



Original article

Investigation of fluorosis cases in the villages of Dadin Kowa and Gobirawa, Tessaoua Health District, Maradi Region 19 to 24 November 2023

Investigation des cas de fluorose dans les villages de Dadin Kowa et Gobirawa, District Sanitaire de Tessaoua, Région de Maradi 19 au 24 novembre 2023

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Résumé

Introduction : La fluorose est une maladie métabolique chronique causée par les ions fluorés. La teneur élevée en fluorure des eaux souterraines constitue la cause principale. Les fluorures sont responsables de nombreuses atteintes chroniques des dents ou des os, appelées fluorose. Au Niger, la fluorose a commencé depuis 1985 par la réalisation des forages. En 2023, des cas de déformation osseuse ont été observés chez les enfants de moins de 15 ans. Des équipes d'investigation pluridisciplinaire et multisectorielle ont permis d'identifier les causes de ces déformations osseuses et apporter les mesures de santé publique adéquates.

Méthodologie : Nous avons mené une étude descriptive des cas de fluorose recensés du 19 au 24 novembre 2023. Une recherche active des enfants suspects a été menée dans les villages. Des spécialistes dans plusieurs domaines ont travaillé ensemble pour examiner cliniquement ces enfants. Des prélèvements des échantillons des liquides biologiques et biochimiques ont été réalisés chez ces enfants et des

analyses physico-chimiques ont été effectuées sur les eaux prélevées des puits et forages réalisés. Une liste linéaire de cas a été établie. Epi Info 7.2 et Excel® utilisés pour l'analyse.

Résultats : Au total 67 enfants ont été recensés. Sur les 67 enfants, 49 enfants ont un âge compris entre 1 à 4 ans soit 73%. La moyenne d'âge est de 4 ans et le sexe masculin est le plus touché avec 37 cas (56,71%) et un sex ratio H/F de 1,23. 61(91%) enfants provenaient de Dadin Kowa. 81% consommaient l'eau provenant du forage Ouest de Dadin Kowa. Le genou varum bilatéral est plus fréquent avec 53%. Deux forages présentaient des teneurs en fluor de 6,1 mg/l et 8,1 mg/l.

Conclusion : La mission d'investigation des cas suspects de fluorose au niveau des villages de Dadin Kowa et Gobirawa a permis de diagnostiquer la fluorose chez certains enfants. Des prélèvements ont été effectués sur ces enfants afin de doser la teneur en fluor dans leur sang.

Mots-clés : Investigation, Fluorose, Niger.

Abstract

Introduction: Fluorosis is a chronic metabolic disease caused by fluoride ions. The main cause is the high fluoride content of groundwater. Fluorides are responsible for numerous chronic dental and bone disorders, known as fluorosis. In Niger, fluorosis began in 1985 with the drilling of boreholes. In 2023, cases of bone deformation were observed in children under 15. Multi-disciplinary and multi-sectoral investigation teams identified the causes of these bone deformations and took appropriate public health measures.

Methodology: We conducted a descriptive study of fluorosis cases recorded from November 19 to 24, 2023. An active search for suspected children was conducted in the villages. Specialists in several fields worked together to examine these children clinically. Samples of biological and biochemical fluids were taken from these children, and physico-chemical analyses were carried out on water taken from wells and boreholes. A linear list of cases was drawn up. Epi Info 7.2 and Excel® were used for analysis.

Results: A total of 67 children were identified. Of the 67 children, 49 (73%) were aged between 1 and 4 years. The average age was 4 years, and males were the most affected, with 37 cases (56.71%) and a M/F sex ratio of 1.23. 61 (91%) of the children were from Dadin Kowa. 81% drank water from the Dadin Kowa western borehole. Bilateral varum knee was more frequent, at 53%. Two boreholes had fluoride levels of 6.1 mg/l and 8.1 mg/l.

Conclusion: The mission to investigate suspected cases of fluorosis in the villages of Dadin Kowa and Gobirawa led to the diagnosis of fluorosis in some children. Samples were taken from these children to measure fluoride levels in their blood.

Keywords: Investigation, Fluorosis, Niger.

Introduction

Fluorosis is a chronic metabolic disease caused by prolonged ingestion or, rarely, inhalation of fluoride

ions. The crucial etiological factor in fluoride toxicity is the high fluoride content of groundwater. Fluoride enters water sources from natural resources, as well as industries where mineral fluoride is used[1–3].

Fluorides can be responsible for many chronic diseases of the teeth or bones, called “fluorosis”. Dental fluorosis is one of the most common pediatric dental conditions, associated with cosmetic concerns, while skeletal fluorosis primarily attacks the bones and is responsible for bone deformities in the majority of cases. This disease is endemic in certain volcanic areas where groundwater contains high doses of fluoride, often exceeding the WHO recommendations of around 1.5mg/L. Poisoning is the result of prolonged ingestion of large amounts of fluoride[4,5]. According to the World Health Organization (WHO), fluorosis is a major public health problem worldwide. More than 260 million people around the world consume water from sources with high concentrations of fluoride. China has the highest prevalence of fluorosis in the world and faces the most severe adverse effects of fluorosis[6].

Fluorosis is endemic in about 50 countries, particularly in India, Asia and Africa. It is therefore more common in developing countries and is often found in fluoride-rich volcanic regions. However, there are no published estimates of the prevalence of fluorosis in the population in sub-Saharan Africa[1,7].

In Niger, fluorosis began in 1985 with the construction of boreholes to supply the community with drinking water. Analyses have been carried out to assess the quality of the water from these boreholes, but no research has been carried out on fluoride. Between 2003 and 2015, following bone deformities, mainly of the pelvic limbs, observed in more than 5,000 children in the Maradi region (Niger), in Tibiri, water analyses were carried out and showed that the drinking water from these boreholes had a high fluoride content varying from 3.24 to 4.77 mg/l[8].

In October 2023, cases of bone deformity were observed in children under 15 years of age in the village of Dadin Kowa (Maigirgui commune, Tessaoua department, Maradi region). This is why

we organized a multidisciplinary and multisectoral investigation mission to the affected localities in order to identify the causes of these bone deformities and to provide appropriate public health measures.

Methodology

Description of the location of the investigation

Located about 15 km from the city of Tessaoua and to the east, the village of Dadin kowa has an estimated population of 2737 inhabitants in 391 households. Public hygiene in this locality is marked by an inadequacy in the management of solid waste composed of animal manure from the concessions. The latter are thrown into the corners of houses where they form piles or simply in the streets or behind the village.

As for the evacuation of excreta, the majority of the population practices open defecation behind the village due to the lack of latrines. Indeed, out of the 391 households in the village, 371 or 94.88% do not have latrines, only 20 households have them, and of these 20 latrines, 3 are filled and are no longer used (source: Dadin Kwa village chief).

The supply of drinking water to the village is done by boreholes of four (4), modern well of which there are two (2). Next to these water sources there are two (2) ponds which are used mainly for watering animals and domestic work as well as human consumption.

Type and period of study

This is a cross-sectional, descriptive study with an evaluative purpose that was carried out in November 2023.

Study population

All cases of fluorosis (bone and dental) recorded between November 19 and 24, 2023 (period of investigation) in the villages of Dadin Kowa and Gobirawa in the health district of Tessaoua constituted our study population.

Procedure adopted in the management of these fluorosis cases

Teams composed of chemists, epidemiologists, hygienists, orthopedists, communicators, dentists,

hydrologists, nurses and laboratory technicians have been deployed in the health district of Tessaoua in the villages of Dadin Kowa and Gobirawa.

Working groups have been formed:

- Communicators with village and neighborhood chiefs mobilized the population so that each parent with a child with a bone deformity and/or «rusty» teeth to bring him or her to the health facility in the village of Dadin Kowa selected as the site for the consultation. Group visits to the Village Chief's Court and household home visits were conducted.
- The orthopaedic surgeon and the dentist each examined all the children presented at the consultation site in their area of expertise.
- Epidemiologists have been investigating human activities that may be sources of fluoride production in and around the village of Dadin kowa. Surveys were carried out on the hygiene and sanitation infrastructure available in the villages.
- The mobile team of the National Laboratory of Public Health and Expertise (LANSPEX) made it possible to test on site the water samples taken from boreholes and cemented wells for the conduct of physico-chemical analyses.
- The nurses took whole blood samples to measure the level of fluoride in the patients' bodies.

Data collection and analysis

To collect the data, we created a database (linear list) from the children received at the consultation site. Other data were collected from the census of the various water points in the villages of Dadin Kowa and Gobirawa. These data were processed using Excel software and their analysis was carried out using the EPI info software. They have been summarized in terms of time, place and person in the form of tables and figures. Proportions and frequencies were calculated.

Ethical considerations

The deployment of the investigation team in the field was granted by the country's health authorities after technical advice from the Ministry of Hydraulics, Sanitation and the Environment by letter No. 000374/

MH. A.E/SG/DGH dated October 04, 2023. Thus, the different members of the team were briefed on the objectives of the mission.

Results

The field mission began with a visit to the Integrated Health Center (IHC) of Nahouta where the team met with the head of the IHC who gave a brief presentation of her health area and the situation of cases of bone deformity reported in children under 15 years of age in the villages of Dadin Kowa and Gobirawa.

Description of the magnitude of the situation in time, place and person

A total of sixty-seven (67) children were registered during the fact-finding mission to the health district of Téssaoua by the experts. Of the 67 children examined for bone or dental fluorosis, 49 children are between 1 and 4 years old, i.e. 73% of the number of children affected. The average age of these children is 4 years old and the male sex is the most affected by this condition with 37 cases (56.71%) and a sex ratio of 1.23.

In terms of case location, 61 (91%) children who consulted for suspected skeletal fluorosis were from Dadin Kowa. The distribution of suspected cases of skeletal fluorosis according to water source shows that 54 children or 81% of the children affected by this condition consumed water from the West borehole of Dadin Kowa.

The distribution of suspected cases of skeletal fluorosis according to the onset of bone deformity in the villages of Dadin, Kowa and Gobirawa, shows that these bone deformities appeared between 2 and 12 months after the start of the first steps in 36 children, i.e. 69.23%, and 16 of them after 12 months. According to the distribution of suspected cases of skeletal fluorosis according to the type of deformity, it can be seen that bilateral varum knee is more common in children with 24 children affected or 53%, followed by left knee valgum present in 11 children or 24%.

The situation of suspected cases of fluorosis sampled according to the severity of the bone deformities,

shows that 23 cases, or 34% of children with severe bone deformities, were collected in the villages of Dadin, Kowa and Gobirawa for biological analysis. The distribution of suspected cases of skeletal fluorosis according to their topography in the villages of Dadin, Kowa and Gobirawa shows that 43 of these deformities are located in the lower limbs, i.e. 95.5%, and 2 are located in both (2) limbs (lower and upper), i.e. 4.5%.

As for dental fluorosis, out of the 67 children consulted in the villages of Dadin Kowa and Gobirawa, the team found that 16 developed signs of dental fluorosis, i.e. 23.88% of the total number of children seen in consultation (Table 1).

Analysis of borehole water samples and cemented wells from the villages of Dadin Kowa and Gobirawa

Following the investigation carried out on all the drinking water supply structures in the two (2) villages (Dadin Kowa and Gobirawa), it appears that all the structures had a fluoride content below the WHO standard (1.5 mg/l) except for the two boreholes carried out by a non-governmental organization for charity, which had respectively fluoride levels of 6.1 mg/l and 8.1 mg/l, which is much higher to the WHO Standard (Table 2).

Environmental health activities related to fluorosis investigation in Dadin Kowa village

Within the framework of the fluorosis investigation mission in the village of Dadin Kowa, the following activities were carried out:

- Research of fluoride source activities in the village and surrounding areas;
- Sanitary inspections around water points (boreholes, wells, ponds);
- Health inspection in the village of Dadin kowa and surrounding areas.

Table 1: Characteristics of skeletal fluorosis cases in the villages of Dadin Kowa and Gobirawa, Tessaoua Health District, Maradi Region 19 to 24 November 2023

Variables	Actual	Percentage (%)	Average
Age groups (n=67)			
1-4 years	49	73	4
5-9 years old	16	24	
10 years and up	2	3	
Sex (n=67)			
Masculine	37	56,71	
Feminine	30	43,29	
Provenance (n=67)			
Dadin Kowa	61	91	
Gobiraoua	6	9	
Source water (n=67)			
Gobirawa Borehole	6	9	
West Drilling Dadin Kowa	7	10	
East Well and West Borehole Dadin Kowa	54	81	
Time to onset of deformity (n=52)			
2-12 months	36	69,23	
After 12 months	16	30,77	
Type of deformation (n=44)			
Right femur deformity	1	2	
Mixed deformation	2	4	
Left valgum knee	11	24	
Right varum knee	1	2	
Left varum knee	5	11	
Bilateral valgum knee	24	53	
Flat feet	1	2	
Dental fluorosis (n=67)			
Yes	16	23,88	
No	51	76,12	

Appendix: Photo of children with severe bone deformities



Fig 1: Child with severe bilateral varum knee



Fig 2: Child with severe bilateral valgum knee

Table 2: Results of the analysis of water samples from boreholes and cemented wells in the villages of Dadin Kowa and Gobirawa, DS Tessaoua, November 2023

Number	Locations	Types of works	Sample Identification	Geographic coordinates	Fluoride content (mg/l)	WHO Standards
1	Dadin Kowa	Drilling	Next to the primary school	13°50'03,2" 8°06'35,5"	0,2	1,5
2		Cemented well	East of the village	13°49'58,7" 8°06'47,2"	Trail	
3		Cemented well	West of the village	13°49'56,2" 8°06'32,8"	0,1	
4		Drilling	AMA	13°49'54,5" 8°06'29,2"	6,1	
5		Drilling	Market gardener	13°50'05,8" 8°06'19,5"	0,3	
6		Drilling	Equipped with volonta	13°49'53,2" 8°06'41,1"	0,3	
7	Gobirawa	Drilling	AMA	13°48'44,5" 8°06'24,9"	8,1	
8		Cemented well	100 m south of AMA drilling	13°48'43" 8°06'25,8"	0,4	
9		Drilling	Market gardener	13°48'27,2" 8°06'34,5"	0,5	

Discussion

The investigation of cases of bone deformity in the villages of Dadin Kowa and Gobirawa has revealed cases of bone and/or dental fluorosis in children of two (2) sexes with an age mainly between 1 and 4 years old. The appearance of these types of deformities in this age group may be due to the immaturity of the bones that are still growing during this period. It should be noted that the male sex is slightly more affected than the female sex. This can be explained by the fact that boys have larger bones than girls[7]. Similar results have been reported in many other countries. This is the case of YIMING LI et al in China in 2001 which found in one of its studies 7.48% in boys and 5.54% in girls and A S Narayana et al in India in 20214 found

that bone fluorosis was present in children aged 6 to 13 years in 60% of cases[9,10].

In our study, we found that more than 80% of children affected by this condition consumed water from the Dadin Kowa boreholes, which has a fluoride content of 6.1 to 8.1 mg/l, far exceeding the WHO standard of 1.5 mg/l. Koini Moussa et al. in a study also in Niger in 2017, found in the Maradi region of Tibiri, disabling bone deformities of the pelvic limbs in children who consumed drinking water with a high fluoride content ranging from 3.24 mg/l to 4.77 mg/l[8].

In 2016, in a study in Kakuma, Kenya, 15 water wells were identified in cases of fluorosis that provided drinking water for residents with fluoride concentrations of 1.5 to 8.4 mg/l[11]. The same observation was made in several localities. This is the

case of Vavuniya District in India in 2018 where 16 people had developed skeletal fluorosis following the prolonged consumption of water from water sources with a high fluoride content[2]. In Poldasht County, Azerbaijan in 2017, Ali Akbar Mohammadi et al also found a correlation between the quality of drinking water and the presence of fluoride ions in the range of 0.68 to 10.30 mg/l[3].

In our series, the distribution of suspected cases of skeletal fluorosis according to their topography shows that these deformities are localized in the lower limbs in 95.5% of cases. In India, A. L. Khandare et al found that in patients with skeletal fluorosis, the lower limbs were most affected and enlargement of the lower limbs often appeared as the first sign[12].

Bounds

The non-availability of reagents on site had not allowed us to analyze the samples taken from the children with severe bone deformities and to ensure their follow-up.

Conclusion

The mission to investigate suspected cases of fluorosis in the villages of Dadin Kowa and Gobirawa in the DS of Tessaoua from November 19 to 24, 2023 concluded:

The existence of bone deformities consistent with the clinical signs of fluorosis;

The time it takes for cases to occur and the distribution of bone deformities by water sources pointed to the two water sources built in 2021 by the non-governmental charity organisation;

The situation of children suspected of bone and/or dental fluorosis and to identify possible solutions for their possible management.

To further elucidate the diagnosis, water samples were taken from several water points in the villages of Dadin Kowa and Gobirawa. After analysis of these water samples, the results showed a high fluoride content in the 2 boreholes of Dadin and Gobirawa carried out by the non-governmental charity in 2021.

Blood samples were taken from children with severe bone deformities to measure the fluoride content in their blood. This blood fluoride test cannot be carried out in Niger.

What we know about this subject

- Fluorosis is a chronic metabolic disease caused by prolonged or rare ingestion by inhalation of fluoride ions ;
- In Niger, fluorosis began in 1985 with the construction of boreholes to supply the community with drinking water;

What this study adds

- Our study has shown that the consumption of water from boreholes carried out without the involvement of the technical services can constitute a danger for the population;
- The involvement of specialists from several sectors in the construction of water boreholes can prevent the population from being exposed to diseases due to the consumption of water from these facilities;
- Water analysis is possible on site and can help to elucidate the diagnosis.

Authors' contributions

All authors were involved in the development of the investigation protocol and participated in the data analysis and report writing. The manuscript was written with input from all authors. All authors have read and approved the final version of this manuscript.

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Conflict interest : None

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