

Dental Surveys in Relation to Nutrition

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In the past, most dental surveys have been concentrated upon dental caries, and no other phase of study has received more attention than the relation between this disease process and the nutrition or diet of the individual, or of the population group in which he has been found. Nonetheless, no consistent association of dental caries with a deficiency of any known nutrient has been established. The evidence from population studies has been interpreted by at least one reviewer as indicating "no correlation between nutritional status in a group of persons and the prevalence or incidence of dental caries within the group, unless group subsistence stands at, or barely above, the level of starvation." At such low levels of subsistence, caries is usually reported as minimal or absent (1).

All of the survey indices commonly employed

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are cumulative, irreversible measures of lifetime caries experience (2); there is no simple, dependable method for determining, in the field, whether caries is presently active or inactive in any individual. The difficulties in relating this lifetime of experience with present (and possibly transient) dietary or nutritional states are obvious. But if nutritional deficiency is cariogenic, it is difficult to explain why the lifetime caries experience is virtually nil among some populations despite a traditional diet grossly inadequate in one or more of the essential nutrients. In one comprehensive review Shaw (3) cites studies in which low caries prevalence was found in populations with diets or nutritive states low in vitamin D, in vitamin A, in the "vitamin B-complex," in vitamin K, in calcium, and in phosphorus.

Conversely, a high prevalence or incidence of caries is not invariably associated with diets low in quality. Collins, Jensen, and Becks (4) have shown that essential food elements were no more deficient in the diets of 122 college students who were experiencing rampant dental caries than they were in a group virtually free of caries. An inference about the nutritive status of a population, then, based solely on its experience with dental caries, is quite likely to be false.

More information may possibly be gained by a study of oral soft tissues, particularly those which, with bone and associated structures, support the teeth in the dental arch. When these

periodontal tissues are diseased, the teeth loosen, become painful and ineffective in chewing, and eventually are lost. Local irritating factors, such as calculus and other debris, seem invariably associated with the process. In addition, clinical and laboratory research indicates that something in the physiological state of the individual modifies susceptibility to or progress of the disease (5), a hypothesis with some support in field studies (6). In the series of surveys reported here emphasis has been given to an effort to discover whether relationships exist between periodontal status in the groups studied and the physical, biochemical, or dietary findings returned by the several field teams of the Interdepartmental Committee on Nutrition for National Defense (ICNND).

Group periodontal status was scored by two methods. One, based on the clinical syndrome of marginal periodontitis, is reversible and responsive to treatment and ephemeral circumstance; it is appropriate for correlation with present nutritive states, as well as indicative of group prevalence of active disease (7). The other is a cumulative measure, a count of teeth involved in recession of investing tissues, suggested by Stahl and Morris (8). For simultaneous evaluation of local irritating factors, the presence or absence of calculus and of oral debris was noted in the Alaska survey. In Ethiopia the prevalence of calculus was universal and it was necessary to record the relative extent of the deposits. In subsequent surveys, a measure which takes into account the extent of oral debris and stain as well as the extent of calculus (9) was employed, modified to include six typical teeth.

All of these examinations were made with mirror and explorer. Patients were seated in a portable dental chair. In Alaska a standard examination lamp was used. In the other areas electricity was not ordinarily available and examinations were made by daylight.

Some striking differences in the prevalence or characteristics of periodontal disease have been seen, concomitant with differences in the nutritional status of the groups studied. Whether these are consistent relationships can be determined only by further analysis and the extension of study to new and appropriate populations.

Brief summaries of the first five ICNND surveys in which dental examiners have participated follow.

Alaska

Dental examinations in the Alaska survey were limited to military personnel. A total of 713 members of the First and Second Scout Battalions, Alaska National Guard, were seen in March 1958. Their ages ranged from 17 to 54 years. They were residents of 55 distinct villages, ranging geographically from Point Barrow, above the Arctic Circle, to Unalaska in the Aleutian chain of islands. The group examined included about one out of each five or six Alaskan Eskimo males in the total adult population. Their general levels of nutrition and physical condition were excellent.

There were extreme variations in dental caries prevalence, associated loosely with place of residence. Men from the principal centers of population averaged 14.5 decayed, missing, and filled (DMF) permanent teeth per person. This is about the same prevalence as has been observed in white males in continental United States at the same average age (about 30 years). Men from selected groupings of villages near the principal centers averaged 13.7 DMF teeth per person. Men in more remote villages averaged 7.1 per person, except those from the Yukon-Kuskokwim delta region, where the mean per man was 2.3. Exposure to fluoride appears not to have been a factor. A decreasing prevalence of caries with increasing isolation is not uncommon in primitive peoples; a similar pattern has been observed in Eskimos of Greenland (10), and about the same prevalence of caries was reported for the Kuskokwim area in 1936 (11, 12). In the present study, men from the high-caries villages were slightly but significantly taller than men from the relatively remote low-caries areas. They were somewhat heavier, and their plasma levels of vitamin A and carotene were significantly higher. Other differences, though generally favoring the high-caries villages, were not significant.

Despite the almost universal presence of oral calculus and debris and a relatively high (38 percent) prevalence of the marked crowding of

teeth described and photographed by Price (13), men from many of the villages showed little tendency toward the formation of periodontal pockets or loss of alveolar bone. These men were mostly residents of such isolated places as Mekoryuk, on Nunivak Island, or Shungnak, deep in the mountainous area inland from Kotzebue. There was some tendency for their excretion of thiamine and riboflavin to be higher (though plasma vitamin A levels were generally lower) than those of men in the larger settlements. In these larger villages the groups showed about the same patterns of periodontal disease as white males of Baltimore. No relation with plasma vitamin C levels could be demonstrated.

In men aged 35 years or older, alveolar recession followed the same geographic distribution as caries, with men in the isolated villages showing significantly less bone resorption than men in the principal towns.

Ethiopia

Of the five surveyed area groups, the Ethiopians showed the lowest prevalence of dental caries.

Dental caries in 1,085 Ethiopians, 1958

Age group (years)	Number examined	Mean DMF teeth per person	Percent free of caries
5-9	62	0.13	90
10-14	310	.18	88
15-19	197	.21	86
20-29	209	.39	78
30-39	124	.69	66
40-49	85	1.31	57
50 and over	98	2.86	48

This study, carried out solely with civilian men, women, and children, was conducted during the fall of 1958. A total of 1,085 persons, ranging in age from 5 through 84 years, were examined. The dental sample had representation from each of the major ethnic groups and was obtained from 26 sites in 8 geographic regions of the country.

The prevalence of caries is summarized in the table.

Seventy-seven percent of the people examined were free of dental caries, and individuals under 40 years of age averaged less than one decayed, missing, or filled permanent tooth per person. No individual in the sample was completely edentulous and only seven had received restorative dental care. There was evidence of very mild dental fluorosis in the teeth of persons living in some locations of northern Ethiopia and Eritrea, but fluoride ingestion does not appear to explain the uniformly low occurrence of dental caries (14).

The diet of these people was considered to be deficient in total calories, marginal in protein, and high in carbohydrates. The consistency of the diet was soft. The use of refined carbohydrate (sugar) was limited. Mean numbers of DMF teeth appeared to be directly related to the reported frequency of sugar, jam, and honey consumption, as obtained from a questionnaire survey administered by the dietary group.

In contrast to the low prevalence of dental caries in this population, the prevalence and severity of gingival and periodontal diseases were relatively high. The usual clinical finding was one of moderate to severe gingival inflammation with widespread periodontal pocket formation after the age of about 30 years. No differences appeared to be related to ethnic origin or geographic area. Abundant deposits of soft debris and calculus were present about the teeth in virtually all mouths examined. The extent of these deposits was directly related to the condition of the periodontal tissues.

Biochemical determinations were available from about 250 individuals included in the dental sample. Evaluated by ICNND criteria (15), 36 percent of the ascorbic acid levels and 5 percent of the vitamin A levels in the serum were low or deficient. Urinary excretion values for thiamine, riboflavin, and N'-methylnicotinamide were all acceptable or high. Within these ranges and as measured by these methods, there was no relation between variations in these values and periodontal lesions.

Peru

The study in Peru was concerned solely with the armed forces. It was conducted during the months of February, March, and April 1959.

During the survey, dental examinations were given to 1,500 men as part of a detailed physical examination in military installations located in seven different geographic areas. The majority (942) of these men were in the age range of 20-24 years, 458 were age 19 years and less, the remainder, age 25 years and older.

Forty-four percent of the men examined had served less than 6 months and 47 percent had from 6 to 24 months of military service. Since these men had lived most of their lives away from the military reservation, the data were tabulated by their previous place of residence as well as by place of examination. Residence areas were grouped as indicated by previous dietary studies (16-21).

The preliminary data reveal that, both by place of residence and place of examination, individuals in and from the southern Sierra had the lowest dental caries experience, averaging about one-fourth to one-fifth of what might be expected from a comparable age group in a low-fluoride area in the United States. Of the troops examined in the Puño-Cuzco area of the southern Sierra, 99.8 percent had lived in the same area prior to induction. Most of the troops examined in this area were descendants of the Inca Indians and were accustomed to strenuous activity at high altitudes. The cereal quinoa, an excellent source of natural proteins, was a typical dietary item in this area. The possibility that quinoa may have caries-inhibiting properties is currently under investigation through animal experimentation conducted at the National Institute of Dental Research, Public Health Service.

Periodontal conditions did not vary appreciably by place of residence, and approximated those reported for persons with 8 years of school or less in Birmingham, Ala. (6). By place of examination, periodontal scores ranged from a low mean of 0.7 per man at Lima to a high of 1.5 per man at Puño-Cuzco. These periodontal values bear an inverse relationship to the DMF means in these areas.

The wear or attrition of teeth was found to be highest among troops examined in the Puño-Cuzco locations, and may be related to food preparation. In villages of the southern Sierra, meal is frequently ground between a stone slab and a stone roller, thereby incorporating

fine abrasive granules into the final food product.

Navy and Air Force enlisted personnel, including a high proportion of skilled technicians of urban origin, scored more favorably on periodontal and oral hygiene status than Army enlisted personnel, a high proportion of whom are relatively unskilled persons of rural origin. Army personnel, however, had considerably lower DMF scores.

Recession of the gums was seen so rarely under the age of 25 years that it was not tabulated, and no cases of what might be considered a functional malocclusion were observed although some crowding of anterior teeth was noted occasionally.

Ecuador

Examinations of 4,975 Ecuadorians ranging in age from 1 to 87 years were carried out during the summer of 1959. Of these, 2,947 were civilians and the remainder, military personnel. Each of the 18 Provinces was represented in this sample.

Dental caries prevalence in the whole population group did not differ greatly from prevalence levels reported for Baltimore, Md. (22). The heterogeneity of the Ecuadorian sample is indicated by the variation in dental caries means from different areas of the country. The highest prevalence was recorded for civilians in the northern (Tulcan-Ibarra) and southern (Loja) regions of the Sierra where the average number of decayed, missing, and filled permanent teeth per person was 11.56 at a mean age of 26.8 years. At the other extreme was the strikingly low prevalence of caries found in the Jivaro Indians living in the eastern jungle. The 52 Jivaros examined, averaging 26.5 years of age, had a mean of 1.25 DMF teeth. For the females the mean was 2.18 at an average age of 26.7 years, and for the males the mean was 0.57 at an average age of 26.2 years. No fluoride was found in the water samples collected in the Jivaro territory. The diet of these people is very simple, consisting primarily of yuca (cassava) and platanos (cooking banana) with occasional wild game and generous helpings of chicha (a native beverage made of yuca and sweet potato, boiled and fermented).

In the central Sierra region, including the cities of Ambato, Latacunga, and Riobamba, dental caries prevalence was significantly lower than the average for the rest of the country. For persons of all ages from other areas (with a mean age of 21.5 years) the average number of decayed, missing, or filled permanent teeth was 8.6. For persons in the central Sierra region (with a mean age of 24.9 years) the average was 5.2 DMF teeth, a difference of 40 percent. In the 20- to 24-year age group the difference between the two areas is 65 percent. This lowered prevalence of dental caries probably is attributable to differences in the fluoride intake between the two groups. Analyses of water, urine, and food samples show that the people in the central Sierra were ingesting amounts of fluoride which were more than adequate for caries inhibition. In fact, the intake of fluoride was much more than the optimal amount since mottled dental enamel was quite prevalent in this area. In contrast, water samples collected from other areas of the country were consistently low in fluoride.

The area of the country (Loja) having the highest caries prevalence also had the highest consumption of sugar, according to the questionnaire survey done by the dietary group.

Females examined in Ecuador had a higher average number of decayed, missing, and filled permanent teeth than the civilian males of the same ages. The difference was greatest in those over 20 years of age.

Periodontal disease scores for all persons examined were higher than those recorded for equivalent ages in the 1954 Baltimore study. Scores for civilians in the 30- to 39-year age group averaged 1.39, while the average score for the same group in Baltimore was 0.70. There were considerable variations in the periodontal scores by location within the country. Disease was recorded as being most extensive in the northern (Tulcan-Ibarra) and southern (Loja) Sierra regions and least extensive in the eastern jungle (Sucua). This geographic distribution was similar to that seen for dental caries.

Approximately 22 percent of the 30- to 39- and 56 percent of the 60- to 69-year-old dentulous civilians examined in Ecuador showed obvious clinical signs of alveolar bone loss with

pocket formation. Of the 30- to 39-year-old males, 68 percent of the military group and 95 percent of the civilians were recorded as having positive signs of gingival inflammation.

Vietnam

The Vietnam survey was carried out in October, November, and December of 1959. As this is being written, analysis of the data is still in the preliminary stage.

Civilians comprised about 65 percent of the sample of 3,700 persons. Dental caries prevalence was low in both civilian and military populations, only slightly higher than that reported for Ethiopians. Periodontal disease was universal in prevalence, and particularly severe and destructive in mountain tribesmen of villages in the central highlands.

Two customs of the people complicated the scoring for dental caries. One, seen in all areas, was the practice of placing gold shell crowns on sound teeth for decorative purposes or as insurance against burial expense. These were ornamented on the facial aspect with cutout designs, most frequently heart shaped, sometimes inlaid with colored plastic or celluloid. An attempt was made, through interpreters, to determine whether these crowns were restorations of carious teeth or purely cosmetic in purpose, and the latter were tabulated separately. On either tabulation, DMF means were minimal. Excluding these gold crowns, the mean number of decayed, missing, and filled permanent teeth for military males of all ages was about two per man. Inclusion of the cosmetic crowns raised the mean per man to about 2.70.

The second custom was observed only in the mountain villages. During puberty rites anterior maxillary teeth had been filed off through the pulp chamber to the level of the gum line; in one area mandibular anterior teeth had been filed to points as well. In this last district the filed stumps were generally carious or, in many instances, had been exfoliated. Elsewhere the filed stumps tended to be free of caries. For the 180 individuals 20 years of age or older in these villages there was an average of 5.3 filed teeth per person. Mean numbers of decayed, missing, and filled permanent teeth were 4.1 if cosmetic crowns and filed teeth were

excluded, 4.4 with inclusion of the crowns, and 9.7 with both crowns and filed teeth included.

The higher basic DMF mean in the mountain people was apparently due to an accelerated loss of teeth from periodontal disease rather than to an increased prevalence of caries. While it was particularly severe in these people, periodontal disease was widespread in the general population as well. Heavy deposits of calculus were present in the mouth of nearly every person aged about 12 years or older. In many of the older people teeth had been coated with a black, relatively permanent lacquer. This was believed to have some protective effect. Betel chewing was a common habit.

The diet was generally soft in consistency. The staple foodstuff was rice, usually highly milled, augmented with vegetables, fish and occasional fowl, rarely with beef or pork. There were indications of deficient or marginal intakes of vitamin A, thiamine, and riboflavin in some areas. Patients with clinical beriberi were not uncommon in hospitals.

Discussion

No consistent patterns of association between nutrition and oral status have been developed in these data, so far as they have been analyzed at this time. Lowered caries prevalence in Ecuadorian adults was related to optimal or high intakes of fluoride. Both high and low levels of caries experience were seen in Eskimos in Alaska with high intakes of animal protein, moderate intakes of fat, and very low intakes of carbohydrates, with generally low plasma levels of vitamin A. Caries prevalence levels as low or lower were seen in Ethiopians on a comparatively low-protein, high-carbohydrate cereal diet, high in thiamine; and in Vietnamese on a diet in which highly milled rice was the staple cereal, yielding only marginal amounts of thiamine and riboflavin. Large proportions of individuals in each group had remained caries free from birth to the time of examination.

If caries prevalence levels were generally low by U.S. standards, the prevalence and severity of periodontal disease were correspondingly high. The only areas where periodontal disease was importantly less prevalent than in the United States were found in Alaska, in men

whose thiamine excretion was somewhat higher, and whose levels of plasma vitamin A were somewhat lower than those for other men in that study; and in the primitive Jivaro Indians examined in Ecuador. Elsewhere in Alaska, and generally in Peru, disease levels were comparable with those seen in United States, among people of low socioeconomic status. In Ethiopia, Ecuador, and Vietnam, prevalence levels were much above any so far recorded for the continental United States.

The analysis of relations within and between these studies is continuing. Detailed reports are to be prepared as these analyses are completed.

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The five leading countries in terms of number of abstracts and citations published are as follows:

	<i>Abstracting- indexing services</i>	<i>Abstracts and citations per annum</i>
United States	73	753, 160
Germany	45	196, 300
Great Britain	36	162, 140
Russia	5	159, 100
France	44	158, 900

English is the language of 120 of the abstracting-indexing services, which together publish more than 1 million abstracts and citations each year. Ger-

man, French, and Russian are each the language of between 150,000 and 200,000 items. Forty-nine journals carry items in German, 50 in French, and 5 in Russian. Four services publish some 92,000 items in Japanese.

How close these many services come to providing complete coverage of the literature is not known. Overlapping in coverage, certainly in the English language, however, must be considerable, for the total annual publication of biological and medical articles is estimated at less than 400,000.

Abstracting and indexing periodicals are described in a recent publication of the World Health Organization entitled "Current Indexing and Abstracting Periodicals in the Medical and Biological Sciences," issued as a supplement to volume 12 (1959) of *Library News*.