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PREVALENCE OF DENTAL FLUOROSIS AND FLUORIDE CONTENT IN DRINKING WATER IN THE FAR NORTH REGIONOF CAMEROON

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ABSTRACT

BACKGROUND: Consumption of fluoridated ground water remains the main cause of dental fluorosis.

AIM: To establish the risk factors of dental fluorosis in three communities of the Far North Region of Cameroon.

METHODOLOGY: A descriptive, cross-sectional study conducted on individuals who have lived for a minimum of 6 years in three communities from Far North Region of Cameroon using structured questionnaires and oral examination. The Thylstrup and Fejerskov index was used in evaluating the severity of dental fluorosis. Fluoride contents of drinking water were analysed using fluoride electrodes.

RESULTS: A total of 1971 persons mean of age 17.15(SD=±16.18) born (85.64%) in the study area participated in the study. The prevalence of dental fluorosis was 89.1%. Fluorosis was first observed between the ages of 1 to 10 years old, 1781(90.01%) perceived dental fluorosis to be normal, 1772(89.90%) did not know the cause of dental fluorosis in their community. A TFI score of 0 was recorded by 10.9% of the population with higher scores in females 3.04(SD=±2.3 SD), illiterates 3.31(±2.45), farmers 3.49(±2.3 SD) and those who lived in their own homes 3.06(±2.31 SD). Sources of drinking water included borehole 61.6%, 47.4% well water,2.2% bottled water while 80% used toothpaste for brushing. One out of five commercial bottled water brands had a higher than normal fluoride content (1.60mgF/L), pipe borne water 1.7mgF/L, wells 1.90mgF/L, boreholes 2.80mg F/L while 51.2% of the population presented with mild fluorosis and 23.7% severe fluorosis.

CONCLUSION: The prevalence of dental fluorosis was extremely high; the knowledge on the origin of fluorosis was poor and the acceptance of dental fluorosis was high. Consumption of ground water was the major risk factor of dental fluorosis.

Key words: Risk factors, knowledge, dental fluorosis, Fluoride, Cameroon

INTRODUCTION

1.0 Background

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Fluorine is an abundant trace element in the Earth's crust (1).The presence of fluorine in bedrocks is the primary source fluoride in ground water, though fluoride occurrence varies with the different rock types (2). High concentrations of fluoride ions are found in regions with igneous rock dominance (3)(4). Volcanoes are the main persistent natural source of fluoride in ground water and in the atmosphere (5)(6) . Fluoride occurs naturally in the environment and it is consumed in small amounts (7). The occurrence of high fluoride in ground water has been reported worldwide as it has a considerable impact on human health (8)(9). Exposure can occur through dietary intake, respiration and by consuming fluoride supplements, but the most important factor for fluoride presence in alimentation is water with high levels of fluoride. During pregnancy, the placenta acts as a barrier, though fluoride does cross the placenta in low concentrations (7). It can also be transmitted through the plasma into the mother's milk in low concentrations.

The most important effect of fluoride on dental caries incidence is through its role in the process of remineralization and demineralization of tooth enamel. The fluoride ion exists in natural waters and it is an essential micronutrient in humans in preventing dental caries and facilitating the mineralization of hard tissues if taken at a recommended range of concentration. Methods which led to greater fluoride exposure and lowered caries prevalence are considered to be one of the greatest accomplishments in the 20th century`s public dental health (7).

The action of fluoride is topical when it is present in the saliva in the appropriate concentration(7). High levels of fluoride in groundwater is a worldwide problem (10). The World Health Organization (WHO) has set a guideline of 1.5 mg/L for fluoride in potable water. Concentrations higher than this value can lead to fluorosis (dental and/or skeletal) and several types of neurological damage in severe cases (11,12).

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Acute toxicity can occur after ingesting one or more doses of fluoride over a short period of time that can then lead to poisoning. Today, poisoning is mainly due to unsupervised ingestion of products for dental and oral hygiene and water with excessively high fluoride levels (7).

Fluoride is the most important caries-preventive agent in dentistry. In the last two decades, increasing fluoride exposure in various forms and vehicles is most likely the explanation for an increase in the prevalence of mild-to-moderate forms of dental fluorosis in many communities (13).

The effects of fluoride on enamel formation causing dental fluorosis are cumulative, rather than requiring a specific threshold dose, depending on the total fluoride intake from all sources and the duration of fluoride exposure. Enamel mineralization is highly sensitive to free fluoride ions, which uniquely promote the hydrolysis of acidic precursors such as octacalcium phosphate and precipitation of fluoridated apatite crystals. Once fluoride is incorporated into enamel crystals, the ion likely affects the subsequent mineralization process s by reducing the solubility of the mineral and thereby modulating the ionic composition in the fluid surrounding the mineral (13). In the light of evidence obtained in human and animal studies, it is now most likely that enamel hypomineralization in fluorotic teeth is due predominantly to the aberrant effects of excess fluoride on the rates at which matrix proteins break down and/or the rates at which the by-products from this degradation are withdrawn from the maturing enamel (13). Any interference with enamel matrix removal could yield retarding effects on the accompanying crystal growth through the maturation stages, resulting in different magnitudes of enamel porosity at the time of tooth eruption. Presently, there is no direct evidence that fluoride, at micro molar levels, affects proliferation and differentiation of enamel organ cells (13). Fluorosis due to excess fluoride *intake* has been reported in Norway while in Mexico, Nigeria and Kenya it was reported to be as a result of excess fluoride in *water(13,14,15).*

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The effects of dental fluorosis range from cosmetic to social and psychological problems (16). Poor aesthetics caused by dental fluorosis may have negative effects on individual's personality, lead to stigmatization within the community and in the job market (17). In addition, the rough tooth surfaces associated with pitting of enamel results in a high prevalence of dental caries (18).

In general, there is strong evidence showing a relationship between knowledge and health outcomes, especially where poor knowledge predisposes to poor health outcomes(19). Knowledge on the cause of fluorosis in communities in the Far North regions of Cameroon is very low as the majority of the communities are uneducated and live in abject poverty. Shrinking water sources and high temperatures due to climate change leave these vulnerable communities not only exposed to water-borne disease such as Cholera (20) but to increased concentrations of excessive fluoride in ground water. This exposes the communities to both water- borne diseases and the occurrence of dental fluorosis.

The Far North region of Cameroon encompasses Lake Chad, which is shrinking at an alarming rate due to climate change. There is a loss of natural water sources due to increasing temperature (21). Together with the rapid rate of desertification, it can be anticipated that more communities in this region are going to be at risk of dental fluorosis. High temperatures favour elevated concentrations of minerals (including fluoride) and salt in local water sources (22). There is paucity of literature on the prevalence and risk factors of dental fluorosis in Cameroon and none from the Far North Region of Cameroon.

Therefore,the aims of the current study was to establish the risk factors and knowledge of dental fluorosis in three communities of the Far North Region of Cameroon, to describe the clinical presentations of fluorosis of the communities using the Thylstrup and Fejerskov (TF) dental fluorosis index and to establish the unmet treatment of the community.

METHODS

This was a descriptive, cross-sectional study with an analytic component that was carried out specifically in the three Far North Regions of Cameroon (Figure 1). The Far North Region, also known as the Extreme North Region (from French: Région de l'Extrême-Nord), is the northernmost constituent province of the Republic of Cameroon. It borders the North Region to the south, Chad and Nigeria to the west. The capital is Maroua. The Northern Province is one of Cameroon's most culturally diverse. Over 50 different ethnic groups populate the area, including the Shuwa Arabs, Fulani, and Kapsiki. Most educated inhabitants speak French, and the Fulani language, Fulfulde, is a common lingua franca. The present study was carried out in the following counties as depicted in Figure 2 below: Logone-et-Chari, with its capital at Kousséri, Diamare with its capital at Maroua and Mayo-Tsanaga, with its capital at Mokolo.

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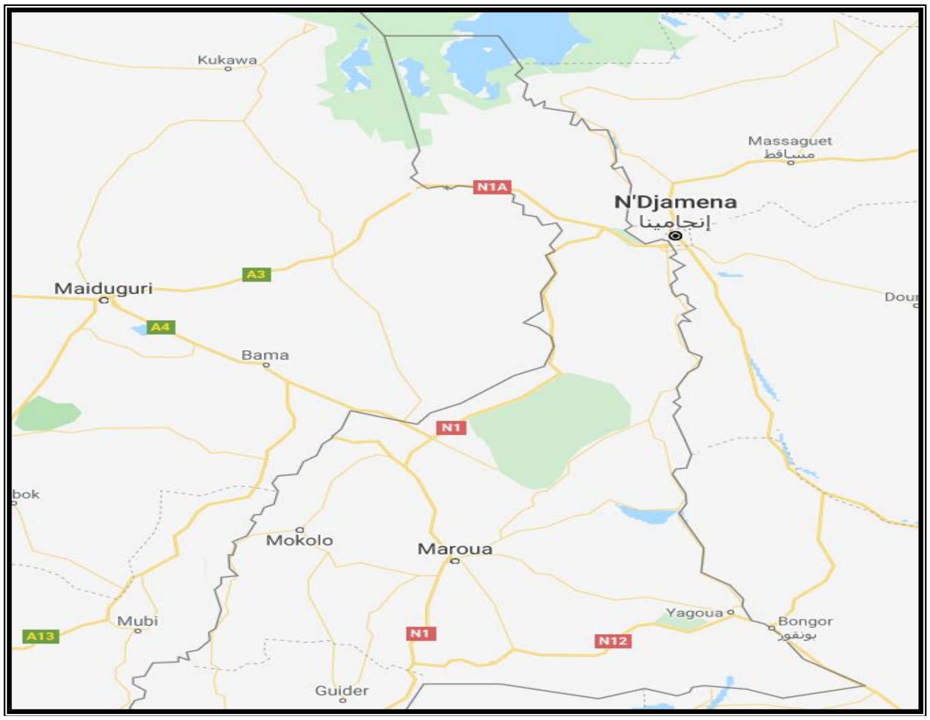

Figure 1: Logone-et-Chari (capital Kousséri); Diamare (capital Maroua) and Mayo-Tsanaga (capital Mokolo) of the Far North region of Cameroon.

Sedimentary rock such as alluvium, clay, limestone, and sandstone forms the greatest share of the Far North's geology. These deposits follow the province's rivers, such as the Logone and Mayo Tsanaga, as they empty into Lake Chad to the north. At the province's south, a band of granite separates the northern area from a zone of metamorphic rock to the southwest. The Rhumsiki Valley, a mountainous field littered by the cores of extinct volcanoes, constitutes a small area of volcanic rock (21).

A number of rivers criss-cross the territory, many of them rising in the Mandara Mountains. The Mayo Kébi, Mayo Louti, and their tributaries form part of the Niger River basin. The Louti rises in the Mandaras, passing and swelling the Kébi in the North Province. The Kébi rises south of Yagoua and flows into western Chad. The province's other rivers are part of the Chad Basin. The El Beid River flows northwest from the Kalamalou National Park and forms the northernmost stretch of the border between Cameroon and Nigeria (21).

The Mandara Mountains at the South-Western border with Nigeria form the highest point, lying between 500 and 1000 metres, with an average of about 900 metres. The area was once volcanically active, as a number of freestanding features of extinct volcanoes attest. This most revealed in the valley near the Rhumsiki (21).

The Far North of Cameroon is hot and dry. Beginning at 10° N, the climate is tropical and Sahelian, and rainfall is a relatively small 400 to 900 mm per year, hence crops planted are subject frequent irrigation for good yield. With rains falling a bit more frequently in the Mandara region. South

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of 10°, the region west of the Mayo Kébi and south to the border with Chad, in the Cameroonian beak. The climate is tropical of the Sudan type, with higher rainfalls of 900 to 1,500 mm per year. Temperatures average 26 °C, except for the Chad Basin, which increases to 28 °C. Actual temperatures of course fluctuate with the seasons, however. At Kousséri, for example, there is an
8.9 °C difference between 23.5 °C in January and 32.4 °C in August (20)

Study population

The study population was a convenience sample who after receiving information about the study gave informed consent. They included anyone who had a *permanent dentition* irrespective of age who have lived in the selected area of study for more than 6 years.

Sample size determination

A prevalence of dental fluorosis of 80% as recorded in the study by El- Nadeef and Honkala (1998) was used in the study. The sample size was calculated using the Lorenz formula (4) for sample size determination and a minimum size of 246 was calculated for each village.

Sampling

Samples were chosen using a multistage stratified sampling technique in which the map of the region was used for selecting counties where fluorosis is predominant. In each county, a subdivision was chosen at random for the sampling and in each subdivision 2 villages was randomly selected to collect data. Subjects in each of the selected villages were selected from house to house randomly; therefore all individuals in each stratum who fulfilled the study criteria were invited to participate.

An interviewer administered questionnaires to collect information from the subjects followed by a clinical oral examination carried out on the subject using a portable dental couch under natural light in a suitable place in the subject's residence. All eligible participants were interviewed using open ended and close ended questionnaires after signing a consent form .Consent for minors were obtained from parents and or their guardians.

Household potable water were collected using a sterile water bottle from the different sources of drinking water from the community. The identification label of the bottle provided for sample collection was recorded indicating the village and the sources of water.

Retail stores located in the localities were identified and randomly selected and visited for the purchase of different brands of bottled water. Water samples of different drinking sources such as wells, pipe borne, and boreholes were collected.

To ensure blinding of the analyzing laboratory personnel, bottled water were transferred to half litre plastic bottles that had been rinsed with de-ionized or distilled water and lids securely sealed. All water samples collected were stored in a dark box, in a cool room before being transported for laboratory analysis for fluoride content. All samples were transported within 48 hours after collection.

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4.3 Selection criteria

Since the water was being measured for its present Fluoride content and not its historical fluoride content from say 25 years ago, a younger cohort from the community that is more likely to have been exposed to the fluoride at present levels was examined.

Therefore included in the study were

All members of the community who have been living in the study area for at least 6-8 years,children and adults with mixed and permanent dentition who have been living in the study area for 6-8 years and children and adults who consent to an interview and to undergo an oral examination .

Excluded in the study were; Individuals who refused to participate in the study or do not consent,individuals with pathologies that can be confused with fluorosis and members of the community who recently migrated into the area of study with or without dental fluorosis presentations

4.6 Instrument used

After a pilot study with a sample size of 10 participants was used to test the questionnaire on individuals with fluorosis in terms of practicability and relevance , irrelevant and problematic items were identified and deleted or reformulated. A final draft of the questionnaire was then printed and used for the final study sample. This structured researcher administered questionnaire was used to collect data. The questionnaire was used to collect information on the socio-demographic profile of the subjects, their general health status, their knowledge of fluorosis, their perception of their oral health, oral health seeking behaviour, sources of drinking water etc.

Data Collection

Data collection was in three parts: (i) Administration of a questionnaire; (ii) an oral examination to determine extent of fluorosis and (iii) collection of drinking water for laboratory analysis

After obtaining all the required administrative and research ethics clearances, a door-to-door recruitment was done and an information sheet (Appendix 1) was given to prospective participants. Informed consent (Appendix 2 and Appendix 2a) was obtained and a semi-structured questionnaire (Appendix 3) was used to obtain demographic and other information, thereafter an oral examination was carried out (Appendix 4). Data was collected using a structured open and closed- ended bilingual (French and English) questionnaires together with a data capture sheet attached to the questionnaire for charting the oral clinical examination.

Respondents were interviewed after reading the information sheet and completing and signing the consent form.

The clinical examination was carried out using examinations instruments under natural light. All subjects who consent to participate received an oral examination and findings were recorded in a specially designed clinical examination data capture sheet (Appendix 4).

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The intra-oral examination followed a standard procedure under natural lighting was used to detect the translucence of enamel and a wooden spatula used to retract oral soft tissues. Teeth were dried with sterile gauze, and the scoring was done according to the Thylstrup and Fejerskov (TFI) dental fluorosis index (Appendix 5).

All erupted and sound teeth were be scored for fluorosis using the TFI index (Appendix 5). The highest recorded TF score in the participants was regarded as the overall TF score for the participant. Photographs were taken after participants have consented to have images of their teeth only (Appendix 6).

Participants who were diagnosed with any type of oral diseases/conditions were be recorded and referred to the nearest dental services (Appendix 7).

The fluoride ion selective electrode analysis method was used and reporting of fluoride concentration was in milligrams per liter (APHA, 1995). Data capture sheets was used to record details of the selected children and matching of water bottles (Appendix 8). All samples of water was transported to the analyzing laboratory at the Universities des Montagnes Pharmacology Laboratories (the only laboratory with a fluoride electrode in Cameroon).

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4.8 Statistical analysis

Information was retrieved from the completed questionnaires and transferred to a spread sheet in Microsoft Excel 2010 for storage and analysis. The collected data was categorized, coded and entered into the computer. Statistical Package for Social Sciences (SPSS) version 23.0 software was used and analysed for descriptive statistics including frequencies, means and standard deviation was used. Statistical significance tests were performed with chi-square test of significance for categorical variables and correlation coefficients. The relationship between participants' response on risk factors for dental fluorosis, reported fluoride level of sampled water and the severity of dental fluorosis were investigated using analysis of variance (ANOVA), and independent sample t-test

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4.9 Validity and reliability of data

Validity: To ensure that the data is valid the researcher who is a qualified dental practitioner were carry out all the examinations. The author was the only investigator involved in the gathering of data. Interpretation of data and statistical analysis was done by the author and an independent statistician. To ensure validity, the questionnaire was subjected to a test-retest procedure.

Reliability: Prior to measurement, the investigator was calibrated by two independent researchers to ensure uniformity of the oral examination. A kappa statistic of 0.873 was obtained, indicating good agreement. Consistency was also controlled by repeating the scoring for every eight individuals examined for intra-examiner reliability. A kappa statistic of 0.840 was obtained, indicating good agreement.

4.10 Ethical considerations

4.10.1 Permission and consent

Permission to carry out this study was obtained from the regional delegation of the Ministry of Higher Education and Scientific Research, the county's administration and the local community leaders. All eligible participants were recruited from the selected houses and the study were described to the participants and they were allowed to participate in the study voluntarily.

The research proposal was approved by the Biomedical Research Ethics Committee of the University of the Western Cape (Ethics Reference Number: BM19/5/17) (Appendix 9). Further research approval was obtained from the Ministry of Higher Education and Scientific Research in Cameroon and the local community (Appendix 10). Participation in the study was completely voluntary and anonymous and signed valid informed consent was obtained from each participant. Anonymity was secured by not using the participant's names on the questionnaire and the questionnaire was recorded with reference codes. A separate consent form (Appendix 6) was signed if photographs were taken. Interviews and oral examinations took place in the privacy of the participants own home.

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RESULTS

Demographic information

Gender

Half of the participants were males (n=1008, 51.1%). The mean TFI score for paticipants was TFI score of 3.01 (SD=2.3), with males recording a mean TF score of 2.98 (SD=2.3) and females (n=963 48.9%) a mean TF score of 3.04 (SD=2.3). The relationship between gender and the TFI scores was not statistically significant (p=0.456) (Table 2).

Table 2: Association between TFI score and gender

Variable		Frequency (%)	TFI Mean Score (SD)	Statistical test	p-value
Gender	Male	1008 (51.1)	2.98 (2.3)	t = -0.617	0.456
	Female	963 (48.9)	3.04 (2.3)		
	Total	1971 (100)	3.01 (2.3)		

t –statistic reported for independent t-test.

Age distribution

A third the sample were aged between 0-6 years old (n=574, 29, 1%), 21.7% were between 6-12 years old and 3.9% were over the age of 50 years. The mean age of the sample was 17.15 and (SD=16, 18) (Table 1).

Level of education, occupation and Occupancy ***status***

More than half 1144(58%) of the participants had only primary education with mean TFI score of 2.99(±2.22 SD), 253(12.8%) were illiterate with mean TFI score of 3.31 (2.45 ±SD) and n=97 (4.9%) had a higher education with mean TFI score of 3.29 (±2.90 SD) .The relationship between TFI Score and level of education was not statistically significant as (F (3,1967) = 2.368, p = 0.069).

More than two thirds 1042 (71.10%) were students with mean TFI score of 2.86 (2.25 ±SD), 380 (19.3%) farmers with mean TFI score of 3.49 (2.3 ±SD), labourers22 were 45(2.28%) with mean TFI score of 2.98 (2.61± SD).The relationship between TFI scores and the occupation of participants was seen to be statistically significant as (F (5, 1965) = 6.128, p = < 0.001). The majority 1706 (86.6%) lived in their own homes with mean TFI score of 3.06 (2.31± SD), 255 (12.9%) rented the houses with mean TFI score score 2.66 (2.38± SD). Only 10 (0.5%) participants lived in corporate or institutional houses with mean TFI score of 4.60 (2.91± SD). The relationship between TFI score and occupancy status was seen to be significant as (F ((2, 1968) = 5.590, p = 0.004) (Table 1).

Table 1: Association between TFI score and age group, educational or occupancy status

Variable	Frequency (%)	TFI Mean Score	Statistical test	p-value

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			(SD)		
Age group	0-6 6-12 12-25 25-50 >50	574 (29.1) 427 (21.7) 407 (20.6) 487 (24.7) 76 (3.9)	17.15 (16.18)	F(3,1967) = 2.368	0.069
Educational level	Illitrate Primary Secondary Tertiary	253 (12.8) 1144 (58) 477 (24.2) 97 (4.9)	3.31 (2.45) 2.99(2.22) 2.88(2.34) 3.29(2.90)	F(3,1967) = 2.368	0.069
Occupation	Students/Pupils Farmer House wife Civil Servant Businessman Labourer	1402(71.1) 380 (19.3) 28 (1.4) 67 (3.4) 49 (2.5) 45 (2.3)	2.86 (2.25) 3.49 (2.3) 3.50 (2.55) 2.89 (2.82) 3.88 (2.57) 2.98 (2.61)	F(5,1965)= 6.128	< 0.001
Occupancy status	Cooperative Own house Rented	10 (0.5) 1706(86.6) 255 (12.9)	4.60 (2.91) 3.06 (2.31) 2.66 (2.38)	F(2,1968)= 5.590	0.004

F statistic reported for analysis of variance (ANOVA)

Place of Birth and Duration of Exposure

The majority 1638 (85.64%) of the inhabitants of the community were born in the area of study while 333 (14.36%) were not. Of the 333

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participants not born in the study sites, more than two thirds 246 (73.87%) had lived in the area for more than 10 years (Table 5).

Table 2. Place of Birth and Duration of Exposure

Variable	Categories	Frequency(n) (%)	Percent
Born in an endermic flouoride area?	YES	1638	85.64
	NO	333	14.36
	TOTAL	1971	100.00
If no how long have you lived in endermic fluoride area?	6 to 10yrs	87	32.67
	>10yrs	246	73.87
	TOTAL	333	100.0

Knowledge of dental fluorosis

Relationship of Participants knowledge on the risk factors for dental fluorosis and severity of dental fluorosis.

The presentation of dental fluorosis in these communities was into groups to facilitate improved cell number statistical analysis. The groups were TFI 0-2, TFI 3-4 and TFI 5-9.Table 5 summarises the relationship of knowledge on dental fluorosis in these communities with severity.

Dental fluorosis was seen to most severe in participants who had primary education which was statistically significant with (p=0.001).An overwhelming majority of participants (n=1805, 91.5%) said they have seen persons with discoloured teeth which was statistically significant as (p=0.051) and that it occurs between the age 1 to 10 years of age .Majority 1779 (90.2%) said they do not know they cause of teeth discoloration recording the most severe forms of fluorosis which was statistically significant as (p=0.001). Teeth discolouration was most severe amongst participants who responded that discoloration is normal by participants 1781 (90.3%) and was statically significant with (p=0.001). Majority of the participants said well (ground) water was given to children 0 to 1yrs for drinking

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which was statistically significant as (p=0.001). Majority did not boil water before drinking and did not use another source of drinking water with (p=0.033) and (p=0.805) respectively.

Table 6 . Relationship of Participants knowledge on the risk factors for dental fluorosis and severity of dental fluorosis.

Variables	Categories	Severity of dental fluorosis			Total	P value
		TFI 0-2	TFI 3-4	TFI 5-9		
What is your level of education?	Primary	582 (50.9)	310 (27.1)	252 (22)	1144	0.001
	Secondary	264 (55.3)	105 (22)	108 (22.6)	477	
	Tertiary	49 (50.5)	13 (13.4)	35 (36.1)	97	
	Illitrate	115 (45.5)	65 (25.7)	73 (28.9)	253	
What is the cause of discoloured teeth?	Fluoride	2 (22.2)	6 (66.7)	1 (11.1)	9	< 0.001
	Salt water	75 (41)	45 (24.6)	63 (34.4)	183	
	Don't know	933 (52.4)	442 (24.8)	404 (22.7)	1779	
At what age can discoloration occur?	Below 1 yer	134 (53.6)	66 (26.4)	50 (20)	250	0.399
	1 – 10 yr	860 (50.7)	423 (24.9)	413 (24.4)	1696	
	10 – 15 yr	16 (64)	4 (16)	5 (20)	25	
What type of water do you give children 0 to 1yr?	Bottle water	207 (60.7)	69 (20.2)	65 (19.1)	341	< 0.001
	Local pipe born	105 (60.7)	45 (26)	23 (13.3)	173	
	We	69	37	380	14	

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	ll water	8 (47.9)	9 (26)	(26.1)	57	
Do you boil water before drinking?	Yes	66 (42)	51 (32.5)	40 (25.5)	157	0.033
	No	944 (52)	442 (24.4)	428 (23.6)	1814	
Do you regularly use other sources of water?	Yes	62 (48.4)	34 (26.6)	32 (25)	128	0.805
	No	948 (51.4)	459 (24.9)	436 (23.7)	1843	
Seen anyone with coloured teeth?	Yes	939 (52)	448 (24.8)	418 (23.2)	1805	0.051
	No	71 (42.8)	45 (27.1)	50 (30.1)	166	

p-value reported for chi-square test. well water represented ground water boreholes inclusive*

5.3.2 Community perception on dental fluorosis

The majority1781 (90.3%) of the population perceived teeth discolouration as normal and was statically significant with (p=0.001) and 1460 (74.1 %) said discoloured teeth cannot be treated at the dental clinic which was statistically significant as (p=0.053).

Table 7. Community perception on dental fluorosis with severity

Variable	**Categories**	**Severity of dental fluorosis** TFI 0-2 n(%)	TFI 3-4 n(%)	TFI 5-9 n(%)	**p-value**
What do you think about brown coloured teeth?	Normal	827(41.9)	672(34.1)	282(14.3)	p =0.001
	Affects smile	35(1.7)	42(2.1)	79(4.0)	
	Difficulty eating	4(0.2)	15(0.7)	21(1.0)	
Do you think discoloured teeth can be treated in the dental clinic?	YES	207(40.5)	168(32.8)	136(26.6)	p =0.053
	NO	603(41.3)	439(30.6)	418(28.6)	

Community perceptions on local drinking water

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The majority 1781(90.36%) of the participants had no problem with the water they drink hence only 190(9.64%) claim to have noticed a problem. Among 190 (7.35%) of them that noticed a problem with their drinking water and 90(83.33 %) experienced a taste problem. While 52(27.37%) said dislike the smell of the water, 48 (25.26%) did not like the colour (Table 8).

Table 8. Community perceptions on local drinking water

Variable	Response	Frequency (%)
Have you noticed any problem with you drinking water?	No	1781 (90.36%)
	YES	190 (9.64%)
If yes , what was the problem	Colour	48(25.26%)
	Smell	52(27.37%)
	Taste	90(47.37%)

Risk factors fordental fluorosis

Sources of drinking water & brushing with toothpaste

Two thirds of the sample 1214 (61.6%) reported that they use borehole water as source of drinking water, 934 (47.4%) use well water and 43 (2.2%) consumed bottled water (Figure 3). Nearly 1576(80%) reported that they use toothpaste when brushing their teeth (Table, 13)

Analysis of Bottle water samples

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Five brands of commercially available bottled mineral water were reportedly consumed by the participants in the present study. Aqua Belle bottled water had a higher than normal fluoride content (1.60mgF/L). The other four brands, Sahel, Faro, Supermont water and Sahel Spring mineral water were found to have safe concentrations of fluoride with their respective values < 1.5mgF/L (Table 9).

Table 9. Analysis of bottled water samples

Brand	Ph	Temperature (^oC)	Mg F/L
Aqua Belle	6.99	23.4	1.60
Supermont	6.99	23.9	0.19
Sahel spring	6.99	23.8	0.10
Sahel	7.01	23.7	0.06

Analysis of drinking water sources

The village of Guilli had high levels of fluoride both water sources with its well and borehole water having values >1.5mg F/L. In the Bourha village, borehole water was found to have very high values of 2.8mg F/L. In Meri well water levels were low at 0.35mg F/L, while the borehole water had unsafe fluoride concentrations of 1.9mg F/L. This was the same Douvangar, while Madana had well water levels within the range of safety of 1.26mg F/L, but its borehole water was high at 2.63mg F/L. Kousseri has pipe borne water as its only source of potable water with values slightly higher than normal at 1.7mg F/L (Table 10).

Table 10. Analysis of Community Drinking Water Sources

Village / Suburban town	Water Source	Temperature	pH	Mg F/L
Guili	Well water	23.7	7.62	1.90
Bourha	Bore hole	24.1	7.10	2.23

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Meri	Well water	24.0	7.42	0.30
	Bore hole	23.8	7.47	2.80
Douvangar	Well water	23.8	6.20	0.35
	Bore hole	24.1	6.75	1.91
Madana	Well water	23.8	6.88	0.53
	Bore hole	23.1	6.59	2.63
Kousseri	Well water	24.0	6.60	1.26
	Bore hole	23.9	6.58	2.63
	Pipe borne	23.9	6.55	1.7

An independent t-test was performed to compare the usage of the various water types as per participants responds. All water sources were seen to be statistically significant. Well water consumers had a mean of TFI score (M), M= 3.3±2.4 SD=; t=5.335, p=<0.001.Pipe borne water consumers M=2.5±0.93 SD; t= -4842, p=<0.001. Borehole water consumers registered M=3.4±2.4 SD; t=4.149, p=<0.001 and bottle water consumers had M=1.9 ±2.3 SD; t= -2.969, p=0.003. Comparing the mean scores difference of borehole water (0.8) with well water (0.5) indicates that borehole water had greater implication than well water (Table 11)

Table 11: Relationship of sources of water used for drinking with mean TFI scores

Variable		**Frequency (%)**	**Mean TFI Score (±SD)**	**Statistical test**	**p-value**
Well	**Y**	**934**	**3.3**	**t =**	**< 0.001**

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	Yes		(±2.4)	5.335	
	No	1037	2.8 (±2.2)		
Pipe-borne water	**Yes**	**422**	**2.5 (±2.2)**	**t = -4.842**	**< 0.001**
	No	**1549**	**3.2(±2.3)**		
Bore hole water	**Yes**	**1214**	**3.4 (±2.4)**	**t = 4.149**	**< 0.001**
	No	**757**	**2.7 (±2.2)**		
Bottled water	**Yes**	**43**	**1.9 (±2.3)**	**t = -2.969**	**0.003**
	No	**1928**	**3.04(±2.3)**		

t – statistic reported for independent t-test.

The mean TFI scores were compared for types of drinking water given to children 0 to 1 year using analysis of variance (ANOVA) and is presented in Table 11 There was a statistically significant difference between the water types and TFI scores as (F (2, 1968) =13.122, p = < 0.001). The mean TFI score for well water (M=3.17±2.32 SD) was statistically different from all the other water type (Table 12)

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Table12: Relationship of types of water suggested to have been given to children 0 – 1 year with TFI scores.

Variable		Frequency (%)	TFI (SD)	Mean Score	Statistical test	p-value
Type of water	Bottel water	341 (17.3)	(2.37)	2.59	F(2,1968) = 13.122	< **0.001**
	Pipeborn water	173 (8.8)	(2.14)	2.53		
	Well water	1457 (73.9)	(2.32)	3.17		

F statistic reported for analysis of variance (ANOVA). in this table well water represented groundwater generally. Therefore borehole water inclusive*

Oral health behaviour

Oral Hygiene Practice

More the three quarters 1558 (79.04%) used toothpaste and tooth brush for their oral hygiene. While 413 (20.95%) use other methods to clean their mouth. 80(52.63%) of those using other method of brushing use salt and tooth brushes, 68 (44.74%) use chewing sticks in place of tooth brushes and 4 (2.63%) of the participants clean their teeth and mouth with their fingers and water only (Table 12).

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***Table* 13. Oral hygiene practices**

Methods	Frequency (n)	Percent (%)
Toothbrush and paste	**1558**	**79.0**
	261	**13.2**
Toothbrush and soap	**80**	**4.1**
Toothbrush and salt		
Chewing sticks	**68**	**3.5**
Fingers and water	**4**	**0.2**
TOTAL	**1971**	**100**

The mean TFI score for participants who used toothpaste during brushing was 3.06(±2.36 SD) and those who did not use toothpaste during brushing had a mean TFI score of 2.87(±2.87 SD).The relationship between toothpaste and TFI scores was not statistically significant (p=0.154). As seen in Table 14

Table 14: Relationship between use of tooth paste and TFI scores

Variable		**Frequency (%)**	**Mean TFI Score (±SD)**	**Statistical test**	**p-value**
Using toothpaste when brushing	Yes	1558 (79.1)	3.06 (±2.36)	t = 1.425	0.154
	No	413(20.9)	2.87 (±2.19)		
	Total	1971 (100)	3.01 (±2.3)		

t –statistic reported for independent t-test.

Oral Health-Seeking Behaviour

The majority of the participants1243 (63.06%) preferred to use herbal mixture as first responds to diseases when sick, 883(44.80%) of the participants used the local health facilities when sick, 18(0.91%) practice self-medication. The majority 1725 (87.51%) of the participants have never been to

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the dental clinic. Amongst those who have had oral care before only 39(15.86%) are regular at the dental clinic while 207(84.14%) are not regular (Table 14)

Prevalence of fluorosis

The prevalence of fluorosis in our study was 89.1% (CI= 87.8 – 90.5)

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Clinical Presentation of fluorosis using the Thylstrup and Fejerskov (TF) index

An overall score TF0 (total absence of any form of dental fluorosis) was seen in 211(10.72%) of the participants while TF9 the worst form of dental fluorosis was seen in 51(2.51%) of the participants. The majority 421(21.50%) presented with a TF score of TF2 (FIG 5).

Severity of dental fluorosis

Dental fluorosis was divided into 3 groups to better reveal severity. Mild represented TFI scores of 0-2 (n=1010), 51.2% CI (49.0 – 53.4). Moderate TFI score of 3-4(n=493), 25% CI (22.8 – 26.8) Severe TFI 5-9 (n=468%), 23.7 % CI (21.8 – 25.7) Table 15.

Table15: Severity of fluorosis

Severity	**Frequency (n)**	**Percent (95% CI)**
0 – 2	**1010**	**51.2 (49.0 – 53.4)**
3 – 4	**493**	**25 (22.8 – 26.8)**
5 – 9	**468**	**23.7 (21.8 – 25.7)**

Treatment needs

FIGURE 5 shows that all forms dental fluorosis score TF0 (normal) to TF9 (severe) were recorded. There is a need for aesthetic treatment and repair of enamel for participants (64.67%) with a score of TF1-TF4 in the form of micro-abrasion and bleaching. Those with TF5-TF7score (18.31%) require veneers while the most severe cases TF8-TF9 (5.5%) required full coverage crowns as recommended by Van Palestein and Mkasabuni (1993).

DISCUSSION

Controlled water fluoridation is very important in the control of dental caries but when fluoride is present in excessive concentration in drinking water, it can affect the oral health of the population. Fluoride is a "natural" pollutant of water in Africa (23). High fluoride levels beyond the recommended World Health Organization limit of 1.5 mg/L has been observed in various Africa countries (23).

In the present study, the presence of dental fluorosis in the Northern region of Cameroon was very high with a prevalence of 89.1%. This is a serious public health problem that requires urgent attention because excessive fluoride does not only affect the teeth, but also skeletal health as about 99% of the fluoride in the body is in the hard tissues (24).

Sociodemographic profile

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The present study sample showed that more males participated in the study. This could be due to the fact that the Far North regions of Cameroon has a very traditional conservative society. The researcher being a male had limited access with adult females due to the practice and beliefs of Islam. Islam is the most practiced religion in this region of Cameroon.

Children aged between 5 to12 years obtained the largest parental consent to participate in the study. Dental fluorosis was present in children with mixed dentition and this confirms the fact that there is early childhood exposure to excessive levels of fluoride in these communities. It has been reported that children with early fluoride exposure have aesthetic damage to their permanent dentition (25).

The majority of adults were peasant farmers with low income levels and had to rely on the natural water source (wells and boreholes) and forms of nutrition (organic) with no alternatives available to them. This was in contrast to the civil servants and businessmen in these communities who could afford to purchase bottled water for their families.

In the present study community, children were also seen to assist and participate in farming practices together with their parents. The intensity of their physical activities under high temperature contributed to increased intake of water, some with excessively high levels of fluoride.

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Temperature directly affects the amount of water intake (26). In the present study, the majority of the participants owned the house they lived in and declared that they were born in the area. Therefore, the duration of exposure to fluoride was over an extended period of time and this can only translate to higher risk of developing dental fluorosis due to chronic fluoride consumption from the water (27).

Knowledge of dental fluorosis

Being aware of the risk factors that cause dental fluorosis can greatly help community members to improve strategies to prevent it. The present study revealed that majority of the participants did not know the cause of dental fluorosis in their communities. A disease or disorder can be prevented if the cause is known. Fluorosis can be prevented by having an adequate knowledge of the fluoride sources, knowing how to manage this issue and therefore, avoid overexposure to dental hard tissues (28).

All of the participants in the present study said they have seen persons in their community who have discoloured tooth and that the majority presents in children between 1 and 10 years old. This means that they are aware about Dental Fluorosis in their community. It is clear that Knowledge and awareness of dental fluorosis are also important factors for individuals in a community to practice self-prevention and control dental fluorosis. Interestingly, nearly all the communities affected by DF perceive it to be a normal occurrence and are not disturbed by its manifestations. It seems that it is not a social problem, but rather the communities have adopted a tolerant approach towards it, possibly because so many are afflicted (29,23) .

Risk factors of dental fluorosis

The occurrence of dental fluorosis in a community acts as an indicator to the extent to which a community is exposed to high levels of fluoride. There are many risks factors to dental fluorosis. In the industrialized countries, fluoride supplements, fluoride dentifrices, fluoridated mouthwash and infant formula are reported to be the major risk factors in the development of fluorosis (31,32).

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In Far North of Cameroon just like elsewhere in Africa, fluoride contamination of drinking water sources is the major risk factor (33,34). Most the water samples (7 out of 11) obtained from the communities was seen to have unsafe levels of fluoride. In addition, one brand of bottled water analyzed was found to have an excessive fluoride content – much higher than normal levels of fluoride in bottled water. This poses a considerable risk considering that 6.89% per cent of the participants reported that they give bottled water to children aged 0 to 1 year. This period of development is seen as a critical age for the development of dental fluorosis (35). There is an unintended exposure to high doses of fluoride in this brand of bottled water and in an attempt to prevent water borne diseases in children, they are exposed to dental fluorosis.

Fluoride in bottled water has been reported to cause dental fluorosis (36). Since this particular brand is most widely used and popular in the entire Far North Cameroon it is a cause for concern. Community members have no access or knowledge of other sources of fluoridated substances for oral health care except toothpaste. Over three quarter of the participants 79.1% reported that they use fluoride dentrifices. This would have suggest that ingested dentifrices from early toothpaste use is an additional source of fluoride exposure and may be a contributing factor to the intensity and presentation of dental fluorosis but from statistical test and result it was revealed that the use of dentrifices had no influence on the occurrence of dental fluorosis in these communities. This accounts for the fact that participants who use toothpaste and those who do not use toothpaste still manifested with dental fluorosis.

Fluoride content of drinking water samples

Groundwater is the major source of drinking water in most places around the world but the concentration of fluoride varies from one geographical zone to another. The communities in the area of the present study used groundwater without any physical or chemical treatment for drinking and other domestic household purposes such as cooking (37). The present study found that excessive fluoride in drinking water sources is not only a major determinant of fluorosis in these communities, but also poses a serious public health problem as more than 90% of the population was affected by fluorosis.

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Fluoride contamination of water in Far North of Cameroon is purely of a geogenic source and this is all that the communities have access to since they rely mainly on ground water as a source of drinking water. Boreholes were mostly favoured as they contain water all year round due to their depth. Wells are less deep and seasonal and hence are not used all year round.

Laboratory analysis showed that most bottled water brands fall within the safety limit, but the most popular brand (consumers preferred choice) had very high levels – well above 1.5mgF/l. All boreholes and pipe-borne water sources were severely contaminated. The deeper the search for ground water into the earth, the greater the concentration of fluoride in the water. Most Well water samples were found to be within the range of safety probably on account of its shallow depth.

Another risk factor of fluorosis found in the present study was the salinity of the drinking water. Though this was not laboratory tested, nearly ten per cent of the participants reported that the saltiness of water was one of the causes of fluorosis. This could be due to the fact that the fluoride contamination in water is commonly seen in places with high water salinity which is associated with increased concentrations of fluoride ions in the soil. A study carried out in India by Mor and colleagues reported that salinity is mainly caused by magnesium salts as compared to calcium salts in the aquifer. The problem of salinization seems mainly compounded by the contamination of the shallow aquifers by the recharging water (38). Though Mor and colleagues (2008) suggested in their study that fluorosis associated with salinity is found in shallow wells, the present study found that the fluoride concentration was higher in deep wells and boreholes. This finding while contrary to Mor and colleagues (2008), concurs with the findings obtained by Idon and Enabulele (2018), possibly because this latter study was carried out in the same geographic zone in terms of rock type and climate as that of the Northern Cameroon. The high fluoride contents in wells and boreholes can also be associated to low rainfall and persistent high temperatures. Global warming associated with persistent rise in temperature and a decrease in the amount and duration of rainfall are some of the determinants encouraging arid conditions. Possibly in such arid conditions, low groundwater drain facilitates increased discharge of fluoride in groundwater system (39) as is the case in the Far North region of the Cameroon.

An interesting finding of the present study was the relationship between the pH of water and dental fluorosis - the fluoride content of the water samples were inversely proportional to the pH of the water. This was seen in borehole water that demonstrated at pH 6.5 corresponding to a

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Fluoride content of 2.6 Mg F/L. Low was seen pH encourages dental fluorosis. At low pH demineralization is activated and the health of the tooth enamel is endangered as excessive intake of fluoride into the enamel occurs. The present study shows that pH is an enhancing factor in fluoride intake as the mean pH of 6.5 seen in borehole water is close to the critical pH (5.5) of enamel demineralization. A similar finding was recorded when Friberger (1975) carried out an *in vitro* experiment on the fluoride intake in dental enamel with sodium and magnesium fluoride dentrifices of different pH ranging from 7.1 to 4.5 and reported that there while there was no significant difference between the agents, the effect of the pH was significant. It was concluded that the uptake of fluoride in the form of fluorapatite was more than five times larger at the lower pH level (40). He further reported that toothpaste gave the same initial rate of fluoride uptake (about 50 parts/10(6)/min) at pH 6 and that the rate of fluoride uptake in the outer layer of the enamel was proportional to the hydrogen ion activity (40).

Clinical presentations of fluorosis

The present study reported an overall high prevalence of dental fluorosis of 89.1%. The population` of Far North of Cameroon with high levels of dental fluorosis does not differ from the levels of severity of fluorosis reported previously in nearby North-eastern Nigeria (33).

All forms of fluorosis presentation where seen in these communities: from mild to moderate to severe those <50 years were seen to be more severely affected. This difference is due to the fact that in the past, communities relied on rainwater harvesting and shallow wells that had little or no fluoride contamination. Nowadays, the increasing population, low rainfall, high temperatures and high demand for water has left the population with no choice but to tap into well and borehole water that has resulted in a high demand to sink more boreholes (41). Since the introduction of boreholes, the younger generations have been encouraged to drink from its source unaware of the very high fluoride content of the water. This could be one of the major reasons why severe dental fluorosis was found in the younger age groups.

Owing to the fact that the present study community has a large stable population that has lived in the area for the more than 10 years, they have had a long exposure fluoride that has increased in severity over time. The prevalence and severity of fluorosis are directly related to the quantity of Fluoride ingested (35).

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According to Fejerskov *et al*. (1990), for each increase in the dose of 0.01 mg F/ kg, an increase of 0.2 in the community fluorosis index (CFI) can be expected. The critical age range for the development of dental fluorosis is around 15 to 30 months of life, when the permanent maxillary incisors are in the stage of transition between the enamel secretory and maturation phase (42). This was confirmed in the present study where fluorosis was reported by 86% of the subjects (in question 16) to develop at ages of between 1 and 10 years. The severity of DF in a community is determined by several factors including duration of consumption, diet, duration of breastfeeding, use of fluoride supplements, age, weight, nutritional status, and altitude (43,44).

Unmet treatment needs due to fluorosis

Treatment options for fluorosis varies with presentation of severity (45). The present study recorded all forms dental fluorosis from TF0 (normal) to TF9 (severe) unlike Okoye et al. (2019) (46) where no severe dental fluorosis was observed. At the high severity scores, teeth were badly damaged and not aesthetically pleasing. There was need for aesthetic treatment and repair of enamel for participants with a score of TF1-TF4 in the form of micro-abrasion and bleaching. Those with TF5-TF7 scores required

RECOMMENDATIONS

The Government of Cameroon, through its Ministry of Water and Energy Resources, needs to develop and establish a National Water Policy. The Policy should include safe levels of fluoride in drinking water. This can be achieved by use of locally available materials and methods in defluoridation treatment and storage facilities to enable populations to obtain water that is both safe to use and that prevents dental caries.

Furthermore, in areas with high levels of fluoride in the water alternative water sources need to be identified. Local and affordable techniques for the defluoridation of water such as defluoridation based on absorption with activated carbon or bone charcoal should be instituted forthwith in communities at risk.

Legislation needs to be developed limit the fluoride concentration in bottled water to below 1 mg per litre, and to ensure that bottled water companies and other water distribution companies clearly label the content and composition of their products.

Mass education about the causes and risk factors for dental fluorosis are urgently needed and should be available in local dialects to reach the vulnerable rural populations. The knowledge about sources of fluoride and its effect on dental fluorosis should be introduced in the children's education curriculum in local primary and secondary schools in the Far North region of Cameroon by the ministry of education because early education could be vital in curbing of the magnitude of the problem.

Parents and carers need to be educated about the risk factors for dental fluorosis including the use of infant formula and fluoride toothpaste for children less than three years of age. Advocacy and social mobilisation for de-fluoridation using appropriate technology.

There is a need for larger, wide-reaching longitudinal studies to establish water supply networks through appropriate mapping. This will assist communities to seek water sources that are safe for domestic use and where to institute de-fluoridation.

Further studies on dental fluorosis should be done so as to establish community fluorosis index

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(CFI) and Fluorosis Risk Index (FRI) in these communities.

REFERENCES

1)Tavener S J. Clark J H. Fluorine: friend or foe? A green chemist's perspective. Adv Fluor Sci 2006; 2: 177-202.

2)Keshavarzi A , Fereydoon S, Ahmad H & Mahmoud O. (2010). Land Suitability Evaluation Using Fuzzy Continuous Classification (A Case Study: Ziaran Region). Modern Applied Science. 4. 72-81.

3) Moghaddam A and Fijani E. (2008). Distribution of fluoride in groundwater of Maku area, northwest of Iran. *Environ Geol* 56**,** 281–287.

4)Berger T, Mathurin FA, Drake H, Åström ME.(2016). Fluoride abundance and controls in fresh groundwater in Quaternary deposits and bedrock fractures in an area with fluorine-rich granitoid rocks. Science of The Total Environment.Volumes 569–570, Pages 948-960

5)Halmer M M, Schmincke HU and Graf HF. (2002).The annual volcanic gas input into the atmosphere, in particular into the stratosphere:a global data set for the past 100 years, *J. Volcanol.Geotherm. Res.*, 115, 511-528.

6) D'Alessandro W , Bellomo S , Parello F. (2012). Fluorine adsorption by volcanic soils at Mt. Etna, Italy. Applied Geochemistry. 27. 1179–1188.

7) Kanduti D, Sterbenk P, Artnik B. Fluoride: A review of use and effects on health. Mater Sociomed. 2016; 28(2):133-7.

8)Ayenew T .The distribution and hydrological control of fluoridein ground water of central Ethiopia and rift adjacent highlands.Environ.Geol.2008 (54)1313-1324.

9)Mondal D, Gupta S, Reddy DV, Dutta G .Fluorine enrichment in alluvial aquifer with its subsequent effect on human health in Birbhum district West Bengal, India.Chemosphere.2017(168)817-824.

10)Khan S A, Thakur S K, Sarkar A, Shekhar S. Worldwide contamination of water by fluoride: Environmental Chemistry Letters.2016;10 (16) 0563-5.

11)Christie D P. The spectrum of radiographic bone changes in children with.Radiology,1980;July 136 (1) 85-90.

12)Haimanot RT .Neurological complications of the endemic skeletal fluorosis with special emphasis on radiculomyelopathy. Spinal cord. 1990;28 (4) 244.

13)Aoba T, Fejerskov O. Dental fluorosis: chemistry and biology. Crit Rev Oral Biol Med. 2002; 13(2):155-70.

14)El- Nadeef M. A. and Honkala E. Fluorosis in relation to fluoride levels in water in central Nigeria. Community Dentistry and Oral Epidemiology 1998; 26:26-30.

15)Chibole, O. (1988). Dental Caries Amongst Children in High Fluoride Regions of Kenya. *Journal of the Royal Society of Health*, *108*(1), 32–33.

16)Chankanka O, Levey SM, Warren JJ, Chalmers JM. A Literature review of the aesthetic perception of dental fluorosis and relationships with psychosocial aspects of oral health related quality of life. Community Dentistry and Oral Epidemiology 2010; 38 (2) 97-109.

Journal of research in health science
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17) De Castilho S, Ferreira F, Perini E Perception of adolescents and young people regarding endemic dental fluorosis in a rural area of Brazil: Psychological suffering. Health and Social Care in the community 2009; 17(6)557-563.

18) Makhanu M, Opinya G, Mutave R.J Dental fluorosis, caries experience and snack intake of 13-15Year olds in Kenya. *East African Med. J.2009: 85: 120-124.*

19)Vann WF, Lee JY, Baker D, Divaris K. Oral health literacy among female caregivers: Impact on the oral health outcomes in early childhood. J Dent Res 2010; 89: 1395-1400.

20)Arabi M, Xiao N, Taiwe KD, Liang S. Cholera Incidence in the Far North of Cameroon: A Geographical Perspective. African Journal of Social Science 2014; 5(3): 127 -141.

21)Ikuse M M, Alhaji M, Abdulssalam N B. Geospatial Assessments of the shrinking Lake Chad. Adamawa State University Journal of Scientific Research 2018;6(1): 114 -130.

22)Grimaldo M, Victor H, Adriana L, Ponce M, Rosas M, Diazbarriga F. Endemic Fluorosis in San-Louis Potasi, Mexico. Identification of Risk factors Associated with Human Exposure to Fluoride. Environmental Research 1995; 68(1):25-30.

23) Malago J,Makoba E, Muzuka AN. Fluoride Levels in Surface and Groundwater in Africa: A Review. *American Journal of Water Science and Engineering.* 2017 ; 3 (1): 1-17.

24)Palmer C A, Gilbert JA. Position of the Academy of Nutrition and Dietetics: The Impact of Fluoride on Health. Journal of the Academy of Nutrition and Dietetics 2012,Volume 112, Issue 9, 1443 – 1453

25)Rodrigues MH, Leite AL, Arana A, et al. Dietary fluoride intake by children receiving different sources of systemic fluoride. *J Dent Res*. 2009; 88(2):142–145.

26)Broffitt B, Levy SM,Warren JJ, Heller KE. Seasonal variation in fluoride intake: the Iowa fluoride study. J Public Health Dent. 2004; 64(4):198-204.

27)Burt BA. The changing patterns of systemic fluoride intake. J Dent Res. 1992;71:1228-37.

28) Jenny A , Karla R , Marocho S & Fabiana A, Paula C , Ana C . Dental fluorosis: Exposure, prevention and management. Medicina oral, patología oral y cirugía bucal. (2009). 14. E103-7.

29)Moturi WN, Tole MP, Davies TC. The contribution of drinking water towards dental fluorosis. A case study of Njoro division, Nakuru district, Kenya. Environmental Geochemistry and Health 2002; 24:123-130.

30)Wondwossen[a] F, Astrom A, Bardsen A, Bjorvan K. Perception of dental fluorosis amongst Ethiopian children and their mothers. *Acta Odontol Scand 2003; 61:81-86.*

31)Brothwell DJ, Limeback H. Fluorosis risk in grade 2 students residing in a rural area with widely varying natural fluoride. Community Dent Oral Epidemiol. 1999; 27(2):130–136.

32)Riordan PJ. Dental fluorosis, dental caries and fluoride exposure among 7 year olds. Caries Res. 1993; 27(1):71–77.

33)Idon PI, Enabulele JE. Prevalence, severity, and request for treatment of dental fluorosis among adults in an endemic region of Northern Nigeria. Eur J Dent. 2018; Apr-Jun; 12(2): 184– 190.

34)Marwa J, Lufingo M, Noubactep C, Machunda R. Defeating Fluorosis in the East African Rift Valley: Transforming the Kilimanjaro into a Rainwater Harvesting Park .Sustainability 2018, 10(11), 4194; doi:10.3390/su1011419446.

Journal of research in health science
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www.journalofresearch.org
info@journalofresearch.org

SJIF 2020: 6.224
IFS 2020 4.085

35)Bosco de Oliveira LY, Ferreira Gandrade SHK, Arsati F, Campos OM, Souza FV. Exposure to fluoride of children during the critical age for dental fluorosis, in the semiarid region of Brazil. Ciênc. Saúde Coletiva 2018; 23(4): 1045-1054.

36)Chigozie I, Nwogu N. Fluoride in Bottled Water. Water Bulletin 2018; 12: 6-16.

37)Brindha K, Elango L,Fluoride in Grounwater:Causes,Implication and Mitigation Measures.1st edition. .NOVA: 2011 , Pages 111-136 .

38)Mor S, Singh S, Yadav P. *et al.* Appraisal of salinity and fluoride in a semi-arid region of India using statistical and multivariate techniques. *Environ Geochem Health* **31,** 643 (2009)

39)Edmunds W, Smedley PL. Fluoride in Natural Water. Water Bulletin 2013; 10:17-28.

40)Friberger P. The effect of pH upon fluoride uptake in intact enamel. Scand J Dent Res. 1975 Nov; 83(6): 339-44.

41)Coertsiers M, Kilonzo F, Walraevens K. Hydrochemistry and source of high fluoride in groundwater of the Nairobi area. *Hydrological Sciences Journal 2008; 53: 1230-1240.*

42)Evans RW, Darvell BH. Refining the estimate of the critical period for susceptibility to enamel fluorosis in human maxillary central incisors. J Public Health Dent 1995; 55(4):238-249.

43)Robinson C, Connel S, Kirkham J, Brookes S J, Shore RC, Smith A M *et al*. The effect of fluoride on the developing tooth. Caries Res 2004; 38: 268-76.

44)Mascarenhas AK. Risk factors for dental fluorosis: A review of the recent literature. Pediatr Dent. 2000; 22: 269-77.

45) Akapata ES. Occurrence and management of dental fluorosis. Int Dent J. (2001)51:325–33.

46)Okoye LO, Ekwueme OEC, Sote EO, Amaechi BT. Prevalence of dental fluorosis among 12–15- year-old students in Enugu Metropolis, Nigeria. Indian J Dent Res 2019;30: 462-7.