# Chapter 7

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

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## Introduction

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 a 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 Volume 3 of this series, *Historical Perspectives of the African Burial Ground: New York Blacks and the Diaspora*—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 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 New York African Burial Ground 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 Diaspora 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 high infant mortality rates. The political economic, environmental, and sociocultural 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 13 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 section presents a brief discussion on paleodemography and its limitations, followed by the paleodemographic data, including the age and sex composition of the New York African Burial Ground sample, mortality patterns of subadults and adults, life expectancy, and sex ratios. The second section summarizes the historical demographic data within a historical context. This includes population size, age and sex composition, sex ratio, and mortality trends identified 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 on the New York African Burial Ground 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 made up the 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 were 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 Euroamericans 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); and undercounts of Africans due to smuggling and underreporting 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 1 or 100 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 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 Volume 3 of this series, *Historical Perspectives of the African Burial Ground: New York Blacks and the Diaspora*. 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 but are less effective with some other demographic variables. For example, estimates of and discussions concerning fertility cannot generally rely on 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 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 1970s, the major focus was on the uses—and problems of using—life tables with skeletal populations (e.g., Buikstra 1976; Moore et al. 1975).

In the 1980s, there were two major critiques of paleodemography, the most significant by Bocquet-Appel and Masset (1982), who stated 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 et al. (1986), who dispelled 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 and analyses could actually distort age at death distributions so that they reflect fertility more than mortality (Milner et al. 2000).

In the early 1990s, Wood et al. (1992) documented three critical problems in paleodemography using archaeological data sets and models to establish their argument. These three problems are: demographic nonstationary populations (populations are not stable, or stationary, as previous models assumed); selective mortality (only those that succumb at any given age are represented in a skeletal population); and hidden heterogeneity in risks (the 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., McCaa 2002; Saunders and Hoppa 1993b). 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 New York African Burial Ground sample consisted of 419 recovered burials of which 301 were available for demographic 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 4. Therefore, paleodemographic assessments are based on these 301 individuals. The adult skeletal remains available for study totaled 171 individuals for whom age and sex 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 (see Chapter 4 for detailed discussion of aging).

### Mortality

New York African Burial Ground overall mortality, based on the total demographic skeletal sample (n = 301), was elevated in the first 2 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), and then mortality remained elevated throughout adulthood. Mortality was highest for infants 0–6 months (9.6 percent), adults in the 30–34 age group (9 percent), and 45–49-year-olds (8.3 percent) (Figure 50).

### Adult Mortality

Adult mortality was highest in the fourth and fifth decades of life when 28.1 percent of adults died in each decade. Female mortality (37.6 percent) was highest in the 30–39 age group, close to double the rate of males (21.6 percent). Male mortality was highest (34.3 percent) in the fifth decade (40–49); female mortality was lower almost by half (18.8 percent). Thus, a differential mortality trend by sex can be observed with approximately two-thirds of the females (62 percent) dying by the end of the fourth decade, compared to 45 percent of the males. Notably, many young adults, aged 15–19, were present in the burial ground.

In general, females entering their reproductive years have higher biological risks than males under non-stressful socioeconomic and environmental circumstances. In the New York African Burial Ground, both groups have similar and high rates. In general, demographers consider the ages 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 male 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 (Figure 51 and Table 15). Several explanations can be proposed here: (1) similar mortality rates for young men and women may result from their having been a greater proportion of the captives imported to New York, which were 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) there may be possible bias in the skeletal sample; (4) enslaved Africans entered into young adulthood biologically compromised and were at greater risk of susceptibility; or (5) an interaction of all the above factors.

### Subadult Mortality

Subadult mortality is an important factor in overall population stability and viability that eventually affects natural population growth. If, indeed, as Sat-

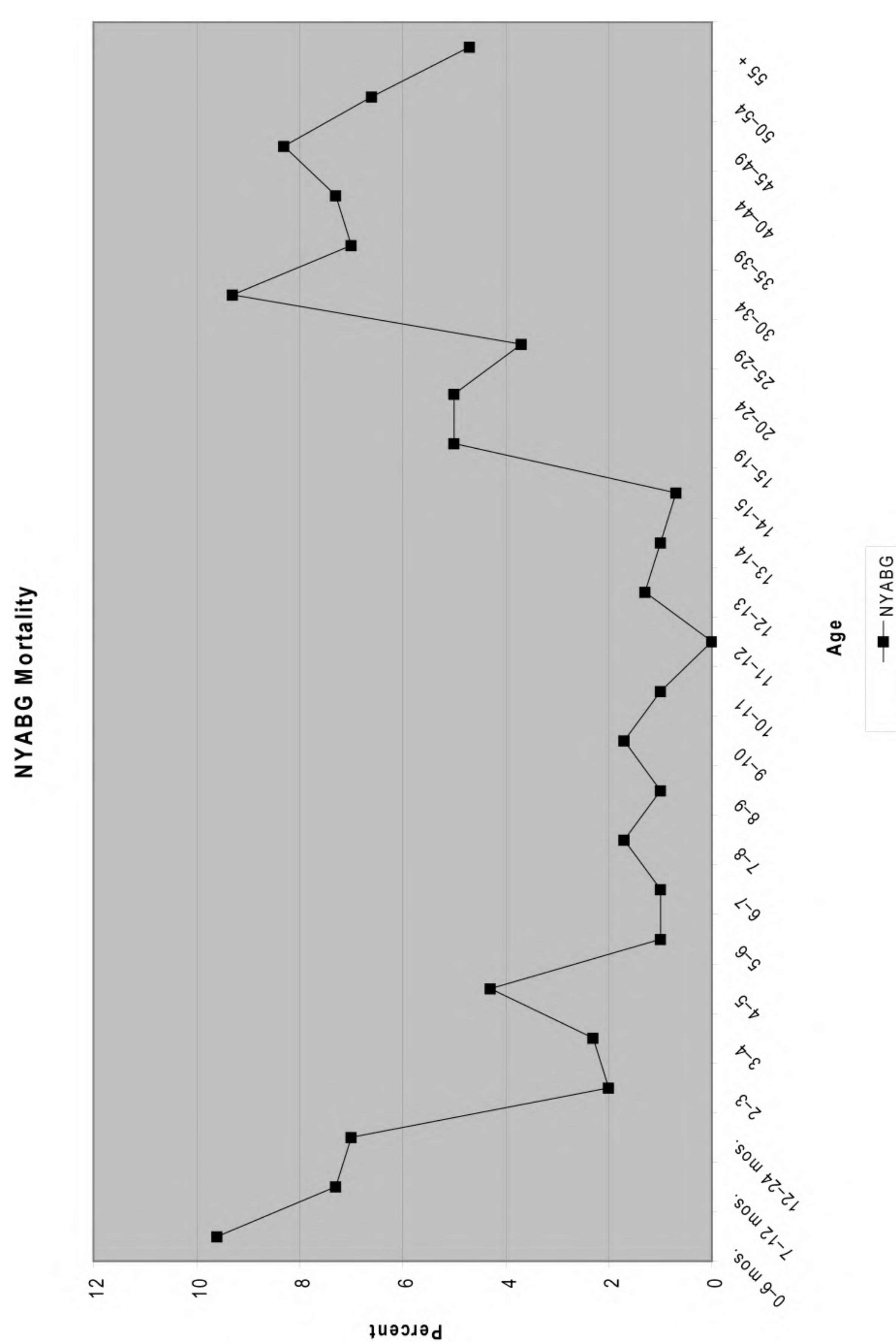


Figure 50. New York African Burial Ground mortality.

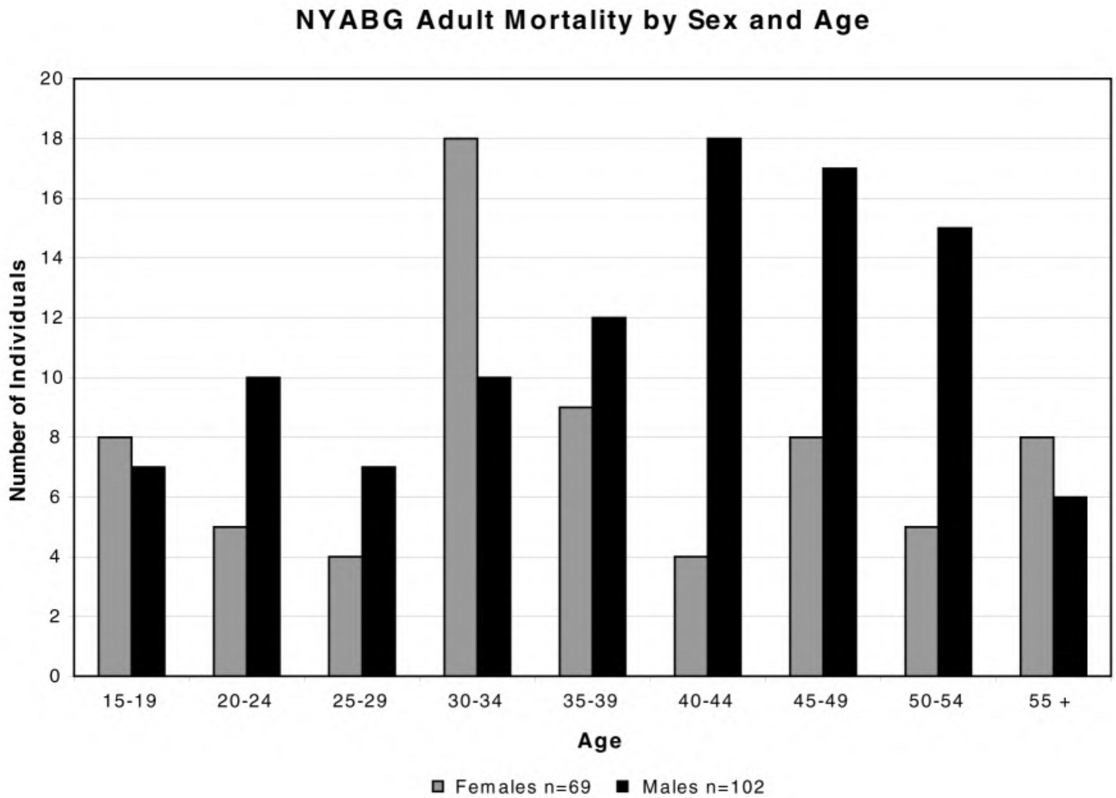


Figure 51. New York African Burial Ground mortality by sex and age.

**Table 15. New York African Burial Ground Adult Mortality**

| Age Group | Male | | | Female | | | Adults | | |
|---|---|---|---|---|---|---|---|---|---|
| | Number | Percent Male | Percent Total Population | Number | Percent Female | Percent Total Population | Number | Percent Adult | Percent Total Population |
| 15–19 | 7 | 6.9 | 2.3 | 8 | 11.6 | 2.7 | 15 | 8.8 | 5.0 |
| 20–24 | 10 | 9.8 | 3.3 | 5 | 7.2 | 1.7 | 15 | 8.8 | 5.0 |
| 25–29 | 7 | 6.9 | 2.3 | 4 | 5.8 | 1.3 | 11 | 6.4 | 3.7 |
| 30–34 | 10 | 9.8 | 3.3 | 17 | 24.6 | 5.6 | 27 | 15.8 | 9.0 |
| 35–39 | 12 | 11.8 | 4.0 | 9 | 13.0 | 3.1 | 21 | 12.3 | 7.0 |
| 40–44 | 18 | 17.6 | 6.0 | 5 | 7.2 | 1.7 | 23 | 13.5 | 7.4 |
| 45–49 | 17 | 16.7 | 5.6 | 8 | 11.6 | 2.7 | 25 | 14.6 | 8.3 |
| 50–54 | 15 | 14.7 | 5.0 | 5 | 7.2 | 1.7 | 20 | 11.6 | 6.6 |
| 55+ | 6 | 5.9 | 2.0 | 8 | 11.6 | 2.7 | 14 | 8.2 | 4.7 |
| | | | | | | | | | |
| Total | 102 | 100.0 | 33.9 | 69 | 100.0 | 22.9 | 171 | 100.0 | 56.7 |

**Table 16. New York African Burial Ground Subadult Mortality**

| Age Category | Number | Percent of Subadults | Percent of Total |
|---|---|---|---|
| 0–6 months | 29 | 22.31 | 9.6 |
| 7–12 months | 22 | 16.92 | 7.3 |
| 12–24 months | 21 | 16.10 | 7.0 |
| 2–3 | 6 | 4.60 | 2.0 |
| 3–4 | 7 | 5.30 | 2.3 |
| 4–5 | 13 | 10.00 | 4.3 |
| 5–6 | 3 | 2.30 | 1.0 |
| 6–7 | 3 | 2.30 | 1.0 |
| 7–8 | 5 | 3.80 | 1.7 |
| 8–9 | 3 | 2.30 | 1.0 |
| 9–10 | 5 | 3.80 | 1.7 |
| 10–11 | 4 | 3.10 | 1.3 |
| 11–12 | 0 | 0.00 | 0.0 |
| 12–13 | 4 | 3.10 | 1.3 |
| 13–14 | 3 | 2.30 | 1.0 |
| 14–15 | 2 | 1.50 | 0.7 |
| | | | |
| Total | 130 | 100.00 | 43.2 |

*Note:* Age category is in years unless otherwise noted.

tenspiel and Harpending (1983) have argued, subadult skeletal remains actually represent subadult birthrates rather than deaths, then birthrates 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 percent) occurred during the first year of life, followed by another 16.1 percent in the second year. Therefore, 55.3 percent of all the subadults died by age 2. A sharp decline between ages 2 and 4, with a doubling at age 4–5, is followed by a radically decreased mortality until adulthood (Table 16).

## Historical Demography of Africans in Early New York

It has been estimated that at a minimum, 6,800 Africans were imported into New York colony between 1700 and 1774, with approximately 2,800 coming directly from Africa and 4,000 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 the 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

**Table 17. Population of New York County, 1698–1800**

| Year | Total | Black | Percent Black | White | Percent White |
|---|---|---|---|---|---|
| 1698 | 4,937 | 700 | 14.2 | 4,237 | 85.8 |
| 1703[a] | 4,391 | 799 | 18.2 | 3,592 | 81.8 |
| 1712 | 5,861 | 975 | 16.6 | 4,886 | 83.7 |
| 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 | 13,294 | 2,368 | 17.8 | 10,926 | 82.2 |
| 1756 | 13,046 | 2,278 | 17.5 | 10,768 | 82.5 |
| 1771 | 21,863 | 3,137 | 14.3 | 18,726 | 85.7 |
| 1786 | 23,614 | 2,107 | 8.9 | 21,507 | 91.1 |
| 1790 | 31,225 | 3,092[b] | 9.9 | 28,133 | 90.1 |
| 1800 | 57,663 | 5,867[c] | 10.2 | 51,796 | 89.8 |

*Note:* From 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.
[a] 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.
[b] Includes 1,036 free and 2,056 enslaved blacks.
[c] Includes 3,333 free and 2,534 enslaved blacks.

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 twelvefold. The African population only grew eightfold during the same period. The proportion of Africans in New York fluctuated throughout the period, actually declining between 1786 and 1800. The Euroamerican population remained fairly constant (around 80–85 percent of the total population) until 1786 when it increased to 91.1 percent (Table 17 as revised by Medford).

## 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 affect the equilibrium produced through natural fertility. An equal sex ratio (presented as 100 on a scale in which lower numbers represent an underrepresentation 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 birthrates 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 the 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, despite the lower sex ratios (more females), the combination of birth, death rates, and health care quality led to declining enslaved populations (e.g., Higman 1991; Fraginals 1977).

Historically, the earliest phases of voluntary migration often produce sex ratios far in excess of 100 because of 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 immigrants tend to come from the most economically productive age groups.

These populations tend to grow rapidly as time goes on and 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 historical 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 3 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 underpopulation and underdevelopment of the African continent.

Eighteenth-century censuses identified by project historians provide a data source for New York inhabitants, including Africans. As in all historical documents, the potential for inaccuracy is recognized, understanding that undercounts of both enslaved Africans and Euroamericans is probable. The selective nature of the slave trade is further substantiated in the New York eighteenth-century censuses, in which the proportional rates of African adults relative to children (excluding 1731 and 1737 when adults were defined by 10 years of age and older) were highest (Table 18). New York's African adult population was fairly consistent around 60–65 percent; in 1746, it decreased to 53 percent followed by a return to the earlier higher rates.

## 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 19). A substantially greater number of males were reported only for 1746 (126.7 percent) and 1737 (110.7 percent). The proportion of males (but not their absolute numbers) decreased most markedly following periods of political upheaval in the Americas (see Table 19) (see Chapter 13 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 (1984, 1991) observed low sex ratios in blacks in West Indian towns, and Morgan (1984) observed a preponderance of women in many years in Charleston, South Carolina. Because 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, a nineteenth-century urban 'free people of colour' (Rankin-Hill 1997).

## Comparisons with the New York Colonial European Community

Historical records provide few contemporary comparative populations, European or African, for the eighteenth century. The best potential source for mortality data was the Trinity Church and burial ground records. Trinity Church, an Anglican Church near the African Burial Ground site, is one of the oldest churches in New York City. Many of those buried in the cemetery were most probably the slaveholders of those interred in the African Burial Ground. The project's Office of Public Education and Information compiled the data set from a publication of existing church records that cover the period from 1700 to 1777 (Corporation of Trinity Church 1969). Although records and epitaphs were available for a greater length of time, these were excluded because of 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-recordation, interment elsewhere, or religious, social, and/or political exclusion from the cemetery, among other reasons. The Trinity Church burial population consisted of 327 interments, 187 adults and 140 children; of the adults, 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 52). In comparing adults by age and sex and subadults, a

**Table 18. African Population by Age and Sex, Eighteenth-Century Censuses**

| Year | Male Adults | Female Adults | Male Children | Female Children | 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 | 1,085 | 568 | 552 | ≤16 | black | black adult males includes 42 males over 60 |
| 1786 | 896 | 1,207 | — | — | — | slaves, negroes | |

*Note:* From United States Bureau of the Census (1909), checked against Brodhead (1856–1887). Some discrepancies in the numbers appearing in Kruger (1985) and Foote (1991) have been corrected.

differential pattern between European and African New Yorkers can be observed. The Trinity Church males had moderate death rates during middle age (30–49) and primarily died in later life (with great longevity into the 80s and 90s). The only age group where Trinity mortality exceeded the New York African Burial Ground males was in the 25–29 and 55-and-older age groups (Figure 53). This higher rate of death in the mid 20s may be explained by the in-migration of young men, who would have constituted a larger segment of the population, would have been subjected more frequently to interpersonal violence, and proportionally would have died in greater numbers. Other reasons for the early mortality of English men are still under investigation by historians. African male mortality was the highest at 40–49 followed by 50–54. Therefore, New York African Burial Ground males were experiencing significantly higher mortality rates in early adulthood.

Female mortality for Trinity Church peaked at ages 55 and older and 25–29; the longevity of English women was only slightly less than that of males and, of course, much higher than the New York African Burial Ground women. High mortality in the 25–29 age group was a repeated pattern throughout the eighteenth and nineteenth centuries in America, primarily based on the stresses of reproduction; this pattern did not decline until the early twentieth century. The New York African Burial Ground women died at proportionately higher numbers throughout early adulthood; by age 40, 62 percent of New York African Burial Ground women and 54 percent of their European counterparts had died. Yet the women of Trinity Church had a reduced mortality regime after the 25–29 peak and went on to live to older ages; very few African women made it to old age (see Figure 53).

Subadult mortality for Trinity Church exceeded the New York African Burial Ground in the 0–5 years of life, whereas the New York African Burial Ground was slightly higher in the 5–9 age group and exceeded Trinity Church subadult mortality in ages 10–14,

**Table 19. Sex Ratio New York City County 1703–1819**

| Year | Sex Ratio | Notes |
|---|---|---|
| 1703 | 107.9 | |
| 1712 | 100.3 | |
| 1723 | 85.7 | |
| 1731 | 98.7 | This year's census counted persons over or under 10 years of age; thus "adults" were not all of childbearing years. Overall sex ratio was 99.1. |
| 1737 | 110.7 | This year's census counted persons over or under 10 years of age; thus "adults" were not all of childbearing years. Overall sex ratio was 110.6. |
| 1746 | 126.7 | |
| 1749 | 92.9 | |
| 1756 | 96.7 | |
| 1771 | 85.9 | |
| 1786 | 74.2 | |
| 1790<br>1800<br>1810 | | Federal censuses did not count blacks by sex. |
| 1805 | 72.3 | Local censuses for the early nineteenth century (Kruger 1985:370). |
| 1819 | 65.8 | |

*Note:* From United States Bureau of the Census (1909). Discrepancies were found in Foote's (1991) and Kruger's (1985) numbers and have been corrected. The numbers in United States Bureau of the Census (1909) were checked in Brodhead (1856–1887).

10 percent and 4 percent respectively (Table 20). The overall mortality regime for the New York African Burial Ground 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 54).

Young children and infants are always underrepresented in historical cemetery populations but the underrepresentation in archaeological cemeteries with varied preservation conditions, such as the New York African Burial Ground, tend to be dramatically higher. Most of the Trinity Church mortality data used here derive from archival records, and Corruccini et al. (1982) clearly showed that such records of infant mortality in contemporary (eighteenth-century) Barbados were several times greater than the numbers of infant skeletons they observed; the numbers of 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 lifestyles and biohistory throughout the eighteenth, nineteenth, and early twentieth centuries (Table 21). 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

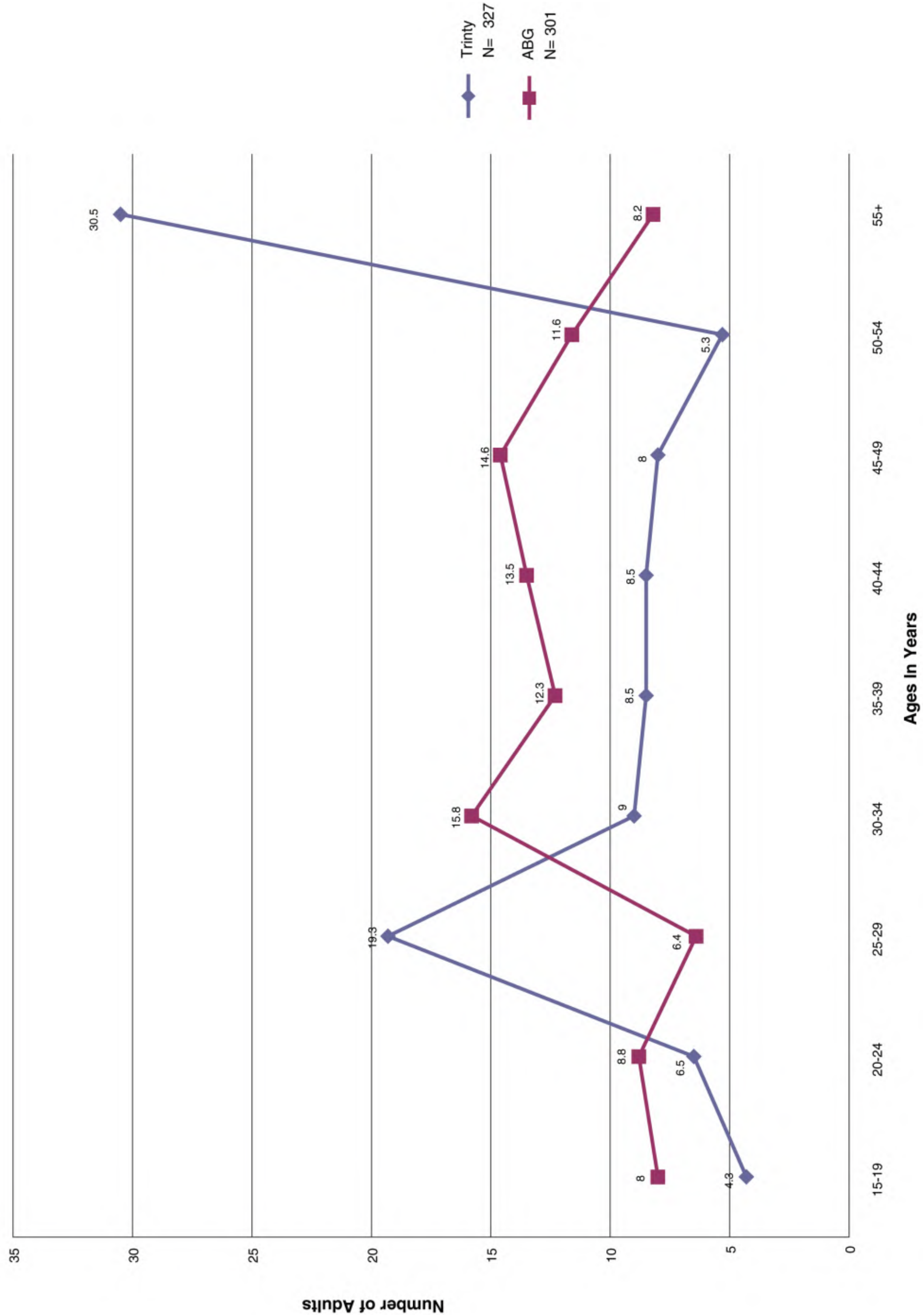


Figure 52. Adult mortality NYABG and Trinity Church.

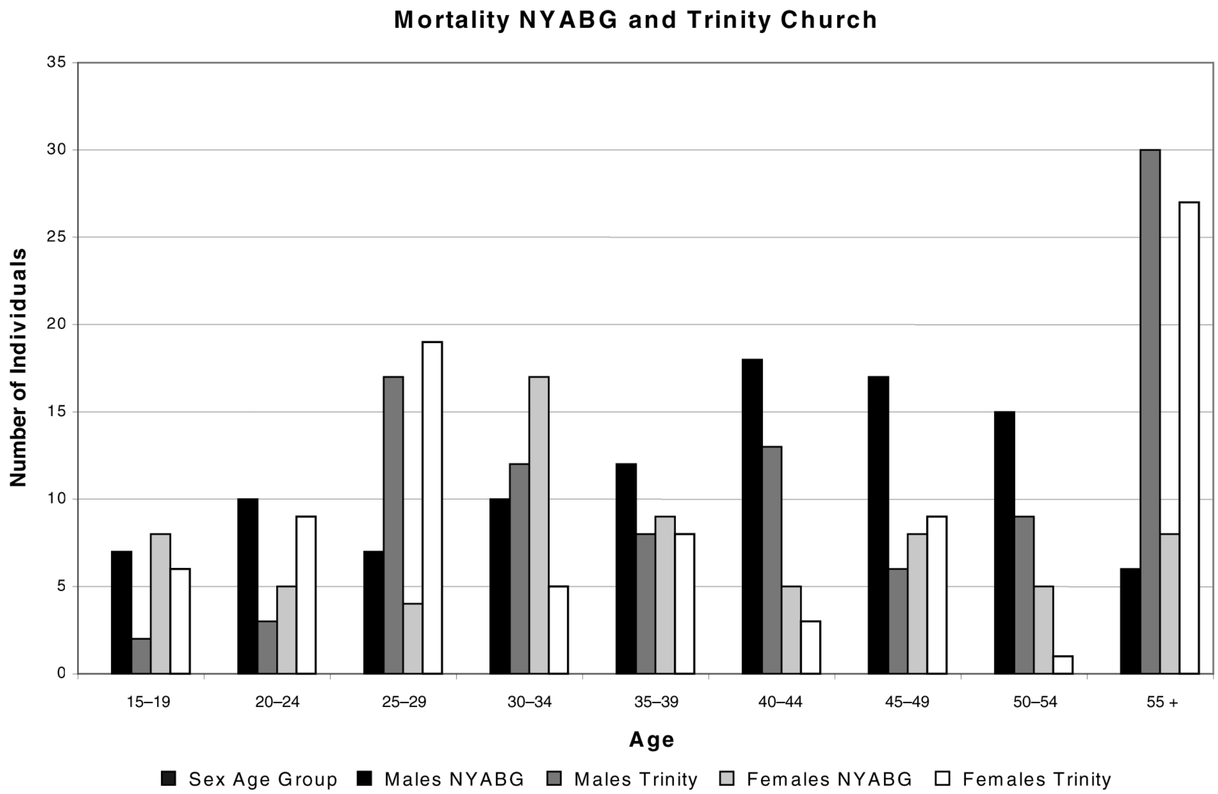


Figure 53. Mortality NYABG and Trinity Church by sex and age.

**Table 20. NYABG and Trinity Church Subadult Mortality**

| Age | NYABG | Percent Subadults | Trinity | Percent 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 |
| | | | | |
| Total | 130 | 100.0 | 140 | 100.0 |

(Rose 1985); urban slaves from New Orleans (Owsley et al. 1987); poor and destitute urban dwellers from Reconstruction-period Atlanta (Blakely and Beck 1982); slaves from several small (containing from one to nine burials) southern Colonial farms or plantations (Angel et al. 1987); Philadelphia urban "free people of colour" (Angel et al. 1987; Crist et al. 1999); Rankin-Hill 1997); and the only Caribbean series, the enslaved at a Barbadian sugar plantation (Handler and Corruccini 1986). Availability of the majority of these African American skeletal populations for analysis has been limited (2 weeks to several years) because of 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 are scheduled for reinterment.

There are three general trends observed in all African Diaspora skeletal series, which concur with biohistorical lifestyle and health analyses (e.g., see Kiple and Kiple 1980; Rankin-Hill 1997): (1) high infant and child mortality, (2) periods of malnutrition and disease

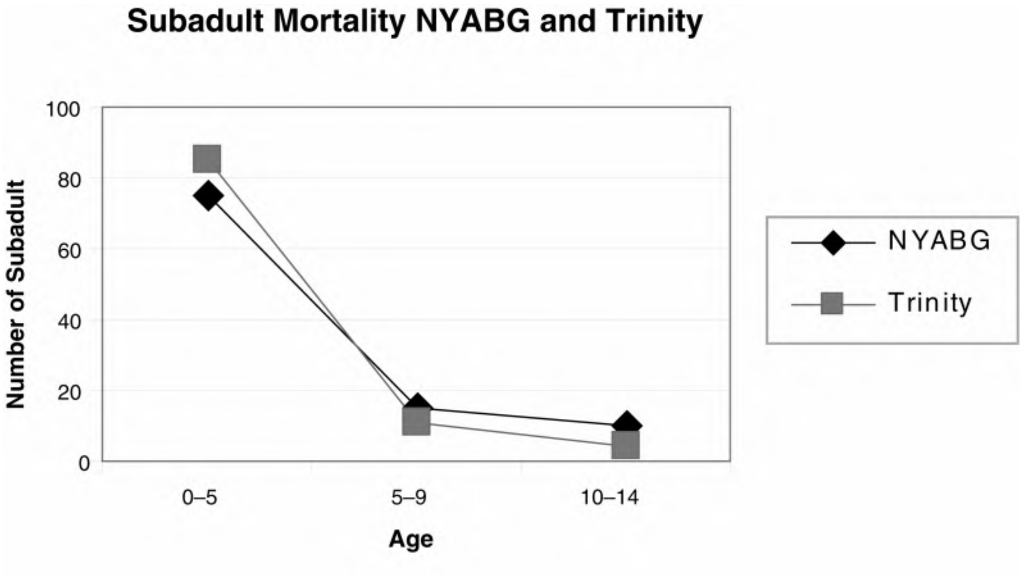


Figure 54. Subadult mortality NYABG and Trinity Church.

indicated by linear enamel hypoplasias and nonspecific infectious lesions, and (3) high incidences 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 Diaspora 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 Diaspora skeletal series. These skeletal series provide comparisons for the New York African Burial Ground where data were available and appropriate.

## Newton Plantation, Barbados, West Indies

Corruccini and coworkers (1982) undertook the only large study of an African American enslaved population from the Caribbean. This series represents a population involved in an intensive sugar-plantation economy. This slave cemetery, associated with the Newton plantation in Barbados, consisted of 104 individuals interred between 1660 and 1820. The analyses indicated a mean age at death of 29.3 years; owing to poor preservation, the sample was not differentiated by sex. Historical data available on the 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, New Orleans, Louisiana

The St. Peter Street Cemetery in New Orleans, Louisiana, dating ca. 1720–1810, was studied by Owsley et al. (1987). St. Peter served as New Orleans's principal cemetery during the city's first 70 years under both Spanish and French rule. Until the discovery of the New York African Burial Ground, this cemetery represented the earliest urban African American skeletal population that had become available for study.

The sample consisted of 29 individuals, 23 adults aged 20 and over, and 6 subadults (1 infant, 2 aged

**Table 21. Skeletal Series of the African Diaspora**

| Site and/or Location | Time Periods | Total Number of Burials | Lifestyle | Preservation | Analysis | Status |
|---|---|---|---|---|---|---|
| Newton, Barbados | 1660–1820 | 104 | 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 to good | indefinite | available[a] |
| St. Peter Street Cemetery, New Orleans[b] | 1720–1810 | 13 | urban slaves | poor | 3 years | reinterred |
| Catoctin Furnace, Maryland | 1790–1820 | 31 | industrial slaves | fragments; poor | indefinite | available[a] |
| FABC 8th Street, Philadelphia | 1821–1843 | 144 | ex-slaves and freeborn | poor to good | 3 years | reinterred |
| FABC 11th Street, Philadelphia | 1810–1822 | 89 | ex-slaves and freeborn | poor to good | 5 years | reinterred |
| 38CH778, South Carolina | 1840–1870 | 36 | plantation slaves | poor to good | 1 year | reinterred |
| Oakland Cemetery, Atlanta, Georgia | 1866–1884 | 17 | poor and indigent | fragments; excellent | ? | reinterred |
| Cedar Grove Cemetery, Arkansas | 1890–1927 | 79 | rural farmers | poor to excellent | 2 weeks | reinterred |

*Note:* From Rankin-Hill 1997.
*Key:* FABC = First African Baptist Church.
[a] Remains available at the Smithsonian Institution, Museum of Natural History.
[b] n = 29; 13 African Americans.

5–9, and 3 aged 15–19); of these, 13 (45 percent) 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; male mortality peaked at 40–49 years. But Owsley et al. (1987:10) cautioned that an "inherent sample bias may misrepresent the actual mortality curve of the colonial population" due to small sample size and the underrepresentation 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 because the rest of the cemetery had been covered by a state highway. This skeletal material was recovered during the widening of the highway and constituted a small sample of 31 individuals (15 adults, 14 children under the age of 12, and 2 teenagers). These individuals were members of an enslaved ironworking 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 28 adults (13 male, 15 female) and 8 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) 8th and Vine Streets, 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 ca. 1822–1843 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 percent) 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 (Kelley and Angel 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 U.S. Army Corps of Engineers led to the salvage excavation of burials scheduled for destruction. The 79 burials were excavated from the section that was in jeopardy of eroding out and targeted for salvage removal. These burials comprised 73.6 percent of the total cemetery population and represented 40 percent of the time the cemetery had been in use since its founding in 1834 by enslaved people (prior to the establishment of the Baptist Church and cemetery).

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 percent) and of a life expectancy of 14 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 Diaspora skeletal series (e.g., Catoctin Furnace).

# Mean Age at Death

The mean age at death for the New York African Burial Ground sample was 22.3. The low mean age at death reflects the high childhood mortality in the New York population. The New York African Burial Ground 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 Diaspora skeletal populations (Table 22), with the exception of enslaved plantation South Carolinians and the New Orleans urban enslaved; however, in these cases, the results may be artifacts of small skeletal samples and preservation status. An independent-samples $t$-test was run in SPSS using the composite ages for adult New York African Burial Ground males and females to test for difference in the mean age at death; no significant difference was found, $t = 1.190$; $p > .05$ ($p = 2.36$).

New York African Burial Ground women have a lower mean age at death than the women from the ironworking Catoctin Furnace, Maryland, site where women were devalued as workers because they only contributed domestic chores. In each of the comparisons, the maximum age of 55 and older 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 New York African Burial Ground sample. In attempting to test whether there was a statistically significant difference among sample mean ages at death considering the difference in sample size, a one-way ANOVA was undertaken in SPSS for New York African Burial Ground, 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 in mean ages of death among the three populations, $F = 0.791$; $df = 2, 260$; $p > .05$ (p = 0.454). In addition, population

**Table 22. Adult Mean Age at Death for African American Skeletal Populations**

| African American Skeletal Populations | Mean Age or Age Range at Death | | |
|---|---|---|---|
| | Males | Females | Total |
| Newton Plantation, Barbados, West Indies [a] | — | — | 29.3 |
| New York African Burial Ground | 38 | 35.9 | 36.9 |
| St. Peter Street Cemetery, Louisiana [b] | 40–49 | 20–24 | — |
| Catoctin Furnace, Maryland [c] | 41.7 | 35.2 | 38.4 |
| First African Baptist Church Cemetery [d] | 44.8 | 38.9 | 41.3 |
| 38CH778, South Carolina [e] | 35.0 | 40.0 | 37.5 |
| Cedar Grove, Arkansas [f] | 41.2 | 37.7 | 39.5 |

[a] From Corruccini et al. 1982
[b] From Owsley et al. 1987
[c] From Kelley and Angel 1983
[d] From Angel et al. 1987 and Rankin-Hill 1997
[e] From Rathbun 1987
[f] From Rose 1985

size had no significant effect on mean age of death, $F = 0.791$; $df = 2, 260$; $p > .05$ (p = 0.454).

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, $t = 2.964$; $df = 261$; p < .05 ($p = .003$). This was followed by individual independent-samples *t*-tests for within-sample differences by sex for the three samples. As reported above, there was no significant difference between the sexes for the New York African Burial Ground sample; for Catoctin Furnace, there was also no significant difference in mean age of death for males and females, $t = 1.285$; $df = 13$; $p > .05$ ($p = .221$). However, for the FABC, there was a significant difference in mean age of death between the sexes, $t = 3.16$; $df = 75$; $p < .05$ ($p = .002$).

## Mortality

The New York African Burial Ground infant mortality rate (under 12 months) was low at 15.2 percent of all individuals who were assigned ages or 16.9 percent of the 301 best-preserved individuals (assessed for both age and sex) compared to FABC at 25 percent. Because the New York population only represents a segment of a large cemetery population, and FABC represents the entire cemetery, the underrepresentation 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, lower fertility, or that a greater number of infants survived and eventually died in later childhood or early adolescence.

New York African Burial Ground 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 the FABC nineteenth-century free African Americans in Philadelphia (Rankin-Hill 1997). In both of these populations, there was a high infant-mortality rate during the first 6 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 New York African Burial Ground sample, however, early childhood mortality remained high throughout the first 2 years of life (Table 23).

## 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, or socioculturally 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

**Table 23. NYABG, FABC, and Cedar Grove Subadult Mortality by Age Group**

| Age[a] | NYABG | | FABC | | Cedar Grove | |
|---|---|---|---|---|---|---|
| | Number of Deaths | Percent of Total Subadults | Number of Deaths | Percent of Total Subadults | Number of Deaths | Percent of Total Subadults |
| 0–6 months | 29 | 22.3 | 26 | 43.3 | 17 | 38.6 |
| 7–12 months | 22 | 16.9 | 8 | 13.4 | 5 | 11.4 |
| Subtotal, <1 | 51 | 39.2 | 34 | 56.7 | 22 | 50.0 |
| <2 | 21 | 16.1 | 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 |
| Total | 130 | 100.0 | 60 | 100.0 | 44 | 100.0 |

[a] In years unless otherwise indicated.

and Demeny (1966) for isolating abnormal characteristics in mortality profiles (Moore et al. 1975). Through these demographic analyses, we can generate population parameters and examine long-term trends in adaptation, health, and disease.

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. These assumptions are: (1) there is a stable static population, (2) mortality is not selective, and (3) risk is constant throughout the population (Wood et al. 1992). In actuality, very few, if any, prehistoric, historical-period, or contemporary populations would meet these criteria. In prehistoric and historical-period skeletal populations, one or more of these criteria are either violated or are unknown to the researcher. In the New York African Burial Ground sample and most African Diaspora collections, all of the criteria are not met (whether working with 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 the 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. Further discussion will be explored in another context. 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 New York African Burial Ground sample using an Excel database computerized-life table (Table 24). In addition, we generated life tables for FABC and Cedar Grove to use for comparisons (Rankin-Hill 1997). Survivorship was higher for the New York African Burial Ground sample compared to Cedar Grove until age 45, although paralleling FABC and Weiss's (1973) model MT30–60.0 in adulthood. The New York African Burial Ground sample had higher survivorship in early childhood than Cedar Grove, FABC, and both model tables. Nevertheless, survivorship (lx) for New York African Burial Ground, FABC, Cedar Grove (MT15.0–45.0 ) [The best fit model life table as reported by Rose et al. (1985)], and MT30–60.0 clearly demonstrate the impact of infant mortality on the overall pattern (Figure 55).

An independent-samples *t* test yielded no significant sex differences in survivorship within the New York African Burial Ground sample, $t = 0.339$; $df = 16$; $p > .05$ ($p = .739$). A one-way ANOVA was run for New York African Burial Ground, FABC, and Cedar Grove, but the analysis yielded no significant differences in survivorship among the three groups, $F = 1.282$; $df = 3, 68$; $p > .05$ ($p = .288$).

## Life Expectancy

Life expectancy ($E^0x$) at birth for the New York African Burial Ground members was 24.2 years. By ages

**Table 24. New York African Burial Ground Life Table**

| Age Interval[a] (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) |
|---|---|---|---|---|---|---|---|
| 0–5 months | 29 | 9.63 | 100.00 | 0.0963 | 9.518 | 2420.316 | 24.20 |
| 6–12 months | 22 | 7.31 | 90.37 | 0.0809 | 8.671 | 2410.797 | 26.68 |
| 1–2 | 21 | 6.98 | 83.06 | 0.0840 | 90.664 | 2402.126 | 28.92 |
| 3–4 | 26 | 8.64 | 76.08 | 0.1135 | 358.804 | 2311.462 | 30.38 |
| 5–9 | 19 | 6.31 | 67.44 | 0.0936 | 321.429 | 1952.658 | 28.95 |
| 10–14 | 13 | 4.32 | 61.13 | 0.0707 | 294.850 | 1631.229 | 26.68 |
| 15–19 | 15 | 4.98 | 56.81 | 0.0877 | 271.595 | 1336.379 | 23.52 |
| 20–24 | 15 | 4.98 | 51.83 | 0.0962 | 246.678 | 1064.784 | 20.54 |
| 25–29 | 11 | 3.65 | 46.84 | 0.0780 | 225.083 | 818.106 | 17.46 |
| 30–34 | 27 | 8.97 | 43.19 | 0.2077 | 193.522 | 593.023 | 13.73 |
| 35–39 | 21 | 6.98 | 34.22 | 0.2039 | 153.654 | 399.502 | 11.67 |
| 40–44 | 23 | 7.64 | 27.24 | 0.2805 | 117.110 | 245.847 | 9.02 |
| 45–49 | 25 | 8.31 | 19.60 | 0.4237 | 77.243 | 128.738 | 6.57 |
| 50–54 | 20 | 6.64 | 11.30 | 0.5882 | 39.867 | 51.495 | 4.56 |
| 55+ | 14 | 4.65 | 4.65 | 1.0000 | 11.628 | 11.628 | 2.50 |
| | | | | | | | |
| Total | 301 | Crude Mortality Rate: 41.32 | | | | | |

[a] In years unless otherwise indicated.

3–4, life expectancy rose to 30.38 years, reflecting the higher incidence of death for subadults under 2 years old, therefore the impact of higher risk of dying. Two life tables for adults by sex were also generated for the New York African Burial Ground. A comparison of these tables indicates different trends based on sex. Males in the 15–19 and 20–24 age groups had life expectancies of 24.41 and 21.03, respectively. By age 25–29, male life expectancy was 18.21 (Table 25).

At ages 15–19 and 20–24, females had life expectancies of 22.21 and 19.80, respectively; by age 25–29, female life expectancy was 16.34 (Table 26).

An independent-samples *t*- test in SPSS indicated no statistically significant differences between the sexes in life expectancy within the New York African Burial Ground sample, $t = .051$; $df = 16$; $p > .05$ ($p = .960$).

New York African Burial Ground life expectancy at birth (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 56). New York African Burial Ground life expectancy was compared to Weiss's (1973:175, 118) model life tables MT30.0–60.0 and to MT15.0–45.0, 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 New York African Burial Ground 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 FABC, but higher than that for Cedar Grove. New York African Burial Ground and FABC are similar from age 20, declining at comparable rates. New York African Burial Ground life expectancy declines even more rapidly than for the "highly stressed" Cedar Grove group after age 45. The differences between New York African Burial Ground, Cedar Grove, and FABC life expectancy and mortality experience are significant. Clearly, post-Reconstruction Cedar Grove rural Arkansas African Americans were at highest risk

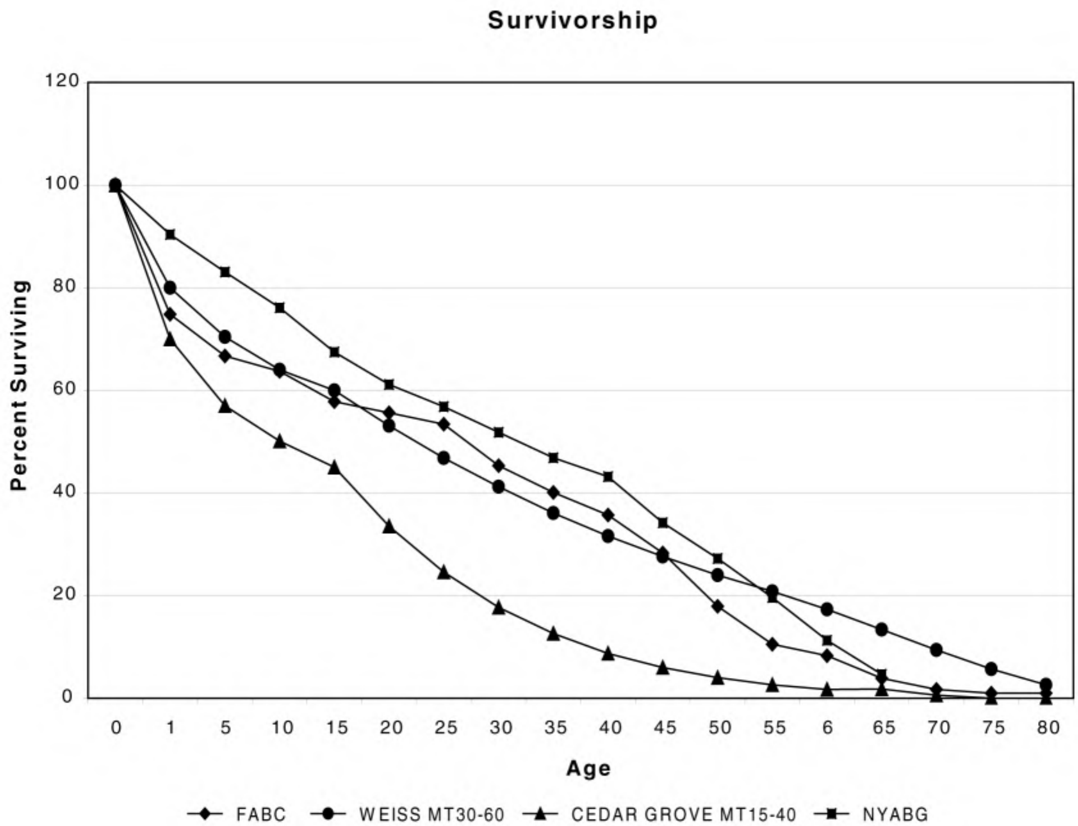


Figure 55. Survivorship.

**Table 25. 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 (e0x) |
|---|---|---|---|---|---|---|---|
| 15–19 | 7 | 6.86 | 100.00 | 0.0686 | 482.843 | 2,441.176 | 24.41 |
| 20–24 | 10 | 9.80 | 93.14 | 0.1053 | 441.176 | 1,958.333 | 21.03 |
| 25–29 | 7 | 6.86 | 83.33 | 0.0824 | 399.510 | 1,517.157 | 18.21 |
| 30–34 | 10 | 9.80 | 76.47 | 0.1282 | 357.843 | 1,117.647 | 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 | | | | | |

**Table 26. 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 (e0x) |
|---|---|---|---|---|---|---|---|
| 15–19 | 8 | 11.59 | 100.00 | 0.1159 | 471.014 | 2,221.014 | 22.21 |
| 20–24 | 5 | 7.25 | 88.41 | 0.0820 | 423.913 | 1,750.000 | 19.80 |
| 25–29 | 4 | 5.80 | 81.16 | 0.0714 | 391.304 | 1,326.087 | 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 | | | | | |

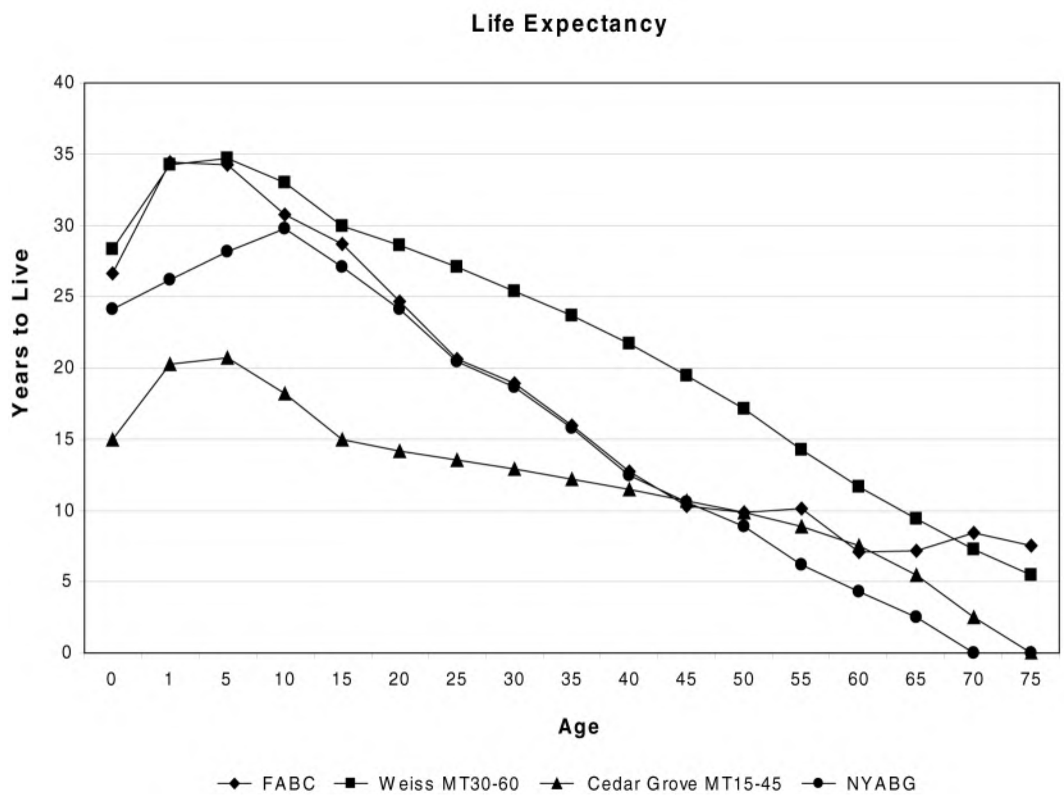


Figure 56. Life expectancy.

of dying earlier. However, at the end of the life span, life expectancy was dramatically reduced for the New York African Burial Ground sample.

## Summary of Findings for the New York African Burial Ground Sample

### Paleodemography

- Mortality was highest for:
  - ~ Infants 0–5 months (29 of 301, or 9.6 percent )
  - ~ Adults 30–34-year-olds (27 of 301, or 8.97 percent).
  - ~ Adults 45–49-year-olds (25 of 301, or 8.3 percent).
  - ~ Young adults aged 15–19 made up 8.8 percent of the adult sample or approximately 5 percent of the total 301 well-preserved skeletons
- 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 (26 of 69, or 37.7 percent) peaked at age 30–39.
  - ~ Male mortality (35 of 102, or 34.3 percent) peaked at age 40–49.
- Subadult mortality was 43.2 percent for the New York African Burial Ground (n = 301).
  - ~ 39.2 percent of the subadult population (51 of 130) died during the first year of life.
  - ~ 16.1 percent of the subadult population (21 of 130) died in the second year.
  - ~ 55.3 percent of all the subadults (72 of 130) died by age 2.

### Historical Demography

- Age-sex composition and sex ratio were shaped by the prevailing political economy.
- New York Africans had a high 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.

### Colonial European Comparison

- High mortality in women 25–29, based on reproductive stress, was a ubiquitous American pattern throughout the eighteenth and nineteenth centuries that declined in the early twentieth.
- Observed is a differential pattern between European and African New Yorkers.
- Trinity Church males had moderate death rates during middle age and great longevity.
- Trinity Church male mortality exceeded New York African Burial Ground males at 25–29 and 55 and older.
- Trinity female mortality peaked at 55 and older and at 25–29, with longevity slightly less than that of males and higher than that of New York African Burial Ground women.
- New York African Burial Ground women died at proportionately higher rates.
  - ~ 62 percent of New York African Burial Ground women died by age 40.
  - ~ 54 percent of European women died by age 40.
- Trinity Church women had a reduced mortality regime after the 25–29 age peak until age 55 and older.

### Skeletal Biological Comparisons

- Mean age at death for the New York African Burial Ground cemetery sample was 22.3, including all ageable adults and subadults (n =301).
- Low mean age at death reflects high childhood mortality.
- New York African Burial Ground 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 FABC was not present at the New York African Burial Ground. Both had high infant mortality rates during the first 6 months, followed by a decline, then followed by an increase again during the second year. The New York African Burial Ground early-childhood mortality remained high throughout the first 2 years of life.

- New York African Burial Ground women had a comparable mean age at death to the women from the ironworking Maryland Catoctin Furnace, who were devalued as workers.
- Life expectancy ($E^{\emptyset}x$) at birth for the New York African Burial Ground sample was 24.2 years, and by ages 3–4, life expectancy rose to 30.38 years.
- New York African Burial Ground 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 New York African Burial Ground, 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 New York African Burial Ground sample.

Section III:

# Life and Death in Colonial New York

# Chapter 8

# Childhood Health and Dental Development

*M. L. Blakey, M. E. Mack, A. R. Barrett, S. S. Mahoney, and A. H. Goodman*

Dental enamel hypoplasias are defects in crown development that appear as transverse grooves or series of pits that are partially or entirely around the circumference of the tooth. Hypoplastic defects, although 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 hypoplasias develop 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 on different teeth and in different locations on teeth represent stresses at different 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; Clarke 1982; Condon and Rose 1992; Corruccini et al. 1985; Goodman and Armelagos 1985; Goodman et al. 1984).

This chapter puts forward an analysis of hypoplasia frequencies in the New York African Burial Ground sample. Comparisons are made of enamel defect frequencies in different age groups and sex/gender groups. We also compare individuals with culturally modified teeth who were probably born in Africa and those with unmodified teeth whose origins are unknown. Finally, we 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 because of 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 (Figures 57 and 58).

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. 1994:372). Dental enamel is acellular and, therefore, lesions and discolorations due to physiological stress are permanent and are not obliterated through cellular renewal. In 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

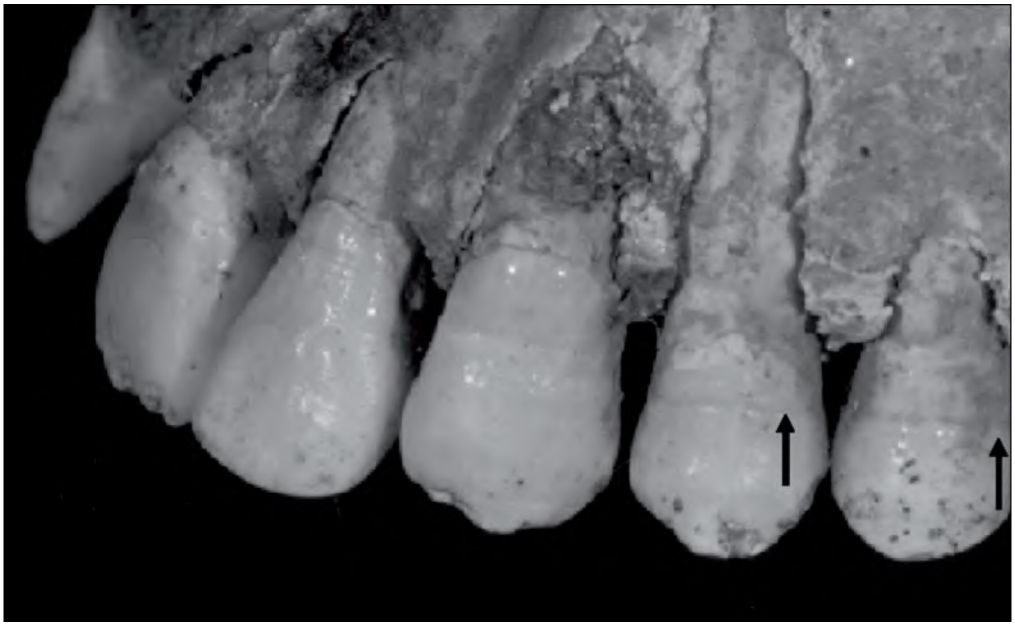

Figure 57. Linear enamel hypoplastic lesions in the anterior maxillary permanent dentition in a female aged 20–25 years (Burial 1).

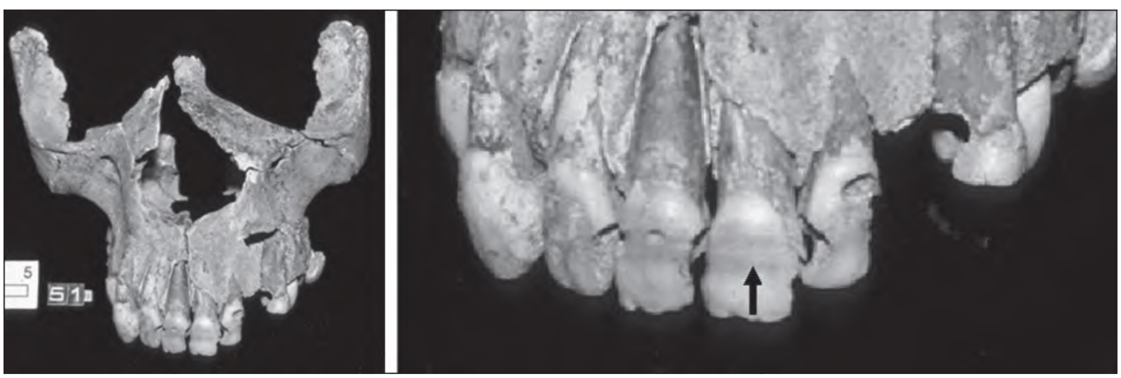

Figure 58. Bands of discoloration caused by hypocalcification in the anterior maxillary permanent dentition in a 24–32-year-old female (Burial 51) (*left*); magnification (*right*).

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" (Blakey et al. 1994; Goodman et al. 1988).

## Materials and Methods

A subsample was selected from the New York African Burial Ground sample to study the occurrence and frequency of hypoplasia within adults and children (Table 27). Within this study, the presence of hypoplasia within an individual was defined by the presence of linear or nonlinear hypoplasia in one of the teeth selected for analysis. The absence of hypoplasia was defined by the absence of hypoplasia in all teeth selected for analysis. According to research conducted by Goodman and coworkers, permanent canines and incisors display 95 percent of enamel hypoplasia observed when all available dentition is represented (Goodman et al. 1980). The current study employed this "best tooth" method; we selected individuals with a permanent left or right maxillary central incisor and

**Table 27. Summary of Study Samples**

| Study Description | Dentition | Sample 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 | |

a left or right mandibular canine. The presence for permanent teeth was defined according to Codes 1, 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 New York African Burial Ground 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 9 years to approximately 16 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 because of 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 5 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 7 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 1 year with one left or right central maxillary incisor, one left or right mandibular canine, and one second molar (Figure 59). The presence of 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 5 months in utero to 16 or 17 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.

Twenty-three individuals were assessed for the chronology of physiological stress episodes that resulted 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 beginnings and endings of hypoplastic lesions had been recorded by members of the New York African Burial Ground Project in the late 1990s (Figure 60). 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 stress episode occurred.

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 1 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 (Table 28). Three and a half years is also the age at which central incisal crown development

Figure 59. Deciduous mandibular dentition with a single non-linear hypoplastic pit in the right canine of a subadult aged 3–5 years (Burial 7). This individual also appears to have been anemic.

Figure 60. Permanent mandibular canine and lateral incisor with linear hypoplasia in a male aged 35–45 years (Burial 9).

**Table 28. NYABG Canine Chronology Formula and Example Calculation: CH/6 = YGI 6.5 – (MID/YGI ) = 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 |

**Table 29. Frequency of Hypoplasias 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) |

*Note*: Six 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.

ends, providing a comparison of frequencies represented between the incisor and canine and between the correspondent ages of crown development within the canine.

## Results

Among the 65 individuals with permanent dentition, 70.8 percent were hypoplastic. Frequencies for hypoplasia in permanent dentition were higher in the New York African Burial Ground 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 were lower than the total frequencies observed in the largely free and freed nineteenth-century Philadelphia First African Baptist Church (FABC) cemetery 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 New York African Burial Ground and Barbados sites more likely were 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 New York African Burial Ground (62.5 percent of the women [n = 15] and 74.3 percent of the men [n = 26]) was not statistically significant, 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 African Burial Ground 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 (Khudabux 1991; Owsley et al. 1987; Rathbun 1987). Blakey and coworkers (1994) reported hypoplasia in 86 percent of the women and 92 percent of the men among 54 individuals from the FABC sample. Angel and coworkers reported that 71 percent of men and 43 percent of the women at Catoctin Furnace, Maryland, had hypoplasias. 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 of males [n = 17] and 37.9 percent of females [n = 11]). Among the populations compared within this study, Rathbun (1987) reported the highest frequencies in men and women at the Charleston, South Carolina, site (71 percent in women and 100 percent for men). Tables 29 and 30 provide comparative frequencies and other data for the studies just discussed, and frequency data for the New York African Burial Ground sample are presented in Table 31.

Among the 99 New York African Burial Ground individuals within the canine and incisor studies (permanent and deciduous), 37.4 percent (n = 37) died before the age of 15 years, 86.5 percent of whom

**Table 30. Comparison of Frequencies Reported in Skeletal Populations**

| 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 | 1694–1794 | 70.8 (n = 46) | 62.5 (n = 15) | 4.3 (n = 26) | 85.3 (n = 34) |
| Newton Plantation, Barbados | Barbados, West Indies | rural | 1660–1820 | 54.5 (n = 56) [a] | | | |
| FABC, Pennsylvania | Northeast, North America | urban | 1821–1843 | 89 (n = 54) [b] | 86 (n = 29) [b] | 92 (n = 25) [b] | 92.5 (n = 30) [c] |
| Catoctin Furnace, Maryland | Southeast, North America | urban | 1790–1820 | 46 (n = 7) [d] | 43 [e] | 71 [e] | |
| | | | | | slight 79.3 (n = 23) [f] | slight 68 (n = 17) [f] | |
| | | | | | moderate to severe 37.9 (n = 11) [f] | moderate to severe 68 (n = 17) [f] | |
| Charleston, South Carolina (38CH778) | Southeast, North America | rural | 1840–1870 | 85 (n = 23) [g] | 71 (n = 10) [g] | 100 (n = 13) [g] | |

[a] Newton Plantation site frequencies from Corruccini et al. (1985).
[b] First African Baptist Church (FABC) adult frequencies reported from Blakey et al. (1994).
[c] First African Baptist Church (FABC) frequencies in children cited from Rankin-Hill (1997).
[d] Catoctin site frequencies reported from Kelley and Angel (1987) for overall frequencies.
[e] Frequencies by sex for Catoctin Furnace are from Angel et al. (1987) and Blakey et al. (1994).
[f] Frequencies reported by Blakey et al. (1994), representing frequencies of slight hypoplasia or moderate to severe hypoplasia within the Catoctin Furnace site.
[g] South Carolina 38CH778 site frequencies for males and females from Rathbun (1987). Combined secondary dentition frequency calculated from male and female frequencies reported by Rathbun.

**Table 31. NYABG Frequency of Hypoplasia by Age Group and Sex (n = 99)**

| Age Group | | Frequency 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 of 6) | 75.0% (n = 6 of 8) |
| 25–55+ (n = 45) | | 66.7% (n = 30) | 72.4% (n = 21 of 29) | 56.3% (n = 9 of 16) |

*Note:* Three children within the 1–14 age category had permanent dentition.

(n = 32) had hypoplasias. 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 who died after the age of 25 years (n = 45), 66.7 percent (n = 30) of whom had hypoplasias. 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 were relatively less stressed, and those who died as children in New York were 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) support those assumptions about the nativity of young children.

Those who died between 15 and 24 years of age had intermediate frequencies of defects in the teeth that developed during early childhood, as shown in Figure 61. We also examined frequencies of hypoplasia in third molars that develop 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 and 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 (Figure 62). These differences were statistically significant (Pearson chi-square with Yates Continuity Correction = 13.035, df = 1, $p < .0005$). 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; however, these hypoplastic lesions may represent more severe episodes of stress (Goodman and Armelagos 1985).

Based on historical documentation of importation ages, we suspect that many of the 15–24-year-olds

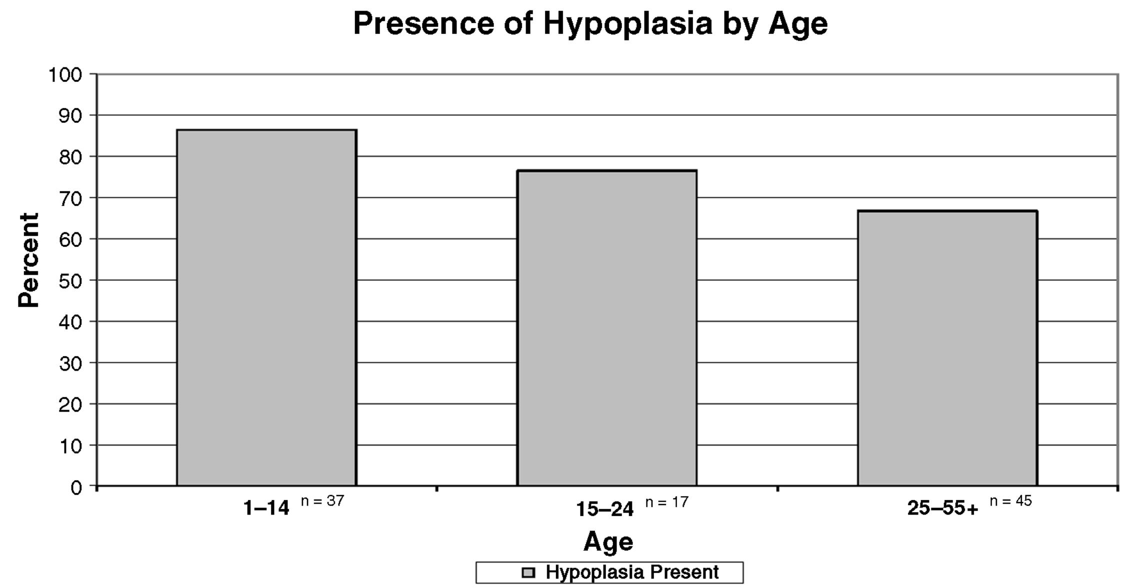


Figure 61. NYABG presence of hypoplasia by age (n = 99).

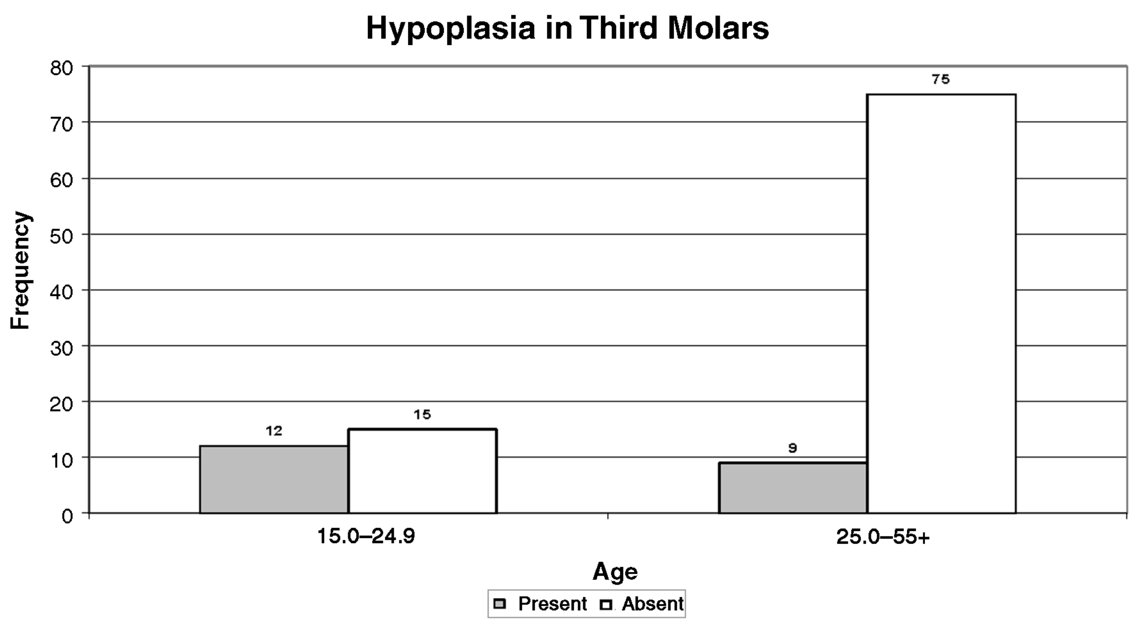


Figure 62. NYABG hypoplasia in third molars (n = 111).

were 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 showed more new infection in the 15–24-year age range than among the older individuals who exhibited a preponderance of sclerotic and healed lesions. Mortality was 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.

The skewing of subadult nativity toward New York, and the skewing of adult nativity toward central and West 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, as 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 slaveholding 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 the urban Northeast, thus greatly improving the reliability of comparisons.

Because 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 because of the 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, df = 1, $p < .002$). Men had higher frequencies of hypoplasia than women within both age groups in the canine and incisor study. These gender differences were not statistically significant. Tables 32 and 33 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 because of tooth attrition.

Maxillary central incisors are intrinsically the most sensitive to developing hypoplasias, among all teeth, followed by the mandibular canine (Goodman and Armelagos 1985a, 1985b). Within this study, we compared hypoplasia frequencies in the permanent maxillary central incisors and the mandibular canines in the New York African Burial Ground. Among the 65 individuals, 26 (40 percent) evinced hypoplasia in the maxillary central incisor versus 41 (63.1 percent) in the mandibular canines. Utilizing the overlap in developmental periods represented by these teeth (birth to 3.5 years in the central incisor and 0.5–6.5 years in the mandibular canine) while taking into analytical consideration the intrinsic sensitivity of incisors to hypoplasia in comparison with canines, we sought to assess the periods most stressful in early childhood between birth and 6.5 years for the New York African Burial Ground population.

Hypoplasia chronologies were calculated for the mandibular canines of 23 individuals (Table 34). Among the 37 hypoplasias recorded for these individuals, 73 percent occurred between the ages of 3.51 and 6.5 (n = 27). Analyzed by individual (n = 23) and age, hypoplasias developed between the ages of 3.51 and 6.5 years of age in 95.7 percent of the cases (n = 22). The maxillary incisor frequency may be compared with the mandibular canine chronology frequencies by individual for an analysis of hypoplasia within the most sensitive teeth, by age range—between birth and 3.5 years (evinced by the most sensitive tooth, the maxillary central incisor) and between 3.51 and 6.5 years of age (evinced by the canine, the most sensitive tooth for this developmental period). The

**Table 32. NYABG Frequency of Hypoplasias in Canines and Incisors (Controlling for Attrition), by Age and Sex (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) |

*Note:* Three individuals with adult dentition in the 15–24 age group were too young to determine sex. Thus, these individuals are not represented in the total number of males and females.

**Table 33. NYABG Frequencies of Hypoplasias in Third Molars by Age Group, 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) |

**Table 34. NYABG Frequency of Hypoplasia by Age Intervals in Mandibular Canines, by Age Intervals (n = 37 Hypoplasias)**

| Age (in years) | Frequency |
|---|---|
| 0.5–1 | |
| 1.01–2 | |
| 2.01–3 | 16.2% (n = 6) |
| 3.01–4 | 18.9% (n = 7) |
| 4.01–5 | 46.0% (n = 7) |
| 5.01–6 | 18.9% (n = 7) |
| 6.01–6.5 | |

difference between these two hypoplasia frequencies—40 percent (maxillary central incisors) and 95.7 percent (mandibular canines, between ages 3.51 and 6.5)—is, we believe, substantial when utilizing these data to understand stress episode frequency and quality of life in early childhood (Table 35).

Another factor that must be considered in the interpretation of the canine chronology data is the variability of susceptibility within tooth types. Goodman and Armelagos (1985b:485), studying the Dickson Mounds population, found mandibular canines to be most sensitive to enamel disruption between ages 3.5 and 4 years of age. Among the 23 New York African Burial Ground individuals in this canine chronology study, only 13.5 percent (n = 5) of the stress episodes occurred during this peak period of enamel susceptibility. However, 59.5 percent (n = 22) of the hypoplasias occurred between 4.1 years and 6.5 years of age. These patterns are not consistent with Goodman and Armelagos (1985b). Thus, our finding that 95.7 percent of individuals developed hypoplasias in the mandibular canine between 3.51 and 6.5 years of age is likely a reflection of real age-related differences in stress frequencies, and not simply an artifact of enamel sensitivity.

The individuals within the age category of 1–14 years were more likely to have been born in New York than individuals who were older at the time of death.

**Table 35. NYABG Comparison of Hypoplasia in Incisors and Canines**

| Tooth | Developmental Period/ Age (in years) | Frequency |
|---|---|---|
| Maxillary central incisor | 0–3.5 | 40% (n = 26 of 65) |
| Mandibular canines | 0.5–6.5 | 63.1% (n = 41 of 65) |
| Mandibular canine chronology | 0–3.5<br>3.51–6.5 | 26.2% (n = 6 of 23)<br>95.7% (n = 22 of 23) |

*Note*: Five individuals within the mandibular canine chronology study had multiple hypoplasias and are represented in both the 0–3.5 and the 3.5–6.5 developmental period/age category frequencies.

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 and 4 years in secondary dentitions observed by Corruccini et al. (1985) among enslaved Barbadians were attributed to weaning at ages 2–3. Blakey et al. (1994) tested the weaning hypothesis within African American enslaved groups to argue that enslaved children experienced physiological stress from multiple sources and that weaning did 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 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, although childhoods in the Caribbean, New York, and other locations were 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 because of variation in hypoplastic sensitivity across different parts of the crown. Moreover, these data represent the experiences of survivors, whereas 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 New York African Burial Ground sample. For example, Susan Goode-Null's (2002) study of childhood health and development in the New York African Burial Ground sample found that the enslaved people brought into New York between the years of 1664 and 1741 were largely from the Caribbean. Following McManus's *A History of Negro Slavery in New York* (1966), Goode-Null explained that between 1741 and 1770, because of 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 aged 13–40 years and children preferably of 9–10 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 13 in this volume and Medford [2009] 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 3.5–6.5 years and who lived to adulthood, were born within the colony of New York. Goode-Null's study reported that enslaved children in New York were frequently sold by the age of 6 years (Goode-Null 2002:37–38; Medford 2009). Advertisements indicated that domestic skills promoted the marketability of enslaved children. Therefore, it is likely that children approaching the age of 6 years may have experienced trauma related to separation from their parents, differential nutrition provisions provided by nonparental custodians or slaveholders, or stresses and increased exposure to disease from induction into domestic or other labor duties. Children under the age of 15 were highly stressed, and approaching the age of 6 may have been a significant stage within the

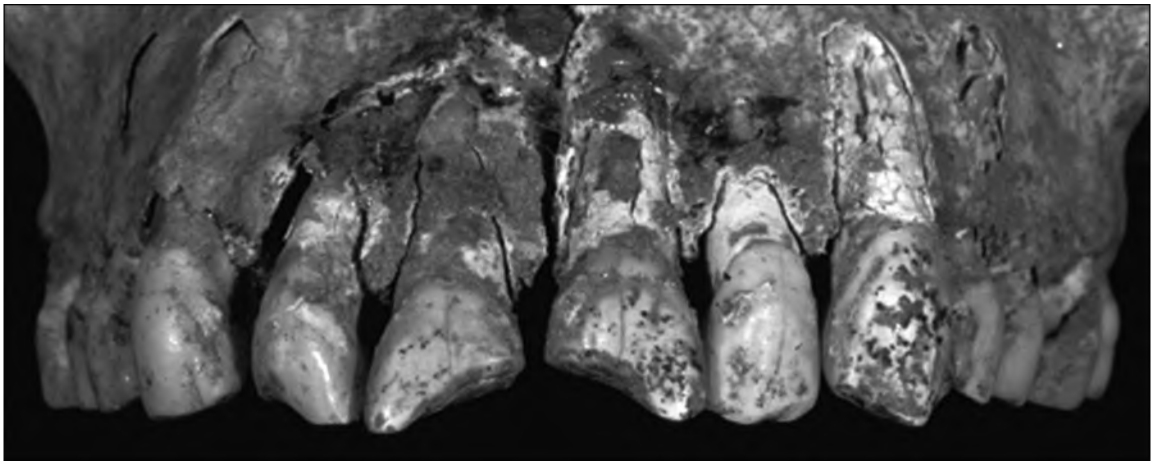

Figure 63. Dental modification.

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 10 years in the 1731 and 1737–1738 censuses, and at 16 years in the census data prior to 1731 and after 1737–1738, including the 1810 census (see Chapter 13) (Goode-Null 2002). This legal status as "adult" would most likely have affected the character of labor expected of young enslaved Africans under the age of 15 and within the age group of 15–24. These data further suggest that a child approaching the age of 9 or 10 may have been 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 9 or 10, 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 frequency of third-molar hypoplasias in those who died between 15 and 24 years of age also suggests 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 (Figure 63 and Table 36). 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 with modified teeth (modified, 66.7 percent [n = 6]; unmodified, 71.4 percent [n = 40]).

**Table 36. 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 mean ages at death for individuals with modified and unmodified teeth were comparable, although slightly older for individuals with modified teeth (34 years of age for individuals with modified teeth and 31 years for individuals with unmodified teeth). Although consistent with the association between African birth and lower defect frequencies, these differences were 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 200 New York African Burial Ground individuals; this should be done in a future study.

The highest levels of hypoplasia were 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 hypoplasias 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 also included children with deciduous left or right maxillary incisors, left or right mandibular canines, and a second molar.

Within this study of the New York African Burial Ground sample, 67.6 percent (n = 23) of the 34 children with deciduous dentition had hypocalcification (Table 37). Among the 65 individuals with permanent dentition, 18.5 percent (n = 12) had hypocalcification. Women had a higher frequency of hypocalcification than did men (72.7 percent of the 24 females versus 27.3 percent of the 35 males).

Within this subsample, 60.5 percent (n = 23) of the 38 children under the age of 15 years had hypocalcification (see Table 37), whereas only 10 percent (n = 2) of the 20 young adults aged 15–24.9 years and 28.6 percent (n = 10) of the adults aged 25 and older had hypocalcification (see Table 37). These differences were statistically significant (Pearson chi-square = 19.84, df = 2, $p < .0005$) 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 percent, n = 23) and permanent dentition (18.5 percent, 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

**Table 37. NYABG Comparison of Hypocalcification and Hypoplasia Frequencies by Age Group (n = 99)**

| Age Group (in years) | | Percentages within Age Groups | |
|---|---|---|---|
| | | Hypocalcification | Hypoplasia |
| 1–14 | | 62.2 (n = 23) | 86.5 (n = 32) |
| 15–24 | | 10 (n = 2) | 80.0 (n = 16) |
| 25–55+ | | 28.6 (n = 10) | 66.7 (n = 30) |

*Note:* Three subadults in the 1.0–14.9 age range had permanent teeth. These individuals are only represented once within the combined studies of permanent and deciduous dentition.

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 caused by 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.

However, 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 percent) versus hypocalcification (65.7 percent) 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. 1994, 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 New York African Burial Ground children who died before the age of 15.

## 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 central and West Africa (see Medford 2009). The fact that higher frequencies of enamel defects were found in children under the age of 15 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 9–16 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 abundance of dentition in archaeological contexts has led to the intensive exploitation of teeth for information about the past. Chapters 6 and 8 of this report address the systemic effects of nutrition in dental development and of ecosystem relationships that changed dental chemistry. 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, accessibility of dental care, and the biological effects of foods commonly eaten.

In order to further understand the diets and living conditions of individuals from the New York African Burial Ground, 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 New York African Burial Ground sample 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 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, but 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 diagenic staining due to the local soil conditions, water seepage and damage, and the time elapsed since interment (Figure 64). This discoloration is not to be confused with enamel hypocalcification; it often affected dental roots and the surrounding alveoli that 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. Finally, antemortem tooth loss and traumatic fractures, especially of the molars, precluded some diagnoses, and in the cases of the 26 individuals with dental modification, along with enamel being lost due to filing/chipping, some pathology information was lost as well (see Table 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

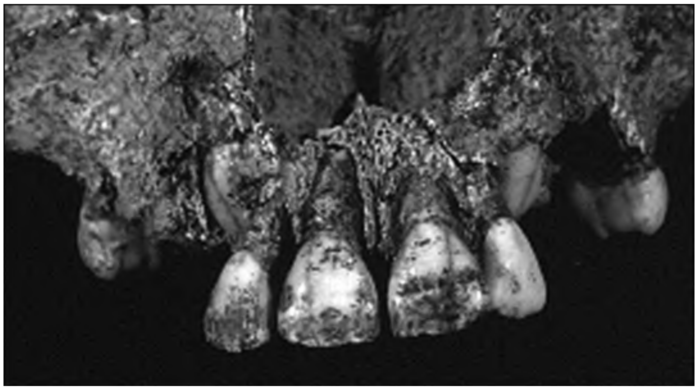

Figure 64. Diagenic staining affecting dentition in a 55–65-year-old female (Burial 241).

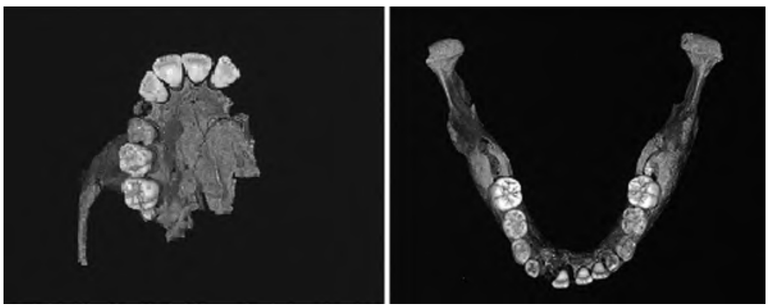

Figure 65. Examples of the photographic record (Burial 95, a subadult aged 7–12 years).

deciduous and/or permanent teeth included dental inventories and tooth loss with alveolar resorption, caries reported 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.). 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 65).

For example, in Figure 65, the plate on the left displays the occlusal surface of the maxillary dentition and alveoli, and the plate on the right provides an occlusal view of the mandibular dentition of Burial 95. This provides 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 were defined as 15–60+ years of age, and subadults were 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 (see 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 38 and 39 contain, respectively for males and females, the frequencies of dental pathologies—caries and abscesses—identified in the New York African Burial Ground sample. Caries were present in all tooth types. However, as expected, the highest frequencies of caries were found in molars, followed by premolars and single-cusped incisors and canines. The highest frequencies found in males were 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 was the right lower second incisor (2.67 percent). As noted, no tooth type was caries free. Whereas just 3 teeth reached caries prevalence of over 30 percent in males, 13 teeth reach a similar threshold in females, including 11 of 12 molars and 2 premolars. As it did in

**Table 38. Dental Pathology Frequencies in NYABG Males, Permanent Dentition**

| Tooth No. | Present | Absent | Total | Absent (%) | No. Caries | Caries (%) | No. 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 |

*Key*: (1) RM3 = upper right third molar; (2) RM2 = upper right second molar; (3) RM1 = upper right first molar; (4) RP2 = upper right second premolar; (5) RP1 = upper right first premolar; (6) RC1 = upper right first canine; (7) RI2= upper right second incisor; (8) RI1= upper right first incisor; (9) LI1= upper left first incisor; (10) LI2= upper left second incisor; (11) LC1 = upper left first canine; (12) LP1 = upper left first premolar; (13) LP2 = upper left second premolar; (14) LM1 = upper left first molar; (15) LM2 = upper left second molar; (16) LM3 = upper left third molar; (17) LM3 = lower left third molar; (18) LM2 = lower left second molar; (19) LM1 = lower left first molar; (20) LP2 = lower left second premolar; (21) LP1 = lower left first premolar; (22) LC1 = lower left first canine; (23) LI2 = lower left second incisor; (24) LI1 = lower left first incisor; (25) RI1 = lower right first incisor; (26) RI2 = lower right second incisor; (27) RC1 = lower right first canine; (28) RP1 = lower right first premolar; (29) RP2 = lower right second premolar; (30) RM1 = lower right first molar; (31) RM2 = lower right second molar; (32) RM3 = lower right third molar.

**Table 39. Dental Pathology Frequencies in NYABG Females, Permanent Dentition**

| Tooth No. | Present | Absent | Total | Absent (%) | No. Caries | Caries (%) | No. 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 |

*Key*: (1) RM3 = upper right third molar; (2) RM2 = upper right second molar; (3) RM1 = upper right first molar; (4) RP2 = upper right second premolar; (5) RP1 = upper right first premolar; (6) RC1 = upper right first canine; (7) RI2= upper right second incisor; (8) RI1= upper right first incisor; (9) LI1= upper left first incisor; (10) LI2 = upper left second incisor; (11) LC1 = upper left first canine; (12) LP1 = upper left first premolar; (13) LP2 = upper left second premolar; (14) LM1 = upper left first molar; (15) LM2 = upper left second molar; (16) LM3 = upper left third molar; (17) LM3 = lower left third molar; (18) LM2 = lower left second molar; (19) LM1 = lower left first molar; (20) LP2 = lower left second premolar; (21) LP1 = lower left first premolar; (22) LC1 = lower left first canine; (23) LI2 = lower left second incisor; (24) LI1 = lower left first incisor; (25) RI1 = lower right first incisor; (26) RI2 = lower right second incisor; (27) RC1 = lower right first canine; (28) RP1 = lower right first premolar; (29) RP2 = lower right second premolar; (30) RM1 = lower right first molar; (31) RM2 = lower right second molar; (32) RM3 = lower right third molar.

**Table 40. New York African Burial Ground Total Number of Carious Teeth, by Sex**

| No. 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) |

males, the lower left first molar displayed the highest frequency of caries in females (55.17 percent).

The prevalence of dental abscesses was also greatest in molars. In males, the highest prevalence of abscessing was 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 was found in the lower left first molars (24.14 percent) and right first molars (18.75 percent).

Most adults (72.9 percent of males and 84.3 percent of females) had at least one carious tooth (Table 40). 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 (see Medford, Brown, Carrington, et al. 2009b).

Some caries were so severe that the entire tooth was 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 New York African Burial Ground sample (Figure 66). Table 41 summarizes the mean and standard deviations for the number of carious, abscessed, and lost teeth and total pathologies—that is, the total chance of having at least one of these three conditions. As was suggested by individual tooth percents in Tables 38 and 39, females had a higher average rate of carious teeth (5.2) compared to males (4.0) (see Table 41). Females also had lost more teeth than males (4.3 vs. 3.7, respectively), and thus females had higher rates of total pathology (10.9 vs.

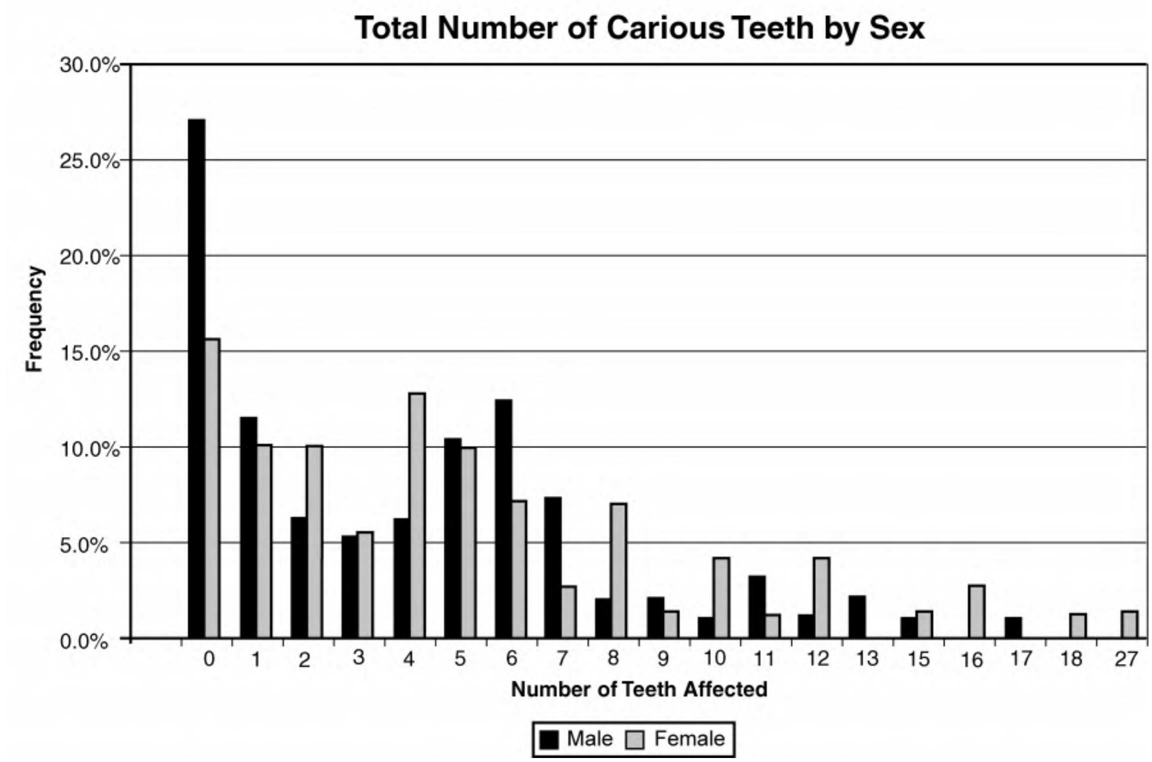


Figure 66. Total number of carious teeth by sex.

**Table 41. 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** |
| Males (n = 96) | | | | |
| Value | 3.7 | 4.0 | 1.5 | 9.1 |
| Standard deviation | (5.4) | 3.9 | 2.6 | 9.0 |
| Females (n = 70) | | | | |
| Value | 4.3 | 5.2 | 1.4 | 10.9 |
| Standard deviation | 6.2 | 5.1 | 2.7 | 9.1 |
| | | | | |
| Total (n = 166) | | | | |
| Value | 4.0 | 4.5 | 1.4 | 9.9 |
| Standard deviation | 5.7 | 4.5 | 2.7 | 9.1 |

9.1 teeth). On average, nearly 10 teeth (9.9, s.d. = 9.1) per permanent dentition were either lost, carious, or abscessed (Figures 67–69).

As young children are weaned onto solid foods, they lose the immunological and nutritional advantages of mother's milk. This can be significant for marginally nourished populations for 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 (Figures 70 and 71). The frequency of dental caries and abscesses in the decidu-

Figure 67. Molar caries in a male aged 26–35 years (Burial 101).

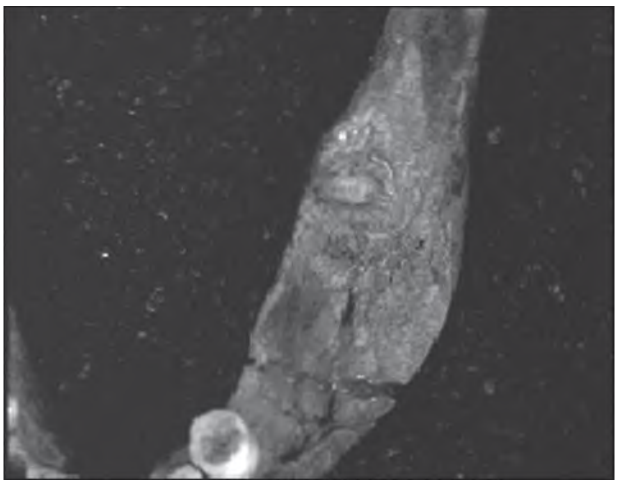

Figure 68. Abscessing in a female aged 25–35 years (Burial 266).

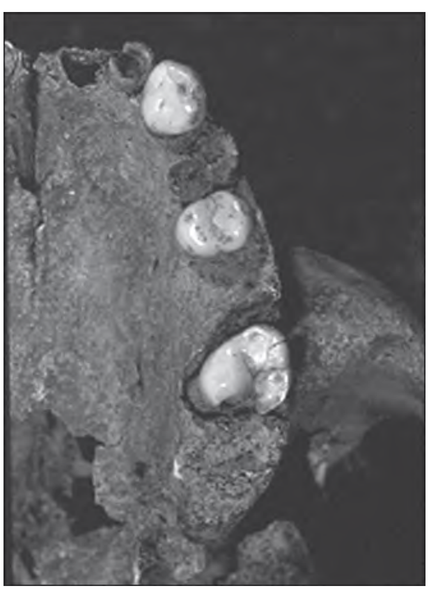

Figure 69. Caries formation in a female aged 35–40 years ( Burial 107).

ous dentition is presented in Table 42. 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 displayed dental cavities, including 18 percent of the upper left first deciduous molars. As with the permanent teeth, deciduous molars were more carious than single-cusped deciduous teeth.

The following section will compare dental pathologies in the New York African Burial Ground sample with other contemporary and modern samples. Tables 43 and 44 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 New York African Burial Ground, the general trend appears to be greater dental pathology in females than males. Caries rates were highest in the FABC sample from Philadelphia but also high in many of these samples (see Table 43). The New York African Burial Ground results fall toward the high end of the middle of the range. Tooth loss was also highest in the FABC and free blacks from Arkansas, with the New York African Burial Ground results falling toward the middle of the range. Finally, the abscess rate was greatest in the New York African Burial Ground (see Table 43), 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 New York African Burial Ground versus select other samples is presented in Table 44. These data also suggest that the prevalence of dental pathologies in the New York African Burial Ground 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

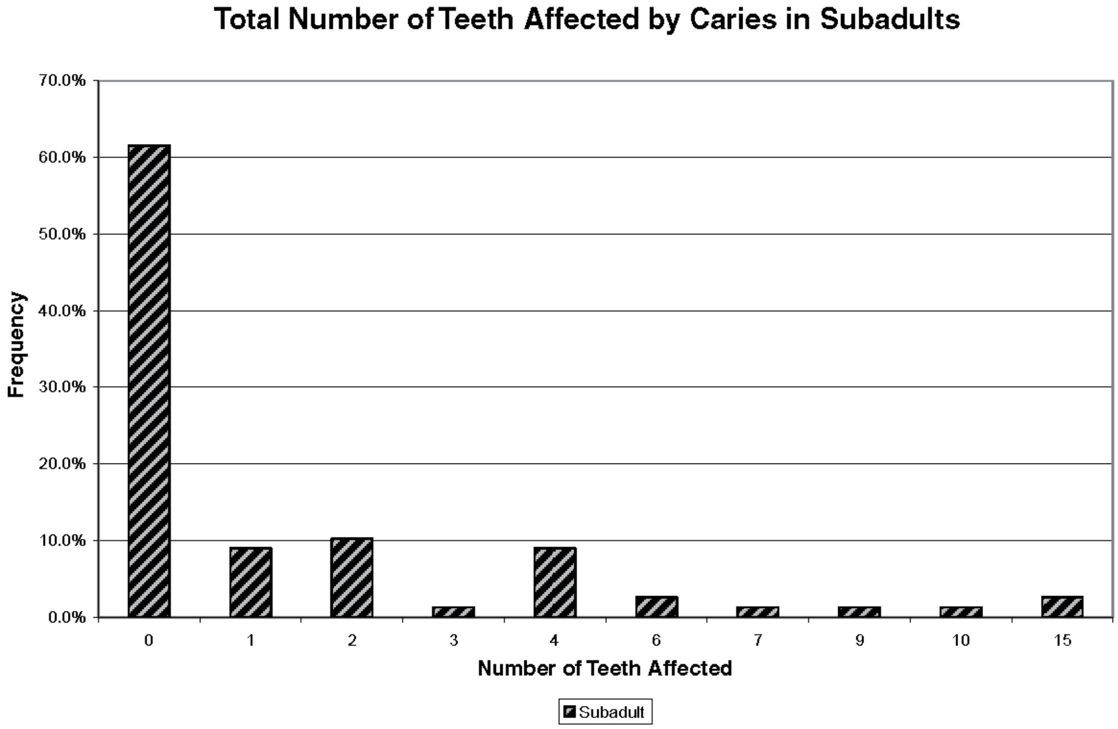


Figure 70. Total number of teeth affected by caries in subadults.

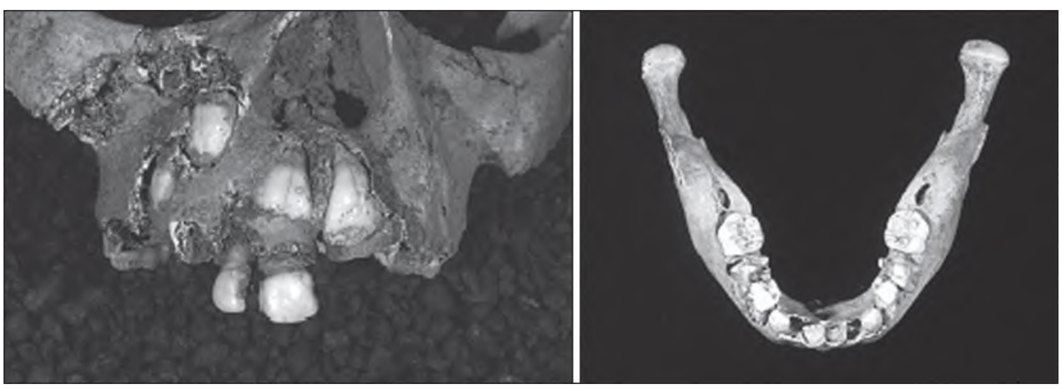

Figure 71. Caries, abscessing, and enamel hypoplasia in a subadult aged 5–7 years (Burial 39).

a form of hypoplasia and hypocalcification (see Chapter 8). The following section contains examples of dental genetic anomalies from the New York African Burial Ground, including dental hypodontia, dental crowding, and hyperdontia.

## Subadult Dentition

One subadult, Burial 17, exhibited hypodontia of the deciduous left maxillary central incisor (Figure 72). Although this may be interpreted as exfoliation, there is no corroborating evidence that the tooth was ever present. This child was also afflicted with craniosynostosis, rickets, enamel hypoplasia and hypocalcification, and a cleft palate. Radiographic analysis of the maxilla and mandible also indicated substantial dental crowding of the permanent dentition.

Dental crowding is the only genetic pathology that affects subadults with any appreciable frequency (Figure 73). Among subadults with intact dental arcades, eight (9.9 percent) exhibited crowding of the deciduous teeth, especially the mandibular incisors. Additionally, radiographic observations indicated that all but one of the eight subadults affected also exhibited dental crowding of the permanent maxillary and mandibular incisors.

**Table 42. Dental Pathology Frequency, Deciduous Dentition**

| Tooth No. | Present | Absent | Total | Absent (%) | No. Caries | Caries (%) | No. 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 | — | — |
| 3) $rc^1$ | 64 | 1 | 65 | 1.54 | 7 | 10.94 | — | — |
| 4) $ri^2$ | 62 | 3 | 65 | 4.62 | 5 | 8.06 | — | — |
| 5) $ri^1$ | 59 | 5 | 64 | 7.81 | 7 | 11.86 | — | — |
| 6) $li^1$ | 56 | 5 | 61 | 8.20 | 6 | 10.71 | — | — |
| 7) $li^2$ | 60 | 2 | 62 | 3.23 | 1 | 1.67 | — | — |
| 8) $lc^1$ | 64 | — | 64 | — | 3 | 4.69 | — | — |
| 9) $lm^1$ | 72 | 1 | 73 | 1.37 | 13 | 18.06 | — | — |
| 10) $lm^2$ | 71 | — | 71 | — | 11 | 15.49 | — | — |
| 11) $lm_2$ | 75 | — | 75 | — | 10 | 13.33 | — | — |
| 12) $lm_1$ | 83 | 1 | 84 | 1.19 | 10 | 12.05 | — | — |
| 13) $lc_1$ | 68 | 1 | 69 | 1.45 | 3 | 4.41 | — | — |
| 14) $li_2$ | 60 | 5 | 65 | 7.69 | 1 | 1.67 | — | — |
| 15) $li_1$ | 56 | 6 | 62 | 9.68 | — | — | — | — |
| 16) $ri_1$ | 52 | 6 | 58 | 10.34 | — | — | — | — |
| 17) $ri_2$ | 57 | 5 | 62 | 8.06 | 2 | 3.51 | — | — |
| 18) $rc_1$ | 63 | 2 | 65 | 3.08 | 4 | 6.35 | — | — |
| 19) $rm_1$ | 78 | 1 | 79 | 1.27 | 11 | 14.10 | 1 | 1.28 |
| 20) $rm_2$ | 80 | — | 80 | — | 12 | 15.00 | — | — |

*Key:* (1) $RM^2$ = upper right second molar; (2) $RM^1$ = upper right first molar; (3) $RC^1$ = upper right first canine; (4) $RI^2$ = upper right second incisor; (5) $RI^1$ = upper right first incisor; (6) $LI^1$= upper left first incisor; (7) $LI^2$= upper left second incisor; (8) $LC^1$ = upper left first canine; (9) $LM^1$ = upper left first molar; (10) $LM^2$ = upper left second molar; (11) $LM_2$ = lower left second molar; (12) $LM_1$ = lower left first molar; (13) $LC_1$ = lower left first canine; (14) $LI_2$ = lower left second incisor; (15) $LI_1$ = lower left first incisor; (16) $RI_1$ = lower right first incisor; (17) $RI_2$ = lower right second incisor; (18) $RC_1$ = lower right first canine; (19) $RM_1$ = lower right first molar; (20) $RM_2$ = lower right second molar.

## Adult Dentition

Observable genetic dental pathologies were extremely rare in adults. Only one adult exhibited hypodontia; Burial 176, a 20–24-year-old male, exhibited alveolar resorption, and his relatively young age, with no tooth loss or caries formation, confirms the assessment of tooth agenesis (Figure 74).

Only two individuals exhibited hyperdontia. Burial 12, a 35–45-year-old female, had a supernumerary tooth at the location for the mandibular right first premolar, thereby obstructing its eruption (Figure 75). Burial 176, a 20–25-year-old male, had a supernumerary tooth adjacent to lingual side of the maxillary left second premolar. The only other genetically caused dental pathology present in adults was dental crowding. Dental crowding was exhibited in five (0.5 percent) of the adults, specifically in the mandibular incisors.

## Conclusions

Overall, we found a high rate of tooth loss, caries, and abscessed teeth. The rates of pathology, especially of dental abscesses, were high in comparison to other

**Table 43. New York African Burial Ground Dental Pathology Mean Comparison with other Eighteenth- and Nineteenth-Century Samples (Rathbun and Steckel 2002)**

| Site/Sex | No. Teeth Lost | No. Carious Teeth | No. Abscesses |
|---|---|---|---|
| African Burial Ground, New York | | | |
| Male | 4 | 4 | 1.5 |
| Female | 4 | 5 | 1.4 |
| Remley Plantation, South Carolina | | | |
| Male | 7 | 2 | 0.5 |
| Female | 12 | 4 | 0.1 |
| Belleview Plantation, South Carolina | | | |
| Male | 5 | 6 | — |
| Female | 6 | 3 | 0.3 |
| Charleston elites, Charleston, South Carolina | | | |
| Male | — | — | 0.3 |
| Female | 2 | 1 | 1.0 |
| FABC, Philadelphia, Pennsylvania | | | |
| Male | 7 | 7 | 1.0 |
| Female | 5 | 9 | 1.0 |
| Black soldiers, South Carolina | | | |
| Male | 1 | 2 | 1.0 |
| 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, New York | | | |
| Male | 5 | 5 | 1.0 |
| Female | 5 | 6 | 0.9 |

groups of the same period. Females generally had a higher rate of dental pathologies than males.

In addition to other hardships, it appears that individuals from the New York African Burial Ground had to endure the pain of dental pathologies and possibly changes in diet because of their 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 characterized the quality of life for the majority of those who lived in bondage.

**Table 44. New York African Burial Ground Dental Pathology Mean Comparison with Other Eighteenth- and Nineteenth-Century Samples (modified from Kelley and Angel 1987:204)**

| Sex | | Dental Pathologies per Mouth per Individual | | | | |
|---|---|---|---|---|---|---|
| | | Eighteenth Century | Catoctin | Nineteenth Century | Forensic Twentieth Century | NY African Burial Ground |
| Female | | 11.8 (9.8) (n = 12) | 11.0 (9.6) (n = 8) | 9.1 (11.3) (n = 16) | 10.3 (8.5) (n = 27) | 10.9 (9.1) (n = 70) |
| Male | | 8.0 (7.7) (n = 16) | 14.4 (10.0) (n = 7) | 9.6 (8.4) (n = 25) | 14.1 (7.8) (n = 46) | 9.1 (9.0) (n = 96) |
| Male and female | | 9.6 (n = 28) | | 9.4 (n = 41) | 12.8 (n = 73) | 9.9 (n = 166) |

*Note:* Standard deviations are in parentheses.

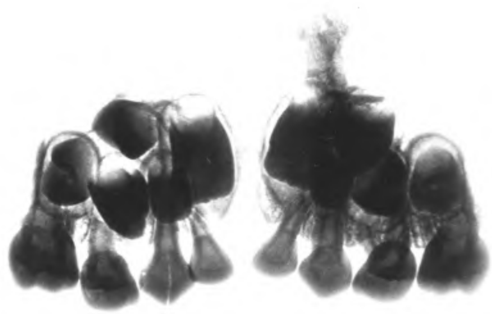

Figure 72. Radiograph of incisor hypodontia in a subadult aged 4–6 years (Burial 17).

Figure 73. Dental crowding in a subadult aged 5–7 years (Burial 39).

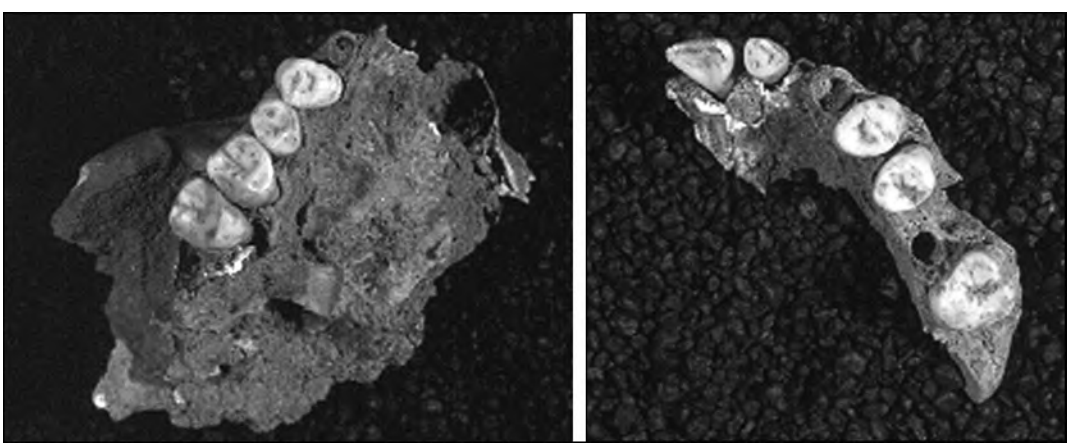

Figure 74. Maxillary molar agenesis in a male aged 20–24 years (Burial 176).

Figure 75. An example of a supernumerary tooth in a female aged 35–45 years (Burial 12).

# Chapter 10

# Osteological Indicators of Infectious Disease and Nutritional Inadequacy

***C. C. Null, M. L. Blakey, K. J. Shujaa, L. M. Rankin-Hill, and S. H. H. Carrington***

## Introduction

The present chapter investigates the prevalence of infectious diseases and nutritional inadequacies in the New York African Burial Ground 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 *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 use 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 nonmetric-trait computer database developed at the New York African Burial Ground Project is a simplified version of the pathology portion of the *Standards* (Buikstra and Ubelaker 1994:107–158).

The modifications of the New York African Burial Ground 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," whereas observations of greater magnitude such as "moderate, severe, or extreme" easily fall 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 classification that many specialists can agree on and that can be compared across many studies, including those conducted before the creation of the new standards. Because 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, and 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 in the *Standards* (Buikstra and Ubelaker 1994:107–108).

It should be noted that some distinctions such as those made between active and healed, and "reactive woven bone" and "sclerotic" lesions, required considerable subjective evaluation (Figures 76–79). As with other qualitative descriptions, we feel that the large number of observations made in this study substantially reduces the effects of errors due to possible misidentification or miscoding of marginal cases. The statistical associations found between plausibly associated variables support a swamping effect on any marginal errors.

Three hundred six of a total of 419 individuals in the New York African Burial Ground exhibited at least one identifiable pathology or nonmetric skeletal trait. An additional 52 individuals were assessed although 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 nonmetric skeletal traits; the majority of these (n = 55) were too poorly preserved to be evaluated.[2] Of these 61, 5 individuals were quarantined because of potentially harmful fungi found in pedestal soil and therefore could not be assessed. We also did not assess Burial No. 100, a young subadult in poor condition, who remained in an earthen pedestal intermingled with its badly decayed coffin. Therefore, for purposes of this study, we used and analyzed a total sample size of 358 individuals (Table 45). This sample included 105 subadults younger than 15 years old, 237 adults 15 years old or older (115 males, 85 females, 37 adults of indeterminable sex, and 16 individuals for whom age and sex were undeterminable).[3] Although 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 indicators of infectious disease and nutritional inadequacy observed in the New York African Burial Ground skeletal sample. General infectious periostitis is considered first. We report prevalence of cases, healed versus active lesions, and the age and sex distributions of those affected. These data are followed by comparative analysis with data from the 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 46). Following discussion of general infectious disease, the occurrence of specific disease indicators will be considered, with specific emphasis on treponemal disease. We then combine the New York African Burial Ground skeletal data with historical information and discuss the potential type, and/or types, of treponemal infection present in this sample. These findings are compared to the high rates of syphilis found at the Waterloo Plantation population from Suriname (Khudabux 1991).

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 New York African Burial Ground will once again be compared primarily to those

[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 condition as to provide no information, possibly hiding additional pathologies. We treat them nonetheless as the sample of nonpathological 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, 5-year demographic age groups (see Table 45) were used when discussing population prevalence of a particular anomaly. However, when sample sizes warranted, e.g., subadults, larger groupings were used. Different groupings were also used in interpopulation comparisons because of 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 although this exclusion had an effect on the frequencies generated, it did not change overall conclusions made in this chapter.

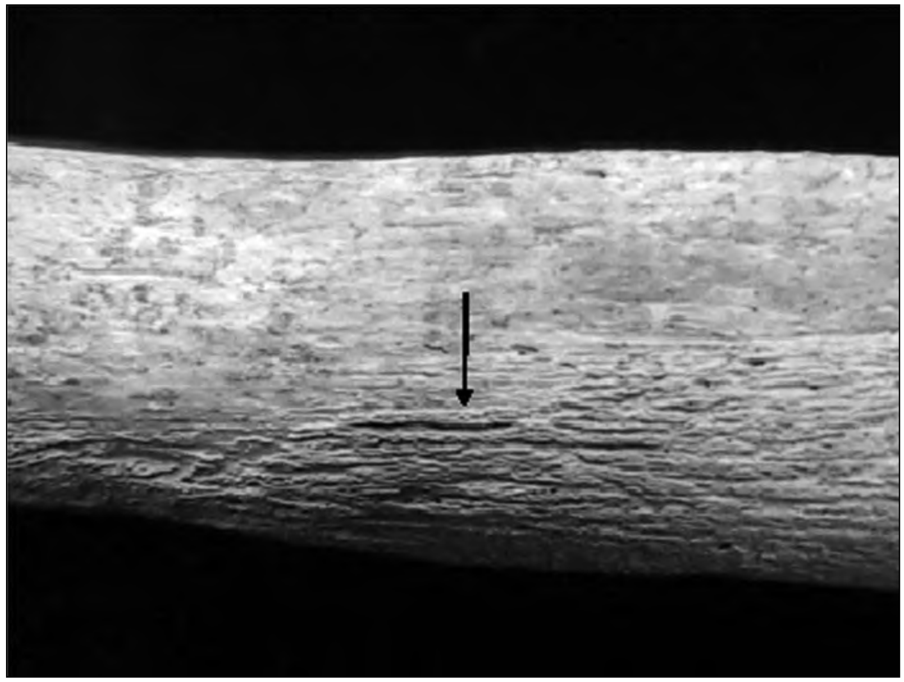

Figure 76. Active periostitis on left posterior ulna of a 35–45-year-old male (Burial 70).

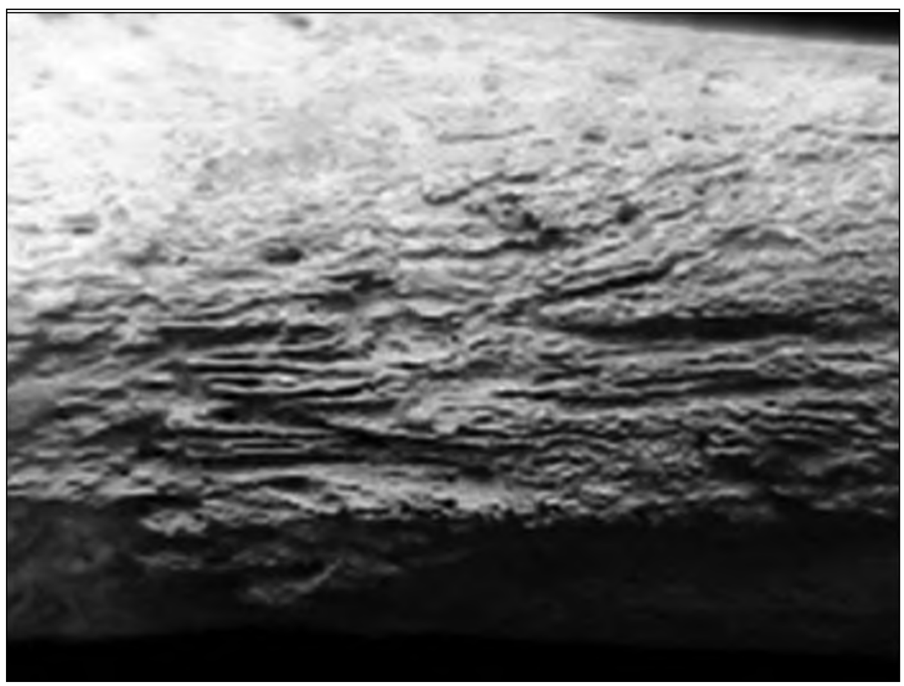

Figure 77. Active periostitis on left posterior ulna of a 35–45-year-old male, magnified (Burial 70).

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 New York African Burial Ground is then compared with available data from Cedar Grove and FABC.

Figure 78. Healed, sclerotic periostitis on right lateral tibia of an adult male (Burial 69).

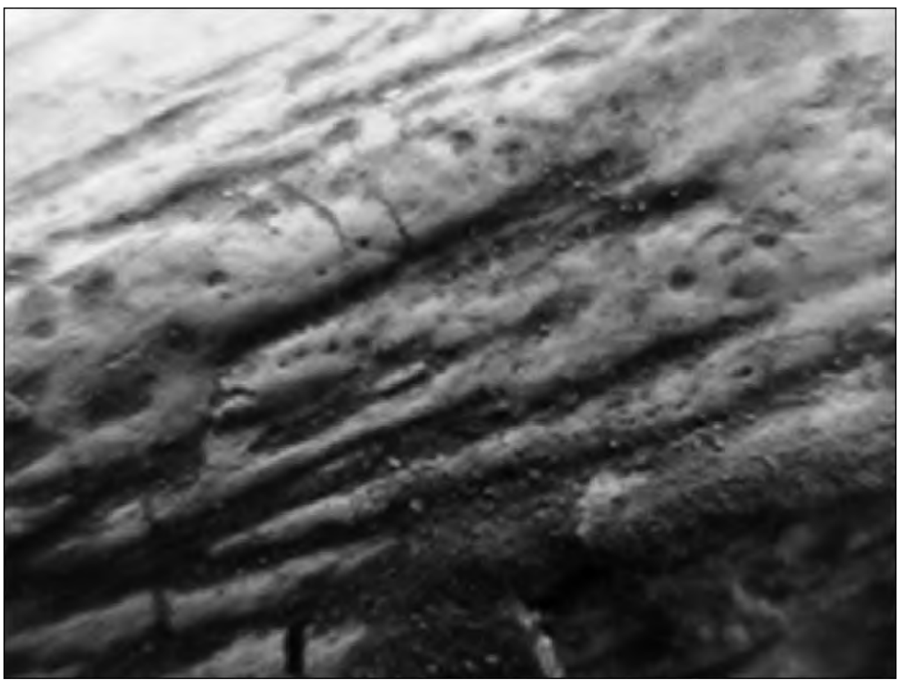

Figure 79. Healed, sclerotic periostitis on left lateral tibia of a 45–50-year-old male, magnified (Burial 20).

Overall, this chapter relates the New York African Burial Ground paleopathology to the New York historical documentation. Therefore, the chapter tests the historical conclusions (see Medford, Brown, Carrington, et al. 2009b) concerning the exposure of enslaved Africans to infectious pathogens in New York and prior to their involuntary transport to the New World.

**Table 45. Age and Sex of Assessed Sample from NYABG**

| Age in Years | 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 (no specific age assigned) | | | 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 (no specific age assigned) | 13 | 16 | 25 | 54 |
| Undetermined | 0 | 1 | 16 | 17 |
| Total | 115 | 85 | 158 | 358 |

**Table 46. African Diaspora Skeletal Series Discussed in this Chapter**

| Site/Location | Time Periods | Total Number of Skeletons | Life Style | Reference |
|---|---|---|---|---|
| Newton, Barbados | 1660–1820 | 104 | plantation enslaved | Jacobi et al. 1992 |
| New York African Burial Ground | 1694–1794 | 419 (358 assessed for pathology) | urban enslaved | |
| St. Peter Street Cemetery, New Orleans[a] | 1720–1810 | 29 | 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—8th 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 | 79 | rural farmers | Rose and Santeford 1985 |

*Note:* Adapted from Rankin-Hill 1997:47.
[a] n = 29; 13 African Americans.

## Infectious Disease

Assessment of skeletal pathology observed in the individuals from the New York African Burial Ground yielded numerous cases of bony response to infectious agents. The most common of these lesions was abnormal bone found on the outer, or 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 periostitis is initially discussed as a general indicator of infectious disease. In the subsequent discussion of treponemal disease, periostisis is considered a specific expression of this disease.

Over half, 200 (55.9 percent) of the individuals in the New York African Burial Ground sample were affected by generalized infectious disease or periostitis (Tables 47 and 48). 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, respectively, 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 200 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, 3 of the 44 (6.8 percent) exhibited at least one periostitic lesion that was assessed as clearly present. Adults displayed a significantly[6] higher proportion of individuals with clearly present lesions; this included 68, or 44.4 percent, of those with periostitis. Periostitis prevalence varied little between males and females—81 (70.4 percent) in males and 60 (70.6 percent) in females. However,

[4] Ortner (2003:51–52) noted that periostosis, rather than periostitis, is the "more appropriate term" for such conditions; however, he continues to use the more common periostitis in his most recent volume because there is less common usage of periostosis in the medical literature.

[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 used in all statistical tests to determine significance.

**Table 47. Occurrence and Status of Generalized Infectious Disease**

| Age/Sex Category | 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 | — | 70.0 | 21.7 |
| Male | 115 | 70.4 | 54.3 | 1.2 | 76.5 | 19.8 |
| | | | | | | |
| Total | 358[a] | 55.9 | 37.0 | 9.0 | 63.0 | 17.0 |

*Note:* "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.

[a] Discrepancies in sample numbers are the result of individuals that could not be aged and/or sexed.

**Table 48. Generalized Infectious Disease Statistical Testing, Intra-Population**

| | Generalized Infectious Disease Presence/Absence | | Clearly Present Presence/Absence | | Status of Lesions | |
|---|---|---|---|---|---|---|
| | $\chi^2$ | $p$ | $\chi^2$ | $p$ | $\chi^2$ | $p$ |
| Subadult/Adult | 15.288 | < .001 | 20.988 | < .001 | 73.473 | < .001 |
| Male/Female | .001 | .981 | 5.178 | .023 | .084* | .772 |

*Note:* Conditions for 2 by 3 contingency table were not met, $x^2$ reflects the collapsing of "Active" and "Both" categories.

males did have a statistically significant 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 New York African Burial Ground, 126 (63.0 percent) exhibited only healed lesions, 18 (9.0 percent) displayed only active lesions, and 34 (17.0 percent) had a combination of both active and healed lesions. Among adults with periostitis, 113 (73.9 percent) displayed healed periostitis; 2 (1.3 percent) displayed active lesions, and 30 (19.6 percent) had 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 (76.5 percent) for males and 42 (70.0 percent) for females; active—1 (1.2 percent) in males and 0 in females; and both active and healed—16 (19.8 percent) for males and 13 (21.7 percent) for females. In subadults, of those who had periostitis, 10 (22.7 percent) exhibited healed lesions, 16 (36.4 percent) displayed active lesions, and 4 (9.1 percent) had a combination of both healed and active lesions. Not surprisingly, those under 1 year of age expressed only active periostitis, having died before observable healing could have occurred. Compared to adults ($p < .001$), those who died as children were prone to dying during their first active infection that was sufficiently severe to leave bony evidence. The dental developmental defects discussed in Chapters 8 and 12 suggest that the majority of older children had experienced bouts of 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 New York African Burial Ground sample exhibited similar, slightly lower infection frequencies than found in the populations at 38CH778 and Cedar Grove, though

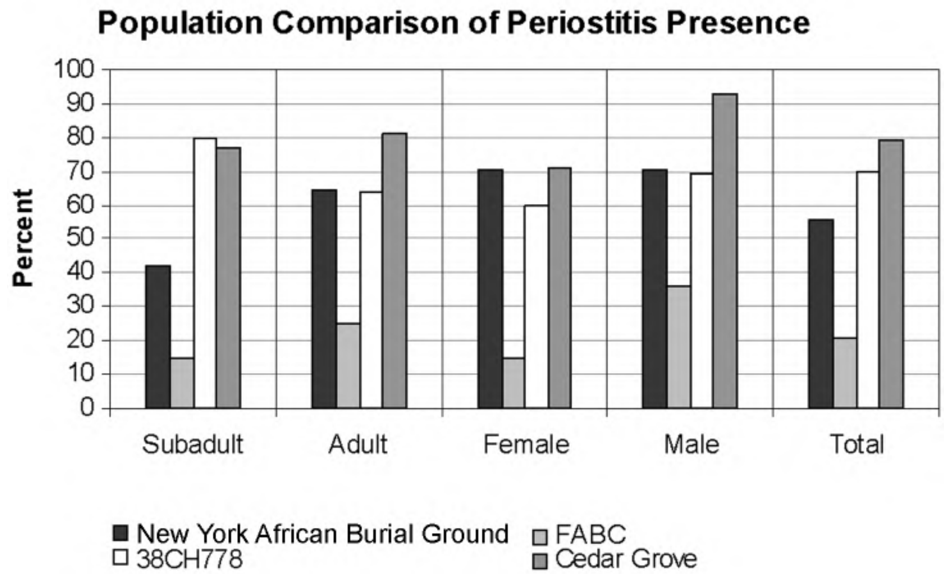


Figure 80. Population comparison of periostitis presence.

**Table 49. Generalized Infectious Disease Statistical Testing, Inter-Population**

| Age/Sex Category | All Populations | | African Burial Ground/ FABC | | African Burial Ground/ Cedar Grove | | African Burial Ground/ 38CH778 | |
|---|---|---|---|---|---|---|---|---|
| | $\chi^2$ | *p* | $\chi^2$ | *p* | $\chi^2$ | *p* | $\chi^2$ | *p* |
| Subadult | 43.722 | <.001 | 12.676 | <.001 | 15.549 | < .001 | 1.480[a] | .224 |
| Adult | 48.116 | <.001 | 35.443 | <.001 | 3.600 | .058 | .033[a] | .857 |
| Female | 38.788 | <.001 | 32.724 | <.001 | .037[a] | .848 | .265[a] | .607 |
| Male | 22.856 | <.001 | 13.746 | <.001 | 2.468[a] | .116 | .053[a] | .818 |
| | | | | | | | | |
| Total | >50.000 | <.001 | 48.654 | <.001 | 14.273 | <.001 | 2.359 | .125 |

[a] Yeats Correction for Continuity used because of small "expected" cell values.

periostitis rates were higher than in the FABC population (Figure 80, Table 49).[7] However, differences in rates found between 38CH778 and the New York African Burial Ground were not found to be statistically significant. When differentiated by age category, it was found that the New York African Burial Ground subadult infection frequency was intermediate between the high rates reported in Cedar Grove and 38CH778—although not statistically significant in the case of 38CH778—and the lower rate observed in FABC. Among adults, rates of infection at the New York African Burial Ground were similar to the high prevalence found at Cedar Grove and in 38CH778. Females in the Cedar Grove and the New York African Burial Ground samples had nearly identical periostitis prevalence figures (approximately 71 percent).

Although not statistically significant, incidence figures for males from Cedar Grove (93 percent) exhibited a 22 percent higher incidence of periostitis than males from the New York African Burial Ground (70.4 percent). The periostitis rate among males from the New York African Burial Ground was most comparable to the rates observed in the 38CH778 South Carolina plantation population (69 percent).

[7] Although the attempt was made to ensure that similar skeletal lesions were being compared in all pathological conditions discussed in this chapter, possible interobserver variation between samples in the identification of these conditions can not be completely discounted. The possible effects that this could have on the analyses discussed in this chapter are unknown at this time.

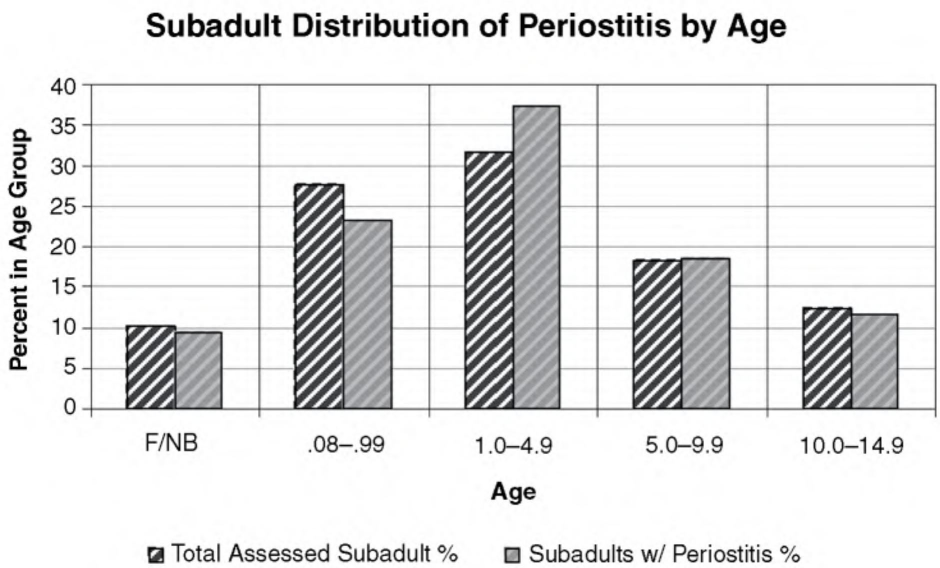


Figure 81. Subadult distribution of periostitis by age.

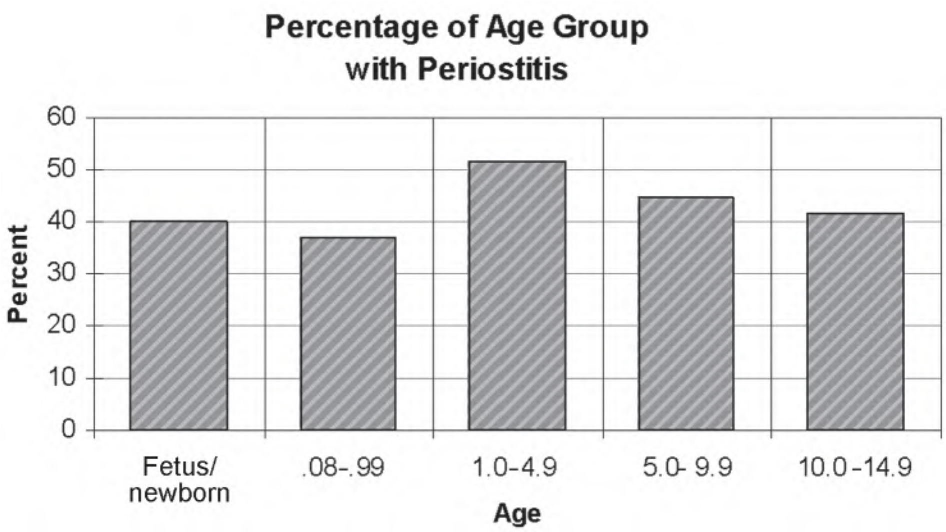


Figure 82. Percentage of age group with periostitis.

The distribution of subadults from the New York African Burial Ground sample that displayed generalized infection closely mirrors the overall age structure for this subgroup (Figure 81). 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 (n = 9) younger than 1 year exhibited only active lesions. It is in the older 1.0–4.9 age group in which the first cases of healed lesions were encountered—two with only active lesions, five with only healed lesions, and two 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 82) may reflect individuals who survived earlier insults. The rate of infection appears to decrease once again in subadults after 5 years of age. Indeed, our mortality data show a decline and stabi-

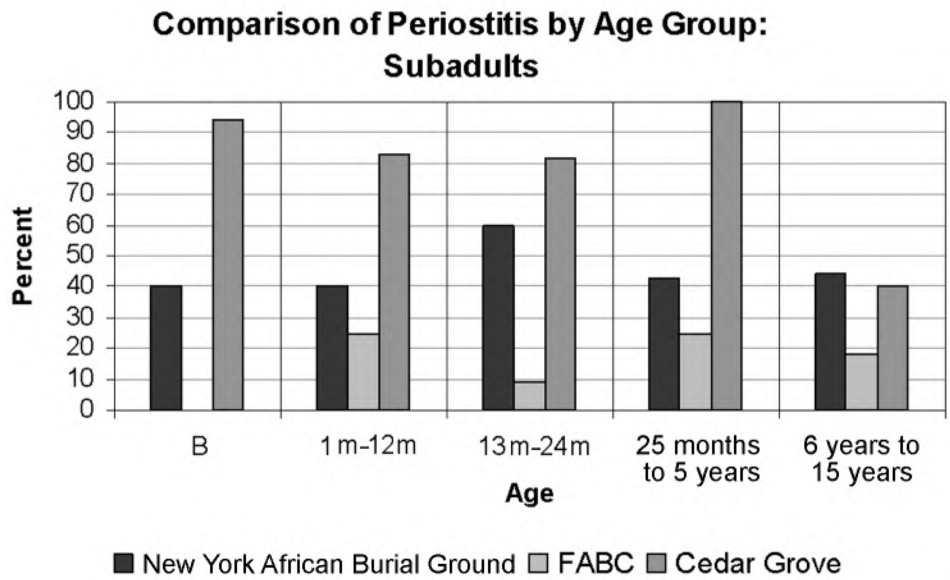


Figure 83. Comparison of periostitis by age group: subadults.

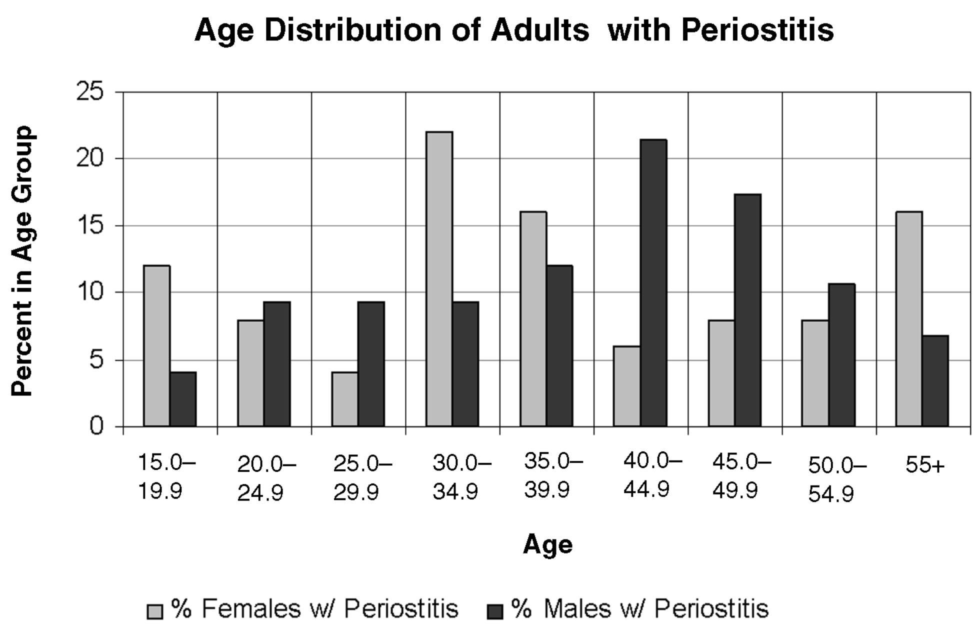


Figure 84. Age distribution of adults with periostitis.

lization in age-specific deaths among older children. Having weathered the vulnerable circumstances of infancy and weaning, older children usually did not see a major wave of new stresses until adolescence and young adulthood.

Subadult periostitis rates for the New York African Burial Ground sample fall between those from Cedar Grove and FABC in most age categories (Figure 83). The proportions of periostitis in the New York African Burial Ground are consistently higher than those found in FABC and considerably lower than Cedar Grove. However, in the oldest age group the trend changes slightly, with the New York African Burial Ground 6–15-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 New York African Burial Ground sample presented generalized infection patterning (Figure 84) that mirrors their sex-specific mortality profiles. The frequency of periostitis is greater

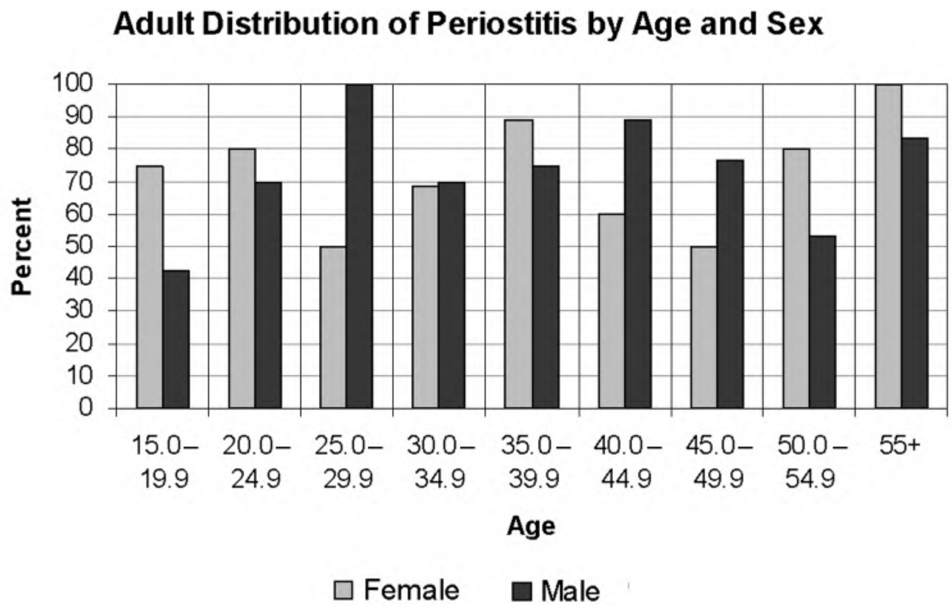


Figure 85. Adult distribution of periostitis by age and sex.

than 50 percent in most male and female age groups throughout the adult segment of the population (Figure 85). Figure 85 shows the greatest peaks in females at ages 35–39.9 and 55+, followed by lesser peaks in age groups 20.0–24.9 and 50.0–54.9. Both males and females display another peak at 55+, although 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 fell between these two examples (Figures 86 and 87). Once again the rates of periostitis among the adults at the New York African Burial Ground were higher than FABC, however, not as extreme as the rates found in the 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 New York African Burial Ground (76.0 percent) exceed the extraordinary rates reported for Cedar Grove (55 percent).

Other infectious processes observed in the New York African Burial Ground series include meningeal reactions. Meningeal reactions, as used 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: six were subadults younger than 6 years old and one was a 25–35-year-old female. The occipital bone was most commonly affected, although 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 New York African Burial Ground 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, there was no clear patterning of lesion locations suggestive of a specific pathogen in these individuals. The most severe case was found in Burial 32, a male 50–60 years old, who displayed systemic osteomyelitis (Figures 88 and 89).

A third example of specific infection is a constellation of pathologies that may reflect treponemal infection (Figure 90), 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

[8] In the St. Peter Street Cemetery sample from New Orleans, six adults were found to have postcranial periostitis, generating a population prevalence of between 4.5 percent and 13.0 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.

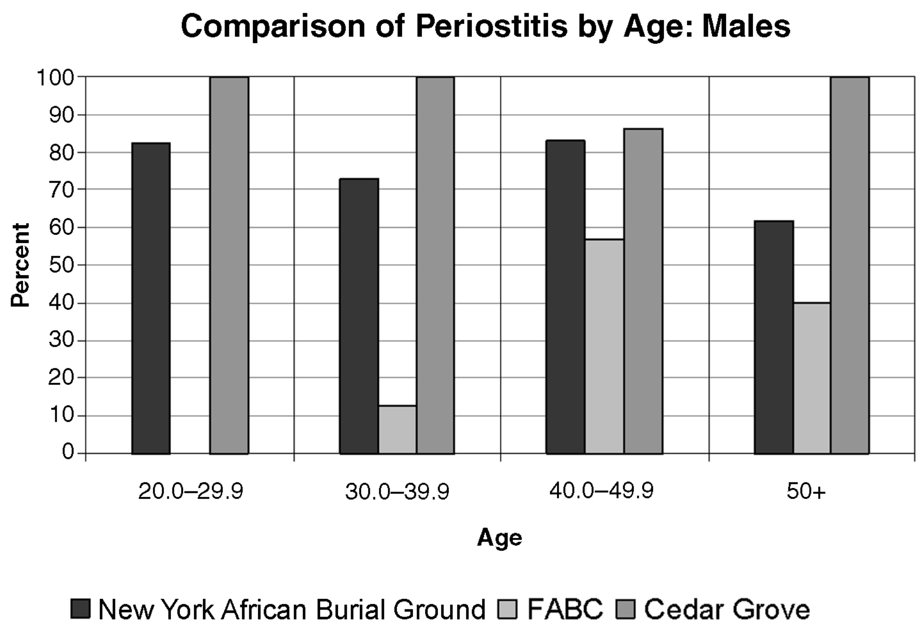


Figure 86. Comparison of periostitis by age: males.

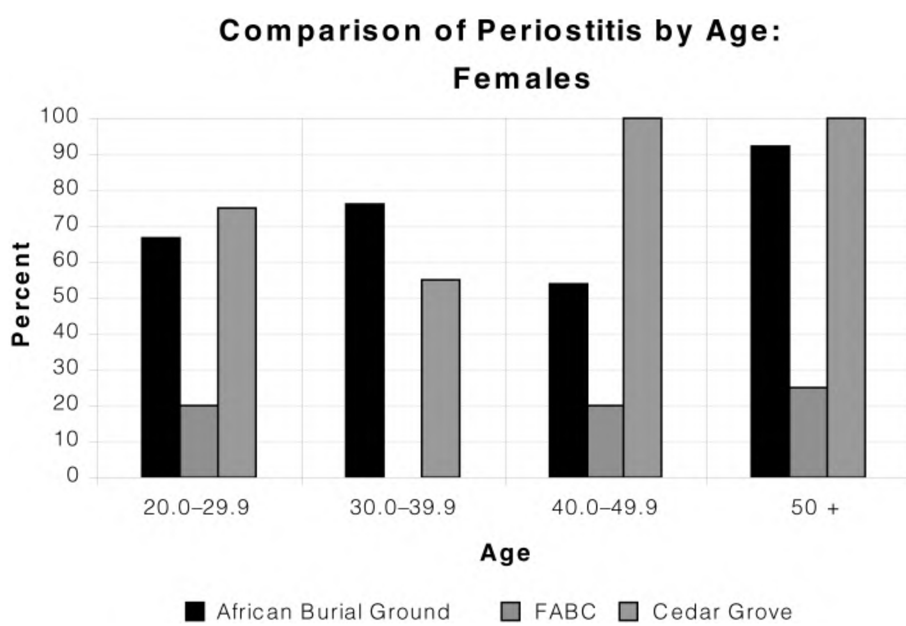


Figure 87. Comparison of periostitis by age: females.

(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 New York African Burial Ground sample. In total, 11 individuals (4 percent of those with observable tibiae) presented evidence of saber shin (Table 50). All but 1 of these were adult males; 8 were between the ages of 30.0 and 54.9 and 2 were of unknown adult age. The remaining individual was a skeleton of unknown sex and undeterminable age.

[9] These two similar conditions, saber shin and boomerang leg, will be referred to singularly as saber shin for the remainder of the chapter.

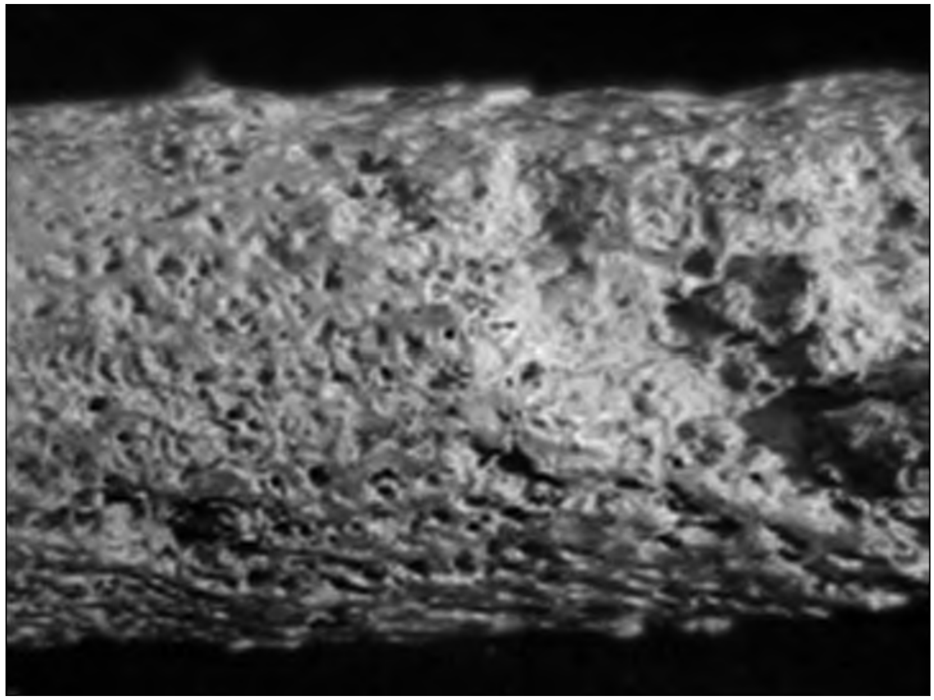

Figure 88. Osteomyelitis in the right anterior distal femur (Burial 32, 50–60-year-old male).

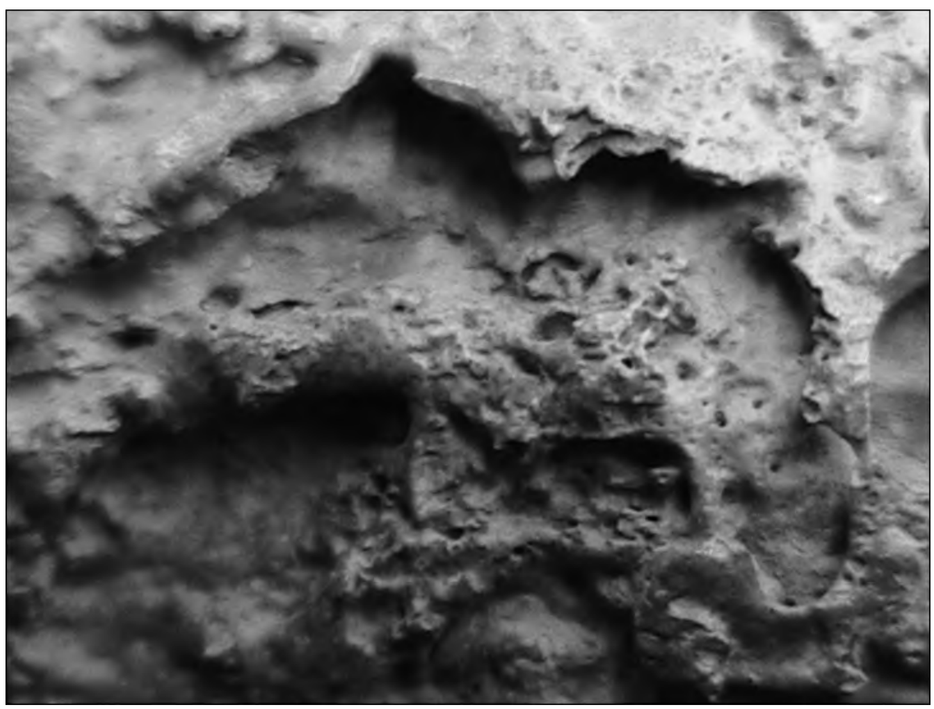

Figure 89. Osteomyelitis in the right anterior distal femur, magnified (Burial 32, 50–60-year-old male).

Figure 90. 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 50. Occurrence of Treponemal Infection Indicators**

| Age/Sex Category | n[a] | Saber Shin | | Suite of Tibial Pathologies | | Total with Treponemal Infection Indicators | |
|---|---|---|---|---|---|---|---|
| | | n[b] | % | n[c] | % | n[d] | % |
| Adult [e] | 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[e, f] | 249 | 11[g] | 4.4 | 29 | 11.6 | 40 | 16.1 |

[a] Equals the number of individuals with observable tibiae.
[b] Equals the number of individuals diagnosed with saber shin.
[c] Equals the number of individuals exhibiting a suite of tibial pathologies indicative of treponemal infection.
[d] Equals the total number of individuals observed with these pathologies.
[e] Discrepancies in sample numbers are the result of individuals that could not be aged and/or sexed.
[f] The 249 "Total Series" includes all individuals with observable tibiae. This includes individuals who could not be specifically aged and/ or sexed.
[g] One subadult of unknown age and sex.

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

**Table 51. Demographic Profile of Occurrence of Treponemal Infection Indicators in the NYABG Population**

| Age Category, in Years | Male | Female | Unknown | Total |
|---|---|---|---|---|
| 15.0–19.9 | 1 | 1 | 1 | 3 |
| 20.0–24.9 | 1 | — | — | 1 |
| 25.0–29.9 | 1 | — | — | 1 |
| 30.0–34.9 | 4 | 4 | — | 8 |
| 35.0–39.9 | 3 | — | — | 3 |
| 40.0–44.9 | 3 | 1 | — | 4 |
| 44.0–49.9 | 5 | — | 1 | 6 |
| 50.0–54.9 | 4 | — | — | 4 |
| 55 + | 1 | 1 | — | 2 |
| "Adult" | 5 | — | 1 | 6 |
| | | | | |
| Total series | 28 | 7 | 3 | 38 |

possibly have had treponemal infection, increasing the total to 40, or 16.1 percent, of individuals with assessable tibiae. None of these individuals appears to have been under the age of 15; however, two were of unknown sex and undeterminable age. This would correspond to 21.0 percent of those being affected. This number includes 7 females (10.1 percent of the observable females) and 28 males (31.5 percent of the observable males). 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 51). 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 tibia was by far the most commonly affected element, followed by the femur and fibula, sequentially. Overall, in most individuals (n = 30, or 75.0 percent) the lesions appeared healed, 1 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 7 individuals (17.5 percent). However, as noted previously, no stellate scars were detected on their cranial vaults.

Although 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) historical 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, although 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

[10] Although 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 noncongenital yaws or other treponemal infections.

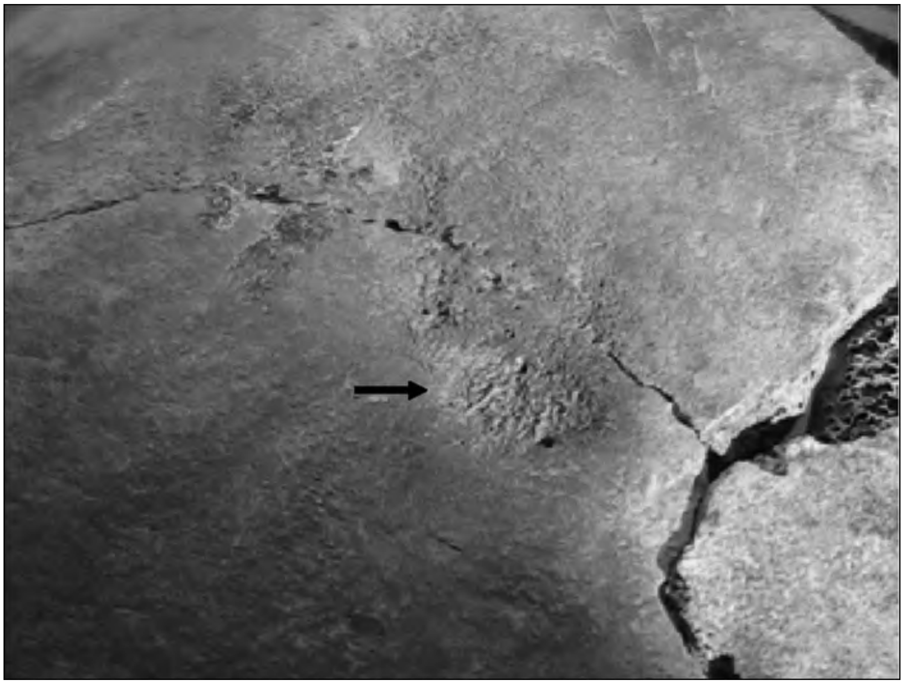

Figure 91. The cranial lesion (arrow) in the left parietal of a 55–65-year-old female (Burial 230) is more similar to stellate scars than any other lesion observed in the African Burial Ground population, yet it lacks the billowing of its margins and other typical characteristics of such scars (most probably a depression fracture).

Figure 92. Cobb Collection (CC101) Left femur showing cloacae in a person who died while diagnosed with syphilis in 1937 (*left*). An adult male 30–55 years of age in the New York 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.

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. Only one individual, Burial 230 (55–65-year-old female), exhibited a cranial lesion even slightly similar to a stellate scar; however, the lesion lacked some of the diagnostic characteristics of such lesions (Figure 91). Another individual, Burial 418 (30–55-year-old male), exhibited lytic lesions that could be interpreted as cloacae associated with venereal syphilis (Figure 92). Furthermore, although most, if not all, individuals discussed here were of sexually mature age, the presence of the saber shin anomaly would seem to suggest involvement during their earlier growth and development.

Thus, the presence 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 historical 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 (see Medford, Brown, Carrington, et al. 2009b). 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 slaveholders 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 New York African Burial Ground. 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.

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 were being imported continuously, coupled with mortality and low fertility (see Chapter 13), supports the inference that high levels of yaws could have been sustained in New York.

Most of these infections may well have been yaws. The presence of yaws in North America is noted in historical documents (see Medford, Brown, Carrington, et al. 2009b). 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 (see Medford, Brown, Carrington, et al. 2009b). 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 slaveholder avoiding afflicted individuals, thus possibly creating a reduction in the rates of disease in the population.

Whatever the nature of treponemal disease in the New York African Burial Ground, it is clear that the associated infection rates were 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 New York African Burial Ground 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, whereas the New York African Burial Ground, 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 New York African Burial Ground. 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. Although 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 have not been investigated for the purpose of differential diagnosis. Furthermore, cranial cross-sectional data, although potentially informative in this regard, were not collected at the New York African Burial Ground.

[11] Jacobi et al. (1992) reported three cases of possible congenital syphilis (based on dental criteria) in the Newton Plantation sample. These three cases equated to 3.8 percent of the sample, from which the authors estimated an actual congenital syphilis rate of approximately 10 percent for the population (Jacobi et al. 1992:153–154). See the dental pathology chapter (see Chapter 11) for a thorough discussion of possible dental indicators of treponemal infection.

An association of porotic hyperostosis observed in the New York African Burial Ground 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, although 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 New York African Burial Ground. Infection as a possible source of porotic hyperostosis serves as the most likely confounding factor. Future studies that incorporate 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 presence of nutritional inadequacy, as represented by porotic hyperostosis observed in crania, is presented in Figures 93–95 and Tables 52 and 53. Almost half—130, or 47.3 percent—of the 275 observable crania exhibited at least one occurrence of porotic hyperostosis. Male and female adults (93, or 50.5 percent) had a higher, although not statistically significant, incidence of this pathology than the subadults (35, or 39.8 percent). Two individuals were adults of indeterminate sex. Among the adults able to be sexed, adult males displayed a higher proportional rate of porotic hyperostosis (55, or 57.9 percent) than females (32, or 43.8 percent), although this was also not statistically significant.

Healed lesions were observed in 74 (88.1 percent) of 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, whereas subadults had a higher number of individuals with only active lesions (3, or 16.7 percent) than adults (1, or 1.5 percent). (*Note:* Status values represent the percentage of those in each group with evidence of porotic hyperostosis; cases of thickened diploe have been removed.) However, the difference in the status of the lesions between subadults and adults was not statistically significant. Although 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). (*Note:* Status values represent the percentage of those in each group with evidence of porotic hyperostosis; cases of thickened diploe have been removed.)

As illustrated in Figures 96 and 97 and Table 54, rates were generally lower for the presence of porotic hyperostosis in the orbits (cribra orbitalia) than for the rest of the cranium. Overall, 23.7 percent (54 individuals) of those with assessed orbits exhibited porotic hyperostosis. 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 (Table 55). The pattern encountered with status of lesions of cribra orbitalia was similar to that found 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 Santeford 1985), and 38CH778 (Rathbun 1987), the New York African Burial Ground sample (47.3 percent) had a higher overall rate of porotic hyperostosis (Figure 98, Table 56). Interestingly, the New York African Burial Ground rates of porotic hyperostosis were very similar to Cedar Grove between the subadults, however more similar to FABC in the adults. Focusing solely on pathology encountered in the orbits (Figure 99, Table 57), the New York African Burial Ground showed a similar population incidence as that found at Cedar Grove although less than that observed at 38CH778. The 38CH778 population displayed higher cribra orbitalia rates in all categories, however, only the total sample comparison was statistically significant. The similarity between the New York African Burial Ground and Cedar Grove diminished when the samples were partitioned by age; there were higher comparative rates found among subadults at Cedar Grove, conversely higher rates in adults at the New York African Burial Ground. The latter was statistically significant.[12]

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[12] Two cases of cribra orbitalia, both adult females, were present in the St. Peter Street Cemetery sample 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.

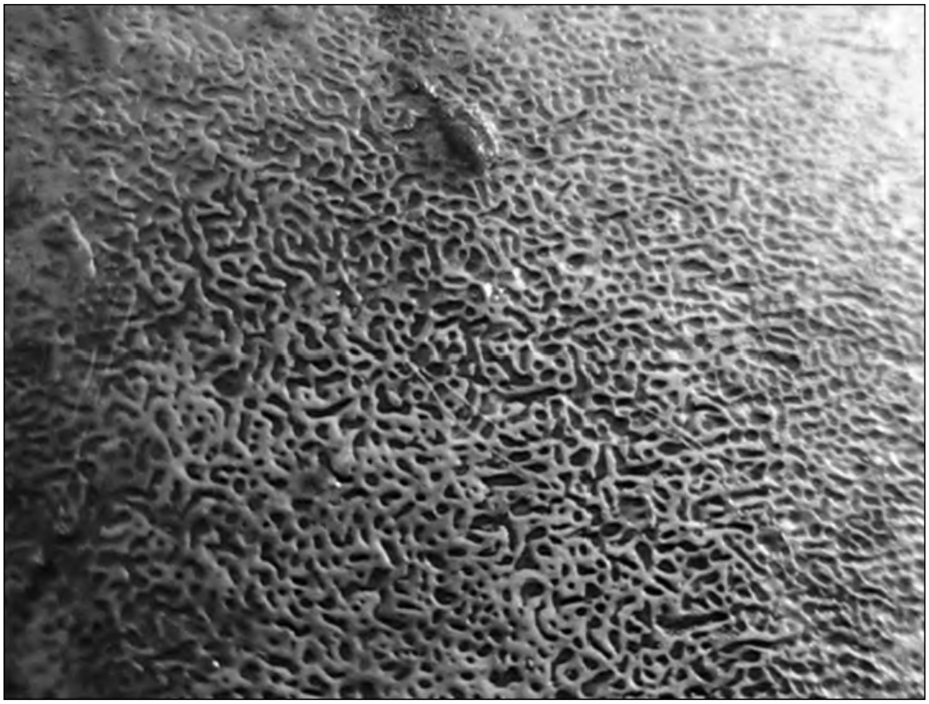

Figure 93. Porotic hyperostosis in right posterior parietal (Burial 138, 3–5 years old).

Figure 94. Porotic hyperostosis (Burial 64, 4.5–10.5 months old).

Porotic hyperostosis (all locations) in subadults was found most frequently in the 1.0–4.9 and 5.0–9.9 age groups (Figure 100). This pattern was also apparent when considering the prevalence of the disorder within age grades (Figure 101). 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 died prior to skeletal involvement of the pathology. Interestingly, all subadult cases of

Figure 95. Thickened diploe of occipital adjacent to lambda, compared with a normal specimen at the same location (Burial 151, 35–45-year-old male).

**Table 52. Porotic Hyperostosis, All Cranial Locations**

| Age/Sex Category | n[a] | Total (%) | Active (%)[b] | Healed (%)[b] | Both (%)[b] |
|---|---|---|---|---|---|
| Subadult | 88 | 39.8 | 16.7 | 83.3 | 0.0 |
| Adult[c] | 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[c] | 275 | 47.3 | 4.8 | 88.1 | 7.1 |

[a] Equals number of individuals with observable cranial elements.
[b] Status values represent the percentage of those in each group with evidence of porotic hyperostosis; cases of thickened diploe have been removed
[c] Discrepancies in sample numbers are the result of individuals that could not be aged and/or sexed.

**Table 53. Porotic Hyperostosis Statistical Testing, Intra-Population**

| | Porotic Hyperostosis, Presence/Absence | | Status of Lesions | |
|---|---|---|---|---|
| | $\chi^2$ | $p$ | $\chi^2$ | $p$ |
| Subadult/adult | 2.772 | .096 | .086* | .769 |
| Male/female | 3.268 | .071 | .285* | .593 |

*Note:* Conditions for 2 × 3 contingency table were not met, $x^2$ reflects the collapsing of "Active" and "Both" categories. Yeats Correction for Continuity used because of small "expected" cell values.

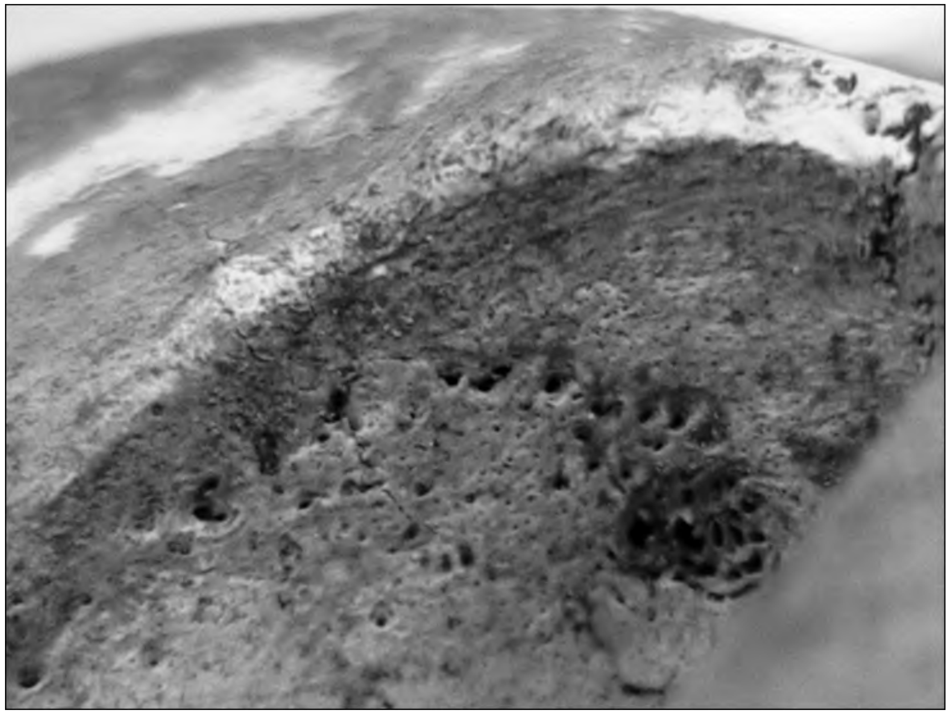

Figure 96. Cribra orbitalia of the left eye orbit (Burial 6, 25–30-year-old male).

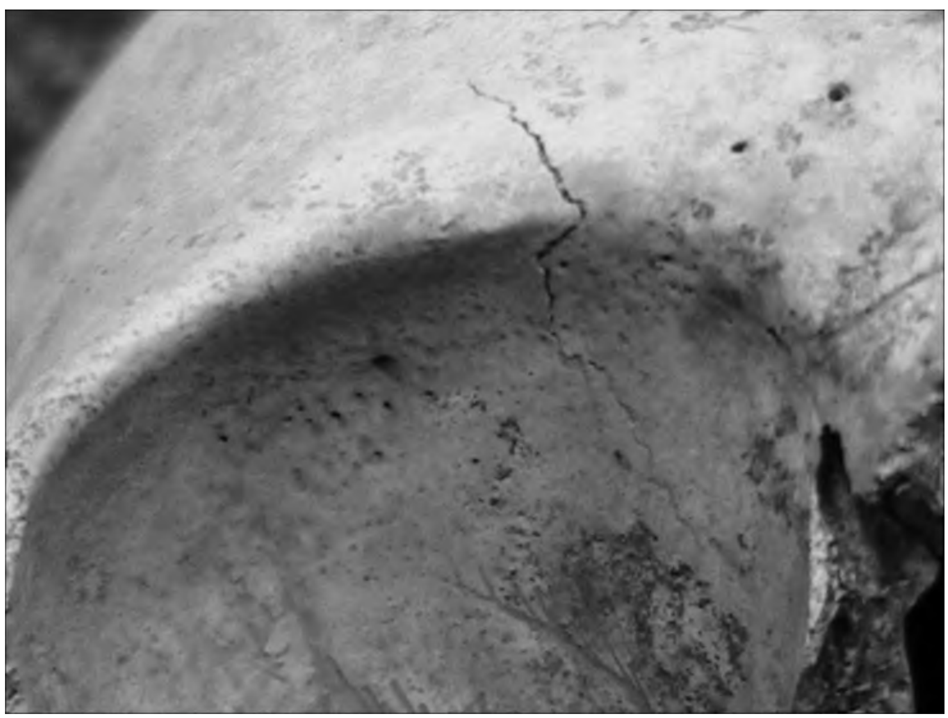

Figure 97. Cribra orbitalia of the right orbit (Burial 39, 5–7 years old).

**Table 54. Frequencies of Cribra Orbitalia in the NYABG Population**

| Age/Sex Category | n[a] | Total (%) | Active (%)[b] | Healed (%)[b] | Both (%)[b] |
|---|---|---|---|---|---|
| Subadult | 63 | 28.6 | 21.4 | 78.6 | 0.0 |
| Adult[c] | 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[c] | 228 | 23.7 | 8.2 | 87.8 | 4.1 |

[a] Equals the number of individuals with observable eye orbits.
[b] Status values represent the percentage of those in each group with evidence of cribra orbitalia; cases of thickened diploe have been removed.
[c] Discrepancies in sample numbers are the result of individuals that could not be aged and/or sexed.

**Table 55. Cribra Orbitalia Statistical Testing, Intra-Population**

| Age/Sex Category | Porotic Hyperostosis Presence/Absence | | Status of Lesions | |
|---|---|---|---|---|
| | $\chi^2$ | *p* | $\chi^2$ | *p* |
| Subadult/adult | 1.100 | .294 | .575[a, b] | .448 |
| Male/female | 1.545 | .214 | | .432[a, c] |

[a] Conditions for 2 × 3 contingency table not met, $x^2$ reflects the collapsing of "Active" and "Both" categories.
[b] Yeats Correction for Continuity used because of small "expected" cell values.
[c] Fishers Exact Test.

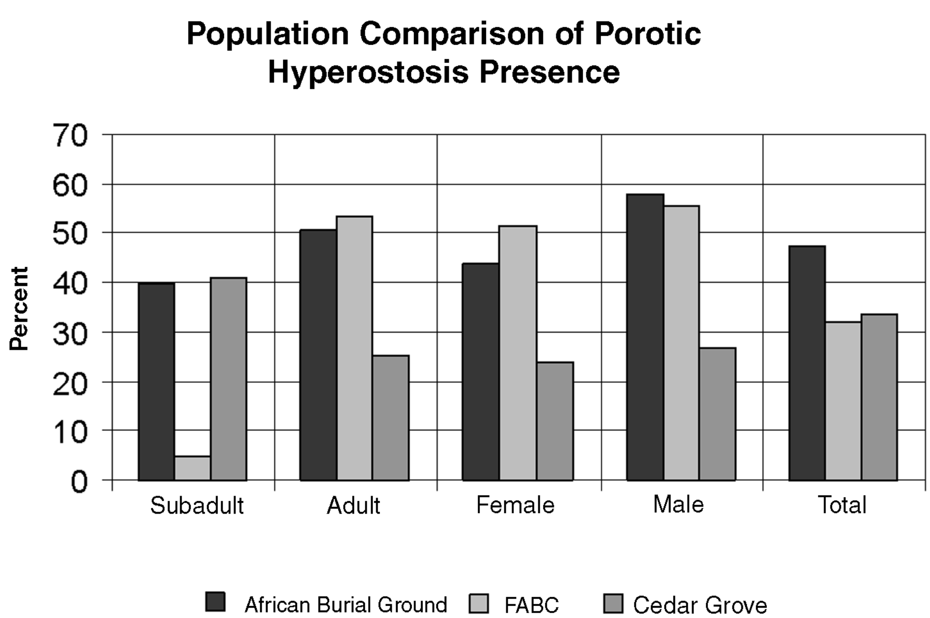


Figure 98. Population comparison of porotic hyperostosis presence.

**Table 56. Porotic Hyperostosis Statistical Testing, Inter-Population**

| Age/Sex Category | All Populations | | African Burial Ground/FABC | | African Burial Ground/ Cedar Grove | |
|---|---|---|---|---|---|---|
| | $\chi^2$ | *p* | $\chi^2$ | *p* | $\chi^2$ | *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[a] | .161 |
| Male | 5.128 | .077 | .058 | .809 | 3.902[a] | .048 |
| | | | | | | |
| Total | 10.890 | .004 | 8.828 | .003 | 4.594 | .032 |

[a] Yeats Correction for Continuity used because of small “expected” cell values.

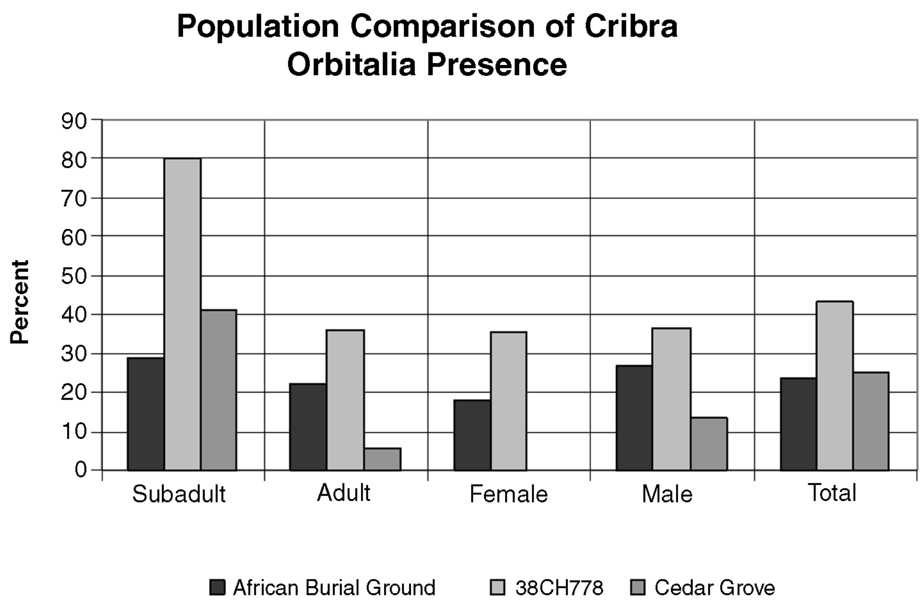


Figure 99. Population comparison of cribra orbitalia presence.

**Table 57. Cribra Orbitalia Statistical Testing, Inter-Population**

| Age/Sex Category | All Populations | | African Burial Ground/ Cedar Grove | | African Burial Ground/38CH778 | |
|---|---|---|---|---|---|---|
| | $\chi^2$ | *p* | $\chi^2$ | *p* | $\chi^2$ | *p* |
| Subadult | | | 1.766 | .184 | 3.495[a] | .062 |
| Adult | 8.688 | .013 | 4.146[a] | .042 | 1.649[a] | .199 |
| Female | 7.902 | .019 | 3.032[a] | .082 | 1.203[a] | .273 |
| Male | 1.894 | .388 | .618[a] | .432 | .098[a] | .754 |
| | | | | | | |
| Total | 5.385 | .068 | .056 | .813 | 4.351[a] | .037 |

*Note:* For subadult, all populations comparison, conditions were not met for 2 by 3 contingency table.
[a] Yeats Correction for Continuity used because of small “expected” cell values.

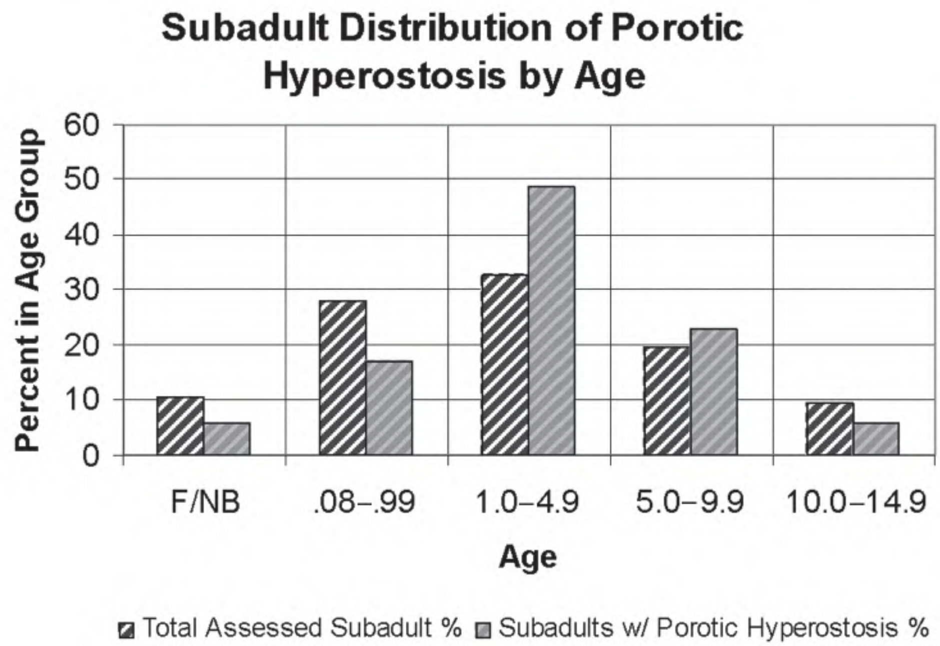


Figure 100. Subadult distribution of porotic hyperostosis by age.

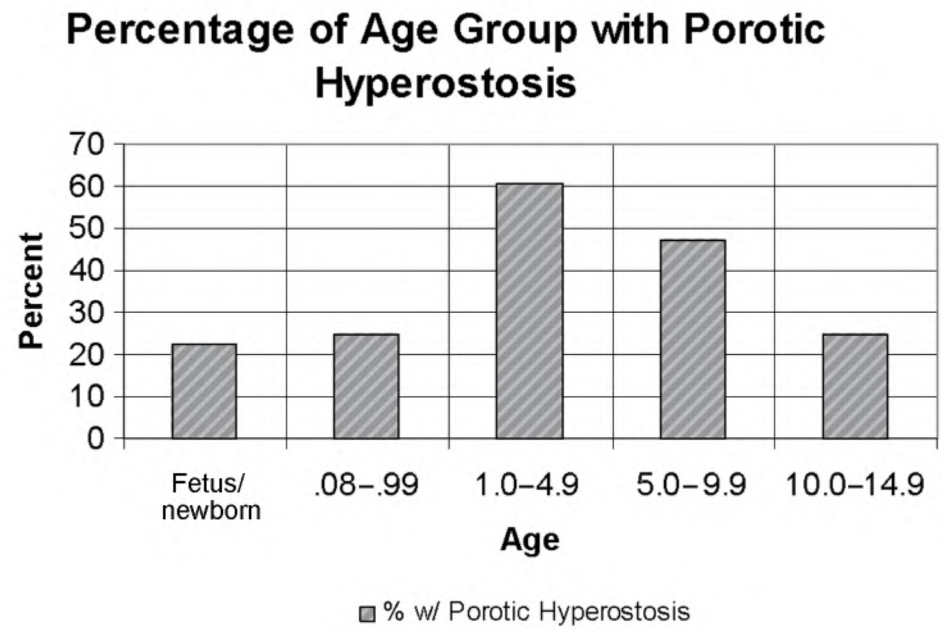


Figure 101. Percentage of age group with porotic hyperostosis.

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 was compared with other populations, rates observed in the New York African Burial Ground samples were consistently higher than those from FABC (Figure 102). Rates of porotic hyperostosis were lower in the first 2 years at the New York African Burial Ground than those found at Cedar Grove. However, the New York African Burial Ground subadults displayed a higher rate than Cedar Grove subadults in the 6–15-year range. The apparent disparity seen in the 25-month–5-year age range may be attribut-

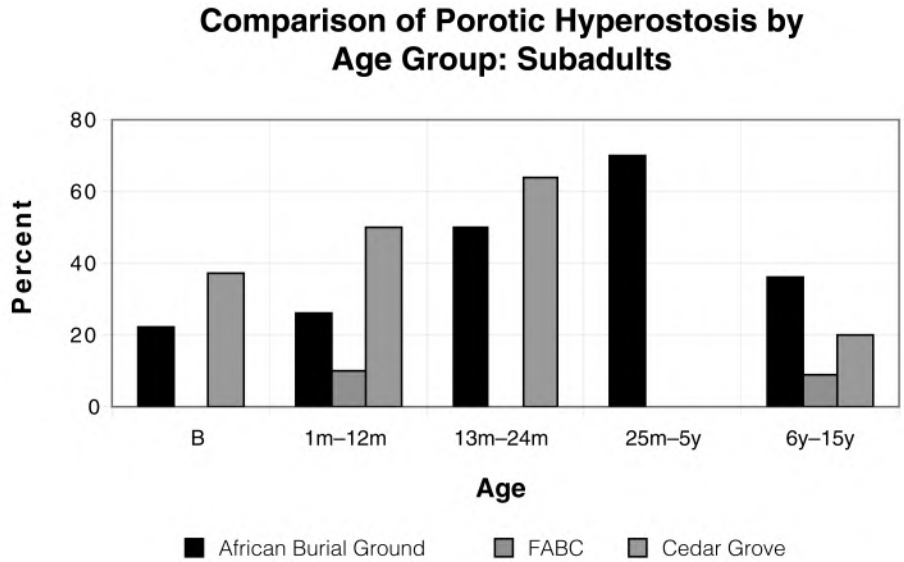


Figure 102. Comparison of porotic hyperostosis by age group.

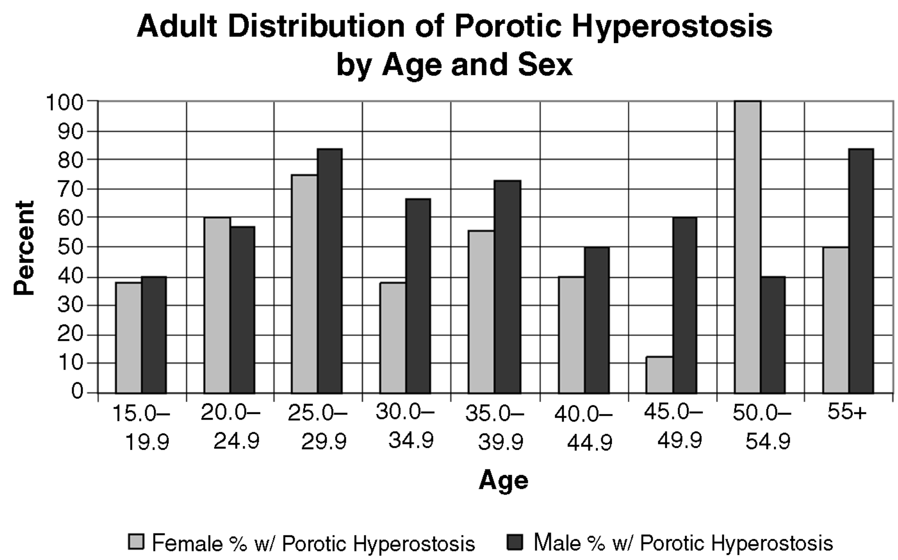


Figure 103. Adult distribution of porotic hyperostosis by age and sex.

able to the sample size in the FABC and Cedar Grove populations.

Among the New York African Burial Ground adults, porotic hyperostosis was more frequent in males overall, except in the 20.0–24.9 and 50.0–54.9 year age groups (Figure 103). Disparities between males and females were not as great in the younger adult age groups, from 15.0 to 29.9 years. Both male and females experienced 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 emerged (Figures 104 and 105). Female rates for porotic hyperostosis in the New York African Burial Ground were higher in all adult age categories except in the 40–49.9-year age range, in which both FABC and Cedar Grove had higher rates. Male rates

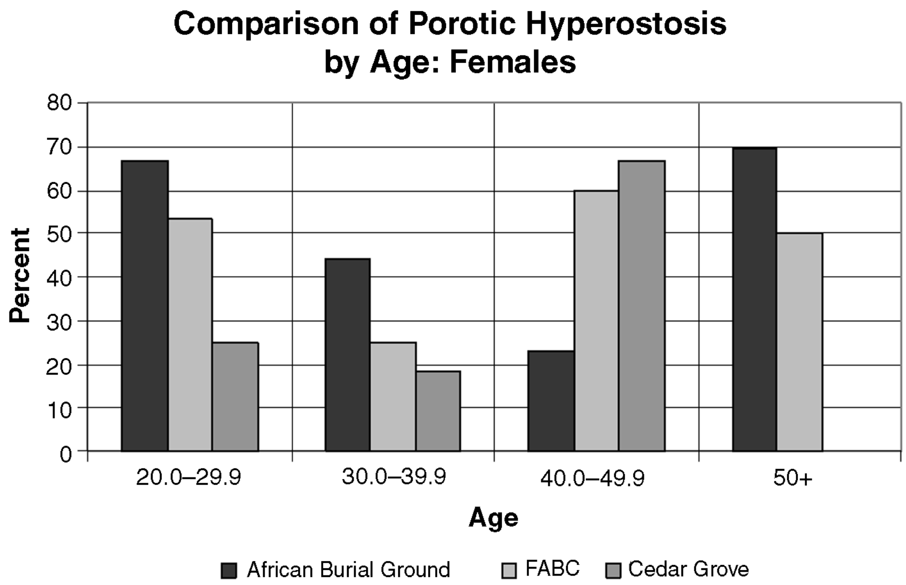


Figure 104. Comparison of porotic hyperostosis by age: females.

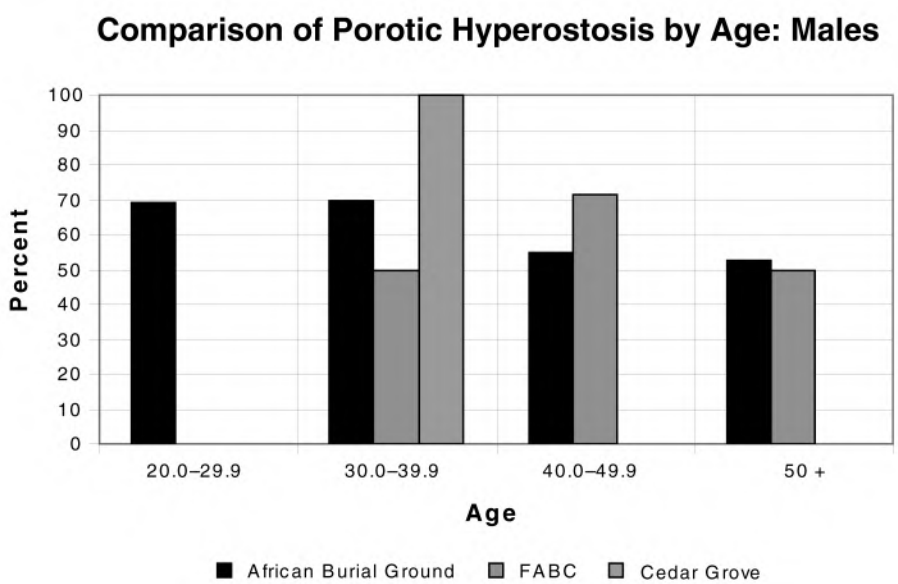


Figure 105. Comparison of porotic hyperostosis by age: males.

of porotic hyperostosis at the New York African Burial Ground were more consistent throughout the adult age ranges than those found in the Cedar Grove and FABC samples, although 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) (Tables 58 and 59). Only individuals who expressed

**Table 58. Medial-Lateral Bowing of the Lower Long Bones**

| Age/Sex Category | n[a] | n[b] | Total Percent | Clearly Present n[c] | Clearly Present Percent |
|---|---|---|---|---|---|
| Subadult | 77 | 5 | 6.5 | 2 | 2.6 |
| Adult [d] | 202 | 29 | 14.4 | 5 | 2.5 |
| Female | 77 | 13 | 16.9 | 1 | 1.3 |
| Male | 102 | 15 | 14.7 | 4 | 3.9 |
| | | | | | |
| Total [d] | 285 | 34 | 11.9 | 7 | 2.5 |

[a] Equals the number of individuals with observable long bones of the lower extremities
[b] Equals the number of individuals with bilateral medial/lateral bowing of the elements.
[c] Equals the number of individuals with "clearly present" bilateral medial/lateral bowing of the elements.
[d] Discrepancies in sample numbers are the result of individuals that could not be aged and/or sexed.

**Table 59. Medial/Lateral Bowing Statistical Testing, Intra-Population**

| Age/Sex Category | Medial/Lateral Bowing Presence/Absence | | Clearly Present | |
|---|---|---|---|---|
| | $\chi^2$ | *p* | $\chi^2$ | *p* |
| Subadult/adult | 2.528[a] | .112 | .137[a] | .711 |
| Male/female | .158 | .691 | .356[a] | .551 |

[a] Yeats Correction for Continuity used because of small "expected" cell values.

bowing bilaterally were included in this analysis thus limiting the confounding effect of postmortem 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), although this difference was not statistically significant.

Among adults, females (16.9 percent) displayed 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. Although 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 New York African Burial Ground. The rate of rickets in the New York African Burial Ground 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). Although this disparity in rates may be in part because of 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 New York African Burial Ground.

The presence of scurvy (vitamin-C deficiency), another nutritional disorder that could potentially be present among the individuals of the New York African Burial Ground, 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 New York African Burial Ground.

## Interaction of Infectious Disease and Nutritional Inadequacy

The interaction of infectious disease and nutrition is of particular concern, especially in enslaved people such

**Table 60. Co-occurrence of Porotic Hyperostosis with Periostitis**

| Age/Sex Category | n[a] | Porotic Hyperostosis | | Porotic Hyperostosis with Periostitis | | |
|---|---|---|---|---|---|---|
| | | n[b] | Percent | n[c] | Percent of Sample | Percent of those with Porotic Hyperostosis |
| Subadult | 88 | 35 | 39.8 | 18 | 20.5 | 51.4 |
| Adult[d] | 184 | 93 | 50.5 | 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[d] | 275 | 130 | 47.3 | 94 | 34.2 | 72.3 |

[a] 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.
[b] Equals the number of individuals with observable porotic hyperostosis.
[c] Equals the number of individuals with observable porotic hyperostosis who also had observable periostitis.
[d] Discrepancies in sample numbers are the result of individuals that could not be aged and/or sexed.

**Table 61. Co-occurrence of Porotic Hyperostosis with Periostitis Statistical Testing, Intra-Population**

| Age/Sex Category | Within Population Presence/Absence | | Within Porotic Hyperostosis Presence/Absence | |
|---|---|---|---|---|
| | $\chi^2$ | *p* | $\chi^2$ | *p* |
| Subadult/adult | 10.909 | .001 | 9.505[a] | .002 |
| Male/female | 2.197 | .138 | .045[a] | .832 |

[a] Yeats Correction for Continuity used because of small "expected" cell values.

as those interred at the African Burial Ground. Interestingly, historical research has found that the synergistic relationship between these two issues was also a concern in the past (Medford 2009). To investigate this synergism, frequencies of porotic hyperostosis and periostitis were considered together (Tables 60 and 61). As can be seen in Table 60, over one-third (34.2 percent) of the individuals from the New York African Burial Ground 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 not statistically 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) exhibited lower rates than adults (80.6 percent); however, males and females had very similar incidences of periostitis among those with porotic hyperostosis (see Table 61).

Upon comparing rates of individuals that had both porotic hyperostosis and periostitis, we found that the New York African Burial Ground sample exhibited higher overall percentages than the values for Cedar Grove (Rose and Santeford 1985) and FABC (Rankin-Hill 1997), although this difference was not statistically significant for several demographic categories (Figure 106 and Table 62). Subadults at the New York African Burial Ground present intermediate rates, lower than Cedar Grove, yet higher than FABC. Among adults, the New York African Burial Ground sample exceeds the co-occurrence incidence of porotic hyperostosis and periostitis in both the Cedar Grove and FABC samples. This pattern continues when sex-specific rates are considered, though the only statistical difference that exists in this case is between females in the New York African Burial Ground and FABC populations.

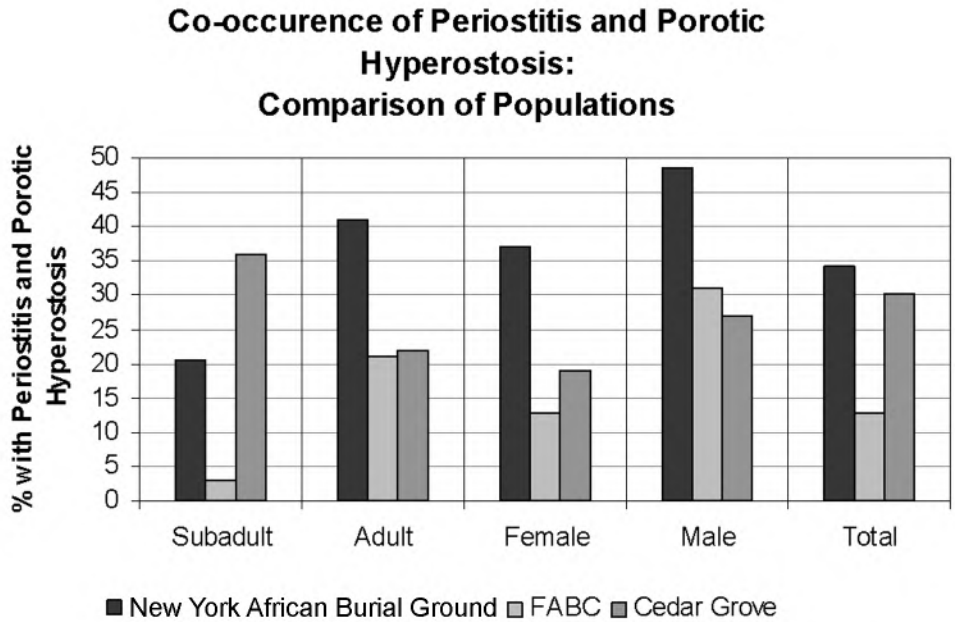


Figure 106. Co-occurrence of periostitis and porotic hyperostosis: comparison of populations.

**Table 62. Co-occurrence of Porotic Hyperostosis with Periostitis Statistical Testing, Inter-Population**

| Age/Sex Category | All Populations | | African Burial Ground/ FABC | | African Burial Ground/ Cedar Grove | |
|---|---|---|---|---|---|---|
| | $\chi^2$ | *p* | $\chi^2$ | *p* | $\chi^2$ | *p* |
| Subadult | 18.489 | <.001 | 7.543[a] | .006 | 3.882 | .049 |
| Adult | 11.383 | .003 | 8.824 | .003 | 4.405 | .036 |
| Female | 8.332 | .012 | 7.274 | .007 | 1.632[a] | .201 |
| Male | 4.996 | .082 | 3.390 | .066 | 1.673[a] | .196 |
| | | | | | | |
| Total | 19.869 | <.001 | 19.823 | <.001 | .488 | .485 |

[a] Yeats Correction for Continuity used because of small "expected" cell values.

These results suggest that although Cedar Grove may indeed have experienced higher overall frequencies of periostitis than that found at the New York African Burial Ground, the interactive patterning for porotic hyperostosis and periostitis was similar at population level. However, this interaction appears to have affected age groups differently, greater among adults in the New York African Burial Ground and greater in subadults at Cedar Grove. The similarity in adult rates for porotic hyperostosis in the New York African Burial Ground 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 New York African Burial Ground 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 New York African Burial Ground.

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: New York African Burial Ground subadults were found to be closer to the post-Reconstruction Cedar Grove subadults, but the adults were 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. Although diagnosis of a specific treponemal form was not possible, the data suggest that 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 vaccinelike 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 New York African Burial Ground. New York African Burial Ground studies of disrupted growth and development and of early mortality are consistent with these findings.

## Chapter 11

# Skeletal Indicators of Work: Musculoskeletal, Arthritic, and Traumatic Effects

*C. Wilczak, R. Watkins, C. 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. Although 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 the onset of degenerate joint disease, 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 New York African Burial Ground Project because physical labor was the principal purpose for which Africans were enslaved. We expect a diverse expression of markers among individuals from this sample owing to anticipated differences in cultural practices and genetic susceptibility, as well as variability in labor patterns. Slave labor in the city would have included 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 groups, reflecting this wide range of activities (Owsley et al. 1987). Although 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 New York African Burial Ground 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

**Table 63. Demography of the Sample Used in Stress Marker Analysis**

| Age in Years Categories | Males | Females | Unknown Sex |
|---|---|---|---|
| 15–24 | 15 | 12 | 8 |
| 25–34 | 17 | 18 | 3 |
| 35–49 | 40 | 20 | — |
| 50+ | 16 | 13 | — |
| Adult | 10 | 15 | — |
| | | | |
| Totals | 98 | 78 | 11 |

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 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 35–49 years and 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 63. Sample size for analysis of specific markers varies from these maximum numbers because of differential preservation of various skeletal elements.

# 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 that made up a joint complex. Osteoarthritis was assessed as present for such a region when any one of the joints showed degenerative changes. Because 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 107 and 108 illustrate severe vertebral osteoarthritis and osteophytosis development. Sample sizes and the frequency of these degenerative changes from osteoarthritis by sex of the vertebral synovial joints and osteophytosis of the vertebral bodies are listed in Tables 64 and 65. Because there is a known age component in the development of osteoarthritis and osteophytosis, frequencies are given with the total sample age range from 15 to 50+ and excluding the oldest and youngest for a sample age range of 25–49 years. Thirty-four males and 29 females had evidence of osteoarthritis in at least one vertebral

Figure 107. Severe osteoarthritis of the vertebral articular processes in a female aged 50–60 years (Burial 40).

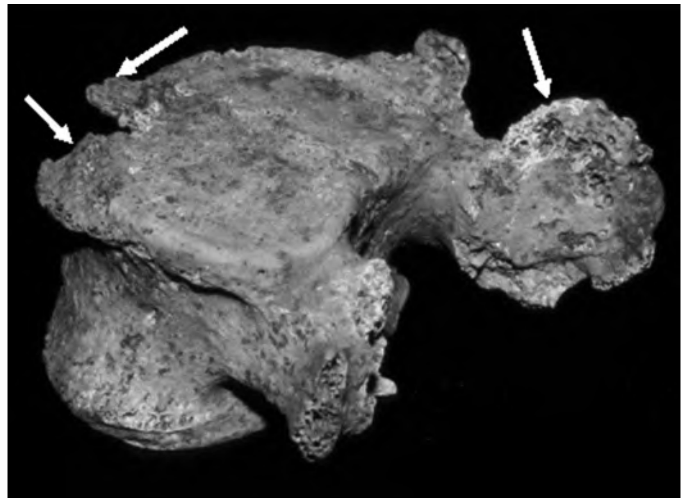

Figure 108. Severe osteophytosis (*left arrows*) and osteoarthritis (*right arrow*) of a lumbar vertebra in a male aged 35–45 years (Burial 63).

**Table 64. Distribution of Moderate to Severe Vertebral Osteoarthritis by Sex**

| Age In Years | Males | | Females | |
|---|---|---|---|---|
| | No. Affected | % | No. Affected | % |
| | 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 |

*Note:* Numbers in parentheses are sample sizes (n).

region. There was little evidence for sex differences in the distribution of vertebral osteoarthritis. Lumbar vertebrae showed 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 was not statistically significant (chi-square test, $p$ = .22). Vertebral osteophytosis was present in 23 males and 21 females in at least one vertebral region. Cervical osteophytosis rates were similar to osteoarthritis rates in individuals 25–49, but thoracic and lumbar osteophytosis occurred 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.

Comparisons among age categories and regions are most clearly seen in Figures 109 and 110. Males, females, and individuals of unknown sex are combined into one sample for this analysis because neither osteophytosis nor osteoarthritis rates show significant sex differences, and sample sizes were as low as eight individuals when the sexes were considered separately by age. Total sample sizes for the indi-

**Table 65. Distribution of Moderate to Severe Vertebral Osteophytosis by Sex**

| Age In Years | Males | | Females | |
|---|---|---|---|---|
| | No. Affected | % | No. 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 |

*Note:* Numbers in parentheses are sample sizes (n).

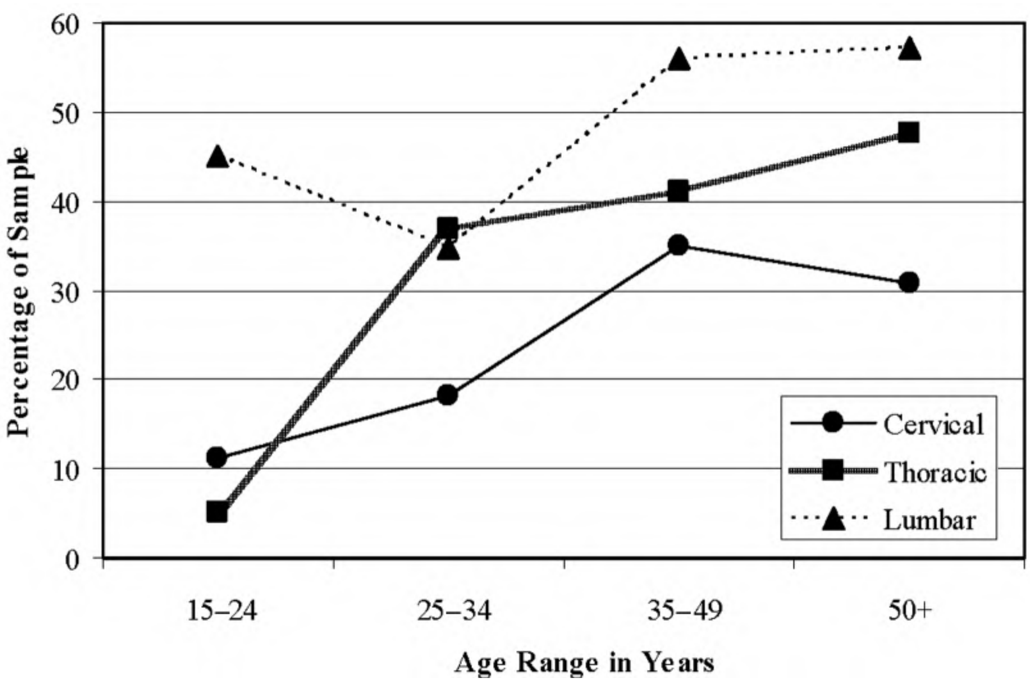


Figure 109. Age and incidence moderate to severe vertebral osteoarthritis.

vidual vertebral regions by age categories ranged 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 had moderate to severe degenerative changes. The most striking example is seen in osteoarthritis of the lumbar vertebrae—45.0 percent of individuals aged 15–24 were affected. Also in this age category, the frequency of moderate to severe cervical osteoarthritis was 11.0 percent and cervical osteophytosis was 10.5 percent.

In this sample, cervical osteophytosis was more frequent than in the thoracic and lumbar regions in all age categories (Figure 111). When the 32 cervical osteophytosis cases with preserved thoracic or

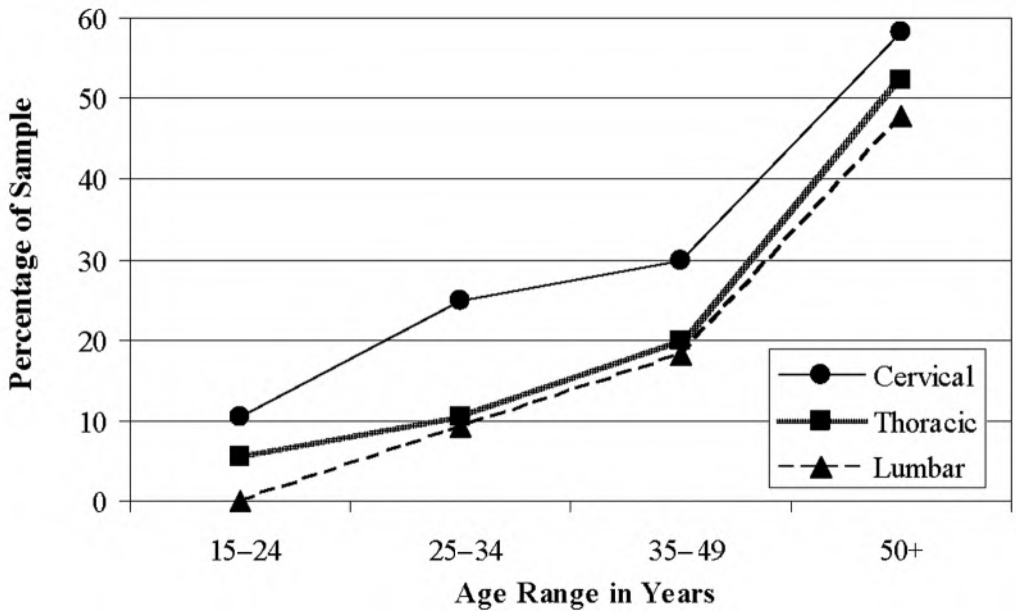


Figure 110. Age and incidence of moderate to severe osteophytosis.

Figure 111. Severe osteophytosis of the cervical vertebrae in a male aged 35–45 years (Burial 63).

lumbar vertebrae were examined individually, 20 (9 females and 11 males), or 62.5 percent, did not have these severe changes in one or both of the other two vertebral regions. For these 20 cases, cervical osteoarthritis was absent in 4 (20 percent), mild in 4 (20 percent), and moderate to severe in 12 (60 percent). The corresponding ages of these 20 individuals with cervical osteophytosis were: 2 aged 15–24, 4 aged 25–34, 8 aged, 35–50, and 6 aged 50+. By the sixth decade, 58.4 percent of the individuals (14 of 24) showed clear evidence of cervical osteophytosis. Osteoarthritis showed 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 because both develop as part of the natural aging process. However, they are 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 although 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 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 perimortem fractures to the cervical vertebrae (Table 66). All but one also had modifications consistent with osteophytosis, osteoarthritis, or both in the cervical region.

The similar rates of cervical osteophytosis do not necessarily mean that men and women 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 New York African Burial Ground 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 caused by compression, whereas 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 appear in either the thoracic or lumbar segments (Bridges 1994; Derevenski 2000). Biomechanically, this is not surprising because 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 of 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 end plates of the vertebral bodies; these pits result from the pressure of cartilaginous protrusions of damaged intervertebral discs (Figure 112).

The general pattern of spinal distribution for 22 affected males and 11 affected females (Table 67) was similar with the greatest frequency in the lumbar region and the lowest in the cervical region for both sexes. Lumbar frequencies were equal, but male frequencies were more than double those of females in the thoracic vertebrae and triple those of females in the cervical vertebrae. Two females and six males had Schmorl's nodes in multiple vertebral regions.

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, Schmorl's nodes were most frequent in the age range of 25–34 for all

**Table 66. Number of Fractures by Skeletal Element in Adults by Sex**

| Skeletal Element | Males | | | | Females | | | |
|---|---|---|---|---|---|---|---|---|
| | Premortem[a] | Perimortem | Ambiguous Perimortem | %[b] | Premortem | Perimortem | Ambiguous Perimortem | %[c] |
| Cranium | — | 9 | 19 | 23.5 | — | 5 | 4 | 11.1 |
| Mandible | — | — | 1 | 0.9 | — | 1 | 1 | 2.5 |
| Cervical vertebrae[b] | 1 | 2 | — | 2.6 | 2 | 2 | 1 | 6.2 |
| Thoracic vertebrae[b] | 2 | 2 | — | 3.4 | — | 1 | 1 | 2.5 |
| Lumbar vertebrae[b] | — | 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 | |

[a] Vertebral fractures do not include spondylolysis (see Table 11.6).
[b] Percentage of the 117 fractures recorded for males.
[c] Percentage of the 81 fractures recorded for females.

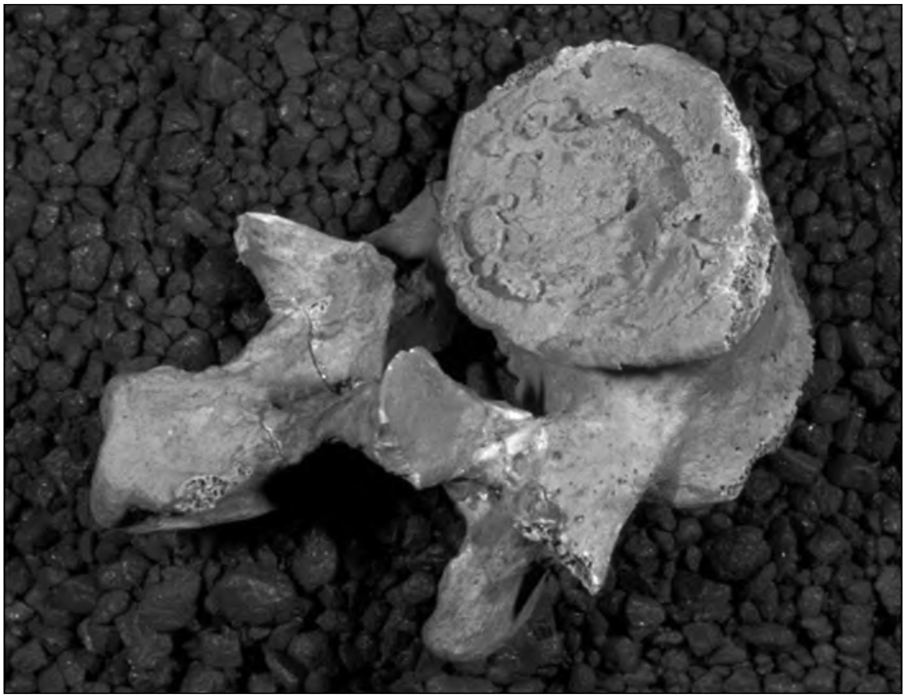

Figure 112. Schmorl's node depression of a lumbar vertebra in a male aged 35–45 years (Burial 70).

**Table 67. Regional Distribution of Schmorl's Nodes**

| Region | Males | | Females | |
|---|---|---|---|---|
| | Number | Percent | Number | 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 |

*Note*: Numbers in parentheses are sample sizes (n).

three vertebral regions (Table 68). 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. Although one might expect to see an 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, who were also affected with osteophytes in the same vertebral region, were 28.6 percent, 42.9 percent, and 21.7 percent, respectively.

## Spondylolysis

Unilateral or bilateral fracture of a vertebral neural arch and subsequent separation from the vertebral body constitute the defect of spondylolysis (Figure 113). Although technically considered a type of fracture, it is discussed here because it can be caused by fatigue fracturing when presenting as typical spondylolysis. Typical spondylolysis is a fracture in the lumbosacral region through pars interarticularis with the fourth and fifth lumbar vertebrae most frequently affected (Merbs 1996). The etiology of typical spondylolysis suggests both genetic factors, likely related to differences in vertebral morphology, and mechanical stresses affecting the lower back, such as general heavy labor, and

**Table 68. Percentage of Individuals with Schmorl's Nodes by Age**

| Age in Years | Cervical | Thoracic | Lumbar |
|---|---|---|---|
| 15–24 | 0.0 (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) |

*Note*: Numbers in parentheses are number of individuals with Schmorl's nodes (n).

Figure 113. Vertebral spondylolysis in a female aged 35–40 years (Burial 107).

in athletics that stress the lower back such as football, gymnastics, and rowing (Merbs 1989a, 1996).

Complete, bilateral spondylolysis of the fourth or fifth lumbar vertebrae was present in four adults from the New York African Burial Ground (Table 69). All of the individuals with spondylolysis also had 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 showed evidence of osteoarthritis of the lumbar apophyseal joints. Osteoarthritis was also present in the cervical vertebrae of Burial 11, in the thoracic vertebrae of Burial 37, and in both the cervical and the thoracic vertebrae of Burials 97 and 107.

Examination of musculoskeletal stress markers (MSMs) and axial osteoarthritis revealed 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 30–40 who showed hypertrophy or stress lesions at 37 percent of 33 muscle or ligament attachments. These attachments included several associated with carrying or heavy lifting, such as the triceps, biceps, deltoid, quadriceps, linea aspera, obturator exturnus/internus, and gluteus minimus/medius muscle attachments. Moderate osteoarthritis of the hip and elbow were also present in the form of peripheral lipping of all articular surfaces. In the elbow, lipping was particularly prominent on the ulna, suggesting bending stress as a greater factor than rotational stress.

Burial 97 is a male aged 40–50 years with extensive MSMs that were scored as moderate to severe for 17 of 30 (56 percent), of the attachments examined, which is over twice the average percentage (25.2 percent) of MSMs for all adult males. Moderate to severe osteoarthritic lipping was 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 35–40 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 as seen in Burial 11 emerged, with stress lesions at the brachialis, deltoid, linea aspera, quadriceps, and obturator internus/externus muscle attachments. Although mild lipping was 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 69, 21 percent of the attachments showed significant hypertrophy or stress lesions, including those of the brachialis, supinator, quadriceps and linea aspera. All of the joints examined in

**Table 69. Spondylolysis and Associated Vertebral Degenerative Changes**

| Typical Spondylolysis | | | Other Degenerative Changes[a] | | |
|---|---|---|---|---|---|
| Burial | Sex | Age Range (yrs) | Osteophytosis | Osteoarthritis | Schmorl's Nodes |
| 11 | M | 30–40 | C,T,L | C,L | |
| 97 | M | 40–50 | | C,T,L | C,T |
| 107 | F | 35–40 | C,T,L | C,T,L | T |
| 37 | M | 45–55 | C,T,L | T,L | T,L |

[a] C = cervical, T = thoracic, L = lumbar

this older individual showed at least mild osteophytic lipping, but more pronounced lipping was present in the hip, ankle, knee, and foot. Although all four burials showed some correspondence between spondylolysis and other stress markers, there were also differences among the individuals. High levels of mechanical stress were indicated by MSMs for Burial 11, by osteoarthritis in Burial 37, and by both MSMs and osteoarthritis in Burials 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, bone density, anatomy, and posture in the performance of similar tasks 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 the first through fourth cervical vertebrae, but grain porters in Cape Province, South Africa, only showed injuries below the fourth cervical vertebra (Capasso et al. 1999). So although there is evidence of general levels of high mechanical stress for the four burials examined here, one must be careful not to overinterpret the specific manifestations for any one individual.

# Results of Appendicular Joint Analysis

In the upper limbs, 22 females and 43 males had 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 was 2.26 for females and 2.09 for males. If the joint and joint complexes are ranked by relative frequency of osteoarthritis, there are differences between the sexes (Table 70). For the 25–49-year age range, females had the highest incidences in the wrist, and males were highest in the elbow (Figures 114 and 115). The shoulder was least affected in both sexes. The greatest frequency difference between males (32.6 percent) and females (19.4 percent) was in the elbow.

In the lower limbs, 40 females and 58 males had 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 was 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 was 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.

There was a higher frequency of osteoarthritis in the lower limbs than in the upper limbs for both sexes (Table 71). Only the male elbow, and perhaps wrist, had comparable incidence levels. Both males and females had the highest lower-limb incidence of osteoarthritis in the ankle (Figures 116 and 117). In

**Table 70. Distribution of Moderate to Severe Osteoarthritis in the Upper Limb**

| Age In Years | Males | | Females | |
|---|---|---|---|---|
| | No. Affected | % | No. 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) | 32.7 | 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) | 17.2 |
| 50+ | 19 (80) | 23.8 | 12 (55) | 21.8 |

*Note:* Numbers in parentheses are sample sizes (n).

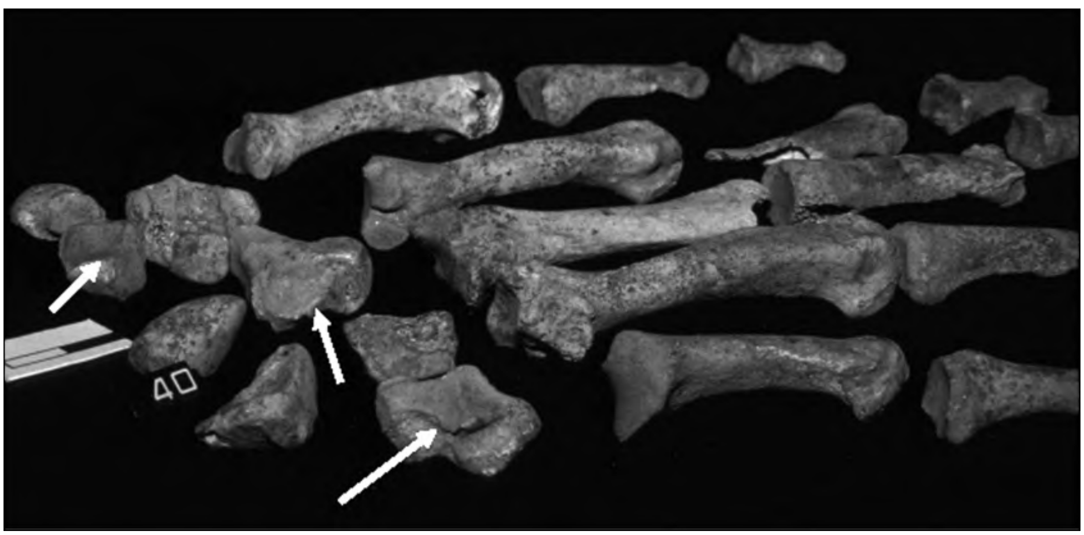


Figure 114. Osteoarthritis with marginal lipping in the wrist of a female aged 50–60 years (Burial 40).

females and males, this was followed by the hip and the knee. The ankle joint showed 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 was not statistically significant.

It was difficult to examine age effects independently for males and females because sample sizes were as low as 10 individuals when the sexes were considered separately by age. Because the joints or joint complexes did not show statistically significant sex differences, all were plotted as combined samples of males, females, and unknown sex initially (Figures 118 and 119). The elbow was also plotted separately for males and females because the greatest sex differences were found at this joint (Figure 120). Total sample sizes for the combined appendicular joints by age categories ranged from 17 to 54 individuals. The general trend for both upper limb and


Figure 115. Mild to moderate osteoarthritis in the humeral articular surface of the elbow in a male aged 30–40 years (Burial 11): (*a*) anterior view; (*b*) posterior view.

**Table 71. Distribution of Moderate to Severe Osteoarthritis in the Lower Limb**

| Age in Years | Males | | Females | |
|---|---|---|---|---|
| | No. Affected | % | No. 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) | 28.6 | 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 |

*Note:* Numbers in parentheses are sample sizes (n).

lower limb joints was toward increased frequencies of affected individuals with age. Nonetheless, a fairly large proportion of the youngest age group had moderate to severe degenerative changes. This was most apparent in the lower limbs where incidences ranged from 15 percent in the foot to 25 percent in the ankle for 15–24-year-olds. In the upper limbs, the elbow of the youngest age group had the highest incidence of 21.7 percent. The lower limbs were clearly more affected than the upper limbs, and it is unlikely that incidences in the lower limb are simply a phenomenon of normal weight-bearing and age because moderate to severe osteoarthritis reached quite high levels in the young adults and was pronounced in those aged

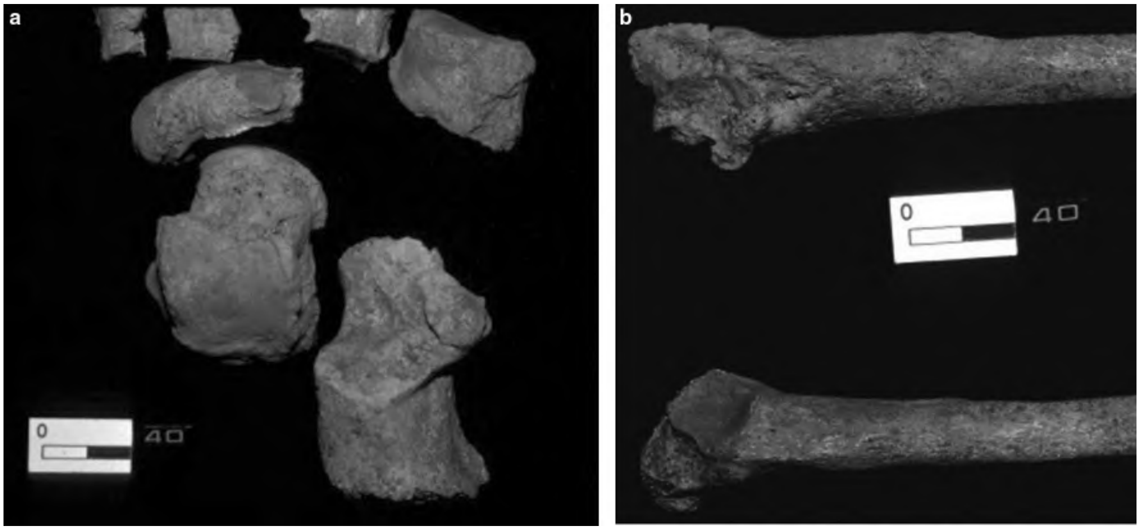


Figure 116. Osteoarthritis of the ankle in a female aged 50–60 years (Burial 40): (*a*) superior aspect of the distal ankle articulations; (*b*) the proximal ankle articulation on the fibula.

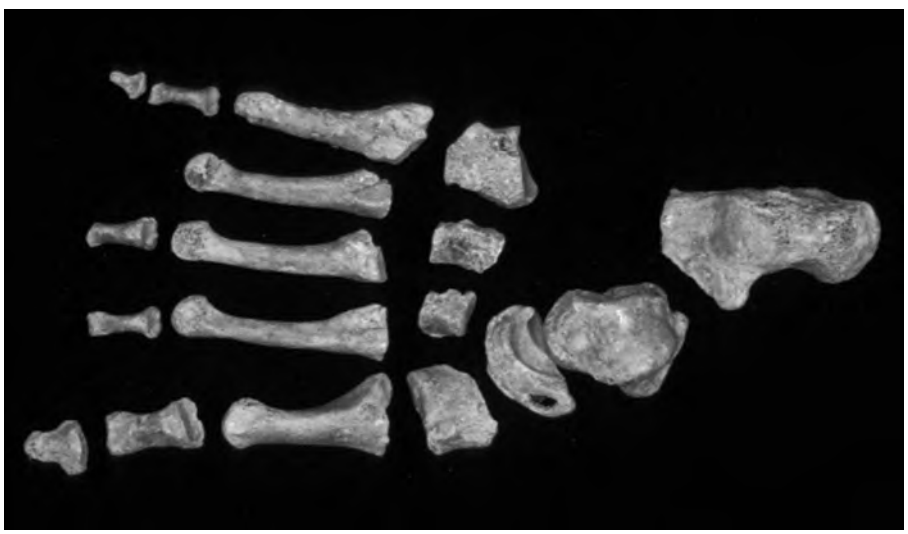

Figure 117. Osteoarthritis in the ankle and foot of a male aged 40–50 years (Burial 238).

25–49 years as well. Figure 119 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 increase to rates greater than 58 percent.

Sample sizes for osteoarthritis of the elbow ranged from 9 individuals for females aged 15–24 and 50+ to 36 individuals for males aged 35–49 years. The trend for males to exceed females was interrupted in the age range of 25–34. In this group of 13 males, none showed significant osteoarthritis. The largest difference was 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).

The incidence of osteoarthritis was higher in the lower limbs, suggesting greater stress than in the upper limbs. 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 have been most important for this population, and it is likely that different stresses were factors for different individuals. An alternative

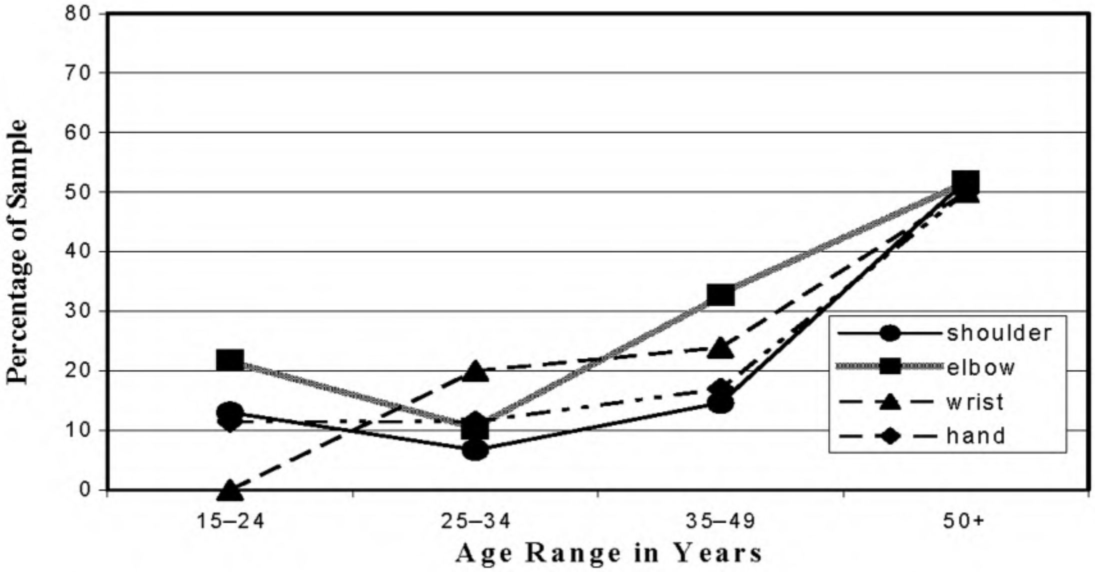


Figure 118. Age and incidence of moderate to severe osteoarthritis in the upper limb.

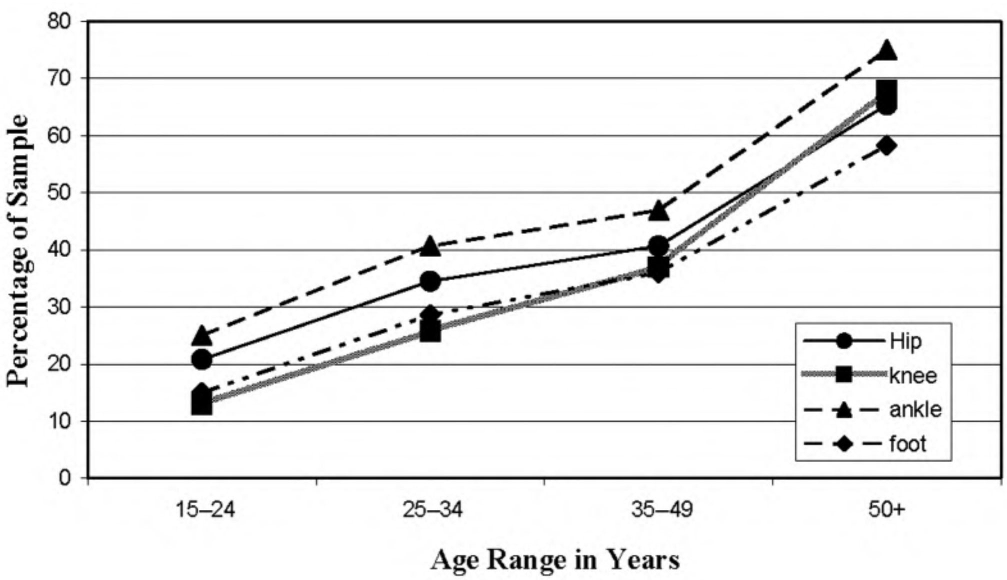


Figure 119. Age and incidence of moderate to severe osteoarthritis in the lower limb.

explanation is that high general stress experienced in this population contributed to osteoarthritis development in all limbs, but rates in the lower limbs were highest because of the additional weight-bearing burden. Perhaps this is true, but the pattern in the vertebral column suggestive of the higher burden in the pelvic girdle. The higher incidence of osteoarthritis in the lower limbs 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 because it is rare in the archaeological record as well as today (Rogers 2000). When it does occur, it is normally caused by 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

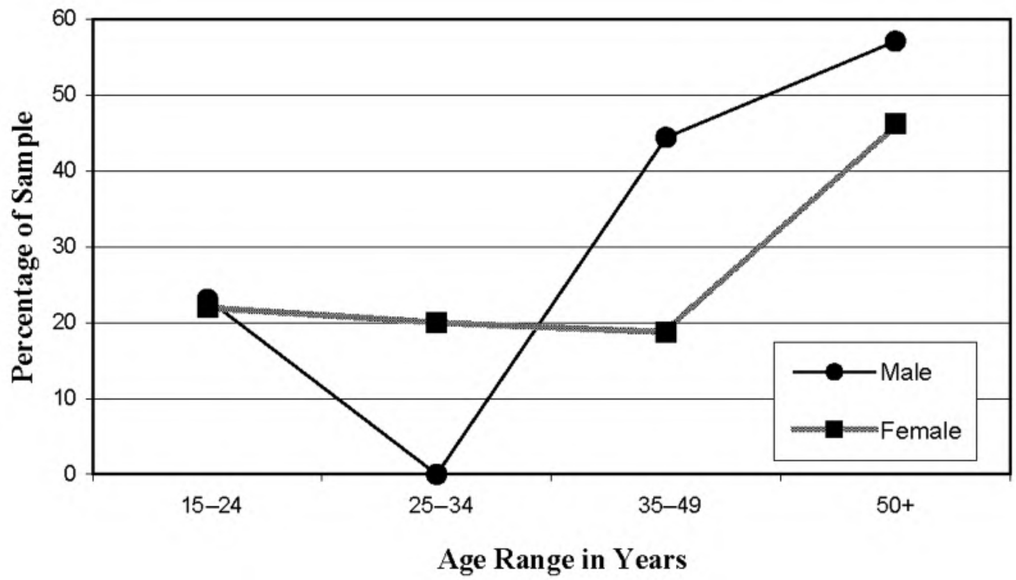


Figure 120. Age and incidence of moderate to severe osteoarthritis of the elbow.

males aged 25–34 with lower rates are more representative of the population. Therefore, it would be an overinterpretation 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 have experienced high stress levels at the elbow. This stress level could have been caused by 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 the formation and enlargement of distinct ridges and crests at the attachment, resulting in a rugose appearance. With extreme stress at the attachment, nonlytic 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 lesions, 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, 19 in the upper limb, and 11 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 7 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 shared a common attachment or when the attachments were 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 121 and 122). In analyses of MSM frequency, only scores of 2 or greater were considered. Exclusion of mild hypertrophy ensured that only clear cases of MSMs were scored.

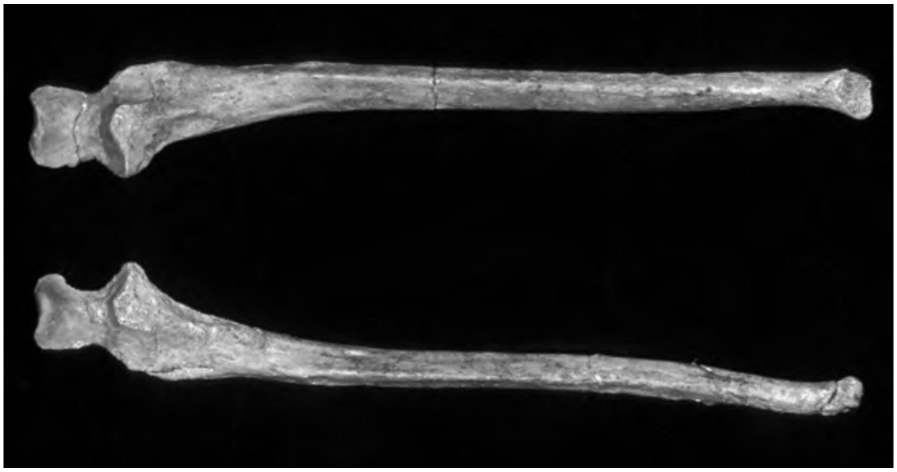

Figure 121. Severe hypertrophy of the ulnar supinator insertions in a male aged 40–50 years (Burial 369).

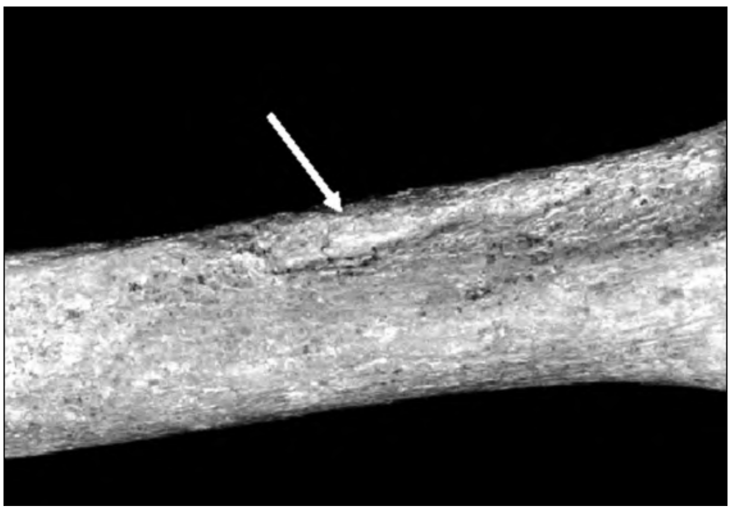

Figure 122. Stress lesion of the right humerus in a male aged 20–23 years (Burial 181).

## 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 9 scorable sites for the 33 attachments (greater than 25 percent) were included. The average percentage of MSMs per individual was 25.1 for males and 19.6 for females (Table 72). This difference was statistically significant (t-test, $p$ = .03).

Average percent MSM scores increased with age for both males and females. Although lower than other age groups, at least some attachments showed significant hypertrophy and/or stress lesions 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 was the lowest and corresponded to an average of 1.6 insertions per individual (out of the 33 total attachments). The youngest females showed a difference of 6.5 percent when compared to females aged 25–34, corresponding to 2.1 fewer insertions per individual. For males, the difference between the two middle-age ranges (7.6 percent, or 2.5 insertions) was 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 in 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

**Table 72. Average Moderate to Severe Musculoskeletal Stress Marker Scores by Age and Sex**

| Age in Years | n[a] | Average No. of Attachments | Average Percent MSM | Highest Percent 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[b] | 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 ages[b] | 68 | 24.9 | 19.6 | 63.6 |

[a] Includes individuals with nine or more insertions present.
[b] All ages category includes adults of indeterminate age.

the "adult" enslaved labor force, giving ample time for hypertrophy and stress lesion formation. Burial 323 is a male aged 19–30 who has moderate to severe MSM development at 39.4 percent (13 of 33) of his scorable attachments. Ten of these were stress lesions that included the linea aspera, quadriceps, biceps, deltoids and pectoralis/latissimus dorsi attachments. The large percentage of stress lesions suggests hard labor began at an early age for this individual.

Moderate to severe forms of MSMs were present in substantial frequencies. On a per case basis, females had an average of 6.5 occurrences, and males had 8.3 occurrences for the 33 attachments in the analysis. Because males had higher frequencies of MSMs and the age composition of the two samples varies, comparisons of specific attachments are presented by relative rank (Table 73). Of the 10 most frequent MSMs, only 2 are not common to both males and females. The coracoclavicular ligament ranked eighth in females (32.7 percent) and eleventh in males (28.2 percent). A much greater difference was seen for the biceps brachii muscle, which ranked tenth for males (33.8 percent), but twenty-third (8.2 percent) for females (Figure 123). In the lower limbs, the highest ranked attachments were the linea aspera and the gluteus maximus (1, 4 males and 2, 6 females; Figures 124 and 125). In the upper limbs, the deltoid, pectoralis major/latissimus dorsi, supinator, finger flexors, lateral scapula, and costoclavicular ligament were among the 10 most common MSMs 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 were much less frequent in this population. Within the top ten, the rankings for the brachialis (Figure 126) was somewhat higher in females (1 vs. 5), whereas the pectoralis major/latissimus dorsi/teres minor was somewhat higher in males (3 vs. 7) (see Table 73).

The cutoff point for further discussion of the 10 most frequently affected attachments is arbitrary because there was no clear breakpoint between common and uncommon MSMs in this population. There was, 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

**Table 73. Frequencies of Musculoskeletal Stress Markers in Males and Females**

| Rank | Male Attachment | No. | Percent | Female Attachment | No. | Percent |
|---|---|---|---|---|---|---|
| 1 | linea aspera | 58 | 66.7 | brachialis | 32 | 55.2 |
| 2 | deltoid | 51 | 62.2 | linea aspera | 34 | 51.5 |
| 3 | pectoralis major, latissimus 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 | finger flexors | 27 | 44.3 |
| 6 | supinator | 45 | 54.2 | gluteus maximus | 29 | 43.9 |
| 7 | finger flexors | 32 | 41.0 | pectoralis major, latissimus dorsi, teres major | 25 | 42.4 |
| 8 | lateral scapula | 28 | 35.4 | coracoclavicular ligament | 18 | 32.7 |
| 9 | costoclavicular ligament | 25 | 35.2 | costoclavicular ligament | 15 | 27.3 |
| 10 | biceps brachii | 26 | 33.8 | lateral scapula | 16 | 26.7 |
| 11 | coracoclavicular ligament | 20 | 28.2 | cranial base-occiput | 13 | 25.5 |
| 12 | hamstrings | 24 | 28.2 | quadriceps | 13 | 18.3 |
| 13 | medial epicondyle-humerus | 22 | 26.5 | obturator internus/externus | 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 | lateral epicondyle-humerus | 19 | 22.4 | triceps brachii | 9 | 14.8 |
| 18 | rotator cuff | 17 | 20.7 | pronator teres/quadratus | 8 | 14.3 |
| 19 | trapezius/nuchal | 15 | 18.1 | medial epicondyle-humerus | 9 | 13.8 |
| 20 | iliopsoas | 15 | 17.2 | lateral epicondyle-humerus | 7 | 10.8 |
| 21 | subclavius | 12 | 16.9 | Achilles tendon | 7 | 10.4 |
| 22 | finger extensors | 13 | 16.7 | gluteus medius/minimus | 5 | 9.3 |
| 23 | triceps brachii | 14 | 15.7 | biceps brachii | 4 | 8.2 |
| 24 | obturator internus/externus | 13 | 15.1 | subclavius | 4 | 7.3 |
| 25 | Achilles tendon | 12 | 13.6 | teres minor | 4 | 7.0 |
| 26 | pronator teres/quadratus | 7 | 8.6 | plantarflexors | 3 | 6.5 |
| 27 | gluteus medius/minimus | 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 |

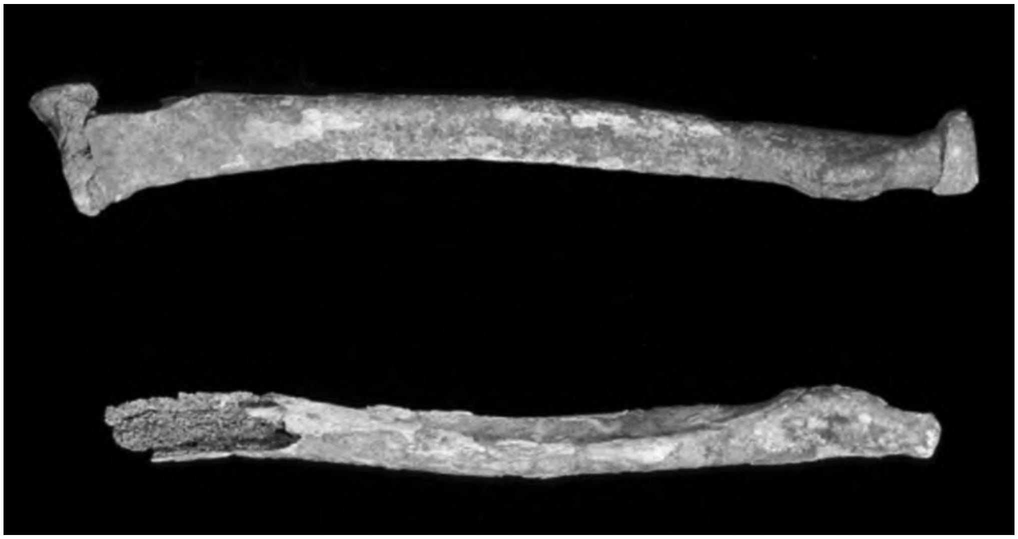

Figure 123. Hypertrophy of the biceps brachii insertion of the radii in a male aged 40–45 years (Burial 10).

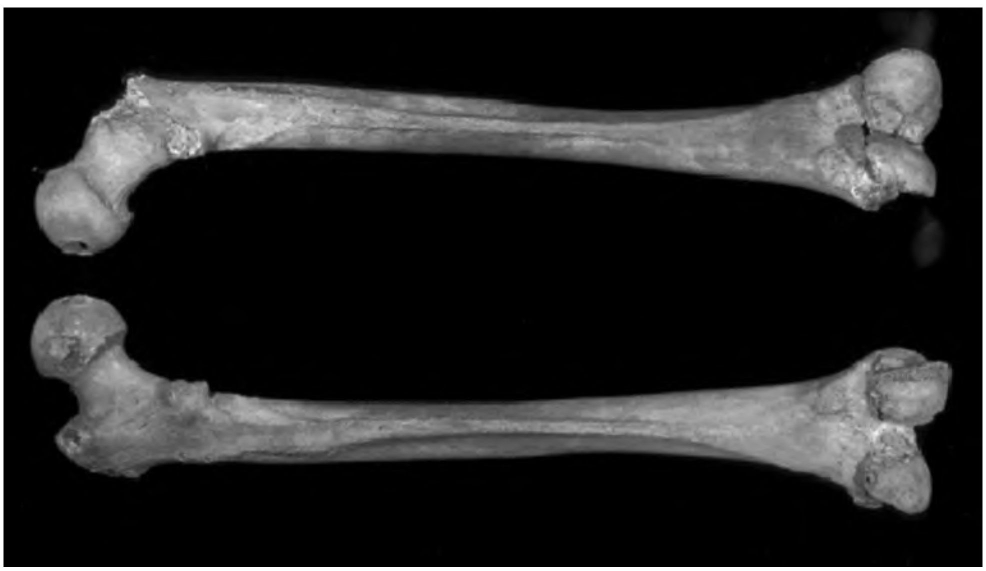

Figure 124. Hypertrophy of the linea asperae of the femora in a female aged 40–50 years (Burial 328).

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 downstroke 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 was 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 coracoclavicular ligament attaches the clavicle to the coracoid process and limits forward and backward movement of the scapula. This pattern of stress suggests activities that include 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 observed in the shoulder is compatible with many types of general

Figure 125. Hypertrophy of the gluteus maximus insertions of the femora in a male aged 17–18 years (Burial 174).

Figure 126. Hypertrophy of the brachialis insertions of the ulnae in a female aged 25–35 years (Burial 223).

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. Although higher in women, both sexes showed evidence of stress at this attachment. An additional flexor of the elbow and shoulder, the biceps brachii, showed hypertrophy in men. This could relate to general carrying functions because the biceps brachii opposes extension of the forearm against a load when 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. The 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; the supinator muscle acts alone when the elbow is straightened (Kelley 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 because MSMs in male and female finger flexors ranked seventh and fifth, 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 limbs 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 magnus, 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 because the quadriceps insertion at the knee is affected in 25.0 percent of males (n = 15) and 18.3 percent of females (n = 12). Linea aspera development has been reported in several groups with strenuous locomotor activities, including Canadian fur traders, who jogged up steep portage trails, and 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 observed lesions and not to assign specific tasks to this population. Although general load carrying would be expected as part of the labor for many enslaved, some of the same MSMs were 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 medieval agriculturists or in a thirteenth-century Inuit population, urban enslaved people would perform many types of labor. As we look at the sample 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 showed the same general pattern of stress but that there were 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 74). 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 Kelley and Angel's (1987) plantation sample did not comprise a single cemetery sample but instead consisted of scattered burials from across Maryland and Virginia.

Direct comparisons of the incidence of specific markers are problematic because of differences in data collection methodologies across studies. However, it is at least possible to compare general patterns of the types of stresses experienced. Kelley and Angel (1987) gave no precise descriptions relating to the occupational markers in the plantation/farm slave sample. They did find that overall nutrition and lon-

**Table 74. Skeletal Studies of Musculoskeletal Stress Markers in Enslaved African Americans**

| Location | Dates | n[a] | Population | Reference |
|---|---|---|---|---|
| Charleston, South Carolina | 1840–1870 | 28 | plantation slaves | Rathbun (1987) |
| New Orleans, Louisiana | 1721–1810 | 13 | urban slaves | Owsley et al. (1987) |
| Catoctin, Maryland | 1790–1820 | 16 | industrial slaves (ironworkers) | Kelley and Angel (1983, 1987) |
| Maryland and Virginia | 1690–1860 | 76 | plantation/farm slaves | Kelley and Angel (1987) |

[a] Includes adult remains only.

gevity for Catoctin males were greater than for rural enslaved and attributed this to the value placed on skilled workers by the slaveholders, 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 showed some broad similarities to the New York African Burial Ground, particularly in the early age of onset for MSMs: (1) an 18–20-year-old female had well-developed attachments, particularly for the deltoid tuberosities and the clavicular attachments; (2) the youngest adult male, around 20 years old, had 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 had a Schmorl's node. In general, Kelley and Angel (1987) painted 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 New York African Burial Ground sample. There were several cases of cervical "arthritis" (osteophytosis?) that they associated with skilled craftpersons rather than carrying loads because of its co-occurrence with MSMs in the finger phalanges.

In their earlier work, Kelley and Angel (1983:17) also suggested a specific link between hypertrophy of the supinator crests in Catoctin males with "manipulating an iron with long reach." A later paper (Kelley and Angel 1987:207–208), however, acknowledged a considerably broader explanation of precision crafts work and use of an axe.

Rathbun (1987) also documented physical stress within a rural enslaved population from South Carolina. Unfortunately, he provided no information on the age of the formation 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 New York African Burial Ground sample, in which 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 (see Tables 70 and 71). Although 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 was found in the New York African Burial Ground sample. 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 were bending the neck while performing some types of craft work and/or household work. The only MSM mentioned by Rathbun (1987) was 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 in the New York African Burial Ground sample.

Owsley et al.'s (1987) sample from New Orleans should be most similar to the one from the New York

African Burial Ground because it also consisted of an urban rather than rural enslaved population, albeit with a very small sample size of 13 individuals. It is unclear at what age degenerative joint changes were first observable in this sample, but only 1 female showed moderate to severe lipping of the glenoid fossae, whereas 8 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 limbs in general were more often affected than the lower limbs, a reversal of the pattern seen at the New York African Burial Ground. Greater similarities were found in MSMs for males with hypertrophy of the deltoid, supinator, and biceps brachii insertions. Muscle attachment sites changes in the lower limbs were "equally profound" for most males (Owsley et al. 1987:191). Although females had lower overall MSM scores in the New York African Burial Ground sample, 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 enslaved domestic laborers. At least 2 of the older African American males at New Orleans did not show MSM development, again suggesting variability in the severity of labor within urban enslaved populations and a social hierarchy. Consistent with this finding, the New York African Burial Ground population had incidences of osteoarthritis and MSMs that varied 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 work and farmwork with less variability in the types of tasks performed.

## Conclusions

There are no historical documents indicating the occupation or types of forced labor experienced by specific individuals from the New York African Burial Ground. 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 New York African Burial Ground, 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 15–24 years. Osteoarthritis in the lower limbs and especially the ankles of individuals 15–35 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, provide evidence of lifting and carrying loads on the back, shoulders, or head.

Few sex differences were 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. Although sex differences were not common, they were present. The elbow joint showed somewhat higher frequencies of osteoarthritis among males, along with relatively higher hypertrophy for the biceps brachii and pectoralis major/latissimus dorsi/teres minor attachments, all of which are associated with carrying and lifting loads. In females, there was 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 (The pectoralis major/latissimus dorsi/teres minor are also included). Variability among individuals in the number and severity of stress markers has been emphasized throughout this chapter. This result is consistent with arduous labor in an eighteenth-century urban environment.

## Trauma

### Dislocation

We found only one clear case of a dislocation is apparent in the New York African Burial Ground population. It was in the left temporomandibular joint of a male aged 35–45 years (Burial 151). Dislocations do not

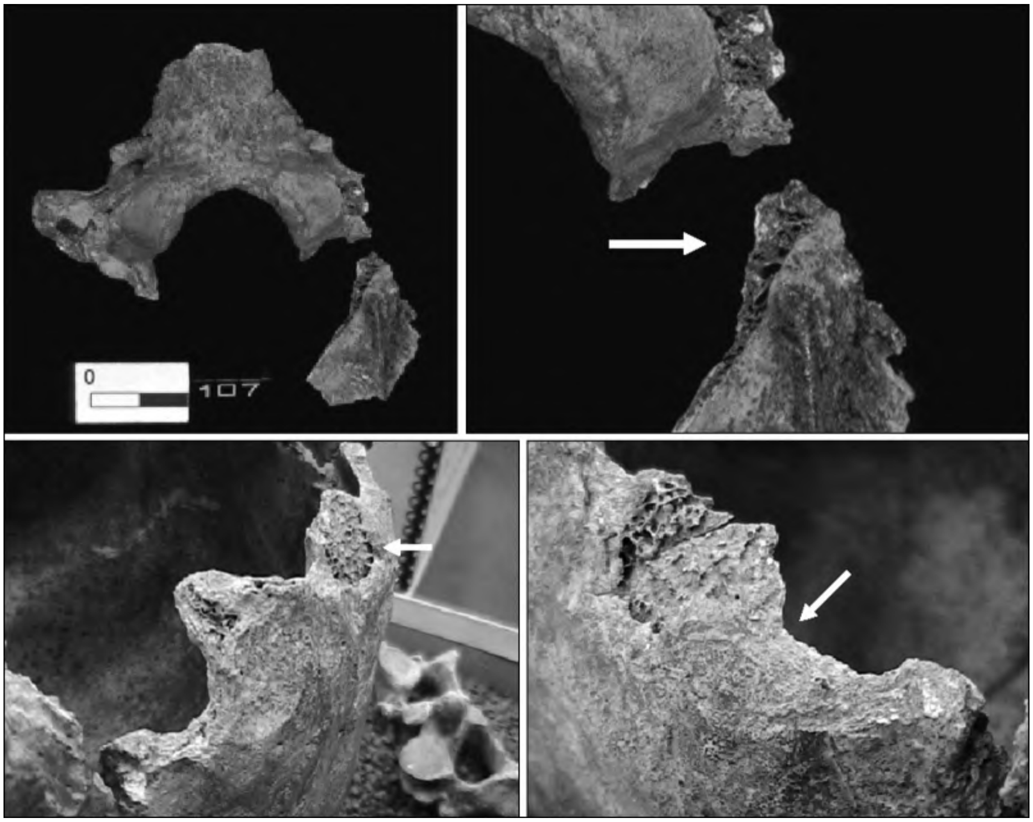


Figure 127. Ring fractures of the base of the skull in a female aged 35–40 years (Burial 107). The basilar is shown (*top left*) with a perimortem fracture (*close up, top right*). Other fractures are shown in the posterior occipital base (*bottom left*) exhibiting a beveled shape consistent with perimortem 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 one's head or the acute compression of skull base and spine produced by a hanging.

often leave a skeletal signature and when they do, they are usually subtle (Jurmain 2001). It is likely that dislocations are underdiagnosed 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 or geologic processes, excavation, or curation (Merbs 1989b). 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. Although 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 were present in adults (see Table 66). The cranium was the most common site for the fractures in males (23.5 percent; Figure 127), followed by the ribs (9.4 percent). Cranial fracture (11.1 percent) was common relative to fracture rates in other elements in females and was similar to the percentage of fractures in the femur (12.4 percent). The vast majority of these fractures were either perimortem or ambiguous perimortem for both males (79.5 percent) and females

**Table 75. Number of Fractures by Skeletal Region in Adults by Sex**

| Skeletal Region | Males | | | | Females | | | |
|---|---|---|---|---|---|---|---|---|
| | Premortem | Perimortem | Ambiguous Perimortem | %[a] | Premortem | Perimortem | Ambiguous Perimortem | %[b] |
| Skull | — | 9 | 20 | 24.8 | — | 6 | 5 | 13.6 |
| Axial | 6 | 9 | 5 | 17.1 | 3 | 8 | 6 | 21.0 |
| Upper limb | 7 | 9 | 11 | 23.1 | — | 22 | 3 | 30.9 |
| Lower limb | 5 | 14 | 13 | 27.4 | 1 | 20 | 2 | 28.4 |
| Hands and feet | 6 | — | 3 | 7.7 | 5 | — | — | 6.2 |

[a] Percentage of the 117 fractures recorded for males.
[b] Percentage of the 81 fractures recorded for females.

(88.9 percent). Roughly equal numbers of fractures were found in the upper and lower limbs (Table 75). Premortem fractures in females were primarily in the hands and feet (5 of 9), but in males they were found in all regions except the skull.

The distribution of fractures among the individuals is especially interesting. The average number of fractures among all individuals with fractures was 5.1 for males and 4.5 for females. If ambiguous perimortem fractures are excluded, the averages were 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 76).

A female aged 18–20 (Burial 205) had the greatest number of fractures, and all 32 were perimortem. The fractures were distributed throughout the skeleton, including the long bones of the arms and legs, the vertebrae, and the skull (Figures 128, 129, and 130). Burial 89 is a female aged 50+ with 2 premortem fractures of the right hand and 8 perimortem fractures to the right arms, legs, and pelvis. She also had a fracture in the occipital and cervical vertebrae. Of the 20 fractures in a male aged 45–55 (Burial 278), only one was a premortem fracture of the left clavicle; the rest were perimortem. The perimortem fractures were distributed throughout the body in the long bones, the pelvis, and vertebrae. He had no fractures in the skull. Burial 171 is a male with 4 premortem fractures of the left and right distal radius and ulnae. The perimortem fractures were located in the skull, vertebrae, and ribs.

**Table 76. Number of Premortem and Perimortem Fractures per Individual**

| No. of Fractures | No. of Males | No. 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 were present in three subadults, of unknown sex, aged 10–14. Burial 253 had a premortem fracture of the occipital and left temporal (Figure 131). Burial 180 had 2 premortem fractures of the left clavicle. There were also 2 ambiguous perimortem fractures to both the radii and ulnae. The remaining 18 fractures in the child of Burial 180 were perimortem. They were distributed throughout the skeleton including the long bones of all four limbs, the pelvis, and the cranium.

Numerous individuals in this population had fractures, and it is especially telling that many of them were perimortem. It is certainly possible that at least some of these fractures are related to the cause of

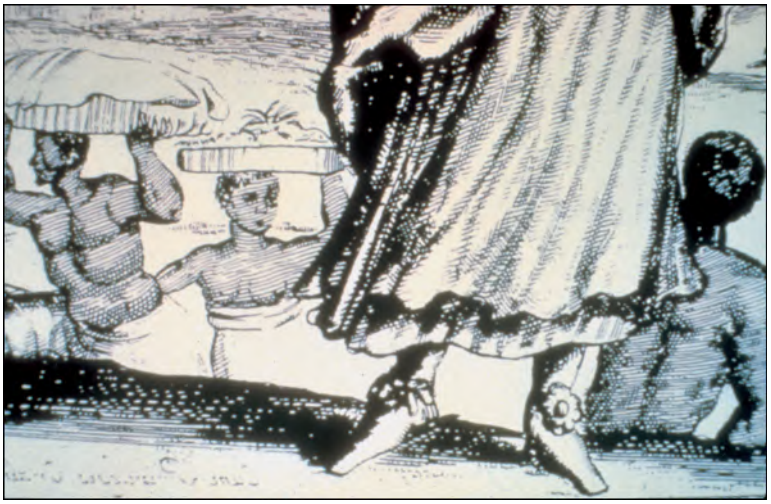

Figure 128. Seventeenth-century drawing of Africans in New Amsterdam showing normal axial loading.

Figure 129. Perimortem fractures of the humerii in a female aged 18–20 years (Burial 205).

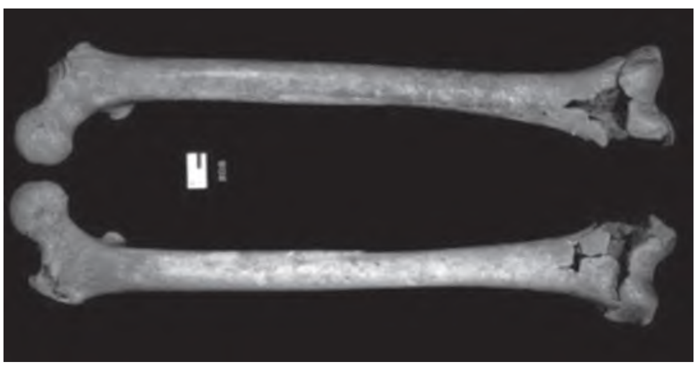

Figure 130. Perimortem fractures of the femora in a female aged 18–20 years (Burial 205).

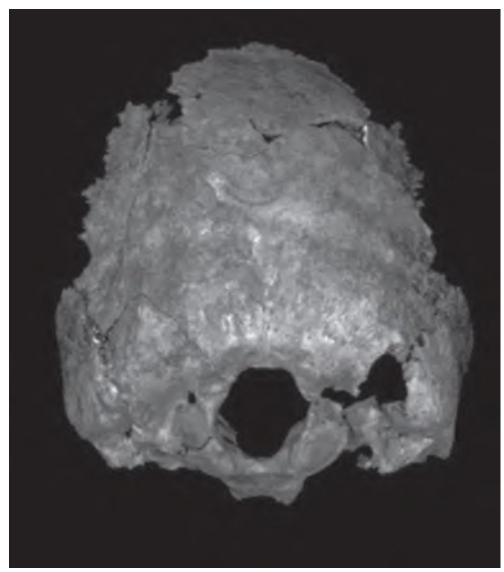

Figure 131. Premortem occipital fracture in a subadult aged 13–15 years (Burial 253).

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 New York African Burial Ground sample. A 20–24-year-old, 5-foot 1-inch tall woman, Burial 25 was found with a lead musket ball lodged in her rib cage (Figure 132). In her pathology assessment in the file of Burial 25, osteologist M. C. Hill wrote "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 have been shattered, with some of its fractures showing darkly stained and beveled

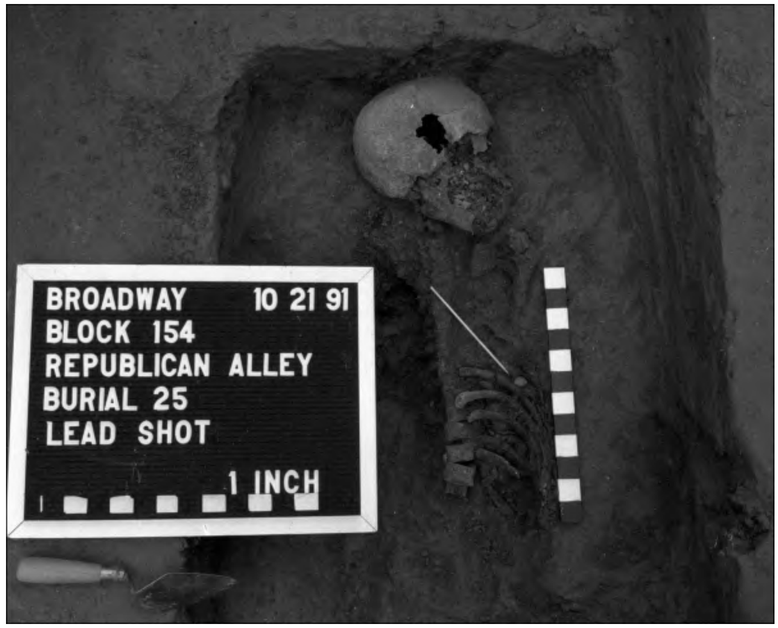


Figure 132. Burial 25 is shown in situ with musket ball.

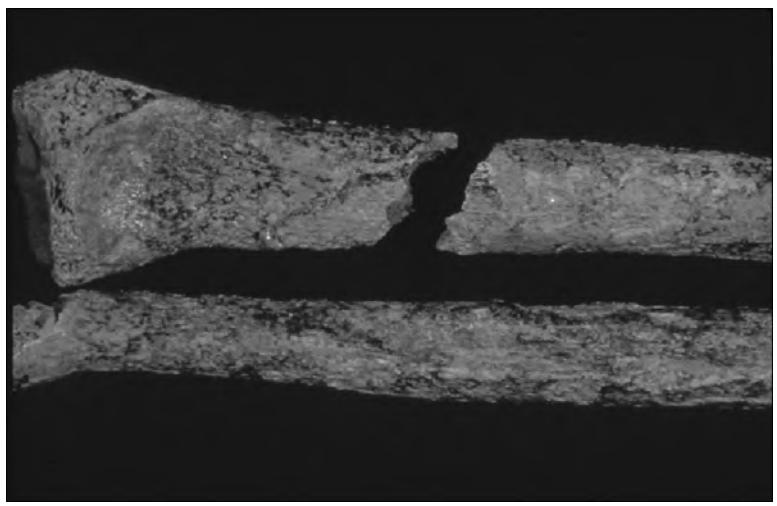

Figure 133. Spiral fracture in lower arm of Burial 25.

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 was 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); she also suffered a "spiral," or oblique, fracture of the lower right arm just above the wrist (Figure 133) caused by simultaneous twisting and pulling. These fractures, by virtue of their beveled form and dark color, were consistent with the fracture of living bone and were definitely not caused by the excavation. The small trace of new bone and the adjacent inflammatory response suggest that this woman lived for some short period, no more than a few days, after she was beaten. Her left arm also showed evidence of perimortem trauma but with less certainty than her other fractures exhibited.

The musket ball was located in the left chest. There was a large hole 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 that was caused by the musket ball within the thorax of this young woman. The thinness of the scapula, however, made it difficult to observe beveling (expected when living or green bone breaks) so that assessment of the point of entry remains plausible although inconclusive. Burial 25, according to Holl's archaeological report (Holl 2001:116), was part of a "tight group of three burials that seems to constitute a well-delineated unit" that also included Burial 32 (a superannuated, 55+-year-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 New York African Burial Ground shows a unique pattern relative to other sites in the number of perimortem fractures. At Catoctin, there were 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, which could have easily been related to accidental injury, although interpersonal violence was not ruled out. Incidence of fracture is not available from South Carolina. At New Orleans, no perimortem fractures were reported, but three males did have antemortem fractures that are more indicative of violence than accidental injury. One male had three cranial fractures and the degree of remodeling suggested that these fractures were inflicted in at least two different episodes. A second male had healed cranial fractures as well as a healed parry fracture of the ulna, and a third male also had a single parry fracture. The New York African Burial Ground 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. J. Shujaa, and L. M. Rankin-Hill***

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 as a proxy for stature estimates for immature remains. On the other hand, Goode et al. (1993:323) proposed 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.[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 and Fitzgerald (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, the Hoppa and Fitzgerald study revealed that diaphyseal long-bone lengths were too variable when comparing four populations across temporal and geographic contexts. Their 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. Their 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, between the sexes, where appropriate, and with other indicators of health and well-being, specifically those associated with physical activity and 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 and 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 New York African Burial Ground population?

Because of the often fragmentary and variable representation of skeletal elements of these individuals, it

[1] Goode-Null (2002) recommended using the broader definition of "disease" that incorporates trauma, rather than the more restrictive definition used by Goode et al. (1993) which focused on infectious events. Goode-Null also noted that this method provides an opportunity to verify age assessment in individuals with extreme $\delta l_i$ or $\delta l_{mean}$ values.

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, 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 ranged 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 included but were not limited to: dental and skeletal age (e.g., epiphyseal closure), sex (for adult remains), 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 first delineates how the baseline sample was selected and is 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 (Demirjian 1986; Lewis and Garn 1960; 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, whereas 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 using pelvic morphology as the primary indicator of age in older subadults and adults. However, it was deemed appropriate to use 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. 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. A maximum cut-off age of 25 years (young adult) for inclusion in the subsamples was chosen to ensure a more complete/complex analysis of how the lifeways of enslavement impacted the growth, development, and health status of this population. 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 were collected and entered into the project database. These data included dental development, epiphyseal union scores, and long-bone measurements, which have been used to calculate composite ages for all individuals. This study used the existing New York African Burial Ground database to meet the objective of assessing overall and differential childhood health and well-being of the New York African Burial Ground immature individuals vis à 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 20 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 represented by postcranial remains comprised the base sample for data collection. The number of individuals that had sufficient aging criteria and long bones (minimally) that could be included in this portion of the analysis was 130. Of these 130 individuals, 48 were 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 was completed, diaphyseal length of a long bone was divided by the appropriate-for-age diaphyseal length found in one of the available growth standards. For example: Burial 96 was designated as a male with composite pelvic age of 17 years. His femoral length was 43 cm, but the Maresh (1970) standard (see below) indicates an average femoral length of 50.89 cm for 17-year-old males. Thus, the resulting proportion, signified by $\delta l$ was 43/50.89 or 0.845. Thus, if an individual was represented by a single long bone ($\delta l_i$), or by multiple long bones, they could be represented in the plot of $\delta l_i$ for the population (for additional information on computing $\delta l$ values, see Goode et al. [1993]). For those individuals represented by more than one long bone, a mean value of the $\delta l_i$ for all separate long bones, designated $\delta l_{mean}$, can be calculated and plotted. As Goode et al. (1993) indicated, a $\delta l_i$ greater than unity would represent a bone (or bones if $\delta l_{mean}$) that was (were) longer than the standard value, whereas the opposite was true for $\delta l_i$ and/or $\delta l_{mean}$ values less than unity.

The standard used to test this method was 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 been republished (Scheuer and Black 2000) 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 used the same standard for long-bone lengths (Maresh 1955) to calculate $\delta l_i$ and subsequent $\delta l_{mean}$ values. However, he substituted Fazekas and Kośa's (1978) long-bone data at 10 lunar months for Maresh's data at 2 months in the birth cohorts of the populations being tested.

Perhaps the most significant contribution of Sciulli's (1994:257) test of the standardized long-bone measure technique is his finding that not all $\delta l_i$ were equivalent, "and therefore the magnitude of the overall measure $\delta l_{mean}$ depends on which long bone(s) contribute to it." 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 (1994:258) demonstrated that the five Native American samples in his test of the method "show a significant concordance in relative long bone length." 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, and radius and ulna (equally large). Sciulli (1994:258) 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." Otherwise, he concluded 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 were of white European descent (primarily Northern European), and were from families whose socioeconomic status can be characterized as middle- to upper-middle class. The logic behind recruiting children from such families was to insure that: (1) 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) adequate food resources were not economically dependent (McCammon 1970:6).

The decision to use this reference population in standardizing long-bone measurements for the New York African Burial Ground 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, are 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 (Center for Disease Control [CDC]/National Center for Health Statistics [NCHS] 2001: http://www.cdc.gov/nccdphp/dnpa/growthcharts/training/powerpoint/slides/011.htm. Here, it is necessary to be explicit regarding the meaning of the terms growth and development. Acheson (1966:465) noted that growth is "the creation of new cells and tissues," whereas maturation and development "is the consolidation of tissues into permanent form." These definitions were reiterated by Bogin (1999) when he noted that growth is a change in size, whereas 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 New York African Burial Ground 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 ($\delta l_i$ and $\delta l_{mean}$) as described by Goode et al. (1993) was followed. However, as outlined by Sciulli, long-bone measures provided by Fazekas and Kośa (1978) were used 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 formulas for African American males and females as developed by Trotter (1970; *cf.* Ubelaker 1989; Table 77). Fazekas and Kośa's (1978:264) non-sex-specific regression formulas, as seen in Table 78, for fetal and neonatal recumbent length were used to estimate the measurements for fetal remains. It should be noted that Table 77 indicates the standard error of the stature estimate per long bone, but Table 78 does not. The standard errors per long bone for fetal and neonatal recumbent length estimates were not provided by Fazekas and Kośa.[2]

Using formulas provided by Trotter and Fazekas and Kośa provides opportunities for comparative analyses with previous studies of enslaved Africans and African Americans.

[2] Based on an examination of the supporting data included in the original text, the lack of standard errors of the estimates is most likely a result of the extremely small values for this measure.

**Table 77. African-American Stature Regression Formulas as Developed by Trotter (1970; cf. Ubelaker 1989)**

| Male | | Female | |
|---|---|---|---|
| **Element** | **Formulas (in cm)** | **Element** | **Formulas (in cm)** |
| Humerus | length × 3.26 + 62.10 ± 4.43 | Humerus | length × 3.08 + 64.67 ± 4.25 |
| Radius | length × 3.42 + 81.56 ± 4.30 | Radius | length × 2.75 + 94.51 ± 5.05 |
| Ulna | length × 3.26 + 79.29 ± 4.42 | Ulna | length × 3.31 + 75.38 ± 4.83 |
| Femur | length × 2.11 + 70.35 ± 3.94 | Femur | length × 2.28 + 59.76 ± 3.41 |
| Tibia | length × 2.19 + 86.02 ± 3.78 | Tibia | length × 2.45 + 72.65 ± 3.70 |
| Fibula | length × 2.19 + 85.65 ± 3.53 | Fibula | length × 2.49 + 70.90 ± 3.80 |

**Table 78. Fetal and Neonate Stature Regression Formulas as Developed by Fazekas and Kośa (1978)**

| Element | Fetal/Neonate Regression Formulas (in cm) |
|---|---|
| Humerus | length × 7.52 + 2.47 |
| Radius | length × 10.61+ 3.95 |
| Ulna | length × 8.20 + 2.38 |
| Femur | length × 6.44 + 4.51 |
| Tibia | length × 7.24 + 4.90 |
| Fibula | length × 7.59 + 4.68 |

Only recently has a study been undertaken using regression formulas for estimating the stature at death for juvenile and subadult remains. In the present study, we use a sex-specific and composite-sex linear regression formulas for the calculation of estimated stature for immature remains (Tables 79–81). The regression formulas were constructed by using the National Center for Health Statistics (NCHS 2000)[3] recumbent length (infant) and stature data (children 2–20 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). Using these reference data sets to compute the regression formulas and applying them to the New York African Burial Ground 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 "promote 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://www.cdc.gov/nccdphp/dnpa/growthcharts/training/powerpoint/slides/011.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 formulas for birth to less than 12 months, and greater than or equal to 12 months to less than 12 years were applied. Individuals over the age of 12 years were assessed by calculating male and female stature estimates that were then averaged to achieve a mean height at death. Stature was computed for a total of

[3] Specifically, the data sets are the product of the U. S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Health Statistics, Data Services.

**Table 79. Regression Formulas for Calculating Stature of the Immature Remains of Male Children**

| Age | Regression Formulas (in cm) |
|---|---|
| | **Humerus** |
| 0 <12 months | length × 7.50 + 1.72 ± 2.34 ($p$ <.05, $r^2$ = .995) |
| ≥12 months <84 months | length × 4.66 + 26.71 ± .53 ($p$ <.001, $r^2$ = .999) |
| ≥84 months <150 months | length × 4.54 + 29.66 ± .80 ($p$ <.001, $r^2$ = .999) |
| ≥150 months <186 months | length × 4.42 + 25.41 ± 3.93 ($p$ <.001, $r^2$ = .996) |
| ≥186 months | adult formula |
| | **Radius** |
| 0 <12 months | length × 9.25 + 1.7 ± 3.29 ($p$ <.05, $r^2$ = .990) |
| ≥12 months <84 months | length × 6.43 + 23.42 ± .49 ($p$ <.001, $r^2$ =1.00) |
| ≥84 months <150 months | length × 6.07 + 29.41 ± .85 ($p$ <.001, $r^2$ = .999) |
| ≥150 months <186 months | length × 5.72 + 28.40 ± 3.52 ($p$ <.001, $r^2$ = .997) |
| ≥150 months <186 months | length × 5.72 + 28.40 ± 3.52 ($p$ <.001, $r^2$ = .997) |
| ≥180 months | adult formula |
| | **Ulna** |
| 0 <12 months | length × 8.88 - 2.87 ± 2.64 ($p$ <.05, $r^2$ = .995) |
| ≥12 months <84 months | length × 6.07 + 20.23 ± .54 ($p$ <.001, $r^2$ =1.00) |
| ≥84 months <150 months | length × 5.68 + 27.41 ± 1.04 ($p$ <.001, $r^2$ = .999) |
| ≥150 months <186 months | length × 5.23 + 32.23 ± 2.87 ($p$ <.001, $r^2$ = .998) |
| ≥186 months | adult formula |
| | **Femur** |
| 0 <12 months | length × 4.59 + 16.27 ± 2.49 ($p$ <.05, $r^2$ = .990) |
| ≥12 months <84 months | length × 2.97 + 35.85 ± .39 ($p$ <.001, $r^2$ = 1.00) |
| ≥84 months <150 months | length × 2.85 + 39.19 ± .57 ($p$ <.001, $r^2$ = 1.00) |
| ≥150 months <216 months | length × 3.14 + 16.13 ± 3.55 ($p$ <.001, $r^2$ = .995) |
| ≥216 months | adult formula |
| | **Tibia** |
| 0 <12 months | length × 6.54 + 8.62 ± 5.93 ($p$ <.05, $r^2$ = .960) |
| ≥12 months <84 months | length × 3.64 + 36.03 ± .37 ($p$ <.001, $r^2$ = 1.00) |
| ≥84 months <150 months | length × 3.40 + 42.10 ± .70 ($p$ <.001, $r^2$ = .999) |
| ≥150 months <216 months | length × 3.79 + 13.43 ± 2.07 ($p$ <.001, $r^2$ = .998) |
| ≥216 months | adult formula |
| | **Fibula** |
| 0 <12 months | length × 6.77 + 9.08 ± 4.98 ($p$ <.05, $r^2$ = .971) |
| ≥12 months < 84 months | length × 3.59 + 37.38 ± .43 ($p$ <.001, $r^2$ =1.00) |
| ≥84 months < 150 months | length × 3.56 + 38.92 ± .71 ($p$ <.001, $r^2$ = .999) |
| ≥150 months < 216 months | length × 3.79 + 19.67 ± 2.75 ($p$ <.001, $r^2$ = .997) |
| ≥216 months | adult formula |

**Table 80. Regression Formulas for Calculating Stature of the Immature Remains of Female Children**

| Age | Regression Formula (in cm) |
|---|---|
| | **Humerus** |
| 0 <12 months | length × 7.49 + 0.92 ± 2.76 ($p$ <.05, $r^2$ = .993) |
| ≥12 months < 84 months | length × 4.70 + 25.63 ± .63 ($p$ <.001, $r^2$ = .999) |
| ≥84 months < 150 months | length × 4.63 + 27.68 ± 1.62 ($p$ <.001, $r^2$ = .998) |
| ≥150 months | adult formula |
| | **Radius** |
| 0 <12 months | length × 10.45 - 5.05 ± 3.36 ($p$ <.05, $r^2$ = .992) |
| ≥12 months <84 months | length × 6.57 + 22.99 ± .81 ($p$ <.001, $r^2$ = .999) |
| ≥84 months <150 months | length × 6.11 + 30.66 ± 1.30 ($p$ <.001, $r^2$ = .998) |
| ≥150 months | adult formula |
| | **Ulna** |
| 0 <12 months | length × 10.06 - 10.52 ± 3.24 ($p$ <.05, $r^2$ = .993) |
| ≥12 months <84 months | length × 6.13 + 19.90 ± .88 ($p$ <.001, $r^2$ = .999) |
| ≥84 months <150 months | length × 5.60 + 29.70 ± 1.45 ($p$ <.001, $r^2$ = .998) |
| ≥150 months | adult formula |
| | **Femur** |
| 0 <12 months | length × 4.49 + 15.90 ± 1.94 ($p$ <.05, $r^2$ = .994) |
| ≥12 months <84 months | length × 3.01 + 34.15 ± .56 ($p$ <.001, $r^2$ = .999) |
| ≥84 months <144 months | length × 2.88 + 38.49 ± 1.16 ($p$ <.001, $r^2$ = .999) |
| ≥144 months | adult formula |
| | **Tibia** |
| 0 <12 months | length × 6.69 + 6.72 ± 5.58 ($p$ <.05, $r^2$ = .965) |
| ≥12 months <84 months | length × 3.70 + 34.39 ± .55 ($p$ <.001, $r^2$ = .999) |
| ≥84 months <144 months | length × 3.34 + 43.68 ± 1.49 ($p$ <.001, $r^2$ = .998) |
| ≥144 months | adult formula |
| | **Fibula** |
| 0 <12 months | length × 6.90 + 7.62 ± 5.71 ($p$ <.05, $r^2$ = .963) |
| ≥12 months <84 months | length × 3.65 + 35.98 ± .65 ($p$ <.001, $r^2$ = .999) |
| ≥84 months <144 months | length × 3.58 + 38.69 ± 1.28 ($p$ <.001, $r^2$ = .998) |
| ≥144 months | adult formula |

**Table 81. Regression Formulas for Calculating Stature of the Immature Remains of Indeterminate Children**

| Age | Regression Formula (in cm) |
|---|---|
| | **Humerus** |
| 0 <12 months | length × 7.51 + 1.17 ± 2.16 ($p$ <.001, $r^2$ = .990) |
| ≥12 months <144 months | length × 4.70 + 25.63 ± .63 ( $p$ <.001, $r^2$ = 1.00) |
| | **Radius** |
| 0 <12 months | length × 9.69 - 0.73 ± 2.58 ($p$ <.001, $r^2$ = .987) |
| ≥12 months <144 months | length × 6.57 + 22.99 ± .81 ($p$ <.001, $r^2$ = .998) |
| | **Ulna** |
| 0 <12 months | length × 9.32 - 5.67 ± 2.49 ($p$ <.001, $r^2$ = .990) |
| ≥12 months <144 months | length × 6.13 + 19.90 ± .88 ($p$ <.001, $r^2$ = .999) |
| | **Femur** |
| 0 <12 months | length × 4.54 + 16.08 ± 2.29 ($p$ <.001, $r^2$ = .980) |
| ≥12 months <144 months | length × 3.01 + 34.15 ± .56 ($p$ <.001, $r^2$ = .999) |
| | **Tibia** |
| 0 <12 months | length × 6.63 + 7.51 ± 3.55 ($p$ <.001, $r^2$ = .967) |
| ≥12 months <144 months | length × 3.70 + 34.39 ± .55 ($p$ <.001, $r^2$ = .999) |
| | **Fibula** |
| 0 <12 months | length × 6.87 + 8.25 ± 3.17 ($p$ <.001, $r^2$ = .973) |
| ≥12 months <144 months | length × 3.65 + 35.98 ± .65 ($p$ <.001, $r^2$ = .999) |

132 individuals from the New York African Burial Ground 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 New York African Burial Ground 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 25 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.

These results were also compared to data available in the project database regarding trauma and nondisease 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 nondisease pathologies of arthritic lesions, enthesopathies, and hypertrophies. Also, generalized nonspecific 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 used included chi-square and correlations, with significance levels set at 5 percent ($p$ = .05). Power analyses were performed to determine the probability of detecting type

**Table 82. Power Values for Statistical Chi-Square Tests Based on Subsample Sizes and Magnitude of Effect**

| 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 |
| ≥6 <16 years | 10 | 0.0615 | 0.1578 | 0.3526 |
| ≥16 <25 years | 8 | 0.0592 | 0.1357 | 0.2930 |

*Note*: Effect size is denoted by w.

II (beta) errors (Hodges and Schell 1988). The power values, provided in Table 82, were calculated for small (w = 0.10), medium (w = 0.30), and large (w = 0.50) effects for the specific subsample sizes.

## 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 (e.g., 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 ($\delta l_i$ or $\delta l_{mean}$) of specific long bones to a corresponding growth standard by element. Table 83 provides the $\delta l_i$ and sex-specific $\delta l_{mean}$ 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—various long bones contribute differentially to $\delta l_{mean}$—is correct. When the chart in Figure 134 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 83 indicates that of the sex-specific calculations the femur, tibia, and fibula (but not the ulna) had some of the lowest $\delta l_{mean}$ 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 were present for analysis represented some of the taller

**Table 83. $\delta l_i$ and $\delta l_{mean}$ Values for the NYABG Population Subsample, by Sex**

| 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 |
| Indeterminate | 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 |

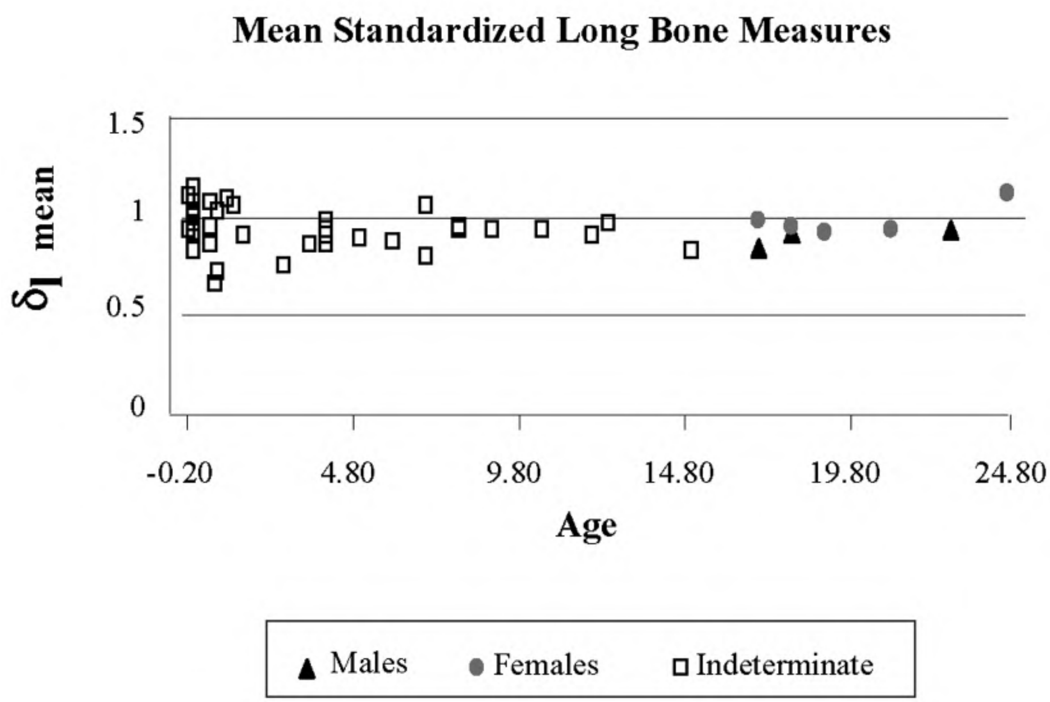


Figure 134. Mean standardized long bone measures.

(see discussion of stature below) and more mature members of the subsample, thus potentially skewing the value upwards.

Individual $\delta l_{mean}$ values indicate that 73 percent (n = 35) of the total subsample fall below the level of unity. Within this subsample, only 1 female had a $\delta l_{mean}$ value in excess of unity, whereas 13 individuals of indeterminate sex and no males had $\delta l_{mean}$ values that exceeded unity. However, the lowest value for $\delta l_{mean}$ (0.69) represented 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) had $\delta l_{mean}$ values that were 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.

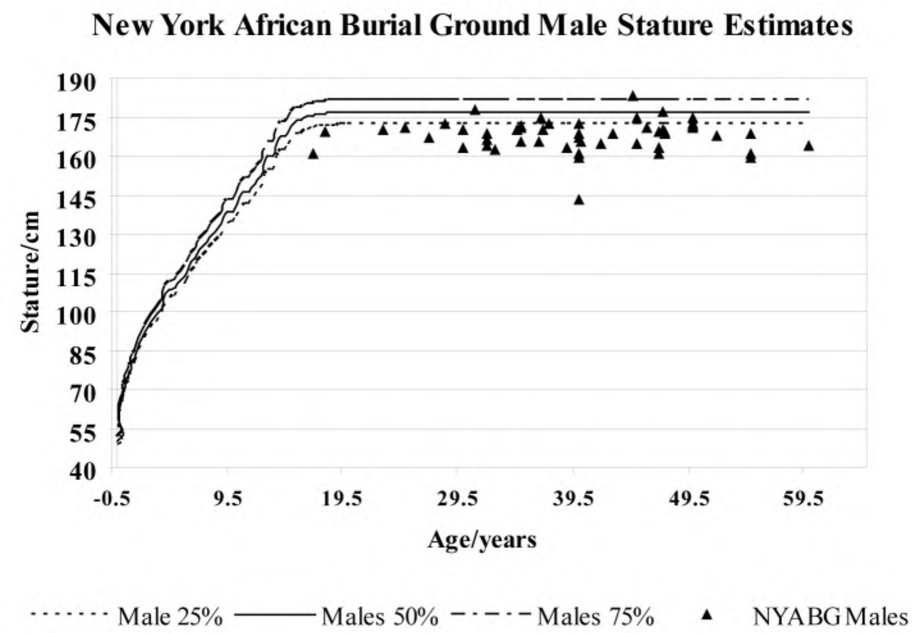


Figure 135. New York African Burial Ground stature estimates: male.

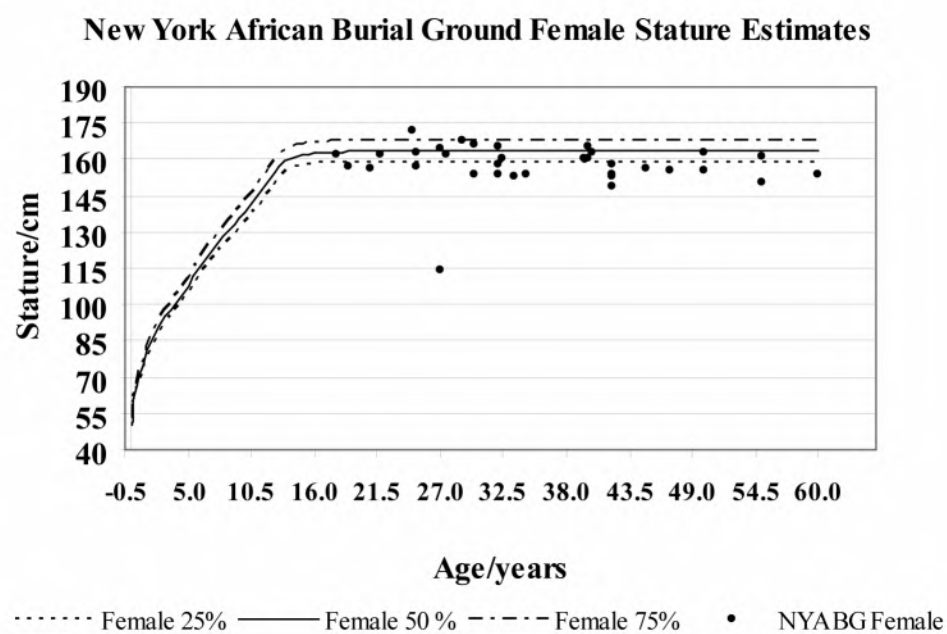


Figure 136. New York African Burial Ground stature estimates: female.

## 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 criteria set forth above. Thus, stature estimates were calculated for a total of 129 individuals (males, n = 54; females, n = 34 indeterminate, n = 41). Figures 135–137 illustrate individual stature estimates for these New York African Burial Ground 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

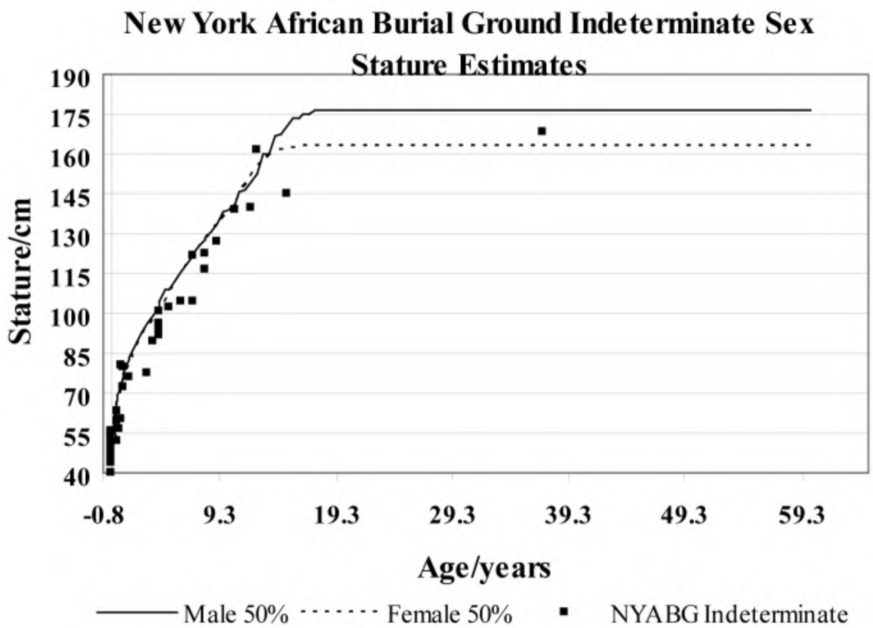


Figure 137. New York African Burial Ground stature estimates: indeterminate sex.

the twenty-fifth, fiftieth, and seventy-fifth percentiles of the CDC growth standards, and individuals of indeterminate sex are compared to the CDC male and female fiftieth percentiles. Although all three figures indicate a "normal" pattern of growth, especially as illustrated in Figure 137, they also indicate the presence of moderate to severe growth deficits at various points in the life span. Figure 135 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 135 and Table 84, it becomes apparent that all (n = 3) males fall below the tenth 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 136 and Table 85, have consistently higher stature estimates for assessed age. Sixty percent of all females (n = 3) fall below the fiftieth percentile, whereas 40 percent (n = 2) fall at or above the fiftieth percentile. Two females (40 percent) fall below the twenty-fifth percentile in growth, which includes one female (20 percent) at the tenth percentile. However, females have a far greater percentage (n = 3, or 60 percent) of individuals who fall within and above the range for normal growth, with one of these females (Burial 276) falling above the ninetieth percentile.

Figure 137 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.

However, by looking at Figure 137 it is quite apparent that the individuals (predominantly infants and young children) were experiencing similar patterns in growth as the male and female standards, although the demarcation between those experiencing poor growth and those with normal or close to normal growth were more pronounced. As with the previous two figures, it is apparent that several individuals fall well below the twenty-fifth 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 are addressed below. 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.

**Table 84. Male Stature Estimates and Growth Standard Percentile Rankings for Individuals Less Than 25 Years of Age Only**

| Burial No. | Age Range (yrs) | Stature (cm) | % Rank |
|---|---|---|---|
| 96 | 16–18 | 161.09 | 2 |
| 427 | 16–20 | 163.19 | 9 |
| 343 | 19–23 | 170.14 | 2 |

**Table 85. Female Stature Estimates and Growth Standard Percentile Rankings for Individuals Less Than 25 Years of Age Only**

| Burial No. | Age Range (yrs) | Stature (cm) | % Rank |
|---|---|---|---|
| 383 | 14–18 | 161.69 | 50 |
| 259 | 17–19 | 162.03 | 49 |
| 205 | 18–20 | 156.65 | 24 |
| 122 | 18–20 | 156.35 | 10 |
| 276 | 20–24 | 158.17 | 94 |

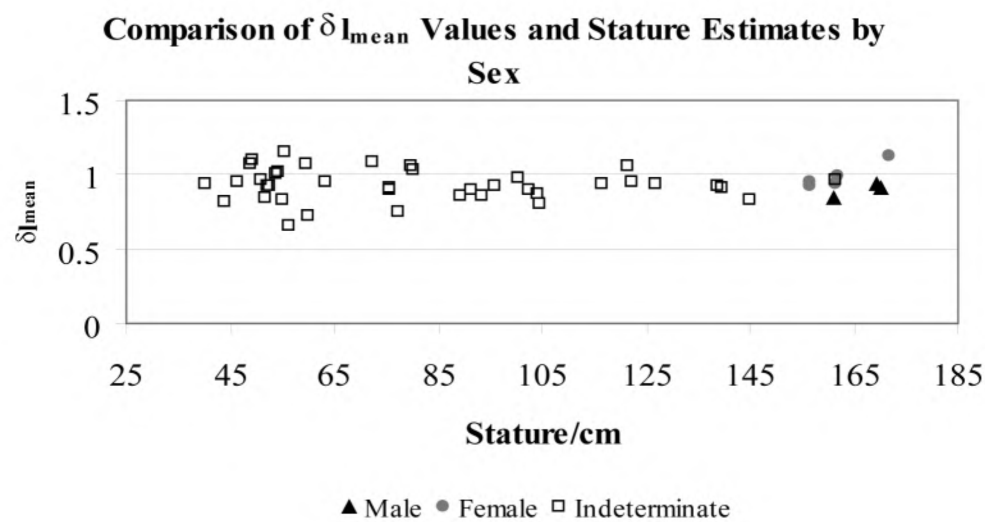


Figure 138. Comparison of individual $\delta l_{mean}$ values and stature estimates by sex.

The relationship between the $\delta l_{mean}$ values presented above and stature is illustrated in Figure 138. The $\delta l_{mean}$ values are presented by sex and in relation to stature estimates. They further illustrate that on the whole, the population was not reaching its growth potential. Of the 71 percent (n = 35) of the subsample that fell below the unity level, 3 (9 percent) were males, 5 (14 percent) were females, and 27 (77 percent) were individuals of young adolescents and children of indeterminate sex. This finding mirrors the 72 percent of the population subsample which fell at or below the twenty-fifth 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 $\delta l_{mean}$ 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 $\delta l_{mean}$ and stature estimates indicated there was a significant relationship between the two variables, something that could easily be predicted from Figures 134 and 137. However, the test of relationship between $\delta l_{mean}$ and percentile rankings of stature was significant at the $p < .01$ level, with a correlation coefficient of 0.781 and an adjusted $r^2$ value of 0.601. The high but not perfect correlation between $\delta l_{mean}$ values and percentile rankings is expected because 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 used 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.

## Pathological Assessments

The database available for pathological assessment of individuals from the New York African Burial Ground 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

Because of 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 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), as well as 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, although 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 relation to 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 à 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 86. In addition to PH, infantile cortical hyperostosis (ICH), which is diagnosed in long

**Table 86. Occurrence of Porotic Hyperostosis and Infantile Cortical Hyperostosis in the NYABG Population Subsample**

| Burial | Age Range (yrs) | Long Bone | Frontal | Parietal | Temporal | Occipital | Orbital | Sphenoid | Maxillary | Zygomatic | Total Pathologies |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Male | | | | | | | | | | | |
| 343 | 19.0–23.0 | — | — | — | — | — | 2 | — | — | — | 2 |
| Female | | | | | | | | | | | |
| 205 | 18.0.–20.0 | — | — | 2 | — | 1 | — | — | — | — | 3 |
| 122 | 18.0–20.0 | — | 1 | 4 | — | 1 | 2 | 1 | — | — | 9 |
| Indeterminate | | | | | | | | | | | |
| 186 | 0.0–0.17 | — | — | — | — | — | 2 | — | — | — | 2 |
| 64 | 0.38–0.88 | — | — | 2 | — | 1 | 1 | — | — | — | 4 |
| 225 | 0.5–1.25 | 6 | — | — | — | — | 2 | — | — | — | 8 |
| 91 | 0.67–1.30 | 2 | — | — | — | — | — | — | — | — | 2 |
| 252 | 1.0–2.0 | 6 | — | — | — | — | — | — | 2 | — | 8 |
| 7 | 3.0–5.0 | — | — | — | — | — | 2 | — | 2 | — | 4 |
| 55 | 3.0–5.0 | — | — | — | — | — | 2 | — | 2 | — | 4 |
| 138 | 3.0–5.0 | — | — | 2 | 2 | 1 | — | — | — | 2 | 7 |
| 39 | 5.0–7.0 | — | — | — | 2 | — | 2 | — | — | — | 4 |
| 35 | 8.0–10.0 | — | — | — | — | — | 2 | — | — | — | 2 |
| 368 | 10.5–13.5 | — | — | — | — | — | 2 | — | — | — | 2 |
| Total (n) | 14 | 3 | 1 | 4 | 2 | 4 | 10 | 1 | 3 | 1 | 61 |

bones and may be a genetic condition or viral disease associated with anemia (Varma and Johny 2002), is included in the table. The number of PH and ICH lesions per individual is represented as a means to characterize individual frailty. Thirteen (27 percent) of 48 individuals have PH lesions, and a total of 29 percent of 48 individuals have hyperostosis lesions (PH or ICH). Males represent 7 percent (n = 1) of the affected individuals with sex assessments, and 33 percent of all males in this population subsample (n = 3). Females, in comparison, represent 14.3 percent (n = 2) of the individuals with PH, and 40 percent of the total number of females in the subsample. The individuals of indeterminate sex with PH (n = 11) were young infants and children. Five of these children (45.5 percent) were infants less than 2 years of age. In all, minimally 61 PH lesions were 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 $\delta l_{mean}$ 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 87. 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

**Table 87. Chi-Square Test Results for Relationship between Porotic Hyperostosis (PH) and $\delta l_{mean}$ and Percentile Rankings for Stature**

| Chi-Square Test | Chi-Square Value | *p* |
|---|---|---|
| Total population subsample (n = 48; power = 0.9337) | | |
| PH by $\delta l_{mean}$ | 4.168 | .654 |
| PH by percentile ranking | 7.352 | .499 |
| Age group: 0 < 6 years (n = 30; power = 0.7819) | | |
| PH by $\delta l_{mean}$ | 4.541 | .604 |
| PH by percentile ranking | 5.284 | .727 |
| Age group: 6 < 16 years (n = 10; power = 0.3526) | | |
| PH by $\delta l_{mean}$ | 0.476 | .788 |
| PH by percentile ranking | 1.667 | .435 |
| Age group: 16 < 25 years (n = 8; power = 0.2930) | | |
| PH by $\delta l_{mean}$ | 1.60 | .449 |
| PH by percentile ranking | 5.156 | .272 |
| Sex: male (n = 3; power = 0.1393) | | |
| PH by $\delta l_{mean}$ | 0.750 | .386 |
| PH by percentile ranking | 3.00 | .223 |
| Sex: female (n = 5; power = 0.2010) | | |
| PH by $\delta l_{mean}$ | 0.833 | .361 |
| PH by percentile ranking | 5.000 | .082 |
| Sex: indeterminate (n = 40; power = 0.8854) | | |
| PH by $\delta l_{mean}$ | 4.333 | .632 |
| PH by percentile ranking | 5.308 | .724 |

calculated assuming a large size effect (w = 0.50; also reported in Table 80).

## 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 the presence of infectious lesions in long bones as these skeletal elements contribute significantly to an individual's overall stature at maturity. As with PH and ICH lesions, the number of infectious lesions per element per individuals is presented in Table 88 as a means to contemplate individual frailty. Table 88 demonstrates that it is possible to calculate that a total of 25 individuals (52 percent) in this subsample (n = 48) were diagnosed as having at least one lesion indicative of generalized infections. As with PH, individuals of indeterminate sex represent the largest group that was diagnosed with generalized infectious lesions. Females, though, had the highest rate of lesion occurrence (18 per person), followed by males and indeterminate individuals, with lesion rates of 15 per person and 10.6 per person, respectively. However, it should be noted that all males (n = 2) and all females (n = 3) with this diagnosis were over the age of 16 years, whereas all individuals of indeterminate sex (n = 20) were under 16 years of age.

**Table 88. Generalized Infectious Lesions as Diagnosed in Long-Bone Skeletal Elements**

| Burial No. | Age Range (yrs) | Humerus | | Radius | | Ulna | | Femur | | Tibia | | Fibula | | Total Lesions |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | L | R | L | R | L | R | L | R | L | R | |
| Male | | | | | | | | | | | | | | |
| 427 | 16.0–20.0 | | | | | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 18 |
| 343 | 19.0–23.0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 |
| Female | | | | | | | | | | | | | | |
| 259 | 17.0–19.0 | | | | | | | 1 | | | 1 | | | 2 |
| 122 | 18.0–20.0 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 36 |
| 383 | 14.0–18.0 | 2 | 2 | 1 | 1 | | | 3 | 3 | 1 | 1 | 1 | 1 | 16 |
| Indeterminate | | | | | | | | | | | | | | |
| 117 | 0.0–0.0 | 1 | | 1 | | 1 | | 1 | | | | | | 4 |
| 42 | 0.0–2.0 | | | 1 | | 1 | | 1 | 1 | 1 | 1 | | | 6 |
| 53 | 0.25–0.75 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | 9 |
| 108 | 0.25–0.75 | 1 | 1 | 1 | 1 | 1 | 1 | | | | | | | 6 |
| 86 | 6.0–8.0 | | 2 | | 2 | | | 2 | 2 | 3 | 3 | | | 14 |
| 225 | 0.5–1.25 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 3 | 1 | 1 | 1 | 1 | 20 |
| 91 | 0.67–1.3 | | | 1 | 1 | 1 | 1 | 1 | 1 | | | | | 6 |
| 252 | 1.0–2.0 | 2 | 2 | | 2 | | 2 | 3 | 3 | | | | | 14 |
| 363 | 1.0–2.0 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | 3 | | | | | 14 |
| 187 | 1.5–4.0 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 24 |
| 22 | 2.5–4.5 | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | | 2 | 17 |
| 55 | 3.0–5.0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 |
| 58 | 3.5–5.5 | 2 | 2 | 1 | 1 | | | | | 2 | 2 | 2 | 2 | 14 |
| 219 | 4.0–5.0 | 2 | 3 | | 1 | | 1 | 2 | 2 | 3 | 3 | 1 | 1 | 19 |
| 39 | 5.0–7.0 | 1 | 2 | | | | | 2 | 2 | 2 | 2 | 2 | 2 | 15 |
| 396 | 6.5–8.5 | | | 1 | 1 | | | 1 | 1 | | | | | 4 |
| 35 | 8.0–10.0 | | | | | 1 | 1 | | | | | | | 2 |
| 180 | 11.0–13.0 | | | | | | | 1 | 1 | | | | | 2 |
| 125 | 16+ | | | | | | | | | 1 | 1 | 1 | 1 | 4 |
| 253 | 13.0–15.0 | 1 | 1 | | | | | 2 | 2 | | | | | 6 |
| Total no. of individuals | 25 | | | | | | | | | | | | | 296 |

Table 88 also indicates that 8 individuals (32 percent) had 15 or more lesions at multiple osseous sites. A total of 20 individuals (80 percent) had multifocal sites of infectious lesions in both upper and lower extremities; these individuals could be classified as having systemic (possibly chronic) infection and represent 42 percent of the total population subsample. Chi-square tests of relationship between infection and indicators of growth (percentile rankings and $\delta_{mean}$ groups) were computed for the total population subsample, by age group and by sex. The results of these tests, shown in Table 89, demonstrate that

**Table 89. Chi-Square Test Results for Relationship between Infectious Lesions and $\delta l_{mean}$ and Percentile Rankings for Stature**

| Chi-Square Test | Chi-Square Value | *p* |
|---|---|---|
| Total Population subsample (n = 48; power = 0.9337) | | |
| Infection by $\delta l_{mean}$ | 9.043 | .171 |
| Infection by percentile ranking | 9.997 | .265 |
| Age Groups: 0 < 6 years ( n= 30; power = 0.7819) | | |
| Infection by $\delta l_{mean}$ | 30.000 | .414 |
| Infection by percentile ranking | 12.254 | .140 |
| Age Group: 6< 16 years (n = 10; power = 0.3526 | | |
| Infection by $\delta l_{mean}$ | 10.000 | .350 |
| Infection by percentile ranking | 1.667 | .435 |
| Age Group: 16 < 25 years (n = 8; power = 0.2930) | | |
| Infection by $\delta l_{mean}$ | 8.000 | .333 |
| Infection by percentile ranking | 5.156 | .272 |
| Sex: Male (n = 3; power = 0.1393) | | |
| Infection by $\delta l_{mean}$ | 3.000 | .083 |
| Infection by percentile ranking | 3.000 | .223 |
| Sex: Female (n = 5; power = 0.2010) | | |
| Infection by $\delta l_{mean}$ | 1.875 | .171 |
| Infection by percentile ranking | 2.917 | .233 |
| Sex: Indeterminate (n = 40; power = 0.8854) | | |
| Infection by $\delta l_{mean}$ | 6.722 | .347 |
| Infection by percentile ranking | 10.250 | .248 |

infection was not related to $\delta_{mean}$ values or percentile rankings for stature in this sample. Additionally, a Fishers Exact chi-square evaluation of the potential relationship between anemia and infectious processes was undertaken. This test resulted in 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.

## 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 40 individuals (83 percent) of the population subsample that were diagnosed with some form of premortem abnormal shape in one or multiple long bones. Twelve individuals (25 percent) were diagnosed with either platycnemia or platymeria (flattening of the tibial and femoral shafts, respectively).

**Table 90. Distribution of Abnormal Long-Bone Shape in the Total NYABG Population Subsample, by Age and Sex**

| Age | Flattening | | Bowing | | Flaring | |
|---|---|---|---|---|---|---|
| | n | Percent | n | Percent | n | Percent |
| Total subsample | 12 | 25.0 | 18 | 37.5 | 36 | 75.0 |
| 0 <6 years | 1 | 3.3 | 9 | 30.0 | 25 | 83.0 |
| 6 <16 years | 5 | 50.0 | 6 | 60.0 | 7 | 70.0 |
| 16 <25 years | 6 | 75.0 | 3 | 37.5 | 4 | 50.0 |
| Males | 3 | 100.0 | 1 | 33.3 | 2 | 66.7 |
| Females | 3 | 60.0 | 2 | 40.0 | 2 | 40.0 |
| Indeterminate | 6 | 15.0 | 15 | 37.5 | 32 | 80.0 |

Eighteen (37.5 percent) were also diagnosed with bowing of one or more long-bone shafts, and 36 (75 percent) individuals were diagnosed with flaring of the metaphyses of one or more long bones. Table 90 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 $\delta l_{mean}$ grouping values. The only significant association was between bowing and infection in children, from newborn to less than 6 years (n = 30; $p = .003$, $< .05$).

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.

## 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 the natural process 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, osteoarthritis 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 the bone is subject to a biomechanical force that exceeds its capacity to maintain structural integrity.

With this in mind, the New York African Burial Ground pathology database was probed for cases 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.

**Table 91. Distribution of Individuals with Biomechanical Stress Indicators by Age and Sex in the NYABG Population Subsample**

| Burial | Age Range (yrs) | Fracture | Arthritis | Hypertrophy | Enthesopathy |
|---|---|---|---|---|---|
| Male | | | | | |
| 96 | 16.0–18.0 | | | X | |
| 427 | 16.0–20.0 | | | X | X |
| 343 | 19.0–23.0 | | X | X | X |
| Female | | | | | |
| 205 | 18.0–20.0 | X | X | X | X |
| 259 | 17.0–19.0 | X | X | X | X |
| 122 | 18.0–20.0 | | X | X | X |
| 383 | 14.0–18.0 | | | X | X |
| Indeterminate | | | | | |
| 58 | 3.5–5.5 | | | X | |
| 138 | 3.0–5.0 | | | X | |
| 219 | 4.0–5.0 | | | | X |
| 39 | 5.0–7.0 | | | X | X |
| 244 | 5.0–9.0 | | | X | X |
| 396 | 6.5–8.5 | | | X | |
| 95 | 7.0–12.0 | | | X | X |
| 405 | 6.0–10.0 | | | X | |
| 180 | 11.0–13.0 | X | X | X | |
| 368 | 10.5–13.5 | | | X | |
| 25 | 20.0–24.0 | X | X | X | |
| 253 | 13.0–15.0 | X | | X | X |
| | | | | | |
| Total no. of individuals (n) | 19 | 5 | 6 | 18 | 11 |

A total of 19 people (39.5 percent) in the population subsample were diagnosed with these biomechanical stress indicators. Table 91 provides a summary of all individuals who were represented by at least one occurrence of any of these four biomechanical stress indicators. An X in a column designates the presence of at least one site of a specific indicator, although many individuals were diagnosed as having multiple sites of biomechanical stress. This table indicates that 5 (26.3 percent) of the 19 individuals were diagnosed with fractures. Approximately 42 percent of the population subsample, 8 out of 19, was diagnosed as having arthritis, and 16 (84.2 percent) and 11 (57.9 percent) individuals were recorded as having hypertrophies or enthesopathies, respectively. What is striking about these frequencies of biomechanical stress indicators is that 12 children (63.2 percent) under the age of 16 years had been diagnosed with fractures, arthritis, hypertrophies, or enthesopathies. Also, 8 of these children were between the ages of 4 and 10 years. The co-occurrence of hypertrophic attachments and enthesopathy was more prevalent in females (100 percent, n = 4), whereas males had a 66.7 percent (n = 2) co-occurrence, followed by indeterminate individuals with a co-occurrence of 33.3 percent (n = 4).

Statistical tests of observable relationships (Table 92) between the three indicators of biomechanical stress were made. Because of the small subsample size

**Table 92. Results of Chi-Square Tests of Relationships between Biomechanical Stressors**

| Chi-Square Test | Chi-Square Value | *p* |
|---|---|---|
| Arthritis by hypertrophy | 15.157 | .0001 |
| Arthritis by enthesopathy | 19.899 | .0001 |
| Hypertrophy by enthesopathy | 19.475 | .0001 |

for fractures, they were not included in this analysis or any of the following analyses. The results of Fisher's Exact chi-square analyses provided in Table 92 demonstrate significant relationships in the pattern of co-occurrence of these variables (n = 48; $p < .05$). Statistical analysis of these biomechanical stress indicators in relation to growth status, PH, generalized infectious lesions, and abnormal shape variables were also tested. The statistically significant relationships for the total population subsample (n = 48) were between: hypertrophy and long-bone flattening ($\chi^2 = 9.341$, $p = .004$); arthritis and long-bone flattening ($\chi^2 = 13.642$, $p = .001$); enthesopathy and long-bone flattening ($\chi^2 = 11.361$, $p = .002$); hypertrophy and bowing ($\chi^2 = 4.713$, $p = .033$); and enthesopathy and bowing ($\chi^2 = 4.159$, $p = .047$). Among individuals of indeterminate sex, statistically significant relationships were also found among a small set of variables. These relationships were: hypertrophy and long-bone flattening ($\chi^2 = 6.536$, $p = .026$) and hypertrophy and long-bone bowing ($\chi^2 = 6.009$, $p = .020$). When considering the relationships between these variables by age grade, only stature ranking (percentile) and enthesopathy ($\chi^2 = 9.000$, $p = .011$) in children between 6 and 16 years of age, and $\delta l_{mean}$ and enthesopathy ($\chi^2 = 8.000$, $p = .018$) in subadults/young adults between 16 and 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 was more likely to result from biomechanical stress rather than nutritional insufficiency. Additionally, the relationship between enthesopathy and $\delta l_{mean}$ 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.

## Craniosynostosis

The presence of craniosynostosis was observed in 15 individuals of the 48 individuals under the age of 25 years (31.3 percent) that comprised the subsample for analysis in this chapter. The suture(s) involved, sex, and age of each of these individuals are provided in Table 93. As can be seen in this table, 12 of the individuals (80 percent) were 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 94 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.

## Discussion

Analyses of standardized long-bone measures and stature estimates of the New York African Burial Ground 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 $\delta l_{mean}$ values presented in Table 83. Sciulli (1994) has published the only comparable data for five Native American populations in the Ohio River Valley (3000–300 B.P.). Table 95 compares the values calculated for the New York African

**Table 93. Individuals with Craniosynostosis by Suture(s)**

| Burial | Age Range (yrs) | Coronal | | Sagittal | Lambdoid | | SF | | SFT | | SFTP | | Total Sutures |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | L | R | L | R | L | R | L | R | |
| Males | | | | | | | | | | | | | |
| 427 | 16.0–20.0 | | | X | | | | | | | | | 1 |
| 96 | 16.0–18.0 | | | X | X | X | | | | | | | 3 |
| 343 | 19.0–23.0 | | | | | | X | | | | | | 1 |
| Females | | | | | | | | | | | | | |
| 122 | 18.0–20.0 | X | X | X | | | | | | | X | X | 5 |
| 383 | 14.0–18.0 | X | X | X | | | | | | | | | 3 |
| Indeterminate | | | | | | | | | | | | | |
| 91 | 0.67–1.3 | | | X | | | | | | | | | 1 |
| 252 | 1.0–2.0 | | | X | X | | | | | | | | 2 |
| 58 | 3.5–5.5 | | X | | | | | X | | | | | 2 |
| 39 | 5.0–7.0 | | X | X | X | | | X | | | | | 4 |
| 95 | 7.0–12.0 | | | X | | | | X | | | | | 2 |
| 405 | 6.0–10.0 | | | X | X | | | | | | | | 2 |
| 35 | 8.0–10.0 | | X | X | X | X | | | | X | | | 5 |
| 180 | 11.0–13.0 | | | X | X | X | | | | | | | 3 |
| 368 | 10.5–13.5 | | | | | | | X | | | | | 1 |
| 253 | 13.0–15.0 | X | | | | | X | | | | | | 2 |
| Total no. of individuals (n) | 15 | 3 | 5 | 11 | 6 | 3 | 2 | 4 | | 1 | 1 | 1 | 37 |

*Key*: S = spheno; F = frontal; T = temporal; P = parietal.

**Table 94. 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 | .006 |
| Craniosynostosis by hypertrophy | 12.738 | .001 |
| Craniosynostosis by enthesopathy | 6.967 | .013 |
| Craniosynostosis by flattening | 14.255 | .0001 |
| Craniosynostosis by bowing | 11.953 | .001 |
| Craniosynostosis by infection | 3.948 | .046 |
| Age group 0 <6 years (n = 30; power = 0.7819) | | |
| Craniosynostosis by bowing | 7.778 | .021 |
| Sex indeterminate (n = 40; power = 0.8854) | | |
| Craniosynostosis by hypertrophy | 14.400 | .001 |
| Craniosynostosis by arthritis | 5.926 | .042 |
| Craniosynostosis by flattening | 6.536 | .026 |
| Craniosynostosis by bowing | 10.276 | .002 |

**Table 95. A Comparison of NYABG $\delta I_i$ and $\delta I_{mean}$ Values with Those of Five Native American Populations (Sciulli 1994)**

| | $\delta I_i$ | | | | | | $\delta I_{mean}$ |
|---|---|---|---|---|---|---|---|
| | **Humerus** | **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 (3,000 years B.P.) | 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 B.P.) | 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 B.P.) | 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 B.P.) | 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 B.P.) | 0.87 | 0.86 | 0.90 | 0.84 | 0.85 | 0.85 | 0.88 |
| n | 28 | 22 | 19 | 35 | 25 | 10 | 43 |

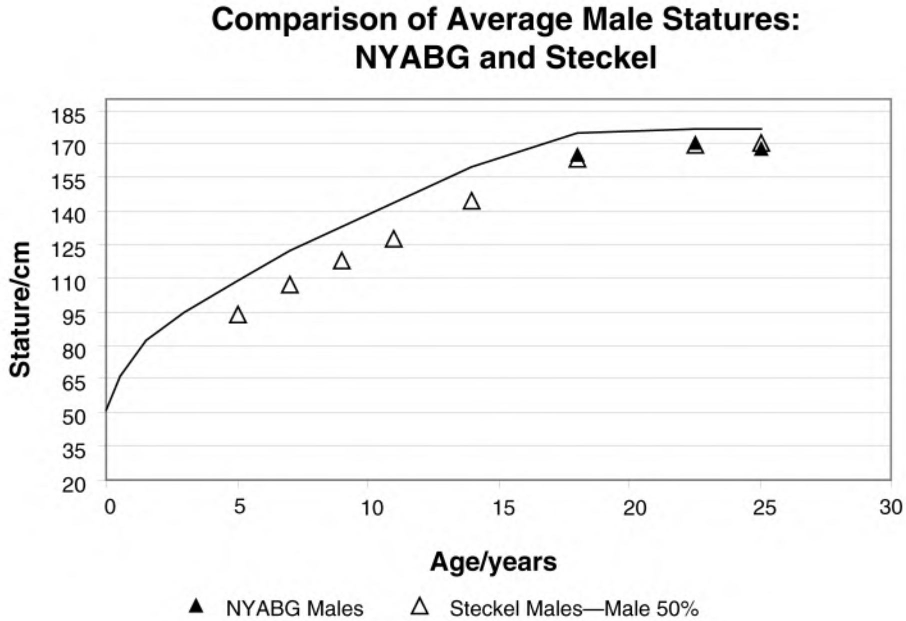


Figure 139. Comparison of average male statures: New York African Burial Ground and Steckel.

Burial Ground sample (n = 48) to those presented by Sciulli (1994). Although the samples compared in this table exhibit temporal heterogeneity, they all show the differential impact that $\delta l_i$ have on $\delta l_{mean}$ values. Also, all skeletal series illustrate that the long bones of the lower extremity, generally the femur, tend to have the lowest $\delta l_i$ values within each population. Although there are considerable differences between $\delta l_i$ values, patterns of long-bone growth are quite similar when subsample size is taken into consideration.

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. Although 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 New York African Burial Ground sample indicate that most of young adults and children were falling well below the twenty-fifth 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 formulas. These factors could either overestimate 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) provided 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 provided mean-stature calculations for enslaved males and females from 4.5 years of age through adulthood. A comparison of the New York African Burial Ground stature estimates and those reported by Steckel are provided in Figures 139 and 140 for males and females, respectively (Figure 141 provides a comparison of the New York African Burial Ground stature estimates for individuals of indeterminate sex and those reported by Steckel for males and females). It should be noted that the values at age 25 years in both figures actually

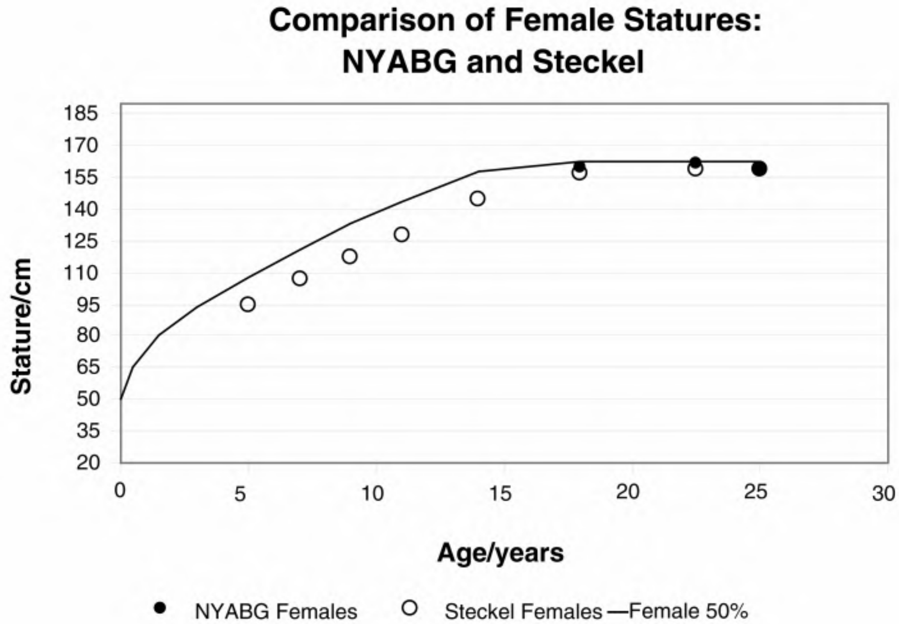


Figure 140. Comparison of average female statures: New York African Burial Ground and Steckel.

reflect adult stature estimates for both the New York African Burial Ground population and those individuals comprising Steckel's sample. This comparison indicates that there were no significant differences between the New York African Burial Ground and antebellum South samples of enslaved Africans and African Americans. The lack of significant differences between 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 New York African Burial Ground juvenile remains provides an accurate reflection of the growth status of these individuals.

Although 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 New York African Burial Ground subsample warrants further discussion. Nutritionally, minimally one-quarter of the 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 subsample had 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 the presence or absence of PH lesions and stature, percentile of growth ranking, or $\delta l_{mean}$. Those individuals who were in the New York African Burial Ground sample that had experienced an anemic episode had already recovered or had 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.

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 $p < .01$ level. Again, this finding

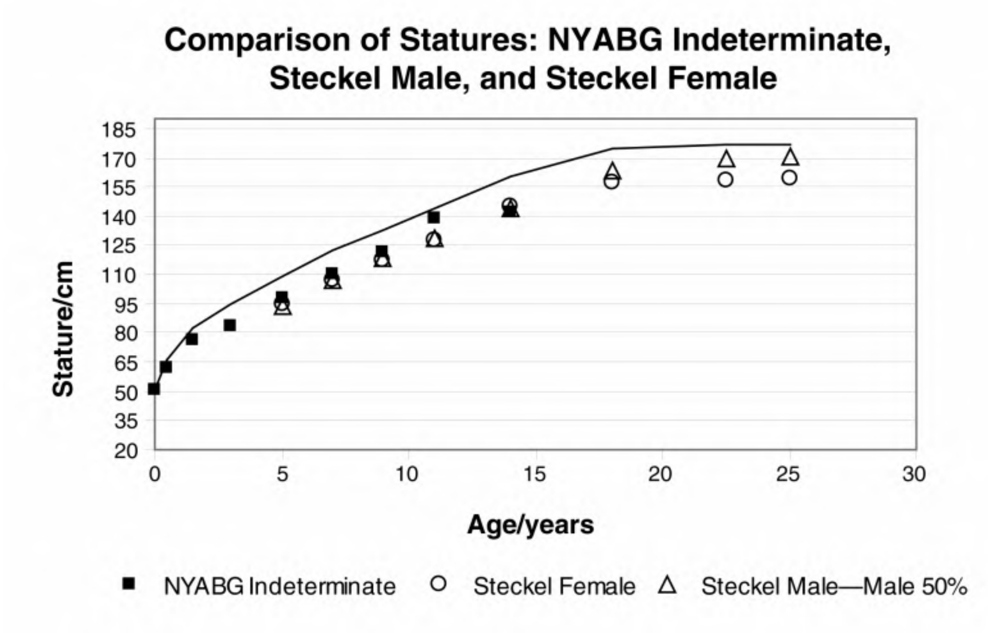


Figure 141. Comparison of statures: New York African Burial Ground indeterminate, Steckel male and Steckel female.

may result from the vast majority of PH lesions in the New York African Burial Ground sample being healed lesions in contrast to the 40 percent active rate for PH lesions in the FABC sample. This difference in the frequencies of active versus inactive PH lesions may actually address the issue of heterogeneous risk of death within and between populations by indicating differential levels of individual frailty, and this 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 from birth to 6 years of age.

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—nearly all (n = 18) of the subset of the 19 individuals in this analysis exhibited at least one area of hypertrophic muscle attachment—whereas 12.5 percent and 22.9 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 eight children, biologically aged from 4 to 8 years, who exhibited hypertrophic attachment—four 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 given 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 (Table 96) revealed 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 (n = 12). Flattening of the long bones was also associated with hypertrophies ($\chi^2 = 6.536$, $p = .026$) in indeterminate individuals as was bowing and hypertrophies ($\chi^2 = 6.009$, $p = .020$). Biomechanical stress indicators were not related to the occurrence of PH lesions in the total population subsample, by age or by sex.

## Conclusion

The analysis of growth and development presented above does not provide a clear picture of cause and

**Table 96. Results of Chi-Square Tests of Relationships between Biomechanical Stressors and Abnormal Flattening of Long Bones**

| Chi-Square Test | Chi-Square Value | *p* |
|---|---|---|
| Hypertrophy by flattening | 9.341 | .004 |
| Arthritis by flattening | 13.642 | .001 |
| Enthesopathy by flattening | 11.361 | .002 |

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 and 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 New York African Burial Ground population was poor.
2. Evidence of biomechanical stressors in individuals as young as 4 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 and productive capabilities of individuals within any population.

## 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, S. D. Wilson, 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 undercounting 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. Some gained legal freedom, gradually building a free African population, but most died enslaved.

A major research focus of the New York African Burial Ground Project 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 African Burial Ground was in use, (2) how the priorities and demands of the regime were regulated and perpetuated, (3) the 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 although 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 the 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 (1961:4) has contended:

> 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.

Thus, enslaved Africans were placed into a system that was already formulated and transforming. In the English colonies, Africans were legally and in practice treated as indentured servants until the legislation of the 1660s. One generation later a unique form of racial, chattel slavery would distinguish the plight of African labor in America from feudal and ancient forms of human bondage (Smedley 1993).Williams (1971:14) maintained 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.

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 debate 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 (1) the heterogeneous nature of western hemisphere African American communities because of diverse African provenience and admixture with diverse Europeans and/or Native Americans; (2) the experience of urban enslaved African Americans and freedmen during the colonial and antebellum periods; (3) the living conditions, health status, and life styles of Africans and African Americans who were enslaved or free; (4) changing sociocultural conditions (e.g., industrialization) and their impact on African American conditions; and (5) the health status and biological adaptability or resilience of African Americans under very stressful conditions. In addition, multidisciplinary, integrative research approaches to the study of African Diasporic populations in the Americas have rarely been undertaken.

The economic, political, and sociocultural characteristics of the trade in human captives will be considered in this chapter. Those characteristic structures and processes are reflected in the criteria for determining the sex and age of the enslaved who would best fulfill the needs of the Dutch, English, and Euroamerican 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 from both private and official correspondence, which indicate some of the parameters of local demand. Although 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 Foote 1991; Kruger 1985; Lydon 1978).

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 because of 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 (see Mullin 1995).

Intermittent periods of direct African trading and importation occurred in 1705, 1710–1712, 1715–1717 and 1721 (Brodhead 1853–1887:5:814; 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 (Agorsah 1994).

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 used 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 (Colden 1918–1937:1:51). 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 15–20 (cited in Foote 1991:82). 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, although 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 4 years of age were subject to an import tax as of 1732 (New York State 1894). 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, whereas older ones were considered valuable commodities. Overall, it appears that enslaved Africans were put to work by their preteen 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 cutoff. Colonial laws also reflect anticipated problems with owners of elderly Africans. In 1773, (New York State 1894:5:533) *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 those in their early teens, to be the primary choice for urban domestic household enslavement is corroborated in the New York Census data (Table 97). The 1746 census indicates a sharp increase in girls over boys (in the under 16 years of age 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 98). Three years later, the sex ratio declined abruptly as girls reached ages 16–18. 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

**Table 97. African Population by Age and Sex, Eighteenth-Century Censuses**

| Year | Adults | | Children | | Age Cut-Off | Label in Census | Notes |
|---|---|---|---|---|---|---|---|
| | Male | Female | Male | Female | | | |
| 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 | |

*Note:* From United States Bureau of the Census (1909), checked against Brodhead (1856–1887). Some discrepancies in the numbers appearing in Kruger (1985) and Foote (1991) have been corrected.

both sexes. A substantially greater number of males are reported only for 1737 (see Tables 97 and 98 and Tables 18 and 19). 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 Medford [2009] for a discussion of the events of 1712 and 1741.)

During the first two historic events, the relative excess of females occurred 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) have suggested that the English reaction to the alleged 1741 African uprising in New York caused 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 (Foote 1991; Kruger 1985; Lydon 1978). 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 142).

**Table 98. African Adult Sex Ratio, New York County, 1703–1771**

| Year | Sex Ratio |
|---|---|
| 1703 | 107.9 |
| 1712 | 100.3 |
| 1723 | 85.7 |
| 1731[a] | 98.7[a] |
| 1737[a] | 110.7[a] |
| 1746 | 126.7 |
| 1749 | 92.9 |
| 1756 | 96.7 |
| 1771 | 85.9 |

*Source:* From United States Bureau of the Census (1909). Discrepancies were found in Foote's (1991) and Kruger's (1985) numbers and have been corrected. The numbers in United States Bureau of the Census (1909) were checked in checked against Brodhead (1856–1887).

*Note:* The 1786 state census and the 1790, 1800, and 1810 federal censuses do not count blacks by sex. According to Kruger (1985:370), local censuses for the early 19th century indicate ratios declining from 72.3 in 1805 to 65.8 in1819.

[a] 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.

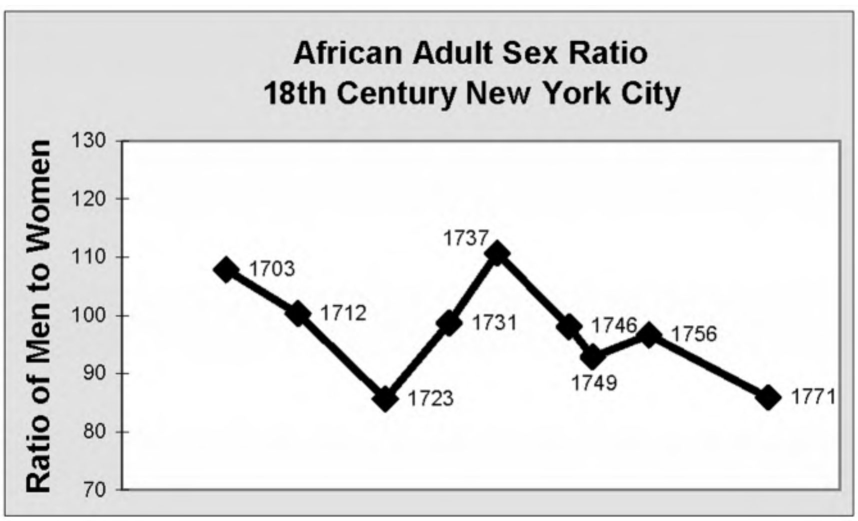


Figure 142. African adult sex ratio: eighteenth-century New York City.

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.

## 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 cited 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 percent 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 3,137 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, 1745–1747, 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 and 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 African Burial Ground were being counted in some form. It is not known how or by whom. During the period of smallpox reporting, 477 Europeans (6.77 percent of their population) and 71 Africans (4.50 percent of their population) died. The overall death toll for August to December of 1731 was 7 percent of Europeans and 5 percent of Africans. This difference in frequency may indicate an underreporting of black burials, which is not surprising since historical accounts imply that the burial ground was most often used without direct observation by Euroamericans. As noted earlier, Philadelphia records indicated an average death rate of 7 percent per year among blacks in the 1767–1775 period, with a rate of about 5 percent for whites—a similar differential probably characterized general mortality in New York.

Although African deaths may have been underreported, 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 (quoted material from letter by Cotton Mather dated July 12, 1716 [Koo 2007]). One of these physicians, Zabdiel Boylston, apparently used the technique in time to have helped reduce the impact of a Boston epidemic in 1721–1722 (Cobb 1981:1199–1200). Smallpox inoculation was controversial among the English (see Medford 2009), 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

**Table 99. Population of New York County, 1698–1800 by Race**

| Year | Total | Black | White | Percent Black |
|---|---|---|---|---|
| 1698 | 4,937 | 700 | 4,237 | 14.2 |
| 1703[a] | 4,391 | 799 | 3,592 | 18.2 |
| 1712 | 5,861 | 975 | 4,886 | 16.6 |
| 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 | 13,294 | 2,368 | 10,926 | 17.8 |
| 1756 | 13,046 | 2,278 | 10,768 | 17.5 |
| 1771 | 21,863 | 3,137 | 18,726 | 14.3 |
| 1786 | 23,614 | 2,107 | 21,507 | 8.9 |
| 1790 | 31,225 | 3,092[b] | 28,133 | 9.9 |
| 1800 | 57,663 | 5,867[c] | 51,796 | 10.2 |

*Note*: From 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.

[a] 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.

[b] Includes 1,036 free and 2,056 enslaved blacks.

[c] Includes 3,333 free and 2,534 enslaved blacks.

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 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 99) has also been interpreted as a result of yellow fever deaths (e.g., Goodfriend 1992:113). However, a tally of the African population of the city in 1703, based on the household-by-household count, puts the total number of Africans at 799 (United States Bureau of the Census 1909). 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 were recorded for the 1743 yellow fever outbreak (Duffy 1968:86).

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) suggested 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 1918–1937:1: 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 1789–1790

(Duffy 1968:86). Both influenza and whooping cough (pertussis) ravaged European and African populations in the West Indies; as these diseases 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 because of the colder climate. Completed parasitological studies on a small number of soil samples from the pelvic area of skeletal remains from the New York African Burial Ground did not provide any evidence of parasites. Preservation factors may account for the complete lack of remains, as 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 New York African Burial Ground skeletal sample. These include:

- The low mean-age at death for the population of 22.3 is even lower than that of a 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 43.2 percent of the burial ground sample; a preponderance of subadult deaths (39.2 percent) occurred during the first year of life, especially during the first 6 months, followed by another 16.1 percent in the second year. Therefore, infants and children were at high risk of dying both in utero and for the first 2 years of their lives. Fifty-five percent of all the subadults died by age 2. Thus, the potential for population replacement was being severely compromised.
- The mortality pattern of adults was the highest in the 30–34 age group (15.8 percent). The second highest was the 45–49-year-olds ( 14.6 percent), followed by 15–19- and 20–24-year-olds (8.8 percent each), and 35–39-year-olds (8.4 percent).
- Adult mortality peaked in the fourth decade of life, when 28 percent of adults had died. This loss of adults indicates the reduction in potential reproductive members early in the life cycle and also corroborates the impact of captivity on the men and women interred in the African Burial Ground.
- Differential mortality patterns indicate that 62 percent of females had died by age 40, compared to 45 percent of the males. Although women and girls were being selected as domestic laborers, their lot was arduous and increased their risk of dying.
- The third highest adult 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.
- Differential mortality patterns were observed in the 15–19 age group where 11.6 percent of girls died, compared to 6.9 percent of boys, although not statistically significant. Women were being removed from the population during a time when they were capable of reproducing or were biologically preparing for reproduction.
- The trends observed in the paleodemography of the New York African Burial Ground 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; biological development selecting against the survival of women; and reduced fecundity 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 African Burial Ground are of some interest in assessing data from the burial ground, especially the sex ratio. The New York African Burial Ground skeletal records reveal a smaller proportion of females than the historical and demographic data on the living population. This observation, along with the trend toward higher risk of mortality at younger ages in males and in 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 between 1801 and 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 years and older) numbered 10 women and 15 men, approximating the skewed ratio found at the New York African Burial Ground. 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 (nine girls and six boys). The excess of girls over boys in older age categories was more marked. In the 5–15-year-old group, there were seven girls and only one boy buried, but no deaths of young women (16–20 years old) were recorded.

Mortality data are also available for a later New York African community known as Seneca Village (1826–1851). In the first decade, which saw final emancipation in New York in 1827, the death records include 8 girls and 5 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 (1836–1846), recorded infant deaths 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 (These unpublished data for Seneca Village were generously provided by N. Rothschild, D. Wahl, and E. Brown). The sample sizes, especially for the colonial period New York African Burial Ground, were 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 New York African Burial Ground 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 interpreted. Therefore, the data used 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 (see Table 98). The European population increased slowly early on, followed by significant growth starting at mid-century (see Table 99).

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 (Vaughn 1972; Wax 1973), and Philadelphia (Nash 1988). All of these populations shared the inability to reproduce themselves owing to deaths that exceeded 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 3 percent of the total population; by 1710, however, there were 3,500 enslaved Africans constituting 24 percent of the population, the result of importations, increased birth rate, and a slight decrease in mortality.

The question then is, why was there little or no growth in the enslaved African population with the ongoing importation of Africans to the port of New York? The historical accounts and 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 and women, whereas 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. Because of 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 (see Figure 142). 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 three-fifths 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 (1985:410–412) calculated median birth spacing at 28 months and inferred that during the period of 1799–1826 breast-feeding appeared to have continued for 16–18 months after birth. Therefore, women were potentially capable of producing four to six offspring between the ages of 15 and 30.

### Child-To-Woman Ratios

Despite the potential for population 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 the ratio of children per woman of childbearing years as importations abated (Figure 143). 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 and hypoplasia data of Chapter 8. The census data used here largely represent survivors and persons imported after ages of highest mortality risk. These children were likely to show disproportionately high frequencies of African birth, 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

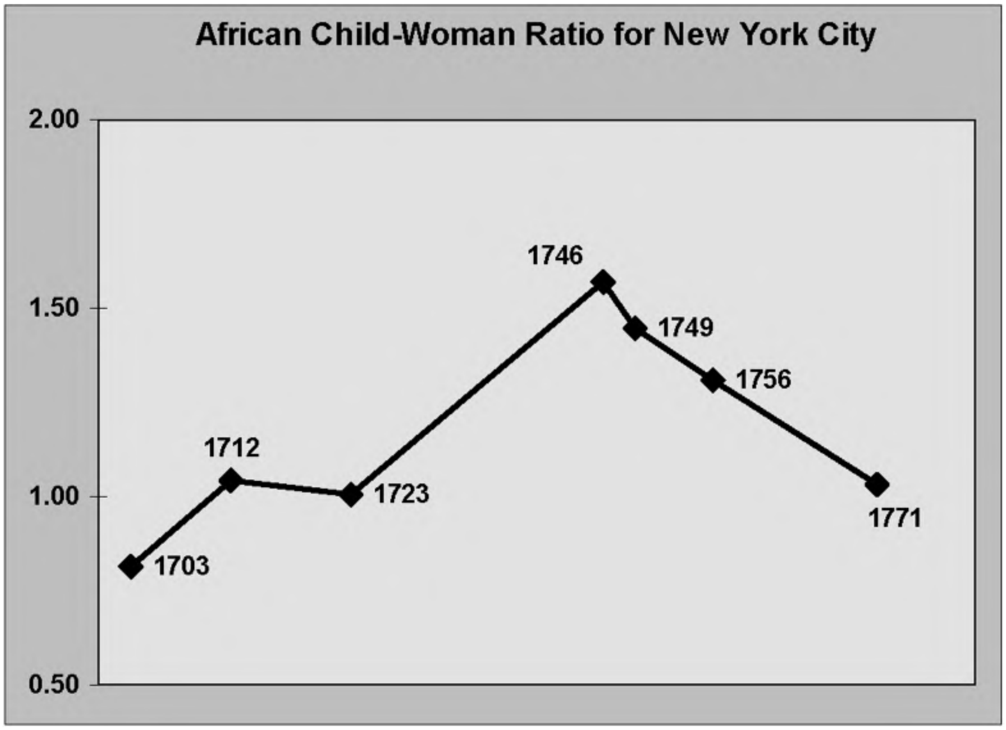


Figure 143. African child-woman ratio, New York City.

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.

## Paleopathology

Paleopathological evidence for the people interred in the New York African Burial Ground site indicates that African women were involved in strenuous labor from adolescence onward and were nutritionally compromised. They also had high rates of degenerative joint disorders and exhibited evidence of enthesopathies and muscle hypertrophy (see Chapter 11), as well as nutritional deficiencies, including porotic hyperostosis and general infection (see 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 because of nutritionally compromised mothers, weaning, nutritional insufficiency, and infection as evidenced by dental enamel defects of both the deciduous and permanent teeth (see Chapter 8), rates of infection and porotic hyperostosis (anemia) (see Chapter 10), and retarded growth and development (see Chapter 12).

The political economic regime (Figure 144) established a biological lifestyle of arduous work for adolescent and adult females that 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 psychophysiological 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 immunosuppression and an increase in susceptibility or risk factors for morbidity and mortality.

- **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 shifted 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 144. Summary of relevant factors of the political economic regime of colonial New York.

- 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." Because enslaved captives could be replaced continuously, European enslavers had no incentive for encouraging fertility or intensive caregiving 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 demonstrated no desire to possess young Africans or to "breed" their captives. They only needed them to keep the market's products and profits flowing.

# Chapter 14

# Discussion

***M. L. Blakey, L. M. Rankin-Hill, A. H. Goodman, and F. L. C. 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 were babies dying? Slaveholders did 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. Although African women also at times allowed their children to die rather than make them into slaves, at other times we see clear archaeological evidence (see *The Archaeology of the New York African Burial Ground*, Volume 2 of this series) 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 Medford, Brown, Carrington, et al. 2009b; Medford, Brown, Heywood, et al. 2009). 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 affects child mortality, particularly when 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, the results of genetic analyses (see 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, in West and West Central Africa.

Complementing the above, the preponderance of the ethnohistorical and chemical evidence indicates that most of the New York African Burial Ground 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 8 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 (see Chapter 6) suggest that individuals among a small, tested sample may have grown up in the Caribbean.

Chapter 6 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 8 years matched the isotopic signature associated with Manhattan, whereas the majority of individuals over the age of 8 years did not. This was especially true for individuals with culturally modified teeth. Similarly for elemental signature analysis, young individuals clustered together, suggesting they were born in New York—adding support to our interpretation of the strontium isotope analyses. These conclusions, however, are based on the small sample of individuals whose chemistry was assayed. Notably, historical evidence points to 9 years as the youngest common age of forced migration from Africa to New York. The study of hypoplasia in the third molar (see 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 the teeth of individuals who were plausibly born in New York were an unexpected finding. Samples of enamel that were calcified during the first years of life were also taken using 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 were 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 samples from other archaeological sites. A similar trend was shown for infectious disease (Chapter 10). An analysis relying on age-differentiated samples showed that older persons who were most likely to have spent childhoods in central and West Africa had the fewest hypoplasias 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 (approximately 200) 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 New York African Burial Ground can be frequently characterized by delayed growth and development due to a combination of nutritional, disease, and probable work-related stresses (see 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 active lesions, in children relative to adults may indicate that those who died as children tended 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 are 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 also had substantial evidence of healed lesions, unlike infants (see Chapter 10). Oral health related to constraints upon menu and hygiene was also generally poor (Chapter 9).

Throughout the eighteenth century, the 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 (see Chapters 7 and 13). This lack of natural increase is consistent with severely exploited enslaved populations in the

Caribbean, 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 high sex ratios. Life expectancy was 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 New York African Burial Ground individuals living beyond 55 years is similar, however, to census data from municipal records (between 1 and 3 percent). This observation is consistent with the study of the Newton Plantation in Barbados, demonstrating comparability between skeletal and archival data on adult mortality, unlike the fragile skeletal remains of infants that underrepresent mortality by virtue of their rapid decay in the ground or selective interment. The English community, who would have presumed to own these Africans, exhibited opposite mortality trends, with many times more English males and females living to old age. Young English men, however, were well represented among the dead, most likely owing 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 differences in the 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 (see 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 because of 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 these comparisons forward, with the necessary qualifying information, for a fair evaluation of their meaningfulness. Comparisons between the New York African Burial Ground and other archaeological sites can be most directly made in relation to our own previous projects, such as the 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 pseudobiological 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 sample cannot be neglected for assessing cranial affinities of the African Diaspora. Interestingly, no English sample 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. We encourage our colleagues 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 collaborators 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, nonracial identities of New York African Burial Ground 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 New York African Burial Ground 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 of 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 New York African Burial Ground Project has resolved significant methodological and technical problems with both chemical sourcing and DNA affiliation studies. Yet it is not currently possible to reliably determine a dead or living person's African ethnic ("tribal") ancestry on the basis of DNA. No one has yet published controlled studies to support such a claim.

Continuously, we have been asked by reviewers, overseers, and audience members about comparisons of the New York African Burial Ground sample to colonial European-American samples. For some, this was a critically important question, one that would validate or invalidate the findings of the New York African Burial Ground Project research. From the very beginning, the project sought comparative European-American colonial skeletal and historical cemetery samples. 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 or 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 or almshouse samples 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 was there for intemperance. To argue that these represent the laboring lower classes of Euro-Americans does not seem plausible. In fact, many if not most were social outcasts, not the class of Europeans who were bound to indentured servitude and who would have been a reasonable comparative sample. 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 nonlaboring 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 African Burial Ground. The latter are representative of the average or vast majority of Africans in New York; the former represents a small minority of unrepresentative Europeans and 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 were enslaved had 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 made up the New York African Burial Ground 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. These would be good things, and we hope to have contributed to it. It seems true, however, that these groups still remain at a distance.

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 historical anthropological 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, but most adults probably were not. Unfortunately, the hardships they endured rival those confronted by and imposed on any other group. Nevertheless, the enslaved Africans of New York rebelled against, survived, endured, and built the material foundation of the financial capitol and capital of the Western world. By the evidence thus ascertained, let these reports put to rest any assumption that this achievement came without the extraordinary abuse and work of Africans in eighteenth-century New York.

# References

Acheson, R. M.
1966 Maturation of the Skeleton. In *Human Development*, edited by F. Falkner, pp. 465–502. W. B. Saunders, Philadelphia, Pennsylvania.

Acsádi, G., and J. Nemeskéri
1970 *History of Human Life and Mortality*. Akadémiai Kiadó, Budapest, Hungary.

Agorsah, E. K.
1994 *Maroon Heritage: Archaeological, Ethnographic, and Historical Perspectives*. Canoe Press, Kingston, Jamaica.

Agorsah, E. K. (editor)
1994 *Maroon Heritage: Archaeological, Ethnographic, and Historical Perspectives*. Canoe Press, University of the West Indies, Kingston, Jamaica.

Albert, A. L., and D. L. Greene
1999 Bilateral Asymmetry in Skeletal Growth and Maturation as an Indicator of Environmental Stress. *American Journal of Physical Anthropology* 110:341–349.

Allegre, C. J., B. Dupre, P. Negrel, and J. Gaillardet
1996 Sr-Nd-Pb Isotope Systematics in Amazon and Congo River Systems: Constraints about Erosion Processes. *Chemical Geology* 131:93–112.

Allen, L. H.
1993 The Nutrition CRSP: What Is Marginal Malnutrition and Does It Affect Human Functions? *Nutrition Reviews* 51:255–267.

Alt, K. W., and S. L. Pichler
1998 Artificial Modifications of Human Teeth. In *Dental Anthropology: Fundamentals, Limits, and Prospects*, edited by K. W. Alt, F. W. Rosing, and M. Teschler-Nicola, pp. 387–415. Springer-Verlag/Wien, New York.

Amarasiriwardena, D., S. F. Durrant, A. Lásztity, A. Krushevska, M. D. Argentine, and R. M. Barnes
1997 Semiquantitative Analysis of Biological Materials by Inductively Coupled Plasma-Mass Spectrometry. *Microchemistry Journal* 56:352–372.

Ambrose, S. H.
1991 Effects of Diet, Climate and Physiology on Nitrogen Isotope Abundances in Terrestrial Foodwebs. *Journal of Archaeological Science* 18:293–317.
1993 Isotopic Analysis of Paleodiets: Methodological and Interpretive Considerations. In *Investigations of Ancient Human Tissue: Chemical Analysis in Anthropology,* edited by M.K. Sanford, pp. 59–129. Food and Nutrition in History and Anthropology Vol. 10. Gordon and Breach, Philadelphia, Pennsylvania.

Ameyaw, M. M., E. S. Collie-Duguid, R. H. Powrie, D. Ofori-Adjei, and H. L. Mcleod
1999 Thiopurine Methyltransferase Alleles in British and Ghanaian Populations. *Human Molecular Genetics* 8(2):367–370.

Andah, B. W.
1995 Studying African Societies in Cultural Context. In *Making Alternative Histories: The Practice of Archaeology and History in Non-Western Settings*, edited by P. R. Schmidt and T. C. Patterson, pp. 149–182. School of American Research Press, Santa Fe, New Mexico.

Angel, J. L.
1969 The Bases of Paleodemography. *American Journal of Physical Anthropology* 48:493–533.

1976 Colonial to Modern Skeletal Change in the U.S.A. *American Journal of Physical Anthropology* 45:723–736.

Angel, J. L., J. O. Kelley, M. Parrington, and S. Pinter

1987 Life Stresses of the Free Black Community as Represented by the First African Baptist Church, Philadelphia, 1823–1841. *American Journal of Physical Anthropology* 74:213–229.

Ansa, K. O.

1995 Identification and Validation of the Sankofa Symbol. *Update* 1:3.

Aptheker, H.

1943 *American Negro Slave Revolts*. International Publishers, New York.

Arends, A., M. Alvarez , D. Velazquez, M. Bravo, R. Salazar, J. M. Guevara, and O. Castillo

2000 Determination of Beta-Globin Gene Cluster Haplotypes and Prevalence of Alpha-Thalassemia in Sickle Cell Anemia Patients in Venezuela. *American Journal of Hematology* 64(2):87–90.

Arizona State University Dental Anthropology System

n.d. *Scoring Procedures for Morphological Traits of the Permanent Dentition*. Arizona State University, Tempe.

Armelagos, G. J.

1968 Paleopathology of Three Archaeological Populations from Sudanese Nubia. Unpublished Ph.D. dissertation, Department of Anthropology, University of Colorado, Boulder.

1969 Disease in Ancient Nubia. *Science* 163:255–259.

Armelagos, G. J., D. S. Carlson, and D. P. Van Gerven

1982 The Theoretical Foundation and Development of Skeletal Biology. In *A History of American Physical Anthropology, 1930–1980,* edited by F. Spencer, pp. 305–328. Academic Press, New York.

Armelagos, G. J., and A. H. Goodman

1998 Race, Racism, and Anthropology. In *Building a New Biocultural Synthesis: Political-Economic Perspectives on Human Biology*, edited by A. H. Goodman and T. L. Leatherman, pp. 359–378. University of Michigan Press, Ann Arbor.

Armelagos, G. J., A. Goodman, and K. H. Jacobs

1998 The Ecological Perspective in Disease. In *Health and the Human Condition: Perspectives on Medical Anthropology*, edited by M. H. Logan and E. E. Hunt, pp. 71–84. Duxbury Press, North Scituate, Massachusetts.

Armelagos, G. J., J. H. Mielke, and J. Winter

1971 *Bibliography of Human Paleopathology*. Research Reports No. 8. Department of Anthropology, University of Massachusetts, Amherst.

Armstrong, D. V.

1990 *The Old Village and the Great House: An Archaeological and Historical Examination of Drax Hall Plantation, St. Ann's Bay, Jamaica*. University of Illinois Press, Urbana.

Armstrong, D. V., and M. Fleishman

1993 *Analysis of Four Burials from African Jamaican House-Yard Contexts at Seville*. Reports of the Jamaican National Historic Trust. Archaeological Report 65. Syracuse University, Syracuse, New York.

Arriaza, B. T.

1993 Seronegative Spondyloarthropathies and Diffuse Idiopathic Skeletal Hyperostosis in Ancient Northern Chile. *American Journal of Physical Anthropology* 91:263–278.

Asala, S. A., and F. E. Mbajiorgu

1996 Epigenetic Variation in the Nigerian Skull: Sutural Pattern at the Pterion. *East African Medical Journal* 73(7):484–486.

Aufderheide, A. C.

1989 Chemical Analysis of Skeletal Remains. In *Reconstruction of Life from the Skeleton*, edited by M. Y. İşcan and K. A. R. Kennedy, pp. 237–260. Alan R. Liss, New York.

Aufderheide, A. C., J. L. Angel, J. O. Kelley, A. C. Outlaw, M. A. Outlaw, G. Rapp, Jr., and L. E. Wittmers

1985 Lead in Bone III: Prediction of Social Correlates in Four Colonial American Populations (Catoctin Furnace, College Landing, Governor's Land and Irene Mound). *American Journal of Physical Anthropology* 66:353–361.

Aufderheide, A. C., F. D. Neiman, L. E. Wittmers, and G. Rapp, Jr.
1981 Lead in Bone II: Skeletal-Lead Content as an Indicator of Lifetime Lead Ingestion and the Social Correlates in an Archaeological Population. *American Journal of Physical Anthropology* 55:285–291.

Aufderheide, A. C., and C. Rodriguez-Martin
1998 *The Cambridge Encyclopedia of Human Paleopathology*. Cambridge University Press, Cambridge, Great Britain.

Aufderheide, A. C., L. E. Wittmers, Jr., G. Rapp, Jr., and J. Wallgren
1988 Anthropological Applications of Skeletal Lead Analysis. *American Anthropologist* 90(4):931–936.

Ayala, F. J., and A. A. Escalante
1996 The Evolution of Human Populations: A Molecular Perspective. *Molecular Phylogenetics and Evolution* 5(1):188–201.

Baber, W. L.
1999 St. Clair Drake: Scholar and Activist. In *African American Pioneers in Anthropology*, edited by I. E. Harrison and F. V. Harrison, pp. 191–212. University of Illinois Press, Urbana.

Baena, A., J. Y. Leung, A. D. Sullivan, I. Landires, N. Vásquez-Luna, J. Quiñones-Berrocal, P. A. Fraser, G. P. Uko, J. C. Delgado, O. P. Clavijo, S. Thim, S. R. Meshnick, T. Nyirenda, E. J. Yunis, and A. E. Goldfeld
2002 TNA-alpha Promoter Single Nucleotide Polymorphisms Are Markers of Human Ancestry. *Genes and Immunity* 3(8):482–487.

Bailit, H. L.
1975 Dental Variation among Populations: An Anthropologic View. *Dental Clinics of North America* 19(1):125–139.

Baker, L. D.
1998 *From Savage to Negro: Anthropology and the Construction of Race, 1896–1954*. University of California Press, Berkeley.

Bandelt, H. J., J. Alves-Silva, P. E. M. Guimares, M. S. Santos, A. Brehm, L. Pereira, A. Coppa, J. M. Larruga, C. Rengo, R. Scozzari, A. Torroni, M. J. Prata, A. Amorim, V. F. Prado, and S. D. J. Pena
2001 Phylogeography of the Human Mitochondrial Haplogroup L3e: A Snapshot of African Prehistory and Atlantic Slave Trade. *Annals of Human Genetics* 65(6):549–563.

Bass, W. M.
1971 *Human Osteology: A Laboratory and Field Manual of the Human Skeleton*. Missouri Archaeological Society, Columbia.
1987 *Human Osteology: A Laboratory and Field Manual.* 3rd ed., 1st printing. Special Publication No. 2. Missouri Archaeological Society, Columbia, Missouri.

Bastide, R.
1967 *Les Ameriques Noires, Les Civilisations Africaines dans Le Nouveau Monde.* Payot, Paris.

Beavers, R. C., T. R. Lamb, and J. R. Greene
1993 *Archaeology and History*. Burial Archaeology and Osteology of Charity Hospital/Cypress Grove II Cemetery, New Orleans, Louisiana, vol. 1. Department of Anthropology, University of New Orleans, New Orleans, Louisiana.

Benjamin, M., T. Kumai, S. Milz, B. M. Boszczyk, A. A. Boszczyk, and J. R. Ralphs
2002 The Skeletal Attachments of Tendons-Tendon "Enthuses." Comparative Biochemistry and Physiology–Part A. *Molecular and Integrative Physiology* 133(4):931–945.

Berlin, I.
1998 *Many Thousand Gone: The First Two Centuries of Slavery in North America*. Harvard University Press, Cambridge, Massachusetts.

Bernal, M.
1987 *The Fabrication of Ancient Greece, 1785–1985*. Black Athena: The Afro-Asiatic Roots of Civilization, vol. 1. Rutgers University Press, New Brunswick, New Jersey.

Biondi, G., O. Rickards, C. Martinez-Labarga, T. Taraborelli, B. Ciminelli, and G. Gruppioni
1996 Biodemography and Genetics of the Berba of Benin. *American Journal of Physical Anthropology* 99:519–535.

Bird, A. R., P. Ellis, K. Wood, C. Mathew, and C. Karabus
1987 Inherited Haemoglobin Variants in a South African Population. *Journal of Medical Genetics* 24(4):215–219.

Blakely, R. L., and L. A. Beck
1982 Bioarchaeology in the Urban Context. In *Archaeology of Urban America: The Search for Pattern and Process*, edited by R. S. Dickens, Jr., pp. 175–207. Academic Press, New York.

Blakey, M. L.
1983 Sociopolitical Bias and Ideological Production in Historical Archaeology. In *The Socio-Politics of Archaeology*, edited by J. M. Gero, D. Lacy, and M. L. Blakey, pp. 5–16. Research Report No. 23. Department of Anthropology, University of Massachusetts, Amherst.
1987 Fetal and Childhood Health in Late 18th and Early 19th Century Afro-Americans: Enamel Hypoplasia and Hypocalcification in the FABC Skeletal Population. *American Journal of Physical Anthropology* 72:179.
1988 Social Policy, Economics, and Demographic Change in Nanticoke-Moor Ethnohistory. *American Journal of Physical Anthropology* 75:493–502.
1990 American Nationality and Ethnicity in the Depicted Past. In *Politics of the Past*, edited by P. Gathercole and D. Lowenthal, pp. 38–48. Allen and Unwin, London.
1994a Psychophysiological Stress and Disorders of Industrial Society: A Critical Theoretical Formulation for Biocultural Research. In *Diagnosing America: Anthropology and Public Engagement*, edited by S. Forman, pp. 149–192. University of Michigan Press, Ann Arbor.
1994b Passing the Buck: Naturalism and Individualism as Anthropological Expression of Euro-American Denial. In *Race*, edited by S. Gregory and R. Sanjek, pp. 270–284. Rutgers University Press, New Brunswick, New Jersey.
1995 Race, Nationalism, and the Afrocentric Past. In *Making Alternative Histories: The Practice of Archaeology and History in Non-Western Settings*, edited by P. R. Schmidt and T. C. Patterson, pp. 213–228. School of American Research Press, Santa Fe, New Mexico.
1996 Skull Doctors Revisited: Intrinsic Social and Political Bias in the History of American Physical Anthropology, with Special Reference to the Work of Aleš Hrdlička. In *Race and Other Misadventures: Essays in Honor of Ashley Montague in His Ninetieth Year*, edited by L. Reynolds and L. Lieberman, pp. 64–95. General Hall, New York.
1998a The New York African Burial Ground Project: An Examination of Enslaved Lives, a Construction of Ancestral Ties. *Transforming Anthropology* 7:53–58.
1998b Beyond European Enlightenment: Toward a Critical and Humanistic Human Biology. In *Building a New Biocultural Synthesis*, edited by A. H. Goodman and T. L. Leatherman, pp. 379–406. University of Michigan Press, Ann Arbor.
2001 Bioarchaeology of the African Diaspora in the Americas: Its Origins and Scope. *Annual Review of Anthropology* 30:387–422.

Blakey, M. L., and G. J. Armelagos
1985 Deciduous Enamel Defects in Prehistoric Americans from Dickson Mounds: Prenatal and Postnatal Stress. *American Journal of Physical Anthropology* 66:371–380.

Blakey, M. L., S. B. Jenkins, D. Jamison, and T. Leslie
1997 Dental Indicators of Fetal and Childhood Health in the Archaeological Remains of a Nineteenth Century African-American Community. In *Pathways to Success*, edited by L. R. Sloan and B. J. Starr, pp. 177–193. Howard University Press, Washington, D.C.

Blakey, M. L., and C. J. La Roche
1997 Seizing Intellectual Power: The Dialogue at the New York African Burial Ground. *Historical Archaeology* 31(3):84–106.

Blakey, M. L., T. E. Leslie, and J. P. Reidy
1992 Chronological Distribution of Dental Enamel Hypoplasia in African American Slaves: A Test of the Weaning Hypothesis. *American Journal of Physical Anthropology* Supplement 14:50 (abstract).
1994 Frequency and Chronological Distribution of Dental Enamel Hypoplasia in Enslaved African Americans: A Test of the Weaning Hypothesis. *American Journal of Physical Anthropology* 95:371–383.

Blum, J. D., E. H. Taliaferro, M. T. Weisse, and R. T. Holmes

2000 Changes in Sr/Ca, Ba/Ca and $^{87}Sr/^{86}Sr$ Ratios between Trophic Levels in Two Forest Ecosystems in the Northeastern U.S.A. *Biogeochemistry* 49:87–101.

Boas, F.

1911 Changes in Bodily Form of Descendants of Immigrants. In *Abstract of the Report on Changes in Bodily Form of Descendants of Immigrants,* pp. 141–154. The Immigration Commission, Washington, D.C. U. S. Government Printing Office, Washington, D.C.

Bocquet-Appel, J. P., and C. Masset

1982 Farewell to Paleodemography. *Journal of Human Evolution* 11:321–333.

Bogin, B.

1999 *Patterns of Human Growth*, 2nd ed. Cambridge University Press, New York.

Bogue, D. J.

1969 *Principles of Demography*. John Wiley and Sons, New York.

Bolles, A. L.

1999 Ellen Irene Diggs: Coming of Age in Atlanta, Havana, and Baltimore. In *African American Pioneers in Anthropology*, edited by I. E. Harrison and F. V. Harrison, pp.154–167. University of Illinois Press, Urbana.

Bond, G. C.

1988 A Social Portrait of John Gibbs St. Clair Drake: An American Anthropologist. *American Ethnologist* 15:762–782.

Boom, R., C. J. Sol, M. M. Salimans, C. L. Jansen, P. M. Wertheim-van Dillen, and J. van der Noordaa

1990 Rapid and Simple Method for Purification of Nucleic Acids. *Journal of Clinical Microbiology* 28(3):495–503.

Bordin, S., V. G. Crespi, A. S. Duarte, D. S. Basseres, M. B. Melo, A. P. Vieira, S. T. Saad, and F. F. Costa

2002 DNAase I Hypersensitive Site 3´ to the Beta-globin Gene Cluster Contains a TAA Insertion Specific for Beta(S)-Benin Haplotype. *Haematologica* 87(3):246–249.

Bortolini, M. C., F. M. Salzano, M. A. Zago, W. A. Da Silva Junior, and T. de A. Weimer

1997 Genetic Variability in Two Brazilian Ethnic Groups: A Comparison of Mitochondrial and Protein Data. *American Journal of Physical Anthropology* 103:147–156.

Boyde, A.

2003 The Real Response of Bone to Exercise. *Journal of Anatomy* 203(2):173–189.

Brakez, Z., E. Bosch, H. Izaabel, O. Akhayat, D. Comas, J. Bertranpetit, and F. Calafell

2001 Human Mitochondrial DNA Sequence Variation in the Moroccan Population of the Souss Area. *Annals of Human Biology* 28(3):295–307.

Brehm, A., L. Pereira, H. J. Bandelt, M. J. Prata, and A. Amorim

2002 Mitochondrial Portrait of the Cabo Verde Archipelago: The Senegambian Outpost of Atlantic Slave Trade. *Annals of Human Genetics* 66(1):49–60.

Bridges, P. S.

1992 Prehistoric Arthritis in the Americas. *Annual Review of Anthropology* 21:67–91.

1994 Vertebral Arthritis and Physical Activities in the Prehistoric Southeastern United States. *American Journal of Physical Anthropology* 93:83–93.

Brodhead, J. R.

1853–1887 *Documents Relative to the Colonial History of the State of New York: Procured in Holland, England, and France*, edited by E. B. O'Callaghan and B. Fernow. 15 vols. Weed, Parson, Albany, New York.

Brooks, S., and J. M. Suchey

1990 Skeletal Age Determination based on the Os Pubis: A Comparison of Acsádi-Nemeskéri and Suchey-Brooks Methods. *Human Evolution* 5(3):227–238.

Broussal, G., G. Coeurdeuil, and O. Ouedraogo

1979 Genetic Structure of the Voltaic Population of the Mossi Plateau (Upper Volta). *Bulletin de la Societé de Pathologie Exotique et de ses Filiales* 72(4):368–374.

Browne, D. L.

1999 Across Class and Culture: Allison Davis and his Works. In *African American Pioneers in Anthropology*, edited by I. E. Harrison and F. V. Harrison, pp. 168–190. University of Illinois Press, Urbana.

Buckley, R. N.
1979 *Slaves in Red Coats: The British West India Regiments, 1795–1815*. Yale University Press, New Haven, Connecticut.

Budd, P., J. Montgomery, A. Cox, P. Krause, B. Barreiro, and R. G. Thomas
1998 The Distribution of Lead within Ancient and Modern Human Teeth: Implications for Long-term and Historical Exposure Monitoring. *Science of the Total Environment* 220:121–136.

Budowle, B., M. R. Wilson, J. A. DiZinno, C. Stauffer, M. A. Fasano, M. M. Holland, and K. L. Monson
1999 Mitochondrial DNA Regions HVI and HVII Population Data. *Forensic Science International* 103(1):23–35.

Buikstra, J. E.
1976 *Hopewell in the Lower Illinois River Valley: A Regional Approach to the Study of Biological Variability and Mortuary Activity*. Archeological Program Research Series Monograph No. 2. Northwestern University, Evanston, Illinois.

Buikstra, J. E., and D. C. Cook
1980 Paleopathology: An American Account. *Annual Review of Anthropology* 9:433–470.

Buikstra, J. E., and L. W. Konigsberg
1985 Paleodemography: Critiques and Controversies. *American Anthropologist* 87:316–333.

Buikstra, J. E., and D. H. Ubelaker (editors)
1994 *Standards for Data Collection from Human Skeletal Remains*. Research Series No. 44. Arkansas Archaeological Survey, Fayetteville, Arkansas.

Burman, M. S., and H. C. Clark
1940 A Roentgenologic Study of the Hip Joint of the Infant in the First Twelve Months of Life. *American Journal of Roentgenology* 44(1):37–47.

Burton, J. H., and T. D. Price
1990 The Ratio of Barium to Strontium as a Paleodietary Indicator of Consumption of Marine Resources. *Journal of Archaeological Science* 17:547–557.

Burton, J. H., and L. E. Wright
1995 Nonlinearity in the Relationship between Bone Sr/Ca and Diet: Paleodietary Implications. *American Journal of Physical Anthropology* 96:273–282.

Buxton, L. H. D., J. C. Trevor, and A. H. Julien
1938 Skeletal Remains from the Virgin Islands. *Man* 38:49–51.

Byers, S. N.
2000 Testing Type II Error Rates in Biological Anthropology. *American Journal of Physical Anthropology* 111:283–290.

Campana, S. E., A. J. Fowler, and C. M. Jones
1994 Otolith Elemental Fingerprinting for Stock Identification of Atlantic Cod (*Gadus morhua*) using Laser Ablation ICP-MS. *Canadian Journal of Fisheries and Aquatic Sciences* 51:1942–1950.

Capasso, L., and G. DiTota
1998 Fifth Toe Distal Inter-phalangeous Synostosis: Paleopathological Description and Possible Evolutionary Significance. *Anthropologie* 36(3):231–234.

Capasso, L., K. A. R. Kennedy, and C. A. Wilczak
1999 *Atlas of Occupational Markers on Human Remains*. Edigrafital, Teramo, Italy.

Carlson, S. J.
1990 Vertebrate Dental Structures. In *Skeletal Biomineralization: Patterns, Processes and Evolutionary Trends*, vol. 1, edited by J. G. Carter, pp. 531–556. Van Nostrand Reinhold, New York.

Carlyle, S. W., R. L. Parr, M. G. Hayes, and D. H. O'Rourke
2000 Context of Maternal Lineages in the Greater Southwest. *American Journal of Physical Anthropology* 113:85–101.

Carrington, S. H. H.
2000 An Assessment of the Epidemiological and Demographic Issues involving Slave Societies in the Eighteenth Century. Unpublished manuscript on file, Department of History, Howard University, Washington, D.C.

Carter, D. R., B. Miki, and K. Padian
1998 Epigenetic Mechanical Factors in the Evolution of Long Bone Epiphyses. *Zoological Journal of the Linnean Society* 123:163–178.

Carter, D. R., M. C. H. van der Meullen, and G. S. Beaupré
1996 Mechanical Factors in Bone Growth and Development. *Bone* 18(1):5S–10S.

Carvalho-Silva, D. R., F. R. Santos, J. Rocha, and S. D. Pena
2001 The Phylogeography of Brazilian Y-chromosome Lineages. *American Journal of Human Genetics* 68(1):281–286.

Cavalli-Sforza, L. L., and M. W. Feldman
2003 The Application of Molecular Genetic Approaches to the Study of Human Evolution. *Nature Genetics* 33 Supplement:266–275.

Charles, D. K., K. Condon, J. M. Cheverud, and J. E. Buikstra
1986 Cementum Annulation and Age Determination in *Homo sapiens*, I. Tooth Variability and Observer Error. *American Journal of Physical Anthropology* 71:311–320.

Chen, B.-Y., and H. W. Janes
2002 *PCR Cloning Protocol.* 2nd ed. Methods in Molecular Biology, vol. 192. Humana Press, Totowa, New Jersey.

Chen, Y. S., A. Olckers, T. G. Schurr, A. M. Kogelnik, K. Huoponen, and D. C. Wallace
2000 mtDNA Variation in the South African Kung and Khwe and their Genetic Relationships to Other African Populations. *American Journal of Human Genetics* 66(4):1362–1383.

Chen, Y. S., A. Torroni, L. Excoffier, A. S. Santachiara-Benerecetti, and D. C. Wallace
1995 Analysis of mtDNA Cariation in African Populations Reveals the Most Ancient of All Human Continent-Specific Haplogroups. *American Journal of Human Genetics* 57(1):133–149.

Chilbeck, P. D., K. S. Davison, D. G. Sale, C. E. Webber, and R. A. Faulkner
2000 Aspects of Physical Activity on Bone Mineral Density Assessed by Limb Dominance across the Lifespan. *American Journal of Human Biology* 12:633–637.

Chima, S. C., C. F. Ryschkewitsch, K. J. Fan, and G. L. Stoner
2000 JC Polyomavirus Genotypes in an Urban United States Population Reflect the History of African Origin and Genetic Admixture in Modern African Americans. *Human Biology* 72:837–850.

Ciminelli, B. M.
2002 Confirmation of the Potential Usefulness of Two Human Beta Globin Pseudogene Markers to Estimate Gene Flows to and from Sub-Saharan Africans. *Human Biology* 74:243–252.

Cipollaro, M., G. Di Bernardo, G. Galano, U. Galderisi, F. Guarino, F. Angelini, and A. Cascino
1998 Ancient DNA in Human Bone Remains from Pompeii Archaeological Site. *Biochemical and Biophysical Research Communications* 247(3):901–904.

Clarke, S. K.
1982 The Association of Early Childhood Enamel Hypoplasias and Radiopaque Transverse Lines in a Culturally Diverse Prehistoric Skeletal Population. *Human Biology* 54(1):77–84.

Cleymaet, R., P. Bottenberg, D. Slop, R. Clara, and D. Coomans
1991 Study of Lead and Cadmium Content of Surface Enamel of Schoolchildren from an Industrial Area in Belgium. *Community Dentistry and Oral Epidemiology* 19:107–111.

Coale, A. J., and P. Demeny
1966 *Regional Model Life Tables and Stable Populations.* Princeton University Press, Princeton, New Jersey.

Cobb, W. M.
1936 Race and Runners. *Journal of Health and Physical Education* 7:1–9.
1939a Thomas Wingate Todd: An Appreciation. *American Journal of Physical Anthropology* Supplement 25:1–3.
1939b The Negro as a Biological Element in the American Population. *Journal of Negro Education* 8:336–348.
1939c *The First Negro Medical Society: A History of the Medico-Chirurgical Society of the District of Columbia 1884–1939*. Associated Publishers, Washington, D.C.
1981 Chapter 3: The Journal Covers. *Journal of the National Medical Association* Supplement 73:1189–1209.

Colden, Cadwallader
1918–1937 *Letters and Papers of Cadwallader Colden, 1711–1775,* 9 vols. The John Watts De Peyster Publication Fund Series, vols. 50–56, 67–68. Collections of the New-York Historical Society. New-York Historical Society, New York.

Collins-Schramm, H. E., R. A. Kittles, D. J. Operario, J. L. Weber, L. A. Criswell, R. S. Cooper, and M. F. Seldin
2002 Markers that Discriminate between European and African Ancestry Show Limited Variation within Africa. *Human Genetics* 111(6):566–569.

Condon, K. W., and J. C. Rose
1992 Intertooth and Intratooth Variability in the Occurrence of Developmental Enamel Defects. *Journal of Paleopathology* 2:61–77.

Condon, K. W., D. K. Charles, J. M. Cheverud, and J. E. Buikstra
1986 Cementum Annulation and Age Determination in *Homo sapiens*, II. Estimates and Accuracy. *American Journal of Physical Anthropology* 71:321–330.

Cook, K.
1993 Black Bones, White Science: The Battle over New York's African Burial Ground. *Village Voice* 4 May:23–27. New York.

Corporation of Trinity Church
1969 Corporation of Trinity Church of Trinity Parish Church Total Alphabetical Population in the City of New York, 27th of October 1969.

Corruccini, R. S., A. C. Aufderheide, J. S. Handler, and L. E. Wittmers, Jr.
1987 Patterning of Skeletal Lead Content in Barbados Slaves. *Archaeometry* 29:233–239.

Corruccini, R. S., J. S. Handler, and K. P. Jacobi
1985 Chronological Distribution of Enamel Hypoplasias and Weaning in a Caribbean Slave Population. *Human Biology* 57:669–711.

Corruccini, R. S., J. S. Handler, R. J. Mutaw, and F. W. Lange
1982 Osteology of a Slave Burial Population from Barbados, West Indies. *American Journal of Physical Anthropology* 59:443–459.

Corruccini, R. S., K. P, Jacobi, J. S. Handler, and A. C. Aufderheide
1987 Implications of Tooth Root Hypercementosis in a Barbados Slave Skeletal Collection. *American Journal of Physical Anthropology* 74:179–184.

Cox, A., F. Keenan, M. Cooke, and J. Appleton
1996 Trace Element Profiling of Dental Tissues using Laser Ablation Inductively Coupled Plasma Mass Spectrometry. *Fresenius Journal of Analytical Chemistry* 354:254–258.

Cox, G., and J. Sealy
1997 Investigating Identity and Life Histories: Isotopic Analysis and Historical Documentation of Slave Skeletons Found on the Cape Town Foreshore, South Africa. *International Journal of Historical Archaeology* 1(3):207–224.

Cox, G., J. Sealy, C. Schrire, and A. Morris
2001 Stable Carbon and Nitrogen Isotopic Analyses of the Underclass at the Colonial Cape of Good Hope in the Eighteenth and Nineteenth Centuries. *World Archaeology* 33(1):73–97.

Crist, T. A., R. H. Pitts, A. Washburn, J. P. McCarthy, D. G. Roberts, and M. Hickey
1999 *"A Distinct Church of the Lord Jesus": The History, Archaeology, and Physical Anthropology of the Tenth Street First African Baptist Church Cemetery, Philadelphia, Pennsylvania*. Submitted to Gaudet & O'Brien/Urban Engineers and the Pennsylvania Department of Transportation. John Milner Associates, Inc., Philadelphia, Pennsylvania.

Crosby, A. W.
1986 *Ecological Imperialism: The Biological Expansion of Europe, 900–1900*. Cambridge University Press, New York.

Crummell, A.
1861 *The Relations and Duties of the Free Colored Men in America to Africa*. Case, Lockwood, Hartford, Conneticut.

Cuellar-Ambrosi, F., M. C. Mondragon, M. Figueroa, C. Prehu, F. Galacteros, and A. Ruiz-Linares
2000 Sickle Cell Anemia and Beta-globin Gene Cluster Haplotypes in Colombia. *Hemoglobin* 24(3):221–225.

Currey, J. D., and G. Butler
1975 The Mechanical Properties of Bone Tissue in Children. *Journal of Bone and Joint Surgery* 57A:810–814.

Curry, L. P.
1981 *The Free Black in Urban America 1800–1850: The Shadow of the Dream*. University of Chicago Press, Chicago.

Curtin, P.
1969 *The Atlantic Slave Trade: A Census*. University of Wisconsin Press, Madison.

Curzon, M. E. J.
1983 Introduction. In *Trace Elements and Dental Disease*, edited by M. E. J. Curzon and T. W. Cutress, pp. 1–9. John Wright, Boston, Massachusetts.

Curzon, M. E. J., and T. W. Cutress (editors)
1983 *Trace Elements and Dental Disease*. John Wright, Boston, Massachusetts.

Curzon, M. E. J., F. L. Losee, and A. S. Macalister
1975 Trace Elements in the Enamel of Teeth from New Zealand and the U.S.A. *New Zealand Dental Journal* 71:80–83.

Dasch, E. J.
1969 Strontium Isotopes in Weathering Profiles, Deep-Sea Sediments, and Sedimentary Rocks. *Geochimica et Cosmochimica Acta* 33:1521–1552.

Davenport, C. B., and M. Steggerda
1929 *Race Crossing in Jamaica*. Carnegie Institution, Washington, D.C.

David, P. A., H. G. Gutman, R. Sutch, P. Temin, and G. Wright
1976 *Reckoning with Slavery: A Critical Study in the Quantitative History of American Negro Slavery*. Oxford University Press, New York.

Day, D. B.
1932 *A Study of Some Negro-White Families in the United States*. Peabody Museum of Harvard University, Cambridge, Massachusetts.

DeCorse, C. R.
1999 Oceans Apart: Africanist Perspectives of Diaspora Archaeology. In *I, Too, Am America: Archaeological Studies of African American Life*, edited by T. Singleton, pp. 299–310. University Press of Virginia, Charlottesville.
2001 *An Archaeology of Elmina: Africans and Europeans on the Gold Coast, 1400–1900*. Smithsonian Institution Press, Washington, D.C.

Delany, M. R.
1861 *Official Report of the Niger Valley Exploring Party.* T. Hamilton, New York.

Demirjian, A.
1986 Dentition. In *Postnatal Growth*, edited by F. Falkner and J. M. Tanner, pp. 269–298. Human Growth, 2nd ed., vol. 2. Plenum Press, New York.

de Pablo R., J. M. Garcia-Pacheco, C. Vilches, M. E. Moreno, L. Sanz, M. C. Rementeria, S. Puente, and M. Kreisler
1997 HLA Class I and Class II Allele Distribution in the Bubi Population from the Island of Bioko (Equatorial Guinea). *Tissue Antigens* 50(6):593–601.

Derevenski, J. R. S.
2000 Sex Differences in Activity-Related Osseous Change in the Spine and the Gendered Division of Labor at Ensay and Wharram Percy, UK. *American Journal of Physical Anthropology* 111:333–354.

de Villiers, H.
1968 *The Skull of the South African Negro: A Biometrical and Morphological Study*. Witwatersrand University Press, Johannesburg, South Africa.

Diop, C. A.
1974 *The African Origin of Civilization: Myth or Reality*. Translated by M. Cook. Lawrence Hill, New York.

Diouf, S. A. (editor)
2003 *Fighting the Slave Trade: West African Strategies*. Ohio University Press, Athens.

Dittrick, J.
1979 Sexual Dimorphism of the Femur and Humerus in Prehistoric Central California Skeletal Samples. Unpublished Master's

thesis, Department of Anthropology, California State University, Fullerton.

Douglass, F.

1854 [1950,1999] The Claims of the Negro Ethnologically Considered. Address delivered at Case Western Reserve College, July 12, 1854. *Frederick Douglass: Selected Speeches and Writings.* Philip S. Foner, editor, International Publishers, New York. Abridged and adapted by Yuval Taylor. Lawrence Hill Books, Chicago, 282–297.

1854 The Claims of the Negro Ethnologically Considered: An Address before the Literary Society of Case Western Reserve College at Commencement, July 12, 1854. Lee, Mann, Rochester, New York. Daily American Office.

1950 [1854] The Claims of the Negro Ethnologically Considered. In *The Life and Writings of Frederick Douglass*, edited by P. S. Foner, pp. 289–309. International Publishers, New York.

Drake, St. C.

1980 Anthropology and the Black Experience. *Black Scholar* 11:2–31.

1987 *Black Folk Here and There: An Essay in History and Anthropology*, vol. 1. Center for Afro-American Studies, University of California, Los Angeles.

1990 *Black Folk Here and There: An Essay in History and Anthropology*, vol. 2. Center for Afro-American Studies, University of California, Los Angeles.

1993 Diaspora Studies and Pan-Africanism. In *Global Dimensions of the African Diaspora*, edited by J. E. Harris, pp. 451–514. Howard University Press, Washington, D.C.

Drake, St. C., and H. R. Clayton

1945 *Black Metropolis: A Study of Negro Life in a Northern City*. Harcourt, Brace, New York.

Du Bois, W. E. B.

1899 *The Philadelphia Negro: A Social Study*. University of Pennsylvania Press, Philadelphia.

1903 *The Souls of Black Folk*. Bedford Books, Boston, Massachusetts.

1915 *The Negro*. Henry Holt, New York.

Duffy, J.

1953 *Epidemics in Colonial America*. Louisiana State University Press, Baton Rouge.

1968 *A History of Public Health in New York City, 1625–1866*. Russell Sage Foundation, New York.

Dutch Reformed Church

1727–1804 New York Burial Register. Transcript on file, New York Genealogical and Biographical Society, New York.

Eblen, J. E.

1979 New Estimates of the Vital Rates of the United States Black Population during the Nineteenth Century. In *Studies in American Historical Demography*, edited by M. A. Vinovskis, pp. 339–357. Academic Press, New York.

Edwards, G. F.

1968 *E. Franklin Frazier on Race Relations*. University of Chicago Press, Chicago.

Elia, R. J.

1991 *Archaeological Excavations at the Uxbridge Almshouse Burial Ground in Uxbridge, Massachusetts*. BAR International Series 564. Tempus Reparatum, Oxford, Great Britain.

El-Najjar, M. Y., M. V. De Santi, and L. Ozebek

1978 Prevalence and Possible Etiology of Dental Enamel Hypoplasia. *American Journal of Physical Anthropology* 48(2):185–192.

Epperson, T. W.

1996 The Politics of "Race" and Cultural Identity at the African Burial Ground Excavations, New York City. *World Archaeological Bulletin* 7:108–117.

1999 The Contested Commons: Archaeologies of Race, Repression, and Resistance in New York City. In *Historical Archaeologies of Capitalism*, edited by M. P. Leone and P. B. Potter, Jr., pp. 81–110. Plenum, New York.

Ericson, J. E.

1985 Strontium Isotope Characterization in the Study of Prehistoric Human Ecology. *Journal of Human Evolution* 14:503–514.

1989 Some Problems and Potentials of Strontium Isotope Analysis for Human and Animal Ecology. In *Stable Isotopes in Ecological Research*, edited by P. W. Rundel, J. R. Ehleringer, and K. A. Nagy, pp. 252–259. Springer-Verlag, New York.

Estes, J. W.
1990 *Dictionary of Protopharmacology: Therapeutic Practices, 1700–1850*. Science History Publications, Canton, Massachusetts.

Evans, R. D., P. M. Outridge, and P. Richner
1994 Applications of Laser Ablation Inductively Coupled Plasma Mass Spectrometry to the Determination of Environmental Contaminants in Calcified Biological Structures. *Journal of Analytic Atomic Spectrometry* 9:985–989.

Evans, R. D., P. Richner, and P. M. Outridge
1995 Microspatial Variations of Heavy Metals in the Teeth of Walrus as Determined by Laser Ablation ICP-MS: The Potential for Reconstructing a History of Metal Exposure. *Archives of Environmental Contamination and Toxicology* 28:55–60.

Excoffier, L., and S. Schneider
1999 Why Hunter-Gatherer Populations Do Not Show Signs of Pleistocene Demographic Expansions. *Proceedings of the National Academy of Sciences of the United States of America* 96(19):10597–10602.

Ezzo, J. A.
1994a Zinc as a Paleodietary Indicator: An Issue of Theoretical Validity in Bone-Chemistry Analysis. *American Antiquity* 59:606–621.
1994b Putting the "Chemistry" Back in Archaeological Bone Chemistry Analysis: Modeling Potential Paleodietary Indicators. *Journal of Anthropological Archaeology* 13:1–34.

Falkner, F.
1966 *Human Development*. W. B. Saunders, Philadelphia, Pennsylvania.

Falomo, O. O.
2002 The Cusp of Carabelli: Frequency, Distribution, Size and Clinical Significance in Nigeria. *West African Journal of Medicine* 21(4):322–324.

Fazekas, I. G., and F. Kośa
1978 *Forensic Fetal Osteology*. Akadémiai Kiadó, Budapest, Hungary.

Ferguson, L.
1992 *Uncommon Ground: Archaeology and Early African America, 1650–1800*. Smithsonian Institution Press, Washington, D.C.

Fergusson, J. E., and N. G. Purchase
1987 Analysis and Levels of Lead in Human Teeth: A Review. *Environmental Pollution* 46:11–44.

Fields, S. J., M. Spiers, I. Hershkovits, and G. Livshits
1995 Reliability of Reliability Coefficients in the Estimation of Asymmetry. *American Journal of Physical Anthropology* 96:83–88.

Firmin, J.-A.
1885 *De l'égalité des races humaines: anthropologie positive*. Translated by A. Charles. Garland, New York.

Flecker, H.
1942 Time of Appearance and Fusion of Ossification Centers as Observed by Roentgenographic Methods. *American Journal of Roentgenography and Radiation Therapy* 47:97–159.

Flores, C., N. Maca-Meyer, J. A. Perez, and V. M. Cabrera
2001 The Peopling of the Canary Islands: A CD4/Alu Microsatellite Haplotype Perspective. *Human Immunology* 62(9):949–953.

Fluehr-Lobban, C.
2000 Antenor Firmin: Haitian Pioneer of Anthropology. *American Anthropologist* 102:449–466.

Fogel, R. W., and S. L. Engerman
1974 *Time on the Cross: The Economics of American Negro Slavery*. Little, Brown, Boston, Massachusetts.

Foote, T.
1991 *Black Life in Colonial Manhattan, 1664–1786*. Ph.D. dissertation, Harvard University. University Microfilms, Ann Arbor, Michigan.

Foote, T. W., M. Carey, J. Giesenberg-Haag, J. Grey, K. McKoy, and C. Todd
1993 *Report of the Site-Specific History of Block 154*. Submitted to the African Burial

Ground Research Project. New York, August 25:11–12.

Forman, S. (editor)
1994 *Diagnosing America: Anthropology and Public Engagement*. University of Michigan Press, Ann Arbor.

Fowler, C.
1972 *A Knot in the Thread: The Life and Work of Jacques Roumain*. Howard University Press, Washington, D.C.

Fraginals, M. M.
1977 Africa in Cuba: A Quantitative Analysis of the African Population in the Island of Cuba. In *Comparative Perspectives on Slavery in the New World Plantation Societies*, edited by V. Rubin and A. Tuden, pp. 187–201. Annals of the New York Academy of Sciences, New York.

Franklin, J. H.
1947 *From Slavery to Freedom: A History of Negro Americans*. McGraw Hill, New York.
1967 *From Slavery to Freedom: A History of Negro Americans.* 3rd. ed. Alfred A. Knopf, New York.

Frazier, E. F.
1930 The Negro Slave Family. *Journal of Negro History* 15:198–259.
1939 *The Negro Family in the United States*. University of Chicago Press, Chicago.

Frost, H. M.
1985 The "New Bone": Some Anthropological Potentials. *Yearbook of Physical Anthropology* 28:211–226.
1998 Changing Concepts in Skeletal Physiology: Wolff's Law, the Mechanostat, and the "Utah Paradigm." *American Journal of Human Biology* 10:599–606.
1999 An Approach to Estimating Bone and Joint Loads and Muscle Strength in Living Subjects and Skeletal Remains. *American Journal of Human Biology* 11:437–458.

Fujii, K., and Y. Matsuura
1999 Analysis of the Velocity Curve for Height by the Wavelet Interpolation Method in Children Classified by Maturity Rate. *American Journal of Human Biology* 11:13–30.

Galera, V., and M. D. Garralda
1993 Enthesopathies in a Spanish Medieval Population: Anthropological, Epidemiological, and Ethnohistorical Aspects. *International Journal of Anthropology* 8(4):247–258.

Garn, S. M.
1980 Human Growth. *Annual Review of Anthropology* 9:275–292.

Garn, S. M., K. Koski, and A. B. Lewis
1957 Problems in Determining the Tooth Eruption Sequence in Fossil and Modern Man. *American Journal of Physical Anthropology* 15:313–331.

Garn, S. M., C. G. Rohmann, and M. A. Guzmán
1966 Malnutrition and Skeletal Development in the Pre-school Child. *Yearbook of Physical Anthropology* 14:82–102.

Gates, H. L. A., and W. L. Andrews
1998 *Pioneers of the Black Atlantic: Five Slave Narratives from the Enlightenment, 1772–1815*. Harvard University Press, Cambridge, Massachusetts.

Gene, M., P. Moreno, N. Borrego, E. Pique, C. Brandt, J. Mas, M. Luna, J. Corbella, and E. Huguet
2001 The Bubi Population of Equatorial Guinea Characterized by HUMTH01, HUMVWA31A, HUMCSF1PO, HUMTPOX, D3S1358, D8S1179, D18S51 and D19S253 STR Polymorphisms. *International Journal of Legal Medicine* 114(4–5):298–300.

General Services Administration
1993 Foley Square Project, Federal Courthouse, and Federal Office Building, New York, New York. 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.

Genovese, E. D.
1976 *Roll, Jordan, Roll: The World the Slaves Made*. Vintage Books, New York.

Gibbons, A.
1993 Geneticists Trace the DNA Trail of the First Americans. *Science* 259(5093):312–313.
1996 DNA Enters Dust Up Over Bones. *Science* 274(5285):172.

Gilbert, C., J. Sealey, and A. Sillen
1994 An Investigation of Barium, Calcium and Strontium as Paleodietary Indicators in the Southwestern Cape, South Africa. *Journal of Archaeological Sciences* 21:173–184.

Gilbert, S. F.
1992 Synthesizing Embryology and Genetics: Paradigms Regained. *American Journal of Human Genetics* 51:211–215.
1997 *Developmental Biology*. 7th ed. Sinauer Associates, Sunderland, Massachusetts.

Gillett, R. M.
1997 Dental Emergence among Urban Zambian School Children: An Assessment of the Accuracy of Three Methods in Assigning Ages. *American Journal of Physical Anthropology* 102:447–454.
1998 Permanent Tooth Emergence among Zambian Schoolchildren: A Standard for the Assignment of Ages. *American Journal of Human Biology* 10:45–52.

Gladstone, M., Y. Lasne, L. Sann, and G. Putet
1998 Non-linear Patterns of Growth and Very Low Birth Weight Infants. *American Journal of Human Biology* 10:637–646.

Golden, M. H.
1988 The Role of Individual Nutrient Deficiencies in Growth Retardation of Children as Exemplified by Zinc and Protein. In *Linear Growth Retardation in Less Developed Countries*, edited by J. C. Waterlow, pp. 143–163. Raven Press, New York.

Goldstein, S. J., and S. B. Jacobsen
1988 Nd and Sr Isotopic Systematics of River Water Suspended Material: Implications for Crustal Evolution. *Earth and Planetary Science Letters* 87(3):249–265.

Gomez, M. A.
1998 *Exchanging Our Country Marks: The Transformation of African Identities in the Colonial and Antebellum South*. University of North Carolina Press, Chapel Hill.

Goncalves, M. S., J. F. Nechtman, M. S. Figueiredo, J. Kerbauy, V. R. Arruda, M. F. Sonati, S. O. Saad, F. F. Costa, and T. A. Stoming
1994 Sickle Cell Disease in a Brazilian Population from São Paulo: A Study of the Beta S Haplotypes. *Human Heredity* 44(6):322–327.

Goode, H., T. Waldron, and J. Rogers
1993 Bone Growth in Juveniles: A Methodological Note. *International Journal of Osteoarchaeology* 3:321–323.

Goode-Null, S. K.
2002 *Slavery's Child: A Study of Growth and Childhood Sex Ratios in the New York African Burial Ground*. Ph.D. dissertation, University of Massachusetts. University Microfilms, Ann Arbor, Michigan.

Goodfriend, J.
1992 *Before the Melting Pot: Society and Culture in Colonial New York City, 1664–1730*. Princeton University Press, Princeton, New Jersey.

Goodman, A. H.
1992 Cartesian Reductionism and Vulgar Adaptationism: Issues in the Interpretation of Nutritional Status in Prehistory. Paper presented at the Southern Illinois State University Center for Archaeological Investigation Conference "Paleonutrition: The Diet and Health of Prehistoric Americans."
1993 On the Interpretation of Health from Skeletal Remains. *Current Anthropology* 34(3):281–288.
1997 Bred in the Bone? *The Sciences* 37 (March/April):20–25.
1998 The Biological Consequences of Inequality in Antiquity. In *Building a New Biocultural Synthesis: Political-Economic Perspectives on Human Biology*, edited by A. H. Goodman and T. L. Leatherman, pp. 147–169. University of Michigan Press, Ann Arbor.

Goodman, A. H., and G. J. Armelagos
1985a The Chronological Distribution of Enamel Hypoplasias: A Comparison of Permanent Incisor and Canine Patterns. *Archaeology of Oral Biology* 30:503–507.
1985b Factors Affecting the Distribution of Enamel Hypoplasias within the Human Permanent Dentition. *American Journal of Physical Anthropology* 68:479–493.
1988 Childhood Stress and Decreased Longevity in a Prehistoric Population. *American Anthropologist* 90:936–944.

Goodman, A. H., G. J. Armelagos, and J. C. Rose
1980 Enamel Hypoplasias as Indicators of Stress in Three Prehistoric Populations from Illinois. *Human Biology* 52:515–528.

Goodman, A. H., A. E. Dolphin, R. Klein, J. R. Backstrand, D. Amarasiriwardena, J. Reid, and P. Outridge
2003 Tooth Rings: Dental Enamel as a Chronological Biomonitor of Elemental Absorption from Pregnancy to Adolescence. *Journal of Children's Health* 1:203–214.

Goodman, A. H., and T. L. Leatherman
1998 *Building a New Biocultural Synthesis: Political-Economic Perspectives on Human Biology.* University of Michigan Press, Ann Arbor.

Goodman, A. H., D. L. Martin, and G. J. Armelagos
1985 Factors Affecting the Distribution of Enamel Hypoplasias within the Human Permanent Dentition. *American Journal of Physical Anthropology* 68:479–493.

Goodman, A. H., D. L. Martin, G. J. Armelagos, and G. Clark
1984 Indicators of Stress in Bones and Teeth. In *Paleopathology at the Origins of Agriculture*, edited by M. N. Cohen and G. J. Armelagos, pp. 13–49. Academic Press, Orlando, Florida.

Goodman, A. H., D. L. Martin, C. P. Klein, M. S. Peele, N. A. Cruse, L. R. McEwen, A. Saeed, and B. M. Robinson
1992 Cluster Bands, Wilson Bands and Pit Patches: Histological and Enamel Surface Indicators of Stress in the Black Mesa Anasazi Population. *Journal of Paleopathology* 2:115–127.

Goodman, A. H., J. R. Reid, M. E. Mack, J. Jones, and C. Spaulding
2000 Chemical Analyses of the Places of Birth and Migration of the Africans of Colonial New York. *American Journal of Physical Anthropology* Supplement 30:162.

Goodman, A. H., and J. C. Rose
1990 Assessment of Systemic Physiological Perturbations from Dental Enamel Hypoplasias and Associated Histological Structures. *Yearbook of Physical Anthropology* 33:59–110.

Goodman, A. H., and R. J. Song
1999 Sources of Variation in Estimated Ages at Formation of Linear Enamel Hypoplasias. In *Human Growth in the Past: Studies from Bones and Teeth*, edited by R. D. Hoppa and C. FitzGerald, pp. 210–240. Cambridge University Press, New York.

Goodman, A. H., R. B. Thomas, A. C. Swedlund, and G. J. Armelagos
1988 Biocultural Perspectives on Stress in Prehistoric, Historical, and Contemporary Population Research. *Yearbook of Physical Anthropology* 31:169–202.

Gould, A. R., A. G. Farman, and D. Corbitt
1984 Mutilations of the Dentition in Africa: A Review with Personal Observations. *Quintessence International* 15:89–94.

Gould, S. J.
1996 *The Mismeasure of Man*. Rev. and expanded ed. Norton, New York.

Grant, M.
1916 *The Passing of the Great Race; Or, the Racial Basis of European History*. Scribner, New York.

Graven, L., G. Passarino, O. Semino, P. Boursot, S. Santachiara-Benerecetti, A. Langaney, and L. Excoffier
1995 Evolutionary Correlation between Control Region Sequence and Restriction Polymorphisms in the Mitochondrial Genome of a Large Senegalese Mandenka Sample. *Molecular Biology and Evolution* 2:334–345.

Green, L. D., J. N. Derr, and A. Knight
2000 mtDNA Affinities of the Peoples of North-Central Mexico. *American Journal of Human Genetics* 66(3):989–998.

Greene, D., D. P. Van Gerven, and G. J. Armelagos
1986 Life and Death in Ancient Populations: Bones of Contention in Paleodemography. *Human Evolution* 1:193–207.

Greene, D. L.
1972 Dental Anthropology of Early Egypt and Nubia. *Journal of Human Evolution* 1(3):315–324.

Greene, L. J.
1942 *The Negro in Colonial New England 1620–1776*. Kennikat Press, Port Washington, New York.

Greene, L. S.
1993 G6PD Deficiency as Protection against Falciparum Malaria: An Epidemiological Critique of Population and Experimental Studies. *Yearbook of Physical Anthropology* 36:153–178.

Greenhalgh, S.
1996 The Social Construction of Population Sciences: An Intellectual, Institutional, and Political History of Twentieth-Century Demography. *Comparative Studies in Society and History* 38(1):26–66.

Gruelich, W. W., and S. I. Pyle
1950 *Radiographic Atlas of Skeletal Development of the Hand and Wrist*. Stanford University Press, Palo Alto, California.

Grupe, G.
1998 Archives of Childhood—the Research Potential of Trace Element Analyses of Ancient Human Dental Enamel. In *Dental Anthropology: Fundamentals, Limits, and Prospects*, edited by K. W. Alt, F. W. Rosing, and M. Teschler-Nicola, pp. 387–415. Springer-Verlag/Wien, New York.

Guatelli-Steinberg, D., J. D. Irish, and J. R. Lukacs
2001 Canary Island–North African Population Affinities: Measures of Divergence based on Dental Morphology. *Homo* 52(2):173–188.

Guatelli-Steinberg, D., and J. R. Lukacs
1999 Interpreting Sex Differences in Enamel Hypoplasia in Human and Non-human Primates: Developmental, Environmental, and Cultural Considerations. *Yearbook of Physical Anthropology* 42:73–126.

Guiteras, P. J.
1927 *Historia de la Isla de Cuba*. Cultural S.A., Havana, Cuba.

Gulson, B. L., C. W. Jameson, and B. R. Gillings
1997 Stable Lead Isotopes in Teeth as Indicators of Past Domicile—a Potential New Tool in Forensic Science? *Journal of Forensic Science* 42(5):787–791.

Gulson, B. L., and D. Wilson
1994 History of Lead Exposure in Children Revealed from Isotopic Analyses of Teeth. *Archives of Environmental Health* 49:279–283.

Guo, S. S., A. F. Roche, W. C. Chumlea, C. Johnson, R. J. Kuczmarski, and R. Curtin
2000 Statistical Effects of Varying Sample Sizes on the Precision of Percentile Estimates. *American Journal of Human Biology* 12:64–74.

Gupta, A., and J. Ferguson
1992 Beyond "Culture": Space, Identity, and the Politics of Difference. *Cultural Anthropology* 7:6–23.

Gustafson, B. E., and G. Koch
1974 Age Estimation Up to 16 Years of Age based on Dental Development. *Odontologisk Revy* 25:297–306.

Gutman, H. G.
1975 *Slavery and the Numbers Game: A Critique of* Time on the Cross. University of Illinois Press, Urbana.
1976 *The Black Family in Slavery and Freedom, 1750–1925*. Vintage Books, New York.

Guy, H., C. Masset, and C. A. Baud
1997 Infant Taphonomy. *International Journal of Osteoarchaeology* 7:221–229.

Haack, K., S. Hummel, and B. Hummel
2000 Ancient DNA Fragments Longer than 300 bp. *Anthropologischer Anzeiger* 58(1):51–56.

Haas, J.
1994 *Standards for Data Collection from Human Skeletal Remains: Proceedings of a Seminar at the Field Museum of Natural History*. Research Series No. 44. Arkansas Archaeological Survey, Fayetteville.

Haas, W. H., G. Bretzel, B. Amthor, K. Schilke, G. Krommes, S. Rusch-Gerdes, V. Sticht-Groh, and H. J. Bremer
1997 Comparison of DNA Fingerprint Patterns of Isolates of *Mycobacterium africanum* from East and West Africa. *Journal of Clinical Microbiology* 35(3):663–666.

Habermas, J.
1975 *Legitimation Crisis*. Translated by Thomas McCarthy. Beacon Press, Boston, Massachusetts.

Hägg, U., and J. Taranger
1980 Skeletal Stages of the Hand and Wrist as Indicators of the Pubertal Growth Spurt. *Acta Odontologica Scandinavica* 38:187–200.

1981 Dental Emergence Stages and the Pubertal Growth Spurt. *Acta Odontologica Scandinavica* 39:295–306.
1992 Pubertal Growth and Maturity Pattern in Early and Late Maturers. *Swedish Dental Journal* 16:199–209.

Hall, G. M.
1992 *Africans in Colonial Louisiana: The Development of Afro-Creole Culture in the Eighteenth Century*. Louisiana State University Press, Baton Rouge.

Hals, E., and K. A. Selvig
1977 Correlated Electron Probe Microanalysis and Microradiography of Carious and Normal Dental Cementum. *Caries Research* 11:62–75.

Hamblin, M. T., E. E. Thompson, and A. Di Rienzo
2002 Complex Signatures of Natural Selection at the Duffy Blood Group Locus. *American Journal of Human Genetics* 70(2):369–383.

Hammer, M. F., T. M. Karafet, A. J. Redd, H. Jarjanazi, S. Santachiara-Benerecetti, H. Soodyall, and S. L. Zegura
2001 Hierarchical Patterns of Global Human Y-Chromosome Diversity. *Molecular Biology and Evolution* (7):1189–1203.

Handler, J. S.
1994 Determining African Birth from Skeletal Remains: A Note on Tooth Mutilation. *Historical Archaeology* 28(3):113–119.
1997 An African-Type Healer/Diviner and His Grave Goods: A Burial from a Plantation Slave Cemetery in Barbados, West Indies. *International Journal of Historical Archaeology* 1(2):91–130.

Handler, J. S., and R. S. Corruccini
1986 Weaning among West Indian Slaves: Historical and Bioanthropological Evidence from Barbados. *William and Mary Quarterly* 43:111–117.

Handler, J. S., R. S. Corruccini, and R. J. Mutaw
1982 Tooth Mutilation in the Caribbean: Evidence from a Slave Burial Population in Barbados. *Journal of Human Evolution* 11:297–313.

Handler, J. S., and F. W. Lange
1978 *Plantation Slavery in Barbados: An Archaeological and Historical Investigation*. Harvard University Press, Cambridge, Massachusetts.

Harrington, S.
1993 Bones and Bureaucrats. *Archaeology* 6:28–38.

Harris, J. E.
1993 *Global Dimensions of the African Diaspora*. 2nd ed. Howard University Press, Washington, D.C.

Harrison, F. V.
1992 The Du Boisian Legacy in Anthropology. *Critical Anthropology* 12:239–260.

Hawkey, D. E.
1988 Use of the Upper Extremity Enthesopathies to Indicate Habitual Activity Patterns. Unpublished Master's thesis, Department of Anthropology, Arizona State University, Tempe.

Hawkey, D. E., and C. F. Merbs
1995 Activity-Induced Musculoskeletal Stress Markers (MSM) and Subsistence Strategy Changes among Ancient Hudson Bay Eskimos. *International Journal of Osteoarchaeology* 5:324–338.

Hemenway, R. E.
1977 *Zora Neale Hurston: A Literary Biography*. University of Illinois Press, Urbana.

Herring, D. A., S. R. Saunders, and M. A. Katzenberg
1998 Investigating the Weaning Process in Past Populations. *American Journal of Physical Anthropology* 105:425–439.

Herrnstadt, C., J. L. Elson, E. Fahy, G. Preston, D. M. Turnbull, C. Anderson, S. S. Ghosh, J. M. Olefsky, M. F. Beal, R. E. Davis, and N. Howell
2002 Reduced-Median-Network Analysis of Complete Mitochondrial DNA Coding-Region Sequences for the Major African, Asian, and European Haplogroups. *American Journal of Human Genetics* 70(5):1152–1171.

Herskovits, M. J.
1928 *The American Negro: A Study of Racial Crossing*. A. A. Knopf, New York.
1930 The Negro in the New World: Statement of a Problem. *American Anthropologist* 32:145–156.
1941 *The Myth of the Negro Past*. Harper and Brothers, New York.

Hewitt, R., A. Krause, A. Goldman, G. Campbell, and T. Jenkins

1996 Beta-globin Haplotype Analysis Suggests that a Major Source of Malagasy Ancestry Is Derived from Bantu-speaking Negroids. *American Journal of Human Genetics* 58(6):1303–1308.

Higgins, R. L., M. R. Haines, L. Walsh, and J. E. Sirianni

2002 The Poor in the Mid-Nineteenth Century Northeast United States: Evidence from the Monroe County Almshouse, Rochester, New York. In *The Backbone of History*, edited by R. H. Steckel and J. C. Rose, pp. 162–184. Cambridge University Press, Cambridge, Great Britain.

Higman, B. W.

1979 Growth in Afro-Caribbean Slave Populations. *American Journal of Physical Anthropology* 50:373–386.

1984 *Slave Populations of the British Caribbean, 1807–1834*. Johns Hopkins University Press, Baltimore, Maryland.

1991 Household Structure and Fertility on Jamaican Slave Plantations: A Nineteenth-Century Example. In *Caribbean Slave Society and Economy*, edited by H. Beckles and V. Shepherd, pp. 527–550. New Press, New York.

Hill, M. C., M. L. Blakey, and M. E. Mack

1995 Women, Endurance, Enslavement: Exceeding the Physiological Limits. *American Journal of Physical Anthropology* Supplement 20:110–111.

Hillson, S. W.

1996 *Dental Anthropology*. Cambridge University Press, Cambridge, Great Britain.

Himes, J. H.

1999 Maturation-Related Deviations and Misclassification of Stature and Weight in Adolescence. *American Journal of Human Biology* 11:499–504.

Hodges, D. C., and L. M. Schell

1988 Power Analysis in Biological Anthropology. *American Journal of Physical Anthropology* 77:175–181.

Hoffman, J. M.

1979 Age Estimations from Diaphyseal Lengths: Ten Months to Twelve Years. *Journal of Forensic Science* 24(2):461–469.

Holl, A. F. C.

1995 African History: Past, Present, and Future; the Unending Quest for Alternatives. In *Making Alternative Histories*, edited by P. R. Schmidt and T. C. Patterson, pp. 183–211. School of American Research Press, Santa Fe, New Mexico.

2000 Toward an Archaeology of Urban Slavery: The Spatial Analysis of the New York African Burial Ground (ca. 1650–1796). Department of Anthropology, University of California, San Diego, La Jolla.

2002 Toward an Archaeology of Urban Slavery: The Spatial Analysis of the New York African Burial Ground (ca. 1650–1796). Department of Anthropology, University of California, La Jolla. Unpublished manuscript on file in the archives of the New York African Burial Ground Project.

Hooton, E. A.

1930 *The Indians of Pecos Pueblo: A Study of their Skeletal Remains*. Yale University Press, New Haven, Connecticut.

1939 *Crime and Man*. Harvard University Press, Cambridge, Massachusetts.

Hoppa, R. D.

1992 Evaluating Human Skeletal Growth: An Anglo-Saxon Example. *International Journal of Osteoarchaeology* 2:275–288.

2000 Variation in Osteological Aging Criteria: An Example from the Pubic Symphysis. *American Journal of Physical Anthropology* 11:185–191.

Hoppa, R. D., and C. M. FitzGerald

1999 From Head to Toe: Integrating Studies from Bones and Teeth in Biological Anthropology. In *Human Growth in the Past: Studies from Bones and Teeth*, edited by R. D. Hoppa and C. M. FitzGerald, pp. 1–30. Cambridge University Press, Cambridge, Great Britain.

Hoppa, R. D., and K. L. Gruspier

1996 Estimating Diaphyseal Length from Fragmentary Subadult Skeletal Remains: Implications for Paleodemographic Reconstructions of a Southern Ontario Ossuary. *American Journal of Physical Anthropology* 100:341–354.

Höss, M., and S. Pääbo
1993 DNA Extraction from Pleistocene Bones by a Silica-Based Purification Method. *Nucleic Acids Research* 21(16):3913–3914.

Howard University and John Milner Associates
1993 *Research Design for Archaeological, Historical, and Bioanthropological Investigations of the African Burial Ground (Broadway Block)*. Howard University and John Milner Associates, New York.

Howells, W. W.
1973 *Cranial Variation in Man: A Study by Multivariate Analysis of Patterns of Difference among Recent Human Populations*. Papers of the Peabody Museum of Archaeology and Ethnology Vol. 67. Harvard University, Cambridge, Massachusetts.

Howson, J. E., S. Goode-Null, M. L. Blakey, E. Brown, and L. M. Rankin-Hill
2000 Political Economy of Forced Migration and Sex Ratio. Paper presented at the 69th Annual Meeting of the American Association of Physical Anthropologists, San Antonio, Texas.

Hrdlička, A.
1918 Physical Anthropology: Its Scope and Aims, its History and Present Status in America. *American Journal of Physical Anthropology* 1:3–34.
1925 *The Old Americans.* Williams and Wilkins, Baltimore, Maryland.
1927 Anthropology and the Negro: Historical Notes. *American Journal of Physical Anthropology* 10:205–235.
1928 The Full-Blood American Negro. *American Journal of Physical Anthropology* 12:15–30.

Huggare, J., and O. Rönning
1995 Growth of the Cranial Vault: Influence of Intracranial and Extracranial Pressures. *Acta Odontologica Scandinavica* 53:192–195.

Huh, Y., and J. M. Edmond
1996 The Isotopic Systematics of Fluvial Sr; New Results from the Big Rivers of Eastern Siberia*. EOS: Transactions of the American Geophysical Union* 77:325.

Hummel, S., and B. Herrmann
1997 Determination of Kinship by aDNA Analysis. *Anthropologischer Anzeiger* 55(2):217–223.

Hummel, S., G. Nordsiek, J. Rameckers, C. Lassen, H. Zierdt, H. Baron, and B. Herrmann
1995 aDNA—a New Approach to Old Questions. *Zeitschrift für Morphologie und Anthropologie* 81(1):41–65.

Hummert, J. R., and D. P. Van Gerven
1983 Skeletal Growth in a Medieval Population from Sudanese Nubia. *American Journal of Physical Anthropology* 60:471–478.

Humphrey, L. T.
1998 Growth Patterns in the Modern Human Skeleton. *American Journal of Physical Anthropology* 105:57–72.

Hunt, E. E., Jr., and I. Gleiser
1955 The Estimation of Age and Sex of Preadolescent Children from Bones and Teeth. *American Journal of Physical Anthropology* 13:479–497.

Huss-Ashmore, R., A. H. Goodman, and G. J. Armelagos
1982 Nutritional Inference from Paleopathology. *Advances in Archaeological Method and Theory* 5:395–474.

Hutchinson, H. W.
1957 *Village and Plantation Life in Northeastern Brazil*. University of Washington Press, Seattle.

Hutchinson, J.
1987 The Age-Sex Structure of the Slave Populations in Harris County, Texas: 1850–1860. *American Journal of Physical Anthropology* 74:231–238.

Ikehara-Quebral, R., and M. T. Douglas
1997 Cultural Alteration of Human Teeth in the Mariana Islands. *American Journal of Physical Anthropology* 104:381–391.

Ingle, M., J. E. Howson, and R. S. Edward
1990 *A Stage IA Cultural Resource Survey of the Proposed Foley Square Project in the Borough of Manhattan, New York, New York*. Edwards and Kelcey Engineers, the General Services Administration, and Historic Conservation and Interpretation, Newton, New Jersey.

Ingman, M., H. Kaessmann, S. Paabo, and U. Gyllensten

2000 Mitochondrial Genome Variation and the Origin of Modern Humans. *Nature* 408(6813):708–713.

Inoue, N., R. Sakashita, M. Inoue, T. Kamegai, K. Ohashi, and M. Katsivo

1995 Ritual Ablation of Front Teeth in Modern and Recent Kenyans. *Anthropological Science* 103(3):263–277.

Inoue, N., R. Sakashita, N. Tadashige, and T. Kamegai

1992 A Preliminary Report on Ritual Ablation of Anterior Teeth in Modern Kenyans. *Journal of the Anthropological Society of Nippon* 100(1):119–123.

Irish, J. D.

1993 Biological Affinities of Late Pleistocene through Modern African Aboriginal Populations: The Dental Evidence. Unpublished Ph.D. dissertation, Department of Anthropology, Arizona State University, Tempe.

1997 Characteristic High- and Low-Frequency Dental Traits in Sub-Saharan African Populations. *American Journal of Physical Anthropology* 102:455–467.

1998 Ancestral Dental Traits in Recent Sub-Saharan Africans and the Origins of Modern Humans. *Journal of Human Evolution* 34(1):81–98.

İşcan, M. Y., S. R. Loth, and R. K. Wright

1984a Age Estimation from the Rib by Phase Analysis: White Males. *Journal of Forensic Science* 29(4):1094–1104.

1984b Metamorphosis at the Sternal Rib End: A New Method to Estimate Age at Death in White Males. *American Journal of Physical Anthropology* 65:147–156.

Ivanhoe, F.

1994 Osteometric Scoring of Adult Residual Rickets Skeletal Plasticity in Two Archaeological Populations from Southeastern England: Relationships to Sunshine and Calcium Deficits and Demographic Stress. *International Journal of Osteoarchaeology* 4(2):97–120.

Jackson, F. L. C.

1997 Concerns and Priorities in Genetic Studies: Insights from Recent African American Biohistory. *Seton Hall Law Review* 27:951–970.

Jacobi, K. P., D. C. Cook, R. S. Corruccini, and J. S. Handler

1992 Congenital Syphilis in the Past: Slaves at Newton Plantation, Barbados, West Indies. *American Journal of Physical Anthropology* 89:145–158.

Jacobs, H. A.

2001 [1861] *Incidents in the Life of a Slave Girl*, edited by L. M. Francis. Published for the author, Boston, Massachusetts. Reprinted as *Incidents in the Life of a Slave Girl: Contexts, Criticisms*, edited by N. Y. McKay and F. S. Foster. Norton, New York.

Jantz, L. M., and R. L. Jantz

1999 Secular Change in Long Bone Length and Proportion in the United States, 1800–1970. *American Journal of Physical Anthropology* 110:57–68.

Jantz, R. L., and D. W. Owsley

1984 Long Bone Growth Variation among Arikara Skeletal Populations. *American Journal of Physical Anthropology* 63:13–20.

Johansson, S. R., and S. Horowitz

1986 Estimating Mortality in Skeletal Populations: Influences of the Growth Rate on the Interpretations of Levels and Trends. *American Journal of Physical Anthropology* 71:233–250.

Johnston, F. E.

1961 Sequence of Epiphyseal Union in a Prehistoric Kentucky Population from Indian Knoll. *Human Biology* 33:66–81.

1962 Growth of the Long Bones of Infants and Young Children at Indian Knoll. *American Journal of Physical Anthropology* 20:249–254.

1969 Approaches to the Study of Developmental Variability in Human Skeletal Populations. *American Journal of Physical Anthropology* 31:335–341.

Johnston, F. E., and C. E. Snow

1961 The Reassessment of the Age and Sex of the Indian Knoll Skeletal Population: Demographic and Methodological Aspects.

*American Journal of Physical Anthropology* 19:237–244.

Johnston, F. E., and L. O. Zimmer
1989 Assessment of Growth and Age in the Immature Skeleton. In *Reconstruction of Life from the Skeleton*, edited by M. Y. İşcan and K. A. R. Kennedy, pp. 11–22. Alan R. Liss, New York.

Jones, A.
1992 Tooth Mutilation in Angola. *British Dental Journal* 173:177–179.

Jones, D. G.
1990 *Preliminary Excavations at a Burial Ground at Galways Plantation, Montserrat, West Indies.* Department of Archaeology, Boston University, Boston, Massachusetts.

Jordan, W. D.
1968 *White Over Black: American Attitudes toward the Negro, 1550–1812*. Norton, New York.

Jorde, L. B., W. S. Watkins, M. J. Bamshad, M. E. Dixon, C. E. Ricker, M.T. Seielstad, and M. A. Batzer
2000 The Distribution of Human Genetic Diversity: A Comparison of Mitochondrial, Autosomal, and Y-Chromosome Data. *American Journal of Human Genetics* 66(3):979–988.

Jorde, P. K.
1993 Memorialization of The African Burial Ground: Federal Steering Committee Recommendations to the Administrator, General Services Administration and The United States Congress. New York. August 6.

Jurmain, R.
1990 Paleoepidemiology of a Central California Prehistoric Population from CA-Ala-329: Dental Disease. *American Journal of Physical Anthropology* 81:333–342.
1999 *Stories from the Skeleton: Behavioral Reconstruction in Human Osteology.* Gordon and Breach, Amsterdam, The Netherlands.
2001 Paleoepidemiological Patterns of Trauma in a Prehistoric Population from Central California. *American Journal of Physical Anthropology* 115:13–23.

Jurmain, R., L. Kilgore, W. Trevathan, and H. Nelson
2003 *Introduction to Physical Anthropology*. 9th ed. Wadsworth, Belmont, California.

Kagerer, P., and G. Grupe
2001 Age-at-Death Diagnosis and Determination of Life-History Parameters by Incremental Lines in Human Dental Cementum as an Identification Aid. *Forensic Science International* 18:75–82.

Karasik, D., I. Otremski, I. Barach, K. Yakovenko, V. Batsevitch, O. Pavlovsky, E. Kobyliansky, and G. Livshits
1999 Comparative Analysis of Age Prediction by Markers of Bone Change in the Hand Assessed by Roentgenography. *American Journal of Human Biology* 11:31–44.

Karol, L. A.
1997 Rotational Deformities in the Lower Extremities. *Current Opinion in Pediatrics* 9:77–80.

Katz, D., and J. M. Suchey
1986 Age Determination of the Male Os Pubis. *American Journal of Physical Anthropology* 69:427–435.
1989 Race Differences in Pubic Symphyseal Aging Patterns in the Male. *American Journal of Physical Anthropology* 80:167–172.

Katzenberg, M. A., D. A. Herring, and S. R. Saunders
1996 Weaning and Infant Mortality: Evaluating the Skeletal Evidence. *Yearbook of Physical Anthropology* 39:177–199.

Katzenberg, M. A., S. R. Saunders, and W. R. Fitzgerald
1993 Age Differences in Stable Carbon and Nitrogen Isotope Ratios in a Population of Prehistoric Maize Horticulturalists. *American Journal of Physical Anthropology* 90:267–282.

Kayser, M., S. Brauer, H. Schädlich, M. Prinz, M. A. Batzer, P. A. Zimmerman, B. A. Boatin, and M. Stoneking
2003 Y Chromosome STR Haplotypes and the Genetic Structure of U.S. Populations of African, European, and Hispanic Ancestry. *Genome Research* 13(4):624–634.

Keclard, L., V. Ollendorf, C. Berchel, H. Loret, and G. Merault
1996 Beta S Haplotypes, Alpha-globin Gene Status, and Hematological Data of Sickle Cell Disease Patients in Guadeloupe (F.W.I.). *Hemoglobin* 20(1):63–74.

Kelley, J. O., and J. L. Angel
1983 The Workers of Catoctin Furnace. *Maryland Archeology* 19(1):2–17.
1987 Life Stresses of Slavery. *American Journal of Physical Anthropology* 74:199–211.

Kennedy, K. A. R.
1989 Skeletal Markers of Occupational Stress. In *Reconstruction of Life from the Skeleton*, edited by M. Y. İşcan and K. A. R. Kennedy, pp. 129–160. Alan R. Liss, New York.

Khudabux, M. R.
1989 Signs of Physical Strain as Indications of Health Status during Growth in a Negro Slave Population in Surinam (S.A.). In *Advances in Paleopathology*, edited by L. Capasso, S. Carmiello, and G. Di Tota, pp. 131–134. Journal of Paleopathology Monographic Publication No. 1. Cheiti, Italy.
1991 *Effects of Life Conditions on the Health of a Negro Slave Community in Suriname.* Rijksuniversiteit te Leiden, Leiden, The Netherlands.

King, W.
1995 *Stolen Childhood: Slave Youth in Nineteenth-Century America*. Indiana University Press, Bloomington.

Kiple, K. F., and V. H. King
1981 *Another Dimension to the Black Diaspora: Diet, Disease, and Racism*. Cambridge University Press, Cambridge, Great Britain.

Kiple, K. F., and V. H. Kiple
1977 Slave Child Mortality: Some Nutritional Answers to a Perennial Puzzle. *Journal of Social History* 10:284–309.
1980 The African Connection: Slavery, Disease and Racism. *Phylon* 41:211–222.

Kister, J., C. Prehu, J. Riou, C. Godart, J. Bardakdjian, D. Prome, F. Galacteros, and H. Wajcman
1999 Two Hemoglobin Variants with an Alteration of the Oxygen-Linked Chloride Binding: Hb Antananarivo [α1(NA1) Val—>Gly] and Hb Barbizon [β144(HC1) Lys—>Met]. *Hemoglobin* 23(1):21–32.

Kittles, R. A., G. Morris, M. George, G. Dunston, M. Mack, F. L. C. Jackson, S. O. Y. Keita, and M. Blakey
1999 Genetic Variation and Affinities in the New York Burial Ground of Enslaved Africans. *American Journal of Physical Anthropology* Supplement 28:170 (abstract).

Kjaer, I.
1995 Human Prenatal Craniofacial Development Related to Brain Development under Normal and Pathological Conditions. *Acta Odontologica Scandinavica* 53:135–143.

Klein, H. S.
1986 *African Slavery in Latin America and the Caribbean*. Oxford University Press, Oxford, Great Britain.

Knight, F. W., and P. K. Liss (editors)
1991 *Atlantic Port Cities: Economy, Culture, and Society in the Atlantic World, 1650–1850*. University of Tennessee Press, Knoxville.

Knodel, J., and H. Kintner
1977 The Impact of Breast Feeding Patterns on the Biometric Analysis of Infant Mortality. *Demography* 14(4):391–409.

Knüsel, C.
2000 Bone Adaptation and its Relationship to Physical Activity in the Past. In *Human Osteology in Archaeology and Forensic Science*, edited by M. Cox and S. Mays, pp. 381–400. Greenwich Medical Media, London, Great Britain.

Kohn, M. J.
1999 You Are What You Eat. *Science* 283:335–336.

Kolman, C. J., and N. Tuross
2000 Ancient DNA Analysis of Human Populations. *American Journal of Physical Anthropology* 111:5–23.

Konigsberg, L. W., S. M. Henss, L. M. Jantz, and W. L. Jungers
1998 Stature Estimation and Calibration: Bayesian and Maximum Likelihood Perspectives in Physical Anthropology. *Yearbook of Physical Anthropology* 41:65–92.

Konstantopoulos, K., T. Vulliamy, D. Swirsky, J. D. Reeves, J. Kaeda, and L. Luzzatto
1996 DNA Haplotypes in Africans and West Indians with Sickle Cell Anemia or SC Disease. *Gene Geography* 10(1):19–24.

Koo, K. S.
2007 Strangers in the House of God: Cotton Mather, Onesimus, and an Experiment in Christian Slaveholding. *Proceedings of the American Antiquarian Society* 117(1):143–175.

Koziel, S. M.
1997 Combined Effects of the Tempo of Maturation and Mid-parent Height on the Shape of Individual Growth Curves. *American Journal of Human Biology* 9:555–564.

Kreshover, S. J.
1960 Metabolic Disturbance in Tooth Formation. *Annals of the New York Academy of Sciences* 85:161–167.

Krogman, W. M.
1962a [1955] Aging Human Skeletal Remains. *Journal for Science* 7:3.
1962b *The Human Skeleton in Forensic Medicine*. Charles C Thomas, Springfield, Illinois.

Kruger, V. L.
1985 *Born to Run: The Slave Family in Early New York, 1626–1827*. Ph.D. dissertation, Columbia University, New York. University Microfilms, Ann Arbor, Michigan.

Kutz Television, Inc.
1994 *The African Burial Ground: An American Discovery.* Parts I–IV. VHS. Written by Christopher Moore and directed by Anna Switzer. National Technical Information Services, National Audiovisual Center, Springfield, Virginia.

Lampl, M., and F. E. Johnston
1996 Problems in the Aging of Skeletal Juveniles: Perspectives from Maturation Assessments of Living Children. *American Journal of Physical Anthropology* 101:345–355.

Lang, S. S.
1997 Cornell Nutritionists Help Establish New International Growth References. *Human Ecology Forum* 25(4):2.

Lanphear, B. P., M. Weitzman, and S. Eberly
1996 Racial Differences in Urban Children's Environmental Exposures to Lead. *American Journal of Public Health* 86(10):1460–1463.

Lanphear, K. M.
1988 Mortality and Health in a Nineteenth Century Poorhouse Skeletal Sample. Unpublished Ph.D. dissertation, Department of Anthropology, State University of New York at Albany.

Lapoumeroulie, C.
1992 A Novel Sickle Cell Mutation of Yet Another Origin in Africa: The Cameroon Type. *Human Genetics* 89(3):333–337.

La Roche, C. J., and M. L. Blakey
1997 Seizing Intellectual Power: The Dialogue at the New York African Burial Ground. *Historical Archaeology* 31(3):84–106.

Larsen, C. S.
1997 *Bioarchaeology: Interpreting Behavior from the Human Skeleton*. Cambridge University Press, New York.

Lassen, C., S. Hummel, and B. Herrmann
1997 Molecular Sex Determination in Skeletal Remains of Premature and Newborn Infants of the Aegerten, Switzerland, Burial Field. *Anthropologischer Anzeiger* 55(2):183–191.
2000 Molecular Sex Identification of Stillborn and Neonate Individuals ("Traufkinder") from the Burial Site Aegerten. *Anthropologischer Anzeiger* 58(1):1–8.

Lee, K. M., J. Appleton, M. Cooke, F. Keenan, and K. Sawicka-Kapusta
1999 Use of Laser Ablation Inductively Coupled Plasma Mass Spectrometry to Provide Element Versus Time Profiles in Teeth. *Analytica Chimica Acta* 395:179–185.

Levy, L. F.
1968 Porter's Neck. *British Medical Journal* 2(5596):16–19.

Lewis, A. B., and S. M. Garn
1960 The Relationship between Tooth Formation and Other Maturational Factors. *Angle Orthodontist* 30:70–77.

Lignitz, H.
1919–1920 Die künstlichen Zahnverstümmlungen in Afrika im Lichte der Kulturkreisforschung. *Anthropos* 14–15:891–943.

Liversidge, H. M.
1994 Accuracy of Age Estimation from Developing Teeth in a Population of Known Age (0–5.4 Years). *International Journal of Osteoarchaeology* 4:37–45.

Livshits, G., K. Yakovenko, L. Kletselman, D. Karasik, and E. Kobyliansky
1998 Fluctuating Asymmetry and Morphometric Variation of Hand Bones. *American Journal of Physical Anthropology* 107:125–136.

Lochner, F., J. Appleton, F. Keenan, and M. Cooke
1999 Multi-element Profiling of Human Deciduous Teeth by Laser Ablation–Inductively Coupled Plasma-Mass Spectrometry. *Analytica Chimica Acta* 401:299–306.

Long Papers
n.d. Archived material. Add Ms. 18,273, folio 131.

Lorenz, J., A. Vosbikian, J. Beck, P. Bender, A. Whittemore, and F. Jackson
2004 African-American Lineage Markers: Determining the Geographic Source of mtDNA and Y Chromosomes. Paper presented at the 73rd Annual Meeting of the American Association of Physical Anthropologists, Tampa, Florida.

Lovejoy, C. O., R. S. Meindl, T. R. Pryzbeck, and R. P. Menforth
1985 Chronological Metamorphosis of the Auricular Surface of the Ilium: A New Method for the Determination of Adult Skeletal Age at Death. *American Journal of Physical Anthropology* 68:15–28.

Lovejoy, C. O., R. P. Mensforth, and G. J. Armelagos
1982 Five Decades of Skeletal Biology as Reflected in the *American Journal of Physical Anthropology*. In *A History of American Physical Anthropology, 1930–1980*, edited by F. Spencer, pp. 239–236. Academic Press, New York.

Lovejoy, P. E.
1997 The African Diaspora: Revisionist Interpretations of Ethnicity, Culture and Religion under Slavery. *Studies in the World History of Slavery, Abolition and Emancipation* II:1.

2003 Transatlantic Narratives: The Impact of Transatlantic Slavery on the Lives of Two Muslims: Muhammad Kaba Saghanaghu and Mahommah Gardo Baquaqua. Paper presented at the Literary Manifestations of the African Diaspora Conference, University of Cape Coast, Ghana.

Lovell, N. C.
1994 Spinal Arthritis and Physical Stress at Bronze Age Harappa. *American Journal of Physical Anthropology* 93:149–164.

Luis, J. R., S. Dios, J. C. Carril, R. Herrera, and B. Caeiro
2002 New STR at the D5S373 Locus and its Relevance in Human Population Studies. *American Journal of Human Biology* 14(3):347–350.

Lukacs, J. R.
1989 Dental Paleopathology: Methods for Reconstructing Dietary Patterns. In *Reconstruction of Life from the Skeleton*, edited by M. Y. İşcan and K. A. R. Kennedy, pp. 261–286. Alan R. Liss, New York.

Lydon, J. G.
1978 New York and the Slave Trade, 1700 to 1774. *William and Mary Quarterly* 35(2):375–394.

Mack, M. E., and M. L. Blakey
2004 The New York African Burial Ground Project: Past Biases, Current Dilemmas and Future Research Opportunities. *Historical Archaeology* 38(1):10–17.

Mack, M. E., M. L. Blakey, and A. H. Goodman
2000 Dental Evidence of Health in African-Born and American-Born Children. *American Journal of Physical Anthropology* Supplement 30:184.

Mack, M. E., C. M. Hill, and M. L. Blakey
1995 Preliminary Analysis of Skeletal Remains from the New York African Burial Ground. Paper presented at the 94th Annual Meeting of the American Anthropological Association, Washington, D.C.

Mandel, I. D.
1979 Dental Caries. *American Scientist* 67:680–688.

Mange, A. P., and E. J. Mange
1988 *Genetics: Human Aspects*. 2nd ed. Sinauer Associates, Sunderland, Massachusetts.

Mann, A., M. Lampl, and J. Monge
1990 Patterns of Ontogeny in Human Evolution: Evidence from Dental Development. *Yearbook of Physical Anthropology* 33:111–150.

Mann, K., and R. Roberts (editors)
1991 *Law in Colonial Africa.* Heinemann Educational Books, Portsmouth, New Hampshire.

Mann, R. W., and J. Krakker
1989 A Black Skeletal Sample from a Washington, D.C. Cemetery in the Context of Nineteenth Century Urban Growth. *Tennessee Anthropologist* 14:1–32.

Mann, R. W., L. Meadows, W. M. Bass, and D. R. Watters
1987 Skeletal Remains from a Black Slave Cemetery, Montserrat, West Indies. *Annals of the Carnegie Museum* 56:319–336.

Mansilla, J., and C. M. Pijoan
1995 Brief Communication: A Case of Congenital Syphilis during the Colonial Period in Mexico City. *American Journal of Physical Anthropology* 97:187–196.

Maples, W. R.
1986 Trauma Analysis by the Forensic Anthropologist. In *Forensic Osteology: Advances in the Identification of Human Remains*, edited by K. Reichs, pp. 218–228. Charles C Thomas, Springfield, Illinois.

Marcus, R.
1996 Endogenous and Nutritional Factors affecting Bone. *Bone* 18S:11S–13S.

Maresh, M. M.
1955 Linear Growth in Long Bones of Extremities from Infancy through Adolescence. *American Journal of Diseases of Children* 89:735–742.
1970 Measurements from Roentgenograms. In *Human Growth and Development*, edited by R. W. McCammon, pp. 157–199. Charles C Thomas, Springfield, Illinois.

Margo, R. A., and R. H. Steckel
1983 Heights of Native-Born Whites during the Antebellum Period. *Journal of Economic History* 43:167–174.

Marks, M. K., J. C. Rose, and W. D. Davenport, Jr.
1996 Technical Note: Thin Section Procedure for Enamel Histology. *American Journal of Physical Anthropology* 99:493–498.

Martin, D. L., A. L. Magennis, and J. C. Rose
1987 Cortical Bone Maintenance in an Historic Afro-American Cemetery Sample from Cedar Grove, Arkansas. *American Journal of Physical Anthropology* 74:255–264.

Marquez-Morfin, L.
1998 Unequal Death in Life: A Sociopolitical Analysis of the 1813 Mexico City Typhus Epidemic. In *Toward a New Biocultural Synthesis*, edited by A. H. Goodman and T. L. Leatherman, pp. 229–243. University of Michigan Press, Ann Arbor.

Martinson, J. J., L. Excoffier, C. Swinburn, A. J. Boyce, R. M. Harding, A. Langaney, and J. B. Clegg
1995 High Diversity of Alpha-globin Haplotypes in a Senegalese Population, Including Many Previously Unreported Variants. *American Journal of Human Genetics* 57(5):1186–1198.

Massler, M., I. Schour, and H. Poncher
1941 Developmental Pattern of the Child as Reflected in the Calcification Pattern of the Teeth. *American Journal of Diseases of Children* 62:33–67.

Mateu, E., D. Comas, F. Calafell, A. Perez-Lezaun, A. Abade, and J. Bertranpetit
1997 Tale of Two Islands: Population History and Mitochondrial DNA Sequence Variation of Bioko and São Tomé, Gulf of Guinea. *Annals of Human Genetics* 61(6):507–518.

May J., D. Comas, F. Calafell, A. Perez-Lezaun, A. Abade, and J. Bertranpetit
1998 HLA DPA1/DPB1 Genotype and Haplotype Frequencies, and Linkage Disequilibria in Nigeria, Liberia, and Gabon. *Tissue Antigens* 52(3):199–207.

McCaa, R.
2002 Paleodemography of the Americas: From Ancient Times to Colonialism and Beyond. In *Backbone of History: Health and Nutrition in the Western Hemisphere*, edited by R. H. Steckel and J. C. Rose, pp. 94–124.

Cambridge University Press, Cambridge, Great Britain.

McCammon, R. W.
1970 *Human Growth and Development*. Charles C Thomas, Springfield, Illinois.

McCord, C. P.
1953 Lead and Lead Poisoning in Early America: Lead Mines and Lead Poisoning. Industrial Medicine and Surgery 22:534–539.

McKee, S.
1935 *Labor in Colonial New York*. Columbia University Press, New York.

McManus, E. J.
1966 *A History of Negro Slavery in New York*. Syracuse University Press, Syracuse, New York.
2001 *Black Bondage in the North.* 1st pbk. ed. Syracuse University Press, Syracuse, New York.

Meckel, R.
1997 Racialism and Infant Death: Late Nineteenth- and Early Twentieth-century Sociomedical Discourse on African American Infant Mortality. In *Migrants, Minorities and Health*, edited by L. Marks and M. Worbeys, pp. 70–92. Routledge, London, Great Britain.

Medford, E. G.
1996 *The African Burial Ground in Historical Perspective*. Research File: OPEI. Howard University, Washington, D.C.

Medford, E. G. (editor)
2009 *Historical Perspectives of the African Burial Ground: New York Blacks and the Diaspora*. The New York African Burial Ground: Unearthing the African Presence in Colonial New York, vol. 3. Howard University, Washington, D. C.

Medford, E. G., and E. Brown
2000 A Constant Source of Irritation: Enslaved Women's Resistance in the City of New York. *HUArchivesNet* 5. Electronic document, http://www.huarchivesnet.howard.edu/0008huarnet/medford1.htm.

Medford, E. G., E. L. Brown, S. H. H. Carrington, L. Heywood, and J. Thornton
2009a "By the Visitations of God": Death, Burial, and the Affirmation of Humanity. In *Historical Perspectives of the African Burial Ground: New York Blacks and the Diaspora*, edited by E. G. Medford, pp. 85–90. The New York African Burial Ground: Unearthing the African Presence in Colonial New York, vol. 3. Howard University, Washington, D.C.
2009b Disease and Health. In *Historical Perspectives of the African Burial Ground: New York Blacks and the Diaspora*, edited by E. G. Medford, pp. 78–84. The New York African Burial Ground: Unearthing the African Presence in Colonial New York, vol. 3. Howard University, Washington, D.C.
2009c The Ubiquity of Work. In *Historical Perspectives of the African Burial Ground: New York Blacks and the Diaspora*, edited by E. G. Medford, pp. 51–64. The New York African Burial Ground: Unearthing the African Presence in Colonial New York, vol. 3. Howard University, Washington, D.C.

Medford, E. G., E. Brown, L. Heywood, and J. Thornton
2009 Slavery and Freedom in New Amsterdam. In *Historical Perspectives of the African Burial Ground: New York Blacks and the Diaspora*, edited by E. G. Medford, pp. 13–23. The New York African Burial Ground: Unearthing the African Presence in Colonial New York, vol. 3. Howard University, Washington, D.C.

Meindl, R. S., and C. O. Lovejoy
1985 Ectocranial Suture Closure: A Revised Method for the Determination of Skeletal Age at Death based on the Lateral-Anterior Sutures. *American Journal of Physical Anthropology* 68:57–66.

Meindl, R. S., C. O. Lovejoy, R. P. Mensforth, and R. A. Walker
1985 A Revised Method of Age Determination using the Os Pubis, with a Review and Tests of Accuracy of other Current Methods of Pubic Symphyseal Aging. *Ameri-*

*can Journal of Physical Anthropology* 68:29–45.

Menard, R.
1975 The Maryland Slave Population, 1658–1730: A Demographic Profile of Blacks in Four Counties. *William and Mary Quarterly,* 3rd ser. 32:29–54.

Mendez, H.
1985 Introduction to the Study of Pre- and Postnatal Growth in Humans: A Review. *American Journal of Medical Genetics* 20:63–85.

Merbs, C. F.
1983 *Patterns of Activity-Induced Pathology in a Canadian Inuit Population*. Paper No. 119. National Museum of Man Mercury Series. National Museums of Canada, Ottowa, Ontario.
1989a Spondylolysis: Its Nature and Anthropological Significance. *International Journal of Anthropology* 4(3):163–169.
1989b Trauma. In *Reconstruction of Life from the Skeleton*, edited by M. Y. İşcan and K. A. R. Kennedy, pp. 161–189. Alan R. Liss, New York.
1996 Spondylolysis and Spondylolisthesis: A Cost of Being an Erect Biped or a Clever Adaptation. *Yearbook of Physical Anthropology* 39:201–228.

Meyer, C. G., and L. Schnittger
1993 A Silent Mutation in HLA-DPBI*0101 and its Evolutionary Implications. *Human Immunology* 38(2):123–126.

Migot-Nabias, F., I. Fajardy, P. M. Danze, S. Everaere, J. Mayombo, T. N. Minh, A. Renaut, and A. J. Georges
1999 HLA Class II Polymorphism in a Gabonese Banzabi Population. *Tissue Antigens* 53(6):580–585.

Mikell, G.
1999 Feminism and Black Culture in the Ethnography of Zora Neale Hurston. In *African American Pioneers of Anthropology*, edited by I. E. Harrison and F. V. Harrison, pp. 51–69. University of Illinois Press, Urbana.

Miles, A. W.
1994 Non-union of the Epiphysis of the Acromion in the Skeletal Remains of a Scottish Population ca. 1700. *International Journal of Osteoarchaeology* 4(2):149–164.

Miles, A. W., and J. S. Bulman
1994 Growth Curves of Immature Bones from a Scottish Island Population of Sixteenth to Mid-Nineteenth Century: Limb-Bone Diaphyses and Some Bones of the Hand and Foot. *International Journal of Osteoarchaeology* 4:121–136.

Milner, G. R., and C. S. Larsen
1991 Teeth as Artifacts of Human Behavior: Intentional Mutilation and Accidental Modification. In *Advances in Dental Anthropology*, edited by M. A. Kelley and C. S. Larsen, pp. 357–378. Wiley-Liss, New York.

Milner, G. R., J. W. Wood, and J. L. K. Boldsen
2000 Paleodemography. In *Biological Anthropology of the Human Skeleton*, edited by M. A. Katzenberg and S. R. Saunders, pp. 467–497. Wiley, New York.

Mintz, S. W.
1951 Canamelar: The Contemporary Culture of a Puerto Rican Proletariat. Unpublished Ph.D. dissertation, Department of Sociology, Columbia University, New York.
1974 *Caribbean Transformations*. Aldine, Chicago.

Mintz, S. W., and R. Price
1992 *The Birth of African-American Culture: An Anthropological Perspective*. Beacon Press, Boston, Massachusetts.

Minutes of the Court of General Sessions
n.d. Municipal Archives, City and County of New York. Microfilm. New York.

Modiano, D., G. Luoni, V. Petrarca, B. Sodiomon Sirima, M. De Luca, J. Simpore, M. Coluzzi, J. G. Bodmer, and G. Modiano
2001 HLA Class I in Three West African Ethnic Groups: Genetic Distances from Sub-Saharan and Caucasoid Populations. *Tissue Antigens* 57(2):128–137.

Monsalve, M. V., and E. Hagelberg
1997 Mitochondrial DNA Polymorphisms in Caribbean People of Belize. *Proceedings of the Royal Society of London, Biological Sciences* 264(1385):1217–1224.

Monteiro, C. A., and A. M. Torres
1992 Can Secular Trends in Child Growth Be Estimated from a Single Cross Sectional Survey? *British Medical Journal* 305(6857):797–799.

Monyeki, K. D., N. Cameron, and B. Getz
2000 Growth and Nutritional Status of Rural South African Children 3–10 Years Old: The Ellisras Growth Study. *American Journal of Human Biology* 12:42–49.

Moore, J. A., A. C. Swedlund, and G. J. Armelagos
1975 The Use of Life Tables in Paleodemography. *American Antiquity* 40:57–70.

Moorrees, C. F. A., E. A. Fanning, and E. E. Hunt, Jr.
1963a Formation and Resorption of Three Deciduous Teeth in Children. *American Journal of Physical Anthropology* 21:205–213.
1963b Age Variation of Formation Stages for Ten Permanent Teeth. *Journal of Dental Research* 42(6):1490–1492.

Moreau, J. L., P. Rouas, and A. Rouas
2002 Carabelli's Tubercule in the Wolof Ethnic Group. *Senegal Morphologie* 86(273):236.

Morgan, Philip
1984 Black Life in Eighteenth-Century Charleston. *Perspectives in American History*, n.s. 1:305–335.

Morilla, J. M., J. M. Afonso, M. Hernández, J. J. Pestano, and J. M. Larruga
1988 Human Enzyme Polymorphism in the Canary Islands. II. African Influence. *Human Heredity* 38(2):101–105.

Morris, A. G.
1998 Dental Mutilation in Southern African History and Prehistory with Special Reference to the Cape Flats Smile. *Journal of the South African Dental Association* 53:179–183.

Mouele, R., J. M. Bodo, D. M. Mpele, J. Feingold, and F. Galacteros
2000 Beta-globin Gene Haplotypes and Alpha-thalassemia Analysis in Babinga Pygmies from Congo-Brazzaville. *Human Biology* 72(2):379–383.

Moynihan, D. P.
1965 *The Negro Family in America: The Case for National Action*. Office of Planning and Research, U.S. Department of Labor, Washington, D.C.

Mullin, M.
1995 *African in America.* University of Illinois Press, Chicago.

Muniz, A., L. Corral, C. Alaez, E. Svarch, E. Espinosa, N. Carbonell, R. di Leo, L. Felicetti, R. L. Nagel, and G. Martinez
1995 Sickle Cell Anemia and Beta-gene Cluster Haplotypes in Cuba. *American Journal of Hematology* 49(2):163–164.

Mwaria, C.
1999 The Continuing Dialogue: The Life and Work of Elliot Skinner as Exemplar of the African-American/African Dialectic. In *African American Pioneers of Anthropology*, edited by I. E. Harrison and F. V. Harrison, pp. 274–292. University of Illinois Press, Urbana.

Nagy, B. L., and D. E. Hawkey
1993 Correspondence of Osteoarthritis and Muscle Use in Reconstructing Prehistoric Activity Pattern. Paper presented at the 20th Annual Meeting of the Paleopathology Association, Toronto, Ontario, Canada.

Nash, G. B.
1988 *Forging Freedom: The Formation of Philadelphia's Black Community, 1720–1840*. Harvard University Press, Cambridge, Massachusetts.

National Historic Preservation Act
1996 Public Law 89-665 § 16 U.S.C. 470.

National Institute of Standards and Technology (NIST)
1992 *Standard Reference Materials 612, Trace Elements in a Glass Matrix*. Gaithersburg, Maryland.

Native American Graves Protection and Repatriation Act
1990 Public Law 101-601§ 25 U.S.C. 3001 *et seq.*

Needleman, H. L.
1998 Childhood Lead Poisoning: The Promise and Abandonment of Primary Prevention. *American Journal of Public Health* 88(12):1871–1877.

Needleman, H. L., and D. Bellinger
1991 The Health Effects of Low Level Exposure to Lead. *Annual Review of Public Health* 12:111–140.

New York City Common Council
1905 *Minutes of the Common Council of the City of New York, 1675–1776*, edited by H. L. Osgood, A. B. Keep, C. A. Nelson, and the New-York Historical Society. 8 vols. Dodd, Mead, New York.

New York State
1894 *Colonial Laws of New York from 1664 to the Revolution*, edited by C. Z. Lincoln, W. H. Johnson, and A. J. Northrup. 5 vols. J. B. Lyons, Albany, New York.

Nichol, C. R.
1989 Complex Segregation Analysis of Dental Morphological Variants. *American Journal of Physical Anthropology* 78:37–59.

Nicolls, C.
1756–1765 C. Nicolls Ledger Books. Archived material, New-York Historical Society, New York.

Nott, J. C., and G. R. Gliddon
1854 *Types of Mankind; Or, Ethnological Researches, based upon the Ancient Monuments, Paintings, Sculptures, and Crania of Races, and upon their Natural, Geographical, Philological, and Biblical History*. Lippincott, Grambo, Philadelphia, Pennsylvania.

Nurse, G. T., M. C. Botha, and T. Jenkins
1977 Sero-genetic Studies on the San of South West Africa. *Human Heredity* 27(2):81–98.

Nurse, G. T., and T. Jenkins
1977 Serogenetic Studies on the Kavango Peoples of South West Africa. *Annals of Human Biology* 4(5):465–478.

Nurse, G. T., T. Jenkins, J. H. David, and A. G. Steinberg
1979 The Njinga of Angola: A Serogenetic Study. *Annals of Human Biology* 6(4):337–348.

Oberfield, S. E., D. L. Wethers, J. L. Kirkland, and L. S. Levine
1987 Growth Hormone Response to Growth Hormone Releasing Factor in Sickle Cell Disease. *American Journal of Pediatrics and Hermetic Oncology* 9(4):331–334.

Ofodile, F. A.
1994 Nasal Bones and Pyriform Apertures in Blacks. *Annals of Plastic Surgery* 32(1):21–26.

Ogden, J. A.
1984a Radiology of Postnatal Skeletal Development XI: The First Cervical Vertebra. *Skeletal Radiology* 12:12–20.
1984b Radiology of Postnatal Skeletal Development XII: The Second Cervical Vertebra. *Skeletal Radiology* 12:169–177.

Ogden, J. A., R. F. Hempton, and W. O. Southwick
1975 Development of the Tibial Tuberosity. *Anatomical Record* 182:431–446.

Ogden, J. A., and S. M. McCarthy
1983 Radiology of Postnatal Skeletal Development VIII: Distal Tibia and Fibula. *Skeletal Radiology* 10:209–220.

Ogden, J. A., and S. B. Phillips
1983 Radiology of Postnatal Skeletal Development VII: The Scapula. *Skeletal Radiology* 9:157–169.

Olin, M. S., H. A. Young, D. Seligson, and H. H. Schmidek
1982 An Unusual Cervical Injury occurring during Cow Milking. *Spine* 7:514–515.

Onat, T.
1997 Growth of Metacarpal II during Adolescence: Relationships to Stature, Weight, and Skeletal and Sexual Maturity. *American Journal of Human Biology* 9:425–438.

Orser, C. E., Jr.
1998 The Archaeology of the African Diaspora. *Annual Review of Anthropology* 27:63–82.

Ortiz, F.
1927 Los Negros Curros. *Glosario de Afronegrismos.* Archivos del Folklore Cubano 2(4):285–307.
1929 Los Afrocubanos Dientimellados. *Archivos del Folkore Cubano* 4:5–24.
1947 *Cuban Counterpoint: Tobacco and Sugar*. Alfred A. Knopf, New York.

Ortner, D. J.
1966 A Recent Occurrence of an African Type Tooth Mutilation in Florida. *American Journal of Physical Anthropology* 25:177–180.
2003 *Identification of Pathological Conditions in Human Remains*. 2nd. ed. Academic Press, San Diego, California.

Ortner, D. J., and A. C. Aufderheide (editors)
1991 *Human Paleopathology: Current Syntheses and Future Options*. Smithsonian Institution Press, Washington, D.C.

Ortner, D. J., E. H. Kimmerle, and M. Diez
1999 Probable Evidence of Scurvy in Subadults from Archaeological Sites in Peru. *American Journal of Physical Anthropology* 108:321–332.

Ortner, D. J., and W. G. Putschar
1981 *Identification of Pathological Conditions in Human Skeletal Remains*. Smithsonian Contributions to Anthropology No. 28. Smithsonian Institution Press, Washington, D.C.

Oschinsky, L.
1954 *The Racial Affinities of the Baganda and other Bantu Tribes of British East Africa*. W. Heffer and Sons, Cambridge, Great Britain.

Outridge, P.
1996 Potential Applications of Laser Ablation ICP-MS in Forensic Biology and Exploration Geochemistry. *Spectroscopy* 11(4):21–26.

Outridge, P. M., R. J. Hughes, and R. D. Evans
1996 Determination of Trace Metals in Teeth and Bones by Solution Nebulization ICP-MS. *Atomic Spectroscopy* 17(1):1–8.

Outridge, P. M., G. Veinott, and R. D. Evans
1995 Laser Ablation ICP-MS Analysis of Incremental Biological Structures: Archives of Trace Element Accumulation. *Environmental Review* 3:160–170.

Owsley, D. W., R. W. Mann, and K. M. Lanphear
1990 *Osteological Examination of Human Remains from the Charity Hospital/Cypress Grove II Cemetery, New Orleans, Louisiana: Final Report of Investigations*, vol. 2. Smithsonian Institution, Department of Anthropology, Washington, D.C.

Owsley, D. W., C. E. Orser, Jr., R. W. Mann, P. H. Moore-Jansen, and R. L. Montgomery
1987 Demography and Pathology of an Urban Slave Population from New Orleans. *American Journal of Physical Anthropology* 74:185–197.

Pagnier, J.
1984 Evidence for the Multicentric Origin of the Sickle Cell Hemoglobin Gene in Africa. *Proceedings of the National Academy of Sciences of the United States of America* 81(6):1771–1773.

Palmer, M. R., and J. M. Edmond
1992 Controls over the Strontium Isotope Composition of River Water. *Geochimica et Cosmochimica Acta* 56:2099–2111.

Pante-De-Sousa, G., R. C. Mousinho-Ribeiro, E. J. Dos Santos, and J. F. Guerreiro
1999 Beta-globin Haplotypes Analysis in Afro-Brazilians from the Amazon Region: Evidence for a Significant Gene Flow from Atlantic West Africa. *Annals of Human Genetics* 26(4):365–373.

Parra, E. J., A. Marcini, J. Akey, J. Martinson, M. A. Batzer, R. Cooper, T. Forrester, D. B. Allison, R. Deka, R. E. Ferrell, and M. D. Shriver
1998 Estimating African American Admixture Proportions by Use of Population-Specific Alleles. *American Journal of Human Genetics* 63(6):1839–1851.

Parrington, M., and D. G. Roberts
1984 The First African Baptist Church Cemetery: An Archaeological Glimpse of Philadelphia's Early Nineteenth Century Free Black Community. *Archaeology* 37:26–32.
1990 Demographic, Cultural, and Bioanthropological Aspects of a Nineteenth Century Free Black Population in Philadelphia, Pennsylvania. In *A Life in Science: Papers in Honor of J. Lawrence Angel*, edited by J. E. Buikstra, pp. 138–170. Scientific Papers No. 6. Center for American Archaeology, Kampsville, Illinois.

Paynter, R.
1992 W. E. B. Du Bois and the Material World of African-Americans in Great Barrington, Massachusetts. *Critique of Anthropology* 12:277–291.

Pearson, M. P.
1999 *The Archaeology of Death and Burial*. Sutton, Phoenix Mill, Great Britain.

Pereira, L., L. Gusmao, M. J. Prata, P. Mota, M. J. Trovoada, and A. Amorim
2000 Variation in STR Loci of the Human Myelin Basic Protein Gene: North Portugal

and São Tomé e Principe. *Human Biology* 72(3):481–487.

Pereira, L., V. Macaulay, A. Torroni, R. Scozzari, M. J. Prata, and A. Amorim
2001 Prehistoric and Historic Traces in the mtDNA of Mozambique: Insights into the Bantu Expansions and the Slave Trade. *Annals of Human Genetics* 65(5):439–458.

Perrson, M.
1995 The Role of Sutures in Normal and Abnormal Craniofacial Growth. *Acta Odontologica Scandinavica* 53:152–161.

Perry, W. R.
1997 Analysis of the African Burial Ground Archaeological Materials. *Newsletter of the African Burial Ground and Five Points Archaeological Projects* 2:1, 3–4, 14.

Perry, W., and M. L. Blakey
1997 Archaeology as Community Service: The African Burial Ground Project in New York City. *North American Dialogue* 2(1). Reprinted in *Lessons from the Past: An Introductory Reader in Archaeology* by K. L. Feder, pp. 45–51.

Perry, W. R., J. Howson, and B. A. Bianco (editors)
2009a *The Archaeology of the New York African Burial Ground*. The New York African Burial Ground: Unearthing the African Presence in Colonial New York, vol. 2, pt. 1. Howard University, Washington, D.C.
2009b *The Archaeology of the New York African Burial Ground: Descriptions of Burials.* The New York African Burial Ground: Unearthing the African Presence in Colonial New York, vol. 2, pt. 2. Howard University, Washington, D.C.

Perry, W. R., and R. Paynter
1999 Artifacts, Ethnicity, and the Archaeology of African Americans. In *I, Too, Am America: Archaeological Studies of African-American Life*, edited by T. Singleton, pp. 299–310. University Press of Virginia, Charlottesville.

Phenice, T. W.
1969a A Newly Developed Visual Method of Sexing the Os Pubis. *American Journal of Physical Anthropology* 30:297–302.
1969b *An Analysis of the Human Skeletal Material from Burial Mounds in North Central Kansas*. Publications in Anthropology No. 1. University of Kansas, Lawrence.

Physician/Pharmacist Day Book
1743–1744 Archived Material, New-York Historical Society.

Piersen, W. D.
1993 *Black Legacy: America's Hidden Heritage*. University of Massachusetts Press, Amherst.

Pittard, E.
1911 La taille, la grandeur du buste et des jambs, l'indice céphalique et l'indice nasal de 253 Tatars a la péninsule des Balkans. *Bulletins de Mémoires de la Société d'Anthropologie de Paris* 2(2):432–441.

Pollitzer, W. S.
1958 The Negroes of Charleston (S.C.): A Study of Hemoglobin Types, Serology, and Morphology. *American Journal of Physical Anthropology* 16:241–263.

Powell, J. S.
1995 *Dental Variation and Biological Affinity among Middle Holocene Human Populations in North America.* Ph.D. dissertation, Texas A&M University. University Microfilms, Ann Arbor, Michigan.

Price, R., and S. Price
1972 *Afro-American Arts of the Suriname Rain Forest*. University of California Press, Berkeley and Los Angeles.

Price, T. D., G. Grupe, and P. Schroter
1994 Reconstruction of Migration Patterns in the Bell Beaker Period by Stable Strontium Isotope Analysis. *Applied Geochemistry* 9:413–417.

Price, T. D., C. M. Johnson, J. A. Ezzo, J. Ericson, and J. H. Burton
1994 Residential Mobility in the Prehistoric Southwest United States: A Preliminary Study using Strontium Isotope Analysis. *Journal of Archaeological Science* 21:315–330.

Price, T. D., M. J. Schoeninger, and G. J. Armelagos
1985 Bone Chemistry and Past Behavior: An Overview. *Journal of Human Evolution* 14:419–447.

Probst, C. M., E. P. Bompeixe, N. F. Pereira, M. M. de O. Dalalio, J. E. Visentainer, L. T. Tsuneto, and M. L. Petzl-Erler

2000 HLA Polymorphism and Evaluation of European, African, and Amerindian Contribution to the White and Mulatto Populations from Paraná, Brazil. *Human Biology* 72(4):597–617.

Pryor, J. W.

1923 Differences in the Time of Development of Centers of Ossification in the Male and Female Skeleton. *Anatomical Record* 25:257–274.

Purchase, N. G., and J. E. Fergusson

1986 Lead in Teeth: The Influence of the Tooth Type and the Sample within a Tooth on Lead Levels. *Science of the Total Environment* 52:239–250.

Pyle, S. I., and N. L. Hoerr

1955 *Radiographic Atlas of Skeletal Development of the Knee*. Charles C Thomas, Springfield, Illinois.

Rando, J. C., V. M. Cabrera, J. M. Larruga, M. Hernández, A. M. González, F. Pinto, and H. J. Bandelt

1999 Phylogeographic Patterns of mtDNA reflecting the Colonization of the Canary Islands. *Annals of Human Genetics* 63(5):413–428.

Rando, J. C., F. Pinto, A. M. González, M. Hernández, J. M. Larruga, V. M. Cabrera, and H. J. Bandelt

1998 Mitochondrial DNA Analysis of Northwest African Populations Reveals Genetic Exchanges with European, Near-Eastern, and Sub-Saharan Populations. *Annals of Human Genetics* 62(6):531–550.

Rankin-Hill, L. M.

1994 Uncovering African Americans' Buried Past. In *Science Year: World Book Annual Scientific Supplement*, pp. 118–133. World Book, Chicago.

1997 *A Biohistory of 19th-Century Afro-Americans: The Burial Remains of a Philadelphia Cemetery*. Bergin and Garvey, Westport, Connecticut.

Rankin-Hill, L. M., and M. L. Blakey

1994 W. Montague Cobb (1904–1990): Physical Anthropologist, Anatomist, and Activist. *American Anthropologist* 96:74–96.

Rathbun, T. A.

1987 Health and Disease at a South Carolina Plantation: 1840–1870. *American Journal of Physical Anthropology* 74:239–253.

Rathbun, T. A., and J. D. Scurry

1991 Status and Health in Colonial South Carolina: Belleview Plantation, 1738–1756. In *What Mean These Bones: Studies in Southeastern Bioarchaeology*, edited by M. L. Powell, P. S. Bridges, and A. M. W. Mires, pp. 148–164. University of Alabama Press, Tuscaloosa.

Rathbun, T. A., and R. H. Steckel

2002 The Health of Slaves and Free Blacks in the East. In *The Backbone of History: Health and Nutrition in the Western Hemisphere*, edited by R. H. Steckel and J. C. Rose. Cambridge University Press, Cambridge, Great Britain.

Reed, W. L.

1992 Lead Poisoning: A Modern Plague among African American Children. In *Health Issues in the Black Community,* edited by R. L. Brathwaite and S. E. Taylor, pp. 178–191. Jossey-Bass, San Francisco, California.

Reich, D. E., S. B. Gabriel, and D. Altshuler

2003 Quality and Completeness of SNP Databases. *Nature Genetics* 33(4):457–458.

Relethford, J. H.

2001 Global Analysis of Regional Differences in Craniometric Diversity and Population Substructure. *Human Biology* 73(5):629–636.

Relethford, J. H., and H. C. Harpending

1994 Craniometric Variation, Genetic Theory, and Modern Human Origins. *American Journal of Physical Anthropology* 95:249–270.

Relethford, J. H., and L. B. Jorde

1999 Genetic Evidence for Larger African Population Size during Recent Human Evolution. *American Journal of Physical Anthropology* 108:251–260.

Ribot, I., and C. Roberts

1996 A Study of Non-Specific Stress Indicators and Skeletal Growth in Two Medieval Subadult Populations. *Journal of Archaeological Science* 23:67–79.

Ricklan, D. E., and P. V. Tobias
1986 Unusually Low Sexual Dimorphism of Endocranial Capacity in a Zulu Cranial Series. *American Journal of Physical Anthropology* 71:285–293.

Ripley, W. Z.
1899 *The Races of Europe: A Sociological Study*. D. Appleton, New York.

Rivero de la Calle, M.
1973 La Mutilación Dentaria en la Población Negroide de Cuba. *Ciencias* 4:3–21.

Rodahl, K.
1966 Bone Development. In *Human Development*, edited by F. Falkner, pp. 503–509. W. B. Saunders, Philadelphia, Pennsylvania.

Rodríguez Romero, W. E., G. F. Sáenz Renauld, and M. A. Chaves Villalobos
1998 Hemoglobin S Haplotypes: Their Epidemiologic, Anthropologic and Clinical Importance. *Revista Panamericana de Salud Pública* 3(1):1–8.

Rogers, J.
2000 The Palaeopathology of Joint Disease. In *Human Osteology in Archaeology and Forensic Science*, edited by M. Cox and S. Mays, pp. 163–182. Greenwich Medical Media, London, Great Britain.

Rose, J. C. (editor)
1985 *Gone to a Better Land: A Biohistory of a Rural Black Cemetery in the Post-Reconstruction South*. Research Series No. 25. Arkansas Archaeological Survey, Fayetteville.

Rose, J. C., K. W. Condon, and A. H. Goodman
1985 Diet and Dentition: Development Disturbances. In *The Analysis of Prehistoric Diets*, edited by R. I. Gilbert and J. H. Mielken, pp. 281–305. Academic Press, Orlando, Florida.

Rose, J. C., and L. G. Santeford
1985 Cedar Grove Burial Interpretation. In *Gone to a Better Land: A Biohistory of a Rural Black Cemetery in the Post-Reconstruction South*, edited by J. C. Rose, pp. 130–145. Research Series No. 25. Arkansas Archaeological Survey, Fayetteville.

Rosen, J. F., and J. G. Pounds
1998 Severe Chronic Lead Insult that Maintains Body Burdens of Lead Related to Those in the Skeleton: Observations by Dr. Clair Patterson Conclusively Demonstrated. *Environmental Research* 78:140–151.

Ross, H. B., A. M. Adams, and L. M. Williams
1999 Caroline Bond Day: Pioneer Black Physical Anthropologist. In *African American Pioneers in Anthropology*, edited by I. E. Harrison and F. V. Harrison. pp. 37–50. University of Illinois, Urbana.

Rosser, Z. H.
2000 Y-Chromosomal Diversity in Europe Is Clinal and Influenced Primarily by Geography, rather than by Language. *American Journal of Human Genetics* 67(6):1526–1543.

Rothschild, N. A.
1990 *New York City Neighborhoods: The 18th Century*. Academic Press, San Diego, California.

Rovillé-Sausse, F.
1998 Growth Rates of Children of Subsaharan African Ancestry Born to Immigrant Parents and French Children in Paris. *American Journal of Human Biology* 10:757–764.

Rudney, J. D., R. V. Katz, and J. W. Brand
1983 Interobserver Reliability of Methods for Paleopathological Diagnosis of Dental Caries. *American Journal of Physical Anthropology* 62:243–248.

Ruff, C. B.
2000 Body Size, Body Shape, and Long Bone Strength in Modern Humans. *Journal of Human Evolution* 38:269–290.

Runia, L. T.
1987 Strontium and Calcium Distribution in Plants: Effect on Paleodietary Studies. *Journal of Archaeological Science* 14:599–608.

Ryan, A. S.
1997 Iron-Deficiency Anemia in Infant Development: Implications for Growth, Cognitive Development, Resistance to Infection, and Iron Supplementation. *Yearbook of Physical Anthropology* 40:25–62.

Salas, A., M. Richards, T. De la Fe, M. V. Lareu, B. Sobrino, P. Sánchez-Diz, V. Macaulay, and A. Carracedo

2002 The Making of the African mtDNA Landscape. *American Journal of Human Genetics* 71(5):1082–1111.

Samford, P.

1994 Searching for West African Cultural Meanings in the Archaeological Record. *African American Archaeology* 12:Winter.

Sanday, P. R.

1999 Skeletons in the Anthropological Closet: The Life and Work of William S. Willis, Jr. In *African American Pioneers of Anthropology*, edited by I. E. Harrison and F. V. Harrison, pp. 243–264. University of Illinois, Urbana.

Sarnat, B. G., and I. Schour

1941 Enamel Hypoplasias (Chronic Enamel Aplasia) in Relationship to Systemic Diseases: A Chronological, Morphological and Etiological Classification. *Journal of the American Dental Association* 28:1989–2000.

Sarr, M., B. Toure, A. W. Kane, F. Fall, and M. M. Wone

2000 Taurodontism and the Pyramidal Tooth at the Level of the Molar Prevalence in the Senegalese Population 15 to 19 Years of Age. *Odonto-stomatologie Tropicale* 23(89):31–34.

Satake, T.

1999 Sexual Dimorphism in the Relationship between Number of Emerged Permanent Teeth and Percentage of Adult Stature. *American Journal of Human Biology* 11:619–626.

Sattenspiel, L., and H. Harpending

1983 Stable Populations and Skeletal Age. *American Antiquity* 48:489–498.

Saunders, S. R.

1992 Subadult Skeletons and Growth Related Studies. In *Skeletal Biology of Past Peoples: Research Methods*, edited by M. A. Katzenberg and S. R. Saunders, pp. 1–20. Wiley-Liss, New York.

2000 Subadult Skeletons and Growth-Related Studies. In *Biological Anthropology of the Human Skeleton*, edited by M. A. Katzenberg and S. R. Saunders, pp. 135–161. Wiley-Liss, New York.

Saunders, S. R., and L. Barrans

1999 What Can Be Done about the Infant Category in Skeletal Samples? In *Human Growth in the Past: Studies from Bones and Teeth*, edited by R. D. Hoppa and C. M. FitzGerald, pp. 153–209. Cambridge Studies in Biological and Evolutionary Anthropology 25. Cambridge University Press, Cambridge, Great Britain.

Saunders, S. R., C. DeVito, A. Herring, R. Southern, and R. Hoppa

1993 Accuracy Tests of Tooth Formation Age Estimators for Human Skeletal Remains. *American Journal of Physical Anthropology* 97:173–188.

Saunders, S. R., and R. D. Hoppa

1993a Growth Deficit in Survivors and Non-Survivors: Biological Mortality Bias in Subadult Skeletal Samples. *Yearbook of Physical Anthropology* 36:127–151.

1993b Diaphyseal Growth in a Nineteenth Century Skeletal Sample of Subadults from St. Thomas Church, Belleville, Ontario. *International Journal of Osteoarchaeology* 3:265–281.

Savitt, T. L.

1978 *Medicine and Slavery: The Diseases and Health Care of Blacks in Antebellum Virginia*. University of Illinois Press, Urbana.

Schell, L. M.

1991 Effects of Pollutants on Human Prenatal and Postnatal Growth: Noise, Lead, Polychlorobiphenyl Compounds, and Toxic Wastes. *Yearbook of Physical Anthropology* 34: 157–188.

1997 Culture as a Stressor: A Revised Model of Biocultural Interaction. *American Journal of Physical Anthropology* 102:67–77.

Scher, A. T.

1978 Injuries to the Cervical Spine Sustained while Carrying Loads on the Head. *Paraplegia* 16:94–101.

Scheuer, L., and S. Black

2000 *Developmental Juvenile Osteology*. Academic Press, San Diego, California.

Schmerer, W. M., S. Hummel, and B. Herrmann
1997 Reproducibility of a DNA Typing. *Anthropologischer Anzeiger* 55(2):199–206.

Schmidt, P. R., and T. C. Patterson (editors)
1995 *Making Alternative Histories: The Practice of Archaeology and History in Non-Western Settings*. School of American Research Press, Santa Fe, New Mexico.

Schour, I., and M. Massler
1941 The Development of the Human Dentition. *Journal of the American Dental Association* 28:1153–1160.

Schultes, T., S. Hummel, and B. Herrmann
1997 Classification of Isolated Skeletal Elements using aDNA Typing. *Anthropologischer Anzeiger* 55(2):207–216.

Schultz, M.
2003 Light Microscopic Analysis in Skeletal Paleopathology. In *Identification of Pathological Conditions in Human Skeletal Remains*, edited by D. J. Ortner, pp. 73–107. 2nd ed. Academic Press, New York.

Schurr, M. R.
1997 Stable Nitrogen Isotopes as Evidence for the Age of Weaning at the Angel Site: A Comparison of Isotopic and Demographic Measures of Weaning Age. *Journal of Archaeological Science* 24:919–927.

Schwarcz, H. P., L. Gibbs, and M. Knyf
1991 Oxygen Isotope Analysis as an Indicator of Place of Origin. In *An Investigation of a Military Cemetery from the War of 1812*, edited by S. Pfeiffer and R. F. Williamson, pp. 263–268. Dundurn Press, Toronto, Ontario, Canada.

Schwarcz, H. P., and M. J. Schoeninger
1991 Stable Isotope Analysis in Human Nutritional Ecology. *Yearbook of Physical Anthropology* 34:283–321.

Sciulli, P. W.
1979 Size and Morphology of the Permanent Dentition in Prehistoric Ohio Valley Amerindians. *American Journal of Physical Anthropology* 50:615–628.
1994 Standardization of Long Bone Growth in Children. *International Journal of Osteoarchaeology* 4:257–325.

Scott, E. C.
1979 Dental Wear Scoring Technique. *American Journal of Physical Anthropology* 51:213–218.

Scott, G. R.
1991 Dental Anthropology. In *Encyclopedia of Human Biology*, vol. 2, edited by R. Dulbecco, pp.789–804. Academic Press, San Diego, California.
1994 Teeth and Prehistory on Kodiak Island. In *Reckoning with the Dead: The Larsen Bay Repatriation and the Smithsonian Institution*, edited by T. L. Bray and T. W. Killion, pp. 67–74. Smithsonian Institution Press, Washington, D. C.

Scott, G. R., H. Rosario, Y. Potter, J. F. Noss, A. A. Dahlberg, and T. Dahlberg
1983 The Dental Morphology of the Pima Indians. *American Journal of Physical Anthropology* 61:13–31.

Scott, G. R., and C. G. Turner II
1997 *The Anthropology of Modern Human Teeth: Dental Morphology and its Variation in Recent Human Populations*. Cambridge University Press, Cambridge, Great Britain.

Scozzari, R., A. Torroni, O. Semino, F. Cruciani, G. Spedini, A. S. Santachiara Benerecetti
1994 Genetic Studies in Cameroon: Mitochondrial DNA Polymorphisms in Bamileke. *Human Biology* 66(1):1–12.

Scozzari, R., A. Torroni, O. Semino, G. Sirugo, A. Brega, and A. S. Santachiara-Benerecetti
1988 Genetic Studies on the Senegal Population. I. Mitochondrial DNA Polymorphisms. *American Journal of Human Genetics* 43(4):534–544.

Scrimshaw, N.
1991 Iron Deficiency. *Scientific American* 265(4):46–52.

Sealy, J., R. Armstrong, and C. Schrire
1995 Beyond Lifetime Averages: Tracing Life Histories through Isotopic Analysis of Different Calcified Tissues from Archaeological Human Skeletons. *Antiquity* 69:290–300.

Sealy, J. C., and A. Sillen
1988 Sr and Sr/Ca in Marine and Terrestrial Foodwebs in the Southwestern Cape,

South Africa. *Journal of Archaeological Science* 15:425–438.

Sealy, J. C., N. J. Van der Merwe, A. Sillen, F. J. Kruger, and H. W. Krueger
1991 87Sr/86Sr as a Dietary Indicator in Modern and Archaeological Bone. *Journal of Archaeological Science* 18:399–416.

Serjeant, G. R.
1981 Observations on the Epidemiology of Sickle Cell Disease. *Transactions of the Royal Society of Tropical Medicine* 75:228–233.

Shapiro, I. M., H. L. Needleman, and O. C. Tuncay
1972 The Lead Content of Human Deciduous and Permanent Teeth. *Environmental Research* 5:467–470.

Sharon, I. M.
1988 The Significance of Teeth in Pollution Detection. *Perspectives in Biology and Medicine* 24:124–131.

Sharpe, John
1881 *Proposals for Erecting a School, Library and Chapel at New York.* Publication Fund Series, vol. 13, pt. 5. Collections of the New-York Historical Society. New-York Historical Society, New York.

Shieh, A. C., and K. A. Athanasiou
2002 Biomechanics of Single Chondrocytes and Osteoarthritis. *Critical Reviews in Biomedical Engineering* 30(4–6):307–343.

Shields, E. D.
1998 The Origin of Europeans Is Not Rooted in the Middle East but in Southern East Asia. *Journal of Craniofacial Genetic Developmental Biology* 18(2):59–63.
1999 A New Perspective of Human Origin and Dispersals Derived from the Microevolution of Teeth. *Journal of Craniofacial Genetics and Developmental Biology* 19(3):119–127.

Shields, E. D., and G. Jones
1996 Heterochronic Quantitative Microevolution: Dental Divergence in Aboriginal Americans. *American Journal of Physical Anthropology* 100:355–365.

Sillen, A., and M. Kavanagh
1982 Strontium and Paleodietary Research: A Review. *Yearbook of Physical Anthropology* 25:67–90.

Sillen, A., J. C. Sealy, and N. Van der Merwe
1989 Chemistry and Paleodietary Research: No More Easy Answers. *American Antiquity* 54:504–512.

Simpson, S. W., and C. A. Kunos
1998 A Radiographic Study of the Development of the Human Mandibular Dentition. *Journal of Human Evolution* 35:479–505.

Singleton, T. A.
1995 The Archaeology of Slavery in the North. *Annual Review of Anthropology* 24:119–140.

Singleton, T. A., and M. D. Bograd
1995 *The Archaeology of the African Diaspora in the Americas*. Guides to the Archaeological Literature of the Immigrant Experience in America No. 2. Society for Historical Archaeology, Glassboro, New Jersey.

Smedley, A.
1993 *Race in North America: Origins and Evolution of a World View*. Westview, Boulder, Colorado.

Smith, B. H.
1984 Patterns of Molar Wear in Hunter-Gatherers and Agriculturalists. *American Journal of Physical Anthropology* 63:39–56.
1991 Standards of Human Tooth Formation and Dental Age Assessment. In *Advances in Dental Anthropology*, edited by M. A. Kelly and C. S. Larsen, pp. 143–168. Wiley-Liss, New York.

Smith, D.
2002 Slave Site for a Symbol of Freedom. Electronic document, http://www.nytimes.com/2002/04/20/arts/20BELL.html=&pagewanted=print, accessed April 20, 2002.

Soodyall, H., and T. Jenkins
1993 Mitochondrial DNA Polymorphisms in Negroid Populations from Namibia: New Light on the Origins of the Dama, Herero and Ambo. *Annals of Human Biology* 20(5):477–485.

Sow, A., E. Peterson, O. Josifovska, M. E. Fabry, R. Krishnamoorthy, and R. L. Nagel
1995 Linkage-Disequilibrium of the Senegal Haplotype with the Beta S Gene in the Republic of Guinea. *American Journal of Hematology* 50(4):301–303.

Spencer, F.
1979 *Aleš Hrdlička, M.D. 1869–1943: A Chronicle of the Life and Work of an American Anthropologist*. Ph.D. dissertation, Department of Anthropology, University of Michigan. University Microfilms, Ann Arbor, Michigan.

Sperber, G. H., and J. L. Moreau
1998 Study of the Number of Roots and Canals in Senegalese First Permanent Mandibular Molars. *International Endodontic Journal* 31(2):117–122.

Spinola, H., A. Brehm, E. Williams, J. Jesus, and D. Middleton
2002 Distribution of HLA Alleles in Portugal and Cabo Verde: Relationships with the Slave Trade Route. *Annals of Human Genetics* 66(4):285–296.

Stampp, K. M.
1956 *The Peculiar Institution: Slavery in the Ante-Bellum South*. Vintage Books, New York.

Steckel, R. H.
1977 *The Economics of U.S. Slave and Southern White Fertility*. Ph.D. dissertation, Department of Economics, University of Chicago. University Microfilms, Ann Arbor, Michigan.
1986 A Dreadful Childhood: The Excess Mortality of American Slaves. *Social Science History* 10:427–467.
1996 Women, Work, and Health under Plantation Slavery in the United States. In *More than Chattel*, edited by D. C. Gaspar and D. B. Hine, pp. 43–60. Indiana University Press, Bloomington.

Steinbock, R. T.
1976 *Paleopathological Diagnosis and Interpretation, Bone Diseases in Ancient Human Populations*. Charles C Thomas, Springfield, Illinois.

Steinlechner, M., K. Schmidt, H. G. Kraft, G. Utermann, and W. Parson
2002 Gabon Black Population Data on the Ten Short Tandem Repeat Loci D3S1358, VWA, D16S539, D2S1338, D8S1179, D21S11, D18S51, D19S433, TH01 and FGA. *International Journal of Legal Medicine* 116(3):176–178.

Stevenson, J. C.
1983 Mineral Needs of the Fetus. In *Fetal Endocrinology and Metabolism*, edited by L. D. Martini and V. H. T. James, pp. 178–197. Current Topics in Experimental Endocrinology, vol. 5. Academic Press, New York.

Stewart, C. P., and D. Guthrie (editor)
1953 *Lind's Treatise on Scurvy*. Edinburgh University Press, Edinburgh, Great Britain.

Stewart, T. D.
1939 Negro Skeletal Remains from Indian Sites in the West Indies. *Man* 39:49–51.
1953 The Age Incidence of Neural-Arch Defects in Alaskan Natives, Considered from the Standpoint of Etiology. *Journal of Bone and Joint Surgery* 25(A):937–950.
1958 The Rate of Development of Vertebral Osteoarthritis in American Whites and its Significance in Skeletal Age Identification. *Leech* 28(3–5):144–151.

Stewart, T. D., and J. R. Groome
1968 The African Custom of Tooth Mutilation in America. *American Journal of Physical Anthropology* 28:31–42.

Steyn, M., and M. Henneberg
1996 Skeletal Growth of Children from the Iron Age Site at K2 (South Africa). *American Journal of Physical Anthropology* 100:389–396.

Stirland, A. J.
1991 Diagnosis of Occupationally Related Paleopathology: Can It Be Done? In *Human Paleopathology: Current Syntheses and Future Options*, edited by D. J. Ortner and A. C. Aufderheide, pp. 40–47. Smithsonian Institution Press, Washington, D.C.
2000 *Raising the Dead: The Skeleton Crew of King Henry VIII's Great Ship, the Mary Rose.* Wiley, Chichester, Great Britain.

Stoddard, L.
1921 *The Rising Tide of Color Against White World-Supremacy*. Scribner, New York.

Stoneking, M., D. R. G. Hedgecock, L. V. Higuchi, and H. A. Erlich
1991 Population Variation of Human mtDNA Control Region Sequences Detected by Enzymatic Amplification and Sequence-Specific Oligonucleotide Probes. *American Journal of Human Genetics* 48:370–382.

Subcommittee on Zinc, Committee on Medical and Biologic Effects of Environmental Pollutants
1979 *Zinc*. University Park Press, Baltimore, Maryland.

Subscribers for the Abolition of Slavery
1787 Fair Minute Book, May 24. Archived at the British Library.

Suchey, J. M., D. V. Wisely, R. F. Green, and T. T. Nogouchi
1979 Analysis of Dorsal Pitting in the Os Pubis in an Extensive Sample of Modern American Females. *American Journal of Physical Anthropology* 51:628–640.

Sundick, R. I.
1977 Age and Sex Determination of Subadult Skeletons. *Journal of Forensic Science* 22:141–144.
1978 Human Skeletal Growth and Age Determination. *Homo* 29:228–249.

Sutherland, L. D., and J. M. Suchey
1991 Use of Ventral Arc in Pubic Sex Determination. *Journal of Forensic Science* 36(2):501–511.

Swedlund, A.
1990 Infant and Childhood Mortality in the 19th Century United States: A View from Rural Massachusetts. In *Disease in Populations in Transition: Anthropological and Epidemiological Perspectives*, edited by A. Swedlund and G. J. Armelagos, pp. 161–182. Bergin and Garvey, New York.

Swofford, D.
1999 *Phylogenetic Analysis using Parsimony Version 4.0*. Sinauer Associates, Sunderland, Massachusetts.

Tague, R. G.
1998 Bone Resorption of the Pubis and Preauricular Area in Human and Nonhuman Mammals. *American Journal of Physical Anthropology* 76:251–267.

Tanner, J. M.
1990 *Foetus into Man: Physical Growth from Conception to Maturity.* Rev. ed. Harvard University Press, Cambridge, Massachusetts.

Taylor, N. A. S., and J. G. Wilkinson
1986 Exercise-Induced Skeletal Muscle Growth: Hypertrophy or Hyperplasia? *Sports Medicine* 3:190–200.

Ten Cate, A. R.
1985 *Oral Histology: Development, Structure, and Function*. 2nd ed. C. V. Mosby, St. Louis, Missouri.

Thieme, F. P.
1957 Sex in Negro Skeletons. *Journal of Forensic Medicine* 4:72–81.

Thieme, F. P., and W. J. Schull
1957 Sex Determination from the Skeleton. *Human Biology* 29(3):242–273.

Thilander, B.
1995 Basic Mechanisms in Craniofacial Growth. *Acta Odontologica Scandinavica* 53:144–151.

Thomas, D. H.
1998 *Archaeology*. Harcourt Brace College Publishers, Fort Worth, Texas.
2000 *Skull Wars: Kennewick Man, Archaeology, and the Battle for Native American Identity*. Basic Books, New York.

Thomas, D. H., S. South, and C. S. Larsen
1977 *Rich Man, Poor Men: Observations on Three Antebellum Burials from the Georgia Coast*. Anthropological Papers of the American Museum of Natural History Vol. 54, Pt. 3.

Thomas, J. A., D. L. Rimoin, R. S. Lachman, and W. R. Wilcox
1998 Gracile Bone Dysplasia. *American Journal of Medical Genetics* 75:95–100.

Tieslerbos, V. G., and R. L. B. Frausto
2001 Head Shaping and Dental Decoration: Two Biocultural Attributes of Cultural Integration and Social Distinction among the Maya. *American Journal of Physical Anthropology* Annual Supplement 32:149.

Tobias, P. V.
1953 The Problem of Race Determination: Limiting Factors in the Identification of the South African Races. *Journal of Forensic Medicine* 1:113–123.

Todd, T. W.
1921a Age Changes in the Pubic Bone, I: The Male White Pubis. *American Journal of Physical Anthropology* 3:285–334.
1921b Age Changes in the Pubic Bone, III: The Pubis of the White Female. IV: The Pubis of the Female Negro-White Hybrid. *American Journal of Physical Anthropology* 4:1–70.

1937 *The Atlas of Skeletal Maturation*. C. V. Mosby, St. Louis, Missouri.

Tomas, G., L. Seco, S. Seixas, P. Faustino, J. Lavinha, and J. Rocha
2002 The Peopling of São Tomé (Gulf of Guinea): Origins of Slave Settlers and Admixture with the Portuguese. *Human Biology* 74(3):397–411.

Torday, E.
1919 The Northern Babunda. *Man* 19:49–55.

Torroni, A., M. D. Brown, M. T. Lott, N. J. Newman, and D. C. Wallace
1995 African, Native American, and European Mitochondrial DNAs in Cubans from Pinar del Rio Province and Implications for the Recent Epidemic Neuropathy in Cuba. Cuba Neuropathy Field Investigation Team. *Human Mutation* 5(4):310–317.

Torroni, A., O. Semino, R. Scozzari, G. Sirugo, G. Spedini, N. Abbas, M. Fellous, and A. S. Santachiara Benerecetti
1990 Y Chromosome DNA Polymorphisms in Human Populations: Differences between Caucasoids and Africans Detected by 49a and 49f Probes. *Annals of Human Genetics* 54(4):287–296.

Tossi, L. L.
1997 Osteogenesis Imperfecta. *Current Opinion in Pediatrics* 9:94–99.

Trotter, M.
1970 Estimation of Stature from Intact Long Limb Bones. In *Personal Identification in Mass Disasters*, edited by T. D. Stewart, pp. 71-83. Smithsonian Institution Press, Washington, D.C.

Trovoada, M. J., C. Alves, L. Gusmao, A. Abade, A. Amorim, and M. J. Prata
2001 Evidence for Population Sub-Structuring in São Tomé e Principe as Inferred from Y-Chromosome STR Analysis. *Annals of Human Genetics* 65(3):271–283.

Tsuboi, S., H. Nakagaki, Y. Takami, H. Eba, J. Kirkham, and C. Robinson
2000 Magnesium and Fluoride Distribution in Human Cementum with Age. *Calcified Tissue International* 67(6):466–471.

Turner, C. G., II
1987 Late Pleistocene and Holocene Population History of East Asia based on Dental Variation. *American Journal of Physical Anthropology* 73:305–321.

Ubelaker, D. H.
1986 Estimation of Age at Death from Histology of Human Bone. In *Dating and Age Determination of Biological Materials*, edited by M. Zimmerman and L. Angel, pp. 240–247. Croom Helm, London, Great Britain.
1987 Estimating Age at Death from Immature Human Skeletons: An Overview. *Journal of Forensic Science* 32:1254–1263.
1989 *Human Skeletal Remains: Excavation, Analysis, Interpretation*. 2nd. ed. Manuals on Archeology 2. Taraxacum, Washington, D.C.

Ubelaker, D. H., and J. L. Angel
1976 Analysis of the Hull Bay Skeletons, St. Thomas. *Journal of the Virgin Islands Archaeological Society* 3:393–420.

Ubelaker, D. H., and L. G. Grant
1989 Human Skeletal Remains: Preservation or Reburial. *Yearbook of Physical Anthropology* 32:249–287.

Underhill, P. A.
2001 The Phylogeography of Y Chromosome Binary Haplotypes and the Origins of Modern Human Populations. *Annals of Human Genetics* 65(1):43–62.

United States Bureau of the Census
1909 *A Century of Population Growth: From the First Census of the United States to the Twelfth, 1790–1900*. U.S. Government Printing Office, Washington, D.C.

United States Congress. House. Committee on Public Works and Transportation. Subcommittee on Public Buildings and Grounds
1992 Foley Square Construction Project and the Historic African Burial Ground, New York, NY : Hearings before the Subcommittee on Public Buildings and Grounds of the Committee on Public Works and Transportation, House of Representatives. 102nd Cong., 2nd sess., July 27, 1992 (New York City, New York), September 24, 1992 (Washington, D.C.). U.S. Government Printing Office, Washington, D.C.

United States Department of Health and Human Services
2001 Data Services, National Center for Health Statistics, Centers for Disease Control and Prevention. Electronic document, http://www.cdc.gov/nccdphp/dnpa/growthcharts/training/powerpoint/slides/011.htm, accessed June 2, 2009.

Van Cortlandt, J.
1771 Van Cortlandt Letterbooks, 1771–92. Manuscript on file, New York Public Library.

Van der Meulen, M. C. H., and D. R. Carter
1995 Developmental Mechanics Determine Long Bone Allometry. *Journal of Theoretical Biology* 172:323–327.

Van Gerven, D. P., and G. J. Armelagos
1983 Farewell to Paleodemography? Rumors of Its Death Have Been Greatly Exaggerated. *Journal of Human Evolution* 12:353–360.

Van Rippen, B.
1918 Practices and Customs of the African Natives involving Dental Procedures. *Journal of Allied Dental Societies* 13(1):1–22a.

Varma, R., and V. F. Johny
2002 Infantile Cortical Hyperostosis (Caffey's Disease). *Indian Pediatrics* 39:1057.

Vaughn, A. T.
1972 Blacks in Virginia: A Note on the First Decade. *William and Mary Quarterly*, 3rd ser. 29:469–478.

Vigilant, L., M. Stoneking, H. Harpending, K. Hawkes, and A. C. Wilson
1991 African Populations and the Evolution of Human Mitochondrial DNA. *Science* 253(5027):503–1507.

Vivenes de Lugo, M., A. Rodríguez-Larralde, and D. Castro de Guerra
2003 Beta-globin Gene Cluster Haplotypes as Evidence of African Gene Flow to the Northeastern Coast of Venezuela. *American Journal of Human Biology* 15(1):29–37.

Von Ihering, H.
1882 Die künstliche Deformirung der Zahne. *Zeitschrift für Ethnologie* 14:213–262.

Washburn, S. L.
1948 Sex Differences in the Pubic Bone. *American Journal of Physical Anthropology* 6:199–207.

Watkins, W. S., C. E. Ricker, M. J. Bamshad, M. L. Carroll, S. V. Nguyen, M. A. Batzer, H. C. Harpending, A. R. Rogers, and L. B. Jorde
2001 Patterns of Ancestral Human Diversity: An Analysis of Alu-insertion and Restriction Site Polymorphisms. *American Journal of Human Genetics* 68(3):738–752.

Watling, R. J.
1999 Novel Application of Laser Ablation Inductively Coupled Plasma Mass Spectrometry in Forensic Science and Forensic Archaeology. *Spectroscopy* 14:16–34.

Watson, E., K. Bauer, R. Aman, G. Weiss, A. von Haeseler, and S. Paabo
1996 mtDNA Sequence Diversity in Africa. *American Journal of Human Genetics* 59:437–444.

Watson, E., P. Forster, M. Richards, and H. Bandelt
1997 Mitochondrial Footprints of Human Expansions in Africa. *American Journal of Human Genetics* 61(3):691–704.

Watters, D., and J. Petersen
1991 The Harney Site Slave Cemetery, Montserrat: Archaeological Summary. In *Proceedings of the Thirteenth International Congress for Caribbean Archaeology*, *Reports of the Archaeological and Anthropological Institute of the Netherlands Antilles* No. 9, edited by E. N. Ayubi and J. B. Haviser, pp. 317–325. Archaeological and Anthropological Institute of the Netherlands Antilles, Curaçao.

Watts Letter Book
1762–1765 Letter Book of John Watts. Vol. 61. Collections of the New-York Historical Society. New-York Historical Society, New York.

Wax, D. D.
1973 Preferences for Slaves in Colonial America. *The Journal of Negro History* 58(4):371–401.

Webb, E., S. Tauch, E. F. Green, A. Goodman, and D. Amarasiriwardena
2003 Determination of Elemental Concentrations and Lead Isotope Ratios in Teeth from Solis, Mexico, Kalama, Egypt and Bronze Age Magan in Tell Abraq, UAE, by Inductively Coupled Plasma–Atomic Emission Spectroscopy (ICP-AES) and

Mass Spectrometry (ICP-MS). Paper presented at the American Chemical Society National Meeting, New Orleans, Louisiana.

Weintraub, M.
1997 Racism and Lead Poisoning. *American Journal of Public Health* 87(11):1871–1872.

Weiss, E.
2003 Understanding Muscle Markers: Aggregation and Construct Validity. *American Journal of Physical Anthropology* 121:230–240.

Weiss, K. M.
1973 *Demographic Models for Anthropology*. SAA Memoirs No. 27. Society for American Archaeology, Washington, D.C.
1993 A Tooth, a Toe, a Vertebra: The Genetic Dimensions of Complex Morphological Traits. *Evolutionary Anthropology* 2:121–134.

Wentzel, P. J.
1961 *Die Fonolgie en Morfologie van Westlike Shona*. Universiteit van Stellenbosch, Stellenbosch.

Westphal, O.
1995 Normal Growth and Growth Disorders in Children. *Acta Odontologica Scandinavica* 53:174–178.

White, C. D., M. W. Spence, F. J. Longstaffe, H. Stuart-Williams, and K. P. Law
2002 Geographic Identities of the Sacrificial Victims from the Feathered Serpent Pyramid, Teotihuacan: Implications for the Nature of State Power. *Latin American Antiquity* 13(2):217–236.

White, C. D., M. W. Spence, H. L. Q. Stuart-Williams, and H. P. Schwarcz
1997 Oxygen Isotopes and the Identification of Geographical Origins: The Valley of Oaxaca versus the Valley of Mexico. *Journal of Archaeological Science* 25:643–655.

White, S.
1991 *Somewhat More Independent: The End of Slavery in New York City, 1770–1810*. University of Georgia Press, Athens.

Whitten, N. E., Jr., and J. R. Szwed
1970 *Afro-American Anthropology: Contemporary Perspectives*. Free Press, New York.

Wienker, C. W.
1987 Admixture in a Biologically African Caste of Black Americans. *American Journal of Physical Anthropology* 74(2):265–273.

Wienker, C. W., and J. E. Wood
1988 Osteological Individuality Indicative of Migrant Citrus Laboring. *Journal of Forensic Science* 33(2):562–567.

Wilczak, C. A.
1998 *A New Method for Quantifying Musculoskeletal Stress Markers (MSM): A Test of the Relationship between Enthesis Size and Habitual Activity in Archaeological Populations*. Ph.D. dissertation, Department of Ecology and Evolutionary Biology, Cornell University. University Microfilms, Ann Arbor, Michigan.

Wilczak, C. A., and K. A. R. Kennedy
1998 Mostly MOS: Technical Aspects of Identification of Skeletal Markers of Occupational Stress. In *Forensic Osteology: Advances in the Identification of Human Remains*, edited by K. J. Reichs, pp. 461–490. Charles C Thomas, Springfield, Illinois.

Willcox, M., G. Beckman, and L. Beckman
1986 Serum Protein Polymorphisms in a Liberian Population. *Human Heredity* 36(1):54–57.

Williams, E.
1961 C*apitalism and Slavery.* Russell & Russell, New York.

Willis, W. S., Jr.
1999 Skeletons in the Anthropological Closet. In *Reinventing Anthropology*, edited by D. Hymes, with a new introduction by the author, pp. 121–152. University of Michigan Press, Ann Arbor. Originally published 1972, Pantheon Books, New York.

Wood, G. S.
1974 *Revolution and the Political Integration of the Enslaved and Disenfranchised*. American Enterprise Institute for Public Policy Research, Washington, D.C.

Wood, J. W., G. R. Milner, H. C. Harpending, and K. M. Weiss
1992 The Osteological Paradox: Problems of Inferring Prehistoric Health from Skeletal Samples. *Current Anthropology* 33:343–370.

Woodward, C. V.
1968 *The Burden of Southern History.* Rev. ed. Louisiana State University Press, Baton Rouge.

Woodward, J. A.
1968 The Anniversary: A Contemporary Diegueno Complex. *Ethnology* 7:86–94.

Wright, L. E., and F. Chew
1999 Porotic Hyperostosis and Paleoepidemiology: A Forensic Perspective on Anemia among the Ancient Maya. *American Anthropologist* 100(4):924–939.

Wright, L. E., and H. P. Schwarcz
1998 Stable Carbon and Oxygen Isotopes in Human Tooth Enamel: Identifying Breastfeeding and Weaning in Prehistory. *American Journal of Physical Anthropology* 106:1–18.

Yamin, R. (editor)
2000 *A Narrative History and Archaeology of Block 160.* Tales of Five Points: Working Class Life in Nineteenth Century New York, vol. 1. Report prepared for the General Services Administration, John Milner Associates, West Chester, Pennsylvania.

Yasar, I. M., and M. Steyn
1999 Craniometric Determination of Population Affinity in South Africans. *International Journal of Legal Medicine* 112(2):91–97.

Yeboah, E. D., J. M. Wadhwani, and J. B. Wilson
1992 Etiological Factors of Male Infertility in Africa. *International Journal of Fertility* 37(5):300–307.

Y'edynak, G.
1976 Long Bone Growth in Western Eskimos and Aleut Skeletons. *American Journal of Physical Anthropology* 45:569–574.

Zago, M. A.
2001 Rearrangements of the Beta-globin Gene Cluster in Apparently Typical Beta S Haplotypes. *Haematologica* 86(2):142–145.

Zago, M. A., M. S. Figueiredo, and S. H. Ogo
1992 Bantu Beta S Cluster Haplotype Predominates among Brazilian Blacks. *American Journal of Physical Anthropology* 88:295–298.

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