International Journal of Engineering Research and General Science Volume 3, Issue 5, September-October, 2015
ISSN 2091-2730

Fluoride induced water pollution issue and its health efficacy in India- A review

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Abstract— Fluoride is an ordinary constituent of characteristics in water samples. Its concentration, however, different fundamentally relying upon the water source. Fluoride is deductively demonstrated to counteract tooth decay and to help in accomplishing and keeping up great oral wellbeing. Water fluoridation is a safe and practical general wellbeing measure that is prescribed by more than 90 medical, dental, and health organizations at the national and worldwide level. The fluoride deliberate of groundwater at Kommala zone of Warangal district uncovered that around 85.83% specimens are discovered surpassing allowable breaking point Dental fluorosis is more inclined in the youngsters upto the age of 8-10 of fluoride influenced ranges where fluoride concentration is more than passable cutoff of 1.5 mg/l. The local government likewise has a key part to play in guaranteeing that people have admittance to fluoridated water wherever they live and empowering districts over the territory to have the capacity to convey it by sponsoring expenses where important. In the present review, the indian situation and wellbeing issue have been progressed for further view.

Keywords— Defluoridation; Health issue, indian scenario, skeletal fluorosis, dental fluorosis

INTRODUCTION

Water is the elixir of life for their survivals, well-creatures, societal up- liftmen and manageable development [1]. The water covers very nearly 71 percent of surface of the earth approximately 1,39,500,000 sq. miles. The water availability on earth covering is extensively characterized into surface water and sub-surface or ground water. The significant wellspring of water are surface water while ground water contributes just 0.6 % rate of them. However, the greater part of the creating nations like India rely on upon ground water to fulfill their every day necessities beginning from drinking to agricultural purposes. The ground water was the most secure wellspring of drinking water accesible on the globe previously. Presently, this ground water sources are not safe and get badly polluted due to human interferences such as urbanization, industrialization as well as dissolution and mixing of chemical elements from natural mineral resources available in the earth itself. Fluoride is one of the chemical pollutants available in water that comes into water by dissolution of fluoride containing rocks by their weathering and leaching or discharge by agricultural and industrial activities during manufacturing glass, electronics, steel, aluminium, bricks, tiles, ceramics, pesticide and fertilizer [2].

The presence of fluoride in groundwater for drinking purposes may be beneficial or detrimental depends on its concentration and amount indigested. The drinking water having lower concentration of fluoride in the range of 0.4 to 1.0 mg/l beneficial to promote calcification of dental enamel and protects teeth against tooth decay, while excessive level of fluoride causes multiple health problems ranging from mild dental fluorosis to crippling skeletal fluorosis [3]. According to the World Health Organization (WHO) [4], the maximum acceptable concentration of fluoride is 1.5 mg/l, while India's permissible limit of fluoride in drinking water is 1 mg/l [5]. Keeping in view of climatic condition of hot humid region, the US Public Health Service reduces the permissible limit of fluoride from 1.7 to 0.8 mg/l with increases of the average maximum daily air temperature [6]. High F intake has been suspected being involved in a range of adverse health problems in addition to fluorosis, including cancer, impaired kidney function, digestive and nervous disorders, reduced immunity, Alzheimer's disease, nausea, adverse pregnancy outcomes, respiratory problems, lesions of the endocrine glands, thyroid, liver and other organs [7,8].

INDIAN SCENARIO

In India, the fluorosis is broad, concentrated and disturbing throughout the nations since out of 85 million tons of fluoride deposited on earth's shell; 12 millions are found in India [9]. The fluoride was initially identified in mid 1930 at four states including Andhra Pradesh, Tamil Nadu, Uttar Pradesh and Panjab. In 1986, fluorosis was established in 13 states under innovation mission on drinking water. In 1990-1992, two additional states Kerala and Jammu and Kashmir have likewise been distinguished as fluoride inclined states. In 2002, it was secured 17 states, at present, In India, more than 6 million individuals are truly influenced by fluorosis and

another 62 million individuals are at the danger. Fluorosis issue was predominant in 20 out of the 35 states of India, 70-100% districts are influenced in Andhra Pradesh, Gujarat and Rajasthan, 40-70% districts are influenced in Bihar, National Capital Territory of Delhi, Haryana, Jharkhand, Karnataka, Maharashtra, Madhya Pradesh, Odisha, Tamil Nadu and Uttar Pradesh, 10-40% districts are affected in Assam, Jammu & Kashmir, Kerala, Chhattisgarh and West Bengal. While the endemicity for whatever remains of the states are not known. For the most part influenced states because of fluorosis are Rajasthan, Andhra Pradesh, Gujrat, Karnataka, Odisha, Panjab, Haryana, Delhi, Madhya Pradesh, Tamil Nadu and Uttar Pradesh. In Rajasthan, 24 out of 32 districts have been influenced with fluorosis and 15 million of the population are at danger [10,11].

In the examination of groundwater study of Todaraisingh area of Tonk district of Rajasthan, 65.63 percent of samples were crossing the admissible furthest reaches of W.H.O. for drinking water [12]. The middle and eastern parts of the Hanumangarh, a northern most district of Rajasthan can be filed as high hazard area of skeletal fluorosis because moderately high concentration of fluoride (3-4 mg/l) in groundwater [13]. The fluoride concentration of groundwater of four blocks in Ajmer district of Rajasthan changed from 0.24 to 17.60 mg/l with 66 % samples in overabundance of passable utmost of 1.5mg/l bringing on dental and skeletal fluorosis [14,15]. The ten tribal villages of Abu road of Rajasthan were likewise crossing as far as possible [16]. In Andhra Pradesh, 16 out of 23 districts are influenced by fluoride. The fluoride studied of groundwater at Kommala area of Warangal district uncovered that around 85.83% specimens are discovered surpassing admissible utmost [17].

The ground water samples of Nalgonda district of Andhra Pradesh had fluoride concentration upto 8.8 mg/l and around 30% of wells had fluoride concentration over as far as possible [18]. The studied demonstrated that fluoride concentration of distinctive parts of Talupula area of Anantapur district (Andhara Pradesh) reaches between 0.78 to 6.10 mg/l. The general population of this area suffered from dental fluorosis and mild skeletal fluorosis [19]. In Gujrat around 18 districts are confronting fluoride threat. Mehsana, Patna and Banaskantha districts are most fluoride affected districts apart from Amreli, Ahmedabad, Sabarkantha and Baroda. The people of these areas are suffering from dental and skeletal fluorosis [20].

In Karnataka states, fluorosis are spreading in 18 to 20 districts including Bagalkot, Bangalore, Bellary, Belgaum, Bidar, Bijapur, Chamarajnagar, Chikmanglur, Chitradurga, Devangere, Dharwar, Gadag, Gulbarga, Haveri, Kolar, Koppala, Mandya, Mysore, Raichur and Turnkur. The Southern part of Karnataka, covering districts of Gulbarga (2.60 – 7.40 mg/l), Raichur (2.02 – 5.15 mg/l), Bellary (0.80 – 7.40 mg/l), Chitradurga and Tumkur (0.97 – 2.60 mg/l) and Kolar (1.55 – 2.60 mg/l) are epidemic in fluorosis [21].

In Orissa, around 18 districts are influenced by fluorosis. The drinking water quality in numerous villages of Angul, Khurda, Puri, Nayagarh, Boudh, Kandhamal, Bolangir,Nuapada and Balasore districts are contaminated with huge amount of fluoride. The circumstance is additionally distrubing in Balsingh-Singhpur in Khurda district, Karlakote in Nuapada district, Gohiriapadar in Kalahandi District, Krushakpalli in Bargarh district and Balgopalpur Industrial Estate in Balasore districts .

According to CPCB, Kolkata, the fluoride contaminated water established in 57% of tube wells and 67% of dug wells; 10% of these assets had fluoride more than 1.0 mg/l. The fluoride concentration of lake water varies from 0.47 to 3.70 mg/l. The people of Balsingh and Singhpur in Khurda district were completely suffered from fluorosis; over 200 persons have died of fluorosis in last 16 years. The fluoride level was happened in village tube well was 3.18 mg/l while it was as high as 7.10 mg/l and 10.55 mg/l in the open wells and lakes [22].

The groundwater of South – Western districts of Punjab had fluoride concentration of 0.28 to 14.04 mg/l. The people of arid region of Punjab have suffering from dental fluorosis and in addition constant sicknesses like cancer [23]. The districts of Haryana having fluoride concentration more than 6.0 mg/l includes Sonepat, Faridabad, Bhiwani and Fatehabad while districts such as Jind, Hisar, Sirsa, Rohatak, Rewari, Panipat and Mahendragarh having more than 3.0 mg/l. Ambala and Yamunanagar are safe from problem of fluorosis [24]. The fluoride concentration of groundwater in various villages of Gurgaon district of Haryana varied from 0.02 – 6.4 mg/l [25]. The Mega city of Delhi is endemic for fluorosis with 32 ppm of fluoride concentration. Around 50% of the groundwater in Delhi surpasses the most extreme passable point of confinement of fluoride in drinking water.

As indicated by Source Economic Survey of Delhi (2007-08) [26], the fluoride concentrations in distinctive locations in Delhi are Mohammadpur (2.50 mg/l), Shahbad (7.36 mg/l), JJ Colony (6.67 mg/l), Narela (4.87 mg/l), Okhla village (3.00 mg/l), Rohini (4.35 mg/l), Najafgarh (8.70 mg/l), Suraj Park (4.23 mg/l), Sabzi Mandi (1.30 mg/l), Green Park (19.33 mg/l), Hari Nagar (Asharam) (1.50 mg/l), Jangpura (2.44 mg/l), Lodhi Road (4.00 mg/l) and Srinivaspuri (1.38 mg/l). According to Water Aid India 2005 [27], around 4018 villages with 7746 sources in 22 districts have fluoride contamination in water. In Tamil Nadu, totally 214 blocks in 23 districts having fluoride issue. The most influenced districts because of fluorosis are Dindigul, Theni, Virudhunagar and Kanyakumari. Some areas in Tiruvarur, Kancheepuram, Ramnathapuram and western part of Vellore are likewise influenced by fluoride [28].

The dental fluorosis was found in 10 villages of Anthoor block and Nilakkotai block of Dindigul Anna District because of fluoride had found in the range of 1 to 3 ppm whereas skeletal fluorosis was predominant in four villages of Ayodhyapatnam block of Salem District with fluoride extent changed from 3.8 to 8.0 ppm [29,30]. The fluoride accessibility investigation of 61 villages of

Ottapidaram block of Tamilnadu having 81.97% samples crossing the reasonable furthest reaches of 1.5 mg/l. The fluoride concentration in drinking water varies 0.936 to 4.34 mg/l in the study area [31].

The districts of Uttar Pradesh having fluoride concentration more than reasonable point of confinement incorporates Agra, Aligarh, Etah, Firozabad, Jaunpur, Kannuaj, Mahamaya Nagar, Mainpuri, Mathura and Mau. The fluoride concentration in groundwater of three blocks namely Naujhil, Mat and Raya of Mat Tahsil of Mathura district differed from 0.1 to 2.5 mg/l [32] while groundwater samples of Tanda taluka of Rampur district shifted from 0.46 to 4.36 mg/l [33]. Table 1, and 2 demonstrates the state-wise presence of fluoride concentration in ground water of India, and Fluoride in ground water in India for most recent fifteen years (2000-2015).

Table 1: Indian scenario of Fluoride Endemicity

State	Total Districts	Endemic Districts	Fluoride Level
Andhra Pradesh	23	16 (69.57%)	**0.4 - 29.0 mg/L**
Gujarat	19	18 (94.74%)	1.5 - 18.0 mg/L
Rajasthan	32	32 (100.0%)	0.10 - 10.0 mg/L
Karnataka	27	18 (66.66%)	0.2 - 7.79 mg/L
Orissa	32	18 (56.25%)	0.6 - 9.2 mg/L
Punjab	17	14 (82.35%)	0.4 - 42.0 mg/L
Maharashtra	32	10 (31.25%)	0.11 - 10.00 mg/L
Madhya Pradesh	48	16 (35.55%)	1.5 - 4.20 mg/L
Haryana	19	12 (63.16%)	0.2 - 48.32 mg/L
Bihar	41	06 (14.63%)	0.2 - 8.32 mg/L
Tamil Nadu	29	08 (27.59%)	0.1 - 7.0 mg/L
Uttar Pradesh	83	18 (21.69%)	0.2 - 25.0 mg/L
West Bengal	18	04 (22.22%)	1.1 - 14.47 mg/L
Kerala	14	03 (21.43%)	**0.2 - 5.40 mg/L**
Assam	23	02 (08.69%)	1.6 - 23.4 mg/L
Delhi	09	04 (44.44%)	0.2 - 32.0 mg/L
Jammu & Kashmir	14	01(07.14%)	0.5 -4.21 mg/L
Jharkhand	-	-	0.5 - 14.32 mg/L
Chhattisgarh	-	-	-
Uttaranchal	-	-	-

Table 2: Fluoride in groundwater in India (2000-2015)

Location	Fluoride concentration	Reference
Rohtas, Bihar	0.1-2.5 mg/l	Ray et. al. (2000) [33]
Nayagarh district, Orissa	0.16-10.1 mg/l	Kundu et. al. (2001) [34]
Rajgarh Tehsil, Churu district, Rajasthan	0.1 -14.0 mg/l	Murlidharan et. al. (2002) [35]
Delhi	0.11-32.5 mg/l	Susheela et. al. (2003) [36]
Guwahati, Assam	0.18-6.88 mg/l	Das et. al. (2003) [37]
Five villages of Haryana	0.3 – 6.9 mg/l	Meenakshi et. al. (2004) [38]
Seventeen villages of Tehsil Sanganer, District Jaipur, Rajasthan	2.17 – 10.14 mg/l	Sharma et. al. (2005) [39]
Tanda taluka of Rampur district	0.46-4.36 mg/l	Shinde & Shinde (2006) [32]
Andhra Pradesh	0.38-4.0 mg/l	Sreedevi et. al. (2006) [40]
Birbhum , West Bengal	0.006-1.95 mg/l	Gupta et. al. (2006) [41]
Yavatmal district, Maharashtra	0.30-13.41 mg/l	Madhnure et. al. (2007) [42]
Palghat district, Kerala	1.51-5.75 mg/l	Shaji et. al. (2007) [43]

Rajasthan	1.0-5.2 mg/l	Choubisa (2007) [44]
Ajmer district, Rajasthan	0.24-17.60 mg/l	Sharma (2007) [14]
Orissa	0.47-10.55 mg/l	Mahapatra (2007) [22]
Ottapidaram block of Tamil Nadu	0.936-4.34 mg/l	Mishra & Mishra (2007) [31]
North Rajasthan	3.0 – 4.0 mg/l	Suthar et. al. (2008) [13]
Kadayam block of Tirunelveli district	0.73 – 3.02 mg/l	Alagumuthu & Rajan (2008) [45]
Nine blocks of Kanyakumari district, Tamil Nadu	1.5-1.7 mg/l	Baskaradoss et al. (2008) [46]
Sonbhadra, Uttar Pradesh	0.48-6.7 mg/l	Raju et. al. (2009) [47]
Visakhapatnam, Andhra Pradesh	1.15-1.28 mg/l	Rao et. al. (2009) [48]
Hirakud, Orissa	0.5-0.60 mg/l	Mishra et. al. (2009) [49]
Nilakottai block of Dindigul district in Tamil Nadu	0.49-3.12 mg/l	Viswanathan et. al. (2009) [29]
Ajmer, Rajasthan	0.20-17.607 mg/l	Vikas et. al. (2009) [50]
Todaraisingh area of Tonk district, Rajasthan	3.0-4.0 mg/l	Yadav & Khan (2010) [12]
Around Tanda taluka of Rampur district, Uttar Pradesh	1.0-2.5 mg/l	Yadav & Kumar (2010) [32]
Villages of Modasa taluka, Sabarkantha district, North Gujrat	1.0-3.0 mg/l	Dave et. al. (2010) [51]
Ottapidaram block Tamilnadu	0.936 – 4.34 mg/l	Veeraputhiran & Alagumuthu (2010) [52]
Sonitpur District, Assam	0.17 – 5.602 mg/l	Joydev Datta et.al. (2010) [53]
Guntur district, Andhra Pradesh	0.3 – 1.8 mg/l	Subba Rao (2010) [54]
Malpura Tehsil, Tonk, Rajasthan, India	0.08 – 11.30 mg/l	Tailor & Chandel (2010) [55]
Erode district, Tamilnadu	0.5 – 8.2 mg/l	Karthikeyan et.al. (2010) [56]
Wailpalli watershed,Nalgonda district Andhra Pradesh	0.97- 5.83 mg/l	Reddy et.al (2010) [57]
Parts of Nalgonda district, Andhra Pradesh	0.1 – 8.8 mg/l	Brindha et.al. (2011) [58]
Nawa tehsil of Nagaur district, Rajastan	1.10-14.62 mg/l	Gautam et. al. (2011) [59]
Talupula , Andhra Pradesh	0.78 – 6.10 mg/l	Arveti et.al. (2011) [60]
Rameswaram Area Tamilnadu, Southern India	1.5-2.5 mg/l	Sivasankar & Ramachandramoorthy. (2011) [61]
Deoli Tehsil (Tonk District) Rajasthan	0.3-9.6 mg/l	Meena et.al. (2011) [62]
Agra district, Uttar Pradesh	0.1-14.8 mg/l	Sharma et. al. (2011) [63]
Mettur taluk of Salem District, Tamilnadu	0.1-2.8 mg/l (pre-monsoon) 0.4-4.0 mg/l (Post-monsoon)	Srinivasamoorthy et.al. (2012) [64]
Kommala area in Warangal district, Andhra Pradesh	1.1-5.8 mg/l	Veerati Radhika and Praveen (2012) [65]
Dungarpur district of Rajasthan	1.5-4.4 mg/l	Choubisa (2012) [66]
Rural habitations of central Rajasthan	>1.5 – 5.91mg/l	Hussain et.al. (2012) [67]
Mudhol Taluk , Karnataka	0.06-0.573 mg/l	Pol et.al. (2012) [68]
Patripal panchayat of Balasore , Odisha	0.6 – 5.83 mg/l	Das et.al. (2012) [69]
Karera block in Shivpuri district, Madhya Pradesh	1.65 – 3.91 mg/l	Saksena & Narwaria (2012) [70]
Mathura district, Uttar Pradesh	3.4 – 4.6 mg/l	Rawat et.al. (2012) [71]
Anantapur District, Andhra Pradesh	1.8 – 5.2 mg/l	Sunitha et.al. (2012) [72]
Kadiri,Mudigubba & Nallamada mandals of Anantapur District, Andhra	0.1 – 7.0 mg/l	Reddy (2013) [73]

Pradesh		
South and Western Parts of Punjab	0.28-14.04 mg/l	Singh et. al. (2013) [23]
Bassi tehsil of district Jaipur, Rajasthan	0.1-12.5 mg/l	Saxena & Saxena (2013) [74]
Angul district of Orissa	0.2-2.4 mg/l	Reza & Singh (2013) [75]
Didwana block of Nagaur district, Central Rajasthan	0.5-8.5 mg/l	Arif et. al. (2013) [76]
Nilakottai block, Dindigul district, Tamil Nadu	1.5-3.0 mg/l	Amalraj and Pius (2013) [77]
Mysore district, Karnataka	0.25-3.0 mg/l	Mamatha et. al. (2013) [78]
Villages of Jind District, Haryana	0.2-2.0 mg/l	Singh et.al. (2013) [79]
Dindigul town, Tamilnadu	2.47 – 5.26 mg/l	Mohamed & Zahir Hussain (2013) [80]
Central Rajasthan	0.5 – 5.8 mg/l	Hussain et.al. (2013) [81]
Faridabad , Haryana	1.0 – 40 mg/l	Garg & Singh; (2013) [82]
Chittoor District	0.2-2.75 mg/l	Lakshmi (2013) [83]
Vinukonda Mandal of Guntur District, Andhra Pradesh	3.28-4.27 mg/l	Suneetha et. al. (2014-15) [84]
East coastal region from Rameshwaram to Thiruvanmiyur, Tamil Nadu	0.02-1.54 mg/l	Umari & Ramu (2014) [85]
Some villages of West Bengal	1.08-1.75 mg/l	Datta et. al. (2014) [86]
Haryana	3.0-6.0 mg/l	Gupta & Mishra (2014) [24]
Devli Tehsil of Tonk district, Rajasthan	0.2-15.8 mg/l	Agarwal & Chauhan (2014) [87]
Rajasthan	1.0-6.0 mg/l	Jain & Singh (2014) [88]
Gaya district, Bihar	0.6-2.5 mg/l	Ranjan & Yasmin (2015) [89]
Palamu and Garhwa, Jharkhand	0.14-6.98 mg/l	Kumari et. al. (2015) [90]
Kalwakurthyarea, Mahabubnagar District, Telengana	0.16-3.4 mg/l	Ravikanth et. al. (2015) [91]
Five blocks of Kishanganj district, Bihar	0.61-3.74 mg/l	Kumar & Kumar (2015) [92]

HEALTH EFFECTS OF FLUORIDE

The vicinity of fluoride in the drinking water may be useful or perilous to every single leaving creatures, animals and plants relying upon its concentration, amount of indigestion and time of exposure. The fluoride is an essential for human body for the improvement of teeth by hardening the enamel, security against tooth decay and densification of bones when present in allowable farthest point (0.4 – 1.0 mg/l) [93] yet unnecessary intake of fluoride reasons dental fluorosis, skeletal and non-skeletal fluorosis and different issue. The fluoride is more attracted towards calcium because of its most electronegative nature.

Henceforth impact of fluoride on teeth and bone are more critical because of vicinity of calcium and deposited as calcium fluorapatite crystals prompting the formative adjustments. Tooth enamel is made chiefly out of crystalline hydroxyapatite. The ingestion of fluoride containing water prompts the fuse of fluoride ion into the apatite crystal lattice of calciferous tissue enamel its development. The hydroxyl ion gets substituted by fluoride ion since fluorapatite is more steady than hydroxyapatite. In this manner, a lot of fluoride gets bound in these tissues and just a little amount is discharged through sweat, pee and stool.

The strength of fluorosis is not just reliant on the fluoride content in water, additionally relies on upon other source, physical activity and dietary habits. The different types of fluorosis emerging because of intemerate intake of fluoride are indicated in Table 3.

Table 3 – Biological Effects by fluoride [94]

Concentration of Fluoride	Medium	Effects
0.002	Air	Injury to vegetation

< 1.0	Water	Dental carrier reduce
1.0 – 3.0	Water	Dental fluorosis (discoloration, mottling and pitting of teeth
3.0 – 4.0	Water	Stiffened and brittle bones and joints
4.0 – 6.0 and above	Water	Deformities in knee and hip bones and finally paralysis making the person unable to walk or stand in the straight posture, Crippling Fluorosis
500	Food and Water	Thyroid changes
100	Food and Water	Growth retardation
120	Food and Water	Kidney changes

DENTAL FLUOROSIS

Dental fluorosis is more inclined in the youngsters upto the age of 8-10 of fluoride influenced areas where fluoride concentration is more than admissible farthest point of 1.5 mg/l. Because of intemperate fluoride intake, enamel loses its radiance. The gentle type of dental fluorosis is described by white, opaque areas on the tooth surface while in extreme structure yellowish brown to black stains and severe pitting of teeth are showed up. The grown-ups are likewise get influenced by dental fluorosis however the harm appearance are not visible when contrasted with milk teeth. Table 4 demonstrates the predominance of dental fluorosis.

Table 4 : Prevalence (%) of dental fluorosis in different parts of India by age groups

State/Area	Age group (Years)	Prevalence (%)	Author
Alapuzzha, Kerala	10-17	35.6	Gopalakrishnan et.al. (1999) [95]
Assam	All ages	31.3	Chakraborti et. al. (2000) [96]
Davangere region of South India	12-15	16 – 100	Acharya et. al. (2005) [97]
Raigad, Maharashtra	0-23	91.7	Bawaskar and Bawaskar (2006) [98]
Villages of North-Western district, Tamil Nadu	5-14	42.0	Kumar et. al. (2007) [99]
Cuddalore, TN	5-12	31.4	Savannah et.al. (2008) [100]
Palamau Jharkhand	children	83.2	Srikanth et. al. (2008) [101]
Kanyakumari, Tamil Nadu	11-15	15.8	Baskaradoss et. al. (2008) [46]
Jhajjar, Haryana	7-15	30-94.9	Yadav et. al. (2009) [102]
Kaiwara, Chintamani Taluka, hickballapur district	Adults	24.0	Isaac et. al. (2009) [103]
Nalgonda, Andha Pradesh	Adults	30.6	Nirgude et al. (2010) [104]
Durg, Chattisgarh	Adults	8.2	Pandey (2010) [105]
Dungarpur, Udaipur	All ages	39.2-72.1	Choubisa et. al.

(Rajasthan)			(2010) [106]
Birbhum, West Bengal	Adults	61-66.7	Majumdhar (2011) [107]
Punjab	5-60	91.1	Shashi and Bhardwaj (2011) [108]
Raigarh, Chhattisgarh	Adults	8.0	Beg et. al. (2011) [109]
Kanyakumari district	All ages	17.32	Subramanian (2011) [110]
Panyam, Andhra Pradesh	13-15	41.0	Anuradha et. al. (2011) [111]
Uttar Pradesh	All ages	28.6	Srivastava et. al. (2011) [112]
Kareka, Shivpuri Madhya Pradesh	13-50	86.8	Saksena and Narwaria (2012) [70]
Cherapally, Nalgonda district	Adults (41-60)	28.0	Kiran & Vijaya (2012) [113]
Dausa district, Rajasthan	All ages	25.0	Yadav et. al. (2012) [114]
Nalgonda, A.P	12-15	71.5	Shekar et. al. (2012) [115]
Vadodara, Gujarat	Adults	39.2 - 59.3	Kotecha et al. (2012) [116]
Mundaragi, Gadag district, Karnataka	Adults	29.25	Shivayogimath et. al. (2012) [117]
Birdhum, West Bengal	All ages	61.0-66.70	Majumdar (2012) [118]
Sardar Teshil, Udaipur, Rajasthan	6-12	69.84	Sarvaiya et. al. (2012) [119]
Doda district, Jammu and Kasmir	All ages	76.77	Arya et. al. (2013) [120]
Chandrapur, Maharashtra	5-14	80.0	Ragini et. al. (2013) [121]
Sriperumbudur taluka, Kachipurum, Tamil Nadu	12	60.60	Prabhu et. al. (2013) [122]
Chittor district	7-9	2-12	Lakshmi (2013) [83]
Jaipur, Rajasthan	5-16	34.50	Gupta et. al. (2013) [123]
Purulia district, West Bengal	Adults	18.26	Mujumdar & Sundarraj (2013) [124]
Chhatisgarh	All ages	21.40	Gitte et. al. (2014) [125]
Ananthapuram	7-15	33.80	Rani & Kusuma (2014) [126]
Bommireddy palli & Kasipuram, Prakasam District, Andha Pradesh	Adults	70.5 & 59.0	Basha & Rao (2014) [127]
Salem district, Tamil Nadu	11-17	30.80	Ramesh et. al. (2014) [128]
Nalgonda district	12-15	76.80	Sukhabogi et. al.

			(2014) [129]
Himachal Praesh - Northern hilly state	5,9,12	41.0	Chauhan et. al. (2015) [130]
Kishanganj, Bihar	Adults	53.60	Kumar and Kumar (2015) [92]

SKELETAL FLUOROSIS

The skeletal fluorosis in intense to endless structure has happened because of draw out intake of fluoride contaminated water with concentration more than 3 – 6 mg/l. The disabling skeletal fluorosis may happen in individuals who have ingested 10 to 20 mg of fluoride for every day more than 10 to 20 years. India and China has been great extent influenced by disabling skeletal fluorosis, 2.7 million individuals were influenced in China and 6 million individuals have been suffered from skeletal fluorosis in India. The significant source of fluoride bringing about skeletal fluorosis originates from ground water, blazing of coal and different industrial activities. It influences the people as well as creatures encouraged with fluoride rich water and fodder. Skeletal fluoride spread among youngsters and grown-ups with same side-reactions. Additionally harmed the foetus – if mother devoured fluorinated water and foods amid pregnancy or breast feeding, newborn child mortality because of calcification of blood vessels can likewise happens.

Fluoride for the most part gets kept in the joints of neck, pelvic and shoulder bones and makes it hard to move or walk. The side effects of skeletal fluorosis are like spondylitis or arthritis. Early indications incorporates sporadic pain, burning like sensation, pricking and tingling in the limbs, muscle weakness, chronic fatigue, abnormal calcium deposits in bones and ligaments. The propelled stage is osteoporosis in long bones and bony outgrowths may happen. Vertebrae may combine and inevitably the casualty may be disabled. It may even prompt an uncommon bone cancer; osteosarcoma and lastly spine, significant joints, muscles and nervous system get harmed [94,131]. Table 5 demonstrates the commonness of skeletal fluorosis.

Table 5: Prevalence (%) of skeletal fluorosis in different parts of India by age group

State/Area	Age group (Years)	Prevalence (%)	Author
Assam	Adults	1.74	Chakraborti et al. (2000) [96]
Mundagari taluk Dharwad district, Karnataka	All Ages	5.45	Bharati & Rao (2003) [132]
Bihar, India	1-5	20.0	Khandare et al. (2005) [133]
Villages of North-Western district, Tamil Nadu	5-14	42.0 – 53.0	Kumar et. al. (2007) [99]
Palamau, Jharkhand	Adults	47.4	Srikanth et al. (2008) [101]
Central Rajasthan	Above 21	28.33	Hussain et. al. (2010) [134]
Nalgonda, Andhra Pradesh	All ages	24.9	Nirgude et al. (2010) [104]
Durg, Chattisgarh	Adults	6.3- 38.1	Pandey (2010) [105]
Dungarpur and Udaipur Rajasthan	All ages	12-27.6	Choubisa et al. (2010) [106]
Birbhum, West Bengal	Adults	4.8-23.8	Majumdhar (2011) [107]
Uttar Pradesh	All ages	14.2	Srivastava et al. (2011) [112]
Kareka, Shivpuri	13-50	39.2	Saksena and Narwaria

Madhya Pradesh			(2012) [70]
Cherapally, Nalgonda district	Adults (41-60)	21.0	Kiran & Vijaya (2012) [113]
Villages of Chandrapur district, Maharashtra	All ages	31.15	Dhawas et. al. (2013) [135]
Villages of Kankar district, Chhattisgarh	All ages	6.0	Gitte et. al. (2014) [125]
Nelakondapally Mandal of Khammam district, Andhra Pradesh	6-54	13.70	Shanti et. al. (2014) [136]
Kishanganj, Bihar	Adults	11.20	Kumar and Kumar (2015) [92]

NON-SKELETAL FLUOROSIS/OTHERS PROBLEMS

Aside from dental and skeletal fluorosis, other wellbeing's issues happen because of wxorbitant utilization of fluorides from different sources is muscle fibre degeneration, low haemoglobin levels, disfigurements in RBCs, unreasonable thirst, migraine, skin rashes, nervousness, neurological sign, depression, gastrointestinal issues, urinary tract failing, nausea, abdominal pain, tingling sensation in fingers and toes, reduced immunity, repeated abortions or still births, male sterility, and so on. Fluoride additionally influences or changes the functional mechanism of liver, kidney, digestive system, respiratory and excretory system, central nervous system, reproductive system and destruction of around 60 enzymes.

The protestations with the G-l system in endemic ranges are presently settled as ahead of schedule cauting indications of fluoride poisonous quality. Fluoride is known not with hydrochloric acid of the stomach and is changed over to hydrofluoric acid. Hydrofluoric Acid is exceptionally destructive and henceforth the stomach and intestinal lining (mucosa) is annihilated with loss of microvilli [136,137].

It is presently realized that when fluoride is ingested, it will likewise gather on the erythrocyte membrane, which thus looses calcium content. This change causes development of echinocytes. The life span of these echinocytes is not exactly the typical life span of RBC, and subsequently early demolition of the RBCs as echinocytes reasons iron deficiency [138].

Fluoride in abundance anyplace in an biological community has been indicated to have conceivably unsafe impacts on the body systems. Each of the three parts of bone and teeth that is collagen, proteoglycans and calcium are unfavorably influenced by ingestion of high amount of fluoride for delayed span [139,140]. The net consequence of this prompts corruption of collagen and ground substance in bones and teeth and along theses lines prompts side of fluorosis like, delayed eruption of teeth, dental fluorosis, clinical fluorosis, premature aging and so on [141].

In view of the adjustments in ground substance because of high fluoride intake, elevated content of glycosaminoglycans (Mucopolysaccharides - synonymous with the term "Seromucoid" utilized by Winzler) [142] in bone and its reflection in serum is appearance is serum is considered as a file to evaluate fluoride harmfulness and fluorosis at ahead of schedule stages [139,143].

Conclusions

The nature of drinking water is critical for open security and the personal satisfaction [144,145]. The tainting of drinking water with fluoride ions is a genuine wellbeing issue, particularly in parched and semi-dry zones where geography gives wellsprings of fluoride ions. India is drastically concerned by fluorosis. In Gujrat around 18 districts are confronting fluoride threat. Mehsana, Patna and Banaskantha districts are most fluoride influenced districts separated from Amreli, Ahmedabad, Sabarkantha and Baroda. The populance of these areas are experiencing dental and skeletal fluorosis. Fluoride in overabundance anyplace in a biological system has been demonstrated to have possibly unsafe consequences for the body systems. A lot of fluoride gets bound in these tissues and just a little sum is discharge through sweat, pee and stool.

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