CHAPTER FOURTEEN

A Biohistory of Health and Behavior in the Georgia Bight

The Agricultural Transition and the Impact of European Contact

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ABSTRACT

This chapter tracks temporal and regional trends in health in the midregion of the Georgia Bight, a large embayment extending from northern coastal Atlantic Florida to North Carolina. The study explores changes in health in precontact and contact-era native populations that in historic times were known as Guale. Comparison of prehistoric foragers (1100 BC–AD 1150) and prehistoric farmers (AD 1150–1550) and early mission (AD 1550–1680) and late mission (AD 1686–1702) intensive agriculturalists reveals a clear reduction in health and an increase in workload and physical activity in this subtropical coastal setting. In comparison with other regions of the Western Hemisphere, the health index of the Georgia Bight populations was relatively high, with the exception of the late mission group. The latter's position relative to other regions reflects a decline in health with long-term interaction with and exploitation by Spaniards. The trends identified in this study are generally consistent with other patterns identified elsewhere in North and South America, especially regarding health decline with the shift to an agricultural economy and increased population sedentism and aggregation.

INTRODUCTION

Human remains from the Georgia Bight offer a rich record for tracking and interpreting the biohistory of human populations in North America (Figure 14.1). This chapter recounts this record, especially with regard to how bioarchaeological study informs our understanding of two major events and their impact on health and

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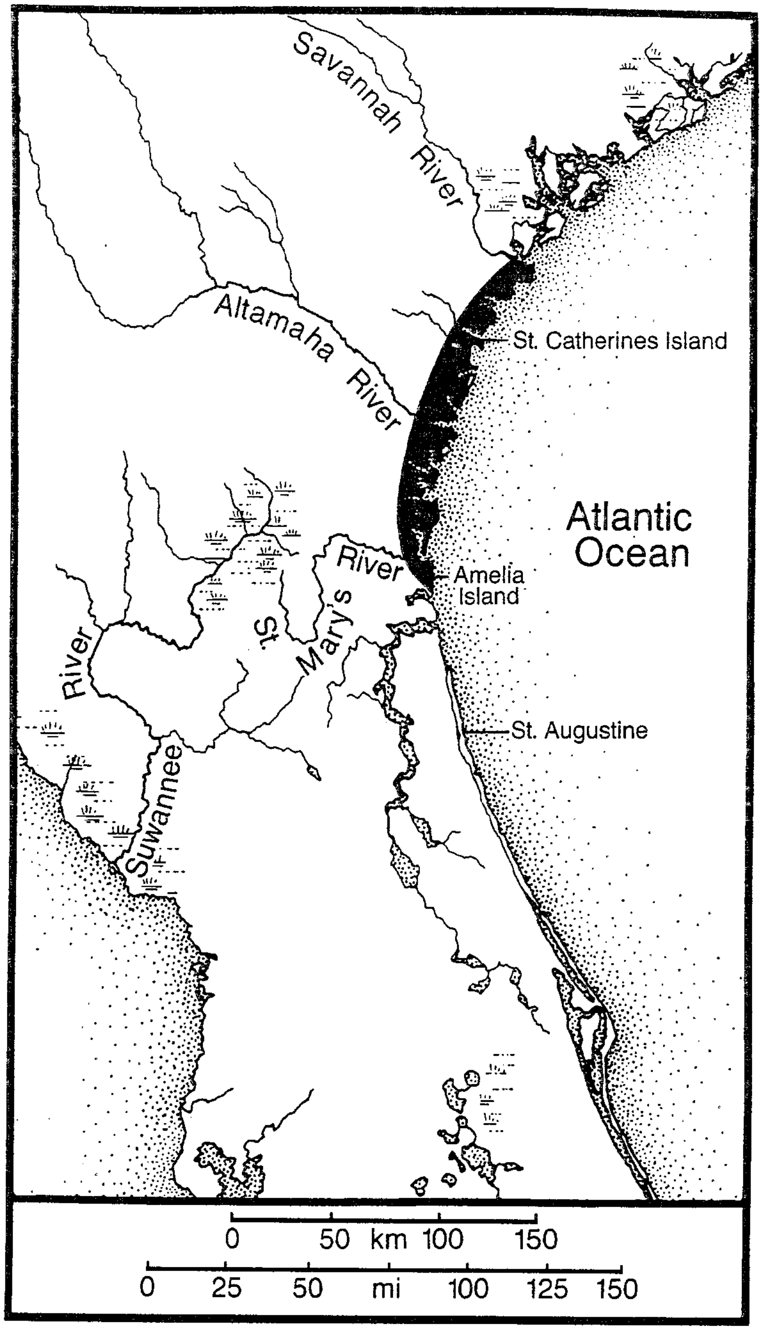

Figure 14.1. Map showing the location of the Georgia Bight.

behavior/activity in this setting: (1) the adoption and intensification of maize agriculture, and (2) the arrival of Europeans and the establishment of Roman Catholic missions. These events mark major departures from previous lifeways both in this area and the Western Hemisphere generally (Reitz 1988; Larsen 1994). The shift from foraging to farming has been studied by archaeologists and others from a range of settings around the world. Traditionally, most scholars and others have regarded the shift to have been very beneficial for humankind, setting the stage for the rise of civilization and complex societies, urbanization, writing, art, and so forth. Evidence from human remains in the Georgia Bight and elsewhere in the Western Hemisphere allows us to address this long-held assumption. The arrival of Europeans in the New

World and its impact on the health of native populations is known mostly from written sources. These sources generally focus on the impact of the introduction of Old World diseases and demographic collapse. The bioarchaeological record suggests reduction in health. However, the range of information provided from study of skeletons provides new insight into adaptations that native peoples make to new and novel circumstances, such as increased workload. Extensive samples of human remains from contact-era sites in coastal Georgia and northern Florida help us to develop a broader picture of biological change in native populations in ways not possible from written documents alone.

THE ENVIRONMENTAL SETTING

The Georgia Bight is a large embayment extending from Cape Hatteras, North Carolina, to Cape Canaveral, Florida (Larsen 1994, 1995). A dominant feature is the chain of barrier islands sharing similar Pleistocene and Holocene depositional and ecological histories. Lying between the outermost barrier islands and the mainland are various marsh islands. The barrier islands and marsh islands are separated by sounds, salt marshes, and tidal creeks. The topography of the islands and adjacent mainland is characterized by very low relief with a diverse subtropical flora and fauna. Primary plant communities on the islands are maritime oak and pine forests. The inshore zone includes a tremendously rich and variable estuarine fauna, including numerous fishes, such as red drum (*Sciaenops ocellatus*), mullets (*Mugil* spp.), and flounders (*Paralichthys* spp.), and invertebrates, such as oyster (*Crassostrea virginica*), shrimp (*Penaeus* spp.), and hard clams (*Mercenaria* spp.). These resources played a crucial role in the foodways of native populations living in the tidewater zone following the establishment of post-Pleistocene sea levels. The remains of terrestrial species of plants (e.g., acorns from live oaks) and animals (e.g., deer) are frequently encountered in archaeological sites, indicating the important role of these resources. Marine foods, however, appear to have been a primary focus of diet throughout prehistory and into the historic period.

THE POPULATION GROUPS

Three broad temporal groups, demarcated by the adoption of maize in later prehistory and the arrival of Europeans and establishment of missions, provide the basis for comparative analysis and identification of significant shifts in health. These groups include the precontact preagricultural, precontact agricultural, and contact samples. Within the contact group, identification of earlier and later mission native populations has been made possible by an abundant historical record. This record documents movement and resettlement of native populations from coastal Georgia to northern Florida in the late seventeenth century. Therefore, for the purposes of this discussion, we divide the contact samples into early contact and late contact groups. In all, the analysis presented here involves comparisons of four subsamples. A summary of the mortuary samples, site, and temporal associations is provided in Table 14.1 The following overview provides a description of each of the four population groupings, including economic and social activities, sources of evidence, dietary ecology, and other relevant information.

Precontact Preagricultural Group (1100 BC–AD 1150)

This series is drawn from 21 sites on the Georgia coast dating from circa 1100 BC to the middle to late twelfth century AD. This spans the Woodland period of eastern North America, known locally as the Refuge (1100–400 BC), Deptford (400 BC–AD 500), Wilmington (AD 500–1000), and St. Catherines (AD 1000–1150) periods. Although covering a lengthy time span, most of the remains postdate AD 700.

Analysis of plant and animal remains from a wide variety of sites indicates that diet was based exclusively on resources acquired through hunting, gathering, and fishing (Larsen 1982; Reitz 1988). These foods include the aforementioned terrestrial and marine flora and fauna. Dietary reconstruction using stable isotopes (carbon and nitrogen) and element (barium and strontium) analysis from human bone (collagen) shows a heavy reliance on marine foods, thus confirming dietary reconstructions based on study of archaeological food remains (Schoeninger et al. 1990; Larsen et al. 1990, 1992, 2000, 2001; Ezzo et al. 1995; Hutchinson et al. 1998).[1]

Analysis of settlement patterns, location of habitation sites, and size and density of habitation sites indicates that population during this time was small, dispersed, and probably highly transitory (Thomas, unpublished; Larsen 1982). This pattern suggests that populations were low in density and followed a foraging strategy involving movement, at least on a seasonal basis, prior to the twelfth century AD.

Precontact Agricultural Group (AD 1150–1550)

The later prehistoric series is from 23 mortuary sites on the Georgia coast dating from circa AD 1150 to 1550 or so. The populations these remains represent are from the earlier and later Mississippian occupations of the region known locally as the Savannah (AD 1150–1300) and Irene (AD 1300–1550) periods, respectively. Analysis of plant and animal remains from late prehistoric sites indicates a continued reliance on the same suite of food items eaten by earlier populations predating AD 1150, including especially marine and terrestrial fauna and nondomesticated plants. Archaeobotanical evidence for consumption of domesticated plants is

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[1] The stable isotopes of carbon (^{12}C and ^{13}C) and nitrogen (^{14}N and ^{15}N) provide a wealth of information about past diets. The ratios of ^{12}C to ^{13}C reveal the kinds of plants eaten. In eastern North America, most economically important plants have a C_3 photosynthesis pathway, whereas maize has a C_4 pathway. Owing to the differences in photosynthesis, the stable isotope ratios of carbon are different. These differences are passed up the food chain to the consumers, leaving a distinctive signature in the bones. Similarly, land-based and marine-based plants utilize nitrogen differently, resulting in a distinction between the stable isotope ratios of nitrogen. These differences are also passed up the food chain, so that humans eating marine foods have different stable nitrogen isotope ratios than humans eating terrestrial foods. The amount of barium and barium/strontium ratios are considerably lower in marine organisms and people consuming these organisms than in people who eat predominantly terrestrial foods. With the combined information provided by stable isotope ratios and barium/strontium ratios, our picture of food use is established.

Table 14.1: Mortuary Localities, Georgia Bight

Site code	Site	*N* (1413)
Precontact preagricultural (pre-AD 1150)		
101	South New Ground Mound	1
102	Cunningham Mound C	4
103	Cunningham Mound D	2
104	Cunningham Mound E	1
105	McLeod Mound	14
106	Seaside Mound I	17
107	Seaside Mound II	8
108	Evelyn Plantation	3
109	Airport	54
110	Deptford (nonmound)	47
111	Walthour	2
112	Cannons Point	18
113	Cedar Grove, Mound B	2
114	Cedar Grove, Mound A	1
115	Sea Island Mound	33
116	Johns Mound	65
117	Marys Mound	5
118	Charlie King Mound	15
119	Cedar Grove Mound C	8
120	South End Mound II	25
121	Indian King's Tomb	5
Precontact agricultural (AD 1150–1550)		
201	North End Mound	1
202	Low Mound, Shell Bluff	1
203	Townsend Mound	2
204	Deptford Mound	5
205	Norman Mound	25
206	Kent Mound	25
207	Lewis Creek, Mound II	7
208	Lewis Creek, Mound III	10
209	Lewis Creek, misc.	3
	Lewis Creek, Mound E	2
210	Red Knoll	5
211	Seven Mile Bend	18
212	Oatland Mound	2
213	Seaside Mound II	2
214	Irene Mound	267
215	Grove's Creek	2
216	South End Mound I	19
217	Skidaway Mitigation 3	3
218	Little Pine Island	17
219	Red Bird Creek Mound	3

Table 14.1 *(continued)*

Site code	Site	*N* (1413)
220	Couper Field	44
221	Taylor Mound	30
222	Indian Field	22
223	Taylor Mound/Martinez Test B	2
Early contact (AD 1550–1680)		
301	Santa Catalina de Guale	335
302	Pine Harbor	109
Late contact (AD 1686–1702)		
303	Santa Catalina de Santa Maria	122

meager (Larsen 1982). However, carbon and nitrogen stable isotope analysis reveals the significant role of maize (Schoeninger et al. 1990; Larsen et al. 1992, 2000, 2001; Hutchinson et al. 1998). In the last prehistoric period, the Irene period, isotopic evidence indicates a clear decline in maize consumption at the principal Mississippian center, the Irene Mound site, which may reflect either environmental stress (e.g., drought) or social disruption or some combination thereof (Larsen et al. 1992; Anderson 1994). The adoption of maize as an important contribution to native diets during this time has important implications for nutritional quality. Protein in maize (zein) is deficient in essential amino acids tryptophan and lysine, and it is lacking in niacin (Food and Agricultural Organization 1953). Endemic in various human populations relying on maize in the twentieth century is pellagra, which is caused by a deficiency of this vitamin (Food and Agricultural Organization 1953). Pellagra may well have been a significant health burden during the precontact agricultural period (and in the contact period). However, pellagra is not identifiable in skeletal remains, since the major symptoms of this deficiency disease are not related to the hard tissues directly. However, the stress caused by the disease could potentially be exhibited as increases in dental defects and other nonspecific indicators of physiological perturbation.

The late prehistoric population shows a major departure from the earlier pattern of small, dispersed settlements: after the twelfth century AD, there is a marked increase in the number and spatial extent of habitation sites (DePratter 1976, 1978, n.d.). This shift in settlement pattern reflects the demographic transition taking place in other agricultural settings, namely, an increase in population size and density and increasing sedentism (Larsen 1982, 1984; Crook 1984). Moreover, evidence from site structure and mortuary archaeology indicates that these population changes coincided with the appearance of complex chiefdoms, evolving out of earlier tribal societies, and the elaboration of social order and structure generally (Caldwell and McCann 1941; Anderson 1994).

Early Contact Group (AD 1550–1680)

Interaction between native populations and Europeans in the Georgia Bight came in two primary stages, the first involving exploration and inchoate attempts at colonization during the first half of the sixteenth century by major powers, principally France and Spain (Jones 1978). Because the explorations were short-term affairs and none of the colonies continued for a significant amount of time, long-term biological changes linked with the contact experience in native populations are difficult to assess. Human remains included in this study dating to the exploratory period are from the Pine Harbor site.

The second stage of contact between Europeans and Indians began in 1565 with the ousting of the French from the region by the Spanish and the founding of the first permanent European colony at St. Augustine by Pedro Menéndez de Avilés (Jones 1978). After the founding of this settlement, a series of Roman Catholic missions were established northward along the Atlantic coastline of the present-day states of Georgia and Florida. The northernmost and principal outpost was located on St. Catherines Island at Mission Santa Catalina among the Indians known as Guale. Unlike the earlier contacts between Europeans and Indians, this and other missions involved long-term, sustained contact and interaction between members of two dramatically different societies – European and Indian – each having their own highly distinctive and contrasting biological, social, and cultural histories.

Santa Catalina de Guale was a functioning mission outpost – complete with resident priests and a small military garrison – from the 1570s to 1680 (Jones 1978; Thomas 1987). Archaeological excavations in the floor of the church produced a large and comprehensive skeletal sample, numbering minimally some 432 individuals (Larsen 1993). Analysis of the architecture and building sequence of the church suggests that most human remains postdate a native uprising that took place in 1597, with subsequent rebuilding of the church a decade later, thus bracketing the skeletal series between 1607 and 1680. Abundant archaeobotanical evidence shows an unambiguous record of maize consumption, along with some other domesticated plants, including several European imports (e.g., grapes, wheat) (Ruhl 1990). Isotopic (carbon and nitrogen) and elemental (barium and strontium) analyses confirm the presence of marked reorientation of diet during the seventeenth century, indicating significant increase in maize consumption. Moreover, shift to the softer diet is indicated by microscopic changes on chewing surfaces of teeth (Teaford 1991; Teaford et al. 2001). That is, the high frequency of microscopic features (pits, scratches) reflecting coarse diet (or consumption of foods containing numerous abrasive materials) reduces. The reduction in number of microwear features may have resulted from consumption of maize cooked into stews and soft mushes in the contact-era Indians.

Analysis of historical records and settlement patterns from this period reveals that populations were even more concentrated than in the late prehistoric period. This concentration of population likely reflects the relocation of native peoples to the immediate vicinity of the mission complex on St. Catherines Island, as is also the case in other areas of Spanish Florida and Spanish America generally (Hann 1988).

The historical documentary record provides a vivid picture of work and activity by the native populations in Spanish Florida. In this region – as is the case with other provinces of New Spain – *repartimiento* labor draft was practiced (Hann 1988; Worth 1995, 2001). In this system, able-bodied Indians, mostly adult males, were required to be available for obligatory labor for a range of activities, such as building projects, road construction, carrying materials over long distances, and agricultural labor. This labor draft frequently involved relocation of adult males from their home villages for lengthy periods of time. The compensation for these activities was marginal at best, and the physical toll was high (Hann 1988; Larsen 1994; Larsen and Ruff 1994; Ruff and Larsen 2001).

Late Contact Group (AD 1686–1702)

The native and European inhabitants of St. Catherines fled the island in 1680 following an attack by British troops and British-allied Indians. Within a few years, Great Britain controlled the area, forcing native groups and the mission effort south to Amelia Island, Florida, after 1685 (Bushnell 1994; Worth 1995, 2001). Archaeological excavations of the relocated mission of Santa Catalina de Santa Maria on Amelia Island resulted in the recovery of the remains of 122 individuals (Larsen 1993). Historical, archaeobotanical, archaeozoological, isotopic, elemental, and tooth microwear analyses indicate a basic continuation of subsistence patterns established in the foregoing early contact period (Larsen 1993). Isotopic analysis suggests, however, an increased emphasis on maize during this time. Population relocation to the mission center appears to have continued. Although historical sources do not mention work patterns on Amelia Island specifically, repartimiento was certainly well in place (Worth 1995, 2001), no doubt indicating continued excessive labor, along with other stressors (e.g., epidemics, warfare, and food shortages).

Although the mission effort appears to have been successful, it was a relatively short-lived affair. Britain's interest in the region continued to move southward from the Carolinas, forcing the abandonment of the mission and its inhabitants in 1702. Indians and Europeans hence moved to St. Augustine (Worth 1995, 2001). This abandonment marks the terminal date of the late contact period skeletal series.

Summary of Georgia Bight Skeletal Series

This chapter compares biological data from native populations representing 47 skeletal samples ($n = 1413$ individuals) distributed over four temporal periods. Assessment of health and behavioral temporal trends is made by comparing the precontact preagriculturalists ($n = 330$) with precontact agriculturalists ($n = 517$), precontact agriculturalists with early contact ($n = 444$), and early contact with late contact ($n = 122$). The first comparison identifies key biological concomitants of the adoption of maize agriculture; the second, the impact of European contact and missionization on native populations; and the third, the continued influence of the mission system and interaction of Europeans and Indians. Data are unavailable for some groups (e.g., degenerative joint disease for early contact). Owing to small sample sizes for some comparisons, periods are combined (e.g., early contact and late contact for femoral growth velocity).

HISTORY OF HEALTH IN THE GEORGIA BIGHT

Our assessment of the history of health in the Georgia Bight is based on the following parameters: demography (mean age-at-death, fertility), skeletal and dental growth (growth velocity, adult height, enamel defects, tooth size), oral health (dental caries, antemortem tooth loss), iron status (cribra orbitalia, porotic hyperostosis), and infection (periosteal reactions).

Demography

The age distribution expressed as number (D_x) and percentage (d_x) of individuals dying by age class is presented in Table 14.2. Temporal comparisons reveal that the precontact agriculturalists have a slightly younger mortality peak and mean age-at-death than the previous group. Although this trend has been documented in other regions and generally interpreted to reflect increasing mortality and declining life expectancy, reevaluation of demographic profiles by several investigators suggest that mean age-at-death in skeletal samples reflects fertility and birthrate, not mortality, especially in populations that are closed to migration and have highly fluctuating growth (Sattenspiel and Harpending 1983). In particular, population growth relating to increased birthrate will express a larger number of younger individuals in the death assemblage, and hence, lower mean age-at-death for the population.

Birthrates in archaeological samples have been estimated by Buikstra and coworkers (1986) as an inverse of the proportion of number of individuals older than 30 years (D_{30+}) to number of individuals older than five years (D_{5+}). Applied to the Georgia Bight, the proportions for the respective precontact preagriculturalists and agriculturalists show a decrease from 0.3790 to 0.3500. This reduction suggests an increase in birthrate in late prehistory in this setting. This finding is consistent with the presumed population increases suggested by the settlement changes observed archaeologically during the final centuries of prehistory.

The early contact group shows a continuation of the trend identified in the prehistoric populations. That is, the early contact series has an average younger age-at-death than the precontact agriculturalists. In the late contact period, however, there is a marked reversal of the trend. That is, mortality is high in the first decade or so – more than in any of the three antecedent periods – and relatively low during the inclusive 5- to 35-year cohorts. It is again elevated after age 40; nearly 40% of the population is older than 40 years. Given the high number of older adults, the traditional perspective on the age structure of this population would indicate a major rebound in population health and well-being. After all, isn't a sign of a healthy population having lots of people live into old age? New interpretations of skeletal assemblage demographic profiles indicate that archaeological skeletons actually provide relatively little information on mortality. Rather, a more likely explanation is that the late contact Indians experienced a significant

Table 14.2: Age-at-Death Distribution, Georgia Bight

	PP	PA	EC	LC
Age group	D_x (d_x)	D_x (d_x)	D_x (d_x)	D_x (d_x)
Total sample[a]				
1: 0–4.99	15 (8.9)	36 (11.4)	22 (6.9)	19 (16.7)
2: 5–9.99	23 (13.7)	24 (7.6)	44 (13.9)	8 (7.0)
3: 10–14.99	10 (5.6)	15 (4.8)	22 (6.9)	4 (3.5)
4: 15–19.99	19 (11.3)	67 (21.2)	36 (11.4)	7 (6.1)
5: 20–24.99	24 (14.3)	56 (17.7)	58 (18.4)	1 (0.8)
6: 25–29.99	19 (11.3)	20 (6.3)	51 (16.1)	6 (5.3)
7: 30–34.99	15 (8.9)	24 (7.6)	33 (10.4)	5 (4.4)
8: 35–39.99	10 (5.9)	28 (8.8)	40 (12.6)	17 (14.9)
9: 40–44.99	12 (7.1)	24 (7.6)	8 (2.5)	20 (17.5)
10: 45+	21 (12.5)	22 (6.9)	2 (0.6)	27 (23.7)
TOTAL *N*	168	316	316	114
MEAN AGE	23.2	22.5	21.3	29.8
D_{30+}/D_{5+}	.3790	3500	.2823	.7263
Adult males (>16.0 years)				
16.1–20	2 (5.4)	12 (14.1)	2 (7.7)	3 (7.7)
20.1–25	11 (29.7)	22 (25.9)	6 (23.1)	1 (2.6)
25.1–30	5 (13.5)	6 (7.1)	6 (23.1)	4 (10.3)
30.1–35	4 (10.8)	13 (15.3)	5 (19.2)	3 (7.7)
35.1–40	3 (8.1)	11 (12.9)	6 (23.1)	7 (18.0)
40.1–45	6 (16.2)	12 (14.1)	1 (1.2)	11 (28.2)
45.1+	6 (16.2)	9 (10.6)	0 (0.0)	10 (25.6)
TOTAL *N*	37	85	26	39
MEAN AGE	32.1	31.4	30.5	38.9
Adult females (>16.0 years)				
16.1–20	12 (21.8)	27 (24.6)	6 (15.0)	2 (4.9)
20.1–25	12 (21.8)	23 (20.9)	8 (20.0)	2 (4.9)
25.1–30	7 (12.7)	18 (16.4)	6 (15.0)	1 (2.4)
30.1–35	2 (3.6)	14 (12.7)	12 (30.0)	4 (9.8)
35.1–40	7 (12.7)	13 (11.8)	5 (12.5)	9 (22.0)
40.1–45	4 (7.3)	8 (7.3)	3 (7.5)	11 (26.8)
45.1+	11 (20.0)	7 (6.4)	1 (2.5)	12 (29.3)
TOTAL *N*	55	110	41	41
MEAN AGE	30.9	28.9	30.3	41.0

[a] Juveniles, sexed and unsexed adults.

decline in birthrate. This is also indicated by a reduction in the D_{30+}/D_{5+} proportion in a comparison of the early contact group (0.2823) and the late contact group (0.7263).

An interpretation of decline in birthrate in the late contact period is also more in line with deteriorating conditions documented in historic sources, including

Table 14.3: Abbreviated Epidemic History of Seventeenth-Century Spanish Florida

Year	Event
1613–1617	Epidemic (plague?)
1649–1650	Epidemic (yellow fever?)
1653	Epidemic (smallpox)
1657	Epidemic
1659	Epidemic (measles)
1672	Epidemic (influenza?)
1675	Epidemic
1686	Epidemic (typhus?)

Sources: Dobyns 1983; Hann 1986, 1988.

reduction in number of settlements. For example, from 1675 to 1686, there was a reduction from seven settlements containing fewer than 500 natives to virtually complete depopulation of the area north of Cumberland Island (Jones 1978). Some of the reduction in population size can be accounted for by significant outmigration, but other factors were also important, especially the ravages wrought by epidemic disease (Table 14.3). One Florida governor remarked in 1657 that the previous years for Guale and Timucua had been difficult, that Indians "have been wiped out with the sickness of the plague and small-pox" (Hann 1986).

Skeletal and Dental Growth

Femoral Growth Velocity. Suggestive trends regarding growth and development of juveniles are provided by observation of the amount of growth per age interval (Table 14.4). These comparisons reveal that for all but the first age cohort (2-year), precontact foragers have more growth per year than the other three samples. Although these findings can be interpreted in a variety of ways, we believe that elevated growth values in the post-2-year cohorts reflect the presence of more robust health in foragers than in later populations.

Adult Height. Comparison of the four periods reveals a reduction in height over time to the early contact period, followed by an increase in the late contact period (Table 14.5). These reductions may be linked to the adoption of maize, a food deficient in high-quality protein and iron bioavailability (Larsen, Ruff, et al. 1992). The increase in height in the late contact period seems on the surface to contradict our

Table 14.4: Femur Velocity (in mm), Georgia Bight

	2 yrs.	5 yrs.	8 yrs.	11 yrs.
PP	23.7	19.7	18.7	18.2
PA	28.0	15.3	12.1	10.7
EC/LC	27.9	17.8	15.2	14.1

Table 14.5: Adult Heights (in cm), Georgia Bight

	PP mean (s.d.)	PA mean (s.d.)	EC mean (s.d.)	LC mean (s.d.)	Significant change[a]
Adult[b]	158.6 (8.5)	156.4 (8.5)	151.7 (13.0)	157.6 (7.8)	PA/EC, EC/LC
n	56	219	44	69	
Male	164.8 (5.8)	163.4 (6.4)	160.8 (9.6)	163.3 (6.6)	None
n	15	83	16	33	
Female	154.8 (7.7)	151.8 (6.5)	148.4 (11.6)	152.6 (4.8)	PP/PA
n	30	109	23	36	

Note: Height calculated following formulae provided by Sciulli et al. 1990.

[a] Statistically significant change (t-test: $p \leq 0.05$, two-tailed).

[b] Includes adult females, males, indeterminate sex.

interpretation of reduced quality of health in the late seventeenth and early eighteenth centuries. However, Ruff and Larsen (1990; Larsen and Ruff 1994) indicate elsewhere that if the quantity of foods – in this case, carbohydrates – consumed increased appreciably during this time, then an increase in height might be expected. Protein consumption would also result in height increases, but stable isotope analysis points to reduced availability of animal protein in the diets of native populations in this setting. We suggest, therefore, that the confines of mission life, coupled with dietary change, led to gains in body mass. This interpretation is consistent with observations of body composition in historic sedentary Indians, such as those living on reservations or in urban settings (Hrdlicka 1908; Miller 1970; Johnston and Schell 1979). At least two seventeenth-century observers remarked on Indian body composition in Spanish Florida: Fray Francisco Alonso described the Indians as "corpulent," and Bishop Calderón stated that the Indians "are fleshy, and rarely is there a small one" (Hann 1988).

Enamel Defects. As with most other data reported in this chapter, enamel defect data were collected well prior to the inception of this volume and the associated project. Enamel defect data were collected with the use of a light microscope (10x), thus preventing comparison with other regions discussed in this book. Nevertheless, a number of observations and interpretations are possible with regard to prevalence of enamel defects on permanent mandibular and maxillary central incisors, lateral incisors, and canines (Hutchinson and Larsen 1988, 1990, 1992, 2001; Simpson et al. 1990; Larsen and Hutchinson 1992). The precontact preagriculturalists have the highest prevalence per tooth type, followed by a slight decrease in the precontact agriculturalists, a slight increase in the early contact group, and a dramatic decrease in the late contact group (Table 14.6). The earliest and latest periods express the strongest contrasts in frequency of defects. For example, maxillary central incisors express 92% and 21% of teeth that are hypoplastic for the precontact preagriculturalists and late contact mission Indians, respectively. These differences are highly statistically significant (chi-square: $p \leq 0.01$). Overall, then, these findings point to the presence of stress events which result in enamel hypoplasia occurring on a more

Table 14.6: Hypoplasia Frequency, Georgia Bight

Tooth	PP % (*n*)[a]	PA % (*n*)	EC % (*n*)	LC % (*n*)	Significant change[b]
Maxilla					
I1	81 (53)	66 (65)	71 (77)	36 (50)	EC/LC
I2	92 (49)	64 (66)	74 (77)	21 (47)	PP/PA, EC/LC
C	88 (67)	70 (81)	78 (128)	38 (45)	PP/PA, EC/LC
Mandible					
I1	58 (40)	40 (65)	43 (84)	19 (47)	EC/LC
I2	72 (57)	55 (77)	52 (90)	19 (53)	EC/LC
C	91 (79)	77 (97)	87 (138)	51 (51)	PP/PA, EC/LC

[a] Percent of teeth affected with at least one hypoplasia; $n =$ total number of teeth and number of individuals examined (hypoplastic + nonhypoplastic teeth).
[b] Statistically significant change (chi-square: $p \leq 0.05$, two-tailed).
Source: From Larsen and Hutchinson 1992.

frequent basis in prehistoric Georgia coastal foragers, with the smallest number in the late contact group.

Three alternative explanations emerge for this finding: (1) late contact populations saw a reduction in physiological perturbation; or (2) the late contact group had more successfully adapted to stressors than their predecessors; or (3) the most stressed component of the population is not present in the death assemblage studied from Amelia Island, thus providing a biased subsample of the population from which it was drawn. It is unlikely that the first or second alternatives are viable explanations, since overwhelming evidence indicates a deterioration in quality of health and well-being during the contact period. The third alternative seems the most likely. That is, we suspect that some type of sample bias affecting hypoplasia prevalence is present. Study of age-at-death profiles indicates that the late contact series is remarkably old in comparison with the three preceding periods (see above). Perhaps, individuals most stressed during childhood have been selected against in determining the composition of the cemetery sample. On the other hand, it is important to point out that there is some evidence for maintenance of high stress levels in the late contact period. We have measured the widths of hypoplasias, which are widest during the late contact period (Larsen and Hutchinson 1992). These greater widths may indicate either greater severity or duration of stress, suggesting that frequency of defects may be but one part of the picture of stress as it affects growth of the dental hard tissues. However, the true significance, causes, and implications of hypoplasia breadth remain uncertain.

Juvenile Adult Permanent Tooth Size. Although largely under genetic control, tooth size is also influenced by environmental factors. Physiologically stressed individuals in living populations have smaller teeth than nonstressed individuals (Larsen 1995). Thus, it is possible to document the effects of stress for the period of time

Table 14.7: Juvenile and Adult Dental Dimensions (Breadths, in mm), Georgia Bight

	Juvenile mean (s.d.)	Adult mean (s.d.)
Maxilla		
I1	7.66 (.56)	7.48 (.40)
n	16	33
I2	6.94 (.39)	6.91 (.36)
n	23	37
C	8.59 (.66)	8.64 (.47)
n	28	55
P3	10.12 (.59)	10.09 (.49)
n	34	70
P4	9.77 (25)	9.89 (.64)
n	25	72
M1	11.93 (.68)	12.14 (.51)
n	38	77
M2	12.09 (.67)	12.01 (.68)
n	21	85
Mandible		
I1	5.84 (.38)	5.89 (.33)
n	20	22
I2	6.23 (.40)	6.34 (.38)
n	27	47
C	7.51 (.57)	7.85 (.53)[a]
n	32	77
P3	8.09 (37)	8.30 (.44)[a]
n	37	95
P4	8.42 (.52)	8.63 (.47)[a]
n	33	95
M1	11.11 (.49)	11.24 (.52)
n	45	72
M2	10.76 (.57)	10.76 (.61)
n	31	87

[a] Statistically significant difference (t-test: $p \leq 0.05$, two-tailed).
Source: From Simpson et al. 1990.

during which teeth develop, namely, from four months in utero to 12 years. Age comparison of tooth size in the early contact sample from St. Catherines Island shows a clear pattern of smaller mean breadths, especially in mandibular teeth, in juveniles than adults (Table 14.7) (Simpson et al. 1990). This suggests the failure of teeth to reach their genetic potential in stressed settings (and see Guagliardo 1982). Additionally, it implies the presence of a link between tooth size and lifespan, a finding consistent with other stress indicators (Larsen 1997). This is not to

Table 14.8: Deciduous Dental Dimensions (Breadths, in mm), Georgia Bight

	PP mean (s.d.)	PA mean (s.d.)
Maxilla		
I1	3.9 (.07)	3.8 (6.7)
n	2	4
I2	4.2 (.49)	4.0 (.22)
n	5	7
C	5.4 (.49)	5.5 (.40)
n	7	16
M1	7.3 (.26)	7.1 (.53)
n	13	28
M2	9.3 (.24)	9.0 (.56)[a]
n	15	27
Mandible		
I1	4.8 (.30)	4.9 (.74)
n	7	9
I2	5.0 (.27)	4.9 (.57)
n	4	9
C	5.9 (.50)	6.0 (1.09)
n	10	15
M1	9.1 (.39)	8.8 (.78)
n	10	23
M2	10.6 (.46)	10.3 (.62)
n	8	25

[a] Statistically significant change (t-test: $p \leq 0.05$, two-tailed).
Source: From Larsen 1983a.

say that small tooth size led to early death. Rather, tooth size is symptomatic of environmental factors (e.g., nutrition) that resulted in reduced tooth size during critical years of growth and development – smaller teeth are symptomatic of reduced health.

Deciduous Tooth Size. There is a general pattern of reduction of crown lengths and breadths in precontact agriculturalists relative to preagriculturalists (Table 14.8). Although the mechanism leading to this reduction is unclear, placental sufficiency and maternal health status strongly influence deciduous tooth size, since the crowns of these teeth begin formation well before birth, and they are completely formed during the first months of life (Garn and Burdi 1971; Garn et al. 1979).

Oral Health

Dental Caries. Dental caries is a highly sensitive indicator of carbohydrate consumption, especially maize in native populations of North America and elsewhere,

Table 14.9: Dental Caries Frequency, Georgia Bight

	PP % (*n*)[a]	PA % (*n*)	EC % (*n*)	LC % (*n*)	**Significant change**[b]
Total[c]	1.2 (2479)	9.6 (5984)	7.6 (4466)	19.6 (1548)	PP/PA, PA/EC, EC/LC
Males	0.3 (638)	8.3 (1931)	14.9 (441)	21.4 (754)	PP/PA, PA/EC, EC/LC
Females	1.1 (1034)	12.8 (2405)	11.0 (598)	21.1 (606)	PP/PA, EC/LC

[a] Percent of teeth affected with at least one carious lesion; n = total number of teeth examined (carious + noncarious teeth).

[b] Statistically significant change (chi-square: $p \leq 0.05$, two-tailed).

[c] Total = juveniles, unsexed adults, adult females, adult males (see also Larsen 1983b).

because of the presence of sugar (sucrose) and other confounding factors (e.g., food consistency) (Milner 1984; Larsen et al. 1991). In concert with the increased reliance on maize in the Georgia Bight, there is a general increase in prevalence of dental caries, including especially a moderate increase within the precontact agriculturalists and a marked increase in the late contact mission Indians (Table 14.9). The latter change is the most conspicuous in the entire temporal span. We regard this change as representing a marked increase in consumption of maize. It is possible that these increases were occasioned by importation of sugar to Amelia Island during the late seventeenth century. However, the historical records do not mention the use of sugar in this region. Therefore, the role of sugar – aside from its association with maize – was likely minimal or nonexistent, at least with regard to explaining high caries prevalence in the late contact group.

The increase in dental caries prior to contact is more pronounced in females than males (Table 14.9). Although many other populations, archaeological and living, express similar sex differences, the pattern is not related to some inherent physiological differences between females and males (Larsen et al. 1991). We conclude that females ingested relatively more carbohydrates than males in the precontact population, which is perhaps related to the sexual division of labor observed in southeastern U.S. native societies: females were responsible for plant gathering, planting, care of crops, and food preparation; males were responsible for hunting and protection of the village. Thus, the greater exposure of cariogenic foods by women in this and similar settings best explains sex differences in carious lesion prevalence.

Be that as it may, the pattern of greater female caries prevalence does not hold true for either the early contact period, where males have more carious teeth than females, or the late contact period, where prevalences are virtually identical. This postcontact pattern of dental caries prevalence suggests that other factors influencing the disease may be operating. The similarity of caries prevalence in the late contact period may very well reflect similarity in diet between males and females as agriculture became more intensified. This finding is also consistent with the similar values of carbon and nitrogen isotope ratios between females and males in these populations (Larsen et al. 1992, 2001; Hutchinson et al. 1998).

Antemortem Loss. Owing to the poor archaeological preservation of the bone tissue supporting teeth in many of the skeletons included for study, we were not able to systematically collect antemortem tooth loss data. Our impression of antemortem tooth loss, however, is that it was high in prevalence, especially in the late contact group. Several older adults with well-preserved crania show complete or near-complete tooth loss, a phenomenon not observed in the preceding periods (Figure 14.2).

Iron Status

Cribra orbitalia and Porotic Hyperostosis. Cribra orbitalia and porotic hyperostosis, pathological indicators of iron-deficiency anemia, show a shift from relatively low prevalence for precontact individuals to increases in the early and late contact groups (Table 14.10). With regard to the latter, prevalences surpass 20% for the total sample in the late contact group, showing an increase over the early contact group. Severity of cribra orbitalia and porotic hyperostosis also increases over the temporal span. These increases denote a transformation in iron status in native populations, especially during the mission period.

The generally low prevalence of this pathology in both premaize and maize consumers prior to contact suggests that maize, at least as it is viewed in this setting, is not the primary factor in determining iron status. Other factors likely came to play, including poor living conditions and sanitation (Walker 1985, 1986). Experimental studies suggest that diets combining maize with fish significantly promote iron absorption (Layrisse et al. 1968). It is possible that the strong dependence on marine resources in precontact populations may have served to increase the bioavailability of iron in precontact maize agriculturalists, thus resulting in low prevalence of porotic hyperostosis.

In the mission settings of St. Catherines and Amelia Island, the concentration of population around limited and heavily used water sources and contamination thereof likely caused diarrheal infections and parasitism, which have also been linked with iron-deficiency anemia (Walker 1986). Unlike prehistoric groups, mission groups in the Georgia Bight constructed wells for sources of potable water (Thomas 1988). Archaeological documentation indicates that these wells were quite shallow, which would have lent themselves to the introduction of anemia-causing parasites. Moreover, at the mission on St. Catherines Island, a freshwater stream appears to have been dammed and utilized as a primary water source. The perimeter of this area contains a profusion of midden and food remains. The presence of trash during the occupation of the mission may have led to contamination and a potential breeding ground for parasites, and hence, increased iron-deficiency anemia. The diagnosis for iron-deficiency anemia is also confirmed by histological analysis of cranial lesions from several individuals (Schultz et al. 2001). We note that the relative high

Figure 14.2. Individual from late-contact-period site, Santa Catalina de Guale de Santa Maria, Amelia Island, Florida, showing complete premortem loss of teeth.

Table 14.10: Cribra Orbitalia and Porotic Hyperostosis Prevalence and Severity, Georgia Bight

	PP % (*n*)[a]	PA % (*n*)	EC % (*n*)	LC % (*n*)	Significant change[b]
Cribra orbitalia					
Total[c]	5.7 (104)	3.1 (287)	12.5 (32)	22.9 (70)	None
Juveniles[d]	38.5 (13)	6.1 (33)	60.0 (5)	73.3 (15)	PP/PA, PA/EC
Males	0.0 (29)	2.4 (84)	8.3 (12)	10.3 (29)	None
Females	0.0 (39)	2.4 (123)	0.0 (13)	4.2 (24)	None
Severity[e]	1.06 (104)	1.03 (287)	1.12 (32)	1.23 (70)	None
Porotic hyperostosis					
Total	0.0 (113)	3.3 (308)	9.4 (32)	21.1 (90)	None
Juveniles	0.0 (13)	0.0 (33)	0.0 (5)	50.0 (18)	EC/LC
Males	0.0 (35)	5.7 (88)	8.3 (12)	11.4 (35)	None
Females	0.0 (42)	0.7 (137)	15.4 (13)	11.4 (35)	PA/EC
Severity	1.00 (113)	1.03 (308)	1.09 (32)	1.21 (90)	None

[a] Percent of orbits/vaults affected; n = total number of orbits/vaults examined (pathological + non-pathological).

[b] Statistically significant change (chi-square: $p \leq 0.05$, two-tailed).

[c] Total = juveniles, unsexed adults, adult females, adult males.

[d] Juveniles < 10 years.

[e] Mean of severity scores: 1 = absent on at least one observable orbit or parietal; 2 = presence of lesion; 3 = gross lesions with excessive expansion and large areas of diploe exposed. All individuals combined.

prevalence of pathology in subadults less than 10 years of age (Table 14.10) is consistent with the general finding that porotic hyperostosis is a childhood condition (Stuart-Macadam 1988).

Infection

Periosteal Reactions. Periosteal lesions (periostitis) in this series range from vascular tracks and minimal inflammation to extensive bone involvement. Temporal comparisons show a general increase in prevalence and severity for the tibia (Table 14.11). The increase is especially marked for the late contact population. Relative to the early contact period, this represents a nearly threefold increase. The increase for adult females is not as great as observed in adult males (65.7% vs. 90.0% in late contact females and males, respectively).

The increase for the precontact agriculturalists is broadly similar to other New World groups undergoing the transition from foraging to farming (Larsen 1995). These changes are not linked with the dietary transition but, rather, with the increase in population sedentism and aggregation, seen both in the foraging-farming transition and in foragers undergoing decreases in mobility (Lambert and Walker 1991; Lambert 1993; Walker and Thornton this volume). For the Georgia Bight,

Table 14.11: Tibial Periosteal Reactions, Prevalence and Severity, Georgia Bight

	PP % (*n*)[a]	PA % (*n*)	EC % (*n*)	LC % (*n*)	Significant change[b]
Total[c]	9.5 (126)	19.8 (331)	15.4 (26)	59.3 (96)	PP/PA, EC/LC
Male[d]	9.3 (32)	23.6 (93)	23.1 (13)	70.0 (36)	PP/PA, EC/LC
Female[d]	4.3 (47)	24.1 (133)	14.3 (7)	65.7 (35)	PP/PA, EC/LC
Severity[e]	1.12 (126)	1.35 (331)	1.23 (26)	1.73 (96)	None

[a] Percent of tibiae/elements affected; n = total number of tibiae/elements examined (pathological + nonpathological).

[b] Statistically significant change (chi-square: $p \leq 0.05$, two-tailed).

[c] Total = juveniles, unsexed adults, adult females, adult males.

[d] Male = adult males; Female = adult females.

[e] Mean of tibial periosteal reactions severity scores: 1 = no lesions of the tibia(e) with at least one tibia available for observation; 2 = slight, discrete patch(s) of periosteal reaction involving less than one-quarter of the tibia(e) surface on one or both tibiae; 3 = moderate periosteal reaction involving less than one-half of the tibia(e) surface on one or both tibiae; 4 = severe periosteal reaction involving more than one-half of the tibia(e) surface (osteomyelitis). All individuals combined.

the dramatic increase in periosteal reactions in the late contact period is likely tied to reduction in mobility and aggregation of population in mission centers where living circumstances – especially sanitation – are less healthful. Additionally, the decline in nutrition with increased reliance on maize would likely have exacerbated deteriorating health. That is, there is a strong synergy between undernutrition or malnutrition and infection: individuals experiencing poor nutrition are less resistant to pathogens and are rendered more susceptible to infection; most infections worsen nutritional status (Scrimshaw 1975). The increase in infection in the contact period is different from other regions (e.g., South America). These differences are likely related to the fact that the populations in the Georgia Bight who came under Spanish control were living in mission settings where population was concentrated and living circumstances were of poorer quality than for those groups not living within the confines of the mission system.

Specific Infectious Diseases. Historical records indicate an abundance of infectious diseases in native New World populations in the Georgia Bight. Most of these diseases were introduced from the Old World, and are rarely registered osteologically. The pattern of skeletal involvement in populations from the precontact preagriculturalists from the Georgia coast indicates the presence of endemic treponematosis and tuberculosis (Powell 1990). Although probably not present prior to contact, venereal syphilis was likely a postcontact phenomenon, as indicated by the observation of René Laudonnière: "Most Indians were found to be diseased by the 'pox,' for they were exceedingly fond of the other sex, calling their female friends 'daughters of the sun'" (Gatschet 1880: 469).

Because periosteal reactions may also be caused by localized trauma, especially in relatively exposed areas such as the anterior surface of the tibia, some of the lesions observed in these skeletal samples may not be caused by infection. However, the overall deterioration in quality of living conditions suggests that infection – nonspecific and specific – was the primary causative factor in explaining the profound increase in prevalence of periosteal reactions in this setting.

HISTORY OF BEHAVIOR AND ACTIVITY

Physical activity and behavior are an important component of the overall picture of health in human populations. For the Georgia Bight, activity and behavior are assessed from observation of pathology (degenerative joint disease, spondylolysis), long bone measurement (femoral subperiosteal diameter, humeral robusticity), and trauma (accidental injury, violence). These variables represent a cumulative history of the mechanical demands of daily living during the lifetime of an individual and the populations from which they are derived. The long-term consequences of physical activity loads on the structure of long bones provide additional perspective on behavior (see Ruff 2000; Ruff and Larsen 2001).

Pathology

Degenerative Joint Disease. Degenerative joint disease, or osteoarthritis, is an age-progressive disorder resulting in a deterioration of the articular joints of the skeleton. Although various factors are involved (e.g., heredity, blood supply, nutrition), the mechanical environment best explains most variation seen in human populations (Hough and Sokoloff 1989). The age-progressive nature of degenerative joint disease in precontact and contact-era native populations from the Georgia Bight is well illustrated by the increase in severity in vertebral joints – cervical, thoracic, and lumbar – from the younger to older age classes (Table 14.12).

Comparison of temporal periods in the Georgia Bight reveals two clear trends in prevalence of degenerative joint disease, including a decrease in precontact agriculturalists and a dramatic increase in the late contact population (Table 14.13). Consistent with these trends are respective decreases and increases in severity of degenerative joint disease in the precontact agricultural and late contact populations. These changes denote significant shifts in behavior after the adoption of maize agriculture and the subsequent period of missionization of native groups in the region. We regard the prehistoric decreases as representing a decline in workload, which is consistent with long bone structural analysis (Ruff and Larsen 2001). It is likely that the older nature of the adults in the late contact period contributed, in part, to the increase in prevalence of degenerative joint disease in them. However, comparison of the groups by subdividing into five-year age groups reveals that age is not the sole, or even most important, factor in explaining the changes in prevalence.

The increases in the contact population suggest a marked reversal in this pattern of behavior. Information provided from historical records supports this hypothesis. The labor demands of the repartimiento draft labor system in mission populations are well understood. Some adult males were required to make long-distance trips to various localities in the Spanish provinces of Florida (Hann 1988). These trips involved carrying heavy burdens over lengthy distances (Hann 1988), which would

Table 14.12: Degenerative Joint Disease Severity by Age Class, Georgia Bight (All Periods Combined)

	Total[a] mean (s.d.)	Females mean (s.d.)	Males mean (s.d.)
Cervical			
1: 0–4.99	1.00 (.0)	—	—
n	16		
2: 5–9.99	1.06 (.24)	—	—
n	17		
3: 10–14.99	1.00 (.0)	—	1.00 (.0)
n	8		1
4: 15–19.99	1.00 (.0)	1.00 (.0)	1.00 (.0)
n	40	18	11
5: 20–24.99	1.08 (.49)	1.00 (.0)	1.14 (.66)
n	37	15	21
6: 25–29.99	1.11 (.32)	1.00 (.0)	1.20 (.42)
n	19	9	10
7: 30–34.99	1.16 (.69)	1.00 (.0)	1.50 (1.23)
n	19	13	6
8: 35–39.99	1.22 (.61)	1.06 (.24)	1.40 (.83)
n	32	17	15
9: 40–44.9	1.56 (.72)	1.60 (.74)	1.53 (.72)
	32	15	17
10: 45 +	1.79 (.77)	1.67 (.73)	1.94 (.80)
n	39	21	18
Thoracic			
1: 0–4.99	1.00 (.0)	—	—
n	14		
2: 5–9.99	1.24 (.08)	—	—
n	17		
3: 10–14.99	1.00 (.0)	—	1.00 (.0)
n	8		1
4: 15–19.99	1.00 (.0)	1.0 (.0)	1.00 (.0)
n	35	17	9
5: 20–24.99	1.03 (.16)	1.06 (.25)	1.00 (.0)
n	38	16	19
6: 25–29.99	1.12 (.33)	1.00 (.0)	1.22 (.44)
n	17	8	9
7: 30–34.99	1.17 (.38)	1.17 (.38)	1.17 (.41)
n	18	12	6
8: 35–39.99	1.47 (.73)	1.25 (.58)	1.71 (.83)
n	30	16	14
9: 40–44.99	1.66 (.72)	1.60 (.74)	1.71 (.73)
n	29	15	14
10: 45 +	1.84 (.76)	1.75 (.64)	1.94 (.89)
n	37	20	17

(continued)

Table 14.12 *(continued)*

	Total[a] mean (s.d.)	Females mean (s.d.)	Males mean (s.d.)
Lumbar			
1: 0–4.99	1.00 (.0)	—	—
n	13		
2: 5–9.99	1.06 (.25)	—	—
n	15		
3: 10–14.99	1.00 (.0)	—	1.00 (.0)
n	7		1
4: 15–19.99	1.11 (.32)	1.11 (.32)	1.20 (.42)
n	37	18	10
5: 20–24.99	1.10 (.31)	1.06 (.25)	1.14 (.36)
n	39	16	21
6: 25–29.99	1.12 (.33)	1.00 (.0)	1.20 (.42)
n	17	7	10
7: 30–34.99	1.31 (.48)	1.31 (.48)	1.30 (.52)
n	19	13	6
8: 35–39.99	1.53 (.78)	1.29 (.58)	1.80 (.89)
n	30	17	13
9: 40–44.99	1.90 (.71)	1.73 (.59)	2.07 (.79)
n	30	15	15
10: 45 +	2.08 (.73)	1.95 (.67)	2.27 (.79)
n	36	21	15

[a] Total = juveniles, unsexed adults, adult females, adult males.

Severity scores: 1 = no lesions on at least two observable vertebrae; 2 = initial osteophyte formation along rim of the vertebral body(-ies); 3 = extensive osteophyte formation along rim of vertebrae; 4 = two or more vertebrae fused together.

have placed heavy demands on weight-bearing articular joints.[2] Thus, draft labor, a practice instituted by the Spanish crown, appears to have had major repercussions for labor and activity, resulting in an increase in labor demands. The osteological evidence clearly shows the change in activity in this setting of the Western Hemisphere.

Spondylolysis. Spondylolysis is a type of stress fracture involving a separation of the neural arches of vertebrae in the area between the superior and the inferior articular processes (called the pars articularis). Most commonly present in the fifth lumbar vertebra of the lower back, high frequencies of fractures have been reported in human populations engaged in physically demanding lifestyles (e.g., traditional Eskimos), or in components of populations with heavy workloads (e.g., athletes) (Stewart 1931; Semon and Spengler 1981). Although the condition is pathological,

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[2] The greater labor demands on males in comparison with females is further indicated by the higher severity and prevalence of degenerative joint disease in males than in females; see Tables 14.12 and 14.13.

Table 14.13: Degenerative Joint Disease Prevalence and Severity, Georgia Bight

Articular joint	PP % (*n*)[a]	PA % (*n*)	LC % (*n*)	Significant change[b]
All adults				
Cervical	26.0 (50)	16.4 (189)	68.3 (60)	PA/LC
Thoracic	15.6 (32)	11.4 (175)	68.3 (60)	PA/LC
Lumbar	41.9 (43)	24.5 (163)	67.2 (58)	PP/PA, PA/LC
Shoulder	9.7 (113)	5.3 (207)	15.2 (66)	PA/LC
Hip	12.0 (108)	6.8 (206)	10.5 (67)	None
Wrist	5.9 (84)	1.1 (187)	13.2 (68)	PP/PA, PA/LC
Hand	5.0 (40)	3.0 (165)	5.9 (68)	None
Males				
Cervical	33.3 (18)	27.5 (80)	74.1 (27)	PA/LC
Thoracic	16.7 (12)	19.2 (73)	74.1 (27)	PA/LC
Lumbar	50.0 (14)	37.7 (69)	75.0 (28)	PA/LC
Shoulder	17.7 (34)	10.1 (79)	16.7 (30)	None
Hip	13.2 (38)	12.5 (80)	9.4 (32)	None
Wrist	15.4 (26)	2.7 (75)	16.1 (31)	PP/PA, PA/LC
Hand	8.3 (12)	5.8 (69)	3.3 (30)	None
Females				
Cervical	22.2 (27)	8.4 (95)	65.6 (32)	PA/LC
Thoracic	16.7 (18)	5.5 (91)	65.6 (32)	PA/LC
Lumbar	38.5 (26)	15.3 (85)	60.0 (30)	PP/PA, PA/LC
Shoulder	5.2 (58)	2.9 (105)	13.9 (36)	PA/LC
Hip	13.2 (53)	3.8 (105)	11.4 (35)	PP/PA
Wrist	2.3 (43)	0.0 (96)	10.8 (37)	PA/LC
Hand	4.0 (25)	1.2 (85)	7.9 (38)	None
Severity[c]				
Cervical	1.22 (58)	1.16 (223)	1.58 (55)	None
Thoracic	1.18 (38)	1.12 (215)	1.89 (62)	None
Lumbar	1.41 (49)	1.24 (119)	1.86 (59)	None

[a] Percent of articular joints affected; n = total number of joints examined (pathological + nonpathological).

[b] Statistically significant change (chi-square: $p \leq 0.05$, two-tailed); data for EC unavailable.

[c] Severity scores: 1 = no lesions on at least two observable vertebrae; 2 = initial osteophyte formation along rim of the vertebral body(-ies); 3 = extensive osteophyte formation along rim of vertebrae; 4 = two or more vertebrae fused together. All individuals combined.

it may contribute to an increase in flexibility of the lower back, thus enabling the individual to experience less discomfort during strenuous physical activity (Merbs 1983). The highest prevalence of spondylolysis is in the late precontact group from Amelia Island: the late precontact group has a prevalence of 9%, whereas earlier populations do not exceed 5% (Larsen and Ruff 1994).

Long Bone Size

Femoral Midshaft Subperiosteal Diameter. From the perspective of engineering principles, a long bone (e.g., femur) can be modeled as a hollow beam. In such a beam, the materials located farthest from an imaginary center running down the middle of the long bone are the strongest and stiffest. All else being equal – especially the total amount of bone in a cross section – a wider long bone will be able to resist the demands of heavy mechanical loading better than a narrower long bone.

Beam analysis involves the measurement of cross-sectional geometric properties from cross sections taken perpendicular to the long axis of the bone. These properties represent measures of the ability of the bone to resist forces placed on it in relation to the location of the cross section (e.g., femur midshaft) (Ruff 2000). Most of these properties require observation of the entire cross section of the bone. However, the external dimension, called total subperiosteal area, or TA, can be determined from external measurements of femoral midshafts. It is important to note that TA is a good general indicator of bone strength. We emphasize that TA or other properties are not qualitative assessments of bone tissue; rather, they are indicators of physical stress and lifestyle relating to the adaptation of bone to mechanical loading arising during physical activity. As with degenerative joint disease, it is not possible to identify specific activities from measurement of bone cross sections. Instead, cross-sectional geometric properties are an overall indicator of bone strength.

Comparison of femoral TA standardized for body mass (TA_{std}) for the four subsamples from the Georgia Bight reveals a pattern that closely parallels observations on degenerative joint disease. Prior to contact, there is a decline in TA_{std} for males and females (Table 14.14). Early and late contact males show appreciable increases, and females show an increase for the early group only, but the value is still high in the late contact group (Table 14.14). This pattern provides confirmation for the observations of degenerative joint disease, namely, that the adoption of an agricultural lifestyle prior to contact led to a decrease in physical demand, and the establishment of missions and accompanying labor demands entailed increased physical activity in native populations. This pattern of size increase and robusticity is also revealed in other measurements of the femora (e.g., midshaft anterior posterior diameter; Table 14.14).

Humeral Robusticity. Female and male humeral robusticity similarly shows declines prior to contact; both sexes show increases in the respective early and late contact periods (Table 14.14). The various measurements taken on the humeri from all periods show similar decreases, followed by increases in overall size of this skeletal element (Table 14.14). These changes reflect shifts in demands of use of the upper limb.

Trauma

Accidental Injury. The frequency of skeletal traumatic injuries due to accident are extremely low in the Georgia Bight populations (Table 14.15). Only seven

Table 14.14: Skeletal Size and Robusticity, Georgia Bight

	PP mean (s.d.)	PA mean (s.d.)	EC mean (s.d.)	LC mean (s.d.)	Significant change[a]
Male, Femur					
Length	452.9 (22.5)	446.5 (22.4)	436.9 (36.1)	446.7 (25.9)	None
n	15	84	16	33	
AP diameter	30.4 (2.9)	29.7 (2.9)	28.8 (1.5)	29.5 (2.5)	None
n	30	96	13	32	
ML diameter	27.0 (2.7)	25.8 (2.0)	26.1 (3.5)	27.1 (1.7)	PP/PA
n	30	96	13	32	
TA	6.45 (.82)	6.05 (.93)	5.90 (.80)	6.30 (.71)	PP/PA
n	30	96	13	32	
TA_{std}[b]	6.98 (1.0)	6.85 (.94)	6.87 (1.0)	7.17 (1.1)	None
n	15	83	13	32	
Male, Humerus					
Length	325.7 (15.4)	317.2 (16.1)	315.1 (15.8)	313.2 (16.4)	PP/PA
n	22	87	12	32	
Circumference	67.6 (7.4)	65.0 (5.5)	65.5 (3.4)	66.0 (5.1)	None
n	29	90	12	33	
Robusticity	20.8 (2.1)	20.6 (1.6)	20.8 (1.5)	21.1 (1.5)	None
n	22	87	12	32	
Female, Femur					
Length	428.7 (26.5)	418.1 (22.6)	406.7 (40.3)	420.2 (17.5)	PP/PA
n	30	111	23	37	
AP diameter	26.9 (2.3)	25.6 (2.3)	26.9 (2.3)	25.9 (1.9)	PP/PA,
n	51	127	21	36	PA/EC
ML diameter	24.8 (2.3)	23.4 (1.7)	23.5 (3.0)	25.4 (1.6)	PP/PA,
n	51	127	21	35	EC/LC
TA	5.26 (.68)	4.73 (.69)	4.97 (.86)	5.18 (.53)	PP/PA
n	51	127	21	35	
TA_{std}	6.71 (.98)	6.48 (.99)	6.85 (10.7)	7.01 (.81)	PA/EC
n	29	108	17	35	
Female, Humerus					
Length	299.1 (24.8)	298.6 (18.5)	296.3 (19.8)	296.8 (13.4)	None
n	39	112	17	37	
Circumference	60.1 (5.4)	57.4 (4.9)	58.2 (5.8)	58.8 (3.6)	PP/PA
n	48	119	17	36	
Robusticity	19.8 (1.8)	19.2 (1.6)	19.7 (1.7)	19.8 (1.3)	PP/PA
n	38	110	17	36	

[a] Statistically significant change (t-test: $p \leq 0.05$, two-tailed).

[b] TA_{std} = total subperiosteal diameter size-standardized by the formula: $(TA \div length^3) \times 10^8$; see Larsen and Ruff, 1994.

individuals, all from the precontact preagricultural period, have fractures. All fractures involve injuries to either the distal radius or ulna.

Violence (Weapon Wounds). Weapon wounds are also a very infrequent occurrence in this setting (Table 14.15). The few weapon wounds that are present include mostly

Table 14.15: Trauma and Weapon Wounds Frequencies, Georgia Bight

Location	PP % (*n*)[a]	PA % (*n*)	LC % (*n*)	Significant change[b]
Trauma				
Arm	5.9 (118)	0.6 (331)	0.0 (91)	None
Hand	2.5 (40)	1.4 (139)	0.0 (85)	None
Face	0.0 (96)	0.4 (276)	0.0 (96)	None
Nasal	0.0 (94)	0.4 (276)	0.0 (95)	None
Skull	2.9 (104)	1.6 (307)	0.0 (94)	None
Leg	1.7 (118)	0.6 (331)	0.0 (92)	None
Weapon wounds				
All	1.9 (315)	1.3 (504)	0.8 (121)	None

[a] Percent of locations affected; n = total number in locations examined (pathological + nonpathological).

[b] Statistically significant change (chi-square: $p \leq 0.05$, two-tailed); data for EC unavailable.

cranial depressed fractures, all of which were well healed at the time of death. One individual – an adult female from the Sea Island Mound (ca. AD 1000–1150) from Sea Island, Georgia – shows extensive proliferative remodeling on much of the ectocranial vault (superior frontal, both parietals), which has been interpreted to represent postscalping modifications (Ortner and Putschar 1985). The presence of complete remodeling and no active infection indicates that the individual survived the trauma.

We expected to see an elevation in violence-related trauma in the contact period, especially in light of historical accounts of conflict (Bushnell 1994; Worth 1995, 2001). However, in this and all other mission samples from the Georgia Bight and other regions of Spanish Florida, only one individual displayed evidence of violent death, a high-status adult male from San Luis de Talimali (Larsen et al. 1996). This individual probably died from a gunshot wound to the abdomen. Additionally, several individuals display trauma from metal-edged weapons from the sixteenth-century nonmission Tatham Mound site on the Florida Gulf coast (Hutchinson and Norr 1994). These findings indicate that, at least with regard to the skeletal evidence, traumatic injury was relatively uncommon in native populations from the Georgia Bight, regardless of time period.

THE HEALTH INDEX: COMPARISONS BETWEEN THE GEORGIA BIGHT AND OTHER SETTINGS OF THE WESTERN HEMISPHERE

The four cultural/temporal samples discussed in this chapter fall within the upper half of 65 samples studied in the compilation of the health index by Steckel and coworkers (Steckel, Sciulli, and Rose this volume).[3] Three of the samples – precontact preagricultural, precontact agricultural, and early contact – are in the top 10 samples.

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[3] The values for the health index in the Georgia Bight are: precontact preagricultural, 23.54; precontact agricultural, 21.34; early contact, 22.10; late contact, 19.41.

The fourth sample, late contact, is in the middle in position. On the whole, the general health differences between samples and their order of ranking in the health index are consistent with the results of this study. The precontact preagriculturalists rank at the top of the list of 65 (rank = 2), and the late contact is in the middle of the list (rank = 30). The order of the precontact agriculturalists and early contact population is reversed, however (ranks are 10 and 5, respectively).

As a group, the overall rankings would suggest that the Georgia Bight populations appear to be relatively healthy compared with other samples discussed in this volume. Indeed, prior to the late contact period, some pathological conditions appear to have lower prevalences than in other settings (e.g., dental caries, periosteal reactions). This relatively high level of health, for the precontact populations especially, may be related to living in a coastal setting where seafood and other resources are relatively rich. For example, the precontact populations have very low levels of porotic hyperostosis and cribra orbitalia, reflecting a virtual lack of iron-deficiency anemia or other factors that may affect iron status (e.g., parasitic infection is a known cause of iron-deficiency anemia). The Georgia Bight in particular is a highly economically productive region as it relates to seafood exploitation. Even today, the estuaries and ocean in the region are extremely productive in marine foods, including various shellfish and fish. The archaeological record also suggests a similar variety of foods available and high level of productivity. Compared to prehistoric populations from the American Southwest, where food sources are less predictable and lacking in the kinds of nutritional seafoods, the Georgia Bight had a range of foods available. Moreover, the prehistoric population density was likely relatively low, at least from what can be determined from settlement studies in the region (see above). Thus, we believe that the relatively better health in the Georgia Bight series – especially in regard to the prehistoric populations – reflects a combination of plentiful resources and low population density. The contact period, however, represents a clear decline in living circumstances, at least with regard to the last period, which is similar to regions experiencing prolonged interaction with Europeans.

SUMMARY, IMPLICATIONS, AND CONCLUSIONS

Comparisons of human skeletal remains from Native Americans from the Georgia Bight provide a compelling picture of alterations in health and lifestyle, with some variation by period (shown in parentheses below):

1. slight increase in fertility (precontact agricultural), followed by decrease in fertility (late contact);
2. reduction in femoral growth velocity (after precontact agricultural);
3. reduction in adult height (precontact agricultural and early contact), followed by increase in adult height (late contact);
4. reduction in enamel defects (especially in late contact);
5. reduction in deciduous tooth size (precontact agricultural);
6. increase in dental caries (precontact agricultural, late contact);
7. increase in antemortem tooth loss (late contact);

8. increase in iron deficiency anemia (early contact, late contact); and
9. increase in infection (precontact agricultural, late contact).

Shifts in workload and activity are indicated by pathology and external bone dimensions:

1. decrease in degenerative joint disease (precontact agricultural), followed by increase in degenerative joint disease (late contact);
2. decrease in subperiosteal diameter and long bone dimensions generally (precontact agricultural), followed by increase in subperiosteal diameter and long bone dimensions (early contact, late contact);
3. no change in hazards of lifestyle due either to accident or violence.

The trends relating specifically to health (e.g., dental caries) are broadly similar to other regions of the Eastern Woodlands and elsewhere in the Western Hemisphere, especially with regard to the effects of the adoption of agriculture prior to European contact, and the effects of contact (Larsen 1994, 1995). The earlier populations are healthier than the later populations. Contrary to popular and scholarly perceptions of the shift from foraging to farming, the change did not represent an improvement in the human condition. Agriculture certainly set the stage for the rise of complex societies and urbanization in the last five or so millennia of human history, but there was a health cost associated with the transition. When viewed within just the region of the Georgia Bight, skeletal and pathology findings suggest a decline in health. Broader comparison with other populations discussed in this volume indicates that the populations from the Georgia Bight were better off than most.

The trends observed here in workload and skeletal pathology and bone size appear to have a much more regional focus. For example, in contrast to our findings, Bridges reports increases in subperiosteal bone diameters (TA) and other external bone dimensions with the adoption of agriculture in other areas of the American Southeast (Bridges 1989). Comparisons of TA in the various populations discussed in this volume show a high degree of variability, which confirms the regional nature of skeletal robusticity. To a great extent, femoral robusticity is influenced by difficulty of terrain (e.g., mountains vs. coast), and less so by subsistence strategy per se (Ruff 2000). It is interesting to note that an increase in workload in the late contact Georgia Bight population appears to be accompanied by a decrease in mobility overall. Thus, the populations are working harder, but except for drafting of male laborers, essentially staying put throughout the year.

For historians, more often than not dependent on documentary evidence which can be discounted as at best impressionistic, the value of bioarchaeological research lends concreteness to such impressionistic accounts. Even so, "documentary" historians must determine if the skeletal data is representative of larger trends and longer periods. For instance, how do the results determined from the study of skeletal remains of native populations from the Georgia Bight fit with the impressions of literate witnesses contemporary with the bones?

The history conveyed to us by the human remains from the Georgia Bight represents two enormously important events, the coming of farming – maize in this setting – and the coming of Europeans. People all over the world have experienced the first event, and people all over the non-European world have experienced the second, representing what one of us has referred to as the "Neo-Europes" (Crosby 1986).

A generation ago, students were taught that both of the above experiences were positive. But human remains – from across the globe, and now in the Georgia Bight – tell us quite clearly that farmers, while greater in number than their hunter and gatherer ancestors, were less healthy. It turns out that being invaded by Europeans, though they be soldiers, traders, missionaries, or simply settlers, was pretty much a disaster for Native Americans. The newcomers might or might not be genocidal in intent, but they worked the aborigines hard, interfered with their food production, and – above all – brought them the communicable diseases of Eurasia and Africa. Europe's expansion was a glorious chapter in history for even its lower classes, but a tragedy for, to cite but one example, the peoples of the Georgia Bight. The stories of other Amerindians, Polynesians, and non-Eurasian peoples swept up in European imperialism were similar (Crosby 1986). History, it seems, was much more complicated and, perennially, tragic than what was taught to previous generations of students. Bioarchaeology makes that clear. On the other hand, study of bone structural changes indicates that native peoples adapted to changing circumstances, especially those involving workload and labor exploitation. Thus, we see a picture involving both decline in health and adaptation to changing behavioral conditions.

In summary, assessment of human remains from the Georgia Bight provides a picture of change in health and behavior in response to alterations in diet, disease, and lifestyle that coincides with major adaptive shifts. The broad temporal trends that emerge from the comparisons of skeletal indicators of health and behavior indicate that the human remains from this region provide a vital part of the history of the human condition in this region of the Western Hemisphere.

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