*International Research Journal of Environmental Sciences*_____ ISSN 2319–1414
Vol. **13(2),** 29-35, April **(2024)** *Int. Res. J. Environmental Sci.*

Review Paper

A Review on optimization of Human Body Fluoride

Himanshu Vashistha[1*], Amit Kumar Agarwal[2] and Anshul Agarwal[3]
[1]Department of Biotechnology, Agra College, Agra, UP, India
[2]Department of Chemistry, Agra College, Agra, UP, India
[3]Department of Applied Science (Chemistry), FET, Agra College, Agra, UP, India
[1,2]Dr. Bhim Rao Ambedkar University, Agra, UP, India
himanshuvashistha001@gmail.com

Available online at: www.isca.in, www.isca.me
Received 23rd September 2023, revised 30th December 2023, accepted 19th January 2024

Abstract

*This review paper studies balanced and unbalanced fluoride effects towards health and therapeutic methods. Excessively fluoridated water is harmful to the current residential society worldwide. In drinking water, fluoride is added mainly due to the activities of biotic and abiotic factors. World Health Organization has an upper limit of 1.5 mg/litre fluoride in drinking water for several countries such as India, China, Australia, Canada and the European Union. As we all know, India is a developing country with an incredible biodiversity and geographical region. So, India has set standards according to its circumstances, and different countries have set standards according to their circumstances. The presence of fluoride ions in drinking water causes several other issues like arthritis, fatigue, muscle damage, skeletal Fluorosis, dental Fluorosis, joint and chronic, etc. In extreme cases, it primarily damages essential organs such as kidneys, arteries, heart, liver, neuron system, and endocrine glands. Some prominent states of India have a wide range of fluoride in the groundwater, like – Uttar Pradesh, Madhya Pradesh, Rajasthan, Gujarat, Andhra Pradesh, Bihar etc. Here we are studying the occurrence, nature, and disease caused by excessive fluoride and the prevention of fluoride. Groundwater is a significant source of Fluorosis in rural areas. **In** this review paper, there is some method to improve this situation with some easy steps. Remediation technology is not readily achievable in India because of the lack of infrastructure in rural areas and some cities. Prevention and a nutritional diet are better options for this situation. Due to high cost and maintenance, remediation is not possible on a large scale in India and in many developing countries.*

Keywords: Ground water, Daily fluoride intake, Prevention, Government program, unbalanced fluoride, fluoride removal, health effect.

Introduction

Fluoridation began as an observation that was shortly shaped as an idea. Five decades later, it ended as a scientific course that hit dentistry at the forefront of preventive therapy. Dental science discovered and finally proved that Fluoride, a mineral found in rocks and soil, prevents tooth decay[1]. An inorganic, monatomic anion of fluorine is known as Fluoride. Which is represented by the chemical formula F− (also written [F]−), which has salts typically white or colorless. The salts of Fluoride typically have distinctive bitterness in their taste and are odorless. Its salts and minerals are essential chemical reagents and industrial chemicals, mainly used in producing hydrogen fluoride for fluorocarbons. It is classified as a weak base since it is only partially associated with the solution. However, concentrated Fluoride is corrosive and can damage the skin. Fluoride is the simplest fluorine anion. Regarding charge and size, the fluoride ion resembles the hydroxide ion. Fluoride ions occur on Earth in several minerals, particularly fluorite, but are present only in trace quantities in bodies of water in nature[2].

Occurrence: In the Earth's crust, fluorine is estimated to be the 13th most abundant element and is widely dispersed in nature, simply in the form of fluoride. Most fluorides are in mineral deposits, and CaF_2 (Fluorite) is essential for commercial purposes. Human activities and weathering of rocks put fluorine in the biosphere. In urban areas, fluoride's natural presence is found in the groundwater, fresh, saltwater and rainwater. Seawater shows fluoride levels usually between 0.86 to 1.4 mg/L and an average of 1.1mg/L. In comparison, chloride concentration in seawater is about 19g/L. The low fluoride concentration reflects the insolubility of the alkaline earth fluorides, e.g., CaF_2. Concentrations in freshwater vary more significantly. Surface water, like rivers or lakes, generally contains between 0.01 and 0.3mg/L. Groundwater (well water) concentrations differ even more depending on local fluoride-containing minerals. In some parts of Asia, the groundwater can contain dangerously high fluoride levels, leading to serious health problems as plants absorb water and the mineral in them. That's why all vegetation includes some amount of fluoride. Some plants extract and concentrate fluoride from their environment more than others. Young and mature tea leaves of the same plant contain different amounts of fluoride. Mature leaves contain 10 to 20 more than young leaves[3].

Cavity prevention: The compounds which contain fluorides, such as sodium fluoride or sodium monofluorophosphate, are used in fluoride therapy to prevent tooth decay. These chemicals are used in many oral hygiene products along with water fluoridation. Initially, sodium fluoride was used to fluoridate water; hexafluorosilicic acid (H_2SiF_6) and its salt sodium hexafluorosilicate (Na_2SiF_6) are more commonly used additives, especially in the United States. Water fluoridation is known to prevent tooth decay[4]. It is considered by the U.S. Centers for Disease Control and Prevention to be "one of 10 great public health achievements of the 20th century". In some countries with uniquely large, centralized water systems, fluoride is delivered to the public by fluoridating table salt for cavity prevention. Fluoridated toothpaste is in everyday use. Some analysis shows the efficacy of 500ppm fluoride in toothpaste. However, no beneficial effect is detected when more than one fluoride source is used for daily oral care[5].

Estimated daily intake of fluoride: Everyday fluoride intake can range wildly according to the different sources. Generally, the values of 0.46 to 3.6–5.4mg/day have been reported in several studies[6]. Fluoride is also naturally present in nearly all foods and beverages at different concentrations[7]. According to the U.S. and European Union, the maximum safe daily fluoride consumption for adults is 10mg/day and 7mg/day, respectively. For infants, toddlers, and children up to 8 years old, the upper limit is set at 0.10mg/kg per day. For older children and adults, the upper limit of fluoride is set at 10 mg/day[8,9]

Some Daily Consumables Food Products *mg/Day*			Adult *Max 10mg/ Day*		Older children 7mg/ day		Infants, Toddlers, Children Upto 8 Years *Max 0.010 mg/Day*	
	1 Kg	250 g						
Carrot	4.1	1.025	✓	✓	✓	✓	X	X
Potato	2.8	0.11	✓	✓	✓	✓	X	X
Tomato	3.4	0.85	✓	✓	✓	✓	X	X
Spinach	2	0.5	✓	✓	✓	✓	X	X
Wheat	4.6	1.15	✓	✓	✓	✓	X	X

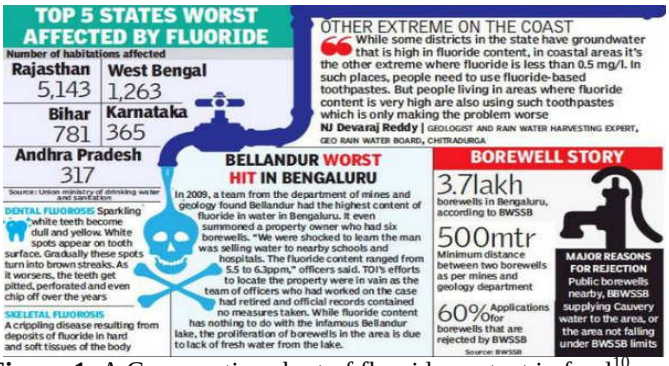

Figure-1: A Comparative chart of fluoride content in food[10].

Figure-2: This picture shows the situation of states affected by fluoride[11].

Higher Rate of Fractures: An analysis of older persons who lived in locations with and without fluoridated water in 1992 looked at the number of fractures. They were detected with a slight but significant increase in the risk of hip fracture in both men and women subjected to artificial fluoridation at 1 ppm, suggesting that even low fluoride levels may raise the risk of hip fracture in older people[14]. An additional trial from 2000 revealed that fluoride did not protect against vertebral fractures and that higher fluoride dosages were linked to a higher risk of non-vertebral fractures and gastrointestinal adverse effects[15].

Equivalent Rates of Fracture: In 1998, German researchers found that consuming fluoridated water did not affect the bone mineral density and may even reduce hip fractures caused by osteoporosis in adults over 85.Researchers examined 1,300 women in 3 small areas with fluoridated water in a more recent study conducted in 2006. They concluded that long-term fluoride exposure did not indicate a connection with bone mineral density or the risk of bone fracture[15].

The Relationship between Fluoride, Bone Density and Bone Strength: In general, fluoride reduces the density of cortical bone, but it increases the density of trabecular bone (also known as cancellous bone). There are two primary bones in the body the trabecular bone in the spine and the cortical bone in the legs and arms. Fluoride does not significantly increase bone strength, despite increases in bone mass. Some human clinical trials and animal studies have found that increased trabecular bone density induced by fluoride does not improve bone strength because fluoride-induced bone mass has an abnormal, inferior quality that fails to protect normal bone. A higher risk of skeletal stiffness and pain is also linked with fluoride-induced bone mass[17].

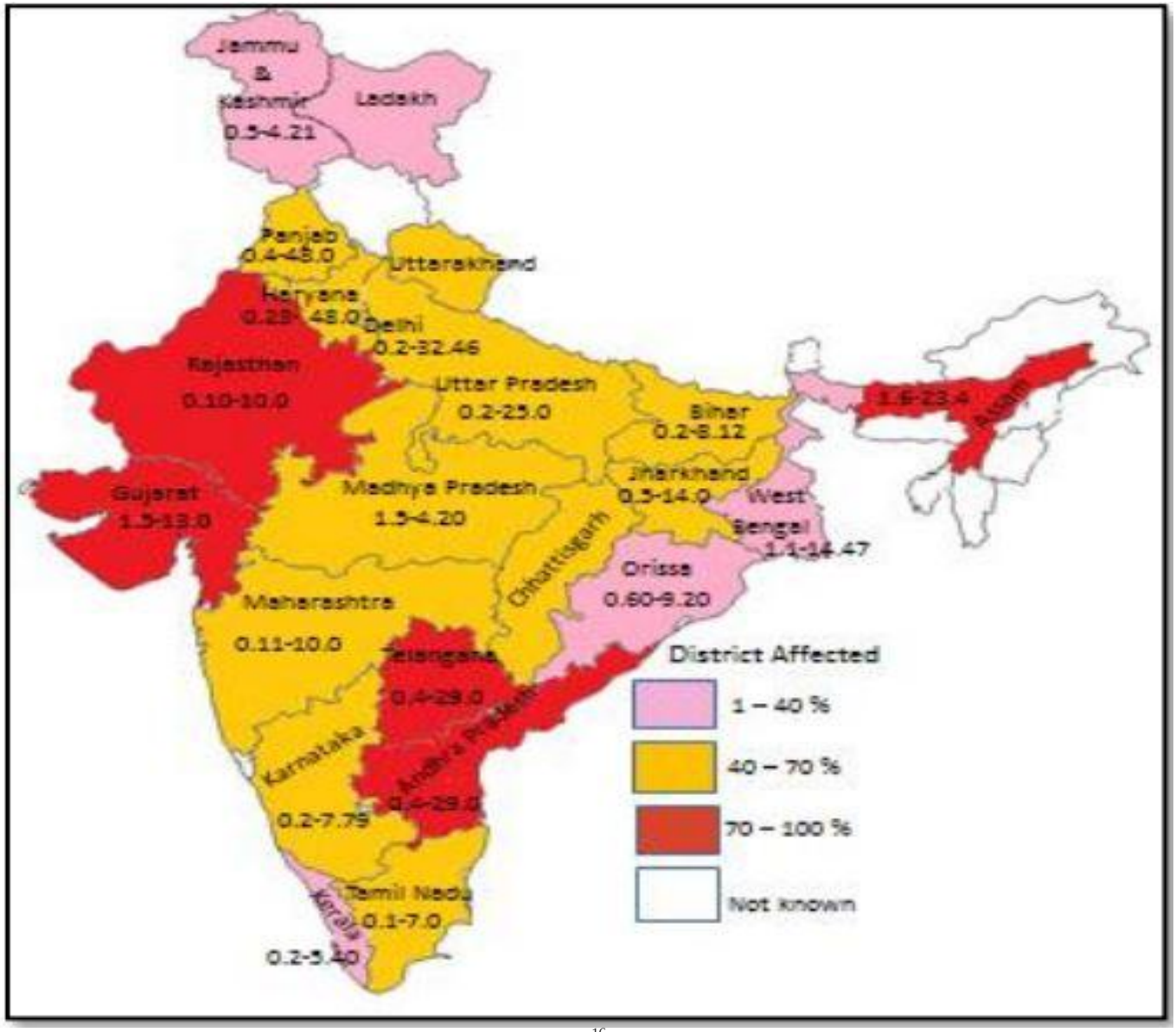

Figure-3: This picture shows children having skeletal Fluorosis[16].

Fluorosis in India: India has been dealing with Fluorosis for about 85 years now. In the sites of Nellore district of Andhra Pradesh and Madras Presidency, excess fluoride in groundwater and the prevalence of Fluorosis were discovered during British rule in India[18]. In recent years increases in the level of fluoride have been reported in several Indian states, indicating that Fluorosis might emerge as an endemic. Commoners living near the fluoride-contaminated zones are at constant high risk of developing Fluorosis, like the village Patti Pachgain of Agra, Uttar Pradesh. The limit of fluoride set up by The Bureau of Indian Standards [BIS] is 1 ppm or 1mg/L. The lesser, the better. Even the slightest increase in the level of fluoride can cause health problems. In India, even the slightest change of 0.5mg/L fluoride can cause Fluorosis; therefore, 1.0mg/L is the upper limit.

To date, 48mg/L of fluoride has been discovered in water sources, but there is a possibility of a higher level of fluoride in the water sources that commoners do not use[19]. The map of India shown here is the compilation of information by UNICEF, India to enable record of the endemicity of Fluorosis disease[19].

With 28 States and 8 Union territories, each state and territory have two records of minimum and maximum Fluoride concentration in water sources. Naturally, safe and unsafe water sources co-exist, but the community needs to be made aware of the safe and unsafe sources. The usage of unsafe sources should be less or should not be used in agriculture, food preparation, drinking purposes, etc[19].

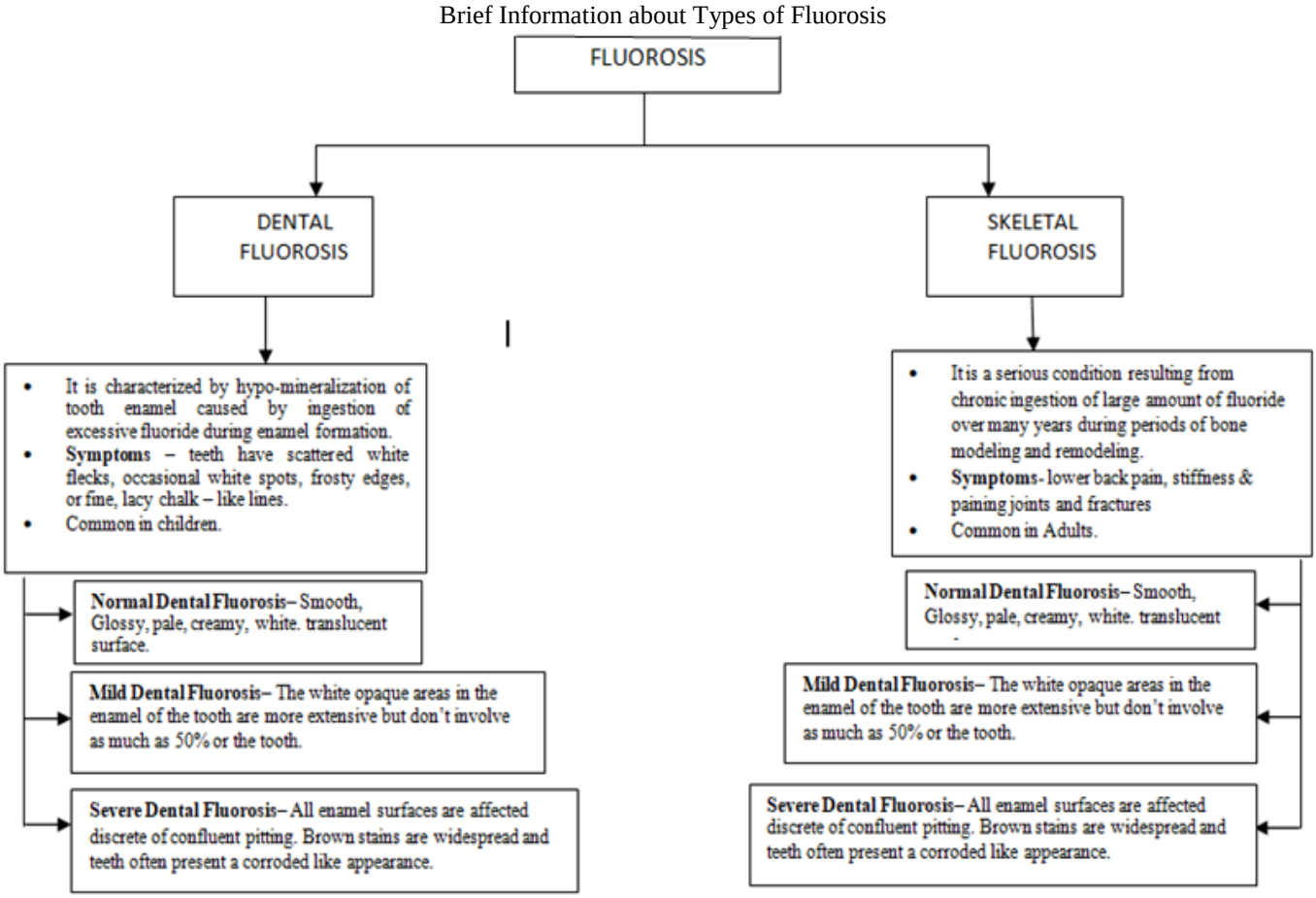

Figure-4: Map of India showing in endemicity of Fluorosis[19].

Figure-5: This picture shows different conditions of dental Fluorosis form normal to Severe[30].

Conventional forms of Fluorosis and their Diagnoses: As we talk about Fluorosis, there are two types of conventional Fluorosis, i.e. Dental & skeletal Fluorosis. Another form of Fluorosis also appears as a 'linked disorders'[20]. When we look towards Fluorosis, we find that dental Fluorosis gives a primary indication of Fluorosis, like the discoloration of teeth which happens mainly on the enamel surface. It occurs in the permanent teeth as the enamel starts hypomineralized by excessive fluoride during mineralization. Discoloration of teeth has been seen in children around 8 years and above, all because of excessive fluoride intake[21].

The discoloration is easily visible to the naked eye. As a matter of fact, dental Fluorosis only occurs in children; in some adults, dental Fluorosis is present due to their childhood exposure to excessive fluoride. The visual forms of Dental Fluorosis are mainly Yellowish, Brownish or Black spots or horizontal streaks on the teeth. Over time the enamel may become pitted, rough and hard to clean. And eventually, this becomes permanent. The commonly affected teeth are: Central incisors Lateral incisors Molars of the permanent dentition[22].

Dental Fluorosis in Children: Most human babies develop their teeth around 6-12 months; on average, a child develops its full set of 20 Milk teeth by the age of 3 years. Then the milk teeth start converting or developing into permanent teeth. Around the age of 8 years, this development takes place. This transitioning phase gives an opening to dental Fluorosis during the age of teeth development if a child comes in contact with sources of excessive Fluoride like contaminated water, fluoridated toothpaste, etc[22,26]. In children, dental caries is seen most often; for prevention of dental caries, WHO recommends that toothpaste should consist of around 1000ppm of Fluoride but not more than 1500ppm of Fluoride for the prevention of fluoride toxicity. While brushing their teeth, children should take care not to swallow the slurry and not use large amounts of toothpaste[23]. Children of age first tooth - 2 years should use rice grain size amount, children aged 2-6 should use pea size and over 6 years should use the full length of the brush[24]. Most people confuse dental

Fluorosis with some cosmetic problem, but it is far more severe than it looks once it sets its feet, then there is no going back. Due to scientific advancements, dentists can change teeth' appearance to their natural state through various treatments[25]. Excessive intake of Fluoride degrades the quality of teeth, but long-term intake of Fluoride can make you helpless and lead to a crippling disorder, i.e. skeletal Fluorosis[26].

Skeletal Fluorosis: High exposure for a long time of fluoride causes skeletal. It is a metabolic bone disease that is only easily recognizable once it reaches an advanced stage. The accumulation of fluoride causes it. It is seen in children and adults, generally related to chronic exposure to fluoride by different means like contaminated groundwater, daily food products, etc. Various studies found that in skeletal Fluorosis, the bones become generally weaker than usual. Commonly or early-found symptoms are stiffness and pain in joints. Skeletal Fluorosis also affects the joints of hands and feet. Muscles are impaired in severe cases, and bones in the central skeleton are irregularly thickened. Malnutrition plays a critical role in skeletal Fluorosis. Skeletal Fluorosis is a big challenge, becoming endemic in developing countries[26].

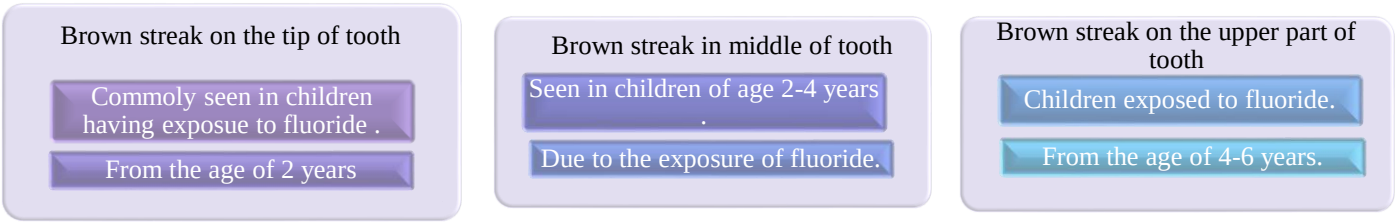

Figure-6: Dental Fluorosis in Children.

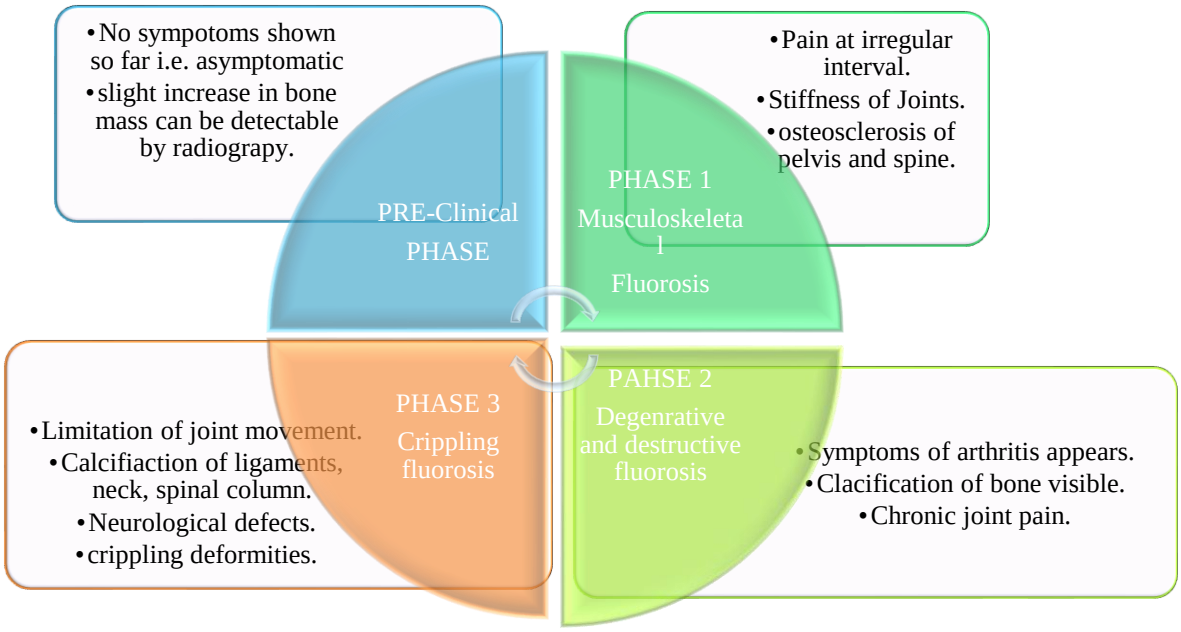

Figure-7: Skeletal Fluorosis.

Fluorosis Prevention: As one said, prevention is better than cure. In the case of Fluorosis, this statement fits without argument. Fluorosis is recoverable on early detection. Prevention can be achieved by simple methods and interventions like having a Diet for withdrawal of Fluoride consumption, Counseling for promoting all nutrients, vitamins, antioxidants and minerals in a diet, making water safe for drinking and having knowledge about the nutritional values of food[27,28].

Action Involve in Making, Drinking Water Safe: India has been dealing with the problem of Fluorosis for a very long time because of a lack of awareness. The sources of safe and unsafe water exist together in India on a large scale; identifying them can make it easy to prevent Fluorosis. The safe water source should be used for only drinking and cooking purposes, and the unsafe can be used for washing clothes, bathing, etc. Some steps for identification of these sources by the commoners. Wells or Hand pumps with safe and unsafe water should be marked as: Safe for drinking and cooking purposes should be marked by a green circle. A red circle should mark unsafe water sources. As it is not fit for drinking, it can be used for other household purposes. If the water of a particular area is entirely unsafe. Try to get water form a source where fluoride concentration is a low as possible. Mix the high-concentration fluoride water with low-concentration fluoride water in an appropriate amount. So, water can become consumable. Harvest water from the rain. Boil it, then consume. If the method mentioned above doesn't work or doesn't give desired results, then use defluoridationas defluoridation produces a certain amount of sludge with high concentration of fluoride, so the sludge must be disposed of properly.

Sources of Some Nutrients: Taking the appropriate amount of nutrients makes the human body healthy and can prevent and control Fluorosis to some levels. Intake of vitamin C, vitamin E, Calcium and antioxidants are some common nutrients used and prescribed in preventing and controlling Fluorosis[27-29].

Sources of these Nutrients: Vitaminc - lemon, oranges, tomato, green leafy vegetables, pulses, etc. Vitamin E - Vegetable oil, nuts, whole grain, cereals, dried beans, etc. Calcium- Milk, yogurt, cheese, other milk products, etc. Antioxidants - garlic, ginger, carrot, green banana leaf, papaya, pumpkin, etc.

Conclusion

In India, water contaminated with fluoride is causing health problems. We have studied occurrence, daily estimated intake and different diseases caused by fluoride in this review paper and how to solve the issues of high concentrations of fluoride ions in drinking water. Every state of India has a different level of fluoride, affecting commoners' lives. Through our research, by using some simple steps, we will be able to provide a better life to society at a low cost so that our community can get maximum benefit.

Acknowledgement

The review paper has been made with the help of Principal Dr. Anurag Sharma and HOD Biotechnology Department Dr. Sandhya Agarwal, Agra College, Agra and Devendra Singh.

References

1. NIH NIDCR (2023). The Story of Fluoridation. https://www.nidcr.nih.gov/health-info/fluoride/the-story-of-fluoridation. 14 April 2023.

2. Wells, J. C. (2008). Longman pronunciation dictionary (3rd ed.). Harlow, England: Pearson Education Limited/ Longman. p. 313. ISBN 9781405881180.

3. Brindha, K., & Elango, L. (2011). Fluoride in groundwater: causes, implications and mitigation measures. Fluoride properties, applications and environmental management, 1, 111-136.

4. NIH (2023). Fluoride: Health Professionals. https://ods.od.nih.gov/factsheets/Fluoride-Health Professional. 18 APRIL 2023

5. Centers for Disease Control and Prevention (2013). Ten great public health achievements in the 20th century. *Centers for Disease Control: Atlanta*, GA.

6. Fawell, J. K. (2006). Fluoride in drinking-water. World Health Organization.

7. Shirmohamadi, A. (1994). Agricultural Research Service, United States Department of Agriculture. Research and development of controlled release formulations of pesticides, 139.

8. Standing Committee on the Scientific Evaluation of Dietary Reference Intakes. (1999). Dietary reference intakes for calcium, phosphorus, magnesium, vitamin D, and fluoride.

9. Levy, S. M., & Guha- Chowdhury, N. (1999). Total fluoride intake and implications for dietary fluoride supplementation. *Journal of public health dentistry*, 59(4), 211-223.

10. Ghosh, S., & Ghosh, D. (2019). Impact of fluoride toxicity on freshwater fishes: A mini-review. *International Journal of Advance Research and Innovation*, 6(2), 13-18.

11. Times of India (2023). Sunitha Rao R. Bengaluru with-365 affected habitations Karnataka is 4th worst Fluoride-Contaminated State. https://timesofindia.indiatimes.com/ city/bengaluru/with-365-affected-habitations-karnataka-is-4th-worst-fluoride-contaminated-state/articleshow/ 68249606.cms. 04 MAY 2023

12. Phipps, K. (1995). Fluoride and bone health. *Journal of Public Health Dentistry*, 55(1), 53-56.

13. Blank, T., Network, F. A., & Canton, N. Y. (2011). Paul Connett, Ph. D. Ellen Connett Michael Connett Chris Neurath.

14. Danielson, C., Lyon, J. L., Egger, M., & Goodenough, G. K. (1992). Hip fractures and fluoridation in Utah's elderly population. *Jama*, 268(6), 746-748.

15. KR, P. (2000). Community water fluoridation, bone minaral density, and fractures: prospective study of effects ion older women. BMJ, 321, 860-864.

16. Suresh Jangir (2023). Posts Index Hans Classroom. https://www.thehansindia.com/posts/index/Hans-Classroom/2018-03-07/Fluorosis/364047. 07 MAY2023

17. Martel, D. M. (2003). Re: Toxicologic Risk of Fluoride in Drinking Water; BEST-K-02-05-A.

18. Shortt, H. E., Pandit, C. G., & Raghavachari, R. S. T. (1937). Endemic fluorosis in the Nellore district of South India. *The Indian Medical Gazette*, 72(7), 396.

19. Dahi, E., Rajchagool, S., & Osiriphan, N. (2000). The state of art of small community defluoridation of drinking water. In *3rd International Workshop on Fluorosis Prevention and Defluoridation of Water, Chiang Mai, Thailand* (pp. 141-170).

20. Susheela, A. K. (2020). Treatise on fluorosis and linked disorders.

21. Molina-Frechero, N., Nevarez-Rascón, M., Nevarez-Rascón, A., González-González, R., Irigoyen-Camacho, M. E., Sánchez-Pérez, L., ... & Bologna-Molina, R. (2017). Impact of dental fluorosis, socioeconomic status and self-perception in adolescents exposed to a high level of fluoride in water. *International journal of environmental research and public health*, 14(1), 73.

22. Beltrán-Aguilar, E. D., Griffin, S. O., & Lockwood, S. A. (2002). Prevalence and trends in enamel fluorosis in the United States from the 1930s to the 1980s. *The Journal of the American Dental Association*, 133(2), 157-165.

23. World Health Organization. (2019). Preventing disease through healthy environments: inadequate or excess fluoride: a major public health concern (No. WHO/CED/PHE/EPE/19.4.5). World Health Organization.

24. Toumba, K. J., Twetman, S., Splieth, C., Parnell, C., Van Loveren, C., & Lygidakis, N. A. (2019). Guidelines on the use of fluoride for caries prevention in children: an updated EAPD policy document. *European Archives of Paediatric Dentistry*, 20, 507-516.

25. Shimazu K, Ogata K, Karibe H. (2013). Evaluation of the caries-preventive effect of three orthodontic band cements in terms of fluoride release, retentiveness, and microleakage. *Dental Materials Journal*, 32(3), 376-80.

26. Susheela, A. K. (2007). A Treatise on Fluorosis (Revised 3rd Edition). *Fluorosis Research & Rural Development Foundation, New Delhi*.

27. Susheela A. K. (1994). Studies on some aspects of Fluorosis in Recent Trends in Nutrition. Edited by C. Gopalan. Oxford Univeristy Press, 143 - 157.

28. Susheela A. K. (2015). Fluorosis mitigation: guidelines for program execution for policy makers, health administrators and doctors.

29. Susheela, A. K. (2016). Healthy life in an era with diseases. *New Delhi, India: Fluorosis Research & Rural Development Foundation*.

30. American academy of Pediatrics (2023). What is Fluorosis. https://ilikemyteeth.org/ what-is-fluorosis.26 May 2023.