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HIGHLIGHT

Debilitating Juvenile Skeletal Fluorosis is a recent phenomenon in India. Why could it be happening? In this Highlight, the author unveils this problem and attributes its main cause to mother and child malnutrition apart from unsafe water. The answer to this problem lies in addressing malnutrition problem of the mother and child along with provision of safe fluoride-free water. Since traditional dietary patterns are not satisfying nutritional needs and therefore leading to this problem; suggestions ask for changes to such dietary patterns. Also, there is a call for external interventions such as fortification and supplementation to enhance nutritional intake in fluoride affected areas. Problems such as juvenile fluorosis are symptomatic of deeper problems that are hidden beneath the surface. Before generational changes occur, the suggestions prescribed need to be urgently acted upon.

Strategies of Sustainable Nutrition to Address Fluorosis and Malnutrition in Children

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Strategies of Sustainable Nutrition to Address Fluorosis and Malnutrition in Children[1]

Research highlight based on a paper with the same title[2]

Introduction

Historically, nutrition has been 'everyone's problem' but 'no-one's responsibility'. The prevalence of child under-nutrition in India is among the highest in the world, and nearly double that of Sub-Saharan Africa, where the food insecurity is much higher in comparison with India. From the last few decades, we are fighting to eliminate nutritional deficiency disorders. In addition, since inadequate dietary intake by pregnant women results in lesser nutrient supply to fetus, a higher prevalence of adult non-communicable diseases such as diabetes, hypertension and coronary heart disease is expected according to the theory of 'fetal origin of adult disease'. The World Bank has predicted that coronary heart disease will become the leading cause of premature death in India by 2015 and that the maximum number of diabetic patients in the world will be in India. Clearly, there is a need for examining several issues of nutritional significance for effective planning of interventions.

Apart from nutritional deficiencies and risk for non-communicable diseases, in endemic areas of fluoride, flourosis will continue to be a public health problem as the fluorine content of the soil has been increasing over the time and at present fluorosis is prevalent in 20 states out of the 35 states and Union Territories of the Indian Republic. The fluoride can be present in foods, water, plants, rocks, soil and even air. The main contribution of fluoride to human beings is from water and to a certain extent from food especially in endemic areas. Significant work has been done to reduce fluoride concentration of water by developing defluoridation plants, but very less emphasis has been played on the role of nutrition.

This Highlight tries to address the role of nutrients and few strategies for effective implementation of nutritional programs to mitigate fluorosis especially to avoid skeletal fluorosis in children which is causing severe crippling and deformities of bone which cannot be corrected or treated.

Malnutrition and fluorosis

Nutrition appears to play a crucial role to reduce the toxicity of fluoride. Diet rich in calories, calcium, magnesium and vitamin C has been found to be effective in this regard especially beneficial to children in endemic areas which should prevent deformities and crippling. Research has shown that magnesium helps in elimination of fluoride from the body by competing with calcium and also it was observed that the fluorosis incidence is less in villages whose water content of magnesium is high compared to those with lower levels with similar fluoride in drinking waters (Reddy and Deme 2010). It has been proved that fluorosis incidence was high in individuals whose diet was poor in vitamin C intake.

Apart from the need for extra amount of these nutrients, malnourished individuals appear to be more prone to develop dental and skeletal fluorosis (Littleton 1999). The role of under-nutrition and fluoride toxicity has been established as early as in 1973 by Krishnamachari and Krishnaswamy (1973) who concluded that the occurrence of bone deformities among the poorer segments of the populations is suggestive of a detrimental role of under-nutrition on fluoride-induced toxicity. Mithal et al. (1993) also observed that the bone deformities due to fluorine toxicity are more commonly found in the poorer and undernourished population. Over 90 percent of the persons affected with severe skeletal fluorosis, bone disease and deformities belong to the poorer socio-economic group of the farming community and they had generalized nutritional deficiencies according to Teotia et al. (1984).

Lower limb deformities that are seen in individuals in endemic areas of Nalgonda are not seen in fluorotic regions of Punjab with same levels of fluoride in drinking water supplies. This may be because the people's nutrition is better in Punjab especially as per their calcium intake. Epidemiological studies in endemic regions in India and Japan suggested that the role of protein, calcium and vitamin C and its relation to severity of fluorosis. There is a great need to reduce fluorosis in much broader way considering various factors like reducing the fluorine content in food and drinking water, providing bone-seeking nutrients like calcium, magnesium, and vitamin C and most importantly the underlying cause that is Malnutrition need to be considered to mitigate fluorosis.

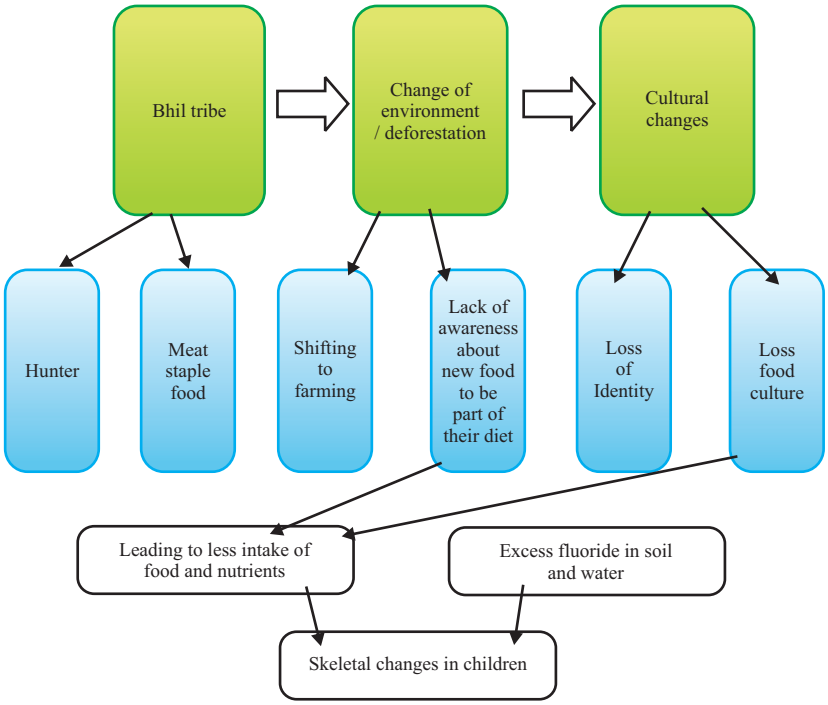
[1]This IWMI-Tata Highlight is not externally peer-reviewed and the views expressed are of the author alone and not of IWMI or its funding partners.

[2]This paper is available on request from p.reghu@cgiar.org

Environmental changes influencing fluorosis

Loss of habitat due to environmental changes leads to lack of known resources and availability of traditional food sources for those habitats and leading to malnutrition in children. The hunter gatherer of Bhil tribe from Jhabua district of Madhya Pradesh is the live example to observe loss of habitat and their access to traditional food and its consequence on the present generation who are stunted, malnourished, crippled and with severe bone deformities at quite a young age (Figure 1). Hunter-gatherers occasionally consumed cereal grains; however these foods were apparently not major dietary components for most of the year (Eaton and Nelson 1991). These hunter gatherers' change in the habitat and environment, lead to forced adaptability of agriculture and dependency on cereal based diet which lead to various nutritional deficiencies and other serious health related problems like skeletal fluorosis.

Figure 1 Fluorosis in Jhabua: Looking at the root causes



It was observed that whenever cereal-based diets were first adopted as a staple food replacing the primarily animal-based diets of hunter-gatherers, there was a characteristic reduction in stature, an increase in infant mortality (Cohen 1987), a reduction in lifespan, an increased incidence of infectious diseases (Lallo et al. 1977), an increase in iron deficiency anemia, an increased incidence of osteomalacia, and other bone mineral disorders. To tackle malnutrition or fluorosis the strategies need to be much broader.

Food security and nutritional interventions

Food Security, that is availability and accessibility of food by everyone at all time in the community, is a major challenge to ensure food security. Cultivating and depending on limited crops is one of the reasons for food insecurity and it also leads to nutritional insecurity. As a country, we are producing 3 times more rice than we consume, but importing pulses, almonds, cooking oil etc. If we had encouraged diversity in agriculture with multi-crop farming methods, we could have saved lot of imports and would have become nutritionally self-reliant. Similarly most of the 1.95 lakh[3] species of flowering plants produce edible parts which could be utilized by human being; however less than 0.1 percent or fewer than 300 species are used for food. Approximately 17 plant species provide 90 percent of mankind's food supply, of which cereal grains supply is far and away from the largest percentage (Loren 1999). There are various edible plants and its products, but still they have not made their way into regular diet, e.g. *Cassia tora* which is abundantly available in the rainy season is usually considered as a weed. UNICEF recommends *Cassia tora* which grows locally and is rich in calcium as a nutritional supplement and various studies have shown that it is one of the richest sources of Calcium; similarly there are various locally available nutritious plants which are abundantly available. Providing subsidy, Minimum Support Price and encouraging traditional and local food crops like *bajra, jowar, ragi* along with rice, wheat etc. would make various food grains available with required amount of essential nutrients at the local level. These cereals such as *bajra* and *ragi* can also be included in PDS and Mid-day meal program in ICDS and higher priority should be given to the local food crops than to the cash crops to ensure food security and to enhance the nutritional status. Calcium supplementation needs to be mandatory in fluorosis.

In spite of various nutritional interventional programs, the levels of child malnutrition in India are exceptionally high and little progress has been made over the past few years, the prevalence of under nutrition in India was 53.4 percent in 1998, it was reduced to 47 percent and 46 percent in 2005; the trend of change is discouragingly slow. We still house highest number of children with Vitamin A deficiency and anemia. In fact the level of anemia and stunting has gone up in NFHS-3 survey in comparison to NFHS-2. Government provides nutritional supplementation, but in endemic areas of Fluorosis regular ICDS supplementation may not be of much help

as the requirement for certain nutrients are much higher in quantity and quality than the general supplementation provided to the population. All the food based nutritional supplements are based on cereal and pulses. Cereal grains lack a number of nutrients which are essential for human health and well-being; additionally they contain numerous vitamins and minerals with low biological availability.

Table 1 Dietary imbalances of cereal grains

Nutrent	Vegetable source	Recommendation to address the micronutrient deficiency
Iron	Non heme iron (less absorbable of Iron)	Vegetarian diets may not entirely meet the requirements of iron and it is imperative that (non-milk) animal foods should be consumed to obtain heme iron (more absorbable); or else if cultural factors do not permit, absorption of heme Iron should be increased with more Vitamin C consumption
Vitamin A	Carotene (need to be converted in the body as active form of Vitamin A)	Need to consume good quantity of fruits and vegetables or need to include animal foods
Calcium	Inappropriate ratio of calcium: Phosphorous (presence of Phytates and oxalates which hinders absorption)	A minimum of 200 ml of milk/day would be essential on a cereal-legume diet.
B12	Vitamin B12 is absent in plant foods	Would need additional supplementation for a vegetarian diet

Table 1 explains the dietary imbalances of cereal grain based diet/ supplementation and ways to improvise the cereal grain based supplementation program.

As more and more cereal grains are included in the diet, they tend to displace the calories and nutrients that would be provided by other foods (meats, dairy products, fruits and vegetables), and can consequently disrupt adequate nutritional balance Loren (1999). So there is a need to relook at the supplements under nutrition programs, considering including non-vegetarian food source wherever it is possible.

Women empowerment and fluorosis

The origin of gender inequalities can be traced to Manu in 200 BC who mentions about the ideal behavior of a woman as "By a young girl, by a young woman, or even by an aged one, nothing must be done independent, even in her own house". According to United Nations Development Programme, on the gender development index (GDI), India's rank is 98 in a universe of 140 countries. A study on women's autonomy carried out by NFHS-2 (1998–1999) indicated that 85 percent of women participated in decisions about what to cook, but only 41 percent could decide independently on how they spend the money they earn. Women in South Asia tend to have lower status and less decision-making power than women in Sub-Saharan Africa. This limits women's ability to access the resources needed for their own and their children's health and nutrition. Excessive fluoride ingestion in pregnant women may possibly poison and alter enzyme and hormonal systems in the fetus causing disturbances in osteoid formation and mineralization Christie (1980). Ensuring appropriate weight gain during pregnancy is one of the important ways to ensure right intake of all nutrients to avoid fluorine toxicity. There are no intense programs in place to improve the overall weight gain during pregnancy which can influence the birth weight of the baby. Monitoring weight gain each month (something similar to child growth chart) and ensuring the weight gain during pregnancy along with calcium supplementation will help the child to be healthier. The nutritional intervention need to be initiated at the time of pregnancy itself, followed by colostrum feeding, exclusive of breast feeding for first 6 months of new born and healthy weaning food are the most important strategies which need to be implemented to avoid fluorine toxicity. These strategies are in place from more than a decade but due to the defined set of culture norms, less decision making power and loss of traditional feeding practices and lack of present nutritional guideline, the implementation of these strategies are not successful. Woman empowerment also include to sensitize the male member/spouse of the family about the special nutritional needs during pregnancy and the importance of good diet and nutrition for the child in the first 1000 days of the new born and consequences due to improper need, to be educated. In Bhil tribe the Dayya's (the male Mid-wife or Traditional Birth Attendant) are the one who conducts deliveries, and usually the father–in law takes the role of

[3]One lakh = 0.1 million

Daaya. Providing appropriate training to Dayya's about mother and child care and need to be taken up seriously.

In relation to maternal and child health, all the education being conducted for the women in the society have made woman more responsible, however without any power to implement; in contrast there is no responsibility or the awareness/education programs to the male member/spouse of the family to be part and ensure safe healthy pregnancy and child care. The fluorine toxicity needs to be reduced during the pregnancy and in the first few years of new born.

Fluoride toxicity afflicts children more severely and over a shorter period of exposure (about 6 months) as compared to adults. This is because the rapidly growing bones of children are metabolically active and more vascular and thus absorb and accumulate fluoride faster and in greater amounts than older bones (Teotia et al. 1998).

The nationwide intervention programs are in operation over decades, still the situation has not changed greatly. The commonly-held assumption is that food insecurity is the primary or even sole cause of malnutrition. Consequently, the existing response to malnutrition in India has been emphasized towards food-based interventions and has placed little emphasis on schemes addressing the other determinants of malnutrition. Various other interventions can be incorporated to strengthen the present programs, and help to improve the nutritional status of Indians.

Conclusion

Juvenile skeletal fluorosis in tribal regions such as in Jhabua (Madhya Pradesh) are symptomatic of larger phenomena – degrading environmental changes bringing upon contamination of water and food along with change in food habits causing under-nutrition. Over generations, communities propagate severe nutrition deficiencies and previously healthy communities now produce children with stunted growth and fluorosis. Addressing fluorosis therefore, needs action not only from water, but also to address this severe malnutrition of the child and the mother. A few nutrients such as Calcium, Magnesium and Vitamin C have been identified as important for fluorosis, but overall nutritional deficiency also matters in general. However, looking at current experiences combating malnutrition, addressing such specific deficiencies is going to be even more difficult. Though larger government policies are going to be important in this through fortification and supplementation, there is urgent need for increased awareness not only of mothers, but also of fathers who could be important decision makers. That child health will be affected by mother's nutrition during pregnancy. Lactation is something that needs to be understood by the father too. Even after such realization, continuation of existing cultural food habits will not solve this problem. In many places, cultural beliefs pose barriers – such as predominantly vegetarian diet. Lack of dairy products among the poor also creates a larger nutrition deficit. Fluorosis is just one disease arising out of nutritional deficiency exacerbated by high fluoride in water. Such severe mother and child malnutrition are causing many such problems which have a longer gestation period and pass away unnoticed. We are at the cusp of time requiring urgent action on this front. An entire generation stands to gain from such effort of proper nutritional program.

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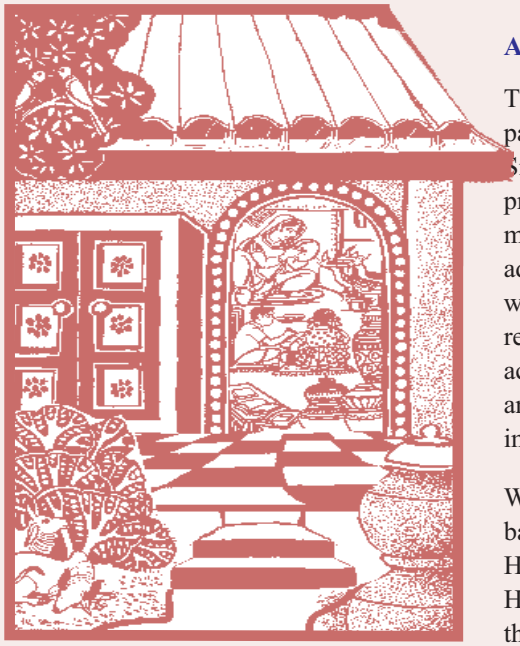

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The IWMI-Tata Water Policy Program (ITP) was launched in 2000 as a co-equal partnership between the International Water Management Institute (IWMI), Colombo and Sir Ratan Tata Trust (SRTT), Mumbai. The program presents new perspectives and practical solutions derived from the wealth of research done in India on water resource management. Its objective is to help policy makers at the central, state and local levels address their water challenges – in areas such as sustainable groundwater management, water scarcity, and rural poverty – by translating research findings into practical policy recommendations. Through this program, IWMI collaborates with a range of partners across India to identify, analyze and document relevant water-management approaches and current practices. These practices are assessed and synthesized for maximum policy impact in the series on Water Policy Highlights and IWMI-Tata Comments.

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