Fluoride's impact on the underground water in the Meerut, UP.

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Abstract

Water is an essential and important component of our life and in various sources of water, Drinking water, irrigation, and industrial uses all rely on groundwater resources. Concern over the deterioration in groundwater quality brought on by geogenic and human activities is growing. Fluoride contamination in drinking water is a significant public health concern in India, leading to dental and skeletal fluorosis and other adverse health effects. While the government has taken several measures to address the issue, there is a need for sustained efforts to provide safe drinking water to the affected populations. Public awareness campaigns on the health effects of fluoride and the importance of safe drinking water should be intensified to prevent further fluoride-related health problems in India. For many rural areas and urban areas where hand pumps and tube wells are the only sources of safe drinking water. Many existing studies on fluoride have focused on the problem of fluidity. The present study is carried out to assess the groundwater near Meerut, Uttar Pradesh to see the impact of the problem on society at the local level.

Keywords*:* Fluorides, Groundwater, Uttar Pradesh, Fluorosis

Introduction

Fluoride is a common occurring mineral found in water, soil, and rocks. In India, fluoride is present in groundwater, especially in regions with high concentrations of fluoride-bearing minerals. While fluoride is essential for healthy teeth and bones, excessive intake of fluoride can cause negative health effects. In this essay, we will discuss the effects of fluoride on human health in India[1-2].

The consumption of fluoride above the permissible limits can cause dental fluorosis, a condition that affects the teeth, leading to discoloration, pitting, and brittleness. Dental fluorosis is a significant public health concern in India, affecting nearly 17 million people across 20 states. The prevalence of dental fluorosis is high in areas with a high concentration of fluoride in groundwater. Children who consume excessive amounts of fluoride through water or food during their tooth development stage are at the highest risk of developing dental fluorosis[3-4].

Besides dental fluorosis, excessive fluoride intake can lead to skeletal fluorosis, a debilitating bone disease that causes joint pain, stiffness, and bone deformities. In India, more than 60 million people are estimated to be at risk of skeletal fluorosis, with the highest prevalence reported in the states of Andhra Pradesh, Telangana, and Rajasthan.

Moreover, chronic exposure to high levels of fluoride in drinking water can also cause other adverse health effects, such as neurological damage, reproductive disorders, and kidney damage. Several studies have reported an association between high fluoride intake and impaired cognitive development in children, with long-term exposure leading to a decline in IQ levels[5].

The Indian government has taken several measures to address the issue of fluoride contamination in drinking water. The Ministry of Drinking Water and Sanitation has launched the National Rural Drinking Water Programme (NRDWP), aimed at providing safe and adequate drinking water to rural areas[6]. Additionally, the government has also implemented several measures to treat fluoride-contaminated water, such as using reverse osmosis (RO) technology, adsorption, and ion-exchange methods.

In the final analysis, fluoride poisoning in drinking water poses a serious public health risk in India and is associated with fluorosis of the teeth and skeleton as well as other harmful consequences. Although the government has taken a number of steps to address the problem, more needs to be done to ensure that the affected populations have access to safe drinking water. To stop more fluoride-related health issues in India, public awareness programmes on the dangers of fluoride and the value of clean drinking water should be stepped up.

Fluoride can have both positive and negative effects on human health depending on the amount and duration of exposure.

Positive Effects:

Dental health: Fluoride has a positive effect on dental health, as it can help prevent tooth decay and cavities. When fluoride is present in the mouth, it can be incorporated into the enamel on teeth, making the enamel stronger and more resistant to acid erosion.

The primary way that fluoride benefits dental health is through its ability to remineralize tooth enamel. When you eat sugary or acidic foods, the bacteria in your mouth produce acid that can erode the enamel on your teeth, leading to cavities. Fluoride can help repair this damage by remineralizing the enamel, which means that it helps to replace the minerals that have been lost due to acid erosion.

Fluoride can also help prevent tooth decay by reducing the ability of bacteria in the mouth to produce acid. When fluoride is present, it can interfere with the metabolism of the bacteria, making it more difficult for them to produce the acids that can damage teeth[7-8].

Overall, fluoride is an important tool for maintaining good dental health. It is often added to toothpaste, mouthwash, and drinking water to help prevent tooth decay and cavities. However, it is important to use fluoride in moderation, as excessive exposure can lead to dental fluorosis, a condition that can cause white or brown spots on teeth and weaken tooth enamel.

Bone health:

Fluoride can have a positive effect on bone health in certain circumstances. When fluoride is present in the diet at appropriate levels, it can help improve bone density and reduce the risk of osteoporosis in older adults[9-10].

Fluoride helps to strengthen bones by increasing the mineral density of the bone tissue. It can also help to slow down bone loss, which can help to prevent osteoporosis. In addition, fluoride has been shown to have a positive effect on the healing of bone fractures.

However, it is important to note that the beneficial effects of fluoride on bone health are limited to appropriate levels of intake. When fluoride is consumed in excess, it can actually weaken bones and increase the risk of skeletal fluorosis, a condition that can cause joint pain, stiffness, and bone deformities.

The ideal amount of fluoride intake for bone health is not well understood and may vary depending on a number of variables such as age, sex, and general health. Adults are generally advised to consume 3–4 mg of fluoride per day, with a daily maximum of 10 mg.

Overall, while fluoride can have a positive effect on bone health when consumed at appropriate levels, excessive intake can be harmful. It is important to consult with a healthcare provider to determine the appropriate level of fluoride intake for your individual needs.

Negative Effects:

Dental fluorosis: Excessive exposure to fluoride during tooth development can lead to dental fluorosis, a condition that causes white or brown spots on teeth and can lead to weakened enamel[11-12].

Skeletal fluorosis: Long-term exposure to high levels of fluoride can cause skeletal fluorosis, a condition that can cause bone pain, stiffness, and joint problems[13].

Neurological effects: Some studies suggest that high levels of fluoride exposure may have negative effects on cognitive development and neurological function.

Thyroid problems: There is some evidence that exposure to high levels of fluoride may interfere with thyroid function and increase the risk of hypothyroidism [14].

It's important to note that the majority of people do not experience negative health effects from fluoride exposure, as long as they are not exposed to excessive amounts. The amount of fluoride in drinking water is carefully regulated in most countries to ensure that it is safe for human consumption.

MITIGATION MEASURES

There are several mitigation measures that can be taken to reduce the negative effects of fluoride exposure:

Limiting fluoride intake: The most important mitigation measure is to limit fluoride intake to levels that are safe for human consumption. This can be achieved by monitoring the fluoride content in drinking water and avoiding excessive consumption of fluoride-rich foods and drinks.

Using alternative water sources: In areas where the fluoride content of drinking water is high, it may be necessary to use alternative water sources such as bottled water or treated rainwater to avoid excessive fluoride intake.

Using fluoride-free dental products: Individuals who are at risk of dental fluorosis or who are concerned about excessive fluoride intake may choose to use fluoride-free dental products such as toothpaste and mouthwash[15-16].

Educating the public: Education campaigns can help to raise awareness about the potential risks of fluoride exposure and encourage individuals to take measures to reduce their exposure.

Treating fluoride toxicity: In cases where individuals have been exposed to excessive levels of fluoride, treatment may be necessary to mitigate the negative effects. This may include treatments such as dialysis or the use of calcium supplements to help reduce the absorption of fluoride in the body.

Monitoring fluoride levels: Regular monitoring of fluoride levels in drinking water and food sources can help to identify areas where excessive fluoride exposure may be a problem, and allow for mitigation measures to be put in place.

Overall, a combination of these mitigation measures can help to reduce the negative effects of fluoride exposure and promote better health outcomes for individuals at risk of excessive fluoride intake.

Material and Methods

To collect primary data on the extent of fluoride contamination, a questionnaire was used in the local language. The questionnaire included questions about water source, usage, number of people relying on the source, and medical history related to contamination. The collected data was analyzed to determine the sample size and sampling sites. Field visits were conducted to collect drinking water samples from surface and underground sources. Samples were collected in PET bottles and duplicates were taken for accuracy. Samples were collected from selected locations between July 2022 and January 2023 and placed in 2L plastic containers. The samples were taken to the lab for parameter analysis using standard techniques outlined in the APHA (2012) and CPCB (2010) manuals[17-18].

The APHA (American Public Health Association) and the CPCB (Central Pollution Control Board) manuals are standard references for water quality testing and analysis in India. The APHA manual provides standard methods for the examination of water and wastewater, including procedures for collecting and analyzing water samples, testing for chemical and biological parameters, and interpreting the results. The CPCB manual provides guidelines for water quality monitoring and management, including standards for drinking water quality, effluent discharge, and ambient water quality. The manual also provides methods for water quality testing and analysis, including procedures for collecting and preserving water samples,

testing for physical, chemical, and biological parameters, and interpreting the results. These manuals are used by government agencies, laboratories, and researchers in India as a standard reference for water quality testing and analysis.

Table:1location of the water samples collected from different urbon regions in meerut city, utter pradesh

S.N0.	Name of the colony	Code No.
1	Ganta garh	S1
2	Partapur, Meerut	S2
3	Hapur adda, Meerut	S3
4	Ganga Nagar, Meerut	S4
5	Garh road, Meerut	S5

Table: 2 Location of the water samples collected from different rural regions in meerut city, utter pradesh

S.N0.	Name of the colony	Code No.
1	Mohkampur, Meerut	S6
2	Kali nadi, Meerut	S7
3	Sugar mill, Mawana	S8
4	Gutta mill, Sardhana, Meerut	S9
5	Kinouni Sugar Mill, Kinouni	S10

Result and discussion

The fluoride concentration in the studied areas ranged from 0.5-1.5 mg/L, which is below or above the desirable limit. The groundwater had no odor or color, but some samples had a slightly brackish taste. Fluoride is essential for healthy teeth and bones, but excessive consumption can lead to fluorosis. The concentration of fluoride in the Meerut district ranged from 0.51 to 1.00 mg/L. Fluoride in water can come from fluoride-bearing minerals or agricultural sources, and there were no major industrial activities identified as a source of contamination in the study area. The moderate concentration of fluoride is likely of geogenic origin or from phosphatic fertilizers used in irrigation.

Table 3: Fluoride Concentration of groundwater/drinking water					
S. No.	Location ID	Sample ID	pH	Fluoride conc. (mg/L)	Who Desirable Limit
1	S1	S1A	7.12	0.9	1.5mg/L
2		S1B	7.61	0.86	
3		S1C	7.33	0.91	
4	S2	S2A	7.33	0.51	
5		S2B	7.4	0.56	
6		S2C	7.1	0.58	
7	S3	S3A	7.5	0.68	
8		S3B	7.3	0.71	
9		S3C	7.6	0.73	
10	S4	S4A	7.1	0.8	
11		S4B	7.3	0.79	
12		S4C	7.2	0.91	
13	S5	S5A	7.59	0.85	
14		S5B	7.44	0.89	
15		S5C	7.38	0.86	
16	S6	S6A	7.1	0.59	
17		S6B	7.3	0.59	
18		S6C	7.2	0.57	
19	S7	S7A	7.59	0.85	
20		S7B	7.44	0.86	
21		S7C	7.5	0.86	
22	S8	S8A	7.59	0.59	
23		S8B	7.44	0.58	
24		S8C	7.38	0.61	
25	S9	S9A	7.2	0.71	
26		S9B	7.3	0.72	
27		S9C	7.2	0.71	
28	S10	S10A	6.8	0.58	
29		S10B	6.9	0.56	
30		S10C	6.8	0.58	

Conclusion

The study conducted in the Meerut district of Uttar Pradesh revealed that the fluoride concentration in the groundwater ranged from 0.51 to 1.00 mg/L, which is within the permissible limits recommended by the Bureau of Indian Standards. The water had no color or odor, but some samples had a slightly brackish taste, and conductivity varied significantly in samples from the same area. Fluoride is essential for healthy teeth and bones, but excessive consumption can

lead to fluorosis. The moderate concentration of fluoride in the groundwater in Meerut is likely of geogenic origin or from phosphatic fertilizers used in irrigation. There were no major industrial activities identified as a source of contamination in the study area. Overall, the study suggests that while the fluoride concentration in the groundwater in Meerut is within permissible limits, continued monitoring is necessary to ensure that the concentration does not exceed the desirable limits, leading to adverse effects on human health.

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