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DENTAL FINDINGS IN A NUTRITIONAL STUDY OF SCHOOL CHILDREN IN FIVE GUATEMALAN HIGHLAND VILLAGES

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THERE are few published reports of the incidence of dental caries and other dental conditions from the Central American area. In view of the wide environmental, racial, and dietary variations encountered in this relatively small region, systematic dental studies comparing different groups should contribute to an understanding of etiological factors. Caries has been reported to be exceedingly prevalent in Nicaragua,[1] and a recent survey of 137 families in the rural zone of Turrialba, Costa Rica, revealed a very high DMF rate.[2] The only previous study from Guatemala[3] showed 5.4 DMF teeth per person in children 6 to 14 years of age in Guatemala City.

During nutrition surveys, workers of the Institute of Nutrition of Central America and Panama (INCAP) found the teeth of school children in the highland department of Sacatepéquez, adjacent to Guatemala City, to be relatively good.[4] The present study uses some of these data and by additional examinations confirms this impression. The dental findings are also compared with some of the laboratory, dietary, and other clinical data available on the same children.

MATERIAL AND METHODS

Four hundred forty-two school children from 6 to 14 years of age were examined in five villages near Antigua, Guatemala, in the Department of Sacatepéquez. All of the villages were located between 4,700 and 6,800 feet and were within one hour's drive of Guatemala City. In the diets of these children an average of nearly 65 per cent of the protein and 70 per cent of the calories came from whole corn consumed in the form of tortillas.[5] Since these tortillas are made by a lime process, considerable additional calcium is introduced into the diet. The average daily calcium intake varied from 520 to 810 mg. per child depending on the village. The diets are exceedingly low in vitamin A and riboflavin as well as in animal protein and fat. The intake of calories, thiamin, and niacin appears to be adequate. The height and weight of these children are 2 to 3 years retarded by United States standards.[6-8] Their bone ages, as read from x-ray films of the wrist,[9] are 1 to 2 years behind the standards of Greulich and Pyle for the United States.[10]

With the help of a dental explorer and tongue depressor, each child was examined for the presence of decay and gingival lesions as well as any malformations or malpositions which might be present. As suggested by Blackerby,[11] a decayed tooth was defined as one with a demonstrable area of caries

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on one or more surfaces. Pits and fissures were considered carious only if they could be definitely penetrated by the explorer. None of the children had received dental care so that apart from the normal loss of deciduous teeth, missing and filled teeth were not tabulated. Gingival lesions were noted as present or absent and their type indicated.

Blood samples were drawn from the majority of these children and refrigerated immediately after being taken. They were delivered to the laboratory within 6 hours for aliquoting and freezing. The blood serum of these samples was analyzed by micromethods for total protein,[12] vitamin A and carotene,[13] total tocopherols,[14] alkaline phosphatase,[15] riboflavin,[16] and ascorbic acid.[17, 18] The method for ascorbic acid was modified by using a solution of copper sulfate and thiourea instead of norite as a reducing agent.

RESULTS

In Fig. 1 the total incidence of caries at each age is shown for children in each of the 5 villages. The number of children in each age group in a single village is often too low to justify conclusions regarding differences among villages. However, the children tend to enter school with 4 or 5 carious teeth and leave at age 12 with 1 or 2 carious.

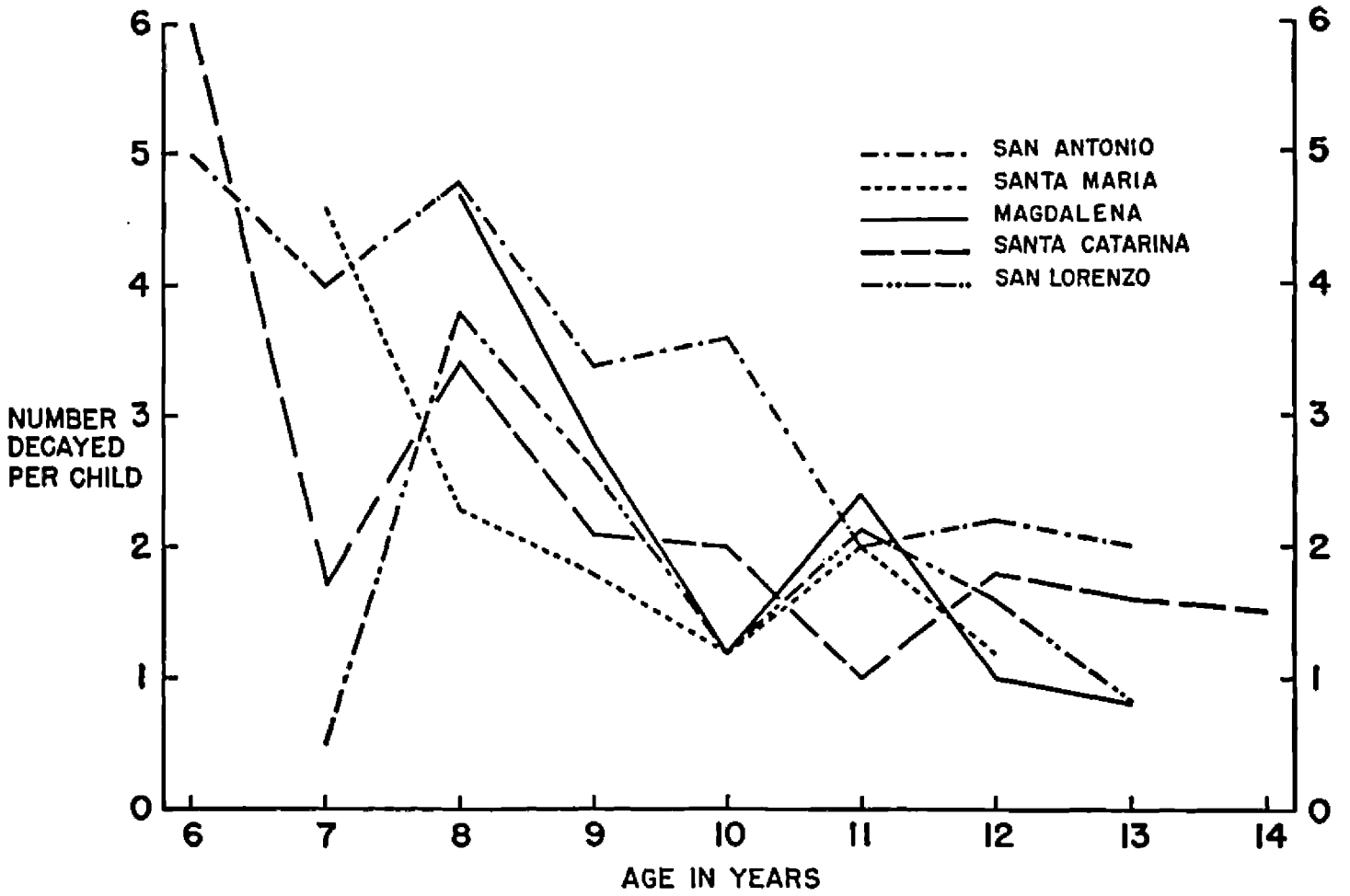

Fig. 1.—Age differences in the incidence of caries in children in five rural Guatemalan villages.

In Fig. 2, the rate of caries in deciduous teeth is shown separately from that in the permanent teeth for children in 3 of the villages. Most of the caries in this age group occurs in the deciduous teeth and, as these are lost,

the total amount of caries decreases, as shown in Fig. 1. However, there is a steady increase in the incidence of caries in the permanent teeth from the time of their first appearance at age 6 to 7, although the total, even at age 13, is less than 2 per child.

The boys appear to have a higher rate of caries in their deciduous teeth and a lower rate in their permanent teeth than the girls. However, the number of children in each group is small and the variation among them considerable so that neither the comparisons by age and sex groups nor the overall comparisons are significant at the 5 per cent level when the chi square test is applied.

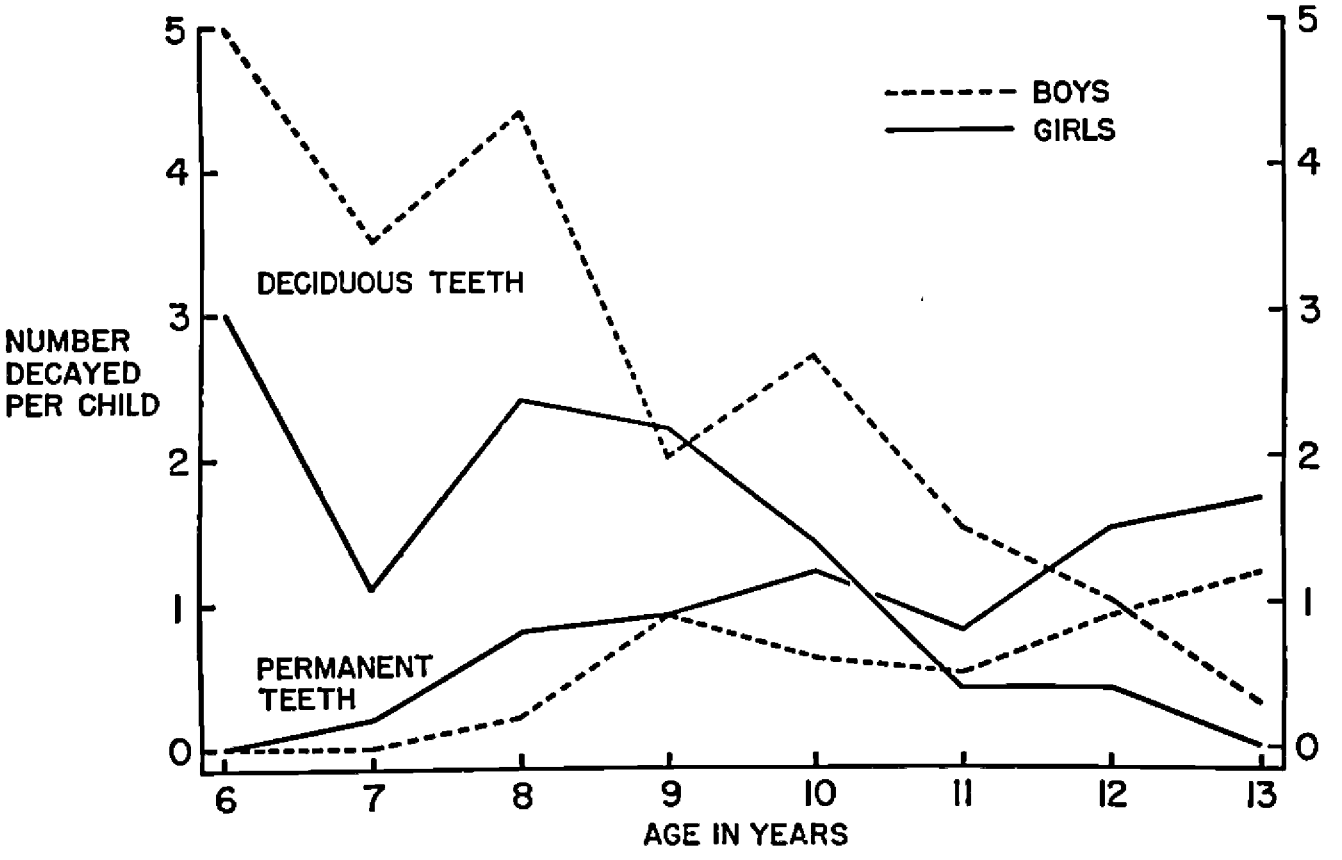

Fig. 2.—Incidence of caries among children of three rural Guatemalan villages.

It is of interest that, at 7 years, one-half of the boys have lost their deciduous incisors and the permanent incisors are beginning to appear, whereas almost all of the girls still have their deciduous incisors at this age. However, at age 12, 41 per cent of the girls have changed all of their teeth and only 26 per cent of the boys have done so. In comparisons with United States standards[19] the eruption of teeth in both boys and girls was found to be retarded at least 1 year.

In Table I the data obtained from examination of the gingivae of the children in all 5 villages are listed together with the number of children in each age group. Nearly all of the cases recorded represent local gingivitis associated primarily with poor dental hygiene. In no age group do more than 10 per cent of the children show gingivitis. No cases were encountered in which systemic disease or nutritional deficiencies were suspected as primary etiological factors.

An attempt was also made to relate serum protein and vitamin levels determined as part of the general nutrition studies of INCAP in these villages

TABLE I. AGE AND DISTRIBUTION OF GINGIVAL LESIONS IN CHILDREN IN FIVE GUATEMALAN HIGHLAND VILLAGES

AGE	NUMBER EXAMINED		GINGIVAL LESION		TOTAL PER CENT
	BOYS	GIRLS	BOYS	GIRLS	
6	1	2	0	0	—
7	14	13	0	1	3.7
8	37	21	4	0	6.8
9	40	38	2	1	3.8
10	45	29	4	1	6.7
11	41	24	1	2	4.6
12	49	31	3	4	8.7
13	34	17	3	1	7.8
14	6	0	1	0	—
Total	267	175	18	10	6.3

to the incidence of gingival and dental lesions. In Table II children free from caries and those with one or more carious teeth are compared in respect to total protein, riboflavin, vitamin C, carotene, vitamin A, vitamin E, and alkaline phosphatase. The levels of each nutrient for each of the 2 groups were compared by means of the t test,[20] but no differences reaching the 5 per cent level of significance were found. Similar comparisons for children with and without gingivitis also failed to reveal significant differences in the blood constituents.

TABLE II. SERUM VALUES IN SCHOOL CHILDREN WITH AND WITHOUT CARIES IN FIVE GUATEMALAN HIGHLAND VILLAGES

		BOYS		GIRLS	
		WITH CARIES	WITHOUT CARIES	WITH CARIES	WITHOUT CARIES
Total protein (Gm. %)	$\bar{x}$	7.27	7.23	7.42	7.43
	s	0.47	0.39	0.46	0.47
	N	76	33	43	34
Free riboflavin (μg %)	$\bar{x}$	1.39	1.68	2.10	1.59
	s	1.07	1.29	1.37	0.65
	N	76	33	43	34
Ascorbic acid (mg. %)	$\bar{x}$	1.32	1.30	1.22	1.23
	s	0.36	0.50	0.36	0.40
	N	76	33	43	34
Carotene (μg %)	$\bar{x}$	111.8	106.3	109.1	106.8
	s	45.5	37.6	56.4	61.7
	N	115	49	63	42
Vitamin A (μg %)	$\bar{x}$	25.2	26.6	24.8	25.6
	s	7.2	8.2	8.5	7.2
	N	111	49	63	42
Vitamin E (mg. %)	$\bar{x}$	0.55	0.54	0.45	0.47
	s	0.26	0.17	0.22	0.32
	N	71	32	34	31
Alkaline phosphatase (u. mm.*)	$\bar{x}$	6.70	5.65	5.95	7.42
	s	3.02	2.60	2.49	3.16
	N	76	33	42	34

*1 millimolar unit = 1.79 Bodansky units.

DISCUSSION

Despite poor dental hygiene and relatively deficient diets, the incidence of dental caries in primary school children in the highland area of Guatemala studied appears to be relatively low. Detailed dietary surveys show the diets of these children to be markedly deficient in vitamin A and animal protein and moderately so in riboflavin. On the other hand, the diets, consisting as they do primarily of whole corn consumed in the form of tortillas, are relatively high in crude fiber and contain little free sugar or refined carbohydrates. Lime is added to the corn before it is soaked to soften it for grinding, and sufficient remains to make a significant contribution to the total calcium content of the diet, which seldom falls below 0.5 Gm.

The diets of children in areas of Central America in which the lime process is not employed are, in general, severely deficient in calcium since the milk consumption throughout the area is very low. This is true for children in Turrialba, Costa Rica, where a high incidence of dental caries was found.[2] Another important difference in the diets of the Costa Rican children is the much higher percentage of calories from refined carbohydrate sources, especially panela, a crude brown sugar which furnished an average of 22 per cent of the calories for families in the rural zone of Turrialba.[21] With the increase in calories derived from sugar and other refined carbohydrates, a decrease in the crude fiber content of the diet occurs. Whether or not these are the important contributory factors to the relatively low incidence of dental caries in the present study compared with reports from other regions cannot be stated with certainty.

As part of the nutrition studies of INCAP, unusually extensive blood studies were carried out for essential serum nutrients. These values are within normal limits for the United States except for the serum vitamin A and carotene levels, which tend to be low, and those for ascorbic acid, which tend to be high. When mean serum levels for total protein, riboflavin, carotene, vitamin A, vitamin E, and alkaline phosphatase, the last as an indicator of vitamin D activity, are compared by means of the t test for children with and without caries, no significant differences are encountered. The number of children is sufficiently large that differences might reasonably have been detected if they had occurred.

An attempt was also made to relate differences in incidence of caries and gingival lesions among the 5 villages to observed differences in the dietary habits. This was not successful because the differences observed among the villages as a result of dental and dietary examinations were not in themselves significant except for a somewhat higher animal protein consumption in Magdalena. This latter did not seem to be reflected in the results of the dental and other examinations. The tendency for sex differences in the caries incidence to occur in the data may be attributable to differences in the dietary and work habits of the girls. Since the former did not prove statistically significant, the matter was not investigated further.

It is possible that differences in the fluorine content of the water supplies had some influence on the survey results. The fluorine content of the waters used in 3 of the villages has been studied with the following results: Santa María, 0.4 ppm, San Antonio 0.5, and Xenacoj 0.7.[22] The same author reported a range of 0.4 to 0.9 for 18 villages in the Department of Sacatepéquez. Dental mottling attributable to fluorosis was not observed and has not been reported in Central America.

It has been claimed by some workers that an inverse relationship exists between the amount of sunshine and susceptibility to dental caries.[10, 23-26] The children of the Guatemalan villages studied are exposed to considerable sunshine since the average number of sunshine hours per year from 1950 to 1953 was 2,400.[27]

It should be noted that the relatively good teeth found in these school children are no indication that the same is true of the adult population. Although the incidence of dental caries in the adults in this area has not been studied, it is apparent to anyone working in the villages that the adult dental status is very poor. This may be due to the neglected accumulated effects of a relatively low rate of caries, differences in dietary and other habits in the adults, or poor dental hygiene in any combination.

SUMMARY

Four hundred forty-two school children, 6 to 14 years of age, in 5 rural highland villages in Guatemala were examined for dental status and gingival lesions as part of a general nutrition study which included dietary surveys, physical examinations, hematologic studies, and serum protein and vitamin determinations. No filled or extracted teeth were found. The incidence of caries in this group averaged 2.4 per person. In deciduous teeth the incidence fell gradually from a high of 5 in boys and 3 in girls at age 6 to 0.3 in boys and 0 in girls at age 13. In permanent teeth the incidence at 13 years was 1.7 for girls and 1.2 for boys. These differences between boys and girls are not statistically significant at the 5 per cent level. Gingival lesions varied from 3.7 per cent at age 7 to 9.8 at age 13 and were almost entirely local in nature due to poor dental hygiene.

The average retardation of over 1 year in eruption of permanent teeth was paralleled by over 1 year's retardation in bone age as compared with United States standards and over 2 years' retardation in height and weight. Malpositions or malformations were observed in only 10 of the children. It is thought that the extremely low percentage of refined carbohydrate in the diet may help to explain the relatively low caries incidence despite obvious deficiencies of vitamin A, riboflavin, and animal protein. No significant difference in the levels of serum protein, vitamin A, carotene, ascorbic acid, free riboflavin, and alkaline phosphatase was observed between children with and without dental caries.

Miguel A. Guzmán furnished the serum vitamin values quoted and rendered valuable assistance in the preparation of the report. Data from the clinical examinations made

by Drs. J. Antonio Muñoz and Fabio Castillo F. are also used. The assistance of other members of the Nutrition Field Team of the Guatemala Ministry of Health and personnel of INCAP is gratefully acknowledged.

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