



SMCH/EH/15: Endemic Fluorosis:



QUADRANT 1

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Description of Module

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Subject name	Social Medicine & Community Health
Paper name	Environmental Health
Module name/Title	Endemic Fluorosis
Module Id	SMCH/EH/15
Pre-requisites	Understanding of fluorine and its role in human health
Objectives	To understand effect of under and over consumption of fluorine and measures to prevent fluoride associated diseases
Keywords	Dental fluorosis, Genu valgum, Skeletal fluorosis, Nalgonda Technique



Introduction:

Fluorine is highly reactive and it is most abundant element in nature. It is needed for normal mineralization of bones and formation of dental enamel. Majority (96%) of the fluoride in the body is found in bone and teeth. Deficiency of fluoride leads to dental carries and excess cause fluorosis. Therefore it is known as double-edged sword.

Learning outcomes

Upon completion of this module, the reader should be able to:

- State properties of Fluorine and its role in human health.
- Mention recommended level of fluoride in drinking water.
- Define fluorosis and enumerate its types
- State magnitude of fluorosis world wide in India
- Enumerate agent, host and environmental factors of fluorosis
- Enumerate features of skeletal and non-skeletal fluorosis.
- State criteria of endemicity of fluorosis
- List methods of prevention of fluorosis
- Describe salient features of national Program for prevention and control of fluorosis.
- Pinpoint role of international organizations in control of fluorosis.

1. Properties of Fluorine:

Fluorine has following properties:

- 13th most abundant element in the earth's crust
- Most electronegative of the elements
- Emitted from volcanoes as gaseous fluorine which reacts immediately with water to form HF
- Mainly found in rock and soil in various forms of barely soluble calcium *fluorides*
- Concentration in seawater about 1.2 mg/L (ppm)
- Concentration in fresh water ranges from near zero to 25 ppm (in the Rift Valley, Tanzania)
- World-wide fresh water fluoride concentrations are generally *less than 0.1 ppm* but commonly up to 2 ppm in some areas



2. Recommended level of fluoride in drinking water:

Recommended level of water is 0.5-0.8 mg/L. Up to 1 ppm in drinking water is desirable. If fluoride level in drinking water is below 0.5mg/L, it leads to dental caries. Above 2 ppm level in drinking water leads to dental fluorosis and skeletal fluorosis. The World Health Organization (WHO) has set the standard of fluoride in drinking water at 1.5 mg/L to be adopted by nations.

3. Role of Fluorine in human health:

Fluorine is one of the important components of teeth and bone. Its deficiency causes dental caries and excess leads to fluorosis.

3.1 Dental Caries: Important diet related disease in terms of both total costs and health care costs. There are evidences to show the potential for health promotion at the population level to target dietary sugar restriction as common risk factor approach.

Approaches for prevention of dental caries:

[A] Fluoride tooth paste: The overall caries inhibiting effects derived from pooled results of 70 trials: 24% (95% CI: 21%- 28%). The effect was independent of background domestic drinking water fluoride status.

[B] Fluoride varnishes: Fluoride varnishes are for preventing dental caries in children and adolescents. Pooled prevented fraction estimate: 33% (95% CI: 19%- 48%) .

[C] Role of diet: For a given dietary challenge, risk of caries at any tooth site will depend on fluoride exposure, plaque bulk, and access to saliva.

3.2. Fluorosis:

Fluorosis is a disease caused by deposition of fluorides in the hard and soft tissues of the body. It is not merely caused by excess intake of fluoride but there are many other attributes and variables which determine the onset of fluorosis in human population.

It is usually characterized by discoloration of teeth and crippling disorders.



3.2.1. Types of Fluorosis:

[A] Dental Fluorosis: Children living in high fluoride zone are bound to get dental discoloration which may be seen even in deciduous teeth. Initially glistening white teeth become dull and yellow-white spots appear on the surface of teeth. Gradually these spots turn brown and present it in brown streaks which are closer to the tip of the teeth. In late stages the whole teeth become black. Teeth may be pitted or perforated and may even get chipped off. In endemic zones people lose their teeth at an early age and may become edentate.

[B] Skeletal Fluorosis: It affects young as well as old. The symptoms include severe pain and stiffness in the backbone, joints and/or rigidity in hip bones. X-ray examinations of the bones reveal thickening and high density of bones. In some patients with calcium deficiency osteomalacia type changes are seen. Constriction of vertebral canal and intervertebral foramen - pressure on nerves leads to paralysis.

[C] Non-Skeletal Fluorosis: There are convincing evidence of involvement of skeletal muscles, erythrocytes, G-I mucosa, ligaments and spermatozoa on consuming more than optimal intake of fluorides. Detection of fluorosis at early stage is possible by understanding the soft tissue manifestation. In the fluorosed muscles, actin and myosin filaments are destroyed and mitochondria lose their structural integrity thereby providing evidence of depletion of muscle energy. The erythrocyte membrane loses its calcium content in presence of high fluoride. Non-ulcer dyspeptic complaints are manifested by consuming high F in water and food. Infertility due to oligospermia and azoospermia is commonly seen in fluorotic belts.

[D] Hydrofluorosis: Water borne fluorosis due to excess fluoride in water is hydrofluorosis.

[E] Food borne fluorosis: If food chain contains high fluoride it results into food borne fluorosis.

[F] Industrial fluorosis: Industrial workers engaged in industries which use fluoride in the manufacturing process and population nearby are the victims of fluoride toxicity. This is known as industrial fluorosis.

Fluoride is used in several industries (Box.1):

Fluoride using industries:

- Aluminum
- Automobile vehicles
- Bricks
- Chemical
- Enamel
- Fertilizers
- Glass and ceramics
- Oil refinery
- Plastic
- Pharmaceuticals
- Pottery
- Refrigeration
- Rust removal
- Steel
- Tooth past
- Welding

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[G] Neighborhood fluorosis: Industries using fluoride may discharge effluents into streams or rivers and pollute the ground water or surface water. People living nearby these industries who depend on ground water may suffer from fluorosis.

3.2.2. Magnitude of fluorosis:

Fluorosis is Worldwide in distribution. It is endemic in 22 countries. Asia and in Asia, India and China are worst affected. Mexico in North and Argentina in Latin America. East and North Africa are also endemic.

Fluorosis is reported from several parts of India. Rajasthan and Gujarat in North India and Andhra in South India are worst affected. Punjab, Haryana, Madhya Pradesh and Maharashtra are moderately affected. Tamil Nadu, West Bengal, Uttar Pradesh (U.P.), Bihar and Assam are mildly affected. Throughout India fluorosis is essentially hydrofluorosis except in parts of Gujarat and U.P. where industrial fluorosis is also seen. In worst affected states, maps have been prepared of geographic pathology on the basis of fluoride distribution in the drinking water.

3.2.3. Socio Economic Implications of Fluorosis:

In India social and economic implications due to fluorosis are enormous because of widespread crippling effects, disability and decreased work capacity. Discoloration of teeth leads to social problems in children.

3.2.4. Epidemiological characteristics of fluorosis:

Epidemiological characteristics of fluorosis are given below under following subheadings:

[A] Agent Factors: Primarily it is Fluoride which is present in drinking water. When fluoride in water is more than 1.5 mg per liter, it is toxic to health. pH in terms of alkalinity of water promotes the absorption of fluoride. Calcium in the diet reduces the absorption of fluoride. Hard water rich in Calcium reduces the fluoride toxicity. Fresh Fruits and Vitamin C reduces the effect of fluoride. Trace elements like Molybdenum enhances the effect of fluoride.

[B] Host Factors: In School going children seen as dental fluorosis. In third and fourth decade of life seen as Skeletal Fluorosis. Males suffer more than females. Illiterates suffer more frequently in the fluorotic belts. Where aluminum ores are mined, it is seen as occupational health hazard.

[C] Environmental Factors :

Environmental factors of fluorosis is given below in (Box 2):

Environmental Factors
<ul style="list-style-type: none">• High Annual Mean Temperature• Low Rainfall• Low humidity• Fluorine rich Natural subsoil rocks• Vegetables from high F belts• Fluoridated tooth paste particularly when used by children• Tropical climate• Developing Countries

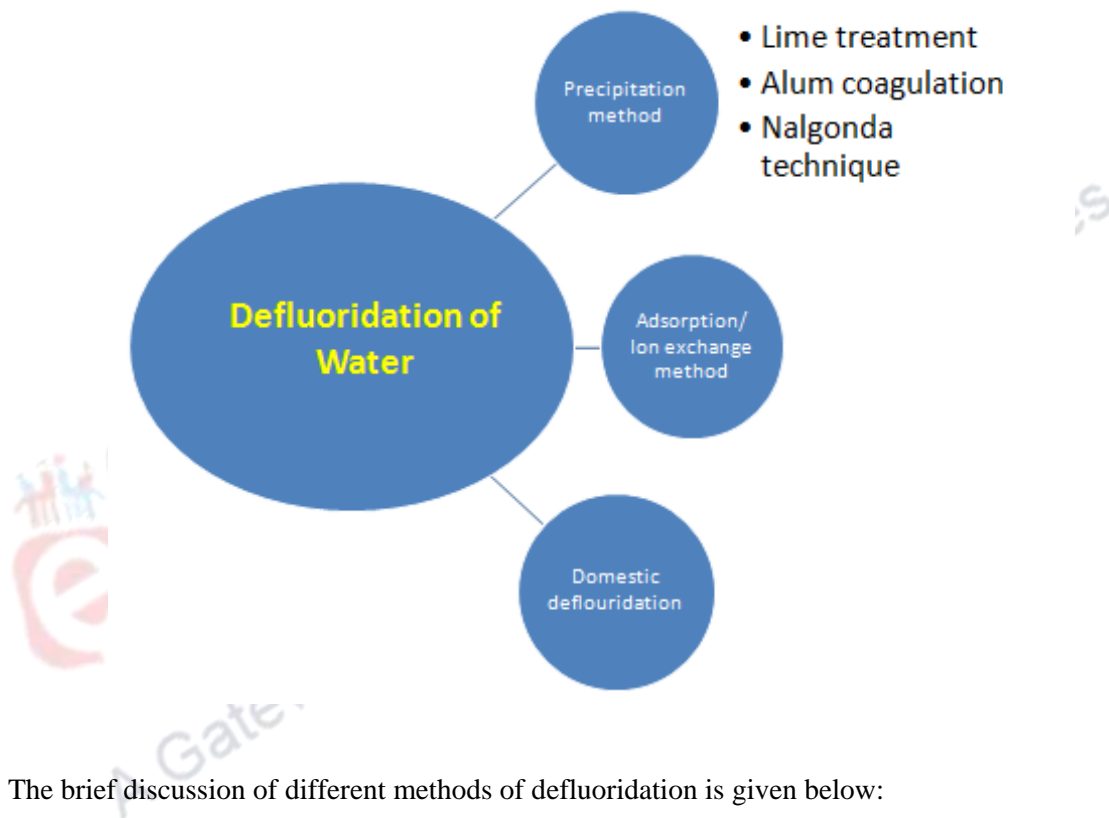
3.2.5. Risk factors of fluorosis:

Lack of awareness about role of fluorine in human health is responsible for occurrence of both dental carries and fluorosis. Increase of population and industrialization lead to shortage of safe drinking water. Excess of fluoride in water does not change the color of water or alters its taste, thus the consumer will not know unless frank stage of fluorosis is produced either in teeth or in bones. Ground water supply having excess of fluoride content and food habits of consumption of excess black tea, tobacco and black salt are important risk factors of fluorosis. Pregnant,

lactating mothers and children are most vulnerable. Under nutrition predisposes to both dental carries and fluorosis.

3.2.6. Prevention of fluorosis:

[A] **Primary prevention:** Activity such as health education, capacity building for health promotion and prevention of fluorosis and defluoridation of water.



The brief discussion of different methods of defluoridation is given below:

Lime treatment: By adding lime excess of fluoride can removed from water. It is effective only for waters with a fluoride concentration in the range of 3-4 mg/L.

Alum coagulation: The addition of high dose of alum results in removal of fluoride from water. However large alum doses can lead to the presence of high residual aluminium in the treated water.

Nalgonda technique: Indian scientists have developed this technique. It is based on the amount of fluorine in drinking water and alkalinity of the water (expressed as mg CaCO_3). Amount of alum to be mixed with water is calculated.



Activated Alumina: Defluoridation of drinking water by activated alumina (AA) is the method of choice in developed countries. Domestic filters using activated alumina have been accepted by users. Use of proper grade of AA is a must to obtain satisfactory result. Regeneration of exhausted AA after 4-5 months.

Domestic defluoridation technique: In order to defluorinate 40 liters of raw water (3 ppm fluoride content and alkalinity 200 ppm) it is mixed with 6 ml of lime solution (10 g of quick lime in one liter of water) + 120 mg of bleaching powder + 120 ml of alum solution (100 g of alum dissolved in one liter of water). After mixing it is stirred slowly for 20 minutes and allowed to settle. The supernatant with fluoride 1 ppm is used for consumption.

[B] Early diagnosis and treatment

For early diagnosis and treatment a number of activities have to be carried out. Capacity building of health personnel is required in early diagnosis and prompt treatment. Identifying skeletal fluorosis on the basis of signs and symptoms is of utmost importance. A number of tests (Box.3) may be used for this purpose.

Fluorosis may be identified on the basis of following clinical features:

- Vague pains and aches in extremities and joints. In fluorosis, the joints become stiff and flexion of joints is difficult.
- X ray changes: new bone formation and calcification of tendons and ligaments.

Radiograph of forearm may assist in diagnosis.

Level of fluoride can be estimated in drinking water, blood (serum) urine (spot urine sample)

Reversal of nonskeletal fluorosis can take place through consumption of vitamin C, Vitamin E, calcium and antioxidants. Consumption of these items also helps in prevention and control of skeletal and nonskeletal fluorosis (Box. 3).

Tests for Skeletal Fluorosis

Affection of the joints can be ascertained through simple tests which can be carried out at the bed-head side and in the field:

- **COIN TEST:** The subject is asked to lift a coin from the floor without bending the knee. A fluorotic subject would not be able to lift the coin without flexing the large joints of lower extremity.
- **CHIN TEST:** The subject is asked to touch the anterior wall of the chest with the chin. If there is pain or stiffness in the neck, it indicates the presence of fluorosis.
- **STRETCH TEST:** The individual is made to stretch the arm sideways, fold at elbow and touch the back of the head. When there is pain and stiffness, it would not be possible to reach to the occiput indicating presence of fluorosis.



When more than one-fifth (20 %) of the persons surveyed in a known high fluoride area shows positivity of the clinical tests just enumerated, it indicates the endemicity of fluorosis.

[C] Tertiary Prevention:

Capacity building of secondary and tertiary care hospital for reconstructive surgery and rehabilitation.

4. National Program for prevention and control of fluorosis.

Fluoride control was taken up as a submission of Rajeev Gandhi National Drinking Water Mission. Surveillance of fluorosis in the community was considered as major activity. It is 100% centrally sponsored program.

4.1-Objectives of the Programme are as follows:

- To assess and use the baseline survey data on fluorosis of Ministry of Drinking water and Sanitation.
- Comprehensive management of fluorosis in selected areas.
- Capacity building for prevention, diagnosis and management of fluorosis cases.

4.2-Guidelines of the Programme

Emphases should be given on the following:

- Identifying and labeling any potable and safe source and educating the population to conserve/ use the source for drinking and cooking only.
- Tapping safe low fluoride aquifers.
- Arranging for blending of water from different sources to obtain adequate quantities of safe water and to supply this potable, 'mixture' through designated 'safe' stand posts.
- Providing piped water supply schemes through distant sources.
- Rainwater harvesting techniques should be used to mitigate fluorosis.
- Providing community treatment plants to remove excess of fluoride.

5. Role of International Organizations in control of fluorosis

Supply of safe drinking water is an important input for control of fluorosis. DANIDA is supporting Rural Drinking Water Supply and Sanitation Project (RDWSSP) in Karnataka. Support for strengthening the district water quality laboratories, development of activated alumina (AA) based domestic defluoridation of water by Indian Institute of Technology,



Kanpur and provision of educational materials to Nongovernmental Organization is extended by DANIDA and UNICCEF to Government of India.

Summary

Fluorosis is a problem in many parts of the world. Onset of fluorosis is not determined by fluoride but a large number of agent, host and environmental factors determine its occurrence. Characteristic features are discoloration of teeth and crippling disorders. Although fluorosis once established is irreversible but it can be prevented through simple infestation. Throughout India fluorosis is essentially hydrofluorosis except in parts of Gujrat and Uttar Pradesh where skeletal fluorosis is also seen. UNICEEF and DANIDA have contributed significantly in the control of fluorosis in India.

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