

DENTAL CARIES IN THE PANAMA CANAL ZONE¹

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In this paper will be reported the results of a dental caries survey² carried out on school children of the Panama Canal Zone, showing rather astonishing affects of migration and continued residence there by American children. Much has been written about the low incidence of dental caries among tropical natives living on primitive diets and its marked increase when white flour, salt, sugar, and other processed foods come into common use. Similar caries behavior has been described for primitive people living at all latitudes from equator to pole. No carefully conducted caries survey has yet been reported, however, to show how caries incidence might differ between tropical and temperate zone residents living under similar economic and health conditions but in more civilized states. Nor have any statistics been reported showing what influence migration from a temperate to a tropical climate might have upon caries prevalence.

In view of the unique conditions existing in the Canal Zone, it seemed desirable to compare caries prevalence there with that existing in the temperate zone homeland from which most of the Canal Zone white residents had migrated. The Canal Zone population offers the one large mass of white tropical residents who have migrated from the temperate zone to live in the tropics under general health conditions fully as good as exist in the best temperate zone communities. Efficient sanitation in the Zone and adjacent populated portions of the Republic of Panama keeps the incidence of malaria and other tropical diseases down to insignificant levels, while the even and rather mild tropical climate of the Isthmus promotes a much lower incidence of respiratory illness than is found in the most healthful regions of middle temperate latitudes of North America. Except for fruits, fresh green vegetables, and some tubers, the white Canal Zone residents eat food imported from the United States (except fresh beef, which is mainly native or, at a much higher price, from the United States). Milk is produced in ample amounts at the large Mindi Dairy, from cows which have been imported from the United States and fed on ample amounts of imported foods mixed according to the best scientific formula.

The Canal Zone therefore offers almost an ideal opportunity to study the effects of residence in a tropical climate, without having the direct effects of

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climate obscured by a high prevalence of infectious and parasitic diseases so common in unsanitated tropical areas. Malnutrition in the usual sense is obviated by use of highgrade imported foods. Into this protected tropical area has gone a continuous stream of migrants from the United States, with a marked increase in this movement in the recent years of new lock construction and defense force expansion. The Zone population thus offers a chance to study the effects of varying periods of tropical residence, and includes a considerable number of people who have resided in the Zone since birth. Close assay of this population mass for direct and largely uncomplicated effects of tropical climate may give information of great biologic importance.

METHODS AND RESULTS

School populations, where attendance is almost universal, offer the best basis for regional comparison of caries prevalence. The recent survey conducted by the U. S. Public Health Service among the school children of some 28 states (1) provided a valuable yard-stick of caries incidence, so we attempted to conduct the Panama survey in an exactly similar manner. Examination was made in a regular dental chair, using probes, mirrors and good natural lighting. Any suspicious cavity that would take the probe and support it in position unheld was recorded as caries. Individual records were kept of the number of carious teeth, number of filled teeth, and the number of missing teeth in each mouth examined. Since the regional aspects of the U. S. Public Health Service survey were worked up only for the 12, 13 and 14 year old school children (2), the present report will deal only with the results obtained on these age groups in the Canal Zone. In addition to the caries record on each child, information was also obtained as to age, sex, race, birthplace, and duration of residence in the Canal Zone.

In Table I are given the data thus obtained on caries incidence in the Canal Zone. Contrary to the prevailing belief in low tropical incidence of caries, the American children born in Panama are seen to show a sharply higher caries incidence than do children recently arrived from the United States. Little change in the caries rate takes place during the first two years' stay of migrants to the Canal Zone, but with longer residence caries tends to become almost as prevalent as in Canal Zone-born children. Native Panamanian children exhibit almost as much caries as do the Americans born there.

Since the Canal Zone population is practically all urban in character, its caries incidence should be compared with that of urban residents of the United States. In the study of Mills (2), there was shown a strong latitude gradient in caries prevalence within the United States, with a steady northward increase in caries rate from about 2.7 (per mouth of 12-14-year-old school boys) in the Gulf States cities to 5.9 in cities of the northernmost states. Since a majority of recent migrants to the Canal Zone were formerly residents of northern states the caries rates here reported for children residing less than one year in the Zone are not significantly different from those of school children of similar ages in their states of origin. Rates for negro school children in the United States always average

TABLE I
Dental caries in the Canal Zone
(12, 13, and 14 year old school children)

	TOTAL NUMBER OF 12-13-14 YEAR OLDS	NUMBER OF PERMANENT TEETH CARIOUS, FILLED OR MISSING (PER MONTH)			
		12 year olds	13 year olds	14 year olds	12-14 year olds combined
<i>Boys</i>					
Panamanian-born Americans	82	6.60±	6.82±	8.47±	7.45 ± 0.29
American-born Americans					
Less than one year in C. Z.	104	5.57±	5.43±	6.39±	5.83 ± 0.21
1.0-1.9 years in C. Z.	54	4.13±	5.21±	6.39±	5.19 ± 0.21
Over 3 " " " "	72	5.28±	7.57±	7.21±	6.88 ± 0.30
Over 6 " " " "	56				7.07 ± 0.37
Native Panamanians	316	6.13±	6.35±	8.17±	7.04 ± 0.16
<i>Girls</i>					
Panamanian-born Americans	92	7.51±	8.51±	8.33±	8.25 ± 0.30
American-born Americans					
Less than one year in C. Z.	85	5.63±	7.24±	6.32±	6.48 ± 0.31
1.0-1.9 years in C. Z.	41	5.50±	5.83±	7.88±	6.50 ± 0.43
Over 3 " " " "	59	7.80±	6.61±	7.72±	7.12 ± 0.33
Over 6 " " " "	41				7.49 ± 0.33
Native Panamanians	343	7.00	8.28	8.02	7.28 ± 0.15

	Defective teeth per month
Pan.-born Amer. boys	7.45 ± 0.29
Amer. " " " (0-0.9 yrs. in C. Z.)	5.83 ± 0.21
Difference	1.62 ± 0.36
Odds against chance occurrence: 1 to 415.	
Amer.-born boys (0-0.9 yrs. in C. Z.)	5.83 ± 0.21
" " " (6+ yrs. in C. Z.)	7.07 ± 0.37
Difference	1.24 ± 0.43
Odds against chance occurrence: 1 to 19.	
Pan.-born Amer. girls	8.25 ± 0.30
Amer.-" " " (0-0.9 yrs in C. Z.)	6.48 ± 0.31
Difference	1.77 ± 0.43
Odds against chance occurrence: 1 to 175.	
Amer.-born girls (0-0.9 yrs in C. Z.)	6.48 ± 0.31
" " " (6+ yrs. in C. Z.)	7.49 ± 0.33
Difference	1.01 ± 0.45
Odds against chance occurrence: 1 to 6.	

slightly lower than for the white, just as is seen here in comparing the native Panamanians with the Panamanian-born white children.

Evidently some factor (or factors) in the Canal Zone is predisposing to great caries activity, constituting there a health problem even more severe than is

encountered in the middle temperate regions where caries had always been considered to be at its worst. There exist various possible and probably reasons for this high Canal Zone rate, among which should be listed water supply, dietary inadequacy of vitamins and minerals, and the debilitating effect of the tropical climate itself. Each of these deserves careful consideration.

Total hardness and fluorine content of drinking waters have been shown to be inversely related to caries prevalence in city populations of the United States (2). Caries rates tend to be 30 to 40 per cent higher in children using water from surface sources (rivers and lakes) than in children drinking well water, with a rather clear inverse relationship between total hardness and caries incidence. The entire Canal Zone water supply is taken from Gatun Lake and possesses a total hardness less than 50 parts per million as calcium carbonate. Here resides one possible causative factor in the serious caries situation existing in the Zone. Fluoride addition to drinking water has been shown to diminish or prevent caries in rats fed on caries-producing diets (3), while human populations using drinking water of high fluorine content exhibit low caries rates. Natural drinking waters high in fluorine are always of high total hardness, however, so it is not clear which factor is responsible for the lessened caries prevalence. It would seem wise to consider increasing the fluorine content or total hardness (or both) of the Canal Zone water supply. The situation in the Canal Zone seems comparable to that in the Cincinnati metropolitan district, where the general caries rate for 12-14-year-old school boys is 8.2 while in Norwood (a city of over 30,000 entirely surrounded by and contiguous with Cincinnati) the rate is only 5.4. Cincinnati uses water from the Ohio river with a total hardness of 110 p.p.m. while Norwood uses well water with a hardness of 383 p.p.m.

The second factor possibly responsible in some degree for the high caries rate in the Canal Zone is dietary inadequacy in vitamins and minerals. Heavy tropical rainfall for 10 months of the year tends to leach out of the soil soluble inorganic materials and to result in vegetables with inadequate amounts of calcium and phosphorus. We ourselves undertook no studies along this line, but merely mention this possible basis for the serious caries situation in Canal Zone residents. With regard to vitamin deficiency we do have positive evidence at hand. Requirements for the vitamin B complex (in particular thiamin and pantothenic acid) have recently been shown to be sharply higher per gram of food for animals kept in tropical warmth than for those kept at 65-70°F. (4). Preliminary studies in Panama have indicated a widespread thiamin deficiency to exist there in people living on native foods. Native-grown meats and animal products seem to be much poorer sources of vitamins than do similar temperate zone products. Tropical residents thus face a double handicap—a heightened vitamin requirement but lowered availability for the B fractions. Panamanian residents of the Canal Zone buy mainly native meats, while Americans use native beef and American processed meat products of all kinds. Since caries is worse in Zone-born Americans than in Panamanian children, however, the B deficiency of native meats cannot be a factor of major importance in the caries situation.

The tropical climate itself may play a considerable part by causing widespread

undernutrition and a lowered level of general vitality in the population. Such debility arises from two different phases of climatic effects. One has to do with the above-mentioned increase of vitamin requirement faced by people or animals living in tropical heat, together with a lowered availability of at least the B complex vitamins from animal product sources. The other depends upon the enforced lowering of general tissue combustion level, as greater difficulty of heat loss is encountered by the body. With this lowered combustion level goes slower growth, retarded development, and a lowered resistance to infection. A recent height-weight survey of the Zone school children (5) has shown a progressive growth impairment of American children as their tropical residence extends beyond one year. Work on experimental animals has shown this debilitating effect of heat to persist even when all vitamins are given in entirely adequate amounts and with diets of optimal constitution. It may therefore be that tropical malnutrition, from the heat itself, may be a factor of some importance in the caries picture of the Canal Zone.

SUMMARY

From the data presented it is evident that a serious caries situation exists in the Canal Zone. Caries rates in the Zone are sharply and significantly higher than in most parts of northern United States where it has usually been considered to be at its worst. It is significantly worse in American children born in the Zone than in those migrating there from the United States.

Among possible causative factors in the situation, drinking water composition should be given first place. Caries rates are highest in those American cities deriving their water supply from river or lake sources, such water being low in both total hardness and fluorine content. The fact that the water supply for the Canal Zone is taken entirely from Gatun Lake may thus be of significance. Only in certain northern cities using river or lake water (Cincinnati, Milwaukee, Portland, Me.) does the caries rate rise as high as is here reported for the Canal Zone.

Discussion is also offered of the possible part vitamin and mineral deficiencies in food may play in the Zone caries situation, and also the possible role of tropical debility from the heat itself.

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