Risk factors and knowledge of dental fluorosis in three communities in the far north region of Cameroon

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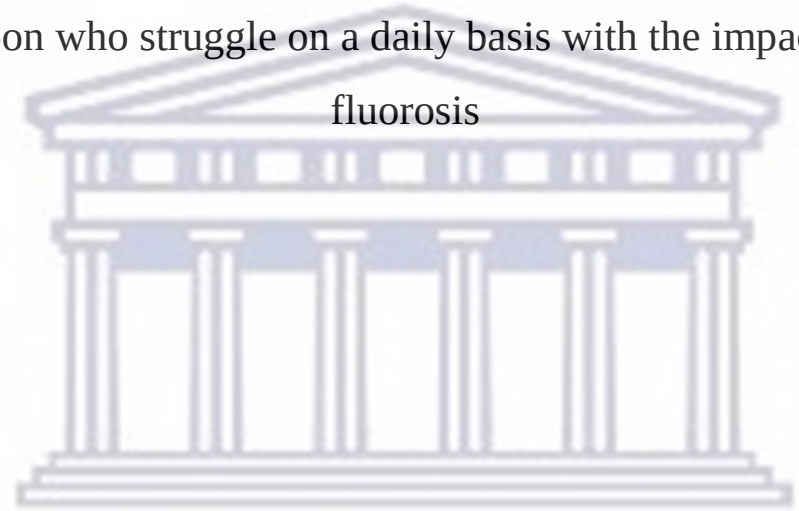
DEDICATION

This work is dedicated to the indigenous people of the Far North Region of Cameroon who struggle on a daily basis with the impact of dental fluorosis



ABSTRACT

BACKGROUND: Fluorine is an abundant trace element in the Earth's crust. The presence of fluorine in bedrocks is the primary source fluoride in ground water, though fluoride occurrence varies with the different rock types. High concentrations of fluoride ions are found in regions of volcanic activities. Volcanoes are the main persistent natural source of fluoride in ground water and in the atmosphere. The occurrence of high concentrations of fluoride in ground water has been reported worldwide. Dental fluorosis is a developmental disturbance of enamel that results from ingestion of high amounts of fluoride during tooth mineralization. Consumption of untreated fluoridated ground water remains the main cause of dental fluorosis in rural settlements.

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

METHODOLOGY: This study was descriptive and cross-sectional study with an analytic component and was conducted in three communities in Far North Region of Cameroon. The study population was a convenience sample irrespective of age, but who must have been living in the selected study sites for a minimum of 6 to 8 years. Structured questionnaires were administered to elicit socio-demographic characteristics, perceptions dental fluorosis and oral health practices. Oral examination was conducted to determine the extent of dental fluorosis that was scored according to the Thylstrup and Fejerskov index. Participants declared their water sources and water samples were obtained from these sources. Samples of commercial bottled mineral water was purchased from various local outlets. These samples were sent to a certified laboratory for fluoride analysis and are reported in milligrams of fluoride per litre.

DATA ANALYSIS: Data was entered into SPSS version 23.0 and analysed for means, ANOVA of means and chi-square test of significance for categorical variables. All tests for significance were set at 95% confidence level.

RESULTS: A total of 1971 persons from the three communities participated in the study. Two thirds were from Logone-et-Chari (n=701, 35.97%) and Mayo-Tsanaga (n= 701, 35.56%) respectively. The overall prevalence of dental fluorosis was 89.1% as (n =1751) with just 10.9% (n=214) recording a TFI score of 0. Slightly more than half of the sample was male (n=1008, 51.1%), recording a mean TF score of 2.98 (SD=2.3) and females a mean TF score of 3.04 (SD=2.3).

The majority of the participants were aged between 0-12 years (n=1001, 50.8%). The overall mean of age was 17.15(SD=16.18). More than half 1144 (58%) of the participants had only a primary education with a mean TFI score (SD) of 2.99(2.22); 253(12.8%) were illiterate with mean TFI score (SD) of 3.31 (2.45). More than two thirds (n=1042, 71.10%) were students with mean TFI score (SD) of 2.86 (2.25). Just under twenty per cent were farmers (380, 19.3%) with mean TFI score (SD) of 3.49 (2.3). A large majority lived in their own homes (n=1706, 86.6%) and had a mean TFI score (SD) of 3.06 (2.31); those that rented houses (255, 12.9%) had a mean TFI score (SD) of 2.66 (2.38). The majority of the participants (85.64%) were born in the area study. Nearly two thirds of the sample (n=1214, 61.6%) reported that they use borehole water as source of drinking water, 934 (47.4%) use well water and less than five per cent (n=43, 2.2%) consumed bottled water. Close 80% reported that they use toothpaste when brushing their teeth. Commercial bottled water analysis revealed that 1 out 5 brands had a higher than normal fluoride content (1.60mgF/L). Analysis of community declared source of water revealed that boreholes had fluoride content as high as 2.80mg F/L, 1.90mgF/L was highest for wells and pipe borne water registered 1.7mgF/L. Mild fluorosis was recorded in just over half (51.2%) and severe fluorosis was seen in nearly a quarter of the sample (23.7%). The majority (n=1704, 86.45%) reported that dental fluorosis is seen in children between the ages of 1 to 10 years old. The majority of the participants 1781(90.01%) perceived dental fluorosis to be normal and 1772 (89.90%) did not know the cause of dental fluorosis in their community.

CONCLUSION: The present study found a dental fluorosis prevalence of 89.1 % and that it is endemic in the three communities studied. Thus, dental fluorosis is a serious public health problem in these communities and children were most affected. There is a serious lack of knowledge and high level of acceptance to dental fluorosis. The present study also found that fluoride contamination of ground water was the major risk factor of dental fluorosis in these communities.

Further studies should be carried out in other areas of the Far North of Cameroon to quantify the extent of the problem. There is a great need for sensitisation, awareness and locally affordable methods of de-fluoridation so that dental fluorosis can be prevented.

CHAPTER 1: INTRODUCTION

1.0 Background

Fluorine is an abundant trace element in the Earth's crust (Tavener and Clark, 2006). The presence of fluorine in bedrocks is the primary source fluoride in ground water, though fluoride occurrence varies with the different rock types (Keshavarzi *et al*, 2010). High concentrations of fluoride ions are found in regions with igneous rock dominance (Moghaddam and Fijani, 2008; Berger *et al*, 2016). Volcanoes are the main persistent natural source of fluoride in ground water and in the atmosphere (Halmer *et al*, 2002; D'Alessandro *et al*, 2012). Fluoride occurs naturally in the environment and it is consumed in small amounts (Kanduti *et al*, 2016). The occurrence of high fluoride in ground water has been reported worldwide as it has a considerable impact on human health (Ayenew, 2008; Mondal *et al*, 2014). 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 (Kanduti *et al*, 2016). 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 (Kanduti *et al*, 2016).

The action of fluoride is topical when it is present in the saliva in the appropriate concentration (Kanduti *et al*, 2016). High levels of fluoride in groundwater is a worldwide problem (Khan *et al*, 2016). 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 (Christie, 1980; Haimanot, 1990).

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 (Kanduti *et al*, 2016).

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 (Aoba and Fejerkov, 2002).

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 by reducing the solubility of the mineral and thereby modulating the ionic composition in the fluid surrounding the mineral (Aoba and Fejerkov, 2002). 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 (Aoba and Fejerkov, 2002). 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 (Aoba and Fejerkov, 2002). 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* (Aoba and Fejerkov, 2002; El-Nadeef and Honkala, 1998; Chibole, 1988).

1.1 Problem Statement

The effects of dental fluorosis range from cosmetic to social and psychological problems (Chankanka *et al*, 2010). 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 (De Castilho *et al*, 2009). In addition, the rough tooth surfaces associated with pitting of enamel results in a high prevalence of dental caries (Makhanu *et al*, 2009).

In general, there is strong evidence showing a relationship between knowledge and health outcomes, especially where poor knowledge predisposes to poor health outcomes (Vann *et al*, 2010). 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 (Arabi *et al*, 2014) 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.

1.2 Justification

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 (Ikuse *et al*, 2018). 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 (Grimaldo *et al*, 1995). 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.

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

2.1 Definition and General Overview of Fluorosis

Fluorosis is a chronic disease resulting from the deposition of fluorides in the hard and soft tissues of body. It is a public health problem caused by excess intake of fluoride through drinking water, food products and industrial pollutants over a long period of time. Ingestion of excess fluoride, most commonly in drinking-water affects the teeth and bones (Aoba and Fejerkov, 2002; El- Nadeef and Honkala, 1998).

The excessive intake of fluorides can result in dental fluorosis, skeletal fluorosis and non-skeletal fluorosis. People exposed to large amounts of fluoride show dental effects much earlier than the skeletal effects (Aoba and Fejerkov, 2002; El-Nadeef and Honkala, 1982).

Dental fluorosis affects both children and adults leaving their teeth discolored and disfigured. Skeletal fluorosis affects the bones and major joints of the neck, backbone, shoulder, hip and knee joints resulting to severe pain, rigidity or stiffness in joints (WHO, 2001). Severe forms of skeletal fluorosis results in marked disability. Non-skeletal forms of fluorosis are earlier manifestations, which develop long before the onset of typical changes in teeth and skeletal bones these are seen as gastro-intestinal symptoms and may overlap with other diseases often leading to misdiagnosis. It affects men, women and children of all age groups (Ramesh *et al*, 2016).

2.1.1 Dental fluorosis

Dental fluorosis is a disorder, characterized by the hypo-mineralization of tooth enamel caused by ingestion of excessive fluoride during enamel development. It appears as a range of visual changes in enamel causing degrees of intrinsic tooth discoloration and in some cases, physical damage to the teeth. The severity of the condition is dependent on the dose, duration, and age of the individual during the exposure (Ramesh *et al*, 2016).

Dental fluorosis is a water-related disease as was stated by the World Health Organization (WHO) in 2001. The WHO provided a guideline of maximum fluoride content in drinking water of 1.5mg/litre/day. However, many countries have revised this to suit their local needs depending on the annual mean temperature and availability of other sources of fluoride.

The optimum level of fluoride for the prevention of dental caries without causing dental fluorosis has been set at 0.7 -1.2mg/litre in the United States (Christopher, 1994). The "very mild" (and most common) form of fluorosis is characterized by small, opaque, "paper white" areas scattered irregularly over the tooth, covering less than 25% of the tooth surface. In the "mild" form of the disease, these mottled patches can involve up to half of the surface area of the teeth. When fluorosis is moderate, all of the surfaces of the teeth are mottled and teeth may be ground down and brown stains frequently "disfigure" the teeth. Severe fluorosis is characterized by brown discoloration and discrete or confluent pitting; brown stains are widespread and teeth often present a corroded-looking appearance (John, 1984). People with fluorosis are relatively resistant to dental caries although they may have poor aesthetics. In moderate to severe fluorosis, teeth are visibly damaged (Ramesh *et al*, 2016; Christopher, 1994).

2.2 Prevalence of Dental Fluorosis

The prevalence of dental and skeletal fluorosis is not entirely clear. It is believed that fluorosis affects millions of people around the world, with the very mild or mild forms the most frequent (WHO, 2001). A study carried out in the USA on the prevalence of dental fluorosis was higher among younger persons and ranged from 41% among adolescents aged 12–15 to 9% among adults aged 40–49. The prevalence was lower among older age groups. The lowest prevalence was among those aged 40– 49 (8.7%). The prevalence of dental fluorosis among children aged 6 to 11 (33.4%) was lower than the prevalence among those aged 12–15 (40.6%) (Beltrán-Aguilar, 2010). In India, Plaka and colleagues (2017) reported that of four hundred school children (207 in the 8-11-year-old group and 193 in the 12-15-year-old group) there was a prevalence of dental fluorosis of 4.1%, which they surmised was linked to a high concentration of fluoride in drinking water at certain locations of rural Punjab. The prevalence of dental caries was 36.5% with a mean DMF score of 0.3 and def score of 0.6. Dental fluorosis was assessed using Dean's index, and dental caries were recorded using decayed, missing, filled/decayed, extracted, filled (DMF/def) indices.

A study carried out in Kenya by Gevera *et al*. (2018) on patients consisting of both young and old members of the Nakuru population who were served by groundwater containing high levels of fluoride ranging from 0.1 to 72 mg/l. The Thylstrup-Fejerskov (TF) index was used to estimate the severity of dental fluorosis. The prevalence of dental fluorosis was 86%, 54% had mild to moderate dental fluorosis and 32% had severe dental fluorosis. While the prevalence of dental fluorosis in patients below the age of 14 years was higher (92%) than in older patients (85.56%), severity was reversed (average TF = 3.77 for older patients; average TF = 2.18 for younger patients).

No significant variation in severity and prevalence of dental fluorosis was recorded with respect to gender. The dental fluorosis prevalence rate amongst the patients of the Egerton University-Njoro Dental Clinic was found to be 79.49% (n = 73) (Gevera *et al*, 2018).

Endemic fluorosis has been reported from various regions of the world including Africa (Gevera *et al*, 2018). Dental fluorosis is endemic in the belt that cuts across in East African Rift Valley that transects through Ethiopia, Kenya, Uganda, Rwanda, Burundi, Zambia, Tanzania, Malawi and Mozambique. In this area, excessive amounts of fluoride in surface and groundwater has been documented dating back to the colonial era (Marwa *et al*, 2018)

An epidemiological survey in Uganda in 13 areas with fluoride concentrations in the drinking water, varying from 0.11 to 3.00 ppm found that dental fluorosis varied from 0.04 in low-fluoride areas to 1.74 in high-fluoride areas. The severity of dental fluorosis was higher among Africans than Asians, and higher in males than in females. The distribution of severity indices for permanent teeth showed the following ranking of the teeth in decreasing order of severity: premolars, second molars, upper incisors, canines, first molars and lower incisors. On the basis of the severity of dental fluorosis and the average mean maximum temperature the optimum fluoride concentration in drinking water in Uganda was considered to be 0.6 ppm F (Moller *et al*, 1970).

Endemic fluorosis has also been reported in Ethiopia. A review and mapping of fluoride test data for 270 water sources in 126 communities and examination of the literature of fluorosis distribution in Ethiopia showed that this health problem extends beyond the Rift Valley into some highland

Communities. Fluoride concentrations above 5.0 mg/l in the Rift Valley were found mostly in hot springs (100% of all sources), lakes (78%), shallow wells (54%) and boreholes (35%) and the lowest concentrations (below 1.5 mg/l) in springs and rivers. Analysis of hydrochemical, economic and demographic factors in the spatial distribution of high-fluoride domestic water sources indicates that the fluorosis problem has become more serious in the Rift Valley in recent decades (Kloos and Haimanot, 1999). A recent study carried out in Kenya by Gevera *et al*. (2018) showed that endemic fluorosis caused by the consumption of high-fluoride in groundwater is a public health problem in Nauru, in the Kenyan Rift Valley.

Apart from Africa, there are reports from many other countries around the world. In various regions in India there are high levels of fluoride in drinking water sources. Many people residing in these areas suffer from dental fluorosis (DF). In one such area, Ramesh *et al*. (2016) found that DF was present in 56.9% of the children examined. It was mostly seen in 9 year old (72%) and male (59%) children. They also reported a positive correlation between the occurrence of DF and the duration of residence in a place with high water fluoride content, consumption of bore well water (64%), the parts per million of fluoride in drinking water and consumption of black tea (59%). However, no correlation was found between DF, dental caries, consumption of milk, and consumption of foods cooked in aluminum vessels (Ramesh *et al*, 2016).

A study in North America compared data collected in 2001-2002 to data from 2011-2012. The results suggested that the prevalence of dental fluorosis ranges increased between 35% and 60% in fluoridated communities and between 20% and 45% in non-fluoridated areas, depending on the influence of different local conditions. While the increase has occurred primarily in the very mild and mild categories of dental fluorosis, there is also some evidence that the prevalence is increasing in the moderate and severe classifications as well (Weiner *et al*, 1994). Weiner *et al*. (1994) recommended that with these continued increases in fluorosis rates in the U.S., additional measures need to be implemented to reduce its prevalence.

2.3 Clinical and histological presentation

Dental fluorosis can cause physical damage to the teeth. The enamel becomes hypo-mineralised leading to increase porosity. It is clinically identified as spots ranging from mild white lines to opaque spots covering all or part of the enamel surface and breakdown after teeth eruption. Clinically the enamel presents with streaks and/or opacities that come with varying colour white, yellow or brown (Molina-Frechero *et al*, 2015).

As an early sign of dental fluorosis, the teeth lose their shiny appearance with the development of chalk-white spots. Later these white patches become yellow and sometimes brown or black and in severe cases, loss of enamel gives the teeth a corroded appearance (Molina-Frechero *et al*, 2015; Cavalheiro *et al*, 2017).

The clinical definition of the fluorosis in teeth is a complex task, exemplified by the many indices that describe the severity, degree and variations of DF. A study conducted in Dindigul district - a known area of fluorosis endemic in India - examined the histological features of fluorosis. Samples of extracted teeth were collected with varying degrees of fluorosis from various dentists across Dindigul district, and studied it under light microscope. Ground sections of 25 fluorosed teeth and 5 normal teeth were observed under light microscope; sections were subsequently stained with acridine orange and studied further under a confocal microscope.

Histological changes were observed in the ground sections of fluorosed teeth as compared with the normal teeth. Depending on the degree of fluorosis, the affected teeth showed various features of hypomineralization in enamel and dentin. They concluded that fluoride interacts with both the mineral phases and organic macromolecules by strong ionic and hydrogen bonds resulting in incomplete crystal growth at prism peripheries. This presents as hypomineralization of enamel and dentin (Priyadharsini *et al*, 2015) Fluoride interferes with the process responsible for the efficient removal of organic matrix components; as a result there is protein retention and disorganized enamel crystal formation resulting in hypomineralization of enamel as well as dentin (Priyadharsini *et al*, 2015). Furthermore it was revealed that 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 most likely affects the subsequent mineralization process by reducing the solubility of the mineral and thereby modulating the ionic composition in the fluid surrounding the mineral.

In the light of evidence obtained from 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. 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 (Avery, 1994; Limeback, 1994). Presently, there is no direct evidence that fluoride at micromolar levels affects proliferation and differentiation of enamel organ cells. Fluoride does not seem to affect the production and secretion of enamel matrix proteins and proteases within the dose range causing dental fluorosis in man. Most likely, the fluoride uptake interferes indirectly with the protease activities by decreasing free Ca^{2+} concentration in the mineralizing milieu (Aoba and Fejerskov, 2002).

2.4 Risk factors for Dental Fluorosis

2.4.1 Temperature

Water fluoridation is an effective and equitable way of preventing tooth decay when used at optimal concentrations and according to the local average temperature (Moimaz *et al*, 2012). Temperature directly affects the amount of water intake, increasing the fluid intake, especially in tropical areas (Broffit *et al*, 2004) thereby increasing the amount of fluoride in tissue fluids.

In a study done in Mexico it was concluded that the higher the temperature of the environment, the greater the risk of getting fluorosis (Grimaldo *et al*, 1995). Regression analysis showed an increment of 0.54 ppm ($p< 0.0001$) of fluoride in urine for each ppm of fluoride in water. Fluoride urinary levels were higher in samples collected during the afternoon (1800 ppm) when compared with samples collected during the morning (1100 ppm).

Taking into consideration all these results, three risk factors for human exposure to fluoride in San Luis Potosi, Mexico were identified as ambient temperature, boiled water, and food preparation with boiled water. These factors explained the prevalence of dental fluorosis in San Luis Potosi (Grimaldo *et al*, 1995).

2.4.2 Soil content

The presence of fluoride in the soil is either from a geogenic or an anthropogenic source. Brindha and Elango (2011) reported that phosphate fertilisers used during farming in irrigated lands contribute to the levels of fluoride in the soil. Coal has also been implicated as a potential source of fluoride - it is used during combustion and disposed as industrial waste in the soil. Improper disposal of fly ash coal on the ground surface contributes to fluoride in ground water and that natural sources of fluoride in the soil is associated to the geological conditions of an area. Several rocks have fluoride-bearing minerals like apatite, fluorite and biotite. Volcanic ashes contains high concentration of fluoride and are readily soluble in water forms another natural source.

Fluoride ions found in ground water wells are mainly from fluoride minerals found in the soil. In a study done in the Gaza strip to determine the fluoride levels in soil, a total of 73 ground water wells and 20 topsoil samples were studied. It was found that calcium fluoride (CaF^2) was the main source of fluoride ions (Shomar *et al*, 2004). Similarly, Hiakel and Frank (1986) found high amounts of fluoride ions in soil samples in the Khouriba area of Morocco which has endemic fluorosis.

2.4.3 Nutrition

There is no clear relationship linking dental fluorosis to the nutritional status of the individual or community. A study in Paraíba, Brazil investigated the relationship between nutritional status and dental fluorosis in areas with fluoride in the drinking water. They reported a high prevalence of dental fluorosis in the communities, but suggested that other factors may play a part (Correia *et al*, 1999).

Fluoride intake, diet, and health status of children in two dental fluorosis-afflicted areas in the Province of Jiangxi, China were studied in an attempt to correlate nutritional status with dental fluorosis. The relationship between milk consumption and the incidence of dental fluorosis among the children was investigated in this study.

Based on the diet and fluoride intake of the studied groups, the areas with a better nutritional status were found to have a lower incidence of dental fluorosis. The incidence of fluorosis among milk-consuming children was 7.1% lower than that of non-milk-consuming children (Chen *et al*, 1997).

2.5 Use of fluoridated toothpastes and fluoride supplements

Osuji and colleagues (1988) found that children who started brushing their teeth before the age of 25 months were at increased risk for dental fluorosis. Another study found an increased risk of fluorosis among children who used fluoridated dentifrice between the ages of 16-36 months (Levy *et al*, 2010). In Brazil, a study among children aged between 1-3 years found that swallowing of dentifrice was responsible for 81.5% of daily fluoride intake (De Almeida *et al*, 2007). Dabeka *et al*. (1982) concluded that children under the age of 3 years swallowed at least a third of the dentifrice during tooth brushing. The early introduction of fluoridated toothpaste, excessive quantities and its inappropriate use in children are recognized risk factors for dental fluorosis (Osuji *et al*, 1988; De Almeida *et al*, 2007; Dabeka *et al*, 1982).

The use of fluoride supplements has also been associated with increased prevalence of dental fluorosis (Levy *et al*, 2010). Presently, an assessment of sources of fluoride for children is advised before a recommendation for use of fluoride supplements (Levy *et al*, 2010). Recommendations also exist for use of fluoride foam as the safer mode of topical fluoride in children due to its ability to adhere quickly to the tooth surface and a slow release that ensures reduced bioavailability when compared to conventional topical fluoride gels (Wong *et al*, 2010).

2.6 Impact of dental fluorosis

Dental fluorosis results in teeth that are discoloured, stained, pitted and mottled often resulting in loss of tooth shape and an undesired appearance (Den Bensten *et al*, 2011). The teeth are a very important part of dental aesthetics and facial appearance and these combine to give a good smile.

A descriptive study was conducted with 15-year-old youth using a questionnaire designed to validate and assess self-perceptions of dental fluorosis in two areas with different socioeconomic status (SES). Fluorosis was clinically evaluated by applying the Thylstrup and Fejerkov (TF) index to the upper front teeth.

A total of 308 adolescents were included in the study that concluded that self-perceptions of dental fluorosis affect adolescents such that adolescents with a medium SES have more negative perceptions than those with a low SES. Such perceptions increased as the TF index increases (Molina *et al*, 2017).

Teeth affected by severe dental fluorosis have post-eruptive enamel breakdown. The effect of fluoride on forming enamel results in a number of changes. These changes in the structure of enamel involve increased porosity, higher protein levels, and lower amounts of minerals and, in severe cases, the formation of a pitted surface (Lyaruu *et al*, 2006). With increasing severity, the surface and subsurface of enamel become more hypomineralized and the tooth becomes more resistant to dental decay because of the higher levels of fluoride contained in the enamel surface. However, severely fluorosed teeth are more susceptible to decay, most likely because of the uneven surface or loss of the outer protective layer (Lyaruu *et al*, 2006). Dental fluorosis causes stigmatisation and social exclusion (De Castilho *et al*, 2009). In addition, tooth sensitivity was found to be higher in patients with fluorosis than in those without fluorosis (Ockerse and Wasserstein, 1955). This may be due to the fact that highly fluorotic teeth become increasingly porous; although teeth with mild dental fluorosis may not cause sensitivity (Mine *et al*, 2011).

2.7 Consumption of potable water in Cameroon

In general rainfall in the Cameroon is high and provides for abundant surface and ground water resources. Cameroon is the second country in Africa after the Democratic Republic of Congo in terms of quantity of available water resources that is estimated to be 322 billion cubic meters (Mafany and Fantong, 2006). Of this total available water resource, ground water constitutes 21% (Nkamjou *et al*, 2002). Most of the potable water in Cameroon comes from surface water and are not fluoridated as the government of Cameroon has no water fluoridation policy. Surface water is delivered in the form of pipe-borne water to urban and suburban settlements while the rural settlements rely on untreated surface water or ground water (Nkamjou *et al*, 2002).

2.8 Community awareness of dental fluorosis

A systematic review of literacy and health outcomes concluded that poor literacy levels predispose to poor health outcomes (DeWalt *et al*, 2004). In a study among female caregivers to assess the impact of oral health outcomes in early childhood, it was observed that irrespective of level of education, race, age and number of children, low knowledge was associated with worse oral health status (DeWalt *et al*, 2004). Yet another study found that the public was not able to link the brown staining of their community's teeth with the water that they consumed (Vann *et al*, 2010).

Communities that have most members affected by dental fluorosis tend to be more tolerant with regard to cosmetic ill effects caused by dental fluorosis (Moturi *et al*, 2002; Wondwossena *et al*, 2003). However, there are differences as to whether mild forms of dental fluorosis (TF 1&2) constitute a public health problem with most professionals taking the view that mild fluorosis is aesthetically acceptable (Wondwossen *et al*, 2003b; Ripa, 1991). Fluorosis levels, even of TF 3 were regarded by lay respondents as an individuals' neglect, and was likely to lead to stigmatization of affected children.

Wondwossen *et al*. (2003b) investigated the perception of dental fluorosis among Ethiopian children aged 12-15 years and their mothers and observed that adolescent children were sensitive to even mild forms of dental fluorosis and they described teeth with TF scores of 2 as unacceptable. The study further noted that children raised in high fluoride areas where dental fluorosis was endemic were more likely to be tolerant of the aesthetic effects of dental fluorosis, while misunderstanding of the cause of dental fluorosis persisted among the study population (Wondwossen *et al*, 2003a; Wondwossen *et al*, 2003b). Experience of dental fluorosis as displayed by high TF scores caused stigmatization due to the perception of neglect of individuals' oral health (Wondwossen *et al*, 2003b). The researchers reported that there was generally a linear relationship between the worsening clinical picture of dental fluorosis and self-reported social and psychological impacts (Wondwossen *et al*, 2003b; Riordan, 1993).

2.9 Prevention of dental fluorosis

Controlling fluoride intake is by far the best way to prevent dental fluorosis and an adequate knowledge of the fluoride source must be known to avoid over-exposure (Van Palestein and

Mkasabuni, 1993). In addition, modalities such as defluoridation may also be useful but are expensive. Health education of mothers and carers of young children is important regarding the use of fluoride dentifrices and other fluoride supplements.

2.10 Measurement of Dental Fluorosis

The presently popular scoring systems used to diagnosis fluorosis use different measurement units, evaluate variable numbers of sites per person, and involve non-comparable groupings of clinical symptoms. Although none of these factors is related to the level of fluoride exposure in the examined population, their combined effect produces fluorosis prevalence values for a population that vary considerably among and within these scoring systems.

Intrinsic factors for a scoring system include the inclusion of a questionable category, the minimal level of fluorotic involvement, and the number of affected sites within a subject required for case definition. Thus, a case definition of fluorosis for each scoring system, although not mandatory, would certainly be desirable so that dental epidemiologists and clinical investigators can interpret fluorosis scores relative to risk assessment (Kingman, 1994). For research purposes the following indices are usually used:

2.10.1 Deans Index

Since the introduction of Deans Index in 1938, various indices or classification systems have been used in surveys and in research to measure dental fluorosis (Alvares *et al*, 2009). In the original Deans Index there were seven classes: '0' for normal, '0.5' for questionable, 1.0' for very mild, '2.0' for mild, '3.0' for moderate '3.5' for moderately severe to '4.0' for severe. In 1942, it was modified and the moderate and moderately severe categories were merged to give a six-point classification (Alvares *et al*, 2009). The Deans Index has been widely used in epidemiological studies due to its ease of use and became the standard for comparison with subsequently developed indices (Alvares *et al*, 2009). Criticism has been levelled at its' lack of sensitivity, with some of the criteria especially the '0.5' for questionable being unclear (Alvares *et al*, 2009; Rozier *et al*, 1994).

2.10.2 Thylstrup and Fejerskov Index (TFI)

The Thylstrup and Fejerskov Index (TFI) was developed decades after the Deans indices in 1978 and later modified in 1988, with an objective of providing a more sensitive classification for dental fluorosis (Alvares *et al*, 2009).

The Thylstrup and Fejerskov Index is based on a ten point ordinal scale that classifies enamel changes associated with increasing fluoride exposure. Teeth surfaces are dried and examined and classified as '0' if normal translucent enamel is observed. TFI score of '1' indicates enamel with thin white opaque lines seen running across the tooth surface, and corresponding to the position of the perikymata. TFI Scores '2', and '3', indicate increasing areas of enamel opacities with TFI score of '4' being marked opacity of entire tooth surface.

Corresponding to Dean's category of 'severe' are TFI scores '5' through to '9' which seek to record the wide variety of clinical changes associated with higher fluoride level consumption (Alvares *et al*, 2009). TFI score '5' depicts enamel with some round pits of less than 2 millimetres in diameter, through '6' where the pits may start to merge while a score of '9' indicates loss of the major part of the outer enamel resulting in change of the shape of the tooth. The TFI index has been praised for its sensitivity by epidemiologists since it corresponds closely to histological changes and to enamel fluoride concentrations, giving it biological validity (Rozier, 1994).

In areas with fluoride concentration ≥5ppm, the TFI should be used because of its sensitivity when measuring severe form of fluorosis (Alvares *et al*, 2009). TFI is easier to use than Dean's index, and allows for comparisons to be made between the two indices (Alvares *et al*, 2009). Due to its further breakdown of what Deans index classified as severe to more groups of TFI 5-9, some clinicians have praised the TFI indicating its value to assist with treatment planning since treatment modalities for cases TFI 1-4 may require micro-abrasion and/or bleaching, while TFI 5-7 may benefit from veneers with TFI 8-9 being an indication for full coverage crowns (Van Palestein and Mkasabuni, 1993).

2.10.3 Tooth Surface Index of Fluorosis (TSIF)

In 1980, the Tooth Surface Index of Fluorosis (TSIF) was developed to assess the aesthetic appearance of tooth surfaces. Teeth are not dried during the examination with anterior teeth getting

a score for the facial and lingual surfaces, while the buccal teeth get scores for buccal, lingual and occlusal surfaces. An 8-point scoring criteria with '0' for no fluorosis, to '1' representing areas of white-patches confined to incisal edges of anterior teeth and cusp tips of posterior teeth. Score '6' has both discrete pitting and staining of intact enamel, while '7' is confluent pitting of enamel surface with possible large areas of enamel missing and the anatomy of the tooth altered. Due to the large number of surfaces to be scored, including lingual surfaces which may not be easily visualized, the TSIF has not found wide acceptance and concern about examiner reliability has been raised (Alvares *et al*, 2009). The utilization of this index of a category '6' where staining is part of the criteria has been questioned since staining *per se* is not a manifestation of fluorosis, but rather a reflection of the dietary habits (Rozier,1994). It is however a good index that can record the aesthetic concerns of individuals.

2.10.4 Fluorosis Risk Index (FRI)

The Fluorosis Risk Index (FRI) was developed by Horowitz and colleagues in 1984 and aimed at relating the time of exposure with the period when enamel can be said to be at risk (Alvares *et al*, 2009). It is a good index for use in analytical epidemiological studies due to its clear criteria for association of age-specific exposure to fluoride, and the development of dental fluorosis (Alvares *et al*, 2009; Rozier, 1994). It is viewed as having improved the understanding of the importance of the secretory and maturation phases of enamel and the risk of development of fluorosis. In this classification, non-fluoride opacities are also provided for as a score of '7', while a score of '9' indicates an excluded surface zone.

The main fluorosis classification has a 4-point scale with '0' for normal translucent enamel, '1' for questionable which covers area of white spots, striations, or fluorotic defects covering less than 50% of the surface. A score of '2' indicates mild to moderate fluorosis with '3' for severe fluorosis involving extensive pitting over more than 50% of the tooth surface, staining and deformity. The index is useful in understanding risk to fluorosis, but because it cannot easily be compared with any of the other indices, it may not be utilized for prevalence studies (Alvares *et al*, 2009). In conclusion, there is a strong correlation between extent and specific measures of fluorosis severity for Dean's Index (DI) and the Tooth Surface Index of Fluorosis (TSIF) scoring system, as well as within each scoring system separately (Kingman, 1994).

2.11 Concluding Remarks

Dental fluorosis is a major problem across the globe and the main cause is fluoride contamination of ground water. Fluoride found in water is mainly from geogenic sources. Fluoride ions in water are from rocks and sediment. This is further enhanced by increased alkalinity and temperature. The Far North Region of Cameroon with extinct volcanic features and Sahelian vegetation favours fluoride contamination of the ground water that is the main source of potable water. As such, the inhabitants of these communities are vulnerable to dental fluorosis. In addition, the effects of climate change in this region is very visible, such as the shrinking waters of Lake Chad and other rivers, advancing desertification and ever increasing temperatures especially in the dry season. These conditions favour an increased intake of ground water from wells hence exposure to fluorosis. Most of the population of these region are mainly peasant farmers living in abject poverty with no mean of alternatives to potable water but rather have to rely on what nature has to offer which is unsafe ground water contaminated with high amounts fluoride. Considering the above-mentioned situation in the Far North of Cameroon there is a need to investigate and report the findings to raise awareness and educate community members, government and organizations on prevention of dental fluorosis so as to improve the quality of life of members of these communities.

CHAPTER 3: AIM & OBJECTIVES

3.1 Aim

The aim of the study was to establish the risk factors and knowledge of dental fluorosis in three communities of the Far North Region of Cameroon.

3.2 Objectives

The objectives were to:

- describe the socio-demographic profile of people living in 3 communities with high levels of fluorosis;
- determine the knowledge of the community regarding dental fluorosis;
- determine the fluoride content of drinking water samples in the communities;
- establish the risk factors of dental fluorosis in these communities;
- describe the clinical presentations of fluorosis of the communities using the Thylstrup and Fejerskov (TF) dental fluorosis index;
- establish the unmet treatment of the community

CHAPTER 4: METHODOLOGY

4.1 Study Design

This was a descriptive, cross-sectional study with an analytic component.

4.2 Study sites

The present study was carried out in the Cameroon (Figure 1), specifically in the three Far North Regions of Cameroon (Figure 2). 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 to the east and Nigeria to the west. The capital is Maroua. Figure 1 below depicts a map of the Cameroon in relation to its neighbours.

Figure 1: Map of the Cameroon in relation to its neighbours

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.

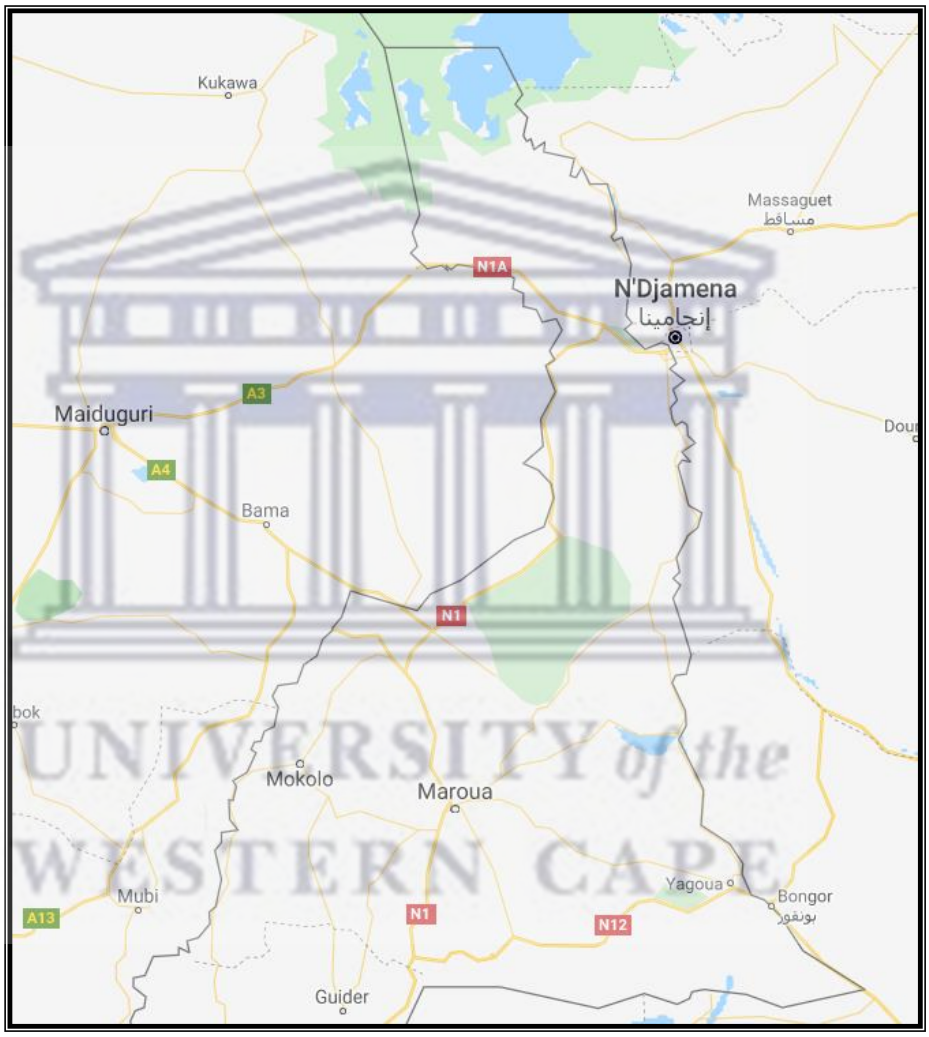


Figure 2: Logone-et-Chari (capital Kousséri); Diamare (capital Maroua) and Mayo- Tsanaga (capital Mokolo)

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 (Ikuse *et al*, 2018).

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 (Ikuse *et al*, 2018).

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 (Ikuse *et al*, 2018).

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 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 (Arabi *et al*, 2014)

4.3 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.

4.4 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.

4.5 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.

The sample size consisted of a minimum of 246 individuals.

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 (Appendix 1).

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 (Appendix 2).

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.

4.6 Selection criteria

4.6.1 Inclusion Criteria

Since the water was being measured for its current 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 current levels was examined.

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

4.6.2 Exclusion criteria

- Individuals who refused to participate in the study or do not consent
- Individuals with pathologies that can be confused with fluorosis
- Members of the community who recently migrated into the area of study with or without dental fluorosis presentations

4.7 Instrument used

A structured researcher administered questionnaire was used to collect data on 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. (Appendix 3).

4.7.1 Developing the study questionnaire

A pilot study was conducted to test the questionnaire in terms of practicability and relevance. A convenience sample was selected (n=10) from the community who presented with fluorosis.

The pilot study was carried out to:

1. test the suitability of the method of collecting the data
2. test how long each examination will take to complete
3. check the adequacy of the data capture sheet
4. check that all the parameter measurements are clear and unambiguous
5. ensure that no major item has been omitted
6. remove any items that do not yield usable data

4.7.2 Preparation for the final draft

After the pilot study, 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.

4.8 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).

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).

4.9 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

4.10 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.

4.11 Ethical considerations

4.11.1 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.

4.11.2 Establishing contacts

Access to the participants of the study was made initially by meeting them at their residence, by door to door visits, providing information about the study, soliciting for their consent and making appointments for future visits. A translator facilitated communication with any participant who could not speak any of the two official languages of Cameroon. An introduction of the researcher, the basic aims and objectives of the study, what participating in the study would involve and how long the examination and questionnaire would take were explained. It was emphasized that that strict confidentiality would be maintained at all times and that the results of the study would be presented in a manner that ensured anonymity. Once signed informed consent was obtained from each participant, appointments were made and the participants interviewed, examined and their declared water sample collected.

4.11.3 Collaborative partnership

In order to obtain access to the selected participants a good relationship was established between the principal investigators and communities where the study was carried out. Meetings with the community elders were held prior to participant recruitments and selection to ensure a level of trust and consideration. During these meetings the study design and procedures were explained in detail regarding the objectives, aim and methodology. An opportunity was also provided for questions to be asked and to ensure proper understanding of the study.

4.11.4 Social value

Beneficiaries of the research are the participants who all received a free dental consultation by a qualified dentist together with essential oral health education and instructions. By incorporating oral health services into their communities they have benefitted from the study documenting oral health problem endemic to their community.

4.11.5 Informed consent

Signed informed consent was obtained from all participants after they are fully informed of the aim, objectives and methodology of the study. Participants were be able to ask questions for clarity. In addition, they were duly informed that they could withdraw from the study at any stage during the interview and examination without any penalty.

4.12 Limitations

Water samples obtained from the study sites were analyzed independently in one laboratory (Universities des Montagnes Pharmacology Laboratories) - the only laboratory in Cameroon with a fluoride electrode. The scarcity of fluoride electrodes locally and lack of funding prevented the researcher from sending the samples to other laboratories outside of the country for analyses. In addition, religious and cultural practices prevented the researcher from accessing certain population groups that could have participated in the present study

CHAPTER 5: RESULTS

This chapter reports on the findings of a cross-sectional study that used a structured researcher administered questionnaire to collect information on the socio-demographic profile of the study subjects, their general health status, their knowledge of fluorosis, their perception of their oral health, oral health seeking behaviour, sources of drinking water etc. In addition, an oral examination was carried out to determine extent of fluorosis and treatment needs.

5.1 Response rate

Three study sites were visited and a total of 1971 participants were included in the study. Two thirds were from Logone-et-Chari (n=701, 35.97%) and Mayo-Tsanaga (n= 701, 35.56%) respectively. Less than a third were from the Diamare community (Table 1). The majority of the participants were from the suburbs of Bourha (24.09%) and Kousseri (18.31%) (Table 1).

Table 1: Communities sampled and Study site

Variable	Description	Frequency (n)	Percent (%)
Communities	Logone-et-Chari	709	(35.97)
	Diamare	561	(28.46)
	Mayo-Tsanaga	701	(35.57)
Suburban Town	Bourha	475	(24.09)
	Kousseri	346	(18.31)
	Guili	306	(15.52)
	Meri	282	(14.82)
	Madana	273	(13.58)
	Douvangar	264	(12.88)
	TOTAL	**1971**	**(100)**

5.2 Demographic information

5.2.1 Gender

Slightly more than half of the sample was male (n=1008, 51.1%). The mean TFI score for participants 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).Seen in Table 2.

Table 2: Association between TFI score and gender

Variable		Frequency (%)	MeanTFI 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

5.2.2 Age distribution

Slightly under 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 (Table 3). The mean age of the sample was 17.15 and (SD=16, 18).

Table 3: Age of Participants

Variable	Years	Frequency (%)	Mean age (SD)
Age group	0-6	574 (29.1)	
	6-12	427 (21.7)	17.15 (16.18)
	12-25	407 (20.6)	
	25-50	487 (24.7)	
	>50	76 (3.9)	
	Total	**1971 (100)**	

5.2.3 Level of education, occupation and occupancy status

More than half 1144 (58%) of the participants had only primary education with mean TFI score and SD of 2.99(2.22), 253(12.8%) were illiterate with mean TFI score and SD of 3.31 (2.45) and only 4.9% (n=97) had a tertiary (higher) education with mean TFI score and SD of 3.29(2.90) .The relationship between TFI Score and level of education was seen not to be statistically significant as (F (3,1967) = 2.368, p = 0.069). More than two thirds (n=1042, 71.10%) were students with mean TFI score and SD of 2.86 (2.25). Just under twenty per cent were farmers 380 (19.3%) with mean TFI score and SD of 3.49 (2.3). Labourers were 45(2.28%) with mean TFI score and SD of 2.98 (2.61). The relationship between TFI scores occupation of participants was statistically significant as (F (5, 1965) = 6.128, p = < 0.001). A large majority lived in their own homes (n=1706, 86.6%) with mean TFI score and SD of 3.06 (2.31). Those that rented the houses they lived (255, 12.9%) had a mean TFI score and SD score of 2.66 (2.38). Only 10 (0.5%) participants lived in corporate or institutional houses with mean TFI score and SD of 4.60 (2.91). The relationship between TFI score and occupancy status was seen to be significant as (F (2, 1968) = 5.590, p = 0.004) as shown in Table 4.

Table 4: Association between TFI score and occupancy status

Variable		Frequency (%)	Mean TFI Score (SD)	Statistical test	p-value
Educational level	Illiterate	253 (12.8)	3.31 (2.45)	F(3,1967) =2.368	0.069
	Primary	1144 (58.0)	2.99 (2.22)		
	Secondary	477 (24.2)	2.88 (2.34)		
	Tertiary	97 (4.9)	3.29 (2.90)		
Occupation	Students/Pupils	1402 (71.1)	2.86 (2.25)	F(5,1965)= 6.128	< 0.001
	Farmer	380 (19.3)	3.49 (2.31)		
	Housewife	28 (1.4)	3.50 (2.55)		
	Civil Servant	67 (3.4)	2.89 (2.82)		
	Businessman	49 (2.5)	3.88 (2.57)		
	Labourer	45 (2.3)	2.98 (2.61)		
Occupancy status	Cooperative	10 (0.5)	4.60 (2.91)	F(2,1968)= 5.590	0.004
	Own house	1706 (86.6)	3.06 (2.31)		
	Rented	255 (12.9)	2.66 (2.38)		

5.2.4 Place of Birth and Duration of Exposure

The majority (n=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 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 5. Place of Birth and Duration of Exposure

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

5.3 Knowledge of dental fluorosis

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

To facilitate improved cell number statistical analyses, the presentation of dental fluorosis in the communities was grouped into three: TFI 0-2, TFI 3-4 and TFI 5-9. Table 5 summarises the relationship of knowledge on dental fluorosis in the communities with severity. Dental fluorosis was seen to most severe in participants that had a primary education and this was statistically significant (p=0.001). An overwhelming majority of participants (n=1805, 91.5%) said they have seen persons with discoloured teeth which was statistically significant (p=0.051) and that it occurs between the age 1 to 10 years of age. The majority said they do not know the cause of teeth discoloration (n= 1779, 90.2%) recording the most severe forms of fluorosis which was statistically significant (p=0.001).

Teeth discolouration was most severe among participants who responded that discoloration is normal (n=1781, 90.3%) and was statically significant (p=0.001). The majority of the participants said well (ground) water was given to children aged between 0 to 1 year old for drinking (p=0.001). The majority reported that they 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. Participant's knowledge on the risk factors for dental fluorosis & severity of dental fluorosis

Variables	Categories	TFI 0-2	TFI 3-4	TFI 5-9	Total	p value
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	
	Illiterate	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 yr	134 (53.6)	66 (26.4)	50 (20)	250	0.399
	1-10 years	860 (50.7)	423 (24.9)	413 (24.4)	1696	
	10-15 years	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	
	Well water	698 (47.9)	379 (26)	380 (26.1)	1457	
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 discoloured 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

Teeth discolouration was most severe amongst participants who responded that discoloration is normal by participants (n=1781, 90.3%) and was statically significant with (p=0.001).Majority of the participants (n=1460, 74.1 %) said discoloured teeth cannot be treated at the dental clinic which was statistically significant as (p=0.053) (Table 7).

Table 7. Community perception on dental fluorosis with severity

Variable	**Categories**	**Severity of dental fluorosis**			**p-value**
		TFI 0-2 n(%)	TFI 3-4 n(%)	TFI 5-9n(%)	
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)	
	No	603(41.3)	439(30.6)	418(28.6)	p=0.053

p-value reported for chi-square test

5.3.3 Community perceptions on local drinking water

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

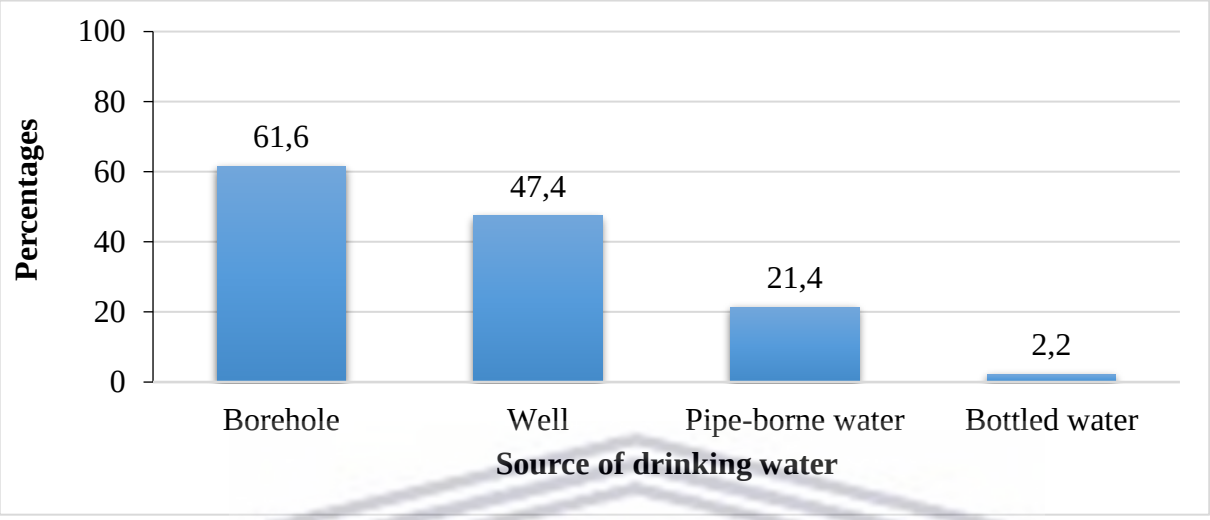
Variable	Response	Frequency (%)
Have you noticed any problem with your drinking water?	No	1781 (90.36%)
	Yes	190 (9.64%)
If yes, what was the problem?	Colour	48(25.26%)
	Smell	52(27.37%)
	Taste	90(47.37%)

5.4 Risk factors for dental fluorosis

5.4.1 Sources of drinking water & brushing with toothpaste

Nearly two thirds of the sample (n=1214, 61.6%) reported that they use borehole water as source of drinking water, 934 (47.4%) use well water and less than five per cent (n=43, 2.2%) consumed bottled water (Figure 3). Nearly 80% reported that they use toothpaste when brushing their teeth (Table 13).

Figure 3. Source of drinking water



5.4.2 Analysis of Bottle water samples

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(°C)	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
Faro	6.99	23.8	0.06

5.4.3 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 (ºC)	pH	mg F/L
Guili	Well water	23.7	7.62	1.90
	Borehole	24.1	7.10	2.23
Bourha	Well water	24.0	7.42	0.30
	Borehole	23.8	7.47	2.80
Meri	Well water	23.8	6.20	0.35
	Borehole	24.1	6.75	1.91
Douvangar	Well water	23.8	6.88	0.53
	Borehole	23.1	6.59	2.63
Madana	Well water	24.0	6.60	1.26
	Borehole	23.9	6.58	2.63
Kousseri	Pipe borne	23.9	6.55	1.70

An independent t-test was performed to compare the usage of the various water types as per participant's responses. All water sources were seen to be statistically significant. Well water consumers had M= 3.3, SD=2.4; t=5.335, p=<0.001.Pipe borne water consumers M=2.5, SD=0.93; t= -4842, p=<0.001. Borehole water consumers registered M=3.4, SD=2.4; t=4.149, p=<0.001 and bottle water consumers had M=1.9, SD=2.3; 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).

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, SD=2.32) was statistically different from all the other water type (Table 12).

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

Variable		Frequency (%)	Mean TFI Score (SD)	Statistical test	p-value
Well	**Yes**	934	3.3 (2.4)	t = 5.335	< 0.001
	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)		
Borehole 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	3.0 (2.3)		

t –statistic reported for independent t-test

Table12: Types of water given to children aged between 0-1 years with TFI scores

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

F statistic reported for analysis of variance (ANOVA).*Note well water represented groundwater generally, including borehole water

5.5 Oral health behaviour

5.5.1 Oral Hygiene Practice

More the three quarters 1558 (79.05%) reported that they used toothpaste and tooth brush for their oral hygiene, while 261(13.2%) use toothbrush and soap. Less than 5 per cent (80, 4.1%) of those using 'other' methods reported brushing with salt and tooth brushes; 68 (3.5%) use chewing sticks instead of tooth brushes and 4 (0.2) participants reported that they clean their teeth and mouth with their fingers and water only (Table 13).

Table 13. Oral hygiene practices

Methods	Frequency (n)	Percent (%)
Toothbrush and paste	1558	79.0
Toothbrush and soap	261	13.2
Toothbrush with salt	80	4.1
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(SD=2.36) and those who did not use toothpaste during brushing had a mean TFI score of 2.87(SD=2.87).The relationship between toothpaste and TFI scores was not statistically significant (p=0.154). As seen in Table 14

Table 14: 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

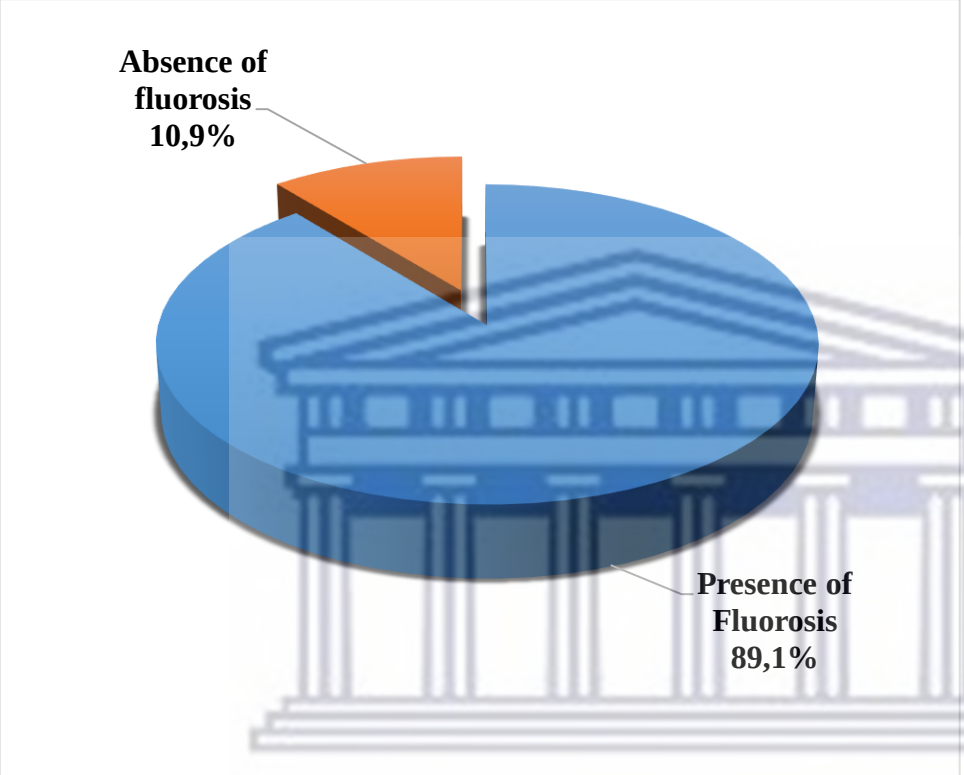
5.5.2 Oral Health-Seeking Behaviour

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 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).

5.6 Prevalence of fluorosis

The prevalence of fluorosis in our study was 89.1% (CI= 87.8 – 90.5) (Figure 4).

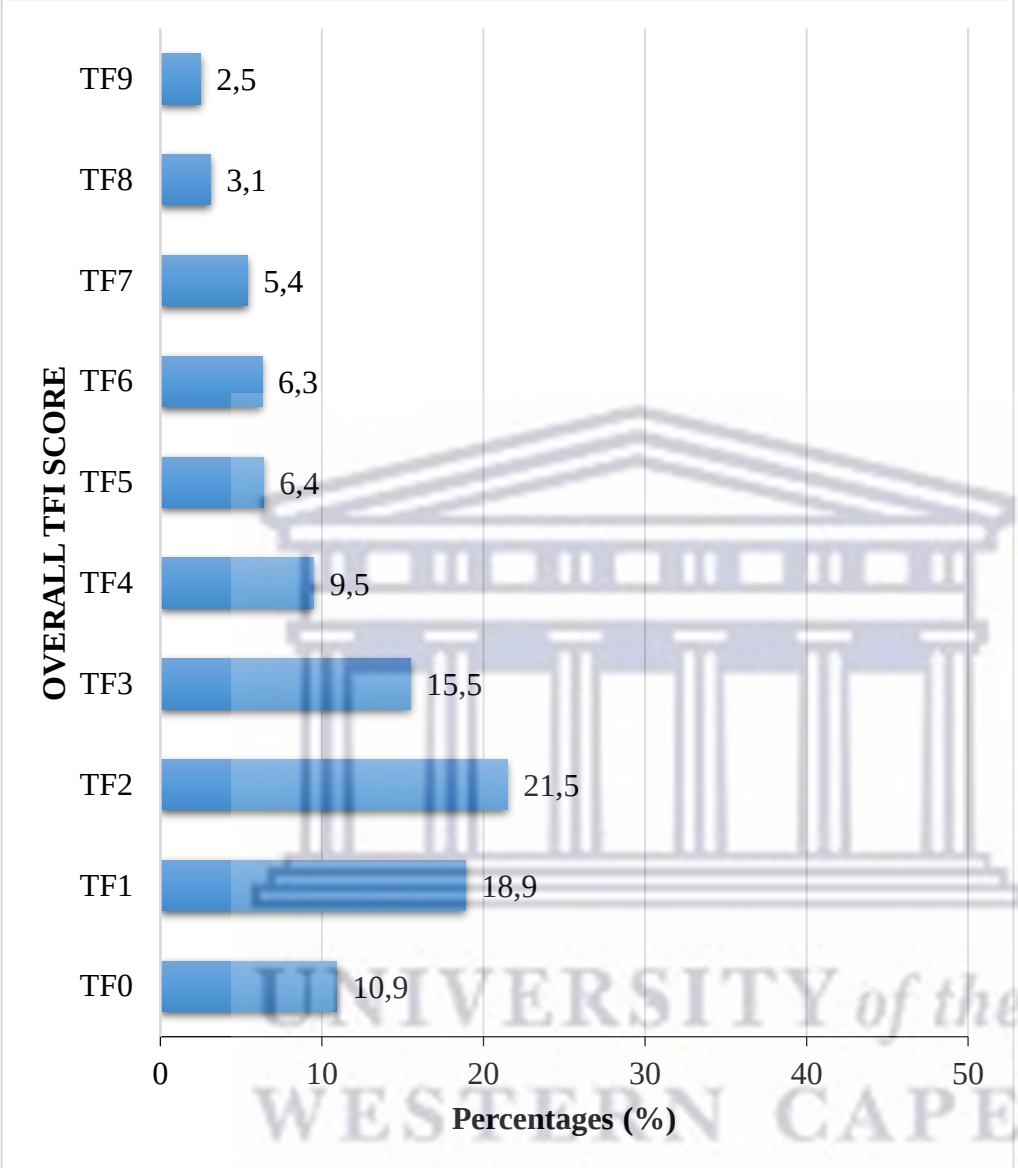
Figure 4. Prevalence of Dental Fluorosis in the Communities



5.6.1. 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 (Figure 5).

Figure 5. Clinical Presentation of Dental Fluorosis



5.6.2 Severity of dental fluorosis

Dental fluorosis was divided into 3 groups to better depict 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	25.1 (22.8 – 26.8)
5 – 9	468	23.7 (21.8 – 25.7)
Total	**1971**	**100**

5.7 Treatment needs

Figure 5 shows that all forms dental fluorosis scores from TF0 (normal) to TF9 (severe) were recorded. There was a need for aesthetic treatment and repair of enamel for 64.76% of the participants with scores between TF1 and TF4 in the form of micro-abrasion and bleaching. Those with TF5-TF7 scores (18.31%) required veneers, while those with the most severe cases TF8-TF9 (5.5%) required full coverage crowns as recommended by Van Palestein and Mkasabuni (1993).

CHAPTER 6: DISCUSSION

Controlled water fluoridation is very important in the prevention 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 (Malago *et al*, 2017). High fluoride levels beyond the recommended World Health Organization limit of 1.5 mg/L has been observed in various Africa countries (Malago *et al*, 2017).

In the present study, the presence of dental fluorosis in the Northern Region of Cameroon was found to be 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 (Palmer and Gilbert, 2012).

Socio-demographic profile

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 and principal investigator (EB), being a male had limited access to 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 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 (Rodrigues *et al*, 2002).

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.

Temperature directly affects the amount of water intake (Broffit *et al*, 2004). 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 (Burt, 1992).

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. 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 (Jenny *et al*, 2009). The present study revealed that majority of the participants did not know the cause of dental fluorosis in their communities.

All of the participants in the present study said they have seen persons in their community who have discoloured teeth and that the majority presents in children aged between 1 and 10 years old, implying that they are aware about the problem of 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 dental fluorosis 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 (Moturi *et al*, 2002; Wondwossen *et al*, 2003a) that it has become the norm.

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 (Brothwell and Limeback, 1999; Riordan 1993).

In Far North of Cameroon just like elsewhere in Africa, fluoride contamination of drinking water sources is the major risk factor (Idon and Enabulele, 2018; Marwa *et al*, 2018). 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 analysed 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 (Bosco *et al* 2018). 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 (Chigozie and Nwogu, 2018). 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 may 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, however from the statistical analyses, the use of dentrifices appeared to have had no influence on the occurrence of dental fluorosis in the communities – as both participants who used toothpaste and those who did not 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 (Brindha and Elango, 2011). 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.

Fluoride contamination of water in Far North of Cameroon is purely of a geogenic source and this is all that the communities have access too, 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 salinisation seems mainly compounded by the contamination of the shallow aquifers by the recharging water (Mor *et al*.2008). Though Mor and colleagues (2008) suggested 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 (Edmunds and Smedley, 2013) 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 fluoride content of 2.6 Mg F/L. Low pH levels 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 (Friberger, 1975). 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 (Friberger, 1975).

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 (Idon and Enabulele, 2018).

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 (Coertsiers *et al*, 2008). 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 (Bosco de Oliveira *et al*, 2018). 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 (Evans and Darvell, 1995). 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 dental fluorosis 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 (Robinson *et al*, 2004; Mascrenhas, 2000).

Unmet treatment needs due to fluorosis

Treatment options for fluorosis varies with presentation of severity (Akapata, 2001). The present study recorded all forms dental fluorosis from TF0 (normal) to TF9 (severe) unlike Okoye *et al*. (2019) 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 veneers for treatments while participants with scores of TF8-TF9 need full coverage crowns as recommended by Van Palestein and Mkasabuni (1993).

CHAPTER 7: RECOMMENDATIONS

To the best of our knowledge there has been no study about risk factors and knowledge of dental fluorosis in the Far North Region of Cameroon. Dental fluorosis was found to be endemic in three communities with a high possibility of it worsening in the near future due to climate changes. Quick and timely actions are needed to reverse the trends of dental fluorosis in these communities of Diamare, Mayo Tsanaga, Logone et Chari.

The following recommendations are suggested:

The Government of Cameroon, through its Ministry of Water and Energy Resources, develop and establish a National Water Policy. The Policy should include safe levels of fluoride in drinking water. This can be achieved by 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 de-fluoridation of water such as de-fluoridation 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 (CFI) and Fluorosis Risk Index (FRI) in vulnerable communities.

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APPENDICES

APPENDIX 1: Information leaflet for Participants

Faculty of Dentistry & WHO Collaborating

Centre for Oral Health

UNIVERSITY OF THE WESTERN CAPE

Private Bag X1, Tygerberg, Cape Town
REPUBLIC OF SOUTH AFRICA

Project Title: Risk Factors and Knowledge of Dental Fluorosis in Three Communities in the Far North Region of Cameroon

What is this study about?

This is a research project being conducted by Etta Barnabas EBOT (a Masters student) under the supervision of Prof. Sudeshni Naidoo at the University of the Western Cape in South Africa. We are inviting you to participate in this research project because you meet the set criterion for the population of interest and your participation will help other people in your community and the country as a whole.

The purpose of this research project is to determine the risk factors and knowledge of dental fluorosis in the far north of Cameroon when these risk factors are identified, proposal sensitization of the communities concerned with the study can be done so as to prevent dental fluorosis which is suspected to be an oral health problem in these communities. Despite extensive knowledge regarding it's causes, prevention and treatment, dental fluorosis remains a major public health problem in the Cameroon and continues to impact negatively on population health and well-being. These challenges are predominantly concentrated among the most vulnerable in our society - the poor and low income earners.

As a person living in a community with high levels of fluoride in the water supply you have therefore been invited to participate in the present study to provide information about the risks and perceptions to dental fluorosis.

What will I be asked to do if I agree to participate?

You will be asked to sign a consent form agreeing to take part in the study. Your participation will involve a verbal questionnaire that should take no longer than 15 minutes for us to complete. These interviews will be conducted at a time and location that is convenient to you. In addition we will examine your mouth and photographs only of your teeth may be taken but will not show your identity or face. You will be issued with a questionnaire to assess your knowledge of the risk factors for dental fluorosis. Your child will have a dental examination to determine if their teeth are affected by dental fluorosis. You may also be required to provide a half-litre of water in the provided bottle from the water used for domestic purposes which will be send for laboratory analysis to determine the level of fluoride. This study will be done in three counties in the far north region of Cameroon: Mayo-Sava, Mayo-Tsanaga and Logone et Chari.

Would my participation in this study be kept confidential?

All the information, including any personal information you provide will be kept strictly confidential. Your real name will not be included on the data capture sheet and all information collected will be locked in secure password protected files on the computer. Additionally, access to any information will be restricted to me, the researcher and my research supervisor only. Summary interview content or direct quotations from the interview that will be made available through my dissertation, academic publications or policy documents will be coded and anonymized. At the end of the study, all data will be kept for as long as legally required and thereafter will be properly disposed of, deleted or destroyed.

What are the risks of this research?

There are no risks associated with participation. As described above, all precautions (coding of data, restricted access, storage in locked cabinets and/or password protected computers…etc.) to protect anonymity and identity will be strictly applied. You also have the right to only answer questions you want to answer.

What are the benefits of this research?

At the end of this study, I will communicate to you and the community the experiences of dental fluorosis among those who will be examined. The fluoride level of water used for domestic purposes will also be communicated to the community. All participants who undergo an oral examination will have referral for any dental diseases. The results and findings of the study will be presented to the local communities, government of Cameroon and other international organisations to take action to prevent the negative effects of dental fluorosis.

Do I have to be in this research and may I stop participating at any time?

Your participation in this research is completely voluntary. You may choose not to take part at all. If you decide to participate, you have the right to withdraw at any time or only answer selected questions. If you decide not to participate in this study or if you stop participating at any time, you will not be penalised in any way.

Is any assistance available if I am negatively affected by participating in this study?

If at any time of the study, you feel uncomfortable and need assistance, the researcher will refer you for counselling via social welfare office in your area.

What if I have questions?

This research is being conducted by: Etta Barnabas EBOT under the supervision of Professor Sudeshni Naidoo. Should you have any questions regarding this study and your rights as a research participant or if you wish to report any problems you have experienced related to the study, please do not hesitate to contact:

1. **Head of Department:** Prof Rob BARRIE
   Head: Department of Community Oral Health
   Faculty of Dentistry, University of the Western Cape
   Private Bag X1, Tygerberg 7505
   (W) +27 21 937 3149 (Cell) +27 82 4440911
2. **Researcher:** Etta Barnabas EBOT
   Cell/Tel: 677009345
   Email: 3970538@myuwc.ac.za
3. **Supervisor:** Prof. S. NAIDOO (UWC)
   Email:suenaidoo@uwc.ac.za
4. **Research Ethics Committee**

Biomedical Research Ethics Committee (BMREC), University of the Western Cape

Private Bag x17, Bellville, 7535
Tel: + 27 21 959 4111
Email: research-ethics@uwc.ac.za

APPENDIX 2: Informed Consent Form (adult)

Faculty of Dentistry & WHO Collaborating

Centre for Oral Health

UNIVERSITY OF THE WESTERN CAPE

Private Bag X1, Tygerberg, Cape Town
REPUBLIC OF SOUTH AFRICA

Project Title: Risk Factors and Knowledge of Dental Fluorosis in Three Communities in the Far North Region of Cameroon

Principal Investigator: Etta B EBOT (MSc Student; University of the Western Cape)

Supervisor: Prof. S. Naidoo (UWC)

Department: Community Oral Health

Telephone: 677009345

Email: 3970538@myuwc.ac.za

Dear ……

You are being invited to participate in the above-mentioned research study. Please take time to read the information that is presented below.

The study entitled "Risk Factors and Knowledge of Dental Fluorosis in Three Communities in the Far North Region of Cameroon" will investigate the level of dental fluorosis in your community. Despite extensive knowledge regarding it's causes, prevention and treatment, dental fluorosis remains a major public health problem in Cameroon and continues to impact negatively on population health and well-being.

As a resident of this community you have been invited to participate in the present study to provide insight and expertise to this important topic. Your participation will involve a verbal administered questionnaire that should take no longer than 15 minutes to complete. Participation is voluntary and you have the right to withdraw at any time, to only answer selected questions or to refuse to participate entirely without the risk of penalty or prejudice. There are **no foreseeable risks** associated with participation in the study. Participation will however allow you to contribute meaningfully to this serious problem in your area. Please indicate your willingness to participate through completion of the attached declaration on the next page.

Thank you for taking time to read this information sheet. Should you have any queries relating to participation or the nature of the study, please do not hesitate to speak to the researcher. You will receive copies of this informational sheet and consent form for your records.

Yours Sincerely

Etta Ebot

Declaration by the Participant

I (full name) …….

- Declare that the study has been described to me in language that I understand;
- Have read, understood and received a copy of the foregoing informational sheet and consent form, written in a language with which I am fluent;
- Have had the opportunity to ask questions regarding the study and my questions have been answered to my satisfaction;
- Understand that my identity will not be disclosed and that I have the right to withdraw from the study at any stage without giving a reason and without the risk of penalty;
- Freely and voluntarily agree to participate in this study.

Name of participant: _____

Signature of participant: _____ Date: _____

Declaration by the Investigator

I, Etta Barnabas EBOT, hereby declare that all information presented has been explained to the participant (name) ……

I encouraged him/her to ask questions, took time to answer the questions they asked and am satisfied that he/she understands all aspects of the study.

Signature of Investigator: _____ Date: _____

APPENDIX 2(b): Informed Consent Form (child)

Faculty of Dentistry & WHO Collaborating

Centre for Oral Health

UNIVERSITY OF THE WESTERN CAPE

Private Bag X1, Tygerberg, Cape Town
REPUBLIC OF SOUTH AFRICA

Project Title: Risk Factors and Knowledge of Dental Fluorosis in Three Communities in the Far North Region of Cameroon

Principal Investigator: Etta B EBOT (MSc Student; University of the Western Cape)

Supervisor: Prof. S. Naidoo (UWC)

Department: Community Oral Health

Telephone: 677009345

Email: 3970538@myuwc.ac.za

Dear …… (name of child or name of parent)

You/Your child …… (name of child) are/is being invited to participate in the above-mentioned research study. Please take time to read the information that is presented below. The researcher will also be able to read and explain the form to you if you cannot understand it yourself.

The study entitled "Risk Factors and Knowledge of Dental Fluorosis in Three Communities in the Far North Region of Cameroon" will look at the levels of dental fluorosis in your community. Despite much knowledge regarding its causes, prevention and treatment, dental fluorosis remains a major public health problem in Cameroon and continues to impact negatively on communities' oral health and well-being. As a resident of this community you have been invited to participate in the present study to provide insight and expertise to this important topic. Your participation will involve a verbal administered questionnaire that should take no longer than 15 minutes to complete. Participation is voluntary and you have the right to withdraw at any time, to only answer selected questions or to refuse to participate entirely without the risk of penalty. There are **no foreseable risks** associated with participation in the study. Participation will however allow you to contribute meaningfully to this serious problem in your area. Please indicate your willingness to participate through completion of the attached declaration on the next page.

Should you have any queries relating to participation or the nature of the study, please do not hesitate to speak to the researcher. You will receive copies of this informational sheet and consent form for your records.

Yours Sincerely

Etta Ebot

Declaration by the Participant

I (full name) ……

- Declare that the study has been described to me in language that I understand;
- Have read, understood and received a copy of the foregoing informational sheet and consent form, written in a language with which I am fluent;
- Have had the opportunity to ask questions regarding the study and my questions have been answered to my satisfaction;
- Understand that my identity will not be disclosed and that I have the right to withdraw from the study at any stage without giving a reason and without the risk of penalty;
- Freely and voluntarily agree to participate in this study.

Name of participant: _____

Signature of participant: _____ Date: _____

Name of parent: _____

Signature of parent: _____ Date: _____

Declaration by the Investigator

I, Etta Barnabas EBOT, hereby declare that all information presented has been explained to the participant (name) …… and the parent(s). I encouraged them to ask questions, took time to answer the questions they asked and am satisfied that they understand all aspects of the study.

Signature of Investigator: _____ Date: _____

APPENDIX 3: Questionnaire

Faculty of Dentistry & WHO Collaborating

Centre for Oral Health

UNIVERSITY OF THE WESTERN CAPE

Private Bag X1, Tygerberg, Cape Town
REPUBLIC OF SOUTH AFRICA

Project Title: Risk Factors and Knowledge of Dental Fluorosis in Three Communities in the Far North Region of Cameroon

1. Sub-unban town: _____
2. Sex: Male Female
3. Occupation: _____
4. What age group are you?
   a. 0 – 6 years
   b. 7 – 12 years
   c. 13 – 25 years
   d. 26 – 50 years
   e. Above 50 years
5. Were you born here?
   a. Yes
   b. No

   If No how long have you lived here? _____
6. What is your educational level?

   (a) None

   (b) Primary

   (c) Secondary

   (d) Higher

7. Occupancy status of your current house?
    a. Own house
    b. Rented house
    c. Company or institutional.

8. What is the source of your water for domestic use (drinking, cooking, etc)
    a. Well
    b. Springs
    c. Bore hole
    d. Local pipe borne water

9. Do you boil water before drinking?
    Yes No

10. Have you noticed any problem with the water you drink?
    Yes No
    If yes,
    a. Smell
    b. Taste
    c. Colour
    d. Others(specify) _____

11. Do you regularly use another source of drinking water?
    Yes No
    If yes state the source _____

12. What type of water do you give children for 0 – 1 year for drinking?
    a. Bottle water
    b. Well water
    c. Pipe borne water
    d. Stream water
    e. Other: ----------

13. Have you seen anybody around with brown discoloration in their teeth? Yes No
14. What do you think is the cause of the discoloration of the teeth?
    a. Drinking water with high fluoride content
    b. Drinking very salty water.
    c. Others (specify): _____
15. What do you think about the brown colour of people's teeth?
    a. Normal
    b. Affect your smile
    c. Makes them difficult drink water or eat easily
16. At what age in development can the condition causing brown discoloration occur?
    a. Below 1 year
    b. Between the age of 1 – 10years
    c. Between 10 – 15 years.
    d. Don't know
17. Do you think discolour teeth can be treated in a dental clinic?

    Yes No Don't know

18. Do you brush your teeth with a toothbrush?

    Yes No

    If no, what do you use to clean your mouth? _____

19. Do you brush your teeth with tooth paste?

    Yes No

    If no, what do you use to clean your mouth? _____

20. Have you ever been to a dental clinic?

    Yes No

21. If yes how often _____
22. When you are sick what do you do?
    a. Go to the hospital
    b. Buy medicine and take
    c. Drink herbal mixture
    d. Go to the herbalist

APPENDIX 4: Data Capture Sheet for Oral Examination

Faculty of Dentistry & WHO Collaborating

Centre for Oral Health

UNIVERSITY OF THE WESTERN CAPE

Private Bag X1, Tygerberg, Cape Town
REPUBLIC OF SOUTH AFRICA

Project Title: Risk Factors and Knowledge of Dental Fluorosis in Three Communities in the Far North Region of Cameroon

Dental Fluorosis (Thylstrup and Fejerskov index)

Name:_____ Gender: _____

Questionnaire Number: _____ Year of Birth:_____

Tooth	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**21**	**22**	**23**	**24**	**25**	**26**	**27**
Score#														
Score#														
Tooth	**47**	**46**	**45**	**44**	**43**	**42**	**41**	**31**	**32**	**33**	**34**	**35**	**36**	**37**

- Highest TF surface score recorded for any tooth will be the individuals TF score.

Overall TF Score _____

APPENDIX 5: Dental Fluorosis TFI Scoring Sheet

Scoring Criteria for dental fluorosis using the Thylstrup and Fejerskov Index

SCORE	CRITERIA
0	Normal translucency of enamel after air-drying
1	Narrow white lines corresponding to the position of the perikymata.
2	More pronounced lines of opacity corresponding to perikymata. May merge to form small cloudy areas scattered over whole tooth surface. Opacity of cusp tips and incisal edges common
3	Merging of white lines with cloudy areas spread through the tooth surface.
4	Entire surface has marked opacity and may appear chalky white
5	Entire surface displays opacity with focal loss of outermost enamel (Pits of less than 2mm in diameter)
6	Pits are regular, arranged in horizontal bands less than 2mm in vertical extension. Teeth may exhibit marked attrition.
7	Loss of outermost enamel in irregular areas involving less than ½ of entire surface
8	Loss of outermost enamel involving more than ½ of the surface. Remaining enamel is opaque
9	Loss of main part of enamel, resulting in change of tooth anatomy. Cervical rim of opaque enamel noted.

TFI SCORING CRITERIA

TF 0

TF 1

TF 2

TF 3

TF 4

TF 5

TFI SCORING CRITERIA

TF 6

TF 7

TF 8

TF 9

APPENDIX 6: Informed Consent for Photography

Faculty of Dentistry & WHO Collaborating

Centre for Oral Health

UNIVERSITY OF THE WESTERN CAPE

Private Bag X1, Tygerberg, Cape Town
REPUBLIC OF SOUTH AFRICA

Project Title: Risk Factors and Knowledge of Dental Fluorosis in Three Communities in the Far North Region of Cameroon

Principal Investigator: Etta B EBOT (MSc Student; University of the Western Cape)

Supervisor: Prof. S. Naidoo (UWC)

Department: Community Oral Health

Phone: 677009345

Email: 3970538@myuwc.ac.za

I, ... hereby consent to photographs being taken of me/my child as requested, I understand that these photographs will be stored appropriately, treated with the utmost confidentiality and be part of my dental record. I hereby give consent for the images or recordings to be used ONLY for the boxes I have indicated with a tick (√):

☐ **Record purposes and for my/my child's future management**: The photographic images and recordings will form part of the information collected for you or your child's care and treatment. This information is handled in accordance with the HPCSA Booklet 14: Guidelines on the keeping of patient records.

☐ **Education and training purposes:** The photographic images and recordings may be used for teaching purposes and viewed by health professionals outside of the UWC Faculty of Dentistry. The images may be used for example, in talks, conference presentations, posters or on the Internet to help train other health professionals in the management of dental and oral diseases

☐ **Approved research purposes & publication:** This may involve the photographic images and recordings being used for example in medical or dental publications, journals, textbooks, conference material, e-publications and on the Internet. Images will be seen by health professionals and researchers who use the publications in their professional education. The images may be seen by the general public. Images will not be used with identifying information such as name, however, full confidentiality is not guaranteed.

☐ **Other purposes** (please specify):

……
……
……

Declaration by the Participant

I (full name) …….

- Have read, understood and received a copy of the foregoing photography consent form, written in a language with which I am fluent;
- Have had the opportunity to ask questions regarding this and any questions I have asked have been answered to my satisfaction;
- I understand that all efforts will be made to conceal my/my child's identity but that full confidentiality cannot be guaranteed.
- I understand that my consent or refusal will in no way affect my /my child's dental care.

Signature of participant: _____ Date: _____

Parent/Guardian: _____Date: _____

Child assent (<17 years): _____Date: _____

Witness Name & Signature: _____Date:_____

We thank you for your contribution to our research.

APPENDIX 7: Referral Letter

Faculty of Dentistry & WHO Collaborating

Centre for Oral Health

UNIVERSITY OF THE WESTERN CAPE

Private Bag X1, Tygerberg, Cape Town
REPUBLIC OF SOUTH AFRICA

Project Title: Risk Factors and Knowledge of Dental Fluorosis in Three Communities in the Far North Region of Cameroon

REFERRAL FOR DENTAL TREATMENT

Dear Participant, Parent/ Guardian,

You and/or your child _____, have received an oral examination and have been found to have Tooth decay/ Gum disease/ or _____ which requires urgent treatment.

I recommend that you take the child to _____hospital dental clinic or a private facility of your choice for management. Please note that you will bear the cost of your or your child's treatment.

Yours Faithfully,

Etta B.Ebot

Masters Student/Dental Researcher

APPENDIX 8: Data Capture Sheet for Laboratory analysis of Water Samples

Faculty of Dentistry & WHO Collaborating

Centre for Oral Health

UNIVERSITY OF THE WESTERN CAPE

Private Bag X1, Tygerberg, Cape Town
REPUBLIC OF SOUTH AFRICA

Project Title: Risk Factors and Knowledge of Dental Fluorosis in Three Communities in the Far North Region of Cameroon

NAME OF COMMUNITY_____

NO	NAME	SEX	DATE OF BIRTH	PARENTS' QUESTIONNAIRE NUMBER	WATER SAMPLE NUMBER
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

WATER SAMPLES FROM COMMUNITIES

Type of source	Location	Fluoride content	> or < than 1ppm

APPENDIX 9: Ethics Clearance UWC BMREC

OFFICE OF THE DIRECTOR: RESEARCH RESEARCH AND INNOVATION DIVISION

31 July 2019

Dr BE Etta

Faculty of Dentistry

Ethics Reference Number: BM19/5/17

Project Title: Risk factors and knowledge of dental fluorosis in three communities in the far North Region of Cameroon

Approval Period: 31 July 2019 – 31 July 2020

I hereby certify that the Biomedical Science Research Ethics Committee of the University of the Western Cape approved the scientific methodology and ethics of the above mentioned research project.

Any amendments, extension or other modifications to the protocol must be submitted to the Ethics Committee for approval.

Ms Patricia Josias

Research Ethics Committee Officer
University of the Western Cape

APPENDIX 9b: Ethics Clearance Department of Education & Research, Cameroon

REPUBLIQUE DU CAMEROUN

Paix - Travail – Patrie
****
MINISTERE DE LA SANTE PUBLIQUE
****
SECRETARIAT GENERAL
****
DELEGATION REGIONALE DE L'EXTREME-NORD
****

Tél : 22 29 10 67
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REPUBLIC OF CAMEROON

Peace – Work - Fatherland
****
MINISTRY OF PUBLIC HEALTH
****
SECRETARIAT GENERAL
****
REGIONAL DELEGATION FOR FAR NORTH
****

N° 275 /L/19/MINSANTE/SG/DRSPEN/ YFF/MRA. Maroua, le 24 Juin 2019

LE DELEGUE REGIONAL DE LA SANTE PUBLIQUE DE L'EXTREME- NORD

A

M. ETTA Banarbas EBOT
Etudiant en Master en Santé Publique
UNIVERSITY OF THE WESTERN CAPE .

Objet : Autorisation de recherche portant sur la fluorose dentaire dans la région de l'Extrême-Nord.

Après étude de votre dossier reçu en date du 21 Juin 2019, dont l'objet est repris en marge, J'ai l'honneur de porter mon accord tout en vous exhortant à respecter la déontologie en matière d'exploitation des données sanitaires.

Y faisant suite, je vous invite à vous rapprocher des services des districts de santé Kousséri,Goulfey,Mada,Makary, Tokombere, Mora, Kolofata, Bourha, Mogodé, Koza, Roua, Mokolo et Hina qui vous permettront d'étoffer la recherche que vous menez sur le thème : **« RISK FACTORS AND KNOWLEDGE OF DENTAL FLUOROSIS IN THREE COMMUNITIES IN THE FAR NORTH REGION OF CAMEROUN. »**

Le Délégué Régional

Dr. Ramadan Bava Soubakary

Ampliations :
-Districts concernés
- Intéressé
-Archives/chronos

TRANSLATED APPENDICES (FRENCH)

APPENDIX 1: Information leaflet for Participants (French)

Faculty of Dentistry & WHO Collaborating

Centre for Oral Health

UNIVERSITY OF THE WESTERN CAPE

Private Bag X1, Tygerberg, Cape Town
REPUBLIC OF SOUTH AFRICA

Titre du projet : Facteurs de risque et les connaissances de fluorose dentaire dans trois localités situées dans la région de L'extrême nord du Cameroun

En quoi consiste cette étude ?

Il s'agit d'un projet de recherche conduit par Etta Barnabas Ebot (une étudiante en maîtrise) sous la supervision du Prof. Sudeshni Naidoo à l'Université de Western Cape en Afrique du Sud. Nous vous invitons à participer à ce projet de recherche car vous répondez au critère de réglage pour la population d'intérêt et votre participation aidera d'autres personnes dans votre communauté et le pays dans son ensemble.

Le but de ce projet de recherche est de déterminer les facteurs de risque et les connaissances de fluorose dentaire dans l'extrême nord du Cameroun, lorsque ces facteurs de risque sont identifiés, la sensibilisation de la proposition des communautés concernées par l'étude peut se faire au éviter la fluorose dentaire, qui est soupçonnée d'être un problème de santé bucco-dentaire dans ces collectivités. Malgré une vaste connaissance au sujet de ses causes, prévention et traitement, la fluorose dentaire reste un problème majeur de santé publique du Cameroun et continue d'avoir une incidence négative sur la santé des populations et le bien-être. Ces défis sont principalement concentrés parmi les plus vulnérables de notre société - les salariés pauvres et à faible revenu.

Comme une personne vivant dans une communauté avec des niveaux élevés de fluorure dans l'eau vous avez donc été invités à participer à la présente étude à fournir des informations sur les risques et les perceptions de la fluorose dentaire.

Ce qui me demandera-t-on à faire si je m'engage à participer ?

On vous demandera de signer un formulaire de consentement acceptant de participer à l'étude. Votre participation impliquera un questionnaire verbal qui prenne pas plus de 15 minutes pour nous remplir. Ces entretiens seront dérouleront à [une heure et le lieu qui vous convient. En outre, nous examinerons votre bouche et photographies uniquement de vos dents peuvent être prises, mais n'affichera pas votre identité ou votre visage. Vous recevrez un questionnaire pour évaluer vos connaissances sur les facteurs de risque de fluorose dentaire. Votre enfant aura un examen dentaire afin de déterminer si leurs dents sont touchées par la fluorose dentaire. Vous devrez également fournir un demi-litre d'eau dans le flacon fourni de l'eau pour des usages domestiques qui sera envoyé pour analyse en laboratoire déterminer le niveau de fluorure. Cette étude se fera dans trois comtés de la région extrême nord du Cameroun: Mayo-Sava, Mayo-Tsanaga et Logone et Chari.

Ma participation à cette étude demeurerait confidentielle? Toutes les informations, y compris les renseignements personnels que vous fournissez demeureront strictement confidentiel. Votre vrai nom ne figurera pas sur la fiche de capture de données et tous les renseignements recueillis seront verrouillés dans les fichiers de mot de passe sécuriser protégé sur l'ordinateur. En outre, accès à des renseignements se limitera à moi, le chercheur et mon directeur de recherche uniquement. Sommaire interview contenu ou directement des citations de l'entrevue qui seront disponibles par le biais de ma thèse, les publications académiques ou les documents de politique seront codées et rendues anonymes. À la fin de l'étude, toutes les données seront conservées pour tant que légalement requis et par la suite seront correctement éliminés, supprimé ou détruit.

Quels sont les risques de cette recherche? Il n'y a pas de risques associés à la participation. Comme indiqué ci-dessus, toutes les précautions nécessaires (le codage des données, accès restreint, rangement dans les armoires verrouillés et/ou d'ordinateurs protégés par mot... etc..) pour protéger l'anonymat et l'identité sera strictement appliquée. Vous avez également le droit seulement de répondre aux questions que vous voulez répondre.

Quels sont les avantages de cette recherche? À la fin de cette étude, je vous communiquerai à vous et à la communauté les expériences de la fluorose dentaire parmi ceux qui seront examinés. Le niveau de fluorure de l'eau utilisée pour volonté d'usages domestiques également être communiquées à la communauté. Tous les participants qui se soumettent à un examen oral aura renvoi pour toute les maladies dentaires.

Les résultants et les conclusions d'étude seront présentés et il est prévu qu'il déclenchera les communautés locales, le gouvernement du Cameroun et les autres organisations internationales à prendre des mesures pour prévenir les effets négatifs de la fluorose dentaire.

Ce que je dois être dans cette recherche et je peux arrêter participant à tout moment ?

Votre participation à cette recherche est entièrement volontaire. Vous pouvez choisir ne pas à prendre part à tous. Si vous décidez de participer, vous avez le droit de retirer en tout temps ou seulement répondre à des questions choisies. Si vous décidez de ne pas participer à cette étude ou si vous cessez de participer à tout moment, vous ne sera pas pénalisé en quelque sorte.

Aucune aide n'est disponible que si je suis affecté négativement par participant à cette étude ?

Si à tout moment de l'étude, vous vous sentez mal à l'aise et ont besoin d'aide, le chercheur vous renverra pour consultation au bureau de la protection sociale dans votre région.

Que se passe-t-il si j'ai des questions ?

Cette recherche est menée par : Etta Barnabas Ebot sous la supervision du professeur Sudeshni Naidoo. Si vous avez des questions concernant vos droits et cette étude comme un participant à la recherche ou si vous souhaitez signaler tout problème que vous avez rencontré associés à the étude, n'hésitez pas à contacter :

1. Chef de service : M. Rob BARRIE
   Chef : Département de santé buccodentaire communautaire
   Faculté de médecine dentaire, University of the Western Cape
   privé X1, Tygerberg 7505
   (bureau) + 27 21 937 3149 (cellule) +27 82 4440911

2. Chercheur : Etta Barnabas EBOT
   Cellulaire/Tel : 677009345
   Courriel email : 3970538@myuwc.ac.za

3. Superviseur : Prof. S. NAIDOO (UWC)
   Courriel email : suenaidoo@uwc.ac.za

4. Comité d'éthique de la recherche
   Comité d'éthique de la Recherche Biomédicale (CERBM),
   University of the Western Cape, Boite Prive x17, Bellville, 7535
   Tel: + 27 21 959 4111 email: research-ethics@uwc.ac.za

APPENDIX 2: Informed Consent Form (adult) (French)

Faculty of Dentistry & WHO Collaborating

Centre for Oral Health

UNIVERSITY OF THE WESTERN CAPE

Private Bag X1, Tygerberg, Cape Town
REPUBLIC OF SOUTH AFRICA

Titre du projet de recherche : Facteurs de risque et les connaissances de fluorose dentaire dans trois localités situées dans le région L'Extrême Nord du Cameroun.

Chercheur principal : Etta B EBOT (MSc étudiant)

Superviseur : Prof. S. Naidoo

Département : Communautaire de santé buccodentaire

Téléphone : 677009345

Email : 3970538@myuwc.ac.za

Cher...

Vous êtes invités à participer à l'étude de recherche mentionnés ci-dessus. Prenez le temps de lire l'information qui vous est présentée ci-dessous. L'étude intitulée " Facteurs de risque et les connaissances de fluorose dentaire dans trois localités situées dans la région de l'extrême nord du Cameroun « étudiera le niveau de fluorose dentaire dans votre communauté. Malgré les connaissances approfondies au sujet de ses causes, prévention et traitement, la fluorose dentaire reste un problème majeur de santé publique au Cameroun et continue d'avoir une incidence négative sur le bien-être et la santé de la population.

En tant que résident de cette communauté, vous avez été invités à participer à cette étude pour fournir un aperçu et une expertise à ce sujet important. Votre participation impliquera un questionnaire administré verbal qui prenne pas plus de 15 minutes à remplir. La participation est volontaire et vous avez le droit de retirer à tout moment, seulement répondre à certaines questions ou de refuser de participer entièrement sans risque de pénalité ou de préjudice. Il n'y a pas de risques liés à la participation à l'étude. Participation toutefois vous permettra de contribuer utilement à ce grave problème dans votre région. Veuillez indiquer votre volonté de participer en complétant la déclaration ci-jointe sur la page suivante.

Merci d'avoir pris le temps de lire cette fiche d'information. Si vous avez des questions relatives à la participation ou la nature de l'étude, n'hésitez pas à prendre la parole au chercheur. Vous recevrez des copies de la présente fiche d'information et formulaire de consentement pour vos dossiers.

APPENDIX 3: Questionnaire (French)

Faculty of Dentistry & WHO Collaborating

Centre for Oral Health

Private Bag X1, Tygerberg, Cape Town
REPUBLIC OF SOUTH AFRICA

Titre du projet : Facteurs de risque et les connaissances de fluorose dentaire dans trois localités situées dans la région de l'extrême nord du Cameroun

1. Ville de banlieue /Village: _____

2. Sexe: Homme Femme

3. Occupation: _____

4. Quel est votre groupe d'âge?
a. 0 à 6 ans
b. 5 à 12 ans
c. 12 à 25 ans
d. 25 à 50 ans
e. Au-delà de 50 ans

5. Êtes-vous né ici?
a. Oui
b. Non
Si non, depuis combien de temps vivez-vous ici? _____

6. Quel est votre niveau de scolarité?
a. Primaire
b. Secondaire
c. Plus élevé
7. État d'occupation/inoccupation de votre maison actuelle?
a. Maison personnelle
b. Maison louée
c. Entreprise ou établissement.

8. Quelle est la source d'eau à usage domestique (boisson, cuisson)?

a. puits
b. Ressorts
c. forage
d. Tuyau local transmises par l'eau

9. Vous faire bouillir l'eau avant de la boire ?

Oui Non

10. Avez-vous remarqué aucun problème avec l'eau que vous buvez ?

Oui Non

Dans l'affirmative,

a. Odeur

b. Goût

c. Couleur

d. Autre,precise…….

11. Utilisez-vous régulièrement une autre source d'eau potable ?

Oui Non

Si oui préciser la source…….

12. Quel type d'eau donnez-vous enfants de 0 à 1 an pour la boisson ?

a. Bouteille d'eau
b. Eau de puits
c. Eau de conduite à la charge
d. Cours d'eau
e. Autres …….

13. Avez-vous vu quelqu'un autour avec la décoloration brune dans leurs dents ?

Oui Non

14. Ce que vous pensez est la cause de la décoloration des dents ?

a. Eau potable avec la teneur en fluor élevé

b. Boire de l'eau très salée.

c. D'autres (préciser) : ___

15. Ce que vous pensez la couleur brune de dents gents?
a. Normal
b. Affectez votre sourire
c. Les rend difficiles à boire de l'eau ou à manger facilement

16. À quel âge peut-on observer une décoloration brune?
a. Moins d'un an
b. Entre 1 et 10 ans
c. Entre 10 et 15 ans.
d.quand je suis devenu adulte

17. Pensez-vous que les dents décolorées peuvent être traitées dans une clinique dentaire?
Oui Non

18. brossez-vous les dents avec une brosse à dents et du dentifrice?
Oui Non
Si non, que faites-vous pour nettoyer votre bouche? _____

19. Avez-vous déjà visité une clinique dentaire?
Oui Non
Si oui, à quelle fréquence _____

20. Que faites-vous lorsque vous êtes malade?
a. Aller à l'hôpital
b. Acheter des médicaments et prendre
c. Boire du mélange à base de plantes
d. Aller à l'herboriste

MERCI DE VOTRE TEMPS!

Et si j'ai des questions? Cette recherche est menée par: Etta Barnabas EBOT sous la supervision du professeur Sudeshni Naidoo. Si vous avez des questions au sujet de cette étude et de vos droits en tant que participant à la recherche ou si vous souhaitez signaler des problèmes liés à l'étude, n'hésitez pas à communiquer avec:

1. Chef de service: M. Rob BARRIE
Chef: Département de santé buccodentaire communautaire
Faculté de médecine dentaire, University of the Western Cape
Sac privé X1, Tygerberg 7505 (bureau) + 27 21 937 3149 (cellule) +27 82 4440911

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4. Comité d'éthique de la recherche
Comité d'éthique de la recherche biomédicale (CERBM), University of the Western Cape, Boite Prive x17, Bellville, 7535
Tel: + 27 21 959 4111 email: research-ethics@uwc.ac.za

APPENDIX 6: Informed Consent Form for Photography (French)

Faculty of Dentistry & WHO Collaborating

Centre for Oral Health

UNIVERSITY OF THE WESTERN CAPE

Private Bag X1, Tygerberg, Cape Town
REPUBLIC OF SOUTH AFRICA

Chercheur principal: Etta B EBOT (MSc étudiant)

Superviseur: Prof de . S. Naidoo

Département: Communautaire de santé buccodentaire

Téléphone 677009345

Email: 3970538@myuwc.ac.za

J m apelle..... consens à des photographies prises de moi / mon enfant comme demandé, je comprends que ces photographies seront stockées de manière appropriée, traités avec la plus grande confidentialité et faire partie de mes dossiers dentaires. Je donne par les présentes de consentement pour les images ou d'enregistrements à utiliser uniquement pour les boîtes, je l'ai indiqué avec un cocher (√) :

□ **Enregistrer les fins et pour la gestion future de l'enfant mon/ma**: Enregistrements et la photographic images feront partie de l'information recueillie pour vous ou votre enfant les soins et le traitement. Cette information est traitée conformément à la HPCSA livret 14 : lignes directrices sur la tenue des dossiers des patients.

□ **L'éducation et formation**: Les photographies et les enregistrements peuvent être utilisés à des fins pédagogiques et lus par des professionnels de la santé à l'extérieur de la faculté de dentisterie de l'UWC. Les images peuvent être utilisées par exemple, dans les pourparlers, des présentations à des conférences. professionnels de la santé dans la gestion des maladies buccodentaires

□ **Approuvé des fins de recherche et de publication**

Cela peut impliquer les photographies et les enregistrements utilisés par exemple dans des publications médicales ou dentaires, revues, manuels scolaires, matériel de conférence, e-publications et sur Internet. Images seront vu par les professionnels de la santé et les chercheurs qui utilisent les publications dans leur formation professionnelle. Les images peuvent être vues par le grand public. Images ne servira pas des informations d'identification telles que le nom, cependant, la confidentialité n'est pas garantie.

□ **Autres fins** (Veuillez préciser) :...----------

Déclaration par le Participant

Je, (nom et prénom).....

- Avoir lu, compris et reçu une copie de la formule de consentement qui précèdent photographie, rédigée dans une langue avec laquelle je suis à l'aise;
- Ont eu l'occasion de poser des questions à ce sujet et des questions que j'ai demandé à avoir répondu à ma satisfaction;
- Je comprends que tous les efforts seront à dissimuler l'identité de l'enfant mon/mes, mais que la confidentialité ne peut être garantie.
- Je comprends que mon consentement ou mon refus sera en aucun cas des soins dentaires affectent mon/mes enfant.

Signature du participant: …… Date:……..

Parents/tuteur:…….. Date:……...

La sanction (< 17 ans) de l'enfant:…… Date:……

Témoin nom et Signature:……. Date ……

Nous vous remercions pour votre contribution à nos recherches