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The Effect of Sugar Cane Chewing on the Development of Dental Caries

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In Tanzania, the effect of sugar cane chewing on the development of caries was investigated. Two groups were selected; those who had easy access to sugar cane (sugar cane cutters) and those who did not (sisal plant workers). These groups had a similar socio-economic background, had similar levels of fluoride in drinking water, consumed similar amounts of refined sugar per day, but had a significant difference in number of pieces of sugar cane chewed per day. The caries prevalence in both groups was low compared with that in adult populations in Western countries. Sugar cane cutters had significantly higher mean DMF/T scores than sisal plant workers. Analysis of Variance revealed a weakly significant effect of sugar cane chewing on the caries scores (p = 0.02 for DMT and p = 0.05 for DMS). Results of the study suggest that sugar cane chewing in large quantities over a long period has a caries-promoting effect in populations with a low caries prevalence, and further, that sugar sales figures reported for such populations are of questionable reliability.


Introduction.

In Central and East Africa, the habit of chewing sugar cane is practiced widely among the population. Crude sugar cane juice is reported to contain a sucrose level between 12 (Osborn et al., 1937) and 15% (New brun, 1978) and should therefore be considered a risk factor for caries. A review of the prevailing literature on sugar cane chewing and dental caries, however, reveals contradicting statements. Some authors (Dreizen and Spies, 1952; Von Künzel et al., 1973) have attributed a caries-inducing effect to sugar cane chewing, whereas Osborn and Noriskin (1937) and Harris and Cleaton-Jones (1978) could not find such an effect. Osborn et al. (1937) suggested that crude sugar cane juice contained a “protective agent” which is removed during the process of refining. This agent would explain the low percentage of teeth decalcified after being exposed to crude cane juice as compared with refined sugars, a result found in their in vitro study. This experiment was repeated by Jenkins et al. (1959), and confirmed the protective effect of cane juice in decalcification of enamel.

Since ethical reasons exclude the possibility of a longitudinal experiment, the second best method is the assessment of a long-term effect by means of comparing two groups of individuals: (1) those who have easy access to sugar cane; and (2) those who have not. The latter approach was chosen in Tanzania, and the findings of the study are reported in this paper.

Materials and methods.

Subjects and examinations.—In order to investigate the effect of sugar cane chewing on the development of caries, we selected two male groups. The selection was based on two criteria: (1) the subjects should belong to the same socio-economic group, and (2) they should differ markedly in their pattern of sugar cane chewing. The two groups selected were permanently employed sugar cane cutters and workers at a sisal estate. Both groups lived more or less isolated from population groups in the neighborhood. The members of each group and both groups were of different tribal background. The sugar cane cutters resided on a sugar estate in Kilombero, Tanzania. During six months of the year, these cutters had the opportunity to chew sugar cane daily in large quantities. The rest of the year they carried out maintenance work on the fields, chewing cane less frequently. The sisal plant workers resided on a sisal estate in Tungi, situated some 125 km from Kilombero. The large majority of these men either cut sisal or worked in the processing or finishing section of the estate. There were no large plots of sugar cane present on or in the neighborhood of the estate, and the opportunity to chew was limited throughout the whole year. To be eligible for selection, sugar cane cutters had to have been employed for at least five consecutive years. This criterion was arbitrarily chosen in order to ensure a long period of intense cane chewing among the individuals under study. Seventy-six percent of the sisal plant workers also fulfilled the five-year criterion.

The composition of the diet of the two groups under study was comparable. Breakfast consisted of sweetened tea and maize porridge. A warm meal, which was taken in the late afternoon, consisted of stiff maize porridge (ugali) and vegetables and/or legumes. Meat and fish were not regularly eaten, while fruit was taken throughout the day, if available.

On the sugar estate, the fluoride concentration in drinking water sources varied between 0.23 and 0.27 ppm (dry season) and between 0.57 and 0.65 ppm (wet season). On the sisal estate, the drinking water was analyzed at the end of the rainy season, and the fluoride concentration was found to be 0.56 ppm.

The study was carried out in November, 1985, and in February, 1986. Out of a total of 105 sugar cane cutters and 94 sisal workers selected, 77 of the former and 68 of the latter group were examined. Caries was diagnosed according to the criteria described by the Oral Health Unit of WHO (1977). All dental examinations were carried out by one examiner. In Kilombero, the examinees were seated indoors on a kitchen chair facing an open window. The same procedure was followed in Tungi, except that there, most of the sisal cutters were examined in the field. Before being examined, the examinees were requested to participate in an interview. The recording of these data was done by one person.

Questionnaire.—The questionnaire was designed to obtain information on the amount and frequency of refined sugar consumed, and the number and frequency of sugar cane chewed, by means of the 24-hour recall method. It was known that in these groups refined sugar was mostly consumed with tea. Little or no luxury food items were for sale in the shops on the two estates. Concerning refined sugar consumption, the following questions were asked:

—How many spoons of sugar do you use in your tea?
—How many cups of tea do you drink per day/week?

The questionnaire was pre-tested, and the following questions concerning sugar cane chewing were compiled as a result of the pre-test:

—Do you chew sugar cane?
—If yes, how often do you chew a piece of sugar cane per day, week, or month?
—How many pingilis (= piece of the cane between two knots) do you chew per occasion?

Reliability of data.—The reliability of the caries data was assessed for intra-examiner variability on 10% of the examinees. A 100% agreement was calculated. The reliability of the data obtained by means of the questionnaire was not assessed.

Statistical methods.—The following independent variables were compiled: (1) amount of sugar consumed per day, (2) number of pingilis chewed per day. The first variable was determined by multiplying the number of spoons of sugar added in the tea with the number of cups of tea drunk per day. The second variable was determined by multiplying the number of pingilis chewed per occasion with the frequency of occasions occurring per day. The results of the multiplications led to an arbitrary “sugar consumption figure” (SCF). The rationale of the multiplication is the fact that sucrose concentrations above 20% bring about strongly increased cariogenicity in rats (Hefti and Schmid, 1979), and that extended sucrose administration also increases cariogenicity (Dawes, 1983). The effect of sugar cane chewing on the development of caries was analyzed by means of ANOVA. For “normality”, a square root transformation (power = 0.5) preceded the execution of the analyses. The ANOVA was carried out with amount of sugar consumed per day (dichotomized in SCF < 5 and ≥ 5), number of pingilis chewed per day (dichotomized in 0 and more than 0), and age (dichotomized in < 30 and ≥ 30) as independent variables.

Results.

The age distribution of sugar cane cutters and sisal plant workers is presented in Table 1. The mean age was 35.9 and 36.1 years for sugar cane cutters and sisal plant workers, respectively.

The number of years of employment ranged from 5 to 24 (mean ± SD = 11.4 ± 6.1) for the sugar cane cutters, and from 2 to 27 (mean ± SD = 9.4 ± 5.8) for sisal plant workers.

There was no age effect observed on the caries scores in both groups. The frequency distribution of DMS scores (no restorations were found) for both groups is presented in Table 2. There was a higher proportion of caries-free dentitions among sisal plant workers than among sugar cane cutters: 37% vs. 23%. Individuals with a DMS score of 26 or more were found more frequently among sugar cane cutters (25%) than among sisal plant workers (6%). The mean DMT score ± SD for sugar cane cutters and sisal plant workers was 3.5 ± 3.8 and 2.0 ± 2.9, respectively (Wilcoxon, p = 0.01), while the mean DMS score and SD was 13.9 ± 16.5 (sugar cane cutters) and 7.8 ± 12.9 (sisal plant workers) (Wilcoxon, p = 0.02).

The percentage of sugar cane cutters who did not eat refined sugar (15%) was higher than that of sisal plant workers (3%). There was no significant difference in the amount of refined sugar (SCF) consumed per day between sugar cane cutters (4.1 ± 3.6) and sisal plant workers (4.3 ± 2.6) (Wilcoxon, p = 0.22), while the number of pingilis chewed per day differed significantly between sugar cane cutters (8.1) and sisal plant workers (0.8) (Wilcoxon, p = 0.0001) (Fig.).

The test results (ANOVA) of the independent variables—

![Fig. — Distribution of number of pingilis chewed per day for sugar cane cutters and sisal plant workers.](image)

age, amount of refined sugar consumed per day (CSF), and number of pingilis chewed per day on the DMT/S scores—only revealed a weakly significant effect for the latter variable (p = 0.05 for DMS and p = 0.02 for DMT).

Discussion.

The caries prevalence found among the sugar cane cutters and sisal plant workers was low compared with that in adult populations in Western countries. Furthermore, a weakly statistically significant effect of sugar cane chewing on the development of caries could be demonstrated.

The caries prevalence found in the present study was markedly lower than that found by Dreizen and Spies (1952) and Von Kunzel et al. (1973) among habitual sugar cane chewers in Cuba, but it was in keeping with results reported by Harris and Cleaton-Jones (1978) among sugar cane chewers in South Africa. The investigators of the two Cuban-based studies had included early enamel lesions in the DMIT index, which might explain, in part, the difference found in caries prevalence between this study and the two Cuban studies. Furthermore, the caries prevalence in this study was in line with results reported.

<table>
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<tr>
<th>TABLE 1</th>
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<td>NUMBER OF SUGAR CANE CUTTERS AND SISAL PLANT WORKERS BY AGE GROUP. N = NUMBER OF INDIVIDUALS EXAMINED</td>
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<tr>
<td>Age Group (yrs)</td>
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<tr>
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<tr>
<td>Cane Cutters</td>
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<td>Sisal Workers</td>
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<th>TABLE 2</th>
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<tr>
<td>FREQUENCY DISTRIBUTION OF DMS SCORES FOR SUGAR CANE CUTTERS AND SISAL PLANT WORKERS</td>
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<td>DMS Scores</td>
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among adults living in rural Tanzania (Gadegaard and Fejerskov, 1983), and with those reported among workers on a sugar estate in Northern Tanzania (Fejerskov et al., 1984). It was remarkable that an almost equally high percentage of sugar cane cutters were either caries-free or had high DMS scores. A plausible explanation for this phenomenon is not apparent, since neither age nor years of employment showed a significant effect on the caries scores.

The 24-hour recall as a method by which to assess dietary history in general is considered valid for use at the population level. In the present study, the method could distinguish very clearly between sugar cane cutters and sisal plant workers in terms of sugar cane chewing, as expected. However, in terms of refined sugar consumed, the method could not make this distinction. Considering the large difference in sugar sales figures per capita per year reported for employees living on the sugar estate (who were eligible to purchase refined sugar as an incentive) and for Tanzanians in general—36 kg (Kimbombe Sugar Company, 1986) vs. 6 kg (Sugar Development Cooperative, 1982), respectively—a more clear distinction was expected. There are, however, a number of valid reasons which suggest that the sugar sales figures reported for the estate employees are of limited value. At the time the study was carried out, refined sugar was a scarce commodity in the country and much sought after by people living outside the estate. It is quite possible that a lot of the sugar may have gone to friends and relatives. Much sugar was also used for the production of home-made beer. These events surely shed a different light on the carefully calculated average sales figure for the estate employees. This approach, in trying to explain the absence of a difference in amount of refined sugar consumed per day (SCF) between the two groups, is not unrealistic. It is, moreover, supported by the results of another study carried out earlier on the same estate (Rugarabamu et al., 1989). In that study, a significant difference in mean DMF/S scores between estate 12-year-olds and 12-year-olds living in urban and rural areas of Tanzania could not be demonstrated, despite the high sugar distribution figure mentioned above, and despite the reported existence of an S-shaped dose-response curve between caries and sugar up to 35 kg per person per year (Takeuchi, 1974). It seems, therefore, very likely that the sales figure reported for the estate population by no means reflected the actual amount of sugar consumed per person per year. However, it does show that official sugar sales figures for such populations are of questionable value.

The shortcoming of a cross-sectional design in the assessment of an association between an etiological factor and the development of a disease makes it difficult to draw clear-cut conclusions. In the present study, the effect of sugar cane chewing on the development of caries was significant, but weak. In considering the practical consequences of this result, the relatively low power of the study should be taken into account. Moreover, it is not known whether the difference observed in caries prevalence between the two groups was already present five years ago (i.e., the limit arbitrarily chosen to select the group of frequent sugar cane chewers). This possibility is supported by the finding that the prevalence of caries was not dependent on the age of the subjects examined, which shows that the prevalence was more or less stable for both groups from the age of 25 onward. However, this does not mean that the difference cannot be attributed to sugar cane chewing. Unfortunately, such important information cannot be derived from the present study. What can be said is that the data of the present study suggest that sugar cane chewing in large quantities and over a long period has a caries-promoting effect.

Our findings also support the conclusions reported by Dreizen and Spies (1952) and Von Künzel et al. (1973). Their studies, however, were not specifically designed to investigate the effect of sugar cane chewing on the development of caries. They concluded that sugar cane chewing had a promoting effect on the caries prevalence on the basis of a large difference found in DMFT scores between frequent and infrequent sugar cane chewers. The possible influence of refined sugar and the pattern of sugar cane chewing were not assessed.

In conclusion, the data of the present study suggest that sugar cane chewing in large quantities over a long period has a caries-promoting effect in populations with a low caries prevalence.

Acknowledgments.

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