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An Evaluation of Dental Flourosis in Bama, Borno State, Nigeria

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Abstract

Dental Fluorosis is a disease most commonly attributed to excessive fluoride in drinking water. The primary source of drinking water in Bama, Borno State, is groundwater tapped from the major aquifer used in the study area. This study aims to investigate the root causes of dental fluorosis among residents in Bama, Borno State, and to determine fluoride concentrations in the aquifer. This was to proffer sustainable solution(s) that will address the effect of dental fluorosis affecting the local populace. Both qualitative and quantitative data were utilised in the study. A total of ten groundwater samples were collected and analysed for fluoride concentration using standard Spectroscopic methods with high affinity of fluorides against certain metals. This was quantified using the Lambert–Beer law using spectrophotometric measurements. The result of the physical parameters, such as pH, ranged from 6.02 in sample location eight to 7.18 in sample five. Likewise, a minimum EC of 121μS/cm was obtained in the sample from location one, and 190μS/cm in the sample from location seven. Also, the TDS values ranged from 89 mg/l to a maximum of 165 mg/l in the samples obtained in location nine. The fluoride concentration varied from 3.7 mg/l to 8.9 mg/l among the ten samples collected in the study area. Location 2 has the lowest calcium level, at 0.67 mg/l, and location 10 has the highest level, at 5.1 mg/l. The magnesium level varied a lot, from 12.3 mg/l to 34.6 mg/l. The concentration of aluminium in the groundwater samples varied from 0.08 mg/l to 1.2 mg/l. The outcome of this study will be vital to local policymakers in providing a sustainable solution to the effects of dental fluorosis in the study area's residents.

Keywords: Fluorosis, Dental, Groundwater, Bama, Nigeria

Introduction

Fluorosis is a condition caused by excessive fluoride exposure. Fluoride is a mineral that occurs naturally. It helps stop tooth decay in small amounts. It's bad for your health in large amounts [1] There is fluoride in almost all water. Depending on where you live, your water source might have too little or too much of something [2] Fluorosis is more common in Nigeria and other developing countries. It is common in less affluent areas where the populace is poor and vulnerable, and lives in shanty areas. Likewise, people who live in rural areas are also vulnerable to dental fluorosis [3].

The United States Department of Health and Human Services says that your drinking water should have 0.7 milligrams per litre (mg/L) of fluoride [4].

Fluorides are found in small amounts in soil, water, plants, animals, and people. The natural amount of fluoride in water depends on several factors, including pH, total dissolved solids, alkalinity, the porosity and acidity of the soil and rocks, temperature, well depth, and other variables (Mandinic et al., 2010).

Fluoride pollution of groundwater is a major concern for people around the world because it is toxic and can harm health. Over the past ten years, reports have come in from all over the world about regions that have been affected for the first time. More than 100 countries were impacted by fluoride contamination in groundwater (levels surpassing the World Health Organisation's recommendation that 1.5 mg/L is an acceptable level. Fluoride poisoning is primarily due to the unmonitored use of dental and oral hygiene products and to drinking water with excessive fluoride [5].

In many parts of the world, high levels of fluoride in underground water can cause dental fluorosis. Fluoride can be found in groundwater in an ionised form. In places where the soil doesn't have enough calcium, like places with a lot of granite or gneiss, groundwater has higher levels of fluoride. Dental fluorosis can happen when the amount of fluoride in drinking water is more than 1.5 mg/l (1.5 ppm). High levels of ionic fluoride have been found in groundwater, vegetables, fruit, and other crops in some parts of Africa, China, the Middle East, southern Asia (India, Sri Lanka), the Americas, and Japan. However, drinking water is usually the main source of fluoride for most people (WHO, 2005). The air in these places may have a lot of fluoride in it because of dust from soils that contain fluoride and gases that come from factories, underground coal fires, and volcanoes (WHO, 2005).

Fluoride-related groundwater problems and health issues affect more than 200 million people from many different countries. The countries with the highest numbers are Africa (38), Asia (28), and Europe (24), the most populous regions, followed by South America (5), North America (3), and Australia (2). Many scholars believe that the main source of fluoride in drinking water is geogenic, along with forage, grains, grasses, tea, and human-made sources [1, 5-8].

Dental fluorosis in Nigeria has been investigated by [9-12]. It is a condition primarily associated with drinking water containing elevated fluoride levels. Groundwater is the main source of drinking water in Borno State [13-15]. It comes from the three main aquifers of the Chad Basin: the upper, middle, and lower aquifers [16, 17]. These aquifers are found at different depths in the state.

In Nigeria, a large percentage of people in the state rely on groundwater from these aquifers. This study aims to investigate the fundamental causes of dental fluorosis among specific populations in Borno State and to determine fluoride concentrations in three distinct aquifers. The goal is to find long-term solutions to help people in the area with dental fluorosis.

The study employed both qualitative and quantitative data. We collected 150 water samples and used an atomic absorption spectrophotometer to determine the fluoride concentration in each sample. The survey results indicate that approximately

15%, 30%, and 55% of the participants experienced mild, moderate, and severe dental fluorosis, respectively. Also, the results of the interviews show that only a small number (21%) of the people who were interviewed have mild mottled teeth. About 25% and 54% have moderate-to-severe dental fluorosis, respectively. Also, about 76% of the people in the focus group had severe dental fluorosis. The rest of the people in the focus group had mild fluorosis.

Exposure to fluoride over a long period while teeth are developing can cause enamel fluorosis. Even a small amount of fluoride (about 0.03 μg/kg bw) will cause some fluorosis in a population. There is a clear linear relationship between dose and response, and there is no critical threshold for fluoride intake below which the effect on dental enamel will not be seen. It is now established that the pathogenic effects of fluoride are unlikely to be attributable to alterations in cellular or systemic metabolism; instead, they result from localised impacts on the mineralising environment [18].

Lastly, more than 90% of people with dental fluorosis don't know that their drinking water (groundwater) had too much fluoride in it. An examination of groundwater quality shows that fluoride concentration is low (1.72 mg/l) in the upper aquifer, whereas it ranges from 4.3 to 8.7 mg/l in the middle and lower aquifers, respectively. The upper aquifer has low fluoride levels because it is shallow. The middle and lower aquifers have high fluoride levels because minerals that contain fluoride are dissolving, likely in the clay horizons surrounding the area. The findings of this study will be crucial for local policymakers in mitigating the effects of dental fluorosis on the population within the study area.

Study Area

Bama is one of the 27 Local Government Areas of Borno State, northeastern Nigeria. It is located at approximately between latitude 11.5243°N and longitude 13.6907°E. Situated along the seasonal River Yedzaram, it is the largest one of the largest Local Government Areas in Borno State (Figure 1).

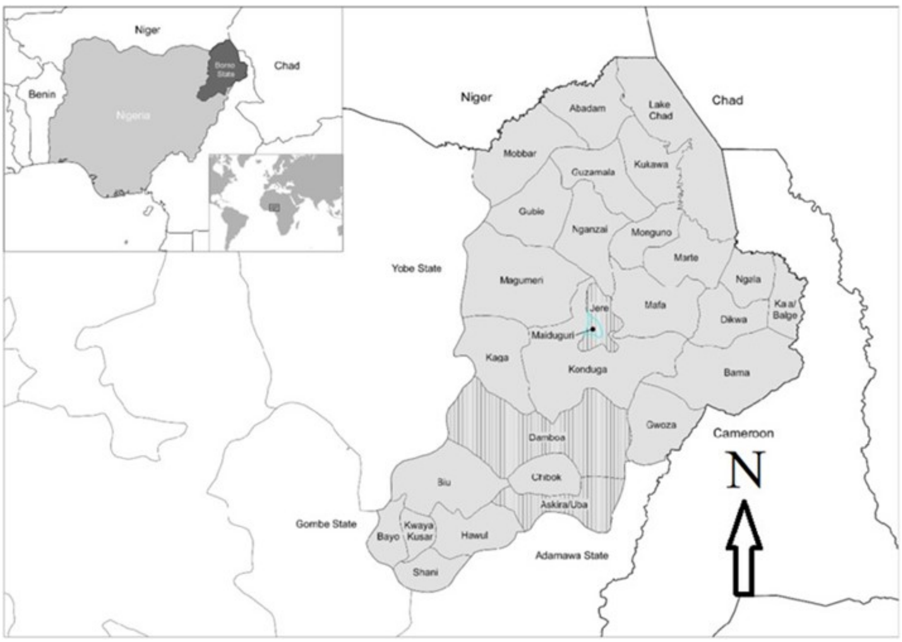

Figure 1: Map of Borno State Showing Bama in Blue, With Nigeria Inserted

According to a 2016 UOCHA statement, Greater Maiduguri saw its population increase from 1 million to 2 million with the influx of people displaced from other areas of the state. An estimated 10-50% of IDPs were projected to remain in the city (Figure 2).

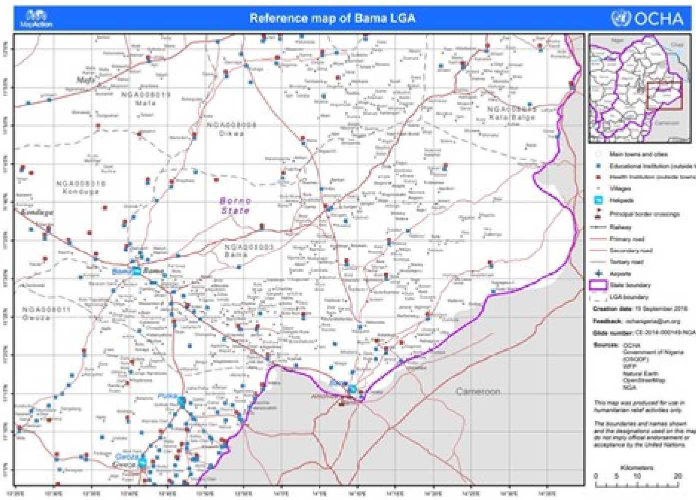

Figure 2: Map of Bama Showing Different Localities Within the City (Adapted From OCHA, 2016).

The climate of the Bama area in Borno State is semiarid, with three distinct seasons: a long, hot, dry season that spans April to May. During this period, daytime temperatures range from 36 to 40 degrees Celsius, and at night they drop to 11 to 18 degrees Celsius. After that, there is a short rainy season in May. In September, the daily temperature ranges from about 24°C to 34°C, with a relative humidity of 40% to 65%. The annual rainfall ranges from 560 to 600 mm (Bakari, 2014). Last but not least, the harmattan season, which is the coldest, lasts from October to March, when temperatures drop to around 20°C, and the air becomes dry and dusty. This originates from the Sahara Desert [19]. The plants of the study area are mostly Savannah woodland, which is split into two areas: the Sahel to the north and the Sudan Savannah to the south

Geology And Hydrogeology of The Study Area

The Chad Basin has been a structural depression since the early Tertiary period, experiencing subsidence and sedimentation rather than erosion. [20] say that the Chad Basin was a tectonic cross point between the NE-to-SW-trending "Tibesti--Cameroon Trough" and the NW-to-SE-trending "Air Chad Trough." More than 3,600 m of sediment have been deposited there [19]. The crystalline basement complex is visible on the eastern, southeastern, southwestern, and northern edges of the basin. Its shape beneath the sediments near the lake resembles a horst-and-graben zone (Oteze and Fayose, 1988). The Chad Basin's stratigraphy (Bornu sub-basin) shows a sequence of deposits from top to bottom, including the younger Quaternary sediments, the Plio-Pleistocene Chad Formation, the Turonian-Maastrichtian Fika shale, the late Cretaceous Gongila Formation, and the Albian Bima Formation [19].

The Bima sandstone is the deeper part of the aquifer series and overlies the basement complex rocks without any breaks. It is between 300 and 2000 m thick and between 2700 and 4600 m deep [20]. Barber and Jones's (1960) groundbreaking study found that the Chad formation is at least 548 m thick at Maiduguri. In the middle of the basin, it could be 600-700 m thick (Offodile, 1992). The Plio-Pleistocene Chad Formation and the Quaternary sediments are the primary sources of groundwater in the Maiduguri region [19].

The Chad formation slopes gently east and northeast toward Lake Chad, in line with the land surface. The formation is of lacustrine origin and consists of thick beds of clay intercalated with irregular beds of sand, silt, and sandy clay (Miller et al., 1968). The only thing that is not lacustrine is a belt of alluvial deposits around the edge of the basin. Based on the preceding information, Barber and Jones (1960) categorised the Chad Formation into three water-bearing zones, referred to as the upper, middle, and lower aquifers [19].

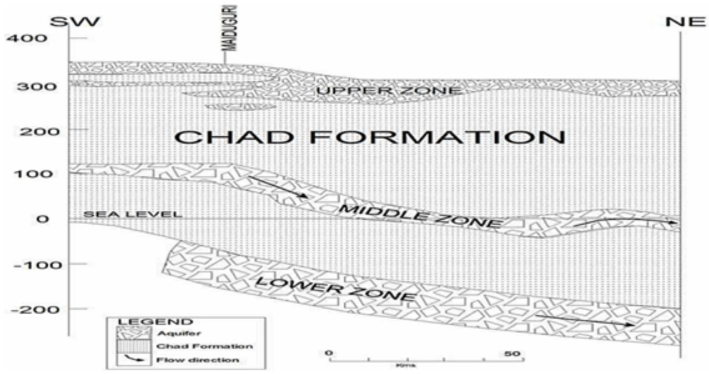

Figure 3: A Cross-Section of The Upper, Middle, And Lower Aquifers in The Study Area [19].

The upper aquifer is made up of Lake Margin's Quaternary alluvial fan and deltaic sediment. This system's reservoir consists of interbedded sands, clays, silts, and sandy clay lenses, which are not always present. This identifies aquifer types ranging from unconfined to semi-confined to confined [21]. It extends from the surface to an average depth of 60 m, but in some places, it reaches 180 m. This aquifer system can transmit between 0.6 and 8.3 m^2/day, and the amount of water it can yield in Maiduguri ranges from 2.5 to 30 l/s [22]. People primarily use this aquifer for drinking water (from hand-dug and shallow wells), growing vegetables, and watering livestock [19, 21].

The middle aquifer (Figure 3) is the most prolific and utilised aquifer in the study area. i.e., the Chad Basin, especially in Nigeria; it covers about 52,000 km^2 in the north-east of Nigeria. This aquifer is between 317 and 393 metres deep. It consists of argillaceous sands that are 15 to 45 metres thick, with clayey units between them and diatomites from the early Pliocene epoch [19]. The sand materials that make up this aquifer dominantly contain quartz and feldspar grains that are medium to coarse in size. The transmissivity value for this aquifer is 360 m^2/day [20] while the aquifer's yield is 25 to 36 litres per second [22].

The lower aquifer is currently found only in the Maiduguri area (Figure 3). It consists of about 70 to 200m of interbedded clay, sandy clay, and sand and is located at depths greater than 500m [22]. There are also a few thin beds of sandstone in the zone. The main water-bearing beds consist of loose layers of medium- to coarse-grained sand, usually between 1 and 5 metres thick. This aquifer is artesian in parts of the Basin and is not abstracted for domestic water supply in most of the Chad Basin. Its yield is between 10 and 35 l/s [22] and its recharge source is thought to be outside of Nigeria [16].

Sampling Locations in Bama

Table 1: Summary of Sampling Location and Borehole Depths in Bama.

S/No	Coordinate	Sampling Location	Depth of Borehole (m)
1	11.5218° N, 13.6884°E	Old Bama	93
2	11.5723°N, 14.2397°E	Shehuri	114
3	11.5453°N, 13.6845°E	Kasugula	151
4	11.5213°N, 13.6895°E	Mairi	89
5	11.5243°N,13.6907°E	Hausari	109
6	11.5242°N, 13.6906°E	Bama Barrack	132
7	11.5219°N, 13.6881°E	Technical School	120
8	11.5186°N, 13.6845°E	Custom Area	115
9	11.5233° N, 13.6892° E	College of Education Bama	67
10	11.5242°N, 13.6906°E	GSSS Bama	74

Material and Methods

Sampling Techniques

Groundwater from ten (triplicate) different places in the study area, the sampling locations are (1) old Bama, (2) Shehuri, (3) Kasugula, (4) Mairi, (5) Hausari, (6) Bama Army Barracks, (7) Technical School, (8) Custom Area, (9) College of Education Bama, and (10) GSSS Bama (Table 1). The justification for choosing these locations is their population concentration.

The samples were stored in sterilised 150 cl bottles. Groundwater taps ran for about 5 minutes before sampling to make sure they were representative. All the groundwater samples were collected from the upper aquifer of the Chad Basin (in Bama). The laboratory received bottles that were full, tightly sealed, labelled, and had an information form with them. The samples were taken to the lab for analysis within 24 hours, and all the bottles were cleaned and sterilised first. The sampling was conducted in accordance to the United States Geological Survey (USGS, 2002) method which provided the standard method for collecting all groundwater samples from across the ten sampling locations which varied accordingly ($p < 0.05$).

Statistical Analysis

A statistical test was carried out to test the difference in concentration of ions across the boreholes using analysis of variance (ANOVA). The Tukey method was utilised in determining the means of fluoride concentration, which are significantly different ($p < 0.05$) across the samples collected in the study area.

Spectroscopic Analysis

Spectroscopic methods are based on the high affinity of fluorides to certain metals. A coloured complex can exchange its ligands with fluorides and change the colour of the solution. This change was quantified using the Lambert–Beer law using spectrophotometric measurements. For this type of determination, it is necessary to quantify the attenuation of a light source passing through a medium, in this case, the solution containing the metal complex and the fluorides. The light from a light source with irradiance P will pass through an infinitesimally thin layer of the sample, dx. During the light absorption process, the irradiance P will decay its power in dP; this decay was proportional to the concentration of coloured complexes c, the probability of light absorption β, and the thickness of the section dx:

$$dP = -\beta .\, P .\, c\, dx \qquad E5$$

The negative sign in the expression indicates that P decreases while passing through the solution.

This expression can be rearranged to:

$$-dPP = -\beta .cdx \Rightarrow -\int PP0dPP = \beta .c \int_0^b dx \qquad E6$$

If we integrate this expression with limits P=P0

at x=0

and P=P

at x=b

$$-lnP - (-lnP0) = \beta .c.b \Rightarrow lnP0P = \beta .c.b \qquad E7$$

Changing the logarithm base, we obtain:

$$A = logPP0 = \beta ln10.c.b = \epsilon.c.b \Rightarrow A = \epsilon.c.b \qquad E8$$

This is the linear relationship between concentration and Absorbance, A, where c is the concentration of the coloured analyte, b is the optical path, and ε is a proportional factor.

Because the reaction of fluorides with a metal complex changes colour intensity, which is proportional to fluoride concentration, the fluoride concentration can be determined using this expression.

$$A = \epsilon.c.b.$$

The spectrophotometric method was used to determine fluorides in the water samples. This has a long-standing reputation over the years for its precision and simplicity compared with electrochemical methods, and the most relevant ones will be described herein.

This method shows how concentration and absorbance are related. The coloured analyte's concentration, the optical path, and a proportional factor are all on this line. The expression was used to determine the fluoride concentration because the reaction of fluorides with a metal complex changes the colour intensity, and the magnitude of the change is directly related to the fluoride concentration.

Lastly, descriptive statistics and Analysis of Variance (ANOVA) were used at 95% (0.05) confidence level to test fluoride variation in the various groundwater samples obtained. A parametric statistical test was used to measure the differences in means of triplicate sample groups.

Results

The physical parameters, such as pH, ranged from 6.02 at sample location eight to 7.18 at sample in Hausari (location 5 where ($p < 0.05$). Also, strategies that can be used by the Government to map high-risk areas, implement targeted interventions, and integrate fluorosis control into national health programs. Were added to the conclusion to make. Likewise, a minimum EC of 121 µS/cm was obtained in the sample from Old Bama, and 190 µS/cm in the sample from location seven. Also, the TDS values ranged from 89 mg/l to a maximum of 165 mg/l in the samples obtained in location nine. Finally, a minimum temperature of 30.4 °C to a maximum of 32.1 °C in the groundwater samples of location eight (Table 1).

Table 2: Results of Physical Parameters in the Study Area.

Location	PH	EC (µS/cm)	TDS (mg/l)	Temp. (°C)
1	6.61±0.00	121±0.70	112±0.00	31±0.07
2	6.57±0.01	129±1.00	122±0.57	30.3±0.39
3	7.14±0.03	189±1.00	142±0.59	31.8±0.15
4	6.34±0.06	168±1.53	154±0.50	30.7±0.15
5	7.18±0.09	150±0.58	151±0.51	32.1±0.10
6	6.22±0.04	167±1.00	135±1.00	31±0.16
7	7.15±0.06	190±1.00	89±1.53	30.4±0.21
8	6.02±0.07	137±1.73	165±0.52	32.1±0.10
9	6.06±0.08	157±1.15	147±1.15	31.4±0.31
10	6.07±0.01	168±1.00	156±0.57	31.3±0.20

Mean of samples in triplicate ± STD

Across the Bama Local Government Area, the fluoride concentration varied from 3.7 mg/l to 8.9 mg/l among the ten samples collected in the study area ($p < 0.05$). Location 2 (Shehuri) has the lowest calcium level, at 0.67 mg/l, and location 10 has the highest level, at 5.1 mg/l. This concentration varied significantly ($p \leq 0.05$). The magnesium level varied significantly ($p < 0.05$), from 12.3 mg/l to 34.6 mg/l (Table 2). The concentration of aluminium in the groundwater samples varied from 0.08 mg/l to 1.2 mg/l. Sample number 10 (GSSS Bama) had the highest concentration of iron at 5.6 mg/l, while location 1 had the lowest concentration at 1.1 mg/l (Figure 4). In Mairi area the concentration of fluoride is 4.7mg/l, 5.2 mg/l in Hausari, 5.5 mg/l in Bama Barracks, 6.2 mg/l in Bama technical school ($p <0.05$). Others include Customs area, College of Education Bama and GSSS Bama with the corresponding values of 6.1 mg/l, 7.3 mg/l and 8.9mg/l respectively ($p <0.05$). The concentration values for other parameters are presented in Table 3.

Table 3: Concentration of Fluoride and Other Ions in The Bama Groundwater Samples Analysed.

Locatn No.	F^- (mg/l)	Ca^{2+} (mg/l)	Mg^{2+} (mg/l)	A^{2+} (mg/l)	Fe (mg/l)	HCO_3^- (mg/l)
1	3.7^{a} ±0.01	1.77^{c} ±0.44	19.2^{b} ±0.05	0.12^{d} ±0.00	1.1^{a} ±0.09	1.99^{e} ±0.03
2	3.9^{d} ±0.06	0.67^{a} ±0.21	22.3^{b} ±0.03	1.2^{c} ±0.08	1.2^{b} ±0.04	3^{a} ±0.02
3	3.11^{b} ±.0.02	2^{c} ±0.61	17.8^{b} ±0.02	0.17^{a} ±1.00	2.1^{c} ±0.06	3.1^{e} ±0.12
4	4.^{c} 7±0.68	4.2^{b} ±0.03	20.3^{e} ±0.08	0.13^{b} ±0.03	3.89^{b} ±0.4	3.22^{c} ±0.06
5	5.2^{e} ±0.00	3.1^{a} ±0.01	22.5^{c} ±0.07	0.11^{b} ±0.30	3.9^{a} ±0.02	3.76^{c} ±0.05
6	5.5^{b} ±0.11	2.6^{c} ±0.09	29.6^{b} ±0.88	0.08^{d} ±0.1	4^{b} ±0.06	3.2^{e} ±0.11
7	6.2^{d} ±0.19	2.3^{a} ±0.07	12.3^{e} ±0.12	0.12^{c} ±0.7	4.5^{b} ±0.04	4.2^{e} 1±0.12
8	6.1^{a} ±0.10	1.4^{d} ±0.016	19.9^{b} ±0.18	0.9^{c} ±0.06	4.3a±0.17	4.19^{e} ±0.10
9	7.3^{b} ±0.02	4.7^{a} ±0.00	28.9^{a} ±0.01	0.2^{e} ±0.44	5.3^{d} ±0.16	4.89^{a} ±0.00
10	8.9^{b} ±0.03	5.1^{b} ±0.04	34.6^{a} ±0.03	1^{e} ±0.89	5.6^{e} ±0.10	5.02^{d} ±0.98

Results are the mean of triplicates ±SD. Results on the same row followed by different superscript letters (a-e) indicate a significant difference ($p \leq 0.05$) by ANOVA using the Tukey grouping test.

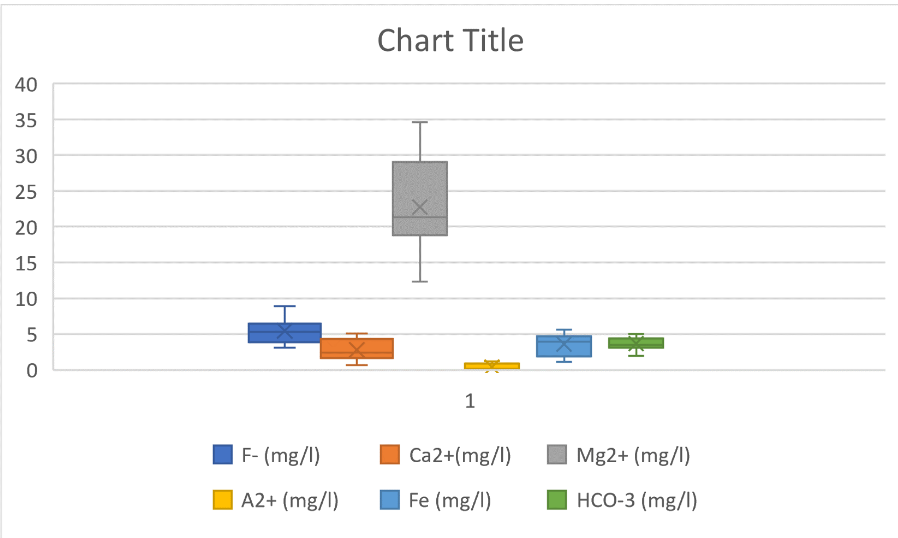

Figure 4: An Illustration of The Major Ions Analysed in The Groundwater Samples

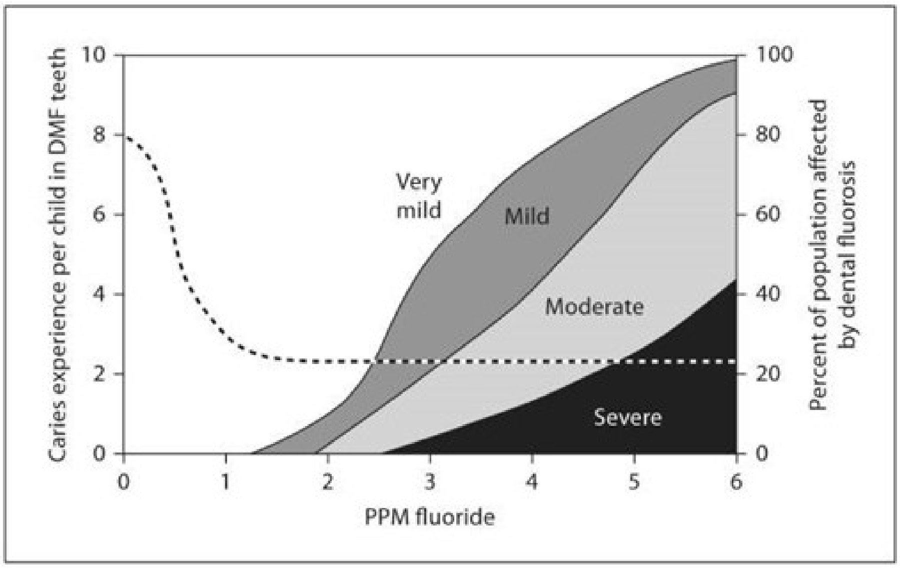

Figure 5: Severity of Dental Fluorosis in Children (Adapted from US Department of Health and Human Services, 1991).

The most significant decreases in dfs and DMFS correlated with rising water fluoride concentrations in the study area, ranging from 0 to 0.8 ppm F, with minimal further decline observed between 3.7 and 8.9 ppm F. The prevalence of fluorosis was 16.5%, 22.8%, 30.4%, and 38.6% among the populace consuming <3.7, 3.9 to <3.11, 4.7 to 5.2, and >5.5 ppm F water respectively ($p \leq 0.05$). Along with fluoridated water, taking fluoride supplements was linked to fewer cavities and more fluorosis (Figure 5).

Discussion

Fluorosis is a problem with tooth enamel that happens when a child gets too much fluoride before they turn eight. You can treat fluorosis for cosmetic reasons, but the damage to the enamel is permanent. Drinking water with fluoride in it, especially when you are a baby, eating fluoride toothpaste, or eating processed foods that were made with too much fluoride water are all common causes of fluorosis. This is especially true in northeastern Nigeria. The analysis of borehole water samples in the study area revealed that no fewer than half of the groundwater samples in the study area have excessive fluoride concentrations. This highlights the importance of fluoride as an essential dietary element. Appropriate concentrations in both food and water are essential; when present in excess, it can lead to fluorosis in children and teenagers as they develop secondary teeth. Groundwater analyses often show a significant positive correlation between fluoride and bicarbonate because high concentrations of them create an alkaline environment, which promotes the dissolution of fluoride-bearing minerals like fluorite.

A high amount of fluoride is also a sign of dry weather conditions. Here is where groundwater flows. slow, and the time it takes for water to react with rocks is thus improved. Less fluoride buildup is said to occur in the humid tropics because of high inputs of rain, which dilute the chemical makeup of groundwater (BGS, 2000). Also, the impact of anthropogenic iron and fluoride enrichment cannot be ruled out in this respect.

Magnesium and fluoride are closely linked when it comes to the development and prevention of fluorosis. Magnesium is very important for how the body uses fluoride. If you don't get enough magnesium in your diet, you may be more likely to get fluorosis. On the other hand, if you eat a lot of magnesium, it can help your body absorb and keep fluoride [23].

Research suggests that high fluoride exposure can cause oxidative degradation of haemoglobin, releasing free iron into the blood and leading to haematological issues like anaemia. In summary, there is a strong geochemical and chemical association where both elements often appear together in groundwater and react with each other (adsorption/complexation) [24]. The same authors argue that Fluoride mobilization from geogenic sources is mainly controlled by alkalinity and temperature. Fluoride occurrence in water is associated with ions such as sodium, chloride, and bicarbonate [25].

Many tropical regions, particularly in areas with high fluoride levels, also exhibit high iron concentrations, leading to combined contamination in drinking water sources. Research consistently demonstrates a significant positive correlation between iron and fluoride in groundwater, typically influenced by analogous geological sources, such as the weathering of rocks (e.g., biotite) or the dissolution of iron-bearing minerals within aquifers [26, 27].

Similarly, [28] argued that fluorosis occurs when you consume too much fluoride over a long period while your teeth or bones are still growing, making enamel less mineralized and bones denser. The effects can be mild, like faint white streaks on the enamel, or severe, such as skeletal pain, joint stiffness, and bone deformity. It can also cause stomach problems.

Solutions

The study area can control fluorosis by testing the groundwater often and using defluoridation methods like activated alumina filters, bone char filtration, and reverse osmosis systems. Other options include combining high-fluoride water with low-fluoride sources, collecting rainwater, and improving nutrition.

Lastly, teaching people in the affected areas about safe fluoride levels and keeping an eye on how children use toothpaste to keep them from swallowing it will help solve this wicked societal problem in the area.

Conclusion

Because of high levels of fluoride in domestic groundwater sources, the Bama area is at a high risk for human fluorosis. The natural environment was identified as the primary cause of fluoride toxicity, whereas weathering and water-rock interaction are mainly accountable for fluoride leaching in the study area's groundwater, exhibiting statistically significant variation among different groundwater samples. There is a big health risk from drinking too much fluoride, which is partly shown by dental fluorosis in some people. This is a public health problem that needs to be addressed right away. Dental fluorosis can happen to anyone, but it usually starts at age six. Children are more likely to get fluoride poisoning. So, contrary to what most people think, dental fluorosis in the Bama area is caused by too much fluoride in the groundwater because of natural processes.

Given the above, defluoridation Programmes should be implemented at the Community-level treatment methods, such as: Nalgonda technique (widely used in developing countries), Activated alumina filters, Bone char filtration, among others, to be implemented by the communities and to be supported by the three tiers of Government (Local, State, and Federal) in Bama, Borno State and Nigeria as a whole.

Lastly, the Government should map high-risk areas, implement targeted interventions, and integrate fluorosis control into national health programs in Bama, Borno State, and Nigeria as a whole. Fluorosis

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Author Contributions

Writing –Review &editing, Project administration. Other activities conducted: Validation, Investigation, writing–Original draft, Writing –Review &editing, Supervision.

Conflicts of Interest

The author declares that there are no conflicts of interest in competing financial or personal relationships that could have appeared to influence the work reported in this work.

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