Research Article

Fluorosis in Jharkhand: From Contaminated Groundwater to a Preventable Public Health Problem

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Abstract

Background: Rocks and groundwater carry fluoride naturally. Small amounts protect teeth; years of drinking water with higher levels damage teeth and, later, bones. Cases of dental and skeletal fluorosis have turned up in different parts of Jharkhand, and new high-fluoride sources keep being found. That alone is reason enough to bring the issue into public health planning.

Methods: We went through published studies and government reports on fluoride, fluorosis and groundwater in Jharkhand, searching PubMed, Scopus, Web of Science and Google Scholar and adding official documents from WHO and Indian agencies. Fluoride terms were paired with groundwater, drinking water and Jharkhand, and with district names where local work existed. Papers from 2000 to October 2026 were considered, with extra attention to recent ones that reported measured fluoride or health findings. The material was summarized narratively. We did not pool data.

Results: Jharkhand's fluoride problem is uneven. Early studies found up to 5.92 mg/L in Garhwa and 4.2 mg/L in Palamu. At Berhait in Sahibganj, 29% of 89 well-water samples crossed the Indian permissible level, and both children and adults had fluorosis. Later studies from the mica belt, East Singhbhum, Giridih and Dhanbad show that more high-fluoride sources are still coming to light. In Baliapur, Dhanbad, 36% of the 315 groundwater samples tested in 2026 exceeded 1.5 mg/L, and the highest reading was 16.2 mg/L. A statewide study in 2025 recorded a maximum of 18.5 mg/L. CGWB's 2024 trend sampling, by contrast, found only 9 of 138 samples above 1.5 mg/L.

Conclusion: Fluoride exposure remains a live environmental health concern in Jharkhand. Finding contaminated water and treating existing cases of fluorosis will not be enough by themselves. Water sources have to be tested, the risky locations marked, safe water provided and exposed people followed up over the years. If these steps are joined together, the state would have a prevention system that works better than any of them alone.

Keywords: fluorosis; fluoride; groundwater; drinking water; Jharkhand; environmental health; children; water quality; surveillance; prevention

1. Introduction

Fluorosis develops when a person takes in more fluoride than the body can handle, and does so for a long time. In children the first sign is dental fluorosis, since fluoride affects teeth while they are still forming. Longer and heavier exposure can reach the bones and joints and cause skeletal fluorosis. Total intake depends on the fluoride in drinking water and how much of it a person drinks, but food and dental products add to it.

WHO's guideline value for fluoride in drinking water is 1.5 mg/L. The guideline itself acknowledges that fluoride reaches people from several sources, so water is just one piece. Risk has to be judged against local patterns of exposure. [1]

The Indian standard sets 1.0 mg/L as desirable and allows up to 1.5 mg/L when no other source exists. India's national fluorosis programme uses the same 1.0 mg/L figure as desirable and puts its emphasis on prevention, diagnosis and treatment. [2,3]

Most rural households in Jharkhand rely on groundwater, and a good part of the state lies on hard rock and mineral-rich formations. CGWB links fluoride occurrence to local geology, the chemistry of the water, and the time water spends in contact with rock. Studies in several districts have recorded individual sources above the recommended level. [4]

The aim of this review is practical. A laboratory result is of little use to a family unless it changes the water they drink. So we looked at the environmental evidence and, alongside it, at what can realistically be done to lower exposure.

2. Methods

2.1 Review design. This is a narrative review written from a public-health angle. We read environmental studies, reports on human exposure and programme documents side by side, because the disease cannot be understood apart from the water that causes it.

2.2 Information sources. Searches ran through PubMed/MEDLINE, Scopus, Web of Science and Google Scholar. For official material we used WHO, the Government of India, NCDC, DGHS, BIS and CGWB. Facts used in the manuscript were checked against the original papers and government documents.

2.3 Search terms. Fluoride and fluorosis were searched together with groundwater, drinking water and Jharkhand. To find local studies, we also entered the names of Palamu, Garhwa, Sahibganj, Dhanbad, Giridih, Bokaro, Hazaribagh and East Singhbhum. Further terms covered dental and skeletal fluorosis, schoolchildren, groundwater quality, health risk and water treatment.

2.4 Eligibility. A study was kept if it was done in Jharkhand and gave measured fluoride values, exposure data or clinical findings. Government groundwater reports were kept when they contained fluoride data. For the current situation we leaned on work from 2020 to 2026, though earlier studies stayed in as a record of how the problem was first documented.

2.5 Data extraction. From each study we recorded where it was done, how many samples were taken, the fluoride concentration or the percentage above the relevant limit, who or what was examined, and the main result. Where a study did not report a figure, we left it blank and did not derive it.

2.6 Quality and interpretation. We read every result in light of how its study was designed. One small survey of a suspected hotspot cannot stand for a whole district, so we did not use it that way. CGWB monitoring was kept apart from research studies as well, since the two select sampling sites for different reasons and their numbers do not line up.CGWB monitoring was also considered separately from research studies because the sampling locations and objectives are different. This helps avoid treating results from different sampling frames as though they were directly comparable.

3. Results: Evidence from Jharkhand

The studies paint an uneven picture. Garhwa, Palamu and Sahibganj were the early reports. Parts of the mica belt, East Singhbhum, Giridih and Dhanbad came later. Government monitoring continues to pick up single sources with high fluoride.

Risk is attached to the source more than to the district. Any district may have plenty of acceptable sources and a few with much higher fluoride. CGWB's 2024 trend assessment sampled 138 sources; most were under 1.5 mg/L and 9 were over it, mainly in Godda, Chatra, Palamu, Bokaro and Hazaribagh. The statewide study of 2025 sampled differently and reported a maximum of 18.5 mg/L. The two sets of results describe different groups of sources, so they do not contradict each other.

Table 1. Evidence of fluoride contamination and fluorosis reported from Jharkhand

District/State	Study area	Sample size	Fluoride result	Population/source	Major finding

Garhwa	Majhiaon block	840 water sources	Not reported in abstract; 402 above permissible limit	Water sources; schools included	402 samples above the study's permissible limit; >50% of school samples above limit. [5]
Garhwa	Six blocks	4012 sources; 295 laboratory-tested	0.018–5.92 mg/L	Public/household sources, schools	Highest concentrations in Kharaundhi and Untari; public hand pumps and schools had high values. [6]
Palamu	Chainpur, Daltonganj, Bishrampur, Pandu	2864 groundwater samples	Maximum 4.2 mg/L	Household/public hand pumps, wells, schools	Daltonganj, Pandu and Chainpur had greater non-permissible proportions; shallow hand-pump sources were vulnerable. [7]
Sahibganj	Berhait block	89 well-water samples; 342 adults + 258 children	29% of water samples above Indian permissible limit	Adults and children	Clinical fluorosis in 85 children and 72 adults; urine fluoride supported exposure. [8]
Jharkhand mica belt	37 locations, seasonal sampling	37 locations	Study reported 31% of groundwater samples above Indian standard	General population risk assessment	Child population had the highest estimated risk; fluoride considered mainly geogenic. [9]

East Singhbhum	District-wide study	Not stated in abstract	0.02–2.7 mg/L pre-monsoon; 0.02–4.7 mg/L post-monsoon	Groundwater; adults, children and infants in risk assessment	97% within 1.5 mg/L; infants had highest hazard quotient range. [10]
Giridih	Tisri block, mica-mining area	40 groundwater samples, replicated thrice	0.34–2.8 mg/L	Groundwater	40% exceeded 1.5 mg/L; geochemical and mining-area factors were assessed. [11]
Jharkhand	Statewide study	545 groundwater samples	0.01–18.5 mg/L	Groundwater	High fluoride reported in Palamu/Garhwa and localized zones including Dhanbad, Baliapur and Jamtara. [12]
Dhanbad	Gharbar Gram Panchayat, Baliapur	315 groundwater samples	0.02–16.2 mg/L; mean 1.68 mg/L	Groundwater + schoolchildren	36% exceeded 1.5 mg/L; urinary fluoride correlated with water fluoride; schoolchildren were a priority group. [13]
Jharkhand	CGWB 2024 pre-monsoon trend assessment	138 samples	0.0–2.53 mg/L	Shallow groundwater	74.7% <1 mg/L; 18.8% 1–1.5 mg/L; 6.5% >1.5 mg/L; high-fluoride locations mainly in Godda, Chatra, Palamu, Bokaro and Hazaribagh. [4]

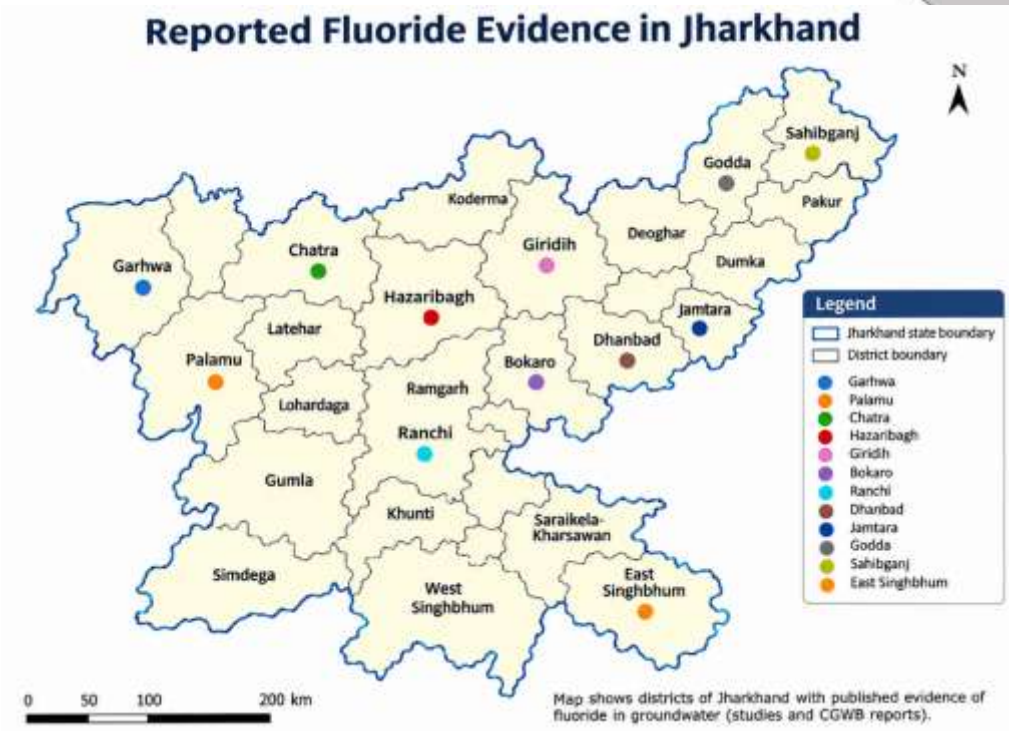


Figure 1. Schematic representation of locations for which fluoride evidence has been reported in Jharkhand. It is intended for orientation and should not be interpreted as a geographic prevalence map.

4. Recent evidence: 2020–2026

Recent studies confirm that fluoride is still a problem in several areas. Giri and colleagues (2021) tested groundwater in the mica belt and found 31% of samples over the Indian drinking-water standard. Children came out as the group at greatest risk in their assessment. [9]

In East Singhbhum, Ambade and colleagues recorded 0.02–2.7 mg/L before the monsoon and 0.02–4.7 mg/L after it. Ninety-seven percent of samples stayed within 1.5 mg/L. Even so, infants had the higher hazard quotient range. A simple count of samples above the limit can therefore miss how exposure differs between age groups. [10]

A 2024 study in Tisri block, Giridih, analysed 40 groundwater samples. Fluoride ran from 0.34 to 2.8 mg/L, and 40% of samples were above 1.5 mg/L. The authors also considered the local hydrogeochemistry and whether mica mining had played a part. [11]

The statewide study of 2025 covered 545 groundwater samples, with fluoride between 0.01 and 18.5 mg/L. Palamu and Garhwa had the highest concentrations. Other localized findings came from Ranchi, Giridih, Katras, Bokaro, Dhanbad, Baliapur and Jamtara. [12]

The Dhanbad study of 2026 stands out because it tested the water and the schoolchildren who drink it. In Gharbar Gram Panchayat, Baliapur, 315 groundwater samples were collected. Thirty-six percent were above 1.5 mg/L and the maximum was 16.2 mg/L. Children's urinary fluoride rose with fluoride in the water. [13]

CGWB's 2024 figures only make sense once the sampling design is understood. The 138 locations were trend sites, chosen without regard to suspected hotspots. Nine samples exceeded 1.5 mg/L, mostly from Godda, Chatra, Palamu, Bokaro and Hazaribagh. These results help track change at those sites. They cannot tell us what proportion of Jharkhand's drinking-water sources is contaminated.

5. Drinking-water standards and program thresholds

Table 2. Comparison of fluoride values used in international and Indian guidance

Source/framework	Fluoride value	Use	Interpretation
WHO drinking-water guideline	1.5 mg/L	Health-based guideline value	Increasing risk of dental fluorosis above this concentration and progressively higher risk of skeletal fluorosis with higher exposure. [1]
BIS IS 10500:2012	1.0 mg/L desirable; 1.5 mg/L permissible when no alternate source is available	Indian drinking-water specification	The lower value is desirable; 1.5 mg/L is the maximum permissible value under the specified condition. [3,4]
NPPCF, Government of India	1.0 mg/L desirable	Programme guidance	NPPCF describes 1.0 mg/L as the desirable limit and supports surveillance, diagnosis, treatment and prevention. [2]
CGWB Jharkhand 2024	>1.5 mg/L classified as high/injurious	Groundwater monitoring	The 2024 bulletin used >1.5 mg/L to identify high-fluoride groundwater locations. [4]

The values in these documents are not interchangeable. WHO gives a health-based guideline, BIS the Indian drinking-water specification, and NPPCF a desirable level for programme use, while CGWB uses its own thresholds to classify groundwater. A report should say which of them it is applying; otherwise its numbers are easy to misread.

6. From contaminated water to human disease

The Berhait study in Sahibganj comes closest to tying contaminated water directly to illness. Twenty-nine percent of its 89 well-water samples were above the Indian permissible limit. Clinical fluorosis affected 85 children and 72 adults, and urinary fluoride confirmed that they had been exposed. [8]

Children deserve special attention because fluoride taken in while teeth are forming can leave lasting marks. A 2025 meta-analysis from India pooled 55 studies and 108,678 participants and put dental fluorosis prevalence at 34.5%, or 32.1% in children aged 5–18. Prevalence was higher where water fluoride was above 1 mg/L. Those are national numbers, not Jharkhand's, and should not be presented as such. [14]

Exposure is hard to notice. Water with too much fluoride looks clear and tastes and smells like any other, so a family

may drink from the same source for years. When fluorosis finally shows, the exposure has often been going on a long time.

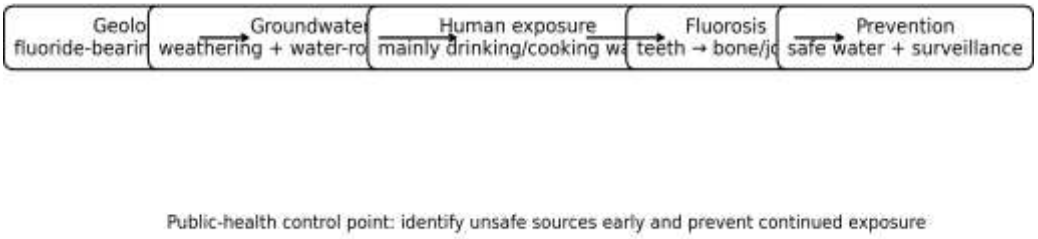


Figure 2. Proposed pathway linking geology, groundwater fluoride exposure, fluorosis and prevention.

7. A practical public-health model for Jharkhand

These findings suggest dealing with the source of exposure and not just the disease. We propose five connected activities for Jharkhand: Find, Map, Protect, Detect and Follow-up.

Find: Test water in habitations with known high fluoride and in other places likely to be at risk, including schools, Anganwadi centers and health facilities where appropriate. Link every result to a source, a place and a date so changes can be tracked.checked where appropriate. Each result should be linked to the source, location and date so that it can be followed over time.

Map: The habitation, or even a single source, is the right unit for action. Telling a family that their district is affected does not tell them which hand pump to avoid. Results should be matched with the number of users and with nearby schools and health facilities.

Protect: Once a source is declared unsafe, people must have something else to drink from. That could be a replacement source, a treatment system or a managed supply. Listing the source achieves nothing for the people using it.

Detect: Frontline health workers and school health teams are well placed to spot children and adults who may have dental or skeletal fluorosis. For each suspected case, the water source the person uses should be taken into account along with the clinical findings.

Follow-up: Supplying a new source is not the end. Retesting the water and following suspected cases will show if exposure has dropped and if people have really switched.

8. Research gaps

1. A statewide village-level map using one common sampling method, so areas can be compared fairly.
2. Long-term studies connecting drinking-water fluoride, urinary fluoride and clinical findings.
3. Studies in schools and Anganwadi centers of children living in suspected high-risk areas.
4. Shared case definitions and standard photographs for dental fluorosis in clinical work.
5. Estimates of total fluoride intake from water, food, salt, dental products and other sources.
6. Field trials of safe-water and defluorination methods, since laboratory results often do not carry over to villages.

7. Cost comparisons of source replacement, piped water, community treatment and household treatment.
8. Work on why families go on using an unsafe source even when another is available.
9. Linked water-quality and health records, so that suspected cases can be traced to their likely source.
10. Intervention studies checking whether exposure and new cases fall after a safe-water measure.

9. Policy recommendations

1. Classify fluoride risk by habitation using a plain Safe–Watch–Unsafe scheme that field staff and villagers can follow.
2. Test schools and Anganwadi centers first wherever high fluoride is known or suspected.
3. Provide a workable alternative before telling people to stop using an unsafe source.
4. Move NPPCF closer to routine groundwater and drinking-water surveillance, so health and environmental data are read together.
5. Set up a state fluoride dashboard with source, location, result, date, population served, nearby school, suspected or confirmed cases, and action taken.
6. Retest after each intervention to see if the gain holds.
7. Give children and infants extra attention; per kilogram of body weight, their exposure may be higher.
8. Improve laboratory capacity and quality control for fluoride testing.
9. Bring in health workers, teachers and Panchayat members to explain the risk and why a safer source matters.
10. Measure programme success by changes in exposure and disease, and not by how many samples were tested.

10. Discussion

Fluorosis in Jharkhand is neither a problem of the past nor one that affects every district equally. It is local. Certain sources carry far more fluoride than others, and families who keep using them can be exposed for years on end.

Studies also differ in how they pick their sites. Researchers usually go where contamination is already suspected, while government monitoring follows chosen trend sites. A hotspot survey will often report a much larger share of unsafe samples than routine surveillance, and neither is necessarily wrong. Future papers should state where their samples came from and why those places were picked.

Knowing about a hazard is one thing; keeping people away from it is another. A lab report describes the water. It does not say what a family can drink tomorrow. That takes a dependable alternative and clear advice, especially in villages where the closest hand pump is also the easiest one to use.step requires a reliable alternative and clear communication. This is particularly important in rural areas where the nearest hand pump may also be the family's most convenient source.

Work from Dhanbad, East Singhbhum and Giridih has improved our understanding of local risk. Evidence on interventions is what we lack now. We need studies that follow a community after a water intervention and check whether exposure goes down. For programme decisions, that would be worth more than yet another list of contaminated sources.

The Find–Map–Protect–Detect–Follow-up model is meant to be practical, and it needs no new programme. Groundwater and water-supply agencies can identify unsafe sources. The drinking-water system can arrange alternatives. Health services can assess suspected cases, and schools and local bodies can help with communication and early detection. The point is to connect these activities so they do not run separately.

11. Limitations

This review has limits. It is a narrative review, not a systematic review or meta-analysis. The studies used different sampling methods, sites, laboratory procedures and populations. Several set out to examine suspected hotspots, so none of them can estimate how widespread contamination is across the state. CGWB data also come from selected monitoring sites and do not cover every drinking-water source in Jharkhand.

The search itself has a weakness too. For this draft we do not hold a complete record of search results, database by database, for every source. Before submission the final search should be repeated, and dates, terms and record counts should be noted if the journal asks. If a journal wants a systematic or scoping review, a more formal process will be needed.

12. Conclusion

Fluoride exposure is still a real environmental health issue in parts of Jharkhand. Studies from Garhwa, Palamu and Sahibganj showed years ago that high-fluoride water and human exposure existed in the state. Newer work from the mica belt, East Singhbhum, Giridih and Dhanbad shows it persists in selected areas, and government monitoring still finds sources with raised fluoride.

For public health, the lesson is plain. A high-fluoride source should set off a response: identify the people who use it, give them a safe alternative, attend to suspected cases, and recheck the situation after the intervention.

Treating fluorosis after it appears is too late. The better course is to find unsafe sources early, cut exposure, and stop new cases from developing.

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