesions per individual is represented as a means to complete individual frailty. In addition to PH, infantile cortical hyperostosis (ICH) may be a genetic condition or viral disease associated with anemia (Varma and Johny 2002) and is included in the table. Thirteen (27 %) of forty-eight individuals have PH lesions. Males represent 7 percent (n=1) of the affected individuals with sex assessments, which is 33 percent of all males in the population subsample (n=3). Females, in comparison, represent 14.2 percent (n=2) of the individuals with PH, and 40 percent of the total number of females in the subsample. Individuals of indeterminate sex (n=11) are young infants and children. Five of these children (45.5 %) are infants less than two years of age. In all, minimally 61 PH lesions are recorded for these 14 individuals. Given the small sample of individuals who could be sexed, the rate of lesions per individual (4.4) was calculated for the entire subsample. Tests for relationships between PH and δl_{mean} and percentile rankings of stature were

made using the chi-square test. These tests were made for the total population subsample, as well as separately for age and sex groupings when the sample size permitted. The results of these chi-square tests are presented in Table 12.11. As can be seen in this table, the significant levels (p) of the chi-square statistic were well above a standard alpha of 0.05. Additionally, the power values computed to assess the possibility of type II (beta) errors (Hodges and Schell 1988:175) are also indicated in this table. The values for power presented in this table are those calculated assuming a large size effect ($w = 0.50$; also reported in Table 12.4).

Table 12.10: Occurrence of Porotic Hyperostosis and Infantile Cortical Hyperostosis in the NYABG Population sub-sample.

Burial	Age	Long Bone	Front	Pariet	Temp	Occip	Orb	Sphen	Max	Zyg	Tot. Path
Male											
343	22.8						2				2
Female											
205	18			2		1					3
122	21		1	4		1	2	1			9
Indeterminate											
186	0.00						2				2
64	0.63			2		1	1				4
225	0.75	6					2				8
91	1.00	2									2
252	1.50	6							2		8
7	4.00						2		2		4
55	4.00						2		2		4
138	4.00			2	2	1				2	7
39	6.00				2		2				4
35	9.00						2				2
368	12.00						2				2
Total (n)	14	3	1	4	2	4	10	1	3	1	61

Table 12.11: Chi-square Test Results for Relationship between PH and δl_{mean} and Percentile Rankings for Stature

Chi square test	Chi-square value	P
Total Population subsample (n=48; power = 0.9337)		
PH by δl_{mean}	4.168	0.654
PH by percentile ranking	7.352	0.499
Age Groups: 0<6 years (n=30; power = 0.7819)		
PH by δl_{mean}	4.541	0.604
PH by percentile ranking	5.284	0.727
Age Group: 6< 16 years (n=10; power = 0.3526)		
PH by δl_{mean}	0.476	0.788
PH by percentile ranking	1.667	0.435
Age Group: 16 < 25 years (n=8; power = 0.2930)		
PH by δl_{mean}	1.60	0.449
PH by percentile ranking	5.156	0.272
Sex: Male (n=3; power = 0.1393)		
PH by δl_{mean}	0.750	0.386
PH by percentile ranking	3.00	0.223
Sex: Female (n=5; power = 0.2010)		
PH by δl_{mean}	0.833	0.361
PH by percentile ranking	5.000	0.082
Sex: Indeterminate (n=40; power = 0.8854)		
PH by δl_{mean}	4.333	0.632
PH by percentile ranking	5.308	0.724

Generalized Lesions of Infection

An analysis of generalized or systemic infectious lesions produced very similar results as those for the relationship between PH and growth status. The pathological

observations that constituted generalized infection as a variable were: lamellar reaction (active lesion), sclerotic bone (healed lesion), bone loss, and presence of reactive woven bone (concurrently active and healing lesion). The analysis presented here focuses on presence of infectious lesions in long bones as these skeletal elements contribute significantly to an individual's overall stature at maturity. As with PH/ICH lesions, the number of infectious lesions per element per individuals is presented in Table 12.12 as a means to contemplate individual frailty. Table 12.12, demonstrates that it is possible to calculate that a total of twenty-five individuals (52 %) in this subsample (n=48) were diagnosed as having at least one lesion indicative of generalized infections. As with porotic hyperostosis, individuals of indeterminate sex represent the largest group to be diagnosed with generalized infectious lesions. Males, though, have the highest rate of lesion occurrence (15 per person), followed by females and indeterminate individuals with lesion rates of 14.7 per person and 10.9 per person, respectively. However, it should be noted that all males (n=2) and all females (n=3) with this diagnosis are over the age of 16 years, while all individuals of indeterminate sex (n=20) are under 16 years of age.

Table 12.12 also indicates that eight individuals (29.6 %) have 15 or more lesions at multiple osseous sites. A total of 20 individuals (74 %) have multi focal sites of infectious lesions in both upper and lower extremities; individuals could be classified as having systemic (possibly chronic) infection to one-third of the total population subsample. Chi square tests of relationship between infection and indicators of growth (percentile rankings and δ_{mean} groups) were computed for the total population subsample, by age group, and by sex. The results of these tests, shown in Table 12.13, demonstrate

that infection is not related to δ_{mean} values or percentile rankings for stature. Additionally, a Fishers Exact chi-square evaluation of the potential relationship between anemia and infectious processes was undertaken. The results of this test were a majority of significance levels in excess of 0.100. The results of these analyses indicate that generalized infection does not contribute greatly to our understanding of the variation in growth status among members of this population's subsample nor the presence of PH lesions.

Table 12.12: Generalized Infectious Lesions as Diagnosed in Long Bone Skeletal Elements.

Burial#	Age	Humerus		Radius		Ulna		Femur		Tibia		Fibula		Total
		L	R	L	R	L	R	L	R	L	R	L	R	
Male														
427	18.00					2	2	2	2	2	2	3	3	18
343	22.80	1	1	1	1	1	1	1	1	1	1	1	1	12
Female														
259	18.00							1			1			2
122	21.00	3	3	3	3	3	3	3	3	3	3	3	3	36
383	21.75	2	2	1	1			3	3	1	1	1	1	16
Indeterminate														
117	-.13	1		1		1		1						4
42	.00			1		1		1	1	1	1			6
53	.50	1	1		1	1	1	1	1	1	1			10
108	.50	1	1	1	1	1	1							6
86	.75		2		2			2	2	3	3			14
225	.75	2	2	1	1	2	2	3	3	1	1	1	1	20
91	1.00			1	1	1	1	1	1					6
252	1.50	2	2		2		2	3	3					14
363	1.50	2	2	1	1	1	1	3	3					14
187	2.75	2	2	2	2	2	2	2	2	2	2	2	2	24
22	3.50	2	2	1	2	1	1	1	1	2	2		2	17
55	4.00	1	1	1	1	1	1	1	1	1	1	1	1	12
58	4.00	2	2	1						2	2	2	2	14
219	4.00	2	3		1		1	2	2	3	3	1	1	19
39	6.00	1	2					2	2	2	2	2	2	15
396	7.00			1	1			1	1					4
35	9.00					1	1							2
180	10.50							1	1					2
125	12.50									1	1	1	1	4
253	15.00	1	1					2	2					6
Total	25													302

Abnormal Bone Morphology

The presence of abnormal bone morphology, such as bowing, flared metaphyses, and “flattening” of long bone shafts, can be a result of nutritional deficiency, infectious process, or biomechanical stress. These factors can work singly or in combination to produce various forms of shape abnormalities. For instance, vitamin D deficiency

(rickets) creates a physiological environment in which the absorption of calcium into bone matrix is inhibited. This failure leads to a state where the structural integrity of the cortical bone is weakened and the biomechanical stress of load bearing can cause bowing of the long bones. Symmetry of pre-mortem long bone abnormal shape could not be assessed due to the unequal representation of long bones for most individuals.

There were “a total of” forty individuals (83 %) of the population subsample that were diagnosed with some form of pre-mortem abnormal shape in one or multiple long bones. Twelve individuals (25 %) were diagnosed with either platycnemia or platymeria (flattening of the tibial and femoral shafts, respectively). Eighteen (37.5 %) were also diagnosed with bowing of one or more long bone shafts, while thirty-six (75 %) individuals were diagnosed with flaring of the metaphyses of one or more long bones. Table 12.14 indicates the distribution of these pathologies for the total population subsample by age and by sex.

Potential relationships between shape abnormality and anemia, infection, and growth status were statistically tested using chi square analyses. The results of these tests indicate that there is no relationship between long bone shape abnormalities and anemia or δl_{mean} grouping values. The only significant association was between bowing and infection in children $> 0 \leq 6$ years ($n = 30$; $p = 0.003 < 0.05$).

As was noted above, these morphological variables bridge the three categories of pathologies being analyzed in this chapter. The following section will proceed with an analysis of biomechanical stress indicators in an attempt to more fully elucidate the complex relationships between these factors.

Table 12.13: Chi-square Test Results for Relationship between Infectious Lesions and δl_{mean} and Percentile Rankings for Stature

Chi-square test	Chi-square value	P
Total Population sub-sample (n=48; power = 0.9337)		
Infection by δl_{mean}	9.043	0.171
Infection by percentile ranking	9.997	0.265
Age Groups: 0<6 years (n=30; power = 0.7819)		
Infection by δl_{mean}	30.000	0.414
Infection by percentile ranking	12.254	0.140
Age Group: 6< 16 years (n=10; power = 0.3526)		
Infection by δl_{mean}	10.000	0.350
Infection by percentile ranking	1.667	0.435
Age Group: 16 < 25 years (n=8; power = 0.2930)		
Infection by δl_{mean}	8.000	0.333
Infection by percentile ranking	5.156	0.272
Sex: Male (n=3; power = 0.1393)		
Infection by δl_{mean}	3.000	0.083
Infection by percentile ranking	3.000	0.223
Sex: Female (n=5; power = 0.2010)		
Infection by δl_{mean}	1.875	0.171
Infection by percentile ranking	2.917	0.233
Sex: Indeterminate (n=40; power = 0.8854)		
Infection by δl_{mean}	6.722	0.347
Infection by percentile ranking	10.250	0.248

Table 12.14: Distribution of Abnormal Long Bone Shape in the Total NYABG Population sub-sample by age and sex

Age	Flattening		Bowling		Flaring	
	n	percent	n	percent	n	percent
Total Subsample	12	25	18	37.5	36	75
0 < 6 years	1	3.3	9	30	25	83
6 < 16 years	5	50	6	60	7	70
16 < 25 years	6	75	3	37.5	4	50
Males	3	100	1	33.3	2	66.7
Females	3	60	2	40	2	40
Indeterminate	6	15.0	15	37.5	32	80

Biomechanical Stress Indicators

Indicators of biomechanical stress can manifest themselves skeletally in a variety of ways. One is the absolute change in morphology of a skeletal element, as was mentioned above. Many biomechanical stress indicators are generally “built” over time and are often the result of interactions between load bearing and/or repetitive motion and other factors affecting bone metabolism. In some instances, the factor affecting bone metabolism is due to natural processes of metabolic slowdown related to aging. This is often the case with age-related osteoarthritis—years of “living and doing” manifest as symptoms of arthritis in increasing frequency as individuals age. Arthritis in younger adults and children may be a result of a variety of disorders such as juvenile rheumatoid arthritis and its related autoimmune disorder Lupus. Yet, it may also be a result of intense or increased physical activity (load bearing and repetitive actions) at points in the

life span when bone (and cartilage) is undergoing rapid rates of remodeling due to growth cycles.

Intensified or increased physical activities can also leave their mark by accentuating points of muscle insertions or origins on bone (hypertrophies). These tend to be the result of long term biomechanical stress on those areas. However, acute events of intense physical activity can result in the avulsion of bone at the site of muscle and ligature insertions (enthesopathy and arthropathy, respectively). Fractures are another class of acute events related to biomechanical stress. Whether a fracture is the result of purposeful or inadvertent action, the result of the action is that bone is subject to a biomechanical force that exceeds its capacity to maintain structural integrity.

With this in mind, the NYABG pathology database was probed for occurrences of biomechanical indicators of stress in long bones, specifically looking for occurrences of fractures, arthritis, enthesopathy/arthropathy, and hypertrophy in individuals under the age of 25 years. It should be noted that project Osteologists paid close attention to discerning the differences between bone irregularities resulting from normal growth processes and those directly attributable to acute and/or chronic biomechanical stressors.

A total of nineteen people (39.5 %) in the population subsample were diagnosed with these biomechanical stress indicators. Table 12.15 provides a summary of all individuals who were represented by at least one occurrence of any of these four biomechanical stress indicators. The number one (1) in a column designates the occurrence of at least one site of a specific indicator, though many individuals were diagnosed as having multiple sites of biomechanical stress. This table indicates that five

(26.3 %) of the individuals were diagnosed with fractures. Approximately 42 percent of the population subsample was diagnosed as having arthritis, while sixteen

Table 12.15: Distribution of Individuals with Biomechanical Stress Indicators by age and sex in the NYABG Population sub-sample

Burial	Age	Fracture	Arthritis	Hypertrophy	Enthesopathy
Male					
96	17.00			1	
427	16.50				1
343	22.8		1	1	
Female					
205	18.00	1	1	1	1
259	18.00	1	1	1	1
122	21.00		1	1	1
383	21.75			1	1
Indeterminate					
58	4.00			1	
138	4.00			1	
219	4				1
39	6.00		1	1	1
244	7.00			1	1
396	7.00			1	
95	8.00		1	1	1
405	8.00			1	
180	10.50	1		1	
368	12.00			1	
25	12.5	1	1		
253	15.00	1	1	1	1
Total (n)	19	5	8	16	11

(84.2 %) and eleven (57.9 %) individuals were recorded as having hypertrophies or enthesopathies, respectively. What is striking about this occurrence of biomechanical stress indicators is that a total of eleven children (57.9 %) under the age of 16 years have been diagnosed with fractures, arthritis, hypertrophies, or enthesopathies. Also eight of these children are between the ages of four and ten years. The co-occurrence of hypertrophic attachments and enthesopathy is more prevalent in females (n=4, 100%), while males have a 50 percent (n=1) co-occurrence followed by indeterminate individuals with 33.3 percent (n=4).

Statistical tests of observable relationships (Table 12.16) between the three indicators of biomechanical stress were made. Due to the low subsample size for fractures they were not included in this, or any of the following analyses. The results of Fisher's Exact chi square analyses provided in Table 12.16 demonstrate significant relationships in the pattern of co-occurrence of these variables (n = 48; p < 0.05). Statistical analysis of these biomechanical stress indicators in relation to growth status, PH, generalized infectious lesions, and abnormal shape variables were also tested. The results of statistically significant relationships for the total population subsample (n=48) were between: hypertrophy and long bone flattening ($\chi^2 = 9.341$, p = 0.004 < 0.05); arthritis and long bone flattening ($\chi^2 = 13.642$, p = 0.001 < 0.05); enthesopathy and long bone flattening ($\chi^2 = 11.361$, p = 0.002 < 0.05); hypertrophy and bowing ($\chi^2 = 4.713$, p = 0.033 < 0.05); and enthesopathy and bowing ($\chi^2 = 4.159$, p = 0.047 < 0.05). Among individuals of indeterminate sex, statistically significant relationships were also found among a small set of variables. These relationships are: hypertrophy and long bone

flattening ($\chi^2 = 6.536$, $p = 0.026 < 0.05$) and hypertrophy and long bone bowing ($\chi^2 = 6.009$, $p = 0.020 < 0.05$). When considering the relationships between these variables by age grade, only stature ranking (percentile) and enthesopathy ($\chi^2 = 9.000$, $p = 0.011 < 0.05$) in children $\geq 6 < 16$ years, and δl_{mean} and enthesopathy ($\chi^2 = 8.000$, $p = 0.018 < 0.05$) in subadults/young adults $\geq 16 < 25$ years exhibited statistically significant results. The overall relationships among long bone flattening and arthritis, hypertrophy, and enthesopathy may indicate that this particular form of abnormal bone shape is more likely to result from biomechanical stress rather than nutritional insufficiency. Additionally, the relationship between enthesopathy and δl_{mean} values and stature ranking in children over the age of 6 years is a strong indicator that childhood labor was impinging upon long bone growth.

Table 12.16: Results of Chi-square Tests of Relationships between Biomechanical Stressors

Chi-square Test	Chi-square	p
Arthritis by hypertrophy	15.157	0.0001
Arthritis by enthesopathy	19.899	0.0001
Hypertrophy by enthesopathy	19.475	0.0001

Craniosynostosis

The presence of craniosynostosis was observed in 15 individuals of the 48 individuals under the age of 25 years (31.3 percent) that comprise the subsample for analysis in this chapter. The suture(s) involved sex, and age of each of these individuals is provided in Table 12.17. As can be seen in this table, 12 of the individuals (80 %) are 6 years of age or older. When considering the prevalence of craniosynostosis in relation to growth,

infection, nutrition, and biomechanical indicators, several evocative relationships were revealed. Table 12.18 provides only the statistically significant results between these variables and craniosynostosis. When these results are reviewed, one must remember that all individuals of indeterminate sex in the population subsample are under the age of 16 years. Several significant relationships ($p < 0.05$) exist between craniosynostosis and infectious, nutritional, and biomechanical indicators at the level of the total population subsample. However, the relationships observable among a large segment of the youngest members of this subsample indicate that minimally the presence of craniosynostosis in any given individual can be exacerbated by chronic or acute exposure to biomechanical, nutritional, and/or infectious stressors. In particular, nutritional and biomechanical stressors may accelerate or even cause the expression of this particular developmental pathology.

Table 12.17: Individuals with Craniosynostosis by Suture(s)

(S= spheno, F=frontal, T= temporal; P=parietal)

Burial	Age	Coronal		Sagittal	Lambdoid		SF		SFT		SFTP		Total Sutures
		L	R		L	R	L	R	L	R			
Males													
427	18			x									1
96	17			x	X	x							3
343	18						x						1
Females													
122	21	x	x	x							x	x	5
383	21.75	x	x	x									3
Indeterminate													
91	1			x									1
252	1.5			x	X								2
58	4		x					x					2
39	6		x	x	X			x					4
95	8			x				x					2
405	8			x	X								2
35	9		x	x	X	x				X			5
180	10.5			x	X	x							3
368	12							x					1
253	15	x					x						2
Total (n)	15	3	5	11	6	3	2	4		1	1	1	

Table 12.18: Chi-square Test Results for Relationship between Craniosynostosis and Biomechanical, Nutritional, and Infectious Indicators

Chi-square test	Chi-square value	P
Total Population subsample (n=48; power = 0.9337)		
Craniosynostosis by arthritis	8.828	0.006
Craniosynostosis by hypertrophy	12.738	0.001
Craniosynostosis by enthesopathy	6.967	0.013
Craniosynostosis by flattening	14.255	0.0001
Craniosynostosis by bowing	11.953	0.001
Craniosynostosis by infection	3.948	0.046
Age Groups: 0<6 years (n=30; power = 0.7819)		
Craniosynostosis by bowing	7.778	0.021
Sex: Indeterminate (n=40; power = 0.8854)		
Craniosynostosis by hypertrophy	14.400	0.001
Craniosynostosis by arthritis	5.926	0.042
Craniosynostosis by flattening	6.536	0.026
Craniosynostosis by bowing	10.276	0.002

Discussion

Analyses of standardized long bone measures and stature estimates of the NYABG sample demonstrate that environmental stressors impacted overall growth. Goode et al. (1993) proposed that standardizing measures of long bone length would facilitate intra- and interpopulation comparisons of growth and health. Within this population subsample, neither nutritional, generalized health, nor biomechanical indicators of environmental stressors were associated with low δI_{mean} values presented in Table 12.7. Sciulli (1994) has published the only comparable data for five Native American populations in the Ohio River Valley (3000BP-300BP). Table 12.19 compares

the values calculated for the NYABG sample (n=48) to those presented by Sciulli (1994). While the samples compared in this table exhibit temporal heterogeneity, they all show the differential impact that δl_i have on δl_{mean} values. Also, all skeletal series illustrate that the long bones of the lower extremity, generally the femur, tend to have the lowest δl_i values within each population. While there are considerable differences between δl_i values, patterns of long bone growth are quite similar when subsample size is taken into consideration.

Table 12.19: A Comparison of NYABG δl_i and δl_{mean} Values with those of five Native American Populations (Sciulli 1994)

	δl_i						δl_{mean}
	Humer	Radius	Ulna	Femur	Tibia	Fibula	
NYABG (18th century)	0.95	1.04	0.93	0.93	0.90	0.90	0.94
n	34	17	20	31	14	3	50
Archaic (3000 years BP)	0.92	0.94	0.91	0.88	0.92	0.89	0.90
n	24	15	15	24	16	7	32
Pearson (850 years BP)	0.93	1.00	0.98	0.90	0.98	0.96	0.93
n	26	19	20	45	38	23	59
Sunwatch (800 years BP)	0.87	0.87	0.87	0.82	0.86	0.85	0.86
n	63	58	55	57	54	48	77
Monongahela (600 years BP)	0.89	0.91	0.92	0.85	0.87	0.87	0.89
n	43	39	32	43	38	24	61
Buffalo (300 years BP)	0.87	0.86	0.90	0.84	0.85	0.85	0.88
n	28	22	19	35	25	10	43

This finding demonstrates that the calculation of standardized long bone measures may be quite useful, as Goode et al. (1993) predicted, for comparisons of growth when

the goal is to assess variation that disease has on growth. As these authors noted, it is necessary to broaden the definition of disease within this context. While Goode-Null (2002) promoted the inclusion of trauma, this study has included other biomechanical stress indicators that are more frequently associated with chronic or intense physical activity as a means of investigating labor-related activities of children.

The estimation and assessment of stature for the NYABG sample indicate that most of young adults and children were falling well below the 25th percentile of the CDC/NCHS height for age standards. When the possible factors that may have influenced the overall poor growth status of these individuals are considered, none of the variables representing nutritional status, generalized health status, or biomechanical stress proved to have a significant relationship with estimated stature for the population subsample. Another factor that must be considered is that error in age estimation of young individuals could have influenced the application of regression formula. These factors could either over or underestimate stature calculations depending upon which error was made. However, close examinations of dental aging scores did not demonstrate errors in the extrapolation of mean dental ages. Additionally, the age ranges for each of the juvenile regression equations are generally broad enough to capture minor errors in dental age estimation.

Steckel (1996) provides the only comparable data for enslaved individuals under age 25 years. Reporting on stature estimates taken from ship manifests supplying the Antebellum South (1820-1860), he provides mean stature calculations for enslaved males and females from 4.5 years of age through adulthood. A comparison of the NYABG stature estimates and those reported on by Steckel are provided in Figures 12.6 and 12.7

for males and females respectively. It should be noted that the values at age 25 years in both figures actually reflect adult stature estimates for both the NYABG population and those individuals comprising Steckel's sample. This comparison indicates that there are no significant differences between the NYABG and antebellum South samples of enslaved Africans and African Americans. The lack of significant differences in the two population samples suggests that 1) enslavement was equally detrimental to the health of individuals (as reflected by growth status) in the North and in the South, and 2) the regression formula used to estimate stature for the NYABG juvenile remains provides an accurate reflection of the growth status of these individuals.

While growth status can stand alone as an indicator of population health and nutritional status, it is the result of a complex set of interactions among nutritional intake, disease processes, and energy expenditure during physical activity. Thus, the fact that the majority of independent nutritional and health indicators were not significantly correlated with growth status within the NYABG population subsample warrants further discussion. Nutritionally, minimally one-quarter sample had experienced an episode of anemia. Interestingly, of all lesions diagnosed and identified as PH, only one individual, an approximately 8-month old infant of indeterminate sex (Burial 64), had lesions coded as active only. All other individuals in the population subsample have PH lesions noted as healed and were, therefore, not actively experiencing iron deficiency at the time of their death. This situation may explain why there was no correlation between presence/absence of PH lesions and stature, percentile of growth ranking, or δI_{mean} . Those individuals who are in the mortuary population that had experienced an anemic episode had already recovered or begun to recover their growth—they either had experienced or

were experiencing a catch-up phase of growth at the time of their death. This possibility is not one that can be confirmed or rejected based on the data available from a cross-sectional view study.

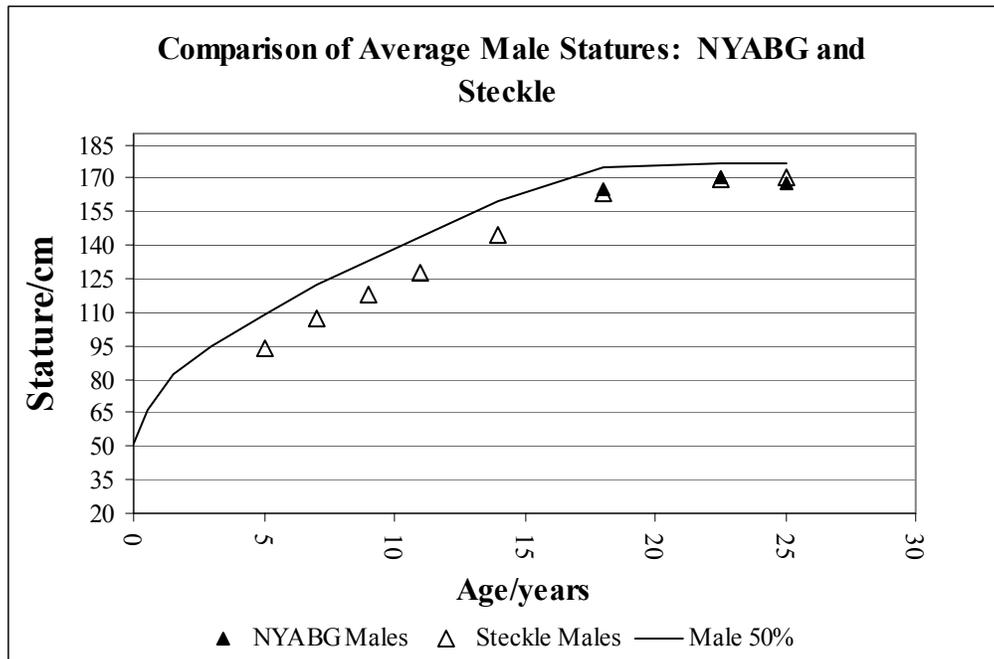


Figure 12.6: Comparison of Average Male Statures: New York African Burial Ground and Steckel

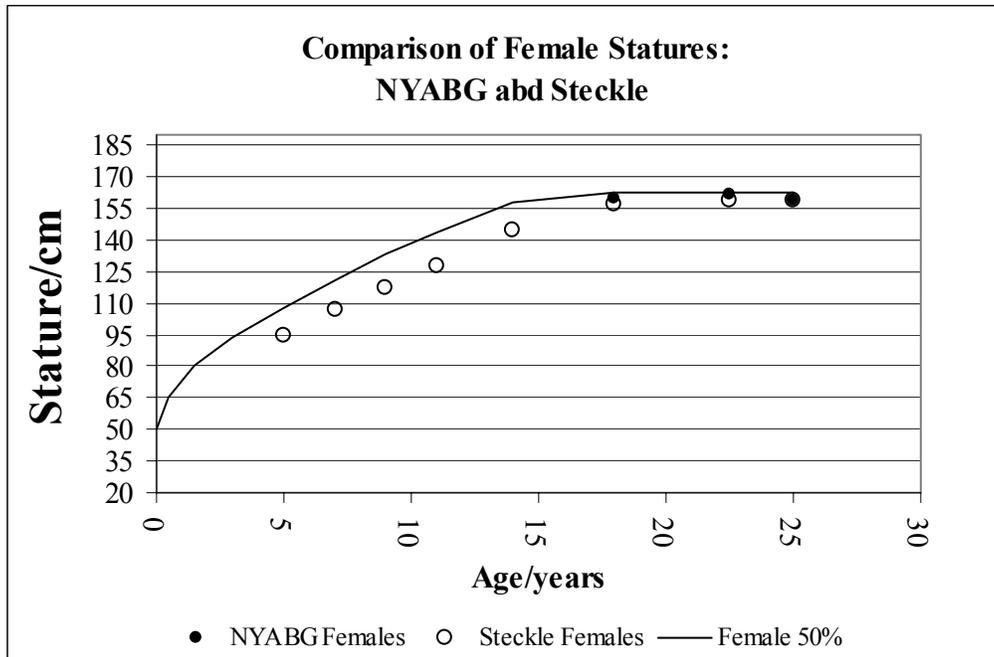


Figure 12.7: Comparison of Average Female Statures: New York African Burial Ground and Steckel

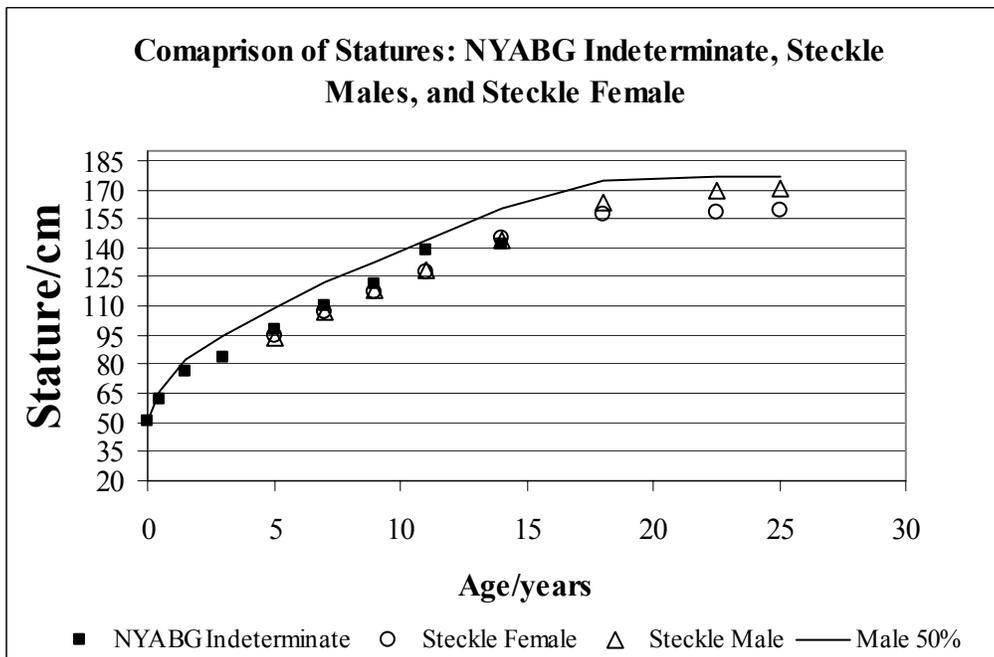


Figure 12.8: Comparison of Statures: New York African Burial Ground Indeterminate, Steckel Male and Steckel Female

The relationship between growth and generalized lesions makes quite apparent that more than half of these young people (52 percent) experienced bouts of chronic infection. However, there were no significant relationships between growth status and the rates of infectious lesions. Nor was there a significant relationship between rates of PH and generalized infectious lesions. This absence is contrary to Rankin-Hill's (1997) findings for the FABC population in Philadelphia where the co-occurrence of these two pathologies was significant at the $p < 0.01$ level. Again, this finding may be due to the vast majority of PH lesions in the NYABG sample being healed lesions in contrast to the 40 percent active rate for PH lesions in the FABC sample. This difference in active versus inactive PH lesion frequencies may actually address the issue of heterogeneous risk of death within and between populations by indicating differential levels of individual frailty, and warrants future consideration.

Statistical tests of abnormal bone shape demonstrated no significant associations with PH in the total population subsample, by age, or by sex. However, bowing of the long bones did have statistically significant relationships with infection in children in the $> 0 \leq 6$ year cohort.

The results from the analysis of biomechanical stress indicators did not demonstrate any significant relationship with growth status. However, several thought-provoking patterns did emerge from this analysis. First, approximately 40 percent ($n=19$) of the population subsample demonstrated some form of biomechanical stress—with all individuals exhibiting at least one area of hypertrophic muscle attachment— while 16.6 percent and 23 percent had been diagnosed with arthritis and enthesopathies, respectively. In general, there were more females than males with biomechanical stress

indicators. However, there were also seven children, biologically aged from four to eight years, who exhibited hypertrophic attachment—three of whom also had at least one enthesopathy and one who also had arthritis. Given the care that was taken to not inadvertently diagnose normal developmental features of the muscle attachment sites as hypertrophic and the co-occurrence of hypertrophy with arthritis and enthesopathies, these individuals are a clear example that enslaved children in New York City engaged in strenuous physical activities.

Chi square tests for associations between these biomechanical stress indicators and abnormal bone shape in the total population subsample (see Table 12.20) did reveal that flattening was related to all three biomechanical variables. This analysis supports a conclusion that long bone shaft flattening should be considered another indicator of biomechanical stress, even in young individuals. Flattening of the long bones was also associated with hypertrophies ($\chi^2 = 6.536$, $p = 0.026 < 0.05$) in indeterminate individuals, as was bowing and hypertrophies ($\chi^2 = 6.009$, $p = 0.020 < 0.05$). Biomechanical stress indicators were not related to the occurrence of PH lesions in the total population subsample, by age, or by sex.

Table 12.20: Results of Chi-square Tests of Relationships between Biomechanical Stressors and Abnormal Flattening of Long Bones

Chi square Test	Chi square	P
Hypertrophy by flattening	9.341	0.004
Arthritis by flattening	13.642	0.001
Enthesopathy by flattening	11.361	0.002

Conclusion

The analysis of growth and development presented above does not provide a clear picture of cause effect in relation to growth status. This chapter used bivariate statistical analyses to affirm that the relationships between disease, nutrition, biomechanics, and the underlying genetics/biology of growth and development are complex. However, this bivariate analysis does allow a few general conclusions:

1. Indicators of growth status, particularly stature rankings, clearly indicate a population that was not reaching its growth potential. Given that growth status is often used as a proxy for overall population health, it is not injudicious to put forth that the overall health status of the NYABG population was poor.
2. Evidence of biomechanical stressors in individuals as young as four years indicates that children were participating in strenuous activities. Given that this population is known to be composed of enslaved Africans and African Americans and supported by historical documentation (see Franklin 1967; Kruger 1985), it is more likely that these youngsters were engaged as laborers.
3. Relationships observed between the presence of craniosynostosis, nutrition, biomechanics, and infection indicate that development was affected negatively by its social milieu. This point is of particular concern, as impairments in developmental processes may have long term effects on the reproductive capabilities of individuals within any population.

Notes

¹ Goode-Null (2002) recommends using the broader definition of “disease” that incorporates trauma, rather than the more restrictive definition used by Goode et al. (1993) which focuses on infectious events. Goode-Null also notes that this method provides an opportunity to verify age assessment in individuals with extreme δl_i or δl_{mean} values.

² Due to the criteria used for constructing this baseline sample, there may be some inconsistencies in the ages reported for some individuals between this and other chapters when results of the analysis are presented and discussed.

³ Based on an examination of the supporting data included in the original text, the lack of standard errors of the estimates is most likely due to the extremely small values for this measure.

⁴ Specifically, the data sets are the product of the United States Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Health Statistics, Data Services.

CHAPTER 13

The Political Economy of Forced Migration: Sex Ratios, Mortality, Population, Growth and Fertility among Africans in Colonial New York

M.L. Blakey, L.M. Rankin-Hill, J.E. Howson and S.H.H. Carrington

The number of Africans imported into the New York colony between 1700 and the eve of the Revolutionary War has been estimated to range between 6,800 and 7,400. The higher estimates are based on under counting of captives due to smuggling from New Jersey, and possibly other states, to avoid tariffs. According to Lydon (1978:382-383), the minimum estimate, based on extant records for the eighteenth century, includes approximately 2,800 people or 41 percent brought directly from Africa and 4,000 from the Caribbean (and less significantly the southern colonies).

Perhaps one-fifth to one-quarter of those disembarked in the New York port remained within the city (Lydon 1978), with many of these individuals living there for the rest of their lives and eventually being buried in the African Burial Ground (ABG). Some gained legal freedom, gradually building a free African population, but most died enslaved.

A major research focus of the ABGP has been the relationship between the political economy of slavery in the urban north and the demography and health of the captive people. This focus included how the routing of captives to New York and the specific character of the market for forced labor in the colonial city affected the demographic patterns reported earlier in Chapter 7. Therefore, the research objectives were to identify: 1) the nature of the political economic regime in place during the period

the ABG was in use; 2) how the priorities and demands of the regime were regulated and perpetuated; 3) factors that may have affected the implementation of the political economic system; and, 4) how the regime impacted the lives of enslaved Africans as can be observed demographically. The basic premise is that while demographic assessment is fundamentally biological in nature (providing a window into the adaptation, health status, and survivability of a population), demography is equally reflective of the social conditions in which individuals are embedded and upon which they are physiologically dependent.

Sources for the analyses presented in this chapter include: the demographic assessment from Chapter 7; historical/archival, and medical historical research undertaken by the historians, archaeologists, and public education and information office research specialists; and skeletal biological evidence assessed by the physical anthropologists.

Pervasive in many historical studies of African Americans is the concept that somehow slavery in the New World stands as an isolated historical deviation of which the western world should be ashamed, apologize for, rationalize and/or study as a separate phenomenon. Others have studied American slavery from a more universal context, as Williams contends:

Slavery was an economic institution of the first importance. It had been the basis of Greek economy and had built the Roman Empire. In modern times it provided the sugar for the tea and the coffee cups of the Western World...It produced the cotton to serve as a base for modern capitalism....Seen in historical perspective, it forms a part of that general picture of the harsh treatment of the underprivileged classes, the unsympathetic poor laws and severe feudal laws, and the indifference... [of] the rising capitalist class. (1971:4)

Thus, enslaved Africans were placed into a system that was already formulated. In the English colonies, Africans were legally and in practice treated as indentured servants until the legislation of the 1660s. Williams maintains in his controversial work *Capitalism and Slavery* that the origin of Negro slavery "...was economic not racial; it had to do not with the color of the laborer, but the cheapness of labor....The features of the man, his hair, color, and dentition, his "subhuman" characteristics so widely pleaded, were only the later rationalizations to justify a simple economic fact: that the colonies needed labor and resorted to Negro labor because it was cheapest and best" (1971:14).

Southern plantation slavery was and continues to be the central focus of the majority of historical studies. The themes discussed earlier were essentially explored within the context of New World slavery as separate and distinct sociohistorical phenomena based on racism and hatred. Much of the debates concerning slavery can be described as two polarized approaches to antebellum American history: that of social historians versus that of economic historians.

Moreover, despite the voluminous anthropological, historical, and sociological literature on the topic of slavery, several areas of research still have been ignored. These include such topics as: the heterogeneous nature of western hemisphere African-American communities because of diverse African provenience and admixture with diverse Europeans and/or Native Americans; the experience of urban enslaved African Americans and freedmen during the Colonial/Antebellum period; the living conditions, health status, and life styles of African Americans who were enslaved or free; changing sociocultural conditions (e.g., industrialization) and their impact on African-American

conditions; and the health status and biological adaptability of African Americans. In addition, multidisciplinary, integrative research approaches to the study of African diasporic populations in the Americas have rarely been undertaken.

Economic, political, and socio-cultural characteristics of the trade in human captives that will be considered in this chapter are the location and choice of points of embarkation for enslaved Africans. Also considered will be the criteria for determining the sex and age of the enslaved who would best fulfill the needs of the Dutch, English, and Euro-American New York population, which could be characteristic of colonial New York, as well as the needs, perceptions and/or priorities of those engaged in the buying and selling of human cargo.

The Trade in African Captives

Data on the trade in captives for colonial New York are available from shipping records, which provide information on the place and timing of the trade from newspaper advertisements, and private/official correspondence, which indicate some of the parameters of local demand. While a number of cargoes direct from Africa came into New York in the seventeenth century, imports from the West Indies were much more important in the eighteenth century, up to the 1740s. After 1741, the trade shifted to an emphasis on direct imports from the African continent rather than from the West Indies (see Lydon 1978; Kruger 1985; Foote 1991).

We suggest that the age-sex structure and ultimately the sex ratio of colonial Africans among New York City's African population was linked to changes in the port's trade in captives, specifically due to changing and intentional selection criteria and the differences between African and West Indian cargoes. It is important to recognize that

most captives from the West Indies were African born and had spent as little as a few weeks to several years of “seasoning” in the Caribbean.

Intermittent periods of direct African trading and importation occurred in 1705, 1710-12, 1715-17 and 1721 (*Docs. Rel. Col. Hist. NY* 5:814; Lydon, 1978:377). The late 1720s and 1730s brought the largest cargoes of enslaved Africans from the West Indies. In 1763 large shipments of enslaved Africans were brought in from the continent. And there were several factors driving the structure of the trade. The especially sharp (and permanent) decline in imports from the West Indies were in most likelihood a reaction to the New York “slave uprisings” of 1712 and 1741 followed by the subsequent conspiracy trials of 1742. These were a catalyst for the redirection to African importation. This redirection was based on a general impression that West Indian consignments often contained individuals who were potentially threatening to the stability of the slaveholding colony. Indeed, Akan-led Maroons defeated the British to establish treaty-protected territories in Jamaica in 1739 after years of warfare.

Most slaveholdings in colonial New York County were quite small (one, two or three persons). Households that included enslaved Africans usually had at least one female domestic. Despite its early agrarian nature (small farmsteads), enslaved Africans were also utilized as dock laborers, construction workers, skilled craftsmen and domestics. Historians have suggested that the New York market shifted from one largely concerned with agricultural and dock labor in the seventeenth and early eighteenth centuries to one, in the mid-eighteenth century which also was driven by the need for domestic servants, best obtained while quite young. Cadwallader Colden, for example, wrote to a correspondent requesting to purchase a “Negro girl about 13 years old” for his

wife, to keep the children and sew, and two young men about 18 years old, strong and well-made for labor (*Coll. NYHS, Colden Papers, Vol. I, p. 51*). Girls were considered to be “ready” for productive domestic work in urban households at younger ages than boys, who were more likely to be needed for physical labor. Thus, this early “urbanization” established the need for age and sex selection in the slave trade for the local market place. New York merchants, well aware of the local market, then initiated a preferential system whereby African cargoes were more likely to include youths, especially girls, than were West Indian shipments.

Age Selection

The youth of new imports appears to have been a selling point in the slave market of New York City. Jacobus Van Cortlandt wrote in 1698 that the New York market was for Negroes aged 15 to 20 (cited in Foote 191:82). It appears from historical accounts and documents that shipments from the continent contained young girls in particular, who then remained in the city because they were in demand as domestics in a typically characteristic urban market. Men and adolescent boys, though in demand as laborers in the port town, were also more in demand in the nearby agricultural areas. It is important to note that selection criteria, preferences, and regulations were reinforced and institutionalized through laws and tariffs.

Africans from the continent who were more than four years of age were subject to an import tax as of 1732 (*Col. Laws.*). Presumably, any younger children who somehow were included in cargoes were not taxed because of their high risk of dying and low potential for immediate productivity, while older ones were considered valuable commodities. Overall, it appears that enslaved Africans were put to work by their pre-

teen years. This was certainly the case for domestic workers; males in their late teens would have been put to work at the most demanding types of physical labor on the docks, in construction, hauling, etc.

In addition, there was a selection bias against older enslaved men and women. Apparently they were considered a burden by slave owners. They were valued at lower rates for tariff and tax purposes, with age 50 generally used as a cut-off. Colonial laws also reflect anticipated problems with owners of elderly Africans. In 1773, (*Col. Laws 5:533*) *An Act to prevent aged and decrepit slaves from becoming burthensome within this Colony*, was passed by the provincial Assembly. The Act cited “repeated instances in which the owners of slaves have obliged them after they are grown aged and decrepit,” to go about begging for “victuals, cloths, or other necessaries” as well as owners who by “collusive bargains, have pretended to transfer the property of such slaves to persons not able to maintain them, from which the like evil consequences have followed.” The penalty imposed was £10 for allowing a slave to beg for necessities, and £20 for each enslaved individual sold to a person who could not support them (and the sale was voided). In 1785, a certificate from the overseer of the poor was needed to free an enslaved person; slaveholders could only obtain the certificate for persons under age 50.

Sex Selection and the Sex Ratio

The local necessity for young women or early teens to be the primary choice for urban domestic/household enslavement is corroborated in the New York Census data (Table 13.1). The 1746 census indicates a sharp increase in girls over boys (in the under age 16 category). Corresponding to this is an inflated adult sex ratio for the year because there were fewer women than men because so many of the females were too young to be

counted as adults (Table 13.2). Three years later, the sex ratio declined abruptly as girls reached ages 16 to 18. These fluctuating values for the 1740s most probably represent the influence of an influx of new captives, rather than a natural population increase.

Throughout the eighteenth century, sex ratios tended to indicate an excess of females or equal numbers of both genders. A substantially greater number of males are reported only for 1737 (see Tables 13.1 and 13.2 and Tables 7.4 and 7.5). The proportion of males (but not their absolute numbers) decreased most markedly following the 1712 African rebellion; the alleged 1741 African rebellion; and the American Revolutionary War that entailed massive African allegiance to and departure with the British. (See the History Final Report for a discussion of the events of 1712 and 1741).

During the first two historic events, the relative excess of females occurs for adults and may either reflect the increased importation of females or sale and exportation of men to areas beyond the city. The substantially larger number of girls, during the 1740s, indicates the effects of high importation of African girls into New York City and/or sale of boys to areas outside of the city. Lydon (1978), Kruger (1985), and Foote (1991) suggest that the English reaction to the alleged 1741 African uprising in New York was the cause of this reduction in the relative (but increase in the absolute) number of African males who were imported during this period. It does seem odd, however, that the absolute number of boys nearly doubled between 1737 and 1746, if fear of rebellious males had actually brought about the skewed sex ratio. On the other hand, boys could be “indoctrinated” into not becoming dangerous men. Women and older children were preferred for importation during this period, as were direct African imports, as means of limiting the militant resistance of enslaved people (Lydon 1978, Kruger 1985, Foote

Table 13.1: African Population by Age and Sex, eighteenth Century Censuses

Year	Adults		Children				Notes
	Male	Female	Male	Female	Age Cut-off	Label in Census	
1703	298	276	124	101	≤16	negroes	
1712	321	320	155	179	≤16	slaves	
1723	408	476	220	258	not given	negroes and other slaves	Presumed 16
1731	599	607	186	185	≤10	blacks	
1737	674	609	229	207	≤10	black	
1746	721	569	419	735	≤16	black	Black adult males includes 76 males over 60
1749	651	701	460	556	≤16	black	black adult males includes 41 males over 60
1756	672	695	468	443	≤16	black	black adult males includes 68 males over 60
1771	932	1085	568	552	≤16	black	black adult males includes 42 males over 60
1786	896	1207				slaves, negroes	

Source: *Century of Population Growth*, checked against *Docs. Rel. Col. Hist. NY*. Some discrepancies in the Kruger and Foot numbers have been corrected.

1991). Demands elsewhere in the international trade might also have had a negative impact on the availability of men for sale in New York. The sex ratio shifted steadily downward (a proportional increase in females) between 1703 and 1723, with a noticeable drop in the proportion of men to women appearing in the 1723 census. It is also the case that between the census years 1756 and 1771, the sex ratio went from 96.7 to 85.9. Conversely, the sex ratio began to climb (a proportional increase in males) during the years that saw the heaviest importation from the West Indies (the late 1720s and 1730s) (Figure 13.1).

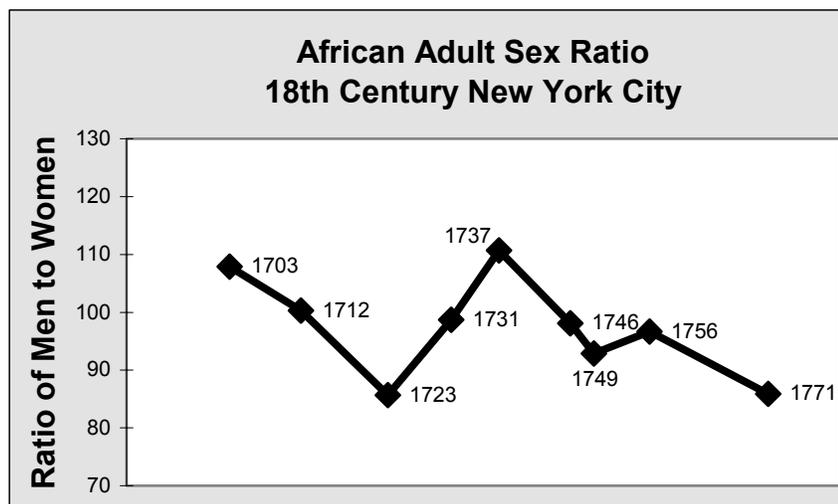


Figure 13.1: African Adult Sex Ratio: Eighteenth Century New York City

Most historians have pointed to the low overall sex ratio for Africans in New York as a typical pattern for urban slavery. Yet, the significant fluctuation observed in the sex ratio appears to be highly associated with political upheaval and subsequent attempts at social and legal controls that preserved the institution of enslavement for reasons of economic stability. In addition, one must also take into consideration the intensity of

biological risk factors that included workload, health and nutritional status and the mortality regime associated with environmental conditions encountered by the population.

**Table 13.2: African Adult Sex Ratio New York County,
1703 – 1800**

Year	Sex Ratio
1703	107.9
1712	100.3
1723	85.7
1731*	98.7*
1737*	110.7*
1746	126.7
1749	92.9
1756	96.7
1771	85.9
<p>Source: <i>Century of Population Growth</i>. Discrepancies were found in Foote's and Kruger's numbers, and have been corrected. The numbers in <i>Century of Population Growth</i> were checked in <i>Docs Rel. Col Hist. NY</i>.</p> <p>*Note that in 1731 and 1737, the censuses counted persons over or under 10 years of age; thus "adults" were not all of child-bearing years. The overall sex ratio for these years was 99.1 for 1731 and 110.6 for 1737.</p> <p>The 1786 state census and the 1790, 1800, and 1810 federal censuses do not count blacks by sex. According to Kruger, local censuses for the early 19th century indicate ratios declining from 72.3 in 1805 to 65.8 in 1819 (Kruger 1985:370).</p>	

Mortality

Mortality for the seventeenth and eighteenth centuries in America was high, especially in cities. New York experienced very similar health and disease patterns as other colonial American urban centers, in particular port cities such as Philadelphia. The impact of periodic epidemics had a differential effect on populations based on their health status and risk factors (Nash 1988).

Contemporary observers believed that black mortality throughout the northern colonies, especially among infants, was so high that only importations could prevent the black population from gradually dying off (Anthony Benezet, writing in 1773, cited in Nash 1988:33; Nash also cites Benjamin Franklin in 1751 and a Bostonian chronicler in 1775). Bills of mortality for Philadelphia in the period 1767-1775 indicate an average of 75 burials of Africans per year; this represented about 7 burials for every 100 blacks per year, a rate about 50% higher than among whites (Nash 1988:34). If a similar death rate were applied to New York, about 219 individuals would have been buried per year in the same period (based on the 1771 census count of 3137 blacks). In each of these circumstances there was an undercount of Africans so mortality rates were actually higher. The Philadelphia rates are more reliable than New York because of the Abolition Society's active role in documenting the accomplishments and conditions of "people of colour" in that city (Rankin-Hill 1997).

Environmental and living conditions during the colonial period tended to be unhealthy; there were problems of poor sanitation, indoor pollution (e.g., coal fires), impotable water and crowded dwellings. For captives, the conditions were most insalubrious leading to high rates of morbidity and mortality (Curry 1981; Rankin-Hill 1997). In addition, American cities throughout the seventeenth, eighteenth, and nineteenth centuries were "hot zones" for epidemics, providing perfect conditions for pathogens to thrive.

Outbreaks of smallpox, yellow fever, measles, diphtheria, influenza, and other unspecified fevers in colonial New York have been documented from historical sources. Smallpox was the greatest single epidemic killer during the period of the African Burial

Ground's use (Duffy 1968:34-35). Smallpox outbreaks occurred in 1702, 1731, 1745-47, and 1752. It is likely that smallpox accounted for a significant portion of the death toll, appearing as a fatal childhood disease rather than as an epidemic between 1756-1767 (Duffy 1968: 53-58).

An examination of the deaths reported in the 1731 smallpox epidemic indicated that both European and African New Yorkers suffered considerable losses. The 1731 bills of mortality are actually numbers of persons buried at the city's church cemeteries, tallied by denomination. The number of "Blacks" buried is listed, but with no church denomination. This indicates that burials at the ABG were being counted in some form. It is not known how or by whom. During the period of smallpox reporting, 477 Europeans (6.77% of their population) and 71 Africans (4.50% of their population) died. The overall death toll for August-December of 1731 was seven percent of Europeans and five percent of Africans. This difference in frequency may indicate an under-reporting of black burials, not surprising since it is believed the burial ground was most often utilized without direct observation by Euro-Americans. As noted earlier, Philadelphia records indicated an average death rate of seven percent per year among blacks in the 1767-1775 period, with a rate of about five percent for whites -- a similar differential probably characterized general mortality in New York.

Although African deaths may have been under reported, another possible basis for a lower African death rate was the existence of a smallpox inoculation. Reportedly, some African societies practiced inoculation and a "Guaramantese" (or Akan man), who had been given the name "Onesimus," taught the technique to a Boston clergyman who, in turn, shared it with physicians in Boston and London. One of these physicians, Zabdiel

Boylston, used the technique in time, apparently, to have helped reduce the impact of a Boston epidemic in 1721-22 (Cobb 1981:1199-1200). Smallpox inoculation was controversial among the English (see *Final History Report*), who feared the practice could spread the disease and prolong its presence, and many English colonials in the city were hesitant to allow inoculation of their slaves, fearful of negative outcomes. Nevertheless, if Africans in America were familiar with the practice of inoculation, it is not unlikely that inoculation may have been practiced by some in the New York black community, with or without the knowledge of slaveholders. The fact that many African New Yorkers had survived smallpox in their youth (whether in Africa, in the West Indies, or in the city) is attested to by the frequent citing of smallpox scarring in descriptions of runaways from the city and as a selling point in sale advertisements; such documents have been compiled for the period by the Office of Public Education and Interpretation of the New York City African Burial Ground Project.

Endemic to the West Coast of Africa, yellow fever is caused by an infectious virus; therefore it is reasonably assumed that some of the Africans brought to the Americas had been exposed to the disease in their youth, thus acquiring some resistance. In New York, a 1702 epidemic killed hundreds of residents within just a few months (Duffy 1953:146); the Society for the Preservation of the Gospel's account of 570 deaths probably included all deaths rather than just yellow fever deaths. The provincial census for 1703 indicated a drop in the overall population of New York City that historians had long attributed to the yellow fever epidemic. The drop in the African population from 700 in 1698 to 630 in 1703 (Table 13.3) has also been interpreted as a result of yellow fever deaths (e.g., Goodfriend 1992:113). A tally of the African population of the city in

1703 based on the household-by-household count, however, puts the total number of Africans at 799 (*Century of Population Growth*); thus, it would appear that their mortality from the epidemic was lower than among Europeans. No “ethnic” breakdowns of the overall New York mortality figure of 217 (*Boston Weekly Post Boy*, Oct. 31, 1743) were recorded for the 1743 yellow fever outbreak (Duffy 1968:86).

**Table 13.3: Population of New York County, 1698 – 1800
by Race**

Year	Total	“Black”	“White”	% Black
1698	4,937	700	4,237	14.2
1703*	4,391	799	3,592	18.2
1712	5,841	975	4,886	16.7
1723	7,248	1,362	5,886	18.8
1731	8,622	1,577	7,045	18.3
1737	10,664	1,719	8,945	16.1
1746	11,717	2,444	9,273	20.9
1749	13,249	2,368	10,926	17.9
1756	13,046	2,278	10,768	17.5
1771	21,863	3,137	18,726	14.3
1786	26,614	2,107	21,507	7.9
1790	31,225	**3,092	28,133	9.9
1800	57,663	***5,867	51,796	10.2

Source: Foote (1991:78) and White (1991:26), except 1703. Both Foote and White have corrected the raw figures. See also Kruger (1985:131), though there are some discrepancies in the percentages for 1786, 1790, and 1800.

* From census of households in New York City (see below). These figures differ from those given in the 1703 census of the colony of New York, which listed only 630 blacks.

** Includes 1,036 free and 2,056 enslaved blacks

*** Includes 3,333 free and 2,534 enslaved blacks

Other diseases, less widespread but also deadly, visited the town over the course of the seventeenth and eighteenth centuries. A number of outbreaks of unspecified diseases occurred in New York in the seventeenth century, which Duffy (1968:19, 34)

suggests these may have included smallpox, whooping cough, and malaria or typhoid. A few cases of measles were reported in 1713, and the disease appeared again in epidemic proportions in 1729 (Duffy 1968:58; *Colden Papers* I:274, 280). Measles made a third appearance in the fall of 1788. Diphtheria, mentioned earlier as a major cause of children's deaths in 1745, reappeared in 1755 and late in the 1760s (Duffy 1968: 59). Influenza was a killer in 1789-90 (Duffy 1968:86). Both influenza and whooping cough (pertussis) ravaged European and African populations in the West Indies; since they were considered more prevalent in colder climates, they may have been present in New York to a greater extent than the records suggest.

Parasitic loads were a common cause of anemia in enslaved communities in the Caribbean and may have also been a health risk in colonial New York. The most prevalent parasites were round worms (*Ascaris lumbricoides*), pork tapeworms (*Taenia solium*), Guinea worms (*Dracunculus medinensis*), and hookworm (*Necator americanus*). The Caribbean plantation environment, with poor sanitation, dirt floors, and chronic damp, was an ideal breeding ground for such organisms. Geophagy (consumption of dirt), often observed among Africans on West Indian plantations, was also frequently cited as the means by which worms were ingested. Infected West Indians brought as captives to New York would have carried their parasites with them. Incidence of infection in New York would have been much reduced due to the colder climate. Completed parasitological studies on a small number of soil samples from the pelvic area of skeletal remains from the ABG did not provide any evidence of parasites. Preservation factors may account for the complete lack of remains, since parasitic infections were not uncommon in colonial America.

New York African Burial Ground Mortality

The synthesis of the paleodemographic profile developed in Chapter 7 and the political economic and historical epidemiological scenarios discussed in the preceding section contextualize the experience of captive Africans in New York. The impact of the political economic regimes' selection processes, the intense physical labor, and disease environments of colonial New York can be assessed by the patterns observed in the ABG skeletal sample. These include:

- The low mean age at death for the population of 22.4 is even lower than that of Barbadian-plantation enslaved people (Handler and Lange 1978) under a regime of plantation sugar production. This points to the synergistic effect of political-economy, environment, and biological susceptibility.
- Subadults comprised 40.75 percent of the burial ground population; a preponderance of subadult deaths (39.2%) occurred during the first year of life, especially during the first six months, followed by another 16.1% in the second year. Therefore, infants and children were at high risk of dying both in utero and for the first two years of their lives. Forty-five per cent of all the subadults died by age two. Thus, the potential for population replacement was being severely compromised.
- The mortality pattern of adults was the highest in the 30-34 age group (9.4%), followed by 15-19 year olds (8.4%), and 35-39 year olds (8.4%).
- Adult mortality peaked in the third decade of life when 30.1 percent of adults had died. This loss of adults indicates both the reduction in potential reproductive

members early in the lifecycle, but also corroborates the impact of captivity on the men and women interred in the ABG.

- Differential mortality pattern showed that by 80.5 percent of females had died by age 40, compared to 54.1 percent males. Although women and girls were being selected as domestic laborers, their lot was arduous and increased their risk of dying.
- The third highest mortality age group was composed of adolescents aged 15-19. Loss in this age group forebodes potential limitations on population reproductive and replacement rates. The high rates of males and females dying in the 15-24 year age group are also indicative of the high rates of forced migration to New York for Africans of those ages.
- The differential mortality pattern was observed in the 15-19 age group where 15.4 percent of girls died, compared to 10.8 percent of boys, although not statistically significant. Women are being removed from the population during a time when they are capable of reproducing or are biologically preparing for reproduction.
- The trends observed in the NYABG paleodemography corroborate what has been learned about the conditions of captivity from historical/archival and medical historical sources. These include: patterns of differential mortality, especially for males and females at ages associated with adult work regimes and living conditions; forced migration; and biological development-selecting against the survival of women; high sex ratios in adults; and reduced fertility that should have suppressed infant and childhood mortality rates.

Nineteenth Century New York Trends

The data available on African mortality in New York in the period following termination of the use of the ABG are of some interest in assessing data from the burial ground, especially the sex ratio. The NYABG skeletal records reveal a smaller proportion of females than data on the living population. This observation, along with the trend toward higher risk of mortality at younger ages in males and females over the age of 15 years, has led us to question the sex ratio among children. Are excess females among the dead girls? Because we are unable to determine the sex of subadults with available methods, we have turned to the burial records of related cemeteries. Spotty death records survive for the period 1801 through 1815, when a new cemetery for Africans was opened on Christie Street in Manhattan and the newly- founded African Methodist Episcopal Zion Church began using its own cemetery. The adults (16 and older) number 10 women and 15 men, approximating the skewed ratio found at the ABG. The preponderance of men at the later cemetery, as at the earlier one, is at odds with census data on the living African New York population, in which sex ratio declined steadily to a low of 61.4 in 1820. Sampling error aside (the records for the period are incomplete); the apparent discrepancy may be attributed to differential official reporting of burials based on sex.

Among the infants, girls in the Christie Street sample experienced slightly higher mortality from 0 to 2 years of age (9 girls and 6 boys). The excess of girls over boys in older age categories was more marked. In the 5- to 15-year-old group there were seven girls and only one boy buried, but no deaths of young women 16 to 20 years old were recorded.

Mortality data are also available for a later New York African community known as Seneca Village (1826 to 1851). In the first decade, which saw final emancipation in New York in 1827, the death records include eight girls and five boys in the 0-2-year-old range, again, the same excess of girls seen in the earlier samples. Boys predominated slightly among older children reported from Seneca Village. By the second decade of the Seneca Village mortality data (1836-46), infant deaths recorded include 12 girls and 16 boys. It is possible there was a lowering of female infant mortality over time with the ending of slavery in New York (unpublished data for Seneca Village generously provided by N. Rothschild, D. Wahl, and E. Brown). The sample sizes, especially for the colonial-period ABG are too small to detect statistically valid differentials in child mortality. What this comparison indicates is a greater likelihood for a higher representation of female infants and children than of boys among the ABG remains. Questions of differential survival of the sexes will have to await chromosome analysis data for definite answers.

Population Growth and Fertility

Both paleodemographic and historical demographic analyses have limitations as to what can be inferred from the data. Paleodemography provides a means of evaluating the impact of environmental conditions on mortality patterns and health status. Historical records and analyses of vital statistics can provide insight into the period but are always biased based on the manner in which the information was recorded, reported, stored, and/or interpreted. Therefore, the data utilized from historical and osteological sources for fertility are proxy measures. Content analysis of historical sources, shipping records, censuses for the period, newspaper advertisements, and private and official

correspondence provide a means of assessing and reconstructing some of the parameters of local demand and characteristics of the New York trade in human beings.

New York City municipal census data for the eighteenth century indicate the exceedingly slow growth in the city's African population. Population increase among Europeans was also slow but far more evident during the same period. The trends for New York County for 1698-1800 indicate that the African ("Black") population remained fairly low throughout; concurrently, importation of Africans from the continent and the West Indies continued with little impact on the overall population (Table 13.2). The European population increased slowly early on, followed by significant growth starting at mid century (Table 13.3).

The pattern of little or no population increase in African populations early in enslavement was also observed in the lower western shore of Maryland (Menard 1975:32), South Carolina (Wood 1974), Virginia, and Philadelphia (Nash 1988). All of these populations shared the inability to reproduce themselves due to deaths exceeding births. In all locations except New York City and some of the Caribbean islands, black population increases occurred later (Fraginals 1977). For example, regionally in the lower western shore of Maryland in 1658 there were 100 (Menard 1975:32) enslaved Africans, approximately three percent of the total population; by 1710, however, there were 3500 constituting 24 percent of the population, that resulted from importations, increased birth rate, and a slight decrease in mortality.

The question then is why with the ongoing importation of Africans to the port of New York was there little or no growth in the enslaved African population. The historical accounts, demographic and paleopathological assessments provide significant

explanatory evidence directly associated with the changing economic imperatives of that developing colony.

Sex Ratio and Mortality

As was reported earlier, the period was primarily characterized by a low sex ratio. The importation directly from Africa had the effect of shifting the sex ratio among New York City's enslaved population in favor of girls/women, while shipments of Africans from the West Indies shifted the ratio in favor of males. The former shift is associated with the aftermath of, and English responses to, African rebellions. Due to the changing needs of the growing urban households, girls were considered to be "ready" for productive domestic work in urban households at younger ages than boys, ultimately increasing the demand for females (Figure 13.1). Therefore, the high numbers of females and adolescent girls with the potential to reproduce at minimum should have led to a natural increase in the African population.

Juxtaposed is the effect of high mortality with differential patterns selecting against infants and toddlers, women and adolescent girls and boys. This establishes a synergistic effect that eliminates segments of the population that are the procreators and the progeny of those that managed to reproduce.

Fertility

Kruger (1985:403-420) has made the most ambitious attempt to analyze the meager data available pertaining to childbearing and fertility in New York's enslaved African population. Almost no data are available on African women's ages when their children were born. In 1796, an individual named "Africanus" proposed emancipation of all enslaved females born after 1796 at age 17, along with all their children. He estimated

that 3/5 of them would already have borne children at that age (*Daily Advertiser*, January 26, cited in Kruger 1985:405). Therefore, African young women were reproducing prior to age 17. Kruger calculated median birth spacing at 28 months, and inferred that during the period of 1799-1826 breastfeeding appeared to have continued for 16 to 18 months after birth (1985:410-412). Therefore, women were potentially capable of producing four to six offspring between ages 15-30.

Child-To-Woman Ratios

Despite the potential for populational growth, the low child-to-woman ratios (a proxy for direct fertility data) derived from census data attest to the absence of increase in the New York African population. The 1746 peak in the presence of African children in New York City appears to be associated with importations of girls and boys under 16 years old, not to births in New York. This is evidenced by the marked decline in children per woman of childbearing years as importations abated (Figure 13.2). These data show clearly that an African woman of reproductive age (and her male partner) had one or fewer children on average. If the number of children in the census who were actually born in New York is small, then fertility in New York City may have been much lower than one child per African woman of reproductive age.

Our general assessment is that although many of these children would have been African-born and forced to migrate to New York, most of those who died as children and were buried in the burial ground were born in New York. This inference is consistent with the chemical tracing data reported in Chapter 6. The census data used here largely represents survivors and persons imported after ages of highest mortality risk. These children are likely to show disproportionately high frequencies of African natality,

compared to those children who were born to captive parents and who died very young. Also, given our evidence of relatively low mortality for children 5-14 years of age in New York, a preponderance of the older children of the census were probably surviving to die in concert with the adult age-specific mortality patterns that we have shown previously. We would, therefore, predict that future testing of those individuals with African-associated chemical levels (Pb and Sr) in early-developing teeth and North American chemical levels in later developing teeth and bone would represent the children identified in the census.

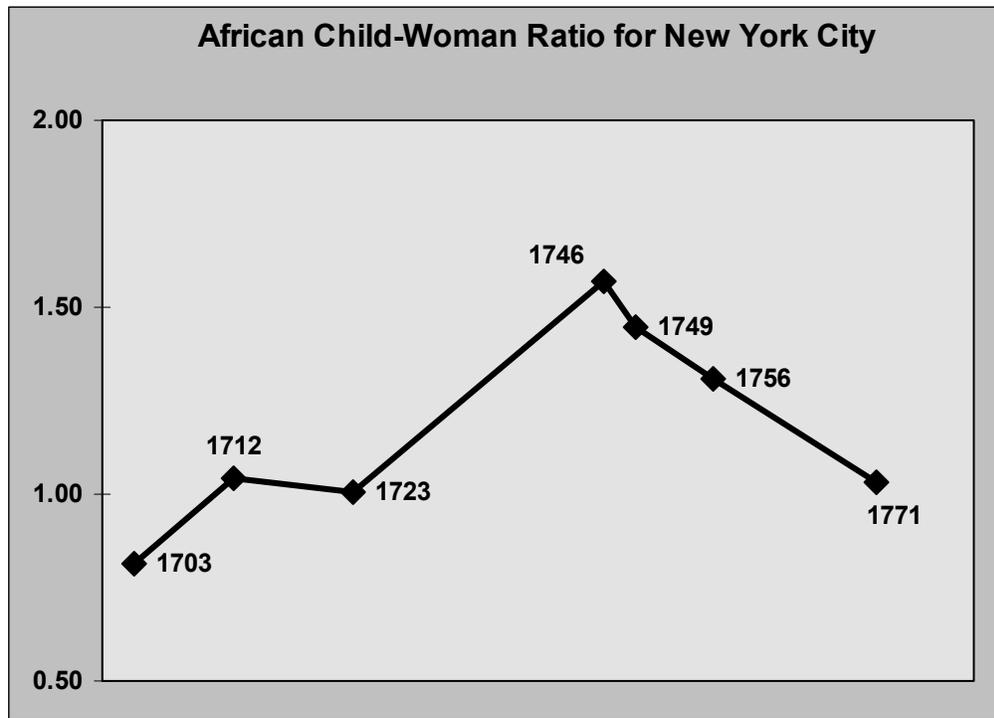


Figure 13.2: African Child-Woman Ratio New York City

Paleopathology

Paleopathological evidence for the people interred in the ABG site indicates that African women were involved in strenuous labor from adolescence and nutritionally

compromised with high rates of degenerative joint disorders, and showed evidence of enthesopathies and muscle hypertrophy (Chapter 11) as well as nutritional deficiencies including porotic hyperostosis and general infection (Chapter 10). Each of these factors has a potential negative impact on fecundity (the ability to conceive and to bring a fetus to term). The large number of perinatal and newborn infants points to these effects just cited.

In addition, subadult data indicate that infants and toddlers were at risk due to nutritionally compromised mothers, weaning, nutritional insufficiency, and infection as evidenced by dental enamel defects of both the deciduous and permanent dentitions (Chapter 8); infection rates and porotic hyperostosis (anemia) rates (Chapter 8); and retarded growth and development (Chapter 12).

The political economic regime (Figure 13.3) established a biological lifestyle of arduous work for adolescent and adult females, which resulted in physiological disruption due to the synergistic interaction of:

- intensive physical exertion and energy expenditure
- intensive utilization of dietary nutrients
- intensive utilization of marginal nutritional stores
- chronic exposure to environmental hazards
- intensive utilization of immunological and psycho-physiological responses.

Therefore, the demographic, paleodemographic and paleopathological data indicate that:

- High mortality among women at the beginning of their reproductive years affected the population fertility (reproductive rates) and fecundity, the biological potential for procreation.

- Nutritional inadequacy, infectious disease loads, and mortality indicate a compromised adult female population, thus reducing fertility (e.g., low fat stores followed by amenorrhea), and a potential for immuno-suppression and increased susceptibility/risk factors for morbidity and mortality.
- Infants and children began life compromised and at high risk of illness and dying. Those who survived past the second year of life were faced with strenuous physical exertion from early childhood and the cycle of exertion, deprivation, increased susceptibility, [although it could be argued that these children were the most adaptable] and early adulthood death.

Therefore, the economic needs and environmental constraints established by New York slaveholders produced a regime of physiological disruption that substantially impacted the fertility rates and almost certainly created a situation of impaired fecundity, which contributed significantly to the lack of population growth in the enslaved African population of seventeenth and eighteenth century New York. In addition, this economic strategy was one of “unlimited good,” since enslaved captives could be replaced continuously. European enslavers had no incentive for encouraging fertility or intensive care giving of infants, who demanded high investment but could do little work. Although the abusive practices of the British Caribbean colonies, where infants might be taken from their mothers immediately so that loss of labor would be minimized, are not documented for New York, this city’s slaveholders showed no desire to possess young Africans or to “breed” their captives. They only needed them to keep the market’s products and profits flowing.

➤ **Trade in Africans**

Responsive to local political, social and economic forces

Mainly from West Indies through 1740

More direct from Africa after 1741

➤ **Urban situation**

Typical low sex ratio

Demand for dockworkers and other day labor, domestic labor

➤ **Local market**

Agricultural and public needs shifting in eighteenth century to domestic and day labor needs

Youth emphasized in local sales

Increasing demand for young girls for domestic drudge labor

➤ **Holding size**

Small urban households with limited in-house labor needs

Average holding of enslaved Africans: 2.4

Sales of young children beginning at age 5

Neglect and disposal of older Africans

➤ **Social control**

Political and market response to active resistance

Decreased importation of men, decreased importation from West Indies

➤ **Ideology**

Unlimited Goods

Figure 13.3: Summary of Relevant Factors of the Political Economic Regime of Colonial New York

Chapter 14

DISCUSSION

Michael L. Blakey, Lesley M. Rankin-Hill, Alan Goodman and Fatimah Jackson

The explanatory frameworks of this study are heavily influenced by our understanding of the historical expediencies of European economic exploitation and power, and the ways these imperatives came to be played out in the condition of Africans in the Atlantic World. Of course, imperatives of safety, profit, moral legitimacy and so forth were negotiated as Europeans wrestled with conditions they could not entirely control, including the needs and responses of Africans themselves. The “hows” and “whys” of the biological effects we have examined are largely explicable in terms of historical, political, and economic motivations, practices, and policies, as well as modes of resistance to them and other limiting factors, such as the natural environment. Why are babies dying? Slave holders do not want them for economic reasons at this time and in this place. The evidence of growth delays in children suggests a lack of investment in them by those empowered to do so. While African women also at times allowed their children to die rather than make them into slaves, at other times we see clear archaeological evidence (*Archaeology Final Report*, forthcoming) of profound love of children, in this mortuary context. And in New York, there were few opportunities for family formation with men and women working and sleeping in isolated workshops and homes, respectively (see *History Final Report*, Chapters 4.0 and 8.0). The sex ratio, ages, and sources of new arrivals reflected English struggles to control Africans who rebelled and to capitalize on market availability and the price of captives. Sex ratio

affects fertility and the spread of diseases affecting child mortality, particularly where females are disempowered as they were under American slavery. Each chapter has examples of biological effects of power and poverty. We will not attempt to explain the more interesting details which each author does best in his and her own words. This discussion is meant as a starting point for pulling together the shadowy evidence that human skeletons bear on 419 all-but-forgotten lives.

The Main Findings of Our Study

What are the findings of the skeletal biological research and what are the limitations and further implications of this work? As to the origin and affiliation of the persons buried in the New York African Burial Ground (NYABG), the results of genetic analyses (Chapter 5), coupled with historical and archaeological research, suggest that most individuals were derived from a variety of known states and empires mainly, but not exclusively, of West and West Central Africa.

Complementing the above, the preponderance of the ethnohistorical and chemical evidence indicates that most of the NYABG individuals who died as adults were African-born, free people who were captured and who then underwent the Atlantic passage to subsequently die enslaved in New York. Conversely, those who died before their first eight years of life were very likely to have been born in New York. Historical documentation suggests that some individuals, especially early in the eighteenth century, would have come from Africa to the Caribbean first and then to New York. Strontium isotope data (Chapter 6) suggest that a couple of individuals could have grown up in the Caribbean.

Chapter six presented results from two chemical methods for assessing where individuals were born and grew up. In the case of strontium isotope analysis, individuals below the age of eight match the isotopic signature associated with Manhattan while the majority of individuals over the age of eight do not. This is especially true for individuals with culturally modified teeth. Similarly for elemental signature analysis, young individuals cluster together, suggesting they were New York born and adding support to our interpretation of the results from the strontium isotope analyses. These conclusions, however, are based on the small sample of individuals whose chemistry was assayed. Notably, historical evidence points to nine years as the youngest common age of forced migration from Africa to New York. The study of hypoplasia in the third molar (Chapter 8) shows high stress that also seems associated with exposure to the slave trade and New York between 9 and 16 years of age. The convergence of these data seems important.

High lead levels in teeth of individuals who were plausibly born in New York are an unexpected finding. Samples of enamel calcified during the first years of life were also taken utilizing an innovative methodology and technology: laser ablation-inductively coupled-plasma mass spectrometry. These results indicate that lead levels were probably high during breast feeding and weaning. It is reasonable to speculate that lead absorption was an additional stressor that had a negative interaction with infant and childhood diets and illnesses. For example, a poor intake of calcium would have increased the absorption of lead, which then could have led to anorexia and decreased intake of food.

Enamel hypoplasia data in Chapter 8 suggest that infant and childhood health was worse for individuals who were born in New York and died in childhood than for

individuals who were more likely to have been born in Africa but who died as adults. Enamel hypoplasia frequencies representing malnutrition and disease events in childhood were extraordinarily high for children born in New York when compared to other archaeological sites. An analysis relying on age differentiated samples showed that older persons who were most likely to have spent childhoods in West and Central Africa had the fewest hypoplasia even when occlusal wear was controlled. An analysis comparing individuals with and without culturally modified teeth showed a similar trend, but the difference was not statistically significant. Planned is a far more rigorous test, comparing enamel defects among a large sample (300) of individuals whose places of birth can, as we predicted in 1993, be shown on the basis of their chemical signatures, of the differences in childhood health in New York, Africa, and the Caribbean. The scientific results of this test would shed light on the human cost of enslavement. Our data do make clear, however, that those who died as children and were buried in the NYABG are frequently characterized by delayed growth and development due to a combination of nutritional, disease, and probable work-related stresses (Chapter 12).

Infant mortality was high and estimated to be much higher than in the English population of New York City. Infants, especially newborns, and weaning age children, had especially high levels of new infection, anemia and other indicators of poor nutrition such as growth retardation and stunting. Low frequencies of pathology, especially healed lesions, in children relative to adults may indicate that those who died as children were tending to die of acute disease and/or nutritional stresses without bearing extended morbidity and recovery from disease. As is frequently the case among diverse human societies, older children were the healthiest persons in the population.

Late adolescents and young adults (15-25 year olds) also experienced distinctively early and high mortality when compared either to their English contemporaries or to later African-American populations. But might this not be partly an artifact of the immigrant nature of those populations? Among Africans, high mortality in those ages reflects the proportionately large number of adolescents and young adults who were forced to migrate to New York, and then to die young, becoming numerically prominent among the buried. Generally, adolescents should be expected to show low mortality that rivals that of older children. Females also had high rates of active infection during these ages, unlike males. Adolescent females, young women, infants, and young children were distinctively exposed to new active infection relative to healed lesions, although adolescent females and young women did also have substantial evidence of healed lesions, unlike infants (Chapter 10).

Throughout the eighteenth century the population size of the New York African population remained fairly constant despite continuous importation. Nor had the African population increased by virtue of fertility, which was actually below replacement values (Chapters 7 and 14). This lack of natural increase is consistent with severely exploited Caribbean enslaved populations, a trend that is associated with an open transatlantic trade in human captives in which the large supply renders the enslaved disposable.

The New York population was probably not exposed to syphilis for very long, unlike Caribbean populations whose low fertility has been partly attributable to the introduction of the venereal disease and low sex ratios. Life expectancy is low and few Africans lived to old age. Yet, the instability of the population with regard to migration makes the interpretation of life tables somewhat problematic. The percentage of ABG

individuals living beyond 55 years is similar, however, to census data from municipal records. This observation is consistent with the study of Barbados's Newton Plantation demonstrating comparability between skeletal and archival data on adult mortality, unlike the fragile skeletal remains of infants that under-represent mortality by virtue of their rapid decay in the ground or selective interment. The English community who would have presumed to own these Africans exhibits opposite mortality trends, with many times more English males and females living to old age. Young English men, however, are well represented among the dead most likely due to ages of migration, interpersonal violence, trauma and stressful conditions as seems the case for even younger African men, women, and adolescents.

Both African men and women experienced elevated work stresses, with some distribution of load bearing toward the upper spine in women and the lower spine in men. The overlap in evidence of muscle hypertrophy in the limbs and degenerative joint disease across gender is perhaps more impressive than the differences (Chapter 11). It is clear that most men and women were exposed to arduous work for extended periods of time.

New York Africans are among highly stressed populations examined by paleopathologists over broad spans of time and space. The physical effects of slavery in New York resemble those of southern plantations and were not in any sense benign. Comparisons with other studies must be considered to be approximate, due to the differences in diagnosis, scoring, and data recovery protocols with which the field of skeletal biology continues to contend. However, every effort has been made to put those comparisons forward with the necessary qualifying information for a fair evaluation of

their meaningfulness. Comparisons between the NYABG and other archaeological sites can be most directly made in relation to our own previous projects such as the First African Baptist Church (FABC), for which we directed the methodology (see Chapter 8).

In some respects, such as the absence of natural population increase, African New Yorkers resemble the mean conditions of workers on Caribbean and Louisiana sugar plantations and South Carolina during a time when open transatlantic trade made it easier to replace dead workers than would be the case after the 1808 cessation of a legal African supply. African New Yorkers were in a quite different geographical setting than the more familiar plantation economies. They were nonetheless part of that larger, slavery-fueled, Atlantic World economy owned and managed by the same colonial European captors as in the British West Indies and the South.

New Problems and Solutions

Some interesting points have been learned as a project, in moving away from racist and inhumane anthropological practices of the past. Those practices are not as readily escaped as some of us had believed, even though we were willing to confront problems head on. Every effort to make comparisons with other skeletal populations attempted to drag us back to race. Whether DNA, dental morphology, or craniometry, the comparative data of anthropologists tended to have taken perfectly good measurements of specific ethnic, linguistic, or historically-particular regional groups and then aggregated them into Sub-Saharan, West African, black, white or some other pseudo biological category. Such essentially racial categories are irrelevant to ascertaining the more specific African geographical regions, and the historically-relevant cultural groups within such regions, with which a skeleton's biological distinctiveness is associated.

Sometimes where specific groups were available for comparison, they had no direct relevance to the early colonial American experience. There are few biological data available on eighteenth century English, Dutch, Seneca, Delaware, Bakongo, Akan, or Yoruba, specifically. A case in point is the Gold Coast (Akan) crania that we measured at the American Museum of Natural History, thanks to the collegial aid of Dr. Ian Tattersall. They had apparently not been of much interest to previous researchers, yet this comparative population cannot be neglected for assessing cranial affinities of the African diaspora. Interestingly, no English population was available for comparison from the same museum. The craniometric database gratefully received from Dr. W.W. Howells had no British, Irish, or Dutch (we used the Scandinavian sample). Indeed, it seems that with racial thinking any conveniently measured or sampled Eastern European, Southwestern Native American, or Sub-Saharan African has been allowed to suffice as a surrogate for any other specific population on those continents. The race concept has allowed this kind of loose thinking to persist and even to pass as rigor when such categories are permitted to define research questions. The research team's use of comparative databases is still imprecise and includes some lumped groups and historically implausible parental samples of cranial measurements. We, nonetheless, believe these data are far less muddy in this regard than usual and we will continue to refine them.

The dearth of DNA data from state-level Central African societies, but sufficient Pigmy and Khoi San samples, communicates much concerning how many physical anthropologists and geneticists view the significance of Africa. Some members of the skeletal biology project team are proceeding under the auspices of the Institute for

Historical Biology to obtain disaggregated data (or to disaggregate secondary data ourselves) to restore culturally and genetically identifiable populations from the “lumped, racialized constructions” that obscure the historically-real populations to which we want to assess American relationships. The team’s collaborator’s at the University of Maryland are taking another strategy, teaming with African nations using sampling methods that are more useful to us in order to obtain proper comparative data. By discussing the range of cultural historical groups who were imported, we have begun to establish the range, if not the specific, non-racial identities of ABG individuals.

By addressing questions raised by African-American community members and scholars, we have begun to identify highly consequential voids in the corpus of anthropological knowledge. The work initiated by this research project, under Dr. Fatimah Jackson’s leadership, toward the establishment of African genetic databanks in Cameroon and elsewhere, has been an unanticipated outcome of our observations. In order to make comparisons of ABG remains to African cultural groups that would result in accurate population affiliations, a more complete set of genetic data needs to be created on descendants of the state-level societies that had been involved in the trade in human captives. A similar case can also be made of European and Native peoples who contributed to early North American colonial history and the genome. The public interest in this research question also spurred interest in the possibility of tracing living African-Americans’ ancestry. The possibility of recovering some of the identity and intercontinental ties that slavery destroyed in order to dehumanize blacks seems an outstanding use of a very different anthropology than we have seen before. The ABGP

has resolved significant methodological and technical problems with both chemical sourcing and DNA affiliation studies.

Continuously, we have been asked by reviewers, overseers, and audience members about comparisons of the NYABG sample to colonial European-American populations. For some, this was a critically important question, one that would validate or invalidate the findings of the ABGP research. From the very beginning, the project sought comparative European-American colonial skeletal and historical cemetery populations. The search was basically unsuccessful; first, apparently European-American populations are rarely disinterred and/or studied; second, when European-American populations are excavated, they are predominantly from poorhouses/almshouses. We considered these populations inappropriate comparisons for establishing the relative conditions of enslaved Africans and colonial Europeans, despite the encouragement from some government oversight agencies and their consultants for us to pursue those comparisons.

Poorhouse/almshouse populations are primarily composed of the insane, sick, aged, lame, blind, chronically intemperate, and indigent (e.g., Elia 1991; Lanphear 1988). In most studies the greater proportion of inmates are there for intemperance. To argue that these represent the laboring lower classes of European-Americans does not seem plausible. In fact, many if not most were the “social outcasts,” not the class of Europeans who were bound to indentured servitude and who would have been a reasonable comparative population. Some portion of the laboring lower social classes is probably represented in poorhouse and almshouse samples, but those segments have not been distinguished from the insane, infirm, and non-laboring inmates. Inmates of these

institutions, at a minimum, experienced similar exposure to infectious diseases and poor nutrition as did enslaved people. Nevertheless, the lower classes and/or “social outcasts” are not socially, biologically or political-economically comparable to the people interred in the ABG. The latter are representative of the average or vast majority of Africans in New York; the former represents a small minority of unrepresentative Euro-Americans, even for the nineteenth century context from which these collections usually derive. A consequence of comparison would be to artificially produce a closer proximity between the conditions of enslaved Africans and free Europeans than is justified. Our solution has been to use cemetery death records for Trinity Church Yard, and these are qualified as evidence of the mortality of those who would have presumed to own Africans in New York, given the high proportion of landowning Englishmen in that congregation. This seems fair until a sample of the majority European population in colonial New York City has been excavated and made available for study using methods comparable to ours.

It should also be noted, with regard to such comparisons as these, that those who are enslaved have no designated social class. Even their membership in the human race was being intensely debated and contested during their lives in New York. Chattel does not have a social class.

Interestingly, only one anthropologist has asked us about the health status of contemporaneous skeletal populations in Africa itself, and was quite disappointed when the response was that none had been sufficiently studied and reported (see Chapter 2). What would their lives, health status, and mortality have been if those who comprise the NYABG population, and others like them, had not been captured and enslaved? That is the question for many people ultimately impacted by these consequences.

Finally, the project may have helped improve African-American interest in archaeology, and archaeologists' and physical anthropologists' interest in ethics. That would be a good thing and we hope to have contributed to it. It seems true, however, that these groups still remain at a distance.

Reviewing Our Themes for an Integrated Volume

The three themes which were developed in the interdisciplinary Sankofa I Conference by the physical anthropologists, archaeologists, historians, and cultural anthropologists has produced the basic structure of this report and of the integrative analyses that have emerged throughout the above chapters and are fundamental to our future research analyses, interpretations, and publications. Although the archaeological analyses are still in progress, the framework provided by the historical component researchers has provided a comprehensive background for identifying and documenting, from diverse international and multi-disciplinary sources, the origins, life and death, and transformations of New York enslaved Africans. The historical research informed the interpretation and the contextualization of the skeletal biological analyses presented in this report.

Unfortunately, to the reader of the skeletal biological volume alone, it may appear that at times interpretations have been based on undocumented assumptions or “leaps of faith”; this is far from accurate. It is critical to understand that the origins, living conditions, ideologies, political economy, and socio-politics of New York enslavement regime(s) have been extensively researched and documented. Historical sources include the records and words of the slaveholders themselves, contemporary historians, social commentators/critics, and archives of the period, in addition to the “classic” and modern

historical sources examined or compiled by the NYABGP historical research team. To a great extent, the final reports of the ABGP skeletal biology and history teams speak to each other and are inseparable.

Origins and Arrival of Africans in Colonial New York

This theme included the determination of the origins and affiliation of the Africans of colonial New York, including their places of birth, the geographic region where they grew up, population affiliations, points of capture and embarkation, and “slave trade” routes. This theme, the questions posited, and possible hypotheses were to be studied by triangulation from the three project disciplinary components (history, physical anthropology, and archaeology), each with their own methodological strengths. The data analyses presented in this volume concerning these questions and issues are based on the documentation generated by the historical component and the observable data generated by the skeletal biological component. The archaeological data are to come later (see Chapter 1). All analyses have been further augmented by hypotheses and questions generated through reviewing preliminary data at the subsequent interdisciplinary Sankofa Conferences II and III.

Life and Death in Colonial New York

This theme focused on the life ways of Africans in early New York, the documentation of the population’s characteristics, their placement on the landscape, their roles in the labor force, living conditions, health conditions (epidemics, mortality, morbidity), resources available, and the limitations they confronted. Based on the skeletal remains, the evidence available for workload and biomechanical behaviors, health and nutritional status, and growth and development were to be integrated and assessed within

the documented historical framework, and eventually the archaeological results. In addition, the factors leading to illness and death would be explored from the perspective of each component.

Transformations

The transformations theme is a complex overview and analytical framework that includes biocultural, environmental, and socio-cultural changes that enslaved Africans underwent once in New York. These included processes of creating a new identity given the nature of the New York slave trade, African-African, African-European, and African-Native American syncretisms, establishing and reformulating social institutions, dietary change, environmental, psycho-social, and biological adaptations. Subsequently, comparative studies of the enslavement regimes and the African experience throughout the African Diaspora of the Americas will also be included. In this thematic research area, cultural anthropologists of the African Diaspora have been consulted and will participate in the future.

Many questions that must still be addressed will occur in several phases, including the following:

- a further synthesis and integration of the historical evidence into elaborating and expanding the skeletal biological analyses;
- the integration of the archaeological data and context into the skeletal biological assessment; for example, mortuary practices and burial patterning in association with the paleodemographic data for analysis of behavioral patterns and taphonomic processes; and

- the incorporation of results from ongoing and future biochemical, genetic, and histological research that will address questions concerning origins, living conditions and health status of enslaved Africans.

These studies may also contribute important insights into the questions associated with biocultural, environmental, and socio-cultural transformations of Africans in New York. Future collaborations, including greater inclusion of ethnographers, were discussed at the May 2004 Sankofa 4 project specialist's conference at the Penn Center on St. Helena's Island, under the auspices of the Institute for Historical Biology. That highly successful meeting of more than 30 old and new members of the research team has affirmed the continuity and development of the information and ideas developed over the past 12 years, and for some time beyond the contractual obligations that have produced the present reports.

Along with the history and archaeology reports, the skeletal biology report is part of a trilogy that should be read together. These reports document the first efforts to tell in detail the story of the eighteenth century enslaved African-American population of New York. In this report, we have been able to reinsert into the historical record, with solid evidence, some of the trials and transformations of this diverse group of individuals. Their bones and teeth speak eloquently of their lives before death, bearing witness to the stresses of malnutrition, infection, poor medical care, lead pollution, overwork, and injury. Individuals came to New York via diverse routes and from diverse areas. Some were born into slavery, while most were first-generation enslaved. Unfortunately, the hardships they endured rival those confronted by and imposed on any other group. Nevertheless, the enslaved Africans of New York rebelled, survived, endured, and

literally made a significant portion of the world that is now enjoyed by much of humanity.

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