Severe dental fluorosis in children consuming fluoride containing magadi salt

W.H van Palenstein Helderman[1], E. Mkasabuni[2], H.J. Mjengera[3], L. Mabelya[4]

[1]WHO Collaborating Centre for Oral Health Care Planning and Future Scenarios, [2]Peramiho Hospital, Songea, Tanzania, [3]Ministry of Water, Dar es Salaam, Tanzania, [4]Department of Community and Preventive Dentistry, Muhimbili University of Health Sciences, Dar es Salaam, Tanzania.

Abstract.

Dental fluorosis in children has been reported in East Africa and its prevalence and severity in several areas was higher than would be expected from the fluoride content in water supplies. This study aimed to measure dental fluorosis in 50 randomly selected 12 to 15-year-old children who were born and raised in an endemic fluorosis area in northern Tanzania, and aimed to relate the prevalence and severity of their dental fluorosis to F^- exposure. Buccal surfaces of all permanent teeth were scored for fluorosis according to the Thylstrup Fejerskov Index (TFI). Children and their mothers were interviewed with aid of a questionnaire about dietary habits and methods of food preparation. 96% of the examined children exhibited fluorosis of TFI) 4 on more than 2 teeth. The water sources used since birth had a low F^- content of less than 0.4 ppm F^-. Results of the interviews revealed the frequent use of "magadi", a potash (trona) salt, which is added to food as a tenderizer. The F^- concentration in magadi samples collected from 25 different house holds ranged from 760 to 6800 ppm (mean 2776 ppm). It was calculated that adults in this community consumed approximately 34 mg F^- per week through magadi containing meals. Although infants started to ingest fluoride through magadi containing meals in the first year after birth, an accurate estimate of F^- consumption during period of tooth formation was not possible on the basis of the present data. The lack of an association between dental fluorosis and F^- exposure in some of the previous reports from African communities may be explained by inadequate identification of available F^- sources. Many areas in Tanzania endemic fluorosis may occur as a result of high F^- supplementation to food rather than exposure to F^- in drinking water. This urges further research.

Introduction

Dental fluorosis is a disorder of tooth mineralization caused by excessive intake of fluoride during tooth development. The severity of dental fluorosis increases with the amount of fluoride ingested during the period of tooth formation (1). The mild form is characterized by opaque white lines along the perikymata which may fuse to form opaque white patches, mottled enamel. It may be stained yellow to dark brown by uptake of pigments from food and drinks after the teeth have erupted. In more severe cases discrete pits and larger areas of hypoplasia of enamel may occur to the extent that the normal morphology of the tooth is lost. Endemic dental fluorosis is most prevalent in areas where the drinking water contains elevated levels of fluoride. The dental fluorosis prevalence in some regions in East Africa is believed to be caused by fluoride in drinking water (2 - 5). However an increasing number of reports have appeared from East African countries indicating a high prevalence and severity of dental fluorosis that can not be explained by the F^- content of the drinking water (6 - 11)

Recently, a low fluoride community which used drinking water with 0.4 ppm F^- but with severe dental fluorosis was identified in the central region of Tanzania. An additional fluoride source was discovered in the form of "magadi" $Na_3H(CO_3)_2.2H_2O$ which was added to the cooking pot as a tenderizer to speed up the cooking time. Magadi is found in numerous places in Tanzania. Not all magadi contain high levels of fluoride but the type used in this community appeared to be heavily contaminated with soluble fluoride salts.

The exposure to magadi with a high fluoride content was considered to explain the observed severity of dental fluorosis in that community (12 - 14). The present study aimed to determine the prevalence and severity of dental fluorosis in association with fluoride levels in drinking water and magadi in a community in the northern region of Tanzania. This region has for decades been known for endemic fluorosis (15) and numerous places with high fluoride in water supplies (3).

Materials and methods

This cross-sectional study which was carried out in Kibosho at 1300m altitude near Moshi in the Kilimanjaro region. School-children aged between 12 - 15 year, who were born and brought up in that community, were identified. All children who met the selection criteria in classes 3 and 4 and some children according to the alphabetical order of their surname in class 5 were selected to form a sample of 50 (mean age 13.9 years).

The children had used several water sources in that area since birth. Water samples from these sources (n = 9) were collected in August 1991 in a period of long rains, in January 1992 during a long dry period and again in october 1992 in a period with occasional rains. The water samples were collected in plastic containers. Analysis of the fluoride ion

concentration was done using the fluoride ion specific electrode.

The children were examined in natural daylight in a shaded area by one examiner (E.M.). Buccal surfaces of erupted permanent teeth were wiped with a gauze and were left to dry before they were scored for fluorosis according to Thylstrup and Fejerskov Index (16). Colour photographs of teeth with different TFI scores were available as an aid to reliability (17). The examiner was not aware of the prevailing fluoride content in the water sources.

Children under study were interviewed about their dietary habits with the aid of a 24-hour-recall questionnaire. In addition they were asked how frequently they consumed tea, fish and magadi on a weekly basis at the time of the interview. Every second mother (n = 25) was interviewed about the frequency of magadi use for food preparation. They were also asked how long they were using magadi and at which age their children were introduced to foods which contained magadi. Each interviewed mother provided the interviewer (E.M.) with a quantity of magadi equal to the amount they normally used for cooking meals. Magadi in this community has been supplied through local market traders who, bring it from salt lakes in the northren part of Tanzania, implying that there are several sources of magadi. The samples of magadi were weighed and subsequently 5 grams were diluted in 20 ml of distilled water prior to the analysis with the fluoride ion specific electrode.

Results

The F^- content in the water sources in Kibosho varied over time but the variation was very low (Table 1). These sources have been used by the studied community for at least 15 years.

The prevalence and severity of dental fluorosis among the 50 children is depicted in Figure 1.

Fourty six percent of the children exhibited TFI > 3 on all their teeth whereas 96% of the children TFI > 4 in more than 2 teeth and 63% showed at least 50% of their teeth with TFI > 4. A TFI > 4 score represents severe fluorosis as it manifests hypoplasia and deformations of the normal morphology of the teeth and due to the porosity of the enamel dark discolouration may occur.

Information from the children revealed that tea was not drank excessively (mean 5.7/week), neither was fish consumed frequently (mean 0.7/week). Mothers reported that "magadi" was added to the boiling pot for taste and to reduce the cooking time particularly for beans. Mothers reported that they

Table 1. Mean and average of fluoride ion concentration in 9 water sources at different times of the year.

Water sources	Mean F^-* ppm	Range F^- ppm
August 1991	0.04	(0.05 - 0.12
January 1992	0.35	0.26 - 0.43
October 1992	0.28	0.21 - 0.56

* mg F^- per litre.

cooked beans with magadi for an average of 4.1 days a week (the children reported nearly the same frquency of 4.3 meals per week). The amount of magadi added to the cooking pot for 6 - 8 persons was on average 21 grams. The usual meal containing beans and cooked bananas was served as a juicy dish. No water was discarded after the cooking process. Consequently all the added fluoride through magadi was consumed. Only when the cooking pot did not contain bananas was some of the remaining water discarded before the meal was served.

The mean F^- concentration in magadi samples collected from the mothers was 2776 ppm F^- with a range of 760 - 6800 ppm. All mothers reported to have introduced magadi to their infants meal in the weaning period between 4 - 9 months (mean 6.9) after birth. The mothers stated that they had always used magadi and that small children shared the meal with adults.

Discussion

The fluoride content of the water sources in the examined community varied with time but was always found low. This finding corroborates previous reports on the fluctuating fluoride concentrations in drinking water in several countries (18). The low fluoride content in the drinking water of the present community (on average < 0.4 ppm F^-) could not explain the high prevalence (96%) of the children with TFI) 4 which is severe according to Dean's score (19). The severity of dental fluorosis in the present community, if caused solely by fluoride in drinking water, would be accounted for by at least 7 ppm F^- (1).

Other usual sources of fluoride prevailing in developed countries e.g. infant formulae, F^- in toothpaste, fluoride tablets fluoride rinsing and other fluoride applications do not exist. However an additional source of fluoride was identified in the form of magadi. The magadi used in this community contained on an average 2800 mg F^-

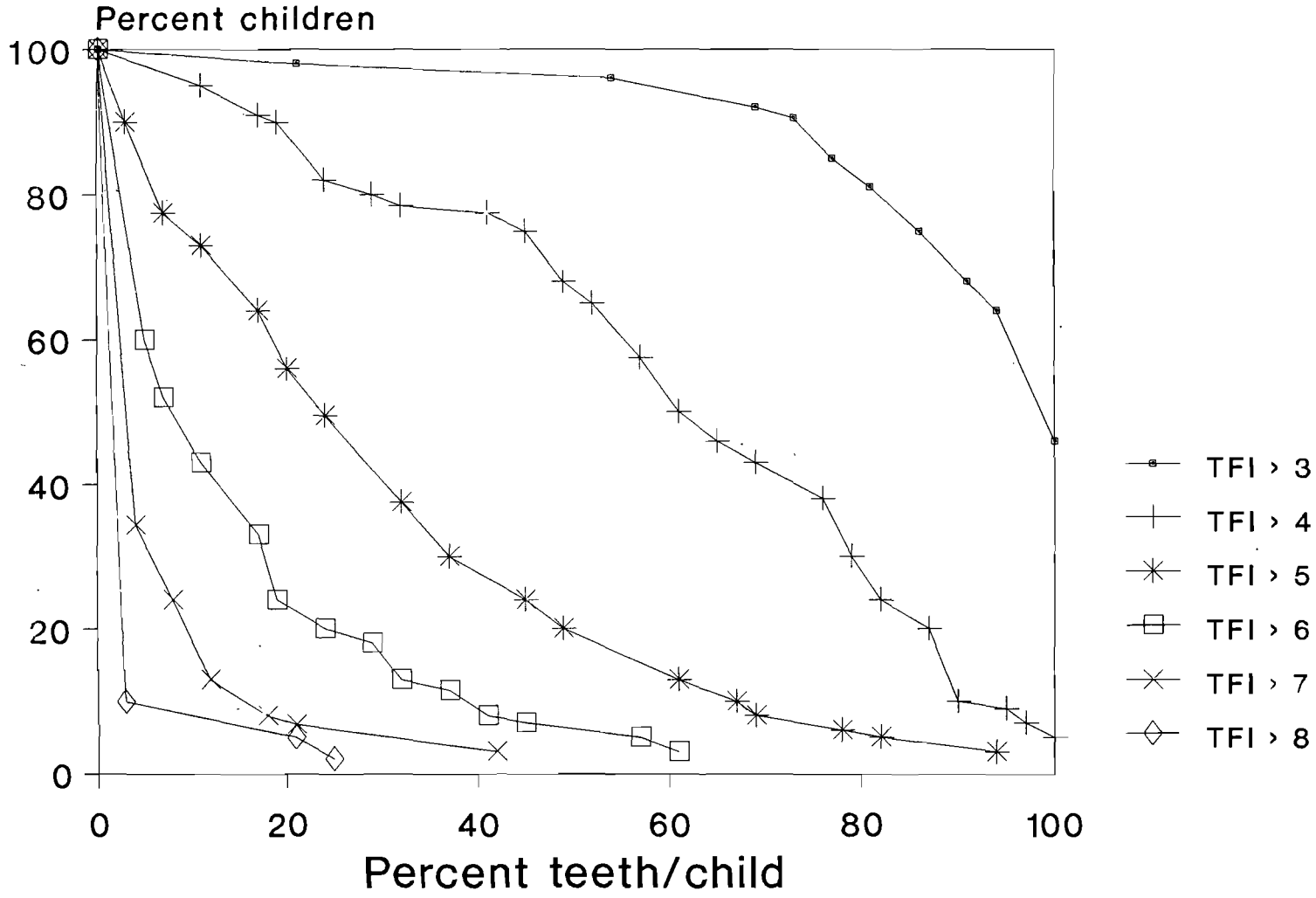

Figure 1: Cumulative frequency distribution of children according to proportion of teeth per child exhibiting TFI scores >3, 4, 5, 6, 7 and 8.

per kg magadi. The average amount of magadi ingested from this source in the Kibosho community for adults was approximately 34 mg per person per week. 4 (times a week) X 21/7 (grams of magadi consumed by 7 persons) X 2.8 (mg F^- per gm magadi). It is precarious on the basis of the present data to calculate the amount of fluoride ingested by infants and young children in this community. According to the information of mothers, their infants ingested magadi in the first year of their life through weaning foods but the quantity is not known, because firstly 50% of the children in Tanzania are breastfed up to the age of 23 months (20) and secondly although they share their meals with other members of the family still the amount consumed through magadi during weaning and later up to the age of 12 years is unknown. Besides the amount and frequency of fluoride consumed per day and duration of exposure during the period of tooth formation uptill the age of 12 years, other factors have been suggested to exert effects on the severity of dental fluorosis (21). Several reports from Tanzania, South Africa, Kenya, and Senegal have shown a higher severity of dental fluorosis than would be expected on the basis of prevailing fluoride content in their drinking water supplies (6 -11, 16, 22). In an attempt to explain the high prevalence and severity of dental fluorosis in those communities climate (8- 10), altitude (21) and diet and malnutrition (22) have been suggested as possible factors. The present community did not exhibit malnutrition among its infants and young children. The climate in Kibosho is not very hot and dry, since Kibosho is located at the foothills of the Kilimanjaro at 1300 meters altitude. The present data on the prevalence and severity of dental fluorosis were in agreement with a report from another Tanzania community in the central region of the country at a comparable altitude, but in disagreement with data from a community in the coastal region at sea level which exhibited low levels of dental fluorosis (12 - 14). Both these communities consumed drinking water with a low fluoride content of 0.4 - 0.6 ppm F^-. The main difference in fluoride exposure between the two communities appeared to be the use of magadi in the community at high altitude (12 - 14). That finding and the present data raise doubts about the explanation given for the Kenyan community that altitude related hypobaric conditions may have modified the susceptibility of individuals to fluoride (21). It seems more likely that unidentified dietary fluoride source in those people may have caused the observed severe dental fluorosis.

It is suggested that in studies on dental fluorosis attention should be paid to dietary habits and local customs in the preparation of food in order to identify possible additional F^- sources.

Tanzania has several endemic dental fluorosis areas and the possibility is suggested that many of these areas may exist as a result of high fluoride supplements to food rather than the F^- content of water supplies. This urges further investigation.

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