This is an extract from:

Archaeology of Formative Ecuador

J. Scott Raymond and Richard L. Burger, Editors

Jeffrey Quilter, General Editor

published by

Dumbarton Oaks Research Library and Collection

Washington, D.C.

www.doaks.org/etexts.html

Health Issues in the Early Formative of Ecuador: Skeletal Biology of Real Alto

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INTRODUCTION

The Early Formative of Ecuador is generally recognized as a period of transition (Meggers 1966). Presumably, prior populations of Ecuador were relatively small, more nomadic, and lived in more dispersed settlements. During the Early Formative, populations began to shift their subsistence base in favor of agriculture and animal domestication (Lathrap 1975), although overall subsistence likely remained mixed (Zeidler and Pearsall 1994). This not only involved a likely change in subsistence but also in settlement patterns. Agriculture and other forms of food production involved a lifestyle transition toward more sedentism, larger population size and density, and increased social stratification and complexity.

Although much of the shift described above is cultural, it includes a substantial biological component. Subsistence and settlement pattern are two important variables in the multifactorial evolution of disease systems. Diet affects nutrition, which in turn affects skeletal growth and maintenance. Population sedentism and density are important factors contributing to the spread of infectious disease. Thus, careful study of well-documented samples of human skeletal remains offers a unique opportunity to examine aspects of community health and understand the dynamic interplay between biology and culture.

Since 1973, I have collaborated with many archaeologists working in Ecuador to assemble and carefully study well-documented samples of human remains from archeological contexts (Ubelaker 1988f). Through this work, I have published analyses of about 1,637 skeletons from 23 distinct samples (Table 1) ranging in antiquity from 192 Preceramic Vegas Complex skeletons (6300–4650 B.C.

Table 1
Chronological Sequence of Skeletal Samples by Culture and Period

Site and no. of samples	Date	Location	Culture
	Preceramic		
Santa Elena complex 192	8250–6600 BP	Guayas	Vegas complex
	Early Formative		
Real Alto 100	3400–1500 B.C.	Guayas	Valdivia
	Intermediate Precontact		
Cotocollao 199	1000–500 B.C.	Pichincha	Cotocollao
La Libertad (OGSE-46) 24	900–200 B.C.	Guayas	Engoroy
Early La Tolita 7	600–200 B.C.	Esmeraldas	Early Tolita
Cumbayá 20	400 B.C.–A.D. 100	Pichincha	Cumbayá
OGSE-MA-172 30	100 B.C.	Guayas	Guangala
Classic La Tolita 20	200 B.C.–A.D. 90	Esmeraldas	Classic Tolita
Late La Tolita 54	90-400	Esmeraldas	Late Tolita
	Late Precontact		
Ayalán (non-urn) 51	500 B.C.-A.D. 1155	Guayas	Milagro
La Florida 76	340	Pichincha	Chaupicruz
Agua Blanca 7	800–1500	Manabí	Manteño
Ayalán (urn) 384	730–1730	Guayas	Milagro
	Early Historic		
Convento de San Francisco			
hallway 30	1500–1570	Pichincha	Historic
Santo Domingo 46	1500–1650	Pichincha	Historic
Convento de San Francisco			
strata cut, upper level 74	1540–1650	Pichincha	Historic
strata cut, lower level 46	1580–1700	Pichincha	Historic
atrium 19	1600–1725	Pichincha	Historic
	Late Historic		
Convento de San Francisco			
church 119	1535–1858	Pichincha	Historic
superficial collection, lower level 52	1670–1709	Pichincha	Historic
main cloister 33	1730–1858	Pichincha	Historic
superficial collection, upper level 21	1770–1890	Pichincha	Historic
boxes 33	1850–1940	Pichincha	Historic

uncorrected radiocarbon years) from the Santa Elena peninsula (Ubelaker 1980a, 1988d) to 33 skeletons from a component of Convento de San Francisco in Quito, dating from the late 19th and early 20th centuries (Ripley and Ubelaker 1992; Teran de Rodriguez 1988; Ubelaker 1994).

Although the skeletal samples referred to above form a column of time representing much of Ecuador's human past, relatively few remains are available from the Early Formative. This essay focuses on the analysis of 100 human skeletons from the Early Formative recovered during excavations at the coastal Ecuador site of Real Alto, OGCH-12 (Fig. 1) initiated in 1974 by Jorge G. Marcos and the late Donald W. Lathrap of the University of Illinois. The site is located near the coastal town of Chanduy and was occupied for a long period during the Early Formative (Damp 1988; Lathrap, Marcos, and Zeidler 1977; Marcos 1988; Marcos, Lathrap, and Zeidler 1976). The recovered human remains date from Valdivia 1 through Valdivia 7. The archaeologists reported evidence of a ceremonial center and considerable social specialization. Some have also argued that diet at Real Alto and related early Formative Ecuadorian sites included maize, perhaps even involving intensive maize agriculture (Zevallos et al. 1977).

At the invitation of Ecuadorian officials, I studied most of the remains from the Real Alto excavations in 1981 in a makeshift laboratory outside of Quito in the Ecuadorian highlands. Since the materials had not been cleaned, I first washed them with water. After they were dry, I conducted a skeletal inventory and collected data that had proven to be of interest in previous studies of Ecuadorian samples (e.g., Ubelaker 1980a,b, 1981). Estimations of age and sex were based on standard techniques (Bass 1987; Ubelaker 1989).

A relatively small portion of the Real Alto cemetery sample had been sent to the University of Illinois at Urbana–Champaign (UIUC). Rather than publish information gleaned from the partial sample studied in Ecuador, I chose to wait until the entire sample had been examined. This opportunity materialized in March 1995 when research assistant Erica Jones and I traveled to Urbana at the invitation of Linda Klepinger of the UIUC Department of Anthropology. We first washed most of this sample and then studied it in the same manner as with the previous material in Ecuador. Some additional data were collected at this time, reflecting expanded protocols developed in recent years (Buikstra and Ubelaker 1994).

DEMOGRAPHY

The entire sample of 100 individuals originates from a variety of time periods within the Early Formative. Linda Klepinger provided a chronological clas-

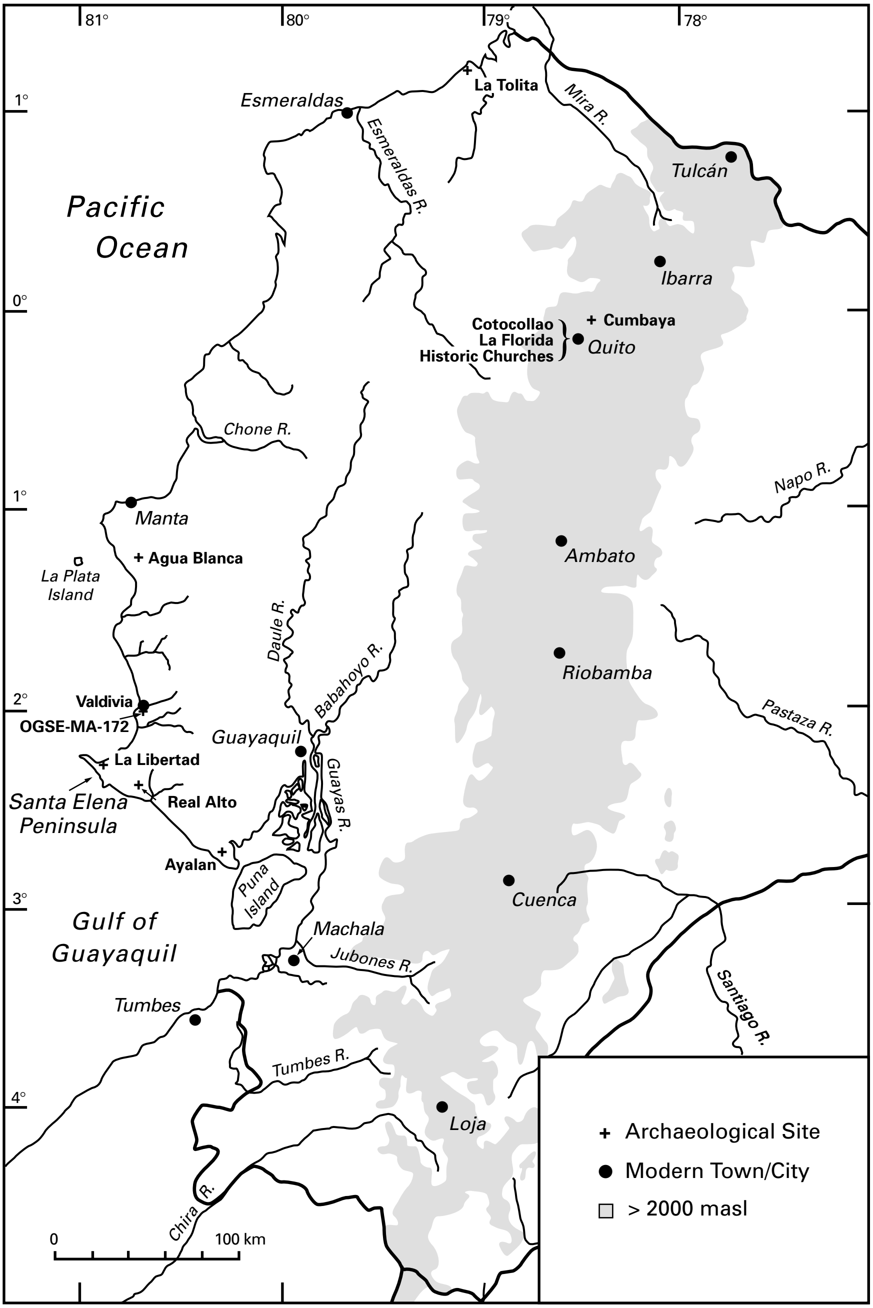

Fig. 1 Ecuadorian sites yielding comparative samples of human remains.

sification of the burial features that had been assembled and given to her by the archaeologists in charge of the Real Alto excavations. Additional information on the chronological affiliation of burials is available in Marcos (1988: 161–173). According to our study of the number of individuals within each feature and this chronological classification, the 100 individuals were assigned to the following periods: 1 from Valdivia 1, 5 from Valdivia 2, 64 from Valdivia 3, 1 from Valdivia 2 through 3, 1 from 3 through 4, 4 from Valdivia 4, 1 from Valdivia 4 through 5, 1 from Valdivia 5, 3 from Valdivia 5 through 6, 14 from Valdivia 6, 1 from Valdivia 1 through 7, and 4 of unknown phase but presumably from sometime within the Early Formative occupations represented by the site. The question marks and multiple designations reflect uncertainty on the part of the archaeologists involved regarding the classification of those particular features. Since the individuals had been assigned to so many closely affiliated cultural levels, for purposes of this essay, they were grouped into one sample of 100 individuals representing the Early Formative. Any attempt to separate out subsamples beyond the large number from Valdivia 3 would produce individual samples too small to be useful in statistical comparisons.

The entire sample of 100 contained individuals of all ages and of both sexes, thus presenting no evidence for cultural exclusion of any particular sex or age group. Of all individuals in the sample, 8 percent were below the age of 1 year and about 21 percent were less than age 5. The ratio of the number of individuals less than age 15 (37) to the number 15 years or greater (63) was 0.59. The mean age at death for males was 38.7 years compared with 33.9 years for females. Summary data on each of the burial features are presented in Table 2. Inventory columns explain the relative completeness of the skeleton. Some remains were not available for analysis, some could be identified as being present but were in some way incomplete, and other materials were relatively complete and present.

Table 3 presents a life table reconstructed from the entire Real Alto sample. The life table suggests that 8 percent of the sample died prior to age 1. An additional 13 percent died during the following five years. Life expectancy at birth was about 24 years with a first-year mortality of 8 percent. Mortality during the first five years was about 21 percent. Life expectancy at age 15 was about 20 years. Thus, a 15-year-old could expect to live until about age 35.

Comparative data on the demographic variables as well as others are available from additional samples from Ecuador. Klepinger's (1979) previous demographic study of the Real Alto remains focused exclusively on those she attributed to the Valdivia 3 phase. Her published life table suggests 22 percent died before the age of 5, a life expectancy at birth of 20.7 years, life expectancy at age 5 of

Table 2
Individual Burial Data from Real Alto

					Bone Condition					
Burial no.	Individual	Sex	Age (yr)	Stature	Cranial deformation	Cranium	Mandible	Long bones	Other	Valdivia (V) period
4	A	M?	40–45		no	I	I	I	I	V 3
4	B	F	30–60			I	I	A	A	V 3
5		F	ca. 20	(145.6)		I	I	I	I	V 3
6		M?	40–45		no	I	I	I	I	V 3 or 2
7		F	30–35	(141.7)		I	C	I	I	V 6
8		M	30–35	(143.7)	no	I	C	C	I	V 3
9		F	35–40		no	I	I	I	I	V 6
10		?	18–45			I	A	A	I	V 6–7
12		?	4–5			I	A	I	I	V 3
13		M	32–40	(155.0)	no	C	C	I	A	V 5–6
14		?	9–11			A	C	C	I	V 5–6
15	A	M	25–30	162.4		I	I	C	I	V 3
15	B	M	30–35		maybe?	I	I	A	A	V 3
15	C	?	ca. 15			I	A	A	A	V 3
15	D	?	2–3			I	A	A	A	V 3
15	E	?	8–10			I	A	A	A	V 3
15	F	M?	20–30			I	A	A	A	V 3
15	G	?	3–4			I	A	A	A	V 3
15	H	?	5–6			I	A	A	A	V 3
16		?	ca. 9			A	A	I	I	V 6
17		M	33–40	160.4	no	C	C	C	I	V 3
18		M	35–40	(156.8)	no	I	I	C	I	V 3
19		?	10–11			C	C	C	C	V 3
20	A	?	ca. 2			I	I	I	I	V 3

20	B	?	ca. 2			A	I	A	A	V 3
21		?	40–50		no	I	C	I	I	V 3
22		F	35–40	(139.9)		I	I	C	I	V 3
23	A	F?	15–16			I	I	I	I	V 3
23	B	F?	32–35	157.2	no	I	I	C	I	V 3
24		M?	40–45		no	I	I	I	I	V 3
25		M	30–37		no	C	C	C	C	V 5
26	A	M	35–42	(156.8)		I	I	C	I	V 6
26	B	F	28–35			A	A	I	I	V 6
27		F	17–20			I	A	C	I	V 6
28		?	40–50			I	I	I	I	V 3
29		F?	30–40			I	A	I	I	V 3
30		?	ca. 4			I	A	I	A	V 3
32	A	M	35–45	165.4	no	C	I	C	I	V 4
32	B	M	Adult			I	A	A	A	V 4
32	C	F	20–35			I	A	A	A	V 4
32	D	?	7–9			A	A	I	I	V 4
33		F	40–45		no	I	I	I	I	V 5–6
34		?	ca. 0.5			I	I	I	A	V 4 or 5
36		M	40–50		no	I	I	I	I	V 3
37		?	15–16			C	C	C	I	V 3
38		?	0.5–0.75			I	C	I	I	V 2
39		?	2–2.5			I	C	I	I	V 3
40	A	?	3–4.5			I	I	I	I	V 6
40	B	?	10–12			I	I	I	I	V 6
41		F	40–45	(143.0)	no	I	I	C	I	V 3
42		F	35–40			I	A	I	I	V 3
43	A	?	18–20			I	A	I	I	V 3
43	B	?	15–18			I	A	I	A	V 3
44		M	40–45	(159.0)	no	I	I	I	I	V 3

(cont.)

Table 2 (*cont.*)
Information on Individual Burials from Real Alto

					Bone Condition					
Burial no.	Individual	Sex	Age (yr)	Stature	Cranial deformation	Cranium	Mandible	Long bones	Other	Valdivia (V) period
45		F	34–38	145.1	no	I	I	C	I	V 3
46		F?	40–45		no	I	C	I	I	V 3
47		F	20–35	(143.0)		A	A	I	I	V 3
48		?	ca. 5			A	A	I	I	V 3
49		M	50–60		no	C	I	I	I	?
50		?	5–6			I	C	I	I	V 3
51		?	0–.25			I	I	A	I	V 3
52	A	M?	40–50	150.0		I	I	C	I	V 3
52	B	?	10–12			A	C	A	A	V 3
53		M	50–55	164.9	no	C	C	I	I	V 3
55		?	2–3			I	C	I	I	V 3
56	A	F	50–60		no	I	I	I	I	V 2
56	B	?	5–7			I	A	A	A	V 2
57	A	M	adult			A	C	C	I	V 6
57	B	?	2–4			I	C	A	A	V 6
58	A	F	adult		no	I	A	A	A	V 3
58	B	?	5–6			I	C	I	I	V 3
59		?	10–11			C	C	C	I	V 3
63		?	NB			A	I	I	A	V 3?
67		M	adult			I	A	A	A	V 3
68		M?	35–40			I	I	I	I	?
70	A	?	NB			I	I	I	I	V 3
70	B	?	NB			I	A	I	I	V 3
71	A	M	35–40	167.2		C	C	I	A	V 2

71	B	?	5–6		I	C	I	I	V 3
72		?	0–0.25		I	I	I	I	V 3
73		?	15–18		C	C	I	I	V 3
74	A	M	40–60		I	A	A	A	V 6
74	B	?	10–12		I	I	A	A	V 6
75	A	F	20–25		I	I	C	I	V 3
75	B	M	23–28		I	I	I	I	V 3
75	C	M	35–40		I	I	C	I	V 3
75	D	?	0.25		A	A	I	A	V 3
75	E	?	4–5		A	A	I	I	V 3
75	F	?	6–7		I	I	I	A	V 3
75	G	?	ca. 15		I	A	A	A	V 3
76		M	35–40		I	I	I	I	V 3
81		?	2.5–3		I	C	I	I	V 3
83		F	22–26		I	I	C	I	V 6
84		M	40–45		I	C	I	I	?
87		M	40–45		A	I	C	I	V 3
92		M	30–35		A	A	C	I	?
93		?	ca. 15		I	I	I	I	V 6
118		?	35–50		I	I	A	A	V 1
A15–9		?	4–5		I	I	A	A	V 3
S–20f–a–1		M	30–35	no	I	I	I	I	V 3 or 4

Notes: A = absent; C = complete; F = female; I = incomplete; M = male.

Table 3
Life Table Reconstructed from the Real Alto Sample

	Dx	dx	lx	qx	Lx	Tx	e°x (life expectancy in years)
0-.9	8.00	8.00	100.00	.0800	96.000	2413.300	24.13
1-4.9	13.00	13.00	92.00	.1413	342.000	2317.300	25.19
5-9.9	10.00	10.00	79.00	.1266	370.000	1975.300	25.00
10-14.9	6.00	6.00	69.00	.0870	330.000	1605.300	23.27
15-19.9	9.00	9.00	63.00	.1429	292.500	1275.300	20.24
20-24.9	3.24	3.24	54.00	.0600	261.900	982.800	18.20
25-29.9	5.40	5.40	50.76	.1064	240.300	720.900	14.20
30-34.9	9.72	9.72	45.36	.2143	202.500	480.600	10.60
35-39.9	14.04	14.04	35.64	.3939	143.100	278.100	7.80
40-44.9	11.88	11.88	21.60	.5500	78.300	135.000	6.25
45-49.9	5.40	5.40	9.72	.5556	35.100	56.700	5.83
50-54.9	2.16	2.16	4.32	.5000	16.200	21.600	5.00
55-59.9	2.16	2.16	2.16	1.0000	5.400	5.400	2.50
60-64.9	0.00	0.00	0.00	0.0000	0.000	0.000	0.00

Notes: Dx = number who died before reaching the next age group; dx = percentage of the Dx data; lx = percentage of survivors who reached the next age group. See Ubelaker (1989) for further discussion of life tables.

20.9 years, and at age 15 of 17.8 years. She suggested that relatively few individuals lived beyond age 50. Comparison with my Table 3 suggests relatively lower life expectancy values for all younger ages in the Klepinger reconstruction, but greater adult longevity. These differences may suggest that the later time periods exhibited increased life expectancy values. They also could reflect, at least partially, differences in methods utilized to estimate age at death and the fact that Klepinger's estimates were generated from field observations on the remains prior to cleaning.

Comparative data from other archaeologically recovered Ecuadorian samples are available from the numerous published studies summarized in Table 1. For broad comparative purposes, these samples have been grouped into six general successive temporal periods. The earliest comprises solely the 192 individuals from the Preceramic Vegas Complex sample from Santa Elena, dating about 8250 to 6600 BP. Greater detail and more rigorous statistical presentation of these data are available in the individual publications of these samples listed in the literature cited. As noted, the Early Formative sample consists entirely of the 100 Real Alto skeletons discussed in detail in this essay.

The Intermediate Precontact period includes skeletons from the sites of Cotocollao (Ubelaker 1980b; 1988e), La Libertad (Ubelaker 1988a), La Tolita (Ubelaker 1988b), Cumbayá (Buys and Dominguez 1988a,b; Ubelaker 1990), and OGSE-MA-172 (Ubelaker 1983, 1993). Dates from these sites range from 1000 B.C. to A.D. 400.

The Late Precontact period includes both components of the Ayalán site (Ubelaker 1981), as well as Agua Blanca (Ubelaker 1988c) and the highland site of La Florida (Doyon 1988; Ubelaker, Katzenberg, and Doyon 1995). Dates from these samples range from 500 B.C. to A.D. 1730.

The Historic remains originate from two Quito churches and have been divided into early and late groupings. Dates of the five early samples range from 1500 to 1725, while those of the later group range from 1535 to as late as 1940 (Ubelaker 1994).

Although these six temporal groupings generally represent a temporal sequence, they do not correspond exactly with traditional archeological or Historic classifications. The dates of individual component samples of these groupings overlap somewhat as well. For example, the latest date for the Late Precontact sample is 1730 for the Ayalán urn component, while the earliest date for the succeeding Early Historic period is 1500 and the latest date is only 1725. In spite of the overlap, the sequence makes sense because evidence suggests all Late Precontact samples, including Ayalán urn, predominantly represent Indian groups prior to Spanish contact. The Early Historic samples all present evidence that they date from the period of European contact. It also is important to note that many, if not most of the Historic samples likely originate from relatively high-status individuals of European ancestry. In contrast, the samples from the four earlier periods all represent Indians in nonurban settings.

As shown in Figure 2, the life expectancy at birth value of 24 for the Early Formative is slightly less than the Preceramic period and the following Intermediate Precontact, but higher than in the more recent periods. Life expectancy at birth represents the number of years a newborn can expect to survive, and thus reflects the influence of the infant mortality rate as well as adult longevity. Collectively, these data suggest overall mortality did not increase significantly until the Late Precontact and accelerated during the Historic periods.

Figure 3 presents comparative values for life expectancy at age 5. It reveals similar trends but excludes the important infant mortality and considers adult longevity. The Early Formative value drops from the Preceramic levels, gradually increases in successive Precontact periods, and then declines in the Historic periods.

Life expectancy at age 15 was only 20 years during the Early Formative, the lowest value for any period considered here (Fig. 4). This suggests that more adults died as young adults than in any other period of Ecuadorian history. Adult maximum longevity was 55 years, among the lowest values reported.

LIVING STATURE

Estimates of living stature were calculated from long bone measurements by using published regression equations (Ubelaker 1989). Stature values for males from Real Alto ranged from 150 to 167 cm with a mean of 162 cm. This value is similar to mean values from other periods (Fig. 5) suggesting little change in stature among males throughout time. As expected, mean female stature (151 cm) from the Real Alto sample is substantially less than that of males, but within the range of mean values from the other periods. As with males, female stature shows little variation throughout time. These values are Preceramic, 149 cm; Intermediate Precontact, 152 cm; Late Precontact, 151 cm; Early Historic, 151 cm; and Late Historic, 154 cm. The slightly higher value in the Late Historic sample probably reflects European rather than the exclusively Indian constituency of the earlier periods.

TRAUMA

Twelve bones from 10 individuals, all adult, showed evidence of trauma in the Real Alto sample. These individuals consisted of seven likely males and

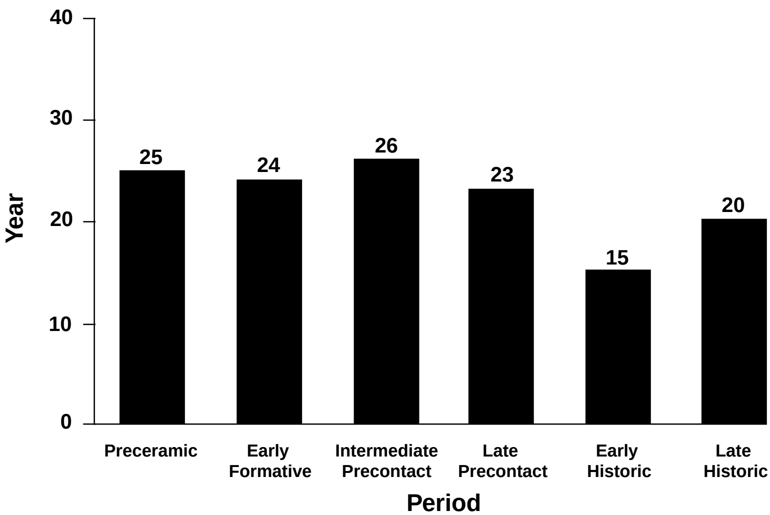

Fig. 2 Temporal change in life expectancy at birth.

three females, mostly from the older age categories. All of these fractures showed evidence of healing; thus they were not directly related to the deaths of the individuals. Various parts of the skeleton were involved, including the cranium, ribs, ulna, femur, fibula, and foot bones (Table 4). Four of these examples represented depressed fractures of the cranium, likely produced by interpersonal

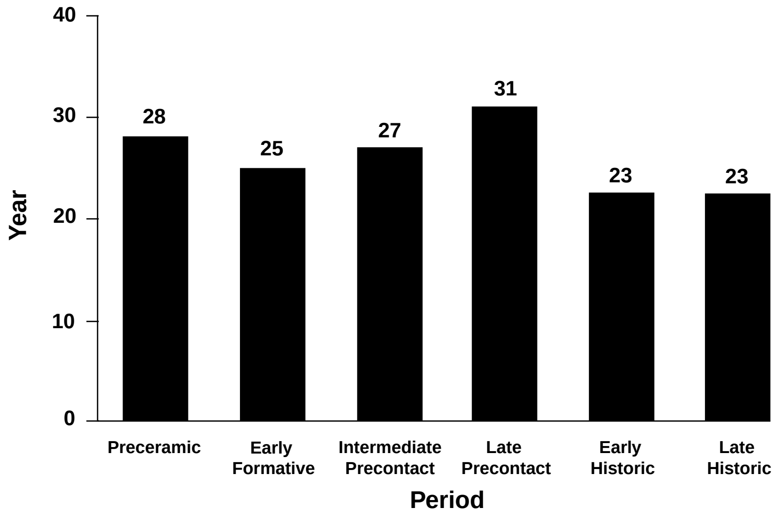

Fig. 3 Temporal change in life expectancy at age 5.

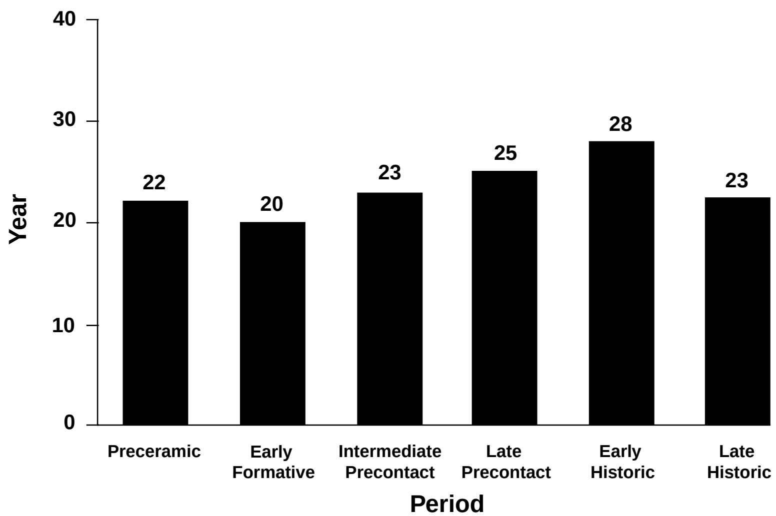

Fig. 4 Temporal change in life expectancy at age 15.

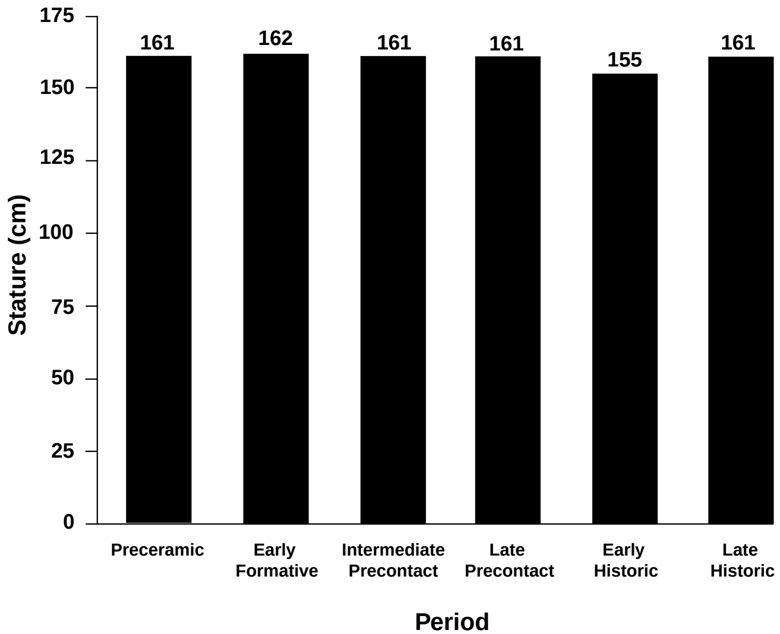

Fig. 5 Temporal change in male stature.

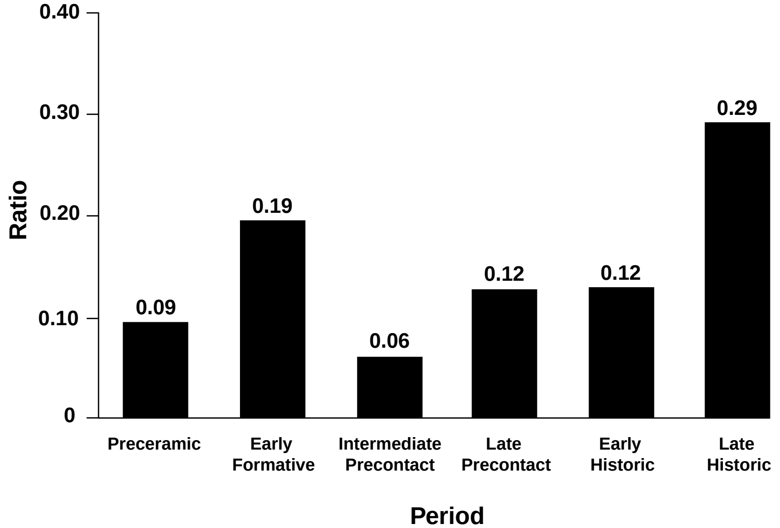

Fig. 6 Temporal change in the ratio of bones with trauma to the number of adults.

Table 4
Evidence for Trauma in the Real Alto Sample

Burial no.	Sex	Age (yr)	Fracture site	Description
8	M	30–35	left frontal	depressed 33 mm above left orbit
9	F	35–40	rib	healed near vertebral end
15B	M	30–35	right parietal	healed depressed
23B	F?	32–35	left ulna	healed midshaft; bone shortened 5 mm; radius not affected
24	M?	40–45	right frontal	depressed 25 mm above right orbit
33	F	40–45	right frontal rib	depressed 35 mm above right orbit fracture
49	M	50–60	right femur	large callus involved
			left 4th metatarsal	remodeling at proximal end
71A	M	35–40	right 4th metatarsal	healed at distal end
84	M	40–45	fibula	healed complete
87	M	40–45	proximal foot phalanx	healed

Note: F = female; M = male.

violence. Three of these individuals date to Phase 3 and one from Phases 5 through 6.

The ratio of the number of bones with evidence of trauma compared with the number of adults in the sample was 0.19 for Real Alto. As shown in Figure 6, this value was higher than for all periods but the Late Historic.

PERIOSTEAL LESIONS

Periosteal lesions represent abnormal bone formation on the outer periosteal bone surface. Although a variety of conditions can stimulate such alterations, they are usually interpreted as indicators of infection. If soft tissue infection is sufficiently severe, the periosteum can be stimulated to produce bone deposits on the preexisting cortical bone surface. Although such bone deposits cannot always be linked to infection, they provide strong evidence of morbidity within the individual. The ratio of bones with periosteal lesions to adults in the Real Alto sample is 0.14. As shown in Figure 7, this value is intermediate between the low Preceramic value and the higher Intermediate Precontact value and substantially lower than the Historic values. In context, the value suggests gradually increasing frequencies of infection, likely correlated with increasing population

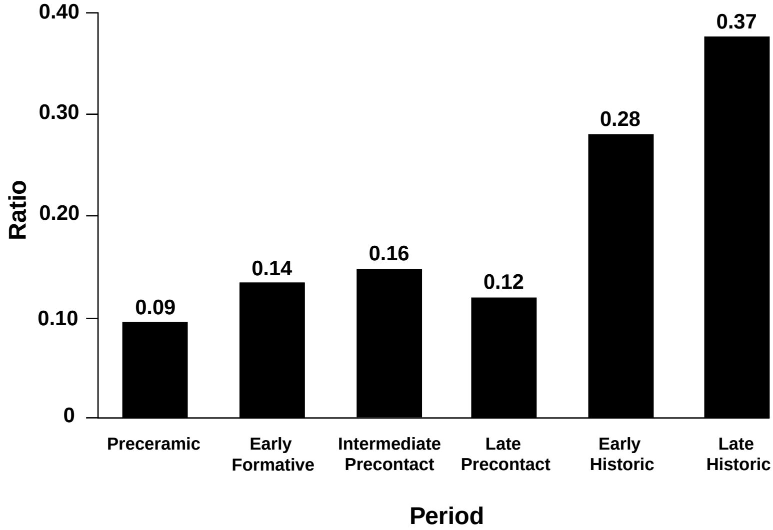

Fig. 7 Temporal change in the ratio of bones with periosteal lesions to the number of adults.

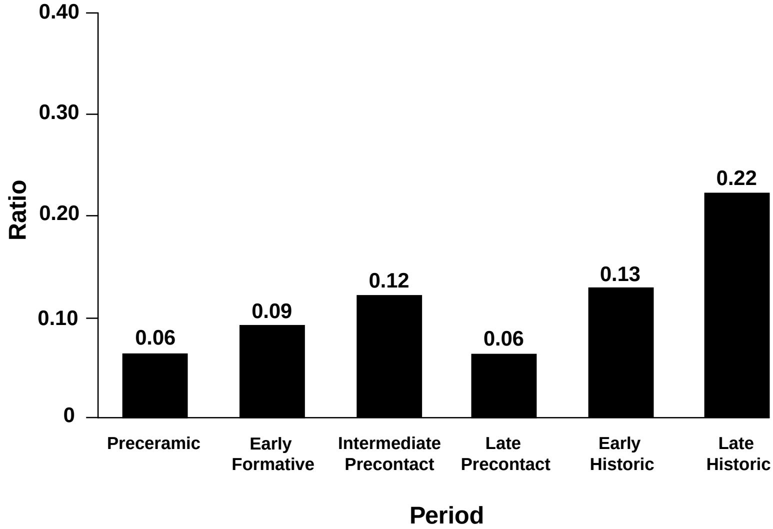

Fig. 8 Temporal change in the ratio of bones with periosteal lesions to the number of individuals.

density. A similar trend is seen when the ratio of bones with periosteal lesions to total number of individuals (of all ages) is plotted through time (Fig. 8). The comparatively high values from the Historic samples likely reflect the obviously elevated levels of infectious disease that contemporary sources documented for that time. The lower value for the Late Precontact is more difficult to explain, since presumably it represents the Precontact period with greatest population density and thus the greatest opportunity for the spread of infectious disease.

DENTAL HYPOPLASIA

Dental hypoplasia represents a structural defect in the tooth produced when tooth formation is temporarily disrupted (Goodman, Martin, Armelagos, and Clark 1984; Goodman, Thomas, Swedlund, and Armelagos 1988; Ubelaker 1992a). Although many factors can influence the formation of dental hypoplasia, the alterations are significantly correlated with morbidity and malnutrition. Although they cannot be linked directly to a specific disease condition or dietary deficiency, they seem to suggest general health problems at the time of their formation.

Ten hypoplastic teeth were found in the Real Alto sample, seven in maxillary teeth but only three in mandibular teeth. Of the maxillary teeth, three were from incisors, three were from canines, and one was from a premolar. Of the mandibular teeth, one was a canine and two were molars. Three teeth were from males, one from a female, and the remaining six from individuals of undetermined sex. Frequencies of affected teeth were 1.2 percent of male teeth and only 0.5 percent of female teeth. The overall frequency of affected teeth was 1.7 percent.

Figure 9 plots the frequency of permanent teeth with hypoplastic defects in the chronological periods. The Real Alto figure is higher than the Preceramic figure, equal to the Intermediate Precontact period and considerably lower than the Late Precontact and Early Historic periods. In fact, the Precontact values show a general temporal trend of increasing hypoplasia frequency with time. The reduction in the Historic values is perplexing, but two explanations are plausible. The hypoplastic defects may represent sites on the tooth especially conducive to caries formation. Thus, the elevated caries frequency, apparent especially in Late Historic times, combined with increased longevity, may have created especially high frequencies of tooth loss for the hypoplastic teeth, thus eliminating them from the sample prior to the death of these individuals.

The other possible explanation may be that the Historic samples represent a different population, both genetically and socially, than the earlier samples. The individuals of predominantly European ancestry and higher social class may have enjoyed better childhood nutrition than the earlier populations.

DENTAL CARIES

Dental caries represents a disease of the teeth. Generally, it is believed that certain foods, especially refined sugar, adhere to the tooth surface, providing an ideal environment for bacteria to multiply and colonize (Larsen, Shavit, and Griffin 1991). Left uninterrupted, these bacterial colonies can produce substances that break down the tooth surface, leading to tissue collapse and formation of a cavity. In the absence of adequate dental hygiene and dentistry, the process continues until much of the tooth surface is destroyed. Eventually, such destruction may produce exposure of the pulp cavity of the tooth, allowing bacteria to enter and infect the inner-tooth structure. The result of such bacterial encroachment is likely an apical abscess and eventual loss of the tooth (Ubelaker 1992b).

Dental caries has attracted considerable attention in anthropological analysis because it continues to be a universal health problem and archaeologically recovered samples reveal a dietary component in its development. The consumption of certain foods promotes the formation of dental caries.

The caries data are especially relevant in studies of Early Formative samples from Ecuador because (a) the literature contains considerable debate regarding

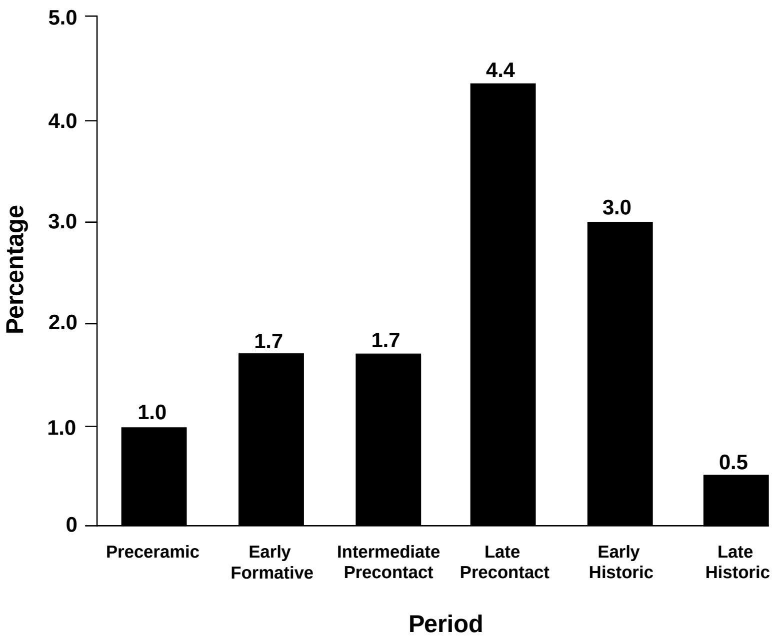

Fig. 9 Temporal change in the frequency of dental hypoplasia.

subsistence (Pearsall 1988; Zevallos et al. 1977) and (b) some data have been published from the Early Formative in Ecuador citing low-caries frequencies and interpreting them as evidence for the lack of consumption of carbohydrates, and thus the lack of the practice of intensive maize agriculture (Turner 1978).

In the Real Alto sample, 8.5 percent of all teeth displayed at least one carious lesion. In this study, a carious lesion was defined as a defect in the tooth at least 1 mm in diameter displaying clear evidence of tissue collapse resulting from caries. Of 209 teeth from males, 29 (13.9%) were carious. Of 183 teeth from adult females, 14 (7.6%) were carious. Three of 149 teeth of unknown sex were carious (2.0%). Of the 21 maxillary teeth with caries, 2 were incisors, 2 were canines, 3 were premolars, and 14 were molars. Of 25 mandibular teeth, not one was from incisors, 3 were from canines, 5 from premolars, and 17 from molars.

The carious teeth in the Real Alto sample originated from 22 individuals, 12 probable males, seven probable females, and three individuals of undetermined sex. As shown in Table 5, one of these individuals was from Valdivia 2, 15 from Valdivia 3, one from Valdivia 5, one from Valdivia 5 through 6, one from Valdivia 6, and 3 of unknown cultural affiliation.

Of the 52 individuals in the sample with at least one tooth sufficiently well preserved to allow observations for carious lesions, 22, or 42.3 percent, had at least one carious lesion. Frequencies for percentage of individuals affected for each phase within the sample were 100 percent (1 of 1) for Phase 2; 44.1 percent (15 of 34) for Phase 3; 0 percent (0 of 1) for Phase 4; 100 percent (1 of 1) for Phase 5; 12.5 percent (1 of 8) for Phase 6; 50 percent (1 of 2) for Phase 5 through 6; 0 percent (0 of 1) for Phase 3 through 4; and 75 percent (3 of 4) for those of unknown phase.

Figure 10 provides temporal perspective for the Real Alto caries data. The Real Alto figure of 8.5 percent of teeth is sharply higher than the previous Preceramic value of 3.0 percent and also markedly higher than the later Intermediate Precontact value of 2.3 percent, and even slightly higher than the Early Historic figure of 5.6 percent.

Turner (1978) summarized much of the relevant literature on caries frequency. He noted that elevated occurrence of caries is frequently associated with intensive maize agriculture, since many of the products, especially maize, involved in such practice are thought to be cariogenic. Of 76 teeth from six individuals of the Early Formative Valdivia sample from the Buena Vista site and 14 teeth from one individual from a nearby Machalilla phase site (La Cabuya), Turner found absence of caries in the Valdivia teeth and two possibly carious teeth from the later Machalilla phase individual. This suggested an overall frequency of 2.2 percent for the entire sample. He suggested that the low fre-

Table 5
Individuals with Dental Carious Lesions by Period

Period	Burial no.	Sex	No. of lesions
Valdivia 2	71A	Male	1
Valdivia 3	5	Female	1
	8	Male	1
	18	Male	2
	21	?	1
	22	Female	3
	24	Male?	5
	28	?	1
	41	Female	3
	43A	?	1
	44	Male	6
	45	Female	3
	46	Female?	2
	53	Male	2
	58A	Female	2
	76	Male	3
Valdivia 5	25	Male	1
Valdivia 5–6	13	Male	2
Valdivia 6	7	Female	1
?	49	Male	1
	68	Male?	2
	92	Male	3

quency offered "no physical anthropological support for the idea of early intensive agriculture in Ecuador" (Turner 1978: 696).

The data presented here suggest that in the Ecuadorian samples, a simple relationship between caries frequency and subsistence remains elusive. In contrast to the data Turner gleaned from his small Early Formative sample, the Real Alto data suggest relatively high caries frequency (8.5%) for the Early Formative and much lower frequencies for the later Intermediate Precontact samples.

Note that the 8.5 percent figure applies, like all other data discussed herein, to the *entire* Real Alto sample, even though a considerable time range is involved. As noted above, the 22 individuals with carious lesions originated from several different cultural phases within the Early Formative. The data show that 68.2 percent of the carious individuals in the sample were from the Valdivia 3 phase and 76.1 percent of carious teeth originated from Valdivia 3. Only 4.5

percent of individuals with caries were from Valdivia 2, and only 2.2 percent of teeth with lesions were from Valdivia 2.

Turner (1978) notes that crown caries and root caries may represent different phenomena. He indicates that the two carious lesions found in his Machalilla sample were located at the crown–root junction and did not involve enamel destruction. He suggests that crown caries are more significantly correlated with intensive agriculture than root caries. He further suggests that root lesions could result from "(a) actual caries, (b) incipient caries, (c) root caries (a wasting process associated with old age), or (d) a form of preservation damage" (Turner 1978: 696).

The Real Alto lesions located in cementum were not judged to result from postmortem factors. Rather, they were scored as present if they appeared to show evidence of structural damage from disease. Of the 46 teeth with lesions, 7 displayed lesions of the cementum that did not involve the crown. The remaining 39 teeth with enamel involvement suggest a crown caries frequency of 7.2 percent. This figure is still high in relationship to the other comparative data from Ecuador. The root carious lesions were found within the dentitions of predominantly young adults suggesting they were not caused by factors relating to old age. It is also worth noting that all comparative data from Ecuador reported here are for total caries frequency, grouping teeth with both crown and cementum lesions.

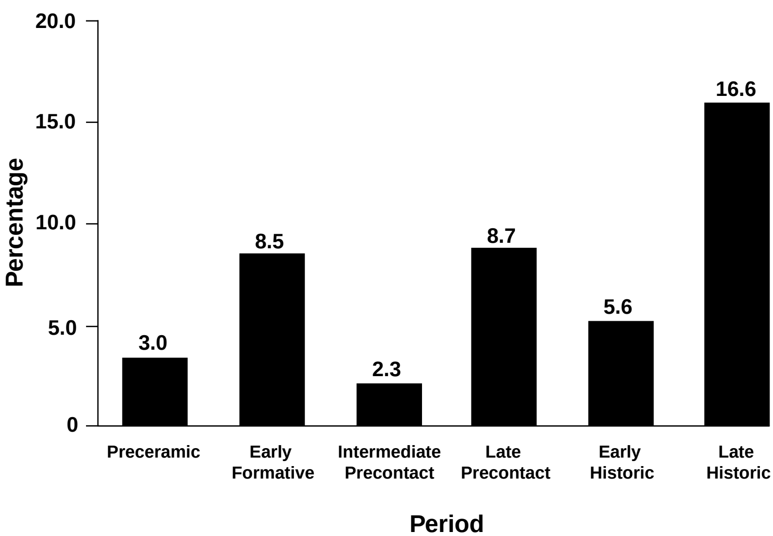

Fig. 10 Temporal change in the frequency of dental caries.

Obviously, extensive maize consumption during Early Formative times would explain the comparatively high frequency of dental caries in the Real Alto sample. Although if maize relating to intensive maize agriculture is the primary explanation, then why are the caries frequencies during the Intermediate Precontact period so low? The answers likely relate to both the dynamics of caries formation, as well as the complexity of food production and preparation. There may be other foods in addition to maize that were consumed during the Early Formative that were cariogenic. The population at Real Alto may have been exploiting a local food source not available to their earlier Preceramic neighbors. They may have favored a method of food preparation that rendered their food especially prone toward caries formation. All of these factors also may have been operating on the later Intermediate Precontact group to limit their caries involvement.

ALVEOLAR ABSCESSES

When the destruction of the tooth surface by caries, attrition, or trauma is such that the pulp cavity is exposed, bacteria can penetrate to the tip of the root and form an abscess in the surrounding bone. Such an alveolar abscess frequently leads to tooth loss, after which the involved area of the bone gradually remodels, destroying the evidence for the abscess as well as the perforations in the bone for the roots.

In the Real Alto sample, alveolar abscesses were found in 8.9 percent of observations for the trait. The frequencies were 11.3 percent in males and 9.7 percent in females. As shown in Figure 11, the overall 8.9 percent value is highest of any of the groupings depicted. It displays a remarkable increase over the low Preceramic value. The high value likely represents a combination of dental problems because of considerable attrition of the occlusal surfaces, combined with a relatively high caries rate. The young mean age of death of the adults in the Real Alto sample also is a contributing factor, since in older individuals many previously abscessed teeth would have been lost, with the alveolus remodeled to the point that a previously existing abscess would not have been detected.

ANTEMORTEM TOOTH LOSS

The final outcome of dental disease is tooth loss. Loss of teeth in these samples usually results from caries or occlusal attrition leading to pulp exposure and apical abscesses. The associated bone loss allows the tooth to be easily extracted. Severe and prolonged periodontal disease also can create bone remodeling and reduction that can lead to tooth loss.

In the Real Alto sample, 10.1 percent of all permanent teeth had been lost antemortem. The values were 10.9 percent for males and 15.6 percent for females. Figure 12 compares the percentage of permanent tooth loss antemortem from the Real Alto sample with the other six temporal samples from Ecuador. The data demonstrate a regular increase in antemortem tooth loss with time. This seems to reflect the general temporal increase in both dental disease and adult longevity.

OTHER PATHOLOGY

In addition to the dental disease discussed above, two examples of interproximal grooves were found. One was found on the mesial surface of the left mandibular first premolar from a male, age 40 to 45, of Feature 84 (Fig. 13). This male also displayed extensive dental attrition, arthritic changes on the glenoid cavity of the scapulae and the left temporomandibular joint, and a well-remodeled fracture of a fibula. Microscopic examination revealed fine parallel striations extending along the long axis of the alteration.

A second interproximal groove was found on the buccal aspect of a large

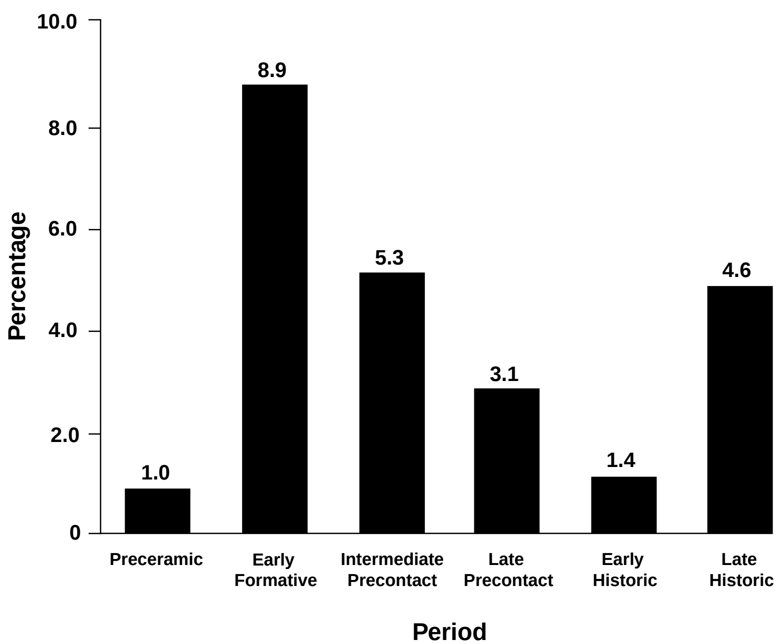

Fig. 11 Temporal change in the frequency of alveolar abscesses.

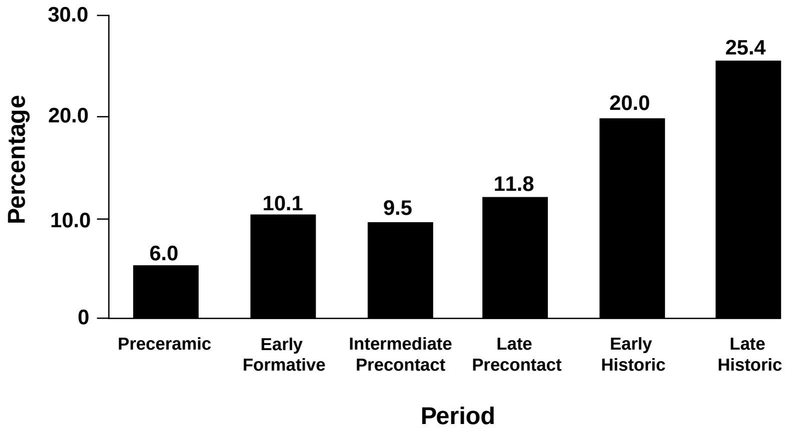

Fig. 12 Temporal change in the frequency of antemortem tooth loss.

carious lesion located in the distal cervical area of a maxillary right second molar of a likely male, age 35 to 40, of Feature 68. The groove extends into the carious lesion.

Both of these lesions appear to represent the use of toothpick-like instruments. Apparently, the instrument was inserted between the teeth with sufficient frequency that grooves were eventually worn. The association of the groove with the carious lesion in Feature 68 likely suggests the instrument was inserted in response to discomfort associated with the carious lesion. Similar type grooves have been reported from numerous other archeological samples throughout the world (Ubelaker, Phenice, and Bass 1969). The fine, parallel striations likely were produced by many individual insertions of the instrument.

Additional pathology, not included in the categories discussed above, includes various examples of congenital disorders. These consist of fused foot phalanges from a likely male, age 40 to 45, of Burial 4; fusion of the second and third cervical vertebrae in a child, age 10 to 11, of Feature 19; fused cervical vertebrae from a female, age 34 to 38, from Feature 45; and an apparent cervical rib from a female, age 22 to 26, from Feature 83.

Only one possible nondefinitive example of cranial deformation was noted in this sample, the Phase 3 male, age 30 to 35, of Burial 15B. In other early samples from Ecuador, cranial deformation was not found at the Vegas Complex site OGSE-80 (Munizaga 1976; Ubelaker 1980a). Cranial deformation

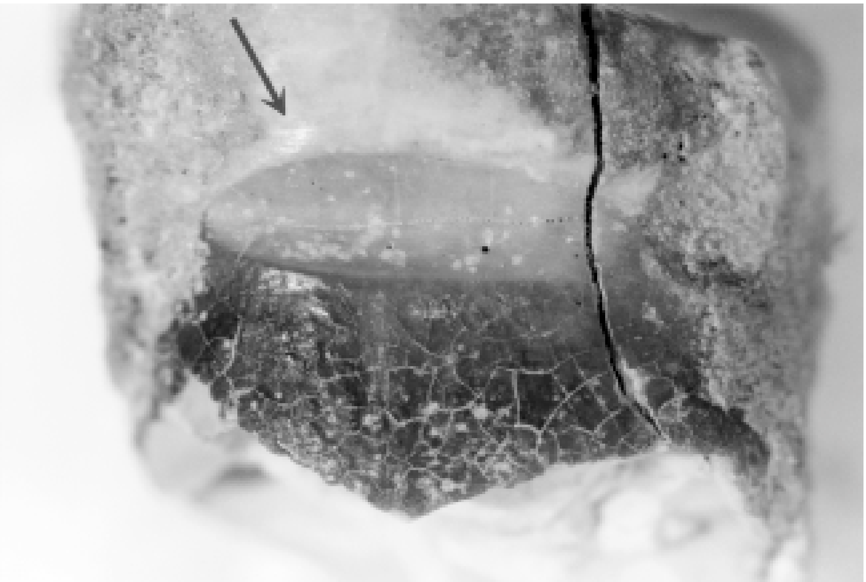

Fig. 13 Interproximal groove on premolar from Feature 84.

has been suggested for Valdivia remains from San Pablo and Engomala (Munizaga 1976) as well as Machalilla (La Cabuya) and various coastal Chorrera samples (Munizaga 1976) and the highland site of Cotocollao (Ubelaker 1988d). Munizaga suggests aspects of this custom began in Ecuador about 2000 B.C.

CONCLUSIONS

The Real Alto data provide much of the missing link in the previously published information on health trends within Ecuador. As expected, the data suggest that tooth loss, most demographic variables, living stature, dental hypoplasia, and skeletal evidence of infection were transitional between the Preceramic and later samples. These data suggest that evidence of infectious disease, growth disruption, and levels of infection were increasing during the Early Formative but had not yet achieved the higher values of later periods. Porotic hyperostosis had not yet appeared, suggesting that subsistence and population density had not yet created conditions conducive to severe anemia in the populations. Such evidence appears to be confined to the coast beginning during Guangala times (what has been called the Intermediate Precontact period) and may represent anemia brought on by severe hookworm infection (Ubelaker 1992b,c).

Unusual features of the Real Alto data consist of the elevated frequencies of trauma, dental caries, and dental abscesses. Although conclusions must be tempered by the small sample sizes involved, the data suggest that during the Early Formative in Ecuador, trauma, including interpersonal violence, may have been on the increase. This may suggest intergroup conflict, competition over territory or resources, or domestic violence. The high levels of dental caries seem to be subsistence related and lend some credence to the archaeological evidence for extensive maize consumption at this time. Other interpretations, relating to subsistence and food preparation cannot be ruled out, however, especially since lower levels of dental caries are found in the later Intermediate period samples. Clearly, simplistic explanations relating dental disease to single foods are not tenable. The interrelationship between biology and culture is both dynamic and complex and a complete explanation likely must await additional research on other well-documented samples.

Acknowledgments Access to the Real Alto samples was graciously provided by Jorge Marcos and Olaf Holm. Access to the portion of the sample at the University of Illinois was graciously provided by Linda Klepinger. Helpful assistance at the Smithsonian Institution was provided by M. Bakry in the preparation of the map and Erica Jones in data collection at the University of Illinois and general manuscript preparation.

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