

Fluoride contamination and its Impact on Human Health: A Case Study of Jayal block of Nagaur District, Rajasthan (India)



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Abstract

The problem of fluoride has socio-economic implications. Deficiency of Fluoride (<0.6 mg /lit) causes dental caries and excess amount (>1.5 mg /lit) causes skeletal fluorosis and other manifestations. Fluorosis; a disease caused by excess intake of fluoride through diverse sources. More than 62 million people in India are affected with dental, skeletal and/or non-skeletal fluorosis. Drinking water is considered as the major contribution to fluoride entering the human body. Out of 33211 fluoride affected villages in the country, Rajasthan has 16560 villages. Nagaur district lies in central part of the Rajasthan state. About 64% villages of Nagaur district are endemic to fluoride related problems. All types of aquifer in Nagaur district have shown a high concentration of fluoride in the groundwater. The aims of this study were to determine fluoride concentration in drinking water consumed by residents of Jayal, Nagaur, Rajasthan and to assess its effect of Dental and Skeletal Fluorosis. Water samples collected from 143 villages of selected block revealed that 65.73 percent villages have fluoride content higher than the upper limited suggested by WHO. Among the studied villages, highest concentration (90 ppm) was reported from the sample collected from Datiyad. Further, pronounced effect of fluoride water drinking was reported on the Dental Fluorosis and 10.24 percent studied respondents have dental problem. Dental Fluorosis was reported highest in the respondents interviewed from Rampur and Gugariyali. In case of Skeletal Fluorosis, trends are bit different and it was reported from the 0.20% percent respondents.

Keywords: Dental Fluorosis, Skeletal Fluorosis, Jayal block, Nagaur, Rajasthan.

Introduction

Deficiency of Fluoride (<0.6 ppm) causes dental caries and excess amount (>1.5 ppm) causes dental fluorosis, skeletal fluorosis and other manifestations. A guideline value of 1.5 mg/L was recommended by WHO as maximum permissible fluoride concentration level in drinking water (WHO, 2006). Higher concentration of the fluoride may be because of weathering of the fractured hard rock pegmatite veins composing of minerals viz. topaz, fluorite fluorapatite, villuamite, cryolite, ferro magnesium silicate, etc. (Saxena, V.K. and Ahmad, S., 2001). Groundwater resource as drinking water is the main source of fluoride intake by humans; along with this some fluoride intake is associated with consumption of vegetables, fruits, fish, tea, cabbage and tooth past products (Bo, et al., 2003; Jha, S., 2009; Edmunds, W.M. and Smedley, P.L., 2013).

Review of the Literature

Higher concentration of fluoride affect metabolic activities of an individual which may cause skeletal fluorosis, dental fluorosis, non ulcer dyspepsia, polyurea (to urinate more frequently), polydispia (excessive thirst), muscle weakness, repeated abortions/ still birth due to hampering of blood flow to fetus on account of hardening and calcification of blood vessels, oligospermia (deficiency of spermatozoa in semen), azoospermia (absence of spermatozoa in semen), low testosterone level, discoloration of teeth enamel (Underwood,1977; W.H.O.,1984; Singh and Saimbi,1988; Machoy et.al.,1991; Susheela,1999; Maanju et al.,2003; Vyas et al., 2006, Vyas, 2015).

Aim of the Study

The aims of this study was to determine fluoride concentration in drinking water consumed by residents of Jayal block of Nagaur district, Rajasthan, India. and to assess its effect of Dental and Skeletal Fluorosis. Total 1948.08 sq. Kms study area of Jayal block lies between 26° 56' 29.1" and 27° 32' 34" North latitudes and 73° 49' 44.5" and 74° 21' 40" east longitudes. It is located in the northern part of Nagaur district. Long term contentious intake of fluoride contaminated groundwater in the study area by the inhabitants can cause extreme Dental and Skeletal Fluorosis. Research is therefore necessary to provide information and representative data to the general public of Jayal block and to evaluate Fluorosis risk in the study area.

Methodology

The study was carried out in Jayal block of Nagaur district of Rajasthan (Figure – 1). Water quality of water was access as per norms and guidelines suggested by Groundwater Resources Estimation Committee (G.R.E.C., 1997). Data and samples of ground water were collected from different sources and villages; have been statistically analyzed. For estimation of health hazards, total 18485 volunteer respondents were selected from 16 villages of Jayal block. Information regarding the Dental and Skeletal Fluorosis was collected by a questionnaire, an interview schedule to collect information from community members and an observation schedule.

Collected data were analyzed to determine the dental and skeletal issues.

Results

Hydrogeological investigation has shown that there are many villages in the Jayal block where fluoride content in the groundwater is exorbitantly high. Out of the total 25 villages surveyed in the block 92.00% villages (total 23) were found to have groundwater with fluoride content exceeding the prescribed permissible limit. Groundwater in 60.00% (15) villages has fluoride content ranging between 1.6 to 3.00 mg/l. About 16.00% (4) villages have fluoride in the groundwater ranging between more than 3 to 6.00 mg/l. Fluoride concentration in groundwater ranges from 0.40 ppm (Dhehroli) to 7.22 ppm (Dugoli)(Bhoora Ram, 2011).

Data related to water samples collected form 143 village of Jayal block of Nagaur District have been analyzed and represented in Table - 1(Paliwal, 1999, Khan, 2000). A wide variation in the fluoride content (0-10+) was reported among the surveyed villages. Among the studied villages, 65.73 percent villages have excess fluoride content than the WHO recommended 1.5 mg/L, this is very critical condition and the resident of these villages are in higher risk of fluoride related diseases. Among the surveyed villages, 34 villages have F⁻ value between 5.0 to 10.0 Mg/L while 10 villages have above 10.0 Mg/L (Table - 2). Among the studied villages highest F⁻ value was reported from the sample collected form Datiyad (90 ppm) and Rampur (40 ppm).

Table - 1 Distribution of Fluoride in Groundwater In Jayal Block of Nagaur District, Rajasthan (Modified after Paliwal, 1999 and Khan, 2000)

| Block | No. of villages sampled | No. of villages with range of Fluoride content between (mg/lit.) | | | | | | | | | No of villages with excess Fluoride | Village with max. Fluoride (mg/litre) |
|-------|-------------------------|--|-----------|---------|-----------|-----------|---------|-----------|--------|-----|-------------------------------------|---------------------------------------|
| | | 0 - 0.8 | 0.8 - 1.6 | 1.7-2.5 | 2.6 - 3.5 | 3.6 - 5.0 | 5.1-6.5 | 6.6 - 8.0 | 8 - 10 | 10+ | | |
| Jayal | 143 | 26 | 23 | 19 | 12 | 19 | 14 | 10 | 10 | 10 | 094 (65.73%) | (90)Datiyad (40)Rampur |

Table –2

Excessive Fluoride Prone Areas of Jayal Block of Nagaur District, Rajasthan (F⁻¹ values 5 mg/lit and above) (G.W.D. Rajasthan, 2008; Vyas et al., 2006; Vyas, 2015)

| S.No. | F ⁻¹ (mg/lit) | Name of villages |
|-------|--------------------------|--|
| 1 | 5.0 to 8.0 | Arwar (Tertiary Sandstone), Bugarda (Bilara Limestone), Chawali (Limestone Saline), Chhawata Khurd (Bilara Limestone), Deh (Bilara Limestone), Deediya Khurd (Bilara Limestone), Kherat (Nagaur sandstone), Kushiya (Nagaur sandstone), Nosariya (Nagaur sandstone), Piriya (Bilara Limestone), Roopathal (Tertiary Sandstone) and Sandeela (Nagaur sandstone) |
| 2 | >8.0 to 10.0 | Burdi (Bilara Limestone), Gadriya (Nagaur sandstone), Igyar (Tertiary Sandstone), Kasnau (Tertiary Sandstone), Khari Jodha (Older Alluvium) and Ramsar (Limestone Saline) |
| 3 | >10.0 to 15.0 | Dhehari (Older Alluvium), Gugriyali (Older Alluvium), Jhalalar (Nagaur sandstone), Lunsara (Tertiary Sandstone), Matasukh (Older Alluvium), Rooniya (Bilara Limestone) and Suwadiya (Bilara Limestone) |
| 4 | >15.0 to 20.0 | Dugastau (Bilara Limestone) |
| 5 | >20.0 to 25.0 | Tanwara (Limestone Saline) |
| 6 | >25.0 to 35.0 | Geloli (Tertiary Sandstone) |
| 7 | 35.0 to 50.0 | ----- |
| 8 | >50.0 | Somra (75.0 mg/lit) (Bilara Limestone) and Datiyad (90.0 mg/lit) (Limestone Saline) |

Total 18485 respondent from 16 villages of Jayal block have been investigated for Dental

Fluorosis. Among these 10.24 percent respondents have Dental Fluorosis. Highest 57.54 percent Dental

Fluorosis was reported from the studied respondents of village Ramsar (Table - 3) (Paliwal, 1999, Khan, 2000). Contradictory to the Dental Fluorosis, the percentage of Skeletal Fluorosis was low (0.20%).

Among the surveyed villages, highest percentage of Skeletal Fluorosis (1.60%) was reported from the village Tarnau, of Jayal block (Table - 4).

Table – 3 Distribution of Patients of Dental Fluorosis in Jayal Block of Nagaur District, Rajasthan (Modified after Paliwal, 1999 AND Khan, 2000)

| Block | No. of villages Sampled and analyzed | Population Surveyed | Total No. of patients and % | No. of villages with patients ranging between | | | | | | Maximum% of patients | Name of Village |
|-------|--------------------------------------|---------------------|-----------------------------|---|-------|--------|--------|--------|------|----------------------|-------------------|
| | | | | Nil | 0--10 | 10--20 | 20--50 | 50--80 | 80+ | | |
| Jayal | 16 | 18485 | 1892 | 2 | 10 | 1 | 1 | 2 | ---- | 57.22% | Gugariyali Ramsar |
| | | | 10.24% | | | | | | | | |

Table – 4 Distribution of Skeletal Fluorosis in Jayal Block of Nagaur District, Rajasthan (Modified after Paliwal, 1999 and Khan, 2000)

| Block | Surveyed No. of Village/ Population | No. of Patients | % | Number of Village with number of Patients between | | | | | | Maximum % of Affected Persons | Village Name |
|-------|-------------------------------------|-----------------|-------|---|-------|--------|---------|----------|----------|-------------------------------|--------------|
| | | | | A | B | C | D | E | F | | |
| | | | | Nil | 1--10 | 10--50 | 50--100 | 100--200 | 200--500 | | |
| Jayal | 16 | 37 | 0.20% | 11 | 4 | 1 | - | - | - | 1.60% | Tarnau |
| | 18485 | | | | | | | | | | |

Discussion

30 districts out of 33 districts of Rajasthan State are facing the fluoride problem. 20% of the fluoride-affected villages of the world are in India. Out of 33211 fluoride affected villages in the country, Rajasthan has 16560 villages > 50% (Maanju et al., 2003). Nagaur district is the most problematic district in the state with regard to high concentration of Fluoride in groundwater. As per the Bureau of Indian Standards (1992) the permissible limit of F⁻¹ content should not be exceed that the 1.5 ppp, but in case of Nagaur, most of the Groundwater samples show concentration of fluoride much higher than the prescribed limit. About 64% villages of the Nagaur district are endemic to fluoride related problems. Fluorides content of groundwater in different litho units in the Nagaur district revealed that groundwater in recent alluvium are richer in fluoride content. Epidemiological survey carried out in 16 villages of Jayal block covering total 18485 persons, has shown that about 10.24% of the population surveyed have been affected by dental fluorosis and 0.20% of the population surveyed have been affected by skeletal fluorosis (Paliwal, 1999, Khan, 2000). All aquifer types in Jayal block and Nagaur district as well, have shown a high concentration of fluoride in the groundwater. In present study, severe cases of Dental and Skeletal Fluorosis were reported in the studied respondents. The data obtained from study is alarming and government should make necessary policy for providing safe and good quality water. Therefore study area is recommended for adoption of adequate measures for conservation and judicious management of groundwater resources. (Quereishi, J. and Vyas, A. 2008 and 2017).

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Figure- 1 Location Map of The Study Area

