Absence of Dental Caries in a Nigerian Bush Village

Abstract. A surprising lack of dental decay was encountered in 600 individuals living in a primitive West African village where severe malnutrition exists. Low values of fluoride in water supplies and in deciduous teeth seem to exclude fluoride as a protective agent. Further studies of caries in this population are warranted.

In 1959, during a general medical survey (*1*) of the primitive Ibo village of Awo Omamma, in coastal Nigeria, only two small dental cavities were found in a group of nearly 600 natives, despite evidence of serious malnutrition in all age groups.

Brief mouth examinations were performed as part of a physical examination of 148 villagers, selected at random from age groups ranging from 2 years to the very aged. Data were also obtained from mouth examination of about 450 additional persons, who had been treated medically. Because no dental picks or mirrors were used, the examination was of the ADA type 4 classification. No fillings were found.

Among the 148 villagers, only one, a 4-year-old child, showed decay—two small cavities. The other 450 individuals on whom only brief records were kept showed not a single instance of decay; missing teeth were not enumerated in this second group.

A comparison between the dental pathology of the more closely studied Awo Omamma group of 148 and the mean number of decayed, missing, or filled teeth per person rates of U.S. Public Health Service beneficiaries [examined by the ADA type 3 method between 1948 and 1952 (*2*)] shows a large difference in decay rate. Children under 16 years of age in the United States had roughly 26 times the rate found in Awo Omamma children; American persons between 16 and 45 years, eight and one-half times, and those over 46 years nearly four times the rate found in the Nigerians. These differences appear to be quite remarkable despite the variation in examination techniques. The Awo Omamma rates were: under 16 years of age, 0.12; age 16 to 45 years, 1.90; and over 46 years, 6.28.

The dental pathology encountered in Awo Omamma is almost entirely outright loss of teeth. Periodontal disease is often severe and exhibits an interesting age and type distribution (see Fig. 1). In children, apparently as a result of nutritional deprivation and infection, gingivitis is a very serious problem. After middle age, chronic destructive periodontal disease is most common. Both conditions spare the middle years. The severity of destructive periodontal processes in the older age groups results in many loosened and lost teeth. In the aged, remaining teeth are usually worn to the gum line and show deep staining, but no mottling or chalky enamel.

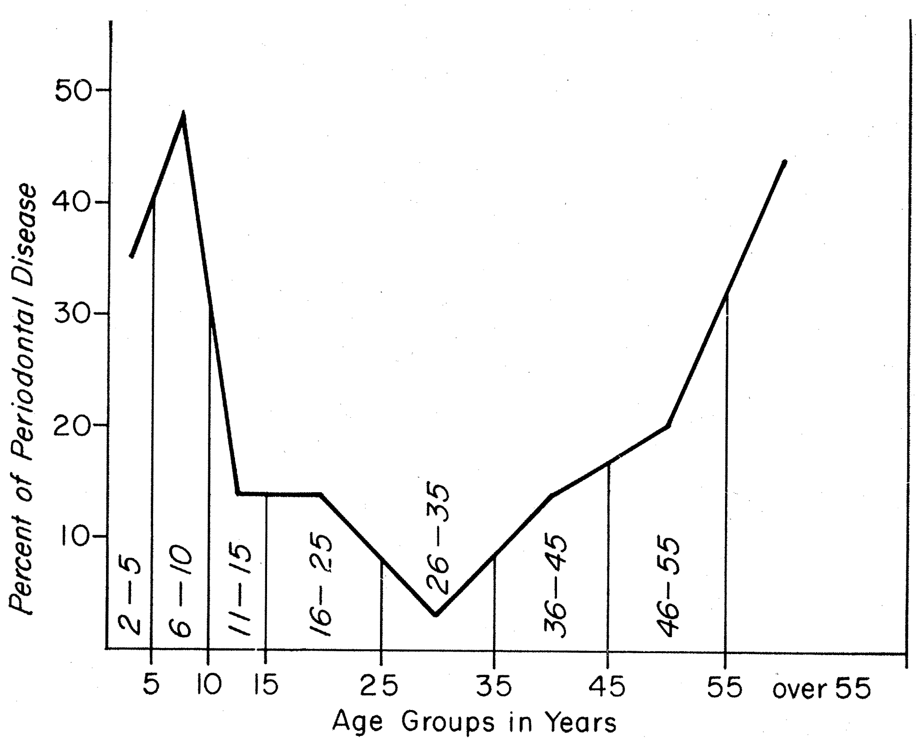

Fig. 1. Incidence (by age) of periodontal disease in Awo Omammans.

The diet of the Awo Omamma native consists of roots, chiefly yams and cassava, which are eaten with sauces, chili pepper, small amounts of green vegetables, and, occasionally, dried fish. This diet is deficient in protein, riboflavin, vitamins, and minerals, and does not include sugar, sweetened baked goods, candy, or carbonated beverages, all of which are prohibitive in cost. Milk is likewise a rarity; it is not used for infant feeding but is occasionally added to tea in sweetened condensed form.

Various water supplies were in use in Awo Omamma at the time of this survey. Characteristic specimens were taken from a deep well, a shallow well, the Njaba River, and rain water from an earthenware pot of the type generally used for household water collection. Fluoride analysis by the Scott Sanchis method (*3*) gave results of 0.3 ppm from the wells and 0.2 ppm for rain water.

With great difficulty (because of local beliefs about safe disposition of deciduous teeth) nine spontaneously shed deciduous teeth were obtained, pooled into two specimens, and analyzed for fluorine (*4*). The fluorine content of the mixed dentin and enamel was 0.008 percent, a low level indicating that there was no significant exposure to fluoride while these teeth were being developed (*5*).

A degree of dental hygiene is accomplished by Awo Omammans by chewing on the end of a small stick of wood (often from the root of the Kola nut plant, *Sterculia nitida* (*6*). The fibers are formed into a brush which can scrub effectively the surfaces of the teeth (*7*). The chewing stick is practically a daily ritual, but whether this cleansing effort plays a large part in preventing decay is unknown. However, its use, by long continued trauma to the gums, might contribute to the high incidence of periodontal disease.

Because of the remarkable lack of dental decay of Awo Omammans raised on inadequate diets and living in a low fluoride area, further attention to this population group might be rewarding in the search for specific causes of caries, particularly if oral bacteriology and salivary *p*H determinations could accompany more detailed dietary and dental studies.

The living pattern of Awo Omammans will rapidly change as community development progresses. The effect of these changes on the decay rate should be closely watched, preferably after a more detailed dental survey of the villagers has been made.

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References and Notes

1. This work was performed while I was serving as medical field consultant for the Unitarian Service Committee, Village Improvement Project, Awo Omamma, Nigeria.
2. W. J. Pelton and E. H. Pennell, *J. Am. Dental Assoc.* **49**, 439 (1954).
3. Determinations were obtained with the assistance of Shinji Soneda, sanitary engineer, Hawaii State Dept. of Health, Hilo.
4. Determinations were obtained with the assistance of Dr. Bruce Forsyth, Regional Dental Consultant, U.S. Public Health Service, and Dr. Manuel C. W. Kau, executive officer, Dental Health Div., Hawaii State Dept. of Health.
5. Water and tooth specimens were obtained by Dr. Hazel M. Hauck, professor of nutrition, Cornell University, Ithaca, N.Y., during her residence in Awo Omamma.
6. O. Nzekwu, *Nigeria Magazine* **71**, 298 (1961).
7. Many other varieties of chewing stick are in use. Commonly found are: Calabar, and in the Ibo language, Atu-ofe, Atu-uloro, Mbacara, Uda, Atu-nkpere, Atu-ubere, Mbeji, Nkpa-aku, Uguri, and Nkpa.

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Bone Density Measurements in vivo

Abstract. Measurements in vivo are complicated by physical and physiological problems. Lack of standard techniques between laboratories and confusion in terminology have prompted this report. The theory underlying the method is presented with data comparing values obtained by different methods.

One method of measuring bone density is comparison of the absorption of x-radiation by a test object with a reference object. When x-rays are absorbed by a uniform material the intensity of radiation is reduced by a constant fraction per unit length of path through the material (*linear absorption coefficient* or μ). An equivalent definition for μ is obtained when a beam of x-rays of unit area in cross section traverses unit volume of the substance. The fraction of energy absorbed when a beam of unit cross section traverses a unit mass of material is called the *mass absorption coefficient* (μ/ρ, where ρ is the density of the material). It is the same for substances of the same atomic number.

When an x-ray beam penetrates to a depth t of a reference object, the intensity is $I = I_o e^{-\mu t}$ where I_o is the intensity at the surface. For a test object, this may be expressed as $I' = I'_o e^{-\mu' t'}$.

If masses of the reference object and the test object absorb equal fractions of the total energy, then

$$\mu t = \mu' t'$$

or

$$\frac{\mu'}{\mu} = \frac{t}{t'}$$

If the reference object has the same mass absorption coefficient (μ/ρ) as the test object (μ'/ρ'), then

$$\frac{\mu'}{\mu} = \frac{\rho'}{\rho} \tag{1}$$

therefore

$$\frac{\mu'}{\mu} = \frac{\rho'}{\rho} = \frac{t}{t'}$$

and

$$\rho' = \frac{\rho t}{t'} \tag{2}$$

In this laboratory, an x-ray picture is taken simultaneously of the little finger and of a reference wedge of known density (ρ). The wedge is a homogeneous alloy of 92.8 percent aluminum and 7.2 percent zinc. Its effective atomic number approximates that of hydroxyapatite (16.65) (*1*). Its mass absorption coefficient, thus, is closely equivalent to that of bone mineral (see Eq. 1), making it appropriate for comparing bones of different density.

After trying various exposure times, the most suitable was chosen along the linear portion of the film response curve. The standard conditions used are 50 kv, 10 ma, 1 second, and 36 inches focal distance.

A recording microphotometer scans across the film image of phalanx 5-2 at its center and along the central longitudinal axis of the wedge image (Fig. 1). Since x-rays and light are absorbed exponentially, the slope of the wedge trace differs from the slope of the wedge (0.1). Measured with a planimeter, the areas under the finger trace represent integrated mass absorption due to the mass of bone plus over- and underlying flesh ($C + B + C'$) and due to flesh lateral to the bone ($A + A'$). Dividing by corresponding pathways of the x-ray beam, a height is found representing the average absorption for each portion. These heights locate places on the base line of the wedge trace indicating thicknesses of wedge which absorb in the same amount.

Average thicknesses of flesh $A + A'$ and of $C + C'$ are calculated from the cross-sectional areas determined from measurements on the trace (r, x, and length of pathways) assuming circular outlines for flesh and bone. Equations used to determine areas are

$$A = \frac{\pi r^2}{2} - [x(r^2 - x^2)^{1/2} + r^2 \sin^{-1}(x/r)]$$

(with the angle expressed in radians) and

$$C + C' = \pi r^2 - [\pi x^2 + \text{area } 2A]$$

A ratio of the thicknesses is used to correct the wedge thickness representing flesh $A + A'$ (Fig. 1, wedge trace) to that representing flesh $C + C'$. The equivalent wedge thickness for flesh plus bone minus that for flesh $C + C'$ gives the thickness (t) of wedge of known density which absorbs the same amount of energy as the hydroxyapatite in the bone slice of unknown density.

A bone consists of supporting tissues plus hydroxyapatite. The density of bone is required—not that of hydroxyapatite. The average thickness (t') of the bone penetrated by the x-ray is obtained from linear measurements on the trace.

The measured values for ρ, t, and t' are substituted in Eq. 2 to solve for ρ'.

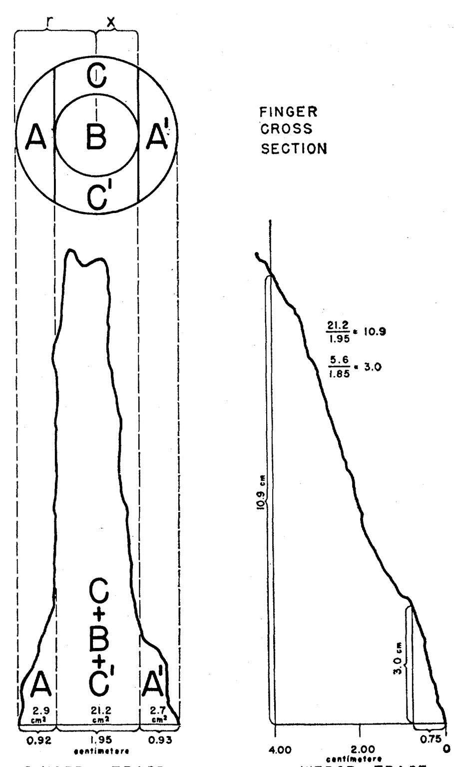

Fig. 1. Measurements needed to calculate density values.