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Critical Discussion and Recommendations on Improving the Intake of Micronutrients in the Diets of School going Bangladeshi Children

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Abstract: Micronutrients are nutrients that are needed in incredibly small quantities for maintaining proper health. In children, these nutrients may be exceptionally important for growth and proper physiological development. This paper has discussed the lack of proper attention given to micronutrient deficiency in growing children caused by an insufficient intake of minerals, B vitamins and essential amino acids, which the body cannot make. Whilst the issue of iodine and vitamin A deficiency in children has been disseminated to the mainstream, the same has not been done for other important micronutrients. This a discussion and recommendation paper that has attempted to lay out the importance of launching a revamped national enlightenment and action programme to address not only persistent Vitamin A deficiency, but also the much less talked about and operationalized minerals, B Vitamins and essential amino acids.
Keywords: Micronutrients, health, minerals, B vitamins.

INTRODUCTORY BACKGROUND

The term micronutrients are a vague concept amongst the masses of rural and inner city financially disadvantaged Bangladeshis. Despite having somewhat of a workable knowledge on nutrition as a whole, the concept of micronutrients is one that is not known to most Bangladeshis, especially the parents of primary and secondary school going children.

According to the World health Organisation [1], *micronutrients* are referred as so because of the fact that these nutrients are required only in tiny amounts. Micronutrients have been referred to as "magic wands that enable the body to produce enzymes, hormones and other substances essential for proper growth and development." It has been noted that the tiny amounts of micronutrients needed by the body should not be in any way be used to judge their importance in the human body.

The World Health Organisation notes that the consequences of the absence of micronutrients may be "severe." Iodine, vitamin A and iron are most important in global public health terms; their lack represents a major threat to the health and development of populations the world over, particularly children and pregnant women in low-income countries.

The following table, Table 1, lays out the necessary micronutrients that are required by the human body in trace amounts, List of Micronutrients [2].

Table-1: List of Micronutrients

Vitamins	Minerals	Amino Acids	Other Essential Nutrients
Vitamin C	Magnesium	Taurine	Green Tea Leaf Extract
Vitamin B3 (Niacin, Niacinamide)	Calcium	L-Lysine	Bioflavonoids
Vitamin B5 (Pantothenate)	Potassium	L-Proline	Inositol
Vitamin B1 (Thiamine)	Phosphorus	L-Arginine	Coenzyme Q-10
Vitamin B2 (Riboflavin)	Trace Elements	L-Carnitine	
Vitamin B6 (Pyridoxine)	Zinc	L-Cysteine	
Vitamin B12 (Cyanocobalamin)	Manganese		
Folic Acid	Copper		
Biotin	Selenium		
Beta-carotene	Chromium		
Vitamin D3	Molybdenum		
Vitamin E (d-alpha-Tocopherol)			
Vitamin B3 (Niacin, Niacinamide)			
Vitamin B5 (Pantothenate)			

It may be argued that Bangladeshi parents are aware of nutrients such as iodine or Vitamin A; however, it may be equally argued that the properties, scope of function, and vital importance of these nutrients for health and human development, and their designation as 'micronutrients,' is not known to most Bangladeshi people. Figure 1 below shows the sources of some micronutrients.

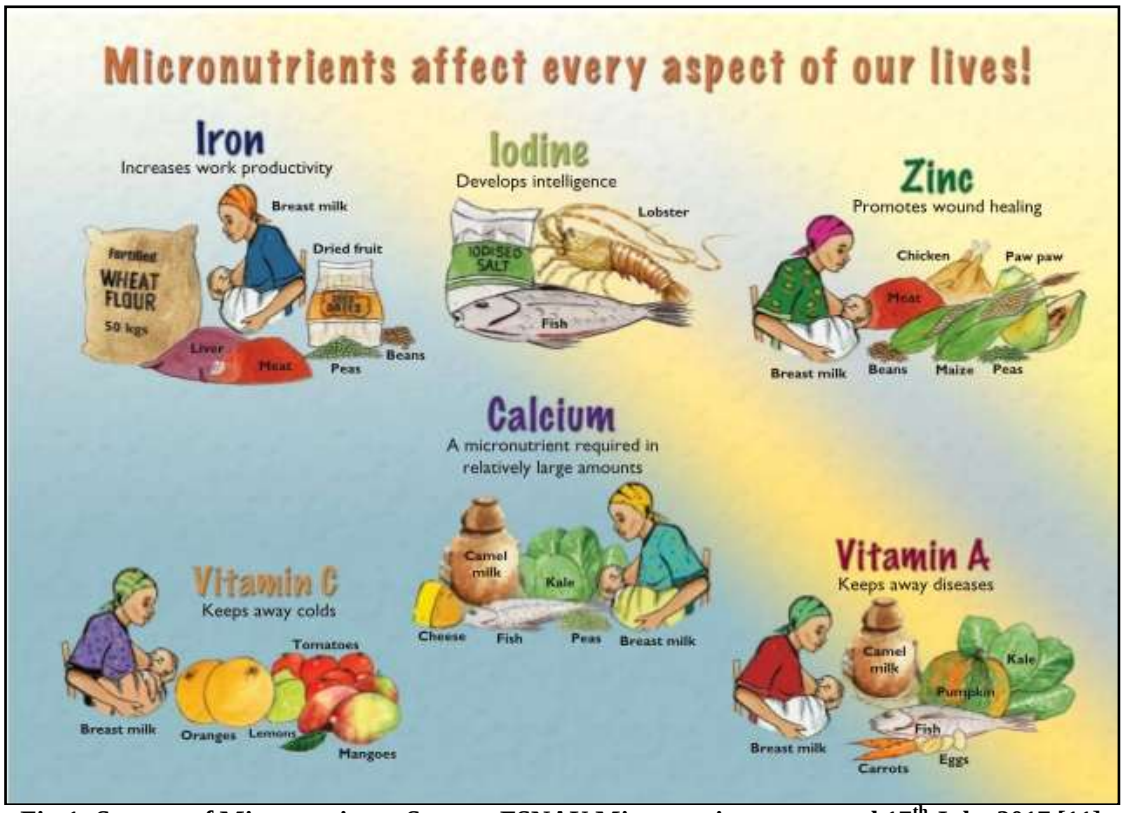

Fig-1: Sources of Micronutrients, Source: FSNAU Micronutrients, accessed 17th July, 2017 [11]

However, the case of Iodine may be taken as an exception; the government has taken strenuous efforts to ensure dissemination of information about Iodine to the general masses in Bangladesh, not least the parents of primary school going children. Vitamin A supplements have also been heavily marketed by NGOs and government agencies alike as a necessary supplement. However, the idea of the necessity of Vitamin A as a supplement in the regular diet has not achieved acceptance in the wider public. Figure 2 highlights the daily amount of micronutrients required per kilogram of body weight, Falcão and Tannuri [3].

Sodium	3-5 mEq
Potassium	3-5 mEq
Magnesium	0.3-0.5 mEq
Calcium	2-4 mEq (preterm, 4-6 mEq)
Phosphorous	1-2 mEq
Zinc	150-200 mg (preterm, 400-600 mg)
Copper	10-20 mg
Iron	1 mg
Vitamin A	233 units
Vitamin C	6 mg
Vitamin D	66 units
Vitamin E	0.66 units
Vitamin B_1 (thiamine)	0.055 mg
Vitamin B_2 (riboflavine)	0.07 mg
Vitamin B_3 (niacine)	0.9 mg
Vitamin B_5 (pantothenic acid)	0.3 mg
Vitamin B_6 (pyridoxine)	0.05 mg
Biotine (vitamin B_7)	30 mg
Folic acid (vitamin B_9)	8 mg
Vitamin B_{12} (cyanocobalamine)	0.04 mg

Fig-2: Daily amount of Micronutrients required per kilogram of body weight, Falcão and Tannuri [3]

The reasons for this are a lack of relevant targeting of information, lack of relevant education, failure of people to peruse necessary books and magazines focusing on nutrition, and also the lack of interest in nutrition in beyond the plain concept of basic fruits and vegetables.

LITERATURE REVIEW

Karim *et al*. [4] conducted and presented a study on the attempt to seek optimal means to address micronutrient deficiencies in food supplements; a case study approach was utilised, with focus on Bangladesh's integrated nutrition project.

The primary focus of the study was placed on two particular micronutrients, namely, iron and vitamin A. According to the authors of the study, cost and bulk constraint analyses (based on cost of supplements), feasibility of delivery mechanisms and serving volumes needed to achieve micronutrient distribution targets were utilised for comparing the different supplement options. The study concluded that as per this methodology of analysis, the "micronutrient multi-mix proved, by far, to be the most advantageous," Karim *et al*. [4]. However, the authors concluded that instead of supplements, actual food was arguably more desirable, due to the fact that actual food provided "dietary benefits additional to that of known micronutrients," and that based on economics, this trend might increase the market demand for food, in turn boosting local production of domestic fruits and vegetables for the population as a whole.

The study finally concluded that it was "cost-effective" to consume powdered micronutrient mixes for the purposes of food enrichment and food fortification, but "encouraged production and consumption of micronutrient- rich foods through programme messages and activities," Karim *et al*. [4].

A report by the World Health Organization and the United Nations Children's Fund in 2007 titled 'Reaching Optimal Iodine Nutrition in Pregnant and Lactating Women and Young Children' stated that in 1994 a special session of the WHO and UNICEF 'Joint Committee on Health Policy' had recommended Universal Salt Iodization (USI) as a "safe, cost-effective and sustainable strategy to ensure sufficient intake of iodine by all individuals." The report also referred to the committee's suggestion that temporary iodine fortification should be considered as an option in "areas of severe iodine deficiency where USI cannot be rapidly implemented," WHO and UNICEF Joint Statement [5].

The report also stated that based on new evidence and lessons learned, it appeared that the most susceptible groups, namely pregnant and lactating women, and children less than two years of age, may not be sufficiently receiving iodized salt in areas where USI was not fully implemented. The statement concluded that this situation may "jeopardize the optimal brain development of the fetus and young child," WHO and UNICEF Joint Statement [5].

A report by the WHO, WFP and the UNICEF in 2007 titled 'Preventing and controlling micronutrient deficiencies in populations affected by an emergency' stated that deficiencies of micronutrients were "a major global health problem," WHO, WFP and UNICEF Joint Statement [6]. The statement highlighted the fact that in excess of 2 billion people globally (at the time) was estimated to be deficient in key vitamins and minerals, "particularly vitamin A, iodine, iron and zinc." The reported pointed out that most of the 2 billion people thought to be micronutrient deficient lived in low income countries and were usually deficient in multiple micronutrients, and not one. According to the report, deficiencies occured when people did not have access to micronutrient-rich foods such as "fruits, vegetables, animal products and fortified foods." The report stated that this was the case because micronutrients were usually too expensive to purchase or were locally unavailable. The report concluded that micronutrient deficiencies increased the general risk of infectious illnesses and death from diseases such as "diarrhea, measles, malaria and pneumonia," and that these conditions were among the 10 leading causes of disease in the world (in 2007), WHO, WFP and UNICEF Joint Statement [6].

Jamil *et al*. from the ICDDR Bangladesh conducted a study in 2008 on micronutrients and anaemia, and the connection between these two phenomena. The study critically identified that micronutrient deficiencies and specifically anaemia remained major health concerns for the children of Bangladesh. As per the findings of the study, fortification of food with vitamin A to children aged less than five years, among other micronutrient interventions, had turned out to be the most successful locally, and especially after vitamin A was distributed combined with the proceedings of National Immunization Days held in Bangladesh annually. Surprisingly, the study concluded that although iodine fortified salt sold was supposed to be distributed in Bangladesh commercially, much of the salt was found to not contain iodine as per their findings, and that iodine deficiency in Bangladesh continued to be a common phenomenon, Jamil *et al*. [7].

Additionally, anaemia was similarly found to be common among all population groups, and the disease up to that date had shown no sign of improvement, even with the full scale operationalization of iron-supplementation programmes. The study finally concluded with a note on zinc deficiency, and identified the micronutrient as a key contributor of deficiency, Jamil *et al*. [7].

Rahman [8] presented a study on the 'Micronutrient Profile of Children and Women in Rural Bangladesh: Study on Available Data for Iron and Vitamin a Supplementation.' The study concluded that only 64% of surveyed children had received vitamin A dosage in the six months preceding the survey, and that overall in general, only a measly 14% and 45% of mothers had received a postpartum vitamin A dosage and an iron tablet respectively. The study also found out that the rate of vitamin A dosage received by children were lower in Barisal division (Bangladesh), when compared to the other five divisions. The study also reported the presence of inequalities in children and women receiving vitamin A and iron supplements. The study concluded that the proportion of children receiving Vitamin A dosage, and mothers receiving adequate iron in their diet was found to be higher in those wealthier families.

A national micronutrient survey was published in 2013. The study was presented based on data that had been collected between 2011 and 2012, and was conducted in collaboration with the ICDDR Bangladesh, UNICEF Bangladesh, Global Alliance for Improved Nutrition (GAIN), and the Institute of Public Health and Nutrition (IPHN). The study revealed many salient findings, as per the conclusions provided by the authors.

The study revealed that the deficiency of vitamin A, as was measured by a low serum retinol (<0.7 mmol/l) was "20.5% and 20.9% respectively in the preschool age children and school age children," National Micronutrient Survey (2013). According to the study, the prevalence of Vitamin A deficiency appeared to be higher among slum children, 38.1% in the preschool age children, and 27.1% in the school age children.

The study very importantly noted that the consumption of vitamin A from regular food intake appeared fairly short of the recommended daily requirement in all of the population groups surveyed. The study stated that the major share of vitamin A (60.0-77.0%, across the population groups studied) came from the plant source Beta-carotene, which was deemed to be "poorly bio-available in the body."

The study noted that the prevalence of zinc deficiency was very high, namely 44.0% in the preschool age children. The deficiency was apparently higher in the slums-52.0% in the preschool age children. The study chiefly noted that the amount of consumption of zinc was well below the recommended daily amount. The study noted that the major proportion of total consumption came from plant origin, which was poorly bio-available. Lastly it was mentioned that Phytate, an inhibitor of zinc absorption in the body, and being present in plant origin food, was high in foods present in a typical Bangladesh diet, was ultimately contributes to high zinc deficiency, National Micronutrient Survey [9].

Regarding iron deficiency, the study noted that the prevalence of anemia in the preschool age children was 33.0%. The prevalence in the school age children was 19.1% and 17.1% in the 6-11 year and 12-14 year old children. The amount of consumption of iron from food was found short of the daily recommended requirement (RDA) in all the population groups studied. The total consumption of iron from food was 41.0-82.0% of the recommended daily requirement across age and sex of the studied population groups. The amount of consumption of animal origin 'heme' iron, which has higher bio-availability, was a meager 6.0-15.0% of the daily requirement, National Micronutrient Survey [9].

In seeking to improve the micronutrient contents of a food supplement used in a major community based nutrition project in Bangladesh, operations research was conducted to compare the provision of needed micronutrients through additional food sources (fresh or dried fruits or vegetables), a micronutrient multi-mix, and a combination of the two. Micronutrient gaps (the difference between micronutrient requirements and actual micronutrient intake) were estimated for four groups of project beneficiaries, with target intakes defined as requirements for iron, calcium, zinc, vitamin A, vitamin C, riboflavin, niacin, and vitamin B12 recommended by the Food and Agriculture Organization/World Health Organization.

Adams *et al*. [10] conducted and presented a study on the impact of fortified biscuits on micronutrient deficiencies among primary school children in Bangladesh. The study was the most recent work on micronutrient deficiency undertaken in Bangladesh. The authors identified that micronutrient deficiencies could compromise the potential for development of school aged children, and that micronutrient deficiency could also affect their later health and productivity down the line as they transition to adulthood. The authors stated that school feeding and school-based fortification programmes had been implemented across countries to address nutritional deficiencies in the school going age group.

The study analysed the "acceptability and impact" of a Bangladesh government sponsored school based micronutrient fortification program for primary school going children in 10 disadvantaged administrative sub-districts.

The study concluded, based on results, that daily consumption of fortified biscuits by primary school children had a significant positive impact on average uptake of iron, folic acid, vitamin B12, retinol and vitamin D. The results were significant even after

sex, baseline deficiency status, CRP, and H. pylori were effectively controlled for. According to the study, the levels of anemia and vitamin D deficiency in studied persons "were also significantly reduced," Adams *et al*. [10].

Qualitative findings indicated the widespread acceptability of the daily biscuit, and additionally, teachers "perceived" students to be more attentive in class, and less tired. Some teachers also attributed better school performance to biscuit consumption, according to the authors. The children who took part in the study also reported similar improvements in "concentration and energy levels," Adams *et al*. [10].

This study has been among the first in the country to widely assess a school-based fortification program in terms of its "acceptability and impact on micronutrient status of children aged 6±11 years of age.

DISCUSSION

The dissemination of micronutrients through special powder mixes have been largely successful, as have been borne out through the review of literature presented above, which are based on field reports and studies by prominent groups. The case of vitamin A, iodine and iron has received much attention from NGOs and government sponsored programmes. However, other micronutrients such as essential amino acids (that the body cannot produce by itself), B group of vitamins, and essential minerals have been largely neglected by such programmes.

The exclusion of these micronutrients from the coverage of programmes has adverse consequences for children's health. Additionally, the cost of some of these micronutrients is also higher than those being included in the programmes. For example, it is generally accepted knowledge that essential amino acids and B vitamins are more expensive than iodine and vitamin A.

However, the inclusion of iodine and vitamin A in most programmes should be used to reach the conclusion that these micronutrients have achieved non-deficient status in the diets of Bangladeshi children. The literature review suggests that there is still a case to be made for vitamin A and iodine deficiency in children. There is additionally the factor of research coverage. The studies that have been mentioned have been conducted using limited samples that are not geographically dispersed. These points to the fact that many children who might be strongly deficient in micronutrients have not been included in the scope of deficiency status studies.

Additionally, there is the point of project duration. Many of the powder fortification programmes are projectized initiatives. Meaning, they have a start and an end. The problem arises when these projects end. Fortification cannot be suspended for long periods of time as children constantly require micronutrients for growth and development. Moreover, there are constantly new babies born who grow to become young school going children in between programmes. Their presence mustn't also be sidelined due in between programmes.

Recommendations

This paper recommends a new form of policy to tackle the problem of micronutrient deficiency. Any policy that seeks to address micronutrient deficiency must address the fact that it is simply not rural parents who are not accustomed to the concept of micronutrients, but also urban inner city parents as well. There is a very hard choice for programme managers because the two areas require somewhat different approaches to the concept of addressing nutrient deficiency. Cultural differences between rural and urban inner city people are a major factor in determining how to address the concept of deficiency.

Additionally, urban slum areas also require a different approach. The cultural values of the residents living in these areas are somewhat of an amalgam of the previously two mentioned types of people.

The nature of the target population, namely school going children of less than 12 years of age, means that it is often unreasonable to directly teach children about nutrition and rely on them to eat the food products. Children that young are unable to purchase foods by themselves and are often not in a position to influence the food purchasing decisions in the household.

Hence, parents must instruct to make the food choices for the children at home. The choice of whether to rely mostly on fortified biscuits versus a reliance on mostly natural market/grocer sourced foods is a matter of discussion. Fortified powder mixes are quick solutions targeted at the children. They are usually specially manufactured and require a separate logistical apparatus to introduce into the target population. They are usually not sold through local grocers, and are instead provided through NGO field workers who deliver them directly to schools and sometimes homes. The problem with this solution is that it is a non-continuous effort. The supply of these products stops when the programme duration, usually 1 to 6 months, is over. Additionally, the product mixes are monotonous in taste and are slightly expensive.

Hence, this paper recommends a policy of natural food reconstitution that will enable grocer sourced food to be fortified, to a certain extent, with the necessary micronutrients. The case of cooking oil is an interesting example. Vitamin A is being added in small amounts to cooking oils such as soybean and sunflower oils, which are consumed on a daily basis at the

household by children. The government could have a strong weapon in the fight against vitamin A deficiency if it can insure maximum coverage of vitamin A fortified cooking oil. The same may be done for typically consumed children's food products such as energy biscuits, cookies, etc. The inclusion of specific B vitamins in small quantities into cooking oil can enable children to acquire this much neglected micronutrient from everyday food through the oil. The same might be done for some amino acids. Additionally, the inclusion of amino acids in children's biscuits can also be an option.

Focusing on normal food for nutrition, as opposed to powders and specially prepared supplements, can be a lesser expensive and logistically feasible option for the government. Additionally, it will set up a national system for addressing micronutrient deficiency, and not a solution that is only tenable for short periods of time. Education at the grassroots level can serve as the primary cure for micronutrient malnutrition. Information can be the most powerful tool, and serves as a longer lasting solution than simply asking people to eat powders. Family nutrition counselling can be used to improve the level of knowledge that families, especially parents, have about micronutrients. This counselling regimen can be integrated into the structure of other programs such as birth control counselling, agricultural counselling, or education counselling. This will bring the benefit of lowering costs of the programme and achieving maximum dissemination of information. Additionally, schools could be used to host meetings between parents and teachers. In such meetings, parents could be directly counselled on the merits of micronutrients, their sources and how to affordably buy them, and consequences of micronutrient deficiency.

The case of minerals is however purely an issue of counselling, as minerals are readily available in roots and tubers that abundantly grow in Bangladesh. The various types of such vegetables are available at affordable prices, or may be grown easily by people at home in front of their plots, or lawns. The problem remains the lack of awareness of the importance of these foods. Proper counselling must aim to correct parent's view of these foods.

In the long term, affordable food will have to be the most viable solution. It is a matter of economics, as expensive food can never be afforded by the masses. Essential foods that are vital sources of micronutrients needed by children must be sold at a price that will allow ordinary families to be able to disseminate them. This is perhaps the most important factor, as affordability and price determines the purchase decision for most people. Even with successful counselling, there is no guarantee of elimination micronutrient deficiency as people will not be able to buy sufficient quantities of food if it is priced too highly.

Lastly, micronutrients must be brought out in the main stream. They should not be relegated to chatter in the nutritional doctor's room. Iodine and Vitamin A have become mainstay terms as far as nutrition is concerned. However, the same is not true for B vitamins, essential minerals, and amino acids. National campaigns must introduce these terms to the mainstream and convey their importance to children's health.

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