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The prevalence and severity of dental fluorosis in the high and low altitude parts of Central Plateau, Nigeria

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Objective To compare the prevalence and severity of dental fluorosis in the high and low altitude parts of the Central Senatorial District of Plateau State. ***Basic research design*** The study was cross-sectional and descriptive. ***Setting*** The community based study was carried out in Central Plateau Nigeria, in 2005. ***Participants*** The study subjects were 12-15 year old life long residents selected using the multistage sampling technique. One Local Government Area each was randomly selected from the high and low altitude parts of the district and from each selected Local Government Area two health districts were randomly selected with probability proportional to size. From each of the selected health Districts two major settlements were selected again with probability proportional to size. 12-15 year old life long residents of the selected settlements were studied. Each respondent completed an interviewer administered questionnaire after which he/she was clinically examined to ascertain his/her fluorosis status. Samples of water were collected from water sources consumed by the respondents in each settlement. ***Main outcome measures*** The main outcome measures were presence and severity of dental fluorosis as measured by the Thylstrup and Fejerskov index. (TF score). ***Results***. One thousand one hundred children were studied, 554 (50.4%) from the high altitude part of the district and 546 (49.6%) from the low altitude part. Fluorosis prevalence was 12.9% in the district, but significantly higher (22.2%) in the high altitude areas compared to the low altitude ones (3.5%). The severest form of fluorosis in the district was TF 6 for tooth 14 and TF 5 for tooth 11. ***Conclusion***. The prevalence and severity of dental fluorosis is significantly higher in the high altitude parts of the District compared to the low altitude ones. Efforts are needed to further investigate and control the problem.

Key words: Central Plateau, dental fluorosis, prevalence, severity

Introduction

Dental fluorosis is a specific disturbance of tooth formation due to excessive fluoride ingestion (Leverett 1986). It is defined as a chronic fluoride induced condition in which enamel development is disrupted and the enamel is hypomineralised (Akpata *et al*,1997). The disturbance affects enamel during its late secretory and early maturation phases resulting in enamel sub-surface porosity (Pang *et al*, 1992). Fluorosis has a very characteristic appearance in terms of tooth surface appearance and distribution in the mouth (Mabelya *et al*, 1992). In its mildest form, the fluorosed enamel is characterized by opaque white lines due to accentuated perikymata. In some cases, the white lines may be confluent while in others there may be discrete white opaque areas. In more severe cases, the entire enamel surface is chalky white. Post-eruptively, the sub-surface porosity may attract extrinsic stains resulting in tooth discolouration (Ferjeskov *et al*, 1994). In cases with extensive sub-surface porosity; post-eruptive trauma causes detachment and pitting of surface enamel. The enamel discoloration and pitting is aesthetically objectionable and may be a cause of psychological ill health (Rewenyonyi *et al*, 1999).

In the past, it was believed that dental fluorosis occurred, almost exclusively, in individuals who have resided in areas with optimal or high fluoride in the drinking water. However, in recent times fluorosis occurrence has become more widespread and its prevalence has increased even in areas with fluoride deficient water supplies (Leverett, 1986; Wang *et al*, 1997). The increased use of fluoride in preventive dentistry has been suggested as the possible explanation.

Although drinking water is by far the greatest source of fluoride ingestion by man, other sources like beverages, tooth pastes, infant formula, fluoride supplements, food tenderizers/condiments and sea foods; have contributed to increased background fluoride exposure in many countries. These other sources may be responsible for the occurrence and high prevalence of dental fluorosis in areas with fluoride deficient water supplies. In addition high altitude has been shown to be a risk factor for fluorosis. In Africa, dental fluorosis is often found at locations with low levels of fluoride. For example, mild fluorosis has been reported to be prevalent in children exposed to only 0.0-0.4ppm fluoride from well drinking water in the high altitude areas of Bauchi and Plateau States of Nigeria (El-nadeef and Honkala, 1998). This fluoride level is much lower than the 0.6ppm recommended for tropical climates. Apart from the high fluoride intake from the food tenderizing "magadi", a condiment that is consumed in East Africa and which has much higher fluoride than the drinking water consumed there, no sources of fluoride, other than drinking water appears to have been reported in African countries. Also, the use of fluoride in preventive dentistry is rather uncommon to many African communities, even where endemic dental fluorosis is prevalent (Ibrahim *et al*, 1995). Since water consumption tends to rise with increase in ambient temperature, the dental fluorosis in endemic areas of tropical

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Africa could be due to high fluoride intake from drinking water and possibly other fluids, although dietary sources cannot be ruled out.

In Plateau State, a study in Langtang town found the prevalence of dental fluorosis to be 26.1%, and its occurrence to be strongly associated with drinking water from streams (Wongdem *et al*, 2000), though it is not known if the same situation exists in other parts of the state. The aim of this study therefore is to compare the prevalence and severity of dental fluorosis in the high and low altitude parts of the Central Senatorial District of Plateau State, an area where drinking water is mainly obtained from wells and streams.

Materials and methods

The Central Senatorial District lies between the Northern and Southern Districts of Plateau state and is bounded on the North by Bauchi State. It is made up of Bokkos, Kanam, Mangu, Kanke and Pankshin Local Government Areas. The main occupation is farming which is generally unmechanised and the main crops cultivated are maize, guinea corn, vegetables, rice, potatoes and yam. Bokkos, Kanam and Mangu Local Government Areas have relatively low altitude (about 1000m above sea level), while Kanke and Pankshin have relatively high altitude (about 1700m above sea level).

The study was descriptive and cross- sectional in design and was community based.

Sampling.

From the high altitude part of the district, Pankshin Local Government Area was randomly selected. Two health districts, Chip and Pankshin Township were randomly selected from the six Health Districts in the Local Government by sampling with probability proportional to size. From each of the selected health districts, two major settlements Pankshin Central and Dokfai in Pankshin Health District and Chip village and Shoro in Chip Health District were selected, again by sampling with probability proportional to size. This was done by creating a cumulative list of community populations and selecting a systematic sample from a random start. From the low altitude part of the district, Mangu Local Government Area was randomly selected and the same procedure was followed to select Ampang West and Kerang, from Kerang Health District, and Sabon-layi and Mangu Central from Mangu Health District. In each settlement, selection of households was done using the Expanded Programme on Immunization's modified cluster sampling technique (Bennet *et al*, 1991). A central point in the settlement was identified and the number of houses between this and the boundary of the settlement, in a randomly selected direction counted. The first household was then selected by ballot among the counted houses. Subsequent households were chosen by taking the nearest house or compound whose gate or door was facing the previous one. This was continued until the requisite numbers of children were examined or the settlement covered. In each selected household, all the 12-15 year old children who were lifelong residents of the communities and who gave their consent were examined. One hundred and thirty-eight (138) children were required from each cluster (selected settlement), totaling 1,100.

Approval for the conduct of the study was obtained from the ethical committee of Jos University Teaching Hospital. Approval was also obtained from the traditional rulers (Mai-Angwa) of the various villages after an explanation of the aims and benefits of the project. Consent for participation of our subjects was obtained verbally from their parents/guardians and the subjects themselves. This was necessary because they were minors. Verbal consent was used because most of our subjects and their parents were illiterates and a written consent would involve troublesome translation and use of ink for thumb printing which was considered unnecessary since the procedure had little or no risk for the subjects. In addition, the subjects were examined in their homes where they had all the liberty to refuse without losing anything.

Eligibility criteria included life long residence in the selected communities and age 12-15years old. This information was obtained from the parents/guardian and confirmed with the child. An interviewer administered structured pre-tested questionnaire which enquired about the socio-demographic characteristics of the subjects, their sources of water supply, diet, use of fluoride toothpaste before age 6years and use of fluoride supplements was completed by each subject before he/she was clinically examined.

One trained dentist examined the children under field conditions. The dentist was trained and calibrated before the commencement of the survey by an experienced examiner. During the examination the child was seated on a chair in a shade. Indirect natural light was used for illumination. The surfaces of the teeth were not specially cleaned. This was because we could not afford the jet air or cotton wool/tooth paste for cleaning and drying the teeth and could be a limitation, as some cases of fluorosis may have been missed. Presence and severity of dental fluorosis was assessed on the buccal/labial surfaces of the upper right permanent central incisor (tooth 1.1) and first premolar (1.4) using the Thylstrup and Fejerskov (TF) index. About 10% of the children were re-examined for reliability tests. The intra-examiner reliability was 0.9 (Kappa statistic).

Drinking water samples were collected in polyethylene bottles from water sources consumed by the study subjects and analysed for fluoride concentration using the SPADNS reagent solution method, a spectrophotometric method that is as sensitive and specific as the ion selective electrode method. All water samples were collected during one season (at the height of the dry season, in April). Statistical analyses were carried out using the Statistical package for social sciences (SPSS 11.0).

Results

One thousand one hundred (1100) children were clinically examined for the presence or absence of dental fluorosis. Five hundred and fifty-four (50.4%) of them were from the high altitude part of the district and five hundred and forty-six (49.6%) from the low altitude part. Males were the preponderant gender in both groups. About 11% of the children in both areas had hawking as their current occupation.

The distribution of TF scores on the upper right permanent central incisor (1.1) and first premolar (1.4) are presented in Table 1. A total of 153 (13.9%) children had TF scores ≥1 on tooth 1.1; the corresponding number for tooth 1.4 was 142 (12.9%) (Table 1). Severe fluorosis with pitting (TFI >/=5) occurred in 0.2% of the maxillary incisors and 0.7% of the maxillary premolars. Most of the subjects with dental fluorosis had the mild form of fluorosis. There were no significant differences in fluorosis distribution in terms of age group and gender but there were significant differences in terms of location.

The high altitude part of district had a much higher prevalence of fluorosis than the low altitude part. The difference was statistically significant. (χ^2=85.734, degree of freedom=1, p<0.0001) (Table 2). Fluorosis, as measured by the TF score was also more severe in the high altitude parts than in the low altitude ones (Table 3)

The fluoride concentration of water sources consumed by the sampled population ranged from 0.27-0.81 ppm. However, very few water sources contained less than 0.60ppm of fluoride and only one of the sampled water sources contained more than 0.80ppm of fluoride.

Table 1. Severity of dental fluorosis as measured by the Thylstrup and Ferjeskov index in the Central Senatorial District of Plateau State

TF score for tooth 11	*Frequency*	*%*	*TF score for tooth 14*	*Frequency*	*%*
0	958	87.1	0	947	86.1
1	85	7.7	1	76	6.9
2	32	2.9	2	46	4.2
3	16	1.5	3	15	1.4
4	7	0.6	4	8	0.6
5	2	0.2	5	7	0.1
6	142		6	1	0.1
Total	1100	100.0		1100	100.0

Table 2. Comparison of the prevalence of fluorosis in the high and low altitude parts of the Central Senatorial District of Plateau State.
(as measured by tooth 11)

Altitude	*Fluorosis*		
	Present	*Absent*	*Total*
High	123 (22.2%)	431 (77.8%)	554 (100%)
Low	19 (3.5%)	527 (96.5%)	546 (100%)

χ^2 =85.735; degree of freedom 1; p<0.0001
Source: Field work 2005

Table 3. Comparison of the severity of fluorosis in the high and low altitude parts of the Central Senatorial District of Plateau State
(as measured by tooth11).

TF Score	*High Altitude*	*Low Altitude*	*Total*
0	431	527	958
1	70	16	86
2	28	3	31
3	16	0	16
4	7	0	7
5	2	0	2
Total	554	546	1100

χ^2 =85.735; degree of freedom 1; p<0.0001

Table 4. Comparison of the fluoride concentration of water sources in the high and low altitude parts of the District.

Water source	*Fluoride content (ppm)*		*T-value*	*df*	*p-value*
	High altitude	*Low altitude*			
Well	0.69 +/- 0.09	0.70 +/- 0.16	1.31	10	>0.05
Stream	0.67 +/- 0.03	0.76 +/- 0.04	3.68	6	<0.05
Borehole	0.59 +/- 0.00	0.65 +/- 0.05	1.56	2	>0.05
Total	0.68 +/- 0.004	0.71 +/- 0.02	2.70	21	<0.05

Discussion.

The prevalence of dental fluorosis in the present study was found to be 12.9% and 13.9% (for right maxillary central incisors and first maxillary premolars respectively). This is much lower than the 25% found by Akpabio (1982), the 51% found by El-Nadeef and Honkala (1998); and the 26.1% found by Wongdem in Langtang town (2000). It is also lower than that reported by Akpata *et al* (1997) in Saudi Arabia, and Lo and Bagramian (1996) in Singapore. Indeed only 16.1% of the 12-15year old children examined in the Saudi Arabian study were free of dental fluorosis even though they were exposed to only 0.5-0.79ppm fluoride in drinking water, a fluoride level that is comparable to that found in this study. The higher fluorosis prevalence found in these studies could be due to other risk factors or fluoride ingestion from non-water sources . Only the subjects in the Wongdem study were exposed to fluoride levels in drinking water markedly above the normal range and that found in this study. (0.72-3.8ppm as against 0.27-0.81ppm). Indeed most water sources in Langtang town according to the Wongdem study have fluoride levels higher than 1.0ppm, in contrast to the waters in the Central Plateau senatorial district, most of which have fluoride levels between 0.61 and 0.80ppm. This fluoride level is still high when considered with the water consumption habits in the area. Daily water consumption is known to affect the total fluoride ingestion from drinking water by any individual regardless of the fluoride concentration of the water. In Plateau State the daily water consumption of children has been found to range from 3.2 litres in the 1-3 year olds to12.4 litres in the 7-9 year olds (Akpata *et al*, 2003). This translates to daily fluoride ingestion from drinking water in excess of the 0.04-0.07mg/kg body weight regarded as appropriate or upper limit during tooth mineralization if the fluoride concentration of the consumed water is 0.7ppm (Ophaug *et al*, 1985; Burt, 1992). Akpata *et al* (2003) had, based on the above findings, recommended that the optimal fluoride level for drinking water in the North-Central geopolitical zone of Nigeria should be less than 0.6ppm.The occurrence of fluorosis in this area may be due to a combination of factors including the inappropriate fluoride level in the drinking water. Its low prevalence could be explained by the relatively low fluoride concentration in the drinking water compared to the very high levels in the waters in Langtang.

The prevalence is however significantly higher in the high altitude part of the district compared to the low altitude ones ($\chi 2=85.735$; df=1;$p < 0.0001$) (Table 2). This is in agreement with the findings of several other workers including Akpata and colleagues who also found a statistically significant relationship between altitude and prevalence of dental fluorosis among school children in the North-Central geopolitical zone of Nigeria. The effect of altitude remained significant after controlling for the fluoride levels of their drinking water. Similarly, Rwenyonyi and colleagues (1999) found altitude to be a significant risk indicator of fluorosis after controlling for potential confounders. Also in Tanzania, Yoder and colleagues reported in 1998 that the main risk factor for the existence of severe dental fluorosis in Tanzanian population consuming water with negligible fluoride concentration was altitude. These reports lend weight to the belief that altitude is a major risk factor for the etiology of dental fluorosis. Previous studies available have all reported significant association between altitude and the prevalence and severity of dental fluorosis though in none was altitude found to be the sole risk factor.

Most of the cases of dental fluorosis found in this study are of the mild type. This is similar to the findings of Akpata *et al* (1997), Wongdem *et al* (2000), El-Nadeef and Honkala (1998), Ng'ang'a and Valderhaug all of which reported similar patterns of severity of fluorosis: most cases have less than moderate fluorosis and only very few have severe fluorosis. The findings of Akpata, Fakiha and Khan in Saudi Arabia and Ollson in Ethiopia were quite different. Most cases had moderate and severe dental fluorosis (Akpata *et al*, 1997); (Ollson, 1979).

It has been maintained that fluoride balance and its tissue concentration, and hence the risk of fluorosis, are increased by factors such as residence at high altitude (Whitford, 1997). This could be the mechanism by which high altitude causes fluorosis and may explain the higher prevalence of fluorosis found in the high altitude areas of this district.

It is therefore concluded that the prevalence of dental fluorosis in the high altitude parts of the Central Senatorial District of Plateau State is higher than that in the low altitude ones. Altitude and the fluoride level of water may be responsible but further studies are needed to determine the individual contributions of these factors to the fluorosis experience.

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