Review Article

Scoping Review of Dubious Journey of Flourosis in India: The Situation Analysis in Telangana and the Encounter so Far

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Abstract

This study aimed to do a situation analysis of Telangana and systematically map the research done in the area of fluorosis and its health risks. Identify existing gaps in the available literature and unsheathe the challenges and threats in the progress so far among the people living in fluorine-contaminated zones in India. After weighing our research question, we adopted an iterative process for our search strategy by including electronic databases. A quality check was performed and guided as per the Preferred Reporting Items for Systematic reviews and Meta-Analyses–scoping review (SCR) for SCRs which included details of the study type, setting, bias, funding, etc. It was found that out of the 15 studies summed up, most of them (>95%) had been conducted in South India. Nearly 27% of the studies were trials or experimental studies, 20% were studies involving groundwater sample testing, and few were *in vitro* studies. Nearly 26% were conducted on animals to see for interventions. With a total of 12,382 habitat affections, we found that Rajasthan had the highest fluoride habitation. There was a need to focus more on the seemingly less important. Many programs in India focus on risk assessment and healthy behavior. Although population affection as depicted by the Indian data statistics from the department of drinking water and sanitation show values as low as 0.01% affection for a few endemic states, they scale up to include and paralyze the lives of a lot many people in the 1.3 billion nations. At a cost, where these lives can be saved from living in suffering, what we need is mere pro-activeness, being responsible, integrating methods to tackle, using local methods to prevent, adequate nutrition, and rehabilitation.

Keywords: Contamination, fluorosis, rehabilitation, risk assessment, water and sanitation

Introduction

Groundwater fluoride contamination has been a global issue for a long. The quality of water underground is rapidly undergoing immense alterations due to enhanced anthropogenic activity, which is the right away affecting the health of people who use it for drinking. Fluorite (CaF_2) is the principal mineral occurring in nature and since fluorine element is highly reactive, it causes deadly epidemics affecting millions.[1,2] In India, where 68% of people are rural-based, a large proportion migrates each year to cities in hopes of a better future, education, and living. This gives rise to a battle of accession for water, space, sanitation, ventilation, food, and other cardinal requisites. When fundamental privileges are at stake, the other pillars for education, housing, earning, etc., start dwindling and become a part of the vicious trap. This shift from an apparent place of abundance to a society of struggles for basic living standards creates a K-shaped discrepancy between the affluent and indigents.

With 200 million affected across 28 nations, it is a global health pandemic lurking to pounce.[2,3] This proclamation that more than 200 million people across the globe are at risk of fluorosis, raises a global alarm and concern which needs immediate address.[4] Those industries dealing with fertilizers, drugs, aluminum, ore, metal electroplating, steel, and nuclear activities use excessive amounts of fluoride-containing compounds.[5] The fluorine toxicity builds up in the human body through foodstuffs, drugs, water, cosmetics, etc. However,

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among these, drinking water is the single main route of daily intake.[6] Low amounts of fluoride are necessary for humans and other animals for tooth and bone development. It is particularly necessary for infants and young children below 8 years old when present within acceptable ranges.[7] Long-term intake of high levels of fluoride in drinking water (above 8 mg/L daily) can result in skeletal and dental fluorosis. These problems are more severe, especially in warm and dry climates where drinking water contains excessive amounts of fluoride.[8] In recent years, this has become more problematic, since people migrate to cities in hope of better and end up staying in deficit with the already exhausted source. Human health risk assessment forms an important tool to potentially estimate the harmful effects on human health.[9-11]

The first report in 1937 in the state of Andhra Pradesh mentioned the plight and Telangana state, now, is considered to be endemic to the problem.[12] Statistics quoted figures as high as 40 million sufferers due to dental fluorosis.[13] Excessive presence was noticed in nearly 177 districts out of 20 states, thereby affecting 65 million people and 6 million children then.[14] Several studies have been done in recent times which highlight the health risk assessment of groundwater pollution on humanity.[15-17] Narsimha and Sudarshan 2016 carried out a hydrogeochemical investigation in Siddipet, Telangana to understand the distribution of fluoride in groundwater zones. It showed that nearly 22% have more than the permissible limit responsible for the major chunk of endemic fluorosis in that area.[18] In Nalgonda district which was previously part of Andhra Pradesh, now Telangana, children present with limb deformities because of which they drop out of school, lead a hopeless life with embarrassment and struggle to be able to cope with their peers. Parents are forced to take care of their physically handicapped kids who were born normal, which if intervened at the right time and the right way would have prevented the circumstances.[19,20]

Even though studies are many, they are mostly disjunctive; some being conducted by geologists and others being done by clinicians and public health experts. The present review will provide us with a wholesome depiction of the challenges and opportunities during the encounter, systematically map the research done in the area of fluorosis and health risks, identify existing gaps in the available literature and unsheathe the challenges and threats in the progress so far among the people living in fluorine-contaminated zones in our country; more specifically in Telangana.

Materials and Methods

Data search and collection

After weighing our research question, we adopted an iterative process for our search strategy by including electronic databases, a list of references, working papers, and patents. The MEDLINE, PUBMED database in NLM was advanced surfed with medical sub-headings like (Fluorosis and India), (De fluoridation and Telangana) and fluoride peril. Articles were chosen as depicted in Table 1 Preferred Reporting Items for Systematic reviews and Meta-Analyses scoping review framework.

Quality check

The search strategies were repeat-checked by two other reviewers using the peer review checklist and finalized over time by discussion. Data Extraction: A single final form was then created which was continuously updated and included details of the study type, setting, bias, funding, etc.

Situation analysis

We provided a snapshot of the present scenario of fluorosis by detailing the prevalence as obtained from reports available from the internet Google search engine, by a secondary strategic analysis.

Result

Perils of fluorosis

Most of the studies related to the problems of fluorosis have been conducted in South India; as depicted in Table 2. Very few studies could be retrieved from other parts such as Rajasthan, Odisha, or Delhi. Nearly 27% of the studies were trials or experimental studies, 20% were studies involving groundwater sample testing, and few were *in vitro* studies. All were from indexed journal articles and published beyond 2005. Nearly 26% were conducted on animals to see for interventions. A retrospective study analyzed data from the previous 2 years (Asawa *et al*.)[28] and case-control highlighted the genetic effect (Rahila *et al*.).[21] Sample size varied from a minimum of 12 rats (Basha and Sujitha)[31] under study to 653 fishermen studied (John *et al*.).[27] The effects of tamarind leaf (Samal *et al*.), Moringa powder (Mandal *et al*.), tetracycline Strontium, citric acid, sodium fluoride (SAF) (Sadanand and Vandana), and Vitamin E/D (Kumar *et al*.) having enhancing

Table 1: Preferred reporting items for systematic reviews and meta-analyses eligibility framework

Eligibility criteria	Reason for exclusion
Records identified through database searching (*n*=149)	Exclusion of records - duplication (*n*=75)
Additional records identified from other sources (*n*=16)	Exclusion after screening (*n*=41)
Records after removing duplication (*n*=75)	Due to in-completeness, animal studies with dissimilar variables, non-Indian studies, abstract, working paper, beyond time frame, language
Records screened (*n*=90)	Full text articles excluded (*n*=34)
Records excluded (*n*=41)	Different sets of objective and outcome (*n*=12)
Full text articles assessed for eligibility (*n*=49)	Dissimilar variables used for assessment (*n*=5)
Full text articles excluded with reasons (*n*=34)	Dental studies with different outcome (*n*=4)
Studies included in quantitative synthesis (*n*=15)	Chemical studies demonstrating mere knowledge about the composition (*n*=8)
	Geologic studies with less on health risk (*n*=3)
	Animal studies of no relevance (*n*=1)
	Combined study of both nitrate and fluorine (*n*=1)

Table 2: Study characteristics and domain on fluorosis in India from 2005 to 2020[17,22,26-39]

Author (1st)	Country	Design	Setting	Time	Publish	Outcome	Sample
Rahila	India	Case control	Patients with dental fluorosis	2019	*Saudi Dental Journal*	Gene polymorphism has significant association with dental fluorosis	22
Samal	India	Clinical trial	Animals with fluoride toxicity	2016	*Veterinary World*	Tamarindus leaf powder corrected the effect of FL toxicity	40
Arya *et al*.	South India	Water sample test	Ground water samples and health risk assessment	2019	*Environmental Geochemistry and Health*	Spatio-temporal variation shows FL conc to be high in monsoons due to the calcite dilution and ion exchange. HQ maximum for kids	118 wells
Levin	Karnataka, India	Water test using smart phone	Endemic areas in Karnataka	2016	*Science of the Total Environment*	The smartphone technic was economic and suitable for ground water analysis	200 sample
Sadanand	India	*In vitro* study	Fluorosed dentin specimen	2016	*The Open Dentistry Journal*	Root biomodification (SAF) using tetracycline, citric acid alters fluorosed dentin	-
Mandal *et al*.	Odisha, India	Screening experimental trial	Among fluorosed cattle in, Odisha	2015	*Veterinary World*	Ameliorative potential of dried *Moringa oleifera* fruit powder in fluorosis affected calves	107
John *et al*.	Kutch, Gujrat	Descriptive cross sectional	Skeletal fluorosis among fishermen using diagnostic tests	2015	*Roczniki Panstwowego Zakladu Higieny*	Skeletal fluorosis - 30.3%, associated with age, gender, tobacco, alcohol consumption habit's duration	653 fishermen
Asawa *et al*.	Pacific hospital	Retrospective analysis	Disease pattern and services in outreach programs	2015	*Roczniki Panstwowego Zakladu Higieny*	33% dental fluorosis. increase community-awareness programs	2-year data
Singh *et al*.	Udaipur	School based survey	Urinary fluoride status and comparison of free T4, free T3	2014	*Springer Plus*	Significant relationship of water fluoride to urine and serum fluoride and relationship with (FT3/FT4) and TSH	60
Naresh kumar *et al*.	-	Intervention with Vitamin D/E supplements	Effect of FL on reproductive system and role of Vitamin D/E	2012	*Toxicol International*	Vitamin E - significant sperm count improvement. Vitamin D - both motility and sperm count improved	60
Basha *et al*.	Bangalore	Experimental study	Effects of high FL on heart of rats	2011	*Toxicology International*	Excess intake - decreases growth rate while selenium has no effect on body weight. Vitamin E - most significant antioxidant	12
Reddy *et al*.	Hyderabad	Review article	Skeletal fluorosis, neurological sequel in renal impairment	2009	*Neurology India*	Anti-curare effects, mostly mechanical neurologic manifests with high complications and no use of surgery	22 articles
Adimalla *et al*.	Telangana	Testing water quality samples	Water samples in borewells collected and health risk assessment done	2018	*Human and Ecological Assessment*	20% of ground water with high fluoride mostly by ingestion. kids face higher health risk and hazard	34 samples
Ayoob *et al*.	Kharagpur	Critical review	Stress effects of fluorine	2007	*Environmental Science and Technology*	Prey increasing and stress effects more on kids. Relation between poverty, heat, labor etc.	
Karunanidhi *et al*.	South India	Estimation of health risk scores	Health risk assessment	2019	*Human and Ecological Risk Assessment: International Journal*	Necessary to estimate THI and HQ levels to screen out. 87% risk in children	60

SAF: Strontium, citric acid, sodium fluoride, HQ: Hazard quotient, THI: Total hazard index, FL: Chronic fluoride, TSH: Thyroid-stimulating hormone

properties were shown as the outcome.[22,25,26,30] Most of the water samples tested showed high levels of fluoride varying from 20% to 35%. The health effects in form of a Hazard quotient were the maximum found in children (as high as 87% risk) as significantly documented in most of the studies (26%).[23,33] Other factors contributing to the increased stress were poverty, age, heat stress, occupation, and nutrition. The stress effects of fluorine toxicity were formulated using the hazard scores and total hazard index (THI) score which gave indirect proof of the health profile of the population. It shows the ratio of the pollutant to the desired reference level. The most common mode of affection was ingestion as demonstrated by all followed by the routes of inhalation. Industrial workers and newborns were highly susceptible to the effects of poisoning (Ayoob and Gupta 2006).[17]

Skeletal and neurological manifests were the severe spectrum with little or no hope of surgery (Reddy and John *et al*.).[27,32]

Discussion

Geographic Distribution and Endemicity

Table 3 depicts the trend of fluoride endemicity and its prevalence as available from the government of India state-wise data for 2019 as obtained from the department of drinking water and sanitation. Rajasthan has the highest fluoride habitation because of the large size of the state, and the percentage of rural dry arid areas which have depleted groundwater levels leading to contamination over time. However, the fluoride population affected is also quite high i.e., 4,194,310 which is the highest contributor for India i.e., 6%. Of particular concern is the state of Bihar which shows fewer habitations to be affected but the population affected is too high in comparison (>1%). This provides us food for thought over causes that lead to fluoride toxicity; one of them being the thyroid–goiter belt. The state of Telangana which was previously part of Andhra Pradesh shows a 3.4% prevalence which is just better than the highest affected state of Rajasthan.

Prominent Schemes

Year-wise lists of predominant schemes rolled out for fluoride decontamination from time to time have been put up in Table 4. The first one started in 1987 by the Rajiv Gandhi National Drinking Water Mission started by the Ministry of Rural Development which had limited coverage[36] The SACHETNA PLUS by the Karnataka government in 1996 covered up the defluoridation techniques by the rainwater harvesting techniques.[37]

With the help of the Banawasi Seva Ashram, the Peoples Science Institute began a program of fluoride testing and fluorosis mitigation in the Sonebhadra district in UP in September 2004.[38] A health-based risk assessment of fluorosis was carried out in the blocks of Gorakhpur Uttar Pradesh, Pradesh, India. The Integrated Fluorosis Mitigation approach imparted a better understanding of the adverse effects of fluoride consumption and allowed them to take proper actions.[39]

The National Programme for Prevention and Control of Fluorosis was launched in 2008 initially as a pilot in 100 districts by the Ministry of Health and Family Welfare, India. The following strategies were considered. Surveillance in the community; Capacity building, diagnostic facilities; management including treatment surgery, and rehabilitation.[40]

The Jal Jeevan Mission was envisioned to provide safe and adequate drinking water through individual household tap connections by 2024 to all households in rural India. The program implemented source sustainability measures as mandatory elements, such as recharge and reuse through grey water management, water conservation, rainwater harvesting, etc.[41]

The Mission Bhagiratha Project owing its success to the Siddipet project which focused on one tap to each household is a continuation of the same with added strategies. With a total of 26 segments and a project outlay of Rs 45,028 crores and 1.11 sq km covered, it is one such large project which has benefitted 2.72 crores of population and 24,225 rural habitations in Telangana.[42]

Review Analysis

There is a need to focus more on the seemingly less important. Although, population affection as depicted by the Indian Data statistics from the department of drinking water and sanitation show values as low as 0.01% affection for a few

Table 3: Trend analysis of fluoride affected areas (2019)[35]

States	Fluoride habittion	Fluoride population	Total population of the state	Percentage population affected
Assam	285	113,837	31,966,238	0.4
Bihar	898	1,100,274	103,804,637	1.05
Chhattisgarh	405	131,263	25,540,196	0.5
Haryana	119	296,751	25,353,081	1.1
Jammu and Kashmir	4	9586	12,548,926	0.07
Jharkhand	552	263,870	32,966,238	0.8
Karnataka	600	402,674	61,130,704	0.6
Kerala	34	80,427	33,387,677	0.24
Madhya Pradesh	171	73,219	72,597,565	0.1
Maharashtra	79	154,985	112,372,972	0.13
Odisha	105	29,993	41,947,358	0.07
Punjab	302	362,035	27,704,236	1.31
Rajasthan	6087	4,194,310	68,621,012	6.1
Telangana	877	1,204,472	35,286,757	3.4
Uttar Pradesh	179	310,011	199,812,341	0.2
West Bengal	1336	838,552	91,347,736	1

https://data.gov.in/resources/state-wise-number-arsenic-and-fluoride-affected-habitations-population-reported-integrated. https://fluoridealert.org/news/state-wise-number-of-arsenic-and-fluoride-affected-habitations-with-population/2019

Table 4: Detail of the various noteworthy schemes and policies for the control of fluorosis in India

Year	Scheme	Governed by	Progress and process
1987–1993	Rajiv Gandhi National Drinking Water Mission started by Ministry of Rural Development https://phed.cg.gov.in/sites/default/files/ruraldrinkingwater-2nd april-0-0-0.pdf	Coordinated by fluorosis control cell at the All-India Institute of Medical Sciences, Delhi had a limited coverage	Worked for control of fluorosis through its awareness campaign
2000	Project SARITA https://www.cdac.in/index.aspx?id=print_page&print=egov1	UNICEF sponsorship in Rajasthan	Fluorosis mitigation programme by the defluoridation technique using drum sets and alumina filters
1996	SACHETANA PLUS https://www.indiawaterportal.org/articles/mid-term-assessment-sachetana-drinking-water-plus-project-fluorosis-mitigation-bird-k	BIRD-K	Defluoridation using rain water harvesting technique
2004	FMP https://peoplesscienceinstitute.org/resrch.html	People science institute in collaboration with Banwasi Sewa Ashram	Fluoride testing and fluoride mitigation and nutritional intervention in UP
2005	FMP, Odisha http://www.svaindia.org/environment-and-ecology/	PSI along with Sahbhagi Vikash Abhiyan	Safe sanitary wells, domestic kits for defluoridation
2008	FMP http://www.vasudhavikassansthan.org/focused_area.htm	Water Aid (UK) PSI, Vasudha Vikas Sansthan	Done in MP with provision of safe water for drinking. Could reverse skeletal fluorosis
2004	Government of AP http://www.saioralhealthfoundation.org/saioralhealth/	In collaboration with Sai Oral Health Foundation	Provision of low fluoride water in affected villages through use of domestic defluoridators using bone char and rain water harvesting
2007	Integrated Fluorosis Mitigation https://www.ircwash.org/resources/integrated-fluorosis-mitigation-guidance-manual	NEERI in association with UNICEF and ICMR	Water dilution, nutrition supplements in schools, IEC, quality chemical assessments, water dilutions etc.
2009	NRDWP https://ejalshakti.gov.in/IMISReports/NRDWP_MIS_NationalRuralDrinkingWaterProgramme.html	By Government of India	Sustain provision of adequate safe water for drinking and household activities
2008–2009	National Programme for Prevention and Control of Fluorosis https://main.mohfw.gov.in/major-programmes/other-national-health-programmes/national-programme-prevention-and-control-fluorosis-nppcf	Ministry of Health and Family Welfare, Government of India. NPPCF	100 districts of 17 states were covered during 11th plan, further 11 districts were taken up during 2013–2015 (over 19 states) and additional 84 new districts are to be taken up during the remaining period of 12th plan
2010	Dependent Schemes https://www.hic-net.org/depleting-groundwater-levels-and-increasing-fluoride-concentration-in-villages-of-mehsana-district-gujarat-india-cost-to-economy-and-health/	Dharoi, Sabarmati and Narmada canal dependent schemes	Import of surface of water. By Government of Gujrat
2016	Mission Bhagirathi https://missionbhagiratha.telangana.gov.in/	By Government of Telangana	Community water treatment and safe water supply

FM: Fluoride mitigation, FMP: Fluoride mitigation project, FMP: Fluoride mitigation program, PSI: People Science Institute, NEERI: National Environmental Engineering Research Institute, NRDWP: National Rural Drinking Water Program, BIRD-K: BAIF Institute for Rural Development, Karnataka, AP: Andhra Pradesh, MP: Member of Parliament, IEC: Information, Education and Communication, NPPCF: National Programme for Prevention and Control of Fluorosis

endemic states, it scales up to include and paralyzes the lives of a lot many people in the 1.3 billion nation.[34,35] Urban area monitoring for any pipe damage or leakage becomes equally important. Many studies done in this regard show that defluoridation techniques, Moringa, Tamarind, Vitamin C, D, E, Selenium, and Tetracycline citric acid SAF have ameliorative potential.[22-24,26,31] Further human trials can establish evidence to halt and reverse the peril. Reddy in their review article discussed that defluoridation methods tend to increase aluminum levels of filtered water which is being incriminated in the causation of neurodegenerative diseases and hence these methods are not preferred by WHO.[32]

Adimalla and Venkatayogi 2018, narrated how the groundwater is facing severe quality problems. The total dissolved solid, bicarbonate, Calcium, Magnesium, etc., were within acceptable limits as per standards in a large number of groundwater samples which however was not true for fluoride (21%) and Nitrate (26%). Based on the total health risk assessment, 67.65%, 79.41%, and 82.35% of the samples had high noncarcinogenic risk, exceeding the maximum allowable limit as per USEPA.[15] Karunanidhi *et al*. mentioned that recently born babies were more helpless to the dual poisonous effects of Nitrate and fluorine; because of the intake of polluted drinking water. This might lead to a physical mechanical problem in form of staining or deformities, but beyond that, it can also create a chronic state of oxygen deficiency.[33] There are many highly efficient governmental efforts being carried out targeting the source, the process, the effect, and the outcome.[39-41] However, the results somewhat seem disproportionate. It becomes important here to work in teams and not as discrete

experts. A geological investigation with apt detailing of the rocks and surface won't do any good if it doesn't process the risk it throws to the human and his health.

The Stumbling Blocks

Telangana with a population of 35,286,757 has an area of 114,840 km^2 with 307/km^2 of population density as per the census state-wise details. The hard rock terrain, deformation features, and joint fractures facilitate the movement of groundwater in the region in different weather conditions.[1,44]

Narsimha and Rajitha 2018 showed that the groundwater samples from the selected districts in Telangana showed higher predilections postmonsoon which drastically reduced in the premonsoon times.[44] Low fluoride concentrations were observed in the northern part of the study region in pre- and post-monsoon seasons and spatial distribution of elevated fluoride concentration was seen in the southern region. Reddy and Rao said that such a distribution pattern was mainly due to the weathering mineral dissolution and the divergent fracture system associated with the hydrochemical process.[45] Relative sparse and abundant distribution of the fluoride-bearing mineral might account for these dissimilarities.

The chronic daily intake, hazard quotient, daily ingestion dose, reference dose, total exposure, and average body weight, are all equally important to determine the ultimate suffering. Many studies have either shown the topographic details or the health risk assessment in disjunction.[46,47] Doing so gives us focal and patchy ideas of the same problem repeatedly and we still land in the tunnel of the problem. For problems whose source is to stay with us, a compensated approach involving sufferers, service providers, and service regulators would benefit the best.

Telangana: Then and Now

Before being a separate state, Siddipet had implemented the pilot project on one tap in each household in 1998. Over the years, the weather conditions, terrain, and landscapes underwent heavy alterations owing to nature. In 2013, the DFMC-District Fluoride Monitoring Centre came up with the Convergence of interdepartmental mitigation strategies for Fluoride monitoring to act from a single platform. UNICEF provided financial and technical support for the same. There was a pledge for the supply of safe and fluoride-free drinking water (Krishna water).[47] Then came the mission Bhagiratha[42] under the present minister of the state with a vision to ensure safe and sustainable piped drinking water supply from surface water sources.

The strategies are staged from the source to the supply with water treatment plant, pump treated water and sumps at the highest points, transmission from the highest point through a second pipeline network to all the habitations by gravity (98%), distribution to each household through a modern, rationalized intra village network thereby providing tap connections to each household. It has thus been declared a flagship program by the Telangana Drinking Water Supply Corporation Limited This Telangana model is also being emulated in Bihar, Karnataka, and Maharashtra states.[42]

The Course of Action to Mitigation

Defluoridation has been the most conventional method used. However, its costly and so water for cooking and drinking purposes are only being treated. The common techniques used are Activated Alumina prepared by low-temperature dehydration of Aluminum hydroxides.[48,49] Calcined Clay which adsorbs excess amount of fluoride present in the raw drinking water,[48,49,50] mud pots for the collection and storage, natural adsorbent using plant-based defluoridation technique, Ion exchange, precipitation, contact precipitation, and the Nalgonda technique as the first community-based plant for removal as developed by National Environmental Engineering Research Institute, Nagpur in 1961[48] A vegetable grown commonly in rural areas has a very high calcium content. Krishnamachari *et al*. reported that consumption of Chakoda Bhaji resulted in reversal of skeletal fluorosis. Hence consumption of Chakoda Bhaji is promoted as a part of Integrated Fluorosis Mitigation.[51] Chemical risk assessment, hazard assessment, dose-response and risk characterization, cluster-wise community diagnosis, facility mapping, reconstructive surgery, financial support, etc., are some of the other public health interventions so far.[51]

The Way Forward

Alternative methods which are cost-effective, less time-consuming, and more efficient need to come up. Although locating an alternative source of water is the best method, it is time-consuming and difficult. Dual water sources help in keeping the cooking and drinking water safe. This saves time and money and a lot of hard work too. Rainwater harvesting is also one such option that can be used for providing a safe water supply to the residents. Industrial fluorosis can be prevented by rigorous enforcement of procedures for minimizing industrial fluoride pollution and ensuring the fluoride content of urine is below 5 ppm.

Conclusion

Geologists, public health engineering, public health specialist, and clinicians together, can depict the association and causation which will then create a way out. When each specialist works for his department, they get the best out, but that in no way is relatable or contributes to resolution. It is before channelizing all the sectors to work in teams and take up metacentric projects to be able to come out of the problem tunnel. A few recommendations are:

For people

Create awareness about the problem, Wash and cook vegetables properly before intake, habituate people regarding the best practices, Vitamin C and E, and other antioxidants, and take

calcium-rich food in the form of vegetables, green leafy products, and milk.

For providers

Alternate and cost-effective sources of de-fluoridation, Alternate sources for providing drinking water from other rivers or areas, Screening of workers in industries, dilution, isolation, and filtration techniques for avoiding the fumes or gases, and diet-rich supplements.

For policy-makers

Institute funding for innovation and initiatives, integrated and mixed model involving public and private enterprises, quality check and surveillance techniques.

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Conflicts of interest

There are no conflicts of interest.

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