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Socioeconomic and Anthropometric Correlates of Linear Enamel Hypoplasia in Children from Solis, Mexico

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Abstract.

In order to better understand the etiology of linear enamel hypoplasias (LEH) in prehistoric and contemporary groups, we studied their association with socioeconomic status (SES) and anthropometric measures of nutritional status in children from Solis, Mexico (n = 296). Enamel hypoplasia on upper, permanent incisor teeth was inversely associated with SES, height-for-age, and weight-for-age. The strongest associations were found for hypoplasias developing closest to the time of measurement of anthropometric and socioeconomic status. The consistent association between these measures suggests that LEH is a sensitive indicator of within-community variation in living conditions.

Introduction.

In recent years two converse trends have emerged in paleopathology. One trend involves the questioning of whether skeletal markers of disease (and stress) should be read as signs of individual and population maladaptation. Ortner (1979), for example, long ago raised the important challenge of whether skeletal markers of infection might just as well be considered signs of the struggle to adapt. At the same time, the use of other skeletal indicators of disease and stress, such as linear enamel hypoplasia (LEH), has expanded without serious questioning of their meaning for health, development and adaptation (Goodman & Rose, 1990).

These trends, both the questioning of the underlying meaning of skeletal indicators of health, and uncritical acceptance of them in paleopathological contexts, has lead us to begin a series of studies of the meaning and correlates of one skeletal indicator, linear enamel hypoplasia, in contemporary situations. It is our belief that such studies are essential to further understanding the significance of linear enamel hypoplasia in prehistory. As well, such studies suggest that enamel hypoplasia might be useful as a measure of childhood conditions in contemporary populations. The specific purpose of this paper is to report on the socioeconomic and nutritional status correlates of enamel defects in contemporary, rural Mexican children. We report on differences in mean socioeconomic status, height-for-age and weight-for-age in children with and without enamel hypoplasia on upper permanent incisor teeth.

Methods and population.

This research was an ougrowth of the Collaborative Research Support Program (CRSP) study of nutrition and function (Allen & al., 1987). The purpose of the CRSP is to better understand the functional consequences of mild-to-moderate undernutrition. Mild-to-moderate undernutrition is of significance because it is the most prevalent form of malnutrition in the contemporary world and is likely to have been endemic throughout most of human history. Despite its pervasiveness, we know little of the functional costs of this form of malnutrition (Allen, 1984).

The research site is located in the Temascalcingo region of the Mexican highlands, about 170 Km northwest of Mexico City and at an altitude of about 2200 meters (Figure 1). The immediate area, the Solis Valley, includes 13 villages, each of about 1,000 individuals. Children from five of these village were included in this study. Living conditions are somewhat «typical» for a rural community in highland Mexico, and perhaps much of the developing world. Roads are unpaved and there is little sanitation. Houses are small, usually consisting of from one to three rooms. The dominant food item is tortillas, though in wealthier families this traditional food is gi way to bread and pastas. The fluo contenent of water in the valley is (ppm.

Children in this populations begi exhibit growth faltering around the s month of age (Allen & al., 1987). A weaning most children are at least Z-score below National Center Health Statistics (NCHS) refere values for weight and 1.5 Z-scores be NCHS values for height. The major e logical correlates of poor growth ar low intake of animal products and p dietary diversity (Allen & al., 1987)

The dental data are from 7-9 year children who were targeted for inclusi in the CRSP study, and their school a siblings. The sample includes 296 ch dren. ages 5 to 15, with slightly more males than males. Defects were scor on anterior teeth by developmen zones approximating sixths of too crowns from the incisal to the cervic border.

Classification followed the Feder tion Dentaire International (FDI) inde of developmental defects of dent enamel (1982; Clarkson, 1989). Fiv types of defects were found. Whit opacities and linear enamel hypoplasi are most prevalent, followed b hypoplastic pits and yellow opacities Nearly half the children had one or mor enamel opacities and one or more ename hypoplasias (Goodman & al., 1987; Good man, 1988). In the permanent incisor the majority of hypoplasia developed i the middle (second to fourth) zones, sug gesting a peak age at formation from about 12 to 30 months.

The following analysis includes only permanent dentition defects, and focuses on linear enamel hypoplasia, the most

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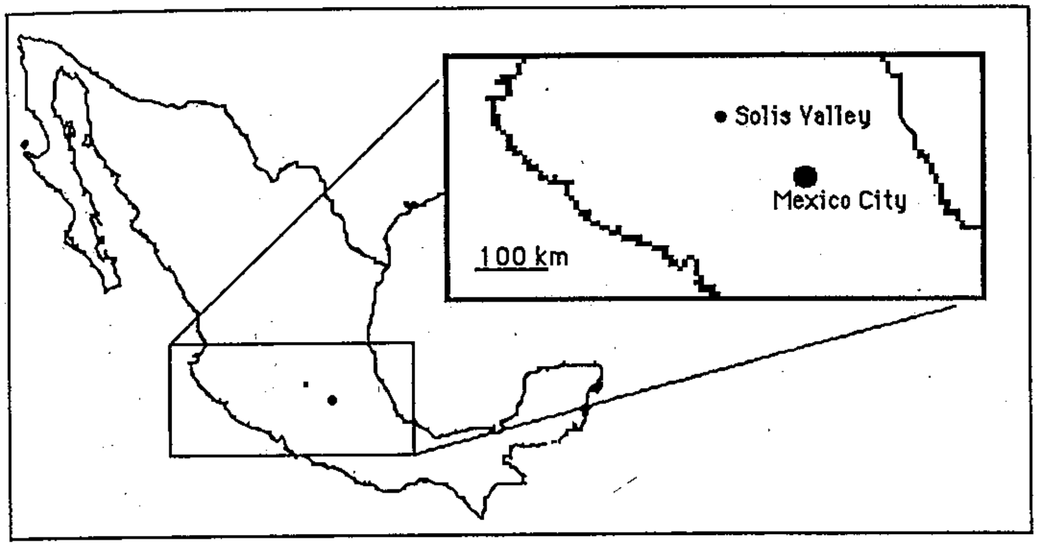


Figure 1. Map of Mexico and location of Solis Valley field site.

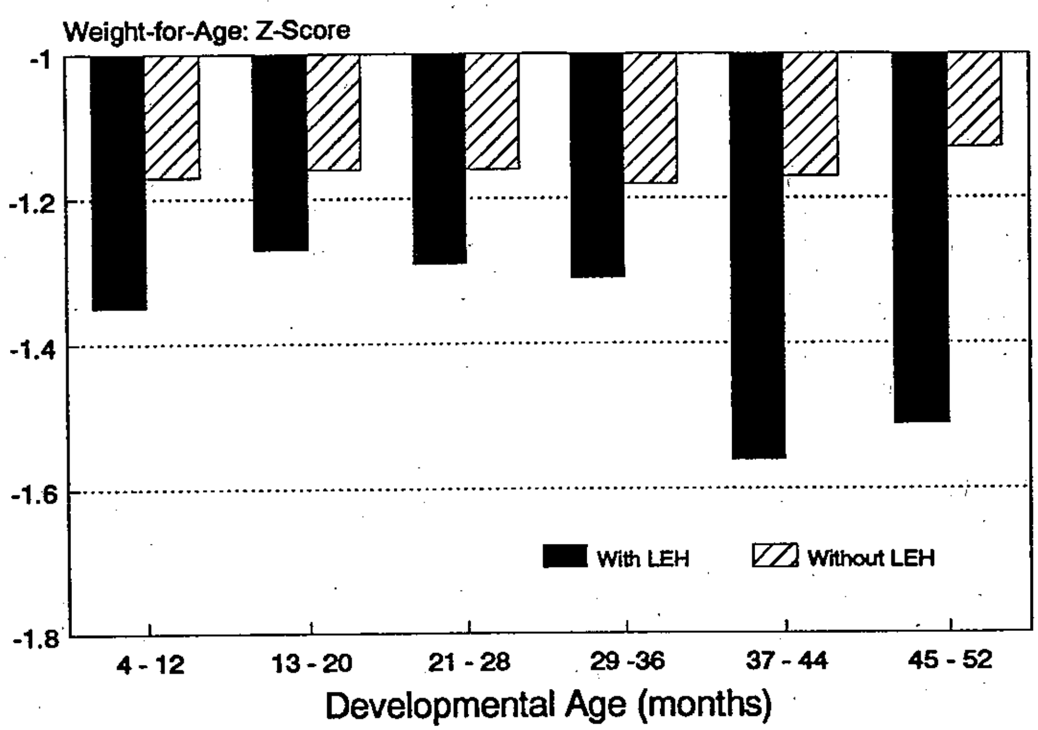


Figure 2. Comparison of mean Z-score of weight-for-age for individuals with and without linear enamel hypoplasias (LEH) on developmental zones of the upper central incisor.

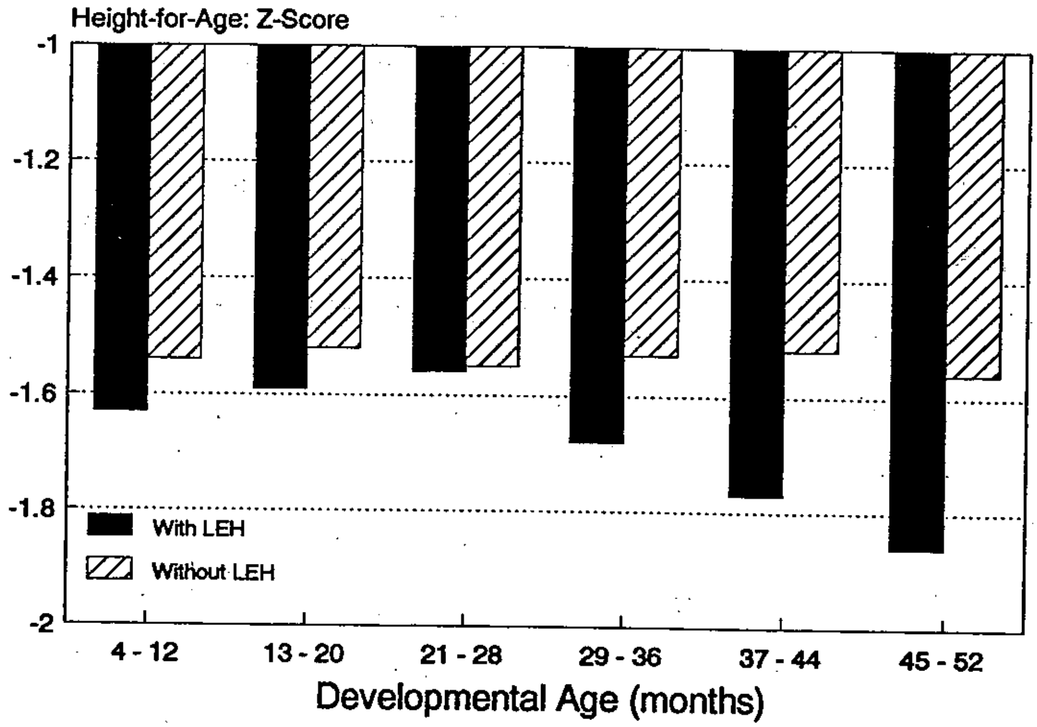


Figure 3. Comparison of mean Z-score of height-for-age for individuals with and without linear enamel hypoplasia (LEH) on developmental zones of the upper central incisor.

common developmental defect found in prehistoric populations. Patterns of association are presented between LEH found on any anterior permanent tooth, upper central incisors, and lateral incisors (the most hypoplastic teeth) and three dependent variables: socioeconomic status, Z-score of height-for-age and Z-score of weight-for-age (Tables 1-3). Height and weight Z-scores were calculated via a U.S. Center for Disease Control (CDC) program, based on National Center for Health Statistics (NCHS) data. Socioeconomic status is based on household characteristics such as the type of walls, flooring and roof; the number of rooms; and signs of material wealth such as ownership of chickens and other animals. Finally, data are presented on mean SES and anthropometric scores for individuals with and without hypoplasia by developmental zone on the maxillary central incisor, the single most hypoplastic tooth (Figures 2-4).

Results.

Weight-for-Age.

A consistent decrease (more negative) Z-score for weight is found for those with hypoplasia versus those without hypoplasia. These differences approach significance for the central incisor and the total of the permanent anterior teeth, and are significant for the lateral central incisor (Table 1).

Table 1. Mean Weight-fc enamel hypoplasia on pe:

	LE X̄
Maxillary I1	−1.29
Maxillary I2	−1.38
Anterior Teeth	−1.27

Table 2. Mean Height- enamel hypoplasia on I

	I X̄ (n)
Maxillary I1	−1.6(
Maxillary I2	−1.7
Anterior Teeth	−1.6

The pattern of scores suggests that t tionship between presence of a defect developing toward th junction, or after (Figure 2). A consist scores in found at a these differences are two zones.

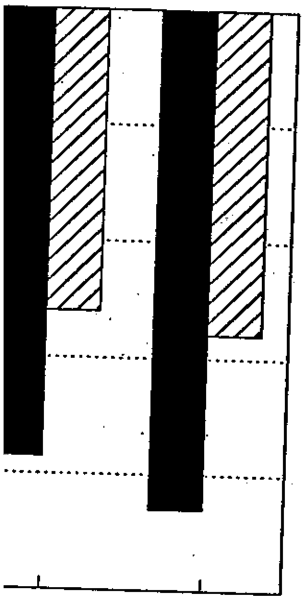


Table 1. Mean Weight-for-Age Z-scores for individuals with and without linear enamel hypoplasia on permanent teeth.

	LEH $\bar{X}$	LEH (s.d.) (n)	no LEH $\bar{X}$	no LEH (s.d.) (n)	T value	2-tail P
Maxillary I1	−1.29	(.59) (71)	−1.13	(.65) (137)	1.72	.086
Maxillary I2	−1.38	(.51) (28)	−1.15	(.65) (180)	2.04	.047
Anterior Teeth	−1.27	(.59) (89)	−1.12	(.67) (119)	1.69	.093

Table 2. Mean Height-for-Age Z-scores for individuals with and without linear enamel hypoplasia on permanent teeth.

	LEH $\bar{X}$ (n)	LEH (s.d.)	no LEH $\bar{X}$ (n)	no LEH (s.d.)	T value	2-tail P
Maxillary I1	−1.66	(.76) (56)	−1.47	(.85) (121)	1.40	.162
Maxillary I2	−1.78	(.79) (20)	−1.50	(.83) (157)	1.39	.168
Anterior Teeth	−1.67	(.81) (71)	−1.44	(.83) (106)	1.85	.066

The pattern of weight-for-age Z-scores suggests that the strongest relationship between weight and the presence of a defect occurs for defects developing toward the cemento-enamel junction, or after about 30 months (Figure 2). A consistent decrease in Z-scores in found at all zones. However, these differences are greatest for the last two zones.

Height-for-Age.

Z-scores for height-for-age are also consistently less for groups with LEH. However, these differences only approach significance for the anterior permanent tooth total (Table 2). By developmental zone there is a consistent decrease in mean height Z-score with hypoplasia (Figure 3). This decrease ap-

Table 3. Mean socioeconomic status (SES) scores for individuals with and without linear enamel hypoplasia on permanent teeth.

	LEH $\bar{X}$	(s.d.) (n)	no LEH $\bar{X}$	(s.d.) (n)	T value	2-tail P
Maxillary I1	211.4	(103.7) (92)	238.0	(106.5) (190)	2.00	.047
Maxillary I2	210.6	(109.9) (37)	232.1	(105.5) (245)	1.15	.252
Anterior Teeth	217.1	(103.8) (118)	238.1	(107.2) (164)	1.66	.099

proaches significance at the next to last zone (37 to 44 months) and is significant at the most cervical zone (45-52 months).

Socioeconomic Status.

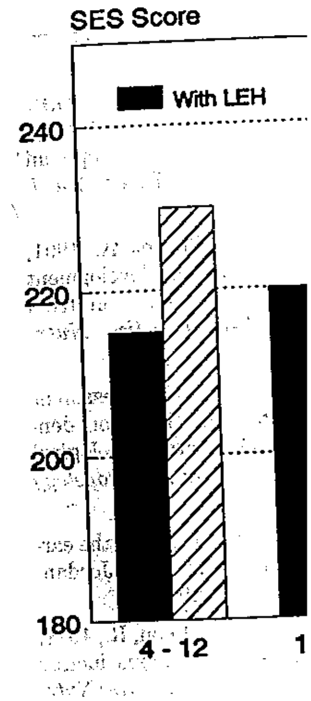
A consistent decrease in socioeconomic status (SES) in seen in those with hypoplasia versus those without hypoplastic defects (Table 3). The decrease in SES of those with hypoplasia approaches significance for the permanent anterior tooth total and is significant for the upper central incisor.

By developmental zone there is a consistent decrease in SES mean with hypoplasia (Figure 4). Very similar to the data shown above for the anthropometric measurements, this difference is greatest for the last two developing zones.

Discussion.

While hopefully a step in the right direction, this study provides a highly imperfect measure of the association between LEH and socioeconomic or nutritional status. First, sample sizes are limited by missing data, especially for height measurements (Table 2). This has surely contributed to the unevenness of the results. Secondly, the anthropometric measures are cumulative indicators of nutritional status, while dental defects may be due to relatively short term events. Third, this study is not prospective. Growth and socio-economic status are not measured during tooth crown formation.

Despite the limitations inherent in this study, the degree of association between LEH and nutrition and socioeconomic status reaffirms the notion that LEH is related to general conditions of life. These data are consistent with prior experimental and epidemiological data on hypoplasia and nutritional status. Sweeney & al. (1971) have linked deciduous hypoplasia to second and third degree malnutrition, measured by growth status, in Guatemalan children. Enwonwu (1973) has similarly found clear associations between socioeconomic status and severe hypoplasia in deciduous teeth of children in Nigeria. This study extends from Sweeney's



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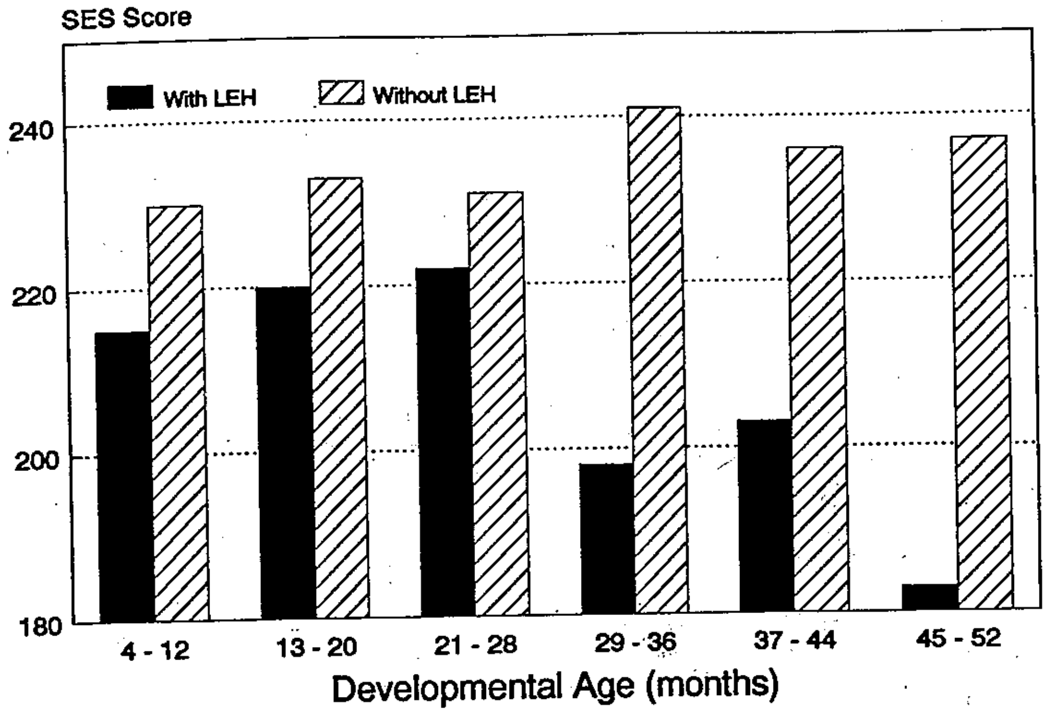

Figure 4. Comparison of mean socioeconomic status (SES) score for individuals with and without linear enamel hypoplasias (LEH) on developmental zones of the upper central incisor.

and Enwonwu's in focusing on permanent tooth defect, a less severe degree of malnutrition and, we believe, less severe hypoplasia.

The pattern of results, with strongest associations for hypoplasia occurring during 3 to 4.5 years of age, may be due to: (1) the more recentness of these defects compared to LEHs occurring right after birth, (2) their lower rate of occurrance or (3) an increased stress necessary to cause these defects.

We have recently been able to prospectively follow another group in Mexico (Goodman & al., 1991). Some of these children, from Tezonteopan, Mexico have received daily nutritional supplements, and therefore, their nutritional status is much better than their peers. Those with improved nutritional status have about half the prevalence of LEH as their non-supplemented peers. Here as well, the greatest difference between supplemented and non-supplemented adolescents is found in the prevalence of hypoplasia developing after about 30 months (Goodman & al., 1991).

In conclusion, this study has reaffirmed the notion that hypoplasia are related to general conditions of life in marginal environments. It is our hope that studies of enamel defects in living populations will both help us to understand the significance of these defects in prehistory and will become important in their own right as tools for understanding the stresses of contemporary conditions.

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