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Impact of Fluoride Contaminated Groundwater on Human Health: A Case Study of Didwana Block of Nagaur District, Rajasthan

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Abstract

The aims of this study were to determine fluoride concentration in drinking water consumed by residents of Didwana, Nagaur, Rajasthan and to assess its effect of dental and skeletal fluorosis. The study used data obtained from revenue department and Public Health and Engineering department and all the selected respondents were interviewed by a well developed questionnaires and physical observation. Water samples collected from 152 villages of selected blocked revealed that 56.57 percent villages have fluoride content higher than the upper limited suggested by WHO. Among the studied villages, highest concentration (26Mg/L) was reported from the sample collected from Chhapri Bari. Further, pounced effect of fluoride water drinking was reported on the dental fluorosis and 12.31 percent studied respondents have dental problem. Dental fluorosis was reported highest in the respondents interviewed from Berwa. In case of skeletal fluorosis, trends are bit different and it was reported from the 4.9 percent respondents. Results of this study are the alarming call for the resident of study area and make a strong appeal to develop a policy for providing safe drinking water.

Keywords: Groundwater, Fluoride concentration, Didwana block, Dental and Skeletal Fluorosis.

Introduction

Fluoride is a common constitute of ground water, which occurs naturally in public water systems as a result of runoff from weathering of fluoride containing rocks and leaching from soil into groundwater (Sajidn, et al. 2008). High fluoride level in the groundwater is a common problem for Rajasthan and associated with all districts. A guideline value of 1.5 mg/L was recommended by WHO as maximum permissible fluoride concentration level in drinking water (WHO, 2006). But wide variation in natural water fluoride levels was reported from all the districts and these concentrations was above and below the optimal range set by the World Health Organization for drinking water.

This abnormal level of 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). Fluoride's presence in groundwater may be associated with the sedimentation processes, since Quaternary sediments of the Didwana are rich in micaceous minerals, which contain fluoride. Investigation of the chemical composition of fluoride bearing waters revealed that waters with excessive fluorides usually have high alkalinity and low calcium content. Various geochemical factors contribute to excessive incidence of fluorides in the ground water. Excessive alkalinity may be responsible for the higher incidence of fluoride in the groundwater of Didwana.This block being in semi-arid area, Calcium and Magnesium/carbonate concentration are high in the soils, therefore groundwater flow is slow and the reaction times with these minerals are therefore high which increase the hardness of water. The fluoride contents of solution in water may increase during evaporation if solution remains in equilibrium with calcite and alkalinity is greater than hardness. Dissolution of evaporative salts deposited in arid zones may be an important source of fluoride (Prasanna, et al., 2010).

Review of the Literature

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 pest products (Bo, et al., 2003; Jha, S., 2009; Edmunds, W.M. and Smedley, P.L., 2013). At low concentration it is an essential component for normal mineralization of bones and formation of dental enamel, but excessive exposure to fluoride can cause a number of adverse effects. Millions of people and animals were suffering from the health hazards associated with the excessive intake of fluoride intake. Continued consumption of higher fluoride concentrations are associated with dental and skeletal fluorosis, osteosclerosis, thyroid, kidney changes and cardiovascular, gastrointestinal, endocrine, neurological, negative effects if concentration is higher than 1.5 mg/l in drinking water (Fisher, et al., 1989; Cinar, A. and Selcuk, M., 2005; Izuora, et al., 2011; Pratusha, et al., 2011; Jarvis, et al., 2013)

Aim of the Study

The aim of this study was to access the fluoride contamination of the groundwater and impact of its exposure on dental and skeletal decay in Human population of Didwana block of Nagaur district, Rajasthan, India. High fluoride concentrations are very critical in arid and semi arid regions of Rajasthan. Very few studies are conducted on the impacts of fluoride contaminated drinking water on the human health of the local community and general public in Didwana block of Naguar district, Rajasthan, India.

Contentious consumption of fluoride contaminated water can cause extreme Dental and Skeletal Fluorosis. Research is therefore necessary to provide information and representative data to the general public of Didwana block and to evaluate Fluorosis risk of the population groups.

Methodology

The study was carried out in Didwana block which is located in the Northeastern part of Nagaur district of Rajasthan. It is located between between 27° 04' 50" and 27° 30' 29" North latitudes and 74° 19' 46" and 74° 50' 34" east longitudes (Figure – 1). Water quality of water was access as per norms and guidelines suggested by Groundwater Resources Estimation Committee (G. R. E.C., 1997) groundwater resources (as on 31.3.2007) of Didwana block of Nagaur district, Rajasthan. Data collected by Paliwal (1999) and Khan (2000) from 152 villages ground water have been collected from revenue department and Public Health and Engineering department statistically analyzed. For estimation of health hazards, total 16684 volunteer respondents were selected from 19 villages of Didwana 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

Data related to water samples collected form 152 village of Didwana block of Nagaur District have been analyzed and represented in Table - 1. A wide variation in the fluoride content (0-10+) was reported among the surveyed villages. Among the studied villages, 56.57 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, 21 villages have F^- value between 5.0 10.0 Mg/L while 6 villages have above 10.0 Mg/L (Table - 2). Among the studied villages highest F^- value was reported from the sample collected form Chhapri Bari.

Table - 1 Distribution of Fluoride in Groundwater in Didwana 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+		
Didwana	152	36	30	28	17	16	06	08	05	06	086 (56.57%)	Chhapri (26)

Table – 2 Excessive Fluoride Prone Areas of Didwana 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	Amarpura, Dabgaon, Dasana chhata, Daulatpura, Dinarpura, Khakali, Kharia, Khudiawas, Lada Basni, Mawa, Morawat, Nimbli Chhoti, Padmariawas and Sagu Khurd
2	>8.0 to 10.0	Barawa, Berwa, Chhapri Chhoti, Pandorai, Pawa
3	>10.0 to 15.0	Pawata, Sherani abad dhani
4	>15.0 to 20.0	Ganeshpura, Sewa
5	>20.0 to 25.0	Khari
6	>25.0 to 35.0	Chhapri Bari

Total 16684 respondent from 19 villages of Didwana block have been investigated for Dental Fluorosis. Among these 12.31 percent respondents have Dental Fluorosis. Highest 51.97 percent Dental Fluorosis was reported from the studied respondents of village Berwa (Table - 3). Contradictory to the Dental Fluorosis, the percentage of Skeletal Fluorosis was low (4.9%). Among the surveyed villages, highest

percentage of Skeletal Fluorosis (44.41%) was reported from the village Chhoti Chhapri, of Didwana block (Table - 4).

Table – 3 Distribution of Patients of Dental Fluorosis in Didwana 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+		
Didwana	19	16684	2053 12.31%	4	7	5	2	1	----	51.97%	Berwa

Table – 4 Distribution of Skeletal Fluorosis in Didwana 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							
				A	B	C	D	E	F	Maximum % of Affected Persons	Village Name
				Nil	1--10	10--50	50--100	100--200	200--500		
Didwana	19 16684	817	4.9%	9	6	4	-	-	-	44.41	Chhoti Chhapri

Discussion

Due to arid climatic condition and scarcity of surface water resources; inhabitants of Rajasthan are dependent largely on groundwater for drinking and agriculture purposes; 30 districts out of 33 districts of the 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). With regard to Fluoride concentration, nagaur district is the most problematic district in the state. As per the Bureau of Indian Standards (1992) the permissible limit of F -1 content should not be exceed that the 1.5Mg/L, but in case of Naguar, most of the Groundwater samples show concentration of fluoride much higher than the limit prescribed by the Bureau of Indian Standards (1992). 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 (Paliwal, 1999, Khan, 2000).

All aquifer types in Didwana block and Nagaur district as well, have shown a high concentration of fluoride in the groundwater. Paliwal (1999b) reported that 92.06% samples from the recent alluvium, 87.50% samples from the Tertiary sandstone, 86.36% samples from the Bilara limestone, 87.50% samples from the Jodhpur sandstone, 77.78% samples from the Aravalli phyllites, 71.43% samples from the Pre-Aravalli granites and gneisses and about 93.75% samples from the unclassified and intrusive rocks contain fluoride more than 2 milligrams per litre in Nagaur district. Groundwater. Finding of present study are in agreement with the findings of Chaudhary R (2010) those who reported fluoride concentration in groundwater ranges from 0.30 ppm to 6.30 ppm. High concentration of fluoride creates health hazards in various parts of Degana, Ladnun, Nagaur, Jayal, Makrana and Didwana blocks of Nagaur district. Like district data, groundwater samples of Didwana block mostly show high concentration of fluoride and this was much higher than the limit prescribed by the Bureau of Indian Standards.

Fluorosis is a very critical disease which affecting millions of people across the world every year. Around the world, more than 200 million people (among 25 nations) are suffer from fluorosis, caused mainly due to excess fluoride in drinking water (Ayoob, S and Gupta, A.K., 2006; Hong-jian, et al. 2013; Ghosh et al. 2013). It severely affect the abnormal tooth enamel, cause joint pain and deformity of the limbs and spine, along with ligamentous calcifications and exostosis formations in patients (Nayak, et al. 2009).

Conclusion

In present study also, severe Dental and Skeletal Fluorosis was reported in the studied respondents. In this manner findings of present study are in agreement with the findings of Nayak, et al. (2009) and Francisca, et al. (2017). The data obtained from study is not only warning for resident of the area but it is also a alarm for the government of Rajasthan, 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