

ERADICATION OF FLUOROSIS IN INDIA

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ENDEMIC FLUOROSIS IN THE WORLD

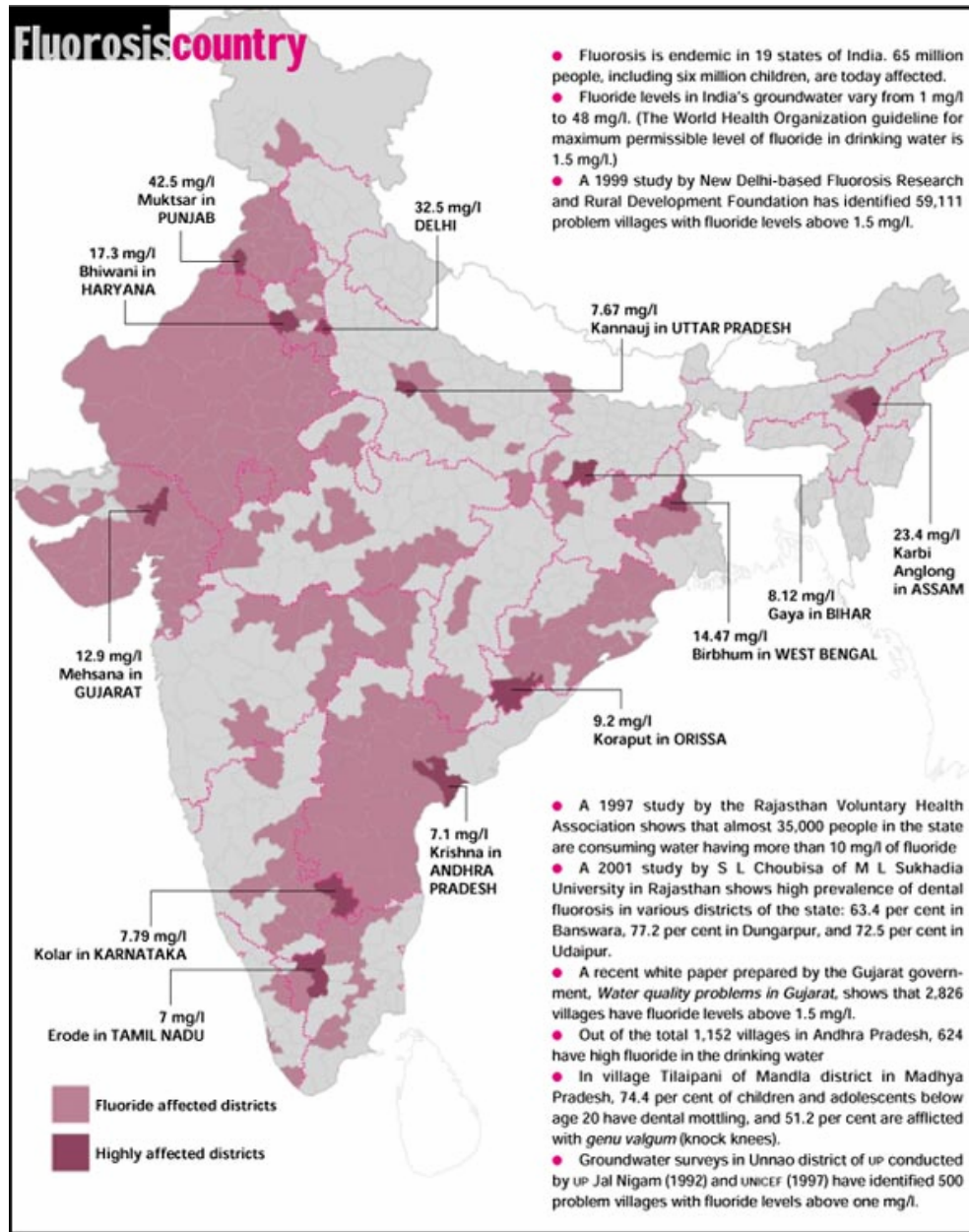
- Churchill from Pennsylvania, Smith *et al.* from Arizona and Velu from South Africa reported independently in 1931 endemic **dental fluorosis** or **mottling** because of drinking water with over 1 mg/l of fluoride during the formation of permanent teeth.
- Möeller and Gudjonsson from USA reported in 1932 **skeletal fluorosis** or **osteofluorosis**, affecting bones and joints of adults, because of cumulative accumulation of fluoride in hard tissues by drinking water with over 7 mg/l fluoride for many years.
- In course of time, fluorosis has been reported in over 22 countries from all over the world, including India.
- Skeletal fluorosis could however be eradicated in USA long ago by changing to a water source with low-fluoride.
- As mottled teeth is unusually resistant to **caries**, fluoridation of water supplies to have a fluoride content of 1 mg/l became a standard public-health practice in most developed countries to check caries.

ENDEMIC FLUOROSIS IN INDIA

- Shortt *et al.* from the King's Institute of Preventive Medicine at Chennai reported in 1937 endemic fluorosis for the first time in India in a cluster of villages around Podili and Darsi in Prakasam District, Andhra Pradesh.
- Pandit *et al.* from the same Institute established in 1940 that the toxic limit for skeletal fluorosis is 2.5 mg/l under Indian conditions owing to poor nutritional status of people.
- Krishnamachari of the National Institute of Nutrition at Hyderabad reported in 1977 the occurrence of endemic **genu valgum (knock-knee)** crippling lower limbs right from childhood in many fluorosis habitations of India.
- The author of this presentation has been studying the fluorosis problem of Andhra Pradesh since 1965.
- The next slide shows the geographical distribution of fluorosis in India.

GEOGRAPHICAL DISTRIBUTION OF FLUOROSIS IN INDIA

(http://www.downtoearth.org.in/html/20030415_map.htm)



GEOCHEMISTRY OF FLUORINE

- Geochemists have established that the fluorine content of the Earth's crust is 950 parts per million (ppm), while chlorine content is seven times less than that. Despite that, sea water contains 1.3 mg/l fluoride as against 19,500 mg/l chloride. This indicates that the natural environment of the Earth has a favourable mechanism to immobilise toxic fluoride for the safe existence of life.
- In the humid, temperate tracts of the world, groundwater is distinctly acidic particularly due to acid rains caused by industrial pollution and contains little fluoride even when local rocks and soils contain high fluorine. People living in such tracts are prone to caries, necessitating fluoridation of drinking water supplies.
- In the arid/semiarid tracts of the world including India, groundwater is distinctly alkaline to contain high fluoride even when local rocks and soils contain less fluorine. People living in such tracts are prone to fluorosis unless provided with low-fluoride drinking water.

FACTORS RESPONSIBLE FOR FLUOROSIS

- The high incidence of fluorosis and its severity are dependent on the quantity of fluoride ingested.
- High-fluoride groundwater used for drinking and cooking is the main source of fluoride to cause fluorosis.
- Consumption of certain locally available foods such as rice, millets, pulses, sorghum, vegetables, milk, fish, chicken, eggs, meat, betel vine, tea and sea salt contribute additional fluoride.
- Regardless of the fluoride ingested through food, it has been found that people drinking high-fluoride water are prone to severe fluorosis compared to those drinking low-fluoride water. This indicates that fluoride is contributed mostly by water rather than food.
- Regardless of the fluoride ingested by all sources, severity of fluorosis increases with an increase in the malnutrition of people.

FLUORIDE CYCLE IN HUMAN BEINGS

- Much of the fluoride ingested by human beings is excreted by the kidney, guts and skin and, in the case of women, lost also through menstruation, offspring and lactation.
- The toxic effects of fluorine retained by the body are minimal owing to more than 95% of it getting immobilized by substituting for hydroxyl ions in apatite present in dental and skeletal structures (hard tissues) to become fluor-apatite.
- Although initial entry of fluorine into the hard tissues is beneficial for the health of teeth and bones, entry of more fluorine results in dental and skeletal fluorosis.
- Once fluorine levels in the hard tissues reach physiologic saturation, which ranges from 0.02 to 0.83%, further ingestion of fluoride leads to flooding of fluoride in the soft tissues leading to skin, urinary, gastric, muscular and neurological problems, besides death due to some inter-current infection.

SYMPTOMS OF DENTAL FLUOROSIS

- Teeth may show dental caries with cavities when drinking water has less than around 1 mg/l.
- Teeth are generally free of both caries and fluorosis when fluoride is around 1 mg/l.
- Mild dental fluorosis is developed when fluoride is in between 1 and 2.5 mg/l.
- Severe dental fluorosis is developed when fluoride is more than 2.5 mg/l.
- In mild dental fluorosis, affected teeth lose lustre and show chalkiness. In course of time, spots and transverse bands of light yellow to dark brown colour appear. But for the disfigurement of teeth, the victims are otherwise healthy.
- In severe dental fluorosis, teeth become brittle and turn black owing to chipping of enamel. In course of time, there can be even loss of teeth.

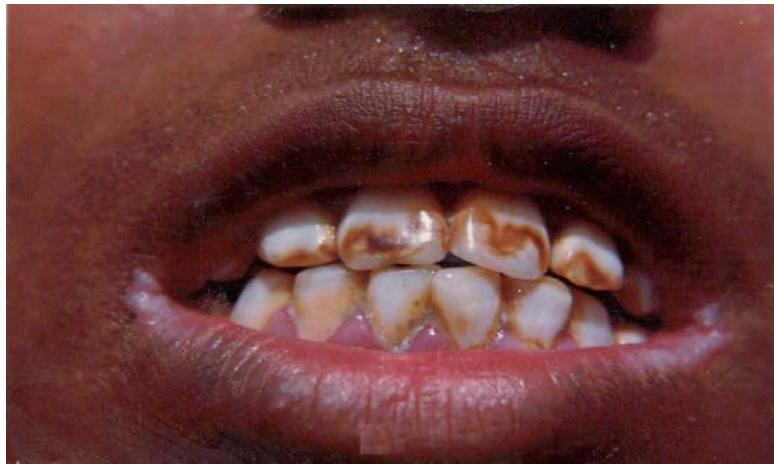
MILD & SEVERE TYPES OF DENTAL FLUOROSIS



Chalkiness of teeth



Brown stain on teeth



Brown wavy striations on teeth



Severe mottling

SYMPTOMS OF SKELETAL FLUOROSIS

- Severity of symptoms increases with increase in age beyond 20 years, malnutrition, and the fluoride content of water. The symptoms include:
 - Body pains, lethargy and tingling sensation in the extremities
 - Progressive stiffness of neck, spine and joints
 - Inability to squat on the floor
 - To see someone on side, the patient has to turn the whole body towards that side
 - To see an airplane, the patient has to lie on the ground
 - Breathing becomes abdominal, gait and posture become ugly, and bones show osteophytic overgrowths.
- Once physiologic saturation of fluorine in hard tissues takes place, there will be flooding of fluoride in the soft tissues resulting in several diseases followed by death.

A VICTIM OF SKELETAL FLUOROSIS WITH STIFFNESS OF NECK AND SPINE



SYMPTOMS OF GENU VALGUM

- Genu valgum (otherwise called knock-knee) is similar to rickets (otherwise called bowlegs). Both these disorders cripple lower limbs at a young age. Feet are far apart when knees are together in genu valgum, while knees are far apart when feet are together in rickets.
- Genu valgum develops right from young age, while skeletal fluorosis develops only in adults. As genu valgum is found even in non-fluorosis habitations, high-fluoride drinking water is not necessary for its development. Many children afflicted with genu valgum do not show dental fluorosis. Despite this, many investigators treat genu valgum as fluorosis.
- Development of genu valgum is attributed to drinking groundwater carrying certain chemical elements in excess/deficiency owing to environmental changes caused by natural and manmade activities. It is believed that genu valgum is caused partly due to malnutrition and partly due to low calcium and high molybdenum in drinking water.

CHILDREN AFFLICTED WITH GENU VALGUM



FLUOROSIS AND GENDER

- The prevailing social customs make most men in the fluorosis villages to remain at the same place right from birth using locally available high-fluoride water for both drinking and cooking. They develop progressively severe symptoms of fluorosis till death.
- The prevailing social customs on the other hand make women to move from father's house to husband's house and in the process may move from a fluorosis area to a non-fluorosis area and *vice versa*.
- Apart from this, women lose some additional fluoride through menstruation, offspring and lactation.
- Between men and women, severity of skeletal fluorosis is therefore generally less in women than in men.

FLUOROSIS IN CATTLE

- High-fluoride drinking water in the fluorosis villages causes skeletal fluorosis not only in human beings but also in cattle. Despite that, cases of livestock showing severe symptoms of skeletal fluorosis in the fluorosis villages are almost absent.
- Once livestock develop symptoms of skeletal fluorosis, impairing their usefulness, they are disposed off to non-fluorosis villages on economic grounds. Once they move to non-fluorosis villages, they become once again healthy and become fit to take up productive work.
- This facility available to cattle is however not available to human beings. The afflicted human beings continue to stay in the same village, drinking high-fluoride water and suffering from progressively-severe symptoms of fluorosis to finally die at a premature age.

METHODS USED TO ERADICATE FLUOROSIS

The following methods, which are in vogue to eradicate fluorosis, essentially aim at making low-fluoride drinking water available in the fluorosis habitations.

- Locating local sources of low-fluoride surface- and ground- waters and educating people to use only such waters for drinking and cooking
- Converting local high-fluoride waters into low-fluoride waters through defluoridation at house-hold and community levels
- Collecting rainwater from rooftops and hill slopes in cisterns and reservoirs
- Injecting treated rainwater direct into wells and thereby dilute the fluoride content of well waters
- Abandon local sources of groundwater and formulate public water supply schemes to obtain piped water from far-off rivers

As effects of fluorosis are more in people with malnutrition, efforts have to be taken to improve the nutritional status of people by providing special diets.

ERADICATION OF FLUOROSIS IN KARNATAKA

The BAIF Institute for Rural Development, Karnataka (BIRD-K) has been guiding the Government of Karnataka for successful implementation of the Sachetna project to eradicate fluorosis in the State by making low-fluoride waters available to the communities mainly in the following ways.

- Rooftop rainwater harvesting to collect rainwater from roofs of houses and public buildings through gutters into storage tanks for drinking and cooking.
- To dilute the fluoride content of groundwater through:
 - Artificial recharge of groundwater by impounding rainwater/ surface water by constructing check dams, percolation ponds, farm ponds etc.
 - Injecting treated rainwater falling on roofs of houses/ public buildings and treated surface runoff direct into the aquifers through recharge wells.

IMPORT OF KRISHNA WATER TO FLUOROSIS HABITATIONS TO ERADICATE FLUOROSIS

- Construction of minor irrigation tanks in the semiarid tracts of Prakasam and Nalgonda districts has led to high fluctuations of groundwater levels leading to formation of thick alkaline soils enriched in water-soluble ions such as sodium, carbonate, bicarbonate and fluoride and poor in calcium, magnesium and copper.
- It is hoped that import of nearly fluoride-free Krishna waters by canals from the Nagarjunasagar reservoir into the fluorosis habitations in the above districts would reduce the fluoride content of groundwater to safe limits and thereby eradicate fluorosis.
- But percolation of canal waters into these alkaline soils has led to high dissolution of soluble salts, leading to severe deterioration in the chemical quality of groundwaters. This has led to widespread occurrence of genu valgum among children, besides increased incidence of fluorosis.

CONCLUSION

- Ever since endemic fluorosis was reported in 1937 and endemic genu valgum in 1977 from India, there has been a remarkable increase in the incidence of fluorosis in the entire country.
- The only way these dreadful diseases can be checked is through making available waters with a fluoride content of 1 mg/l for drinking and cooking, besides providing nutritious foods to people living in the affected habitations.
- As an interim measure, efforts should be taken up to ensure that drinking water in no part of India has more than 2.5 mg/l fluoride so that skeletal fluorosis and severe cases of dental fluorosis are eradicated.
- As there is a strong positive correlation between alkalinity and fluoride, fluorosis can be best eradicated through reclamation of alkaline soils and groundwater through gypsum treatment and thereby immobilize HCO_3^- , CO_3^{2-} and F in water as calcite and fluorite.