Addition of Essential Micronutrients to Foods – Implication for Public Health Policy in Israel

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Abstract

Micronutrient deficiencies have reoccupied the center stage of public health policy with the realization that folic acid deficiency results in neural tube defects and possibly other birth defects as well as ischemic heart disease. These, in turn, have raised an older debate on food fortification policy for the elimination of iodine, iron and vitamin D deficiencies. Data from the First Israeli National Health and Nutrition Survey (MABAT 2000) provided an impetus to develop an active national nutrition policy aimed to improve the nutritional status of iodine, iron, vitamins A and D and B-vitamins, including folate. In this paper we examine some of the micronutrient deficiency issues in Israel and their implications for public health, and suggest options for the formulation of policy.

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Micronutrient deficiencies are of public health concern since they affect health, function, and physical and cognitive development through the life cycle, and contribute to excess morbidity and mortality of billons of people [1]. These deficiencies result in a wide array of health and developmental defects including birth defects, delay in cognitive and physical development, and increased risk of non-communicable diseases [2].

The addition of micronutrients to food for health reasons has been known for many years:

- *Iron:* The first evidence of adding micronutrients dates to 400 B.C. when the Persian physician Melanpus suggested the addition of iron filings to wine to increase soldiers' "potency" [3].
- *Iodine:* In 1825 the French physician Boussingault proposed adding iodine to table salt in Colombia to prevent brain damage from iodine deficiency [3]. In Europe in 1900, iodine was commonly added to table salt. During World War I, goiter was found to be a common reason for the rejection of conscripts, especially among those from the midwestern parts of the United States. In 1924, the first manufacture of iodine-enriched table salt (Morton's Iodized Salt) became the North American universal standard for salt used at the table and in food production [3].
- *Vitamin A:* Vitamin A deficiency occurred in Denmark during World War I. In 1918 margarine was enriched with this vitamin.
- *Vitamins B:* Pellagra with its characteristic "four Ds" (diarrhea, dermatitis, dementia and death) was a serious public health problem in the USA in the early part of the 20th century and was widely regarded as an infectious disease. Investigation by the U.S. Public Health Service, led by Goldberger, between 1914 and 1921 [4] found that pellagra was remediable and preventable by dietary changes. During the 1930s, voluntary fortification of flour was widely implemented to deal with the problem, and subsequently, a number of southern states mandated fortification of flour with vitamins B, resulting in a dramatic drop in pellagra deaths in the country [5].
- *Vitamins D:* Vitamin D was first added to cows' milk in 1931 to improve calcium absorption and prevent rickets. This gradually led to the virtual disappearance of rickets in western countries. In Canada, after World War II, the addition of vitamin D to milk was deregulated and many milk producers ceased fortification. Consequently, in the 1960s, rickets reappeared as a cause of hospital admissions in Montreal. Fortification of milk prodcuts was then made mandatory and rickets completely disappeared in Canada [6].
- *Fortification as a public health policy:* In 1938, in efforts to prevent micronutrient deficiencies in the depression-ridden United States, a food fortification program was established and included vitamin B1 (thiamin) to prevent beriberi, niacin to prevent pellagra, riboflavin for efficient use of vitamin B6, and iron to prevent anemia. In 1941, regulations were enacted to enrich flour. From 1943, all "enriched" flour was required to include these vitamins and minerals, and allowed for the possibility of adding vitamin D and calcium. This was expanded later to include corn flour in 1943, pasta in 1946 and rice in 1958. The success of this approach in reducing nutritional deficiencies led to the White House Conference on Nutrition in 1969, which adopted fortification of breakfast cereals with B-vitamins and iron [4].
- *Folate:* The discovery during the 1980s that folic acid administration prior to pregnancy reduces neural tube defects by some 70% provided a new challenge and stimulus to public health policy makers [7]. Since there is only a 30% compliance with the recommendations for supplementation to women in child-

bearing age both in the USA and in Israel [8,9], it became clear that another approach to intervention was required. Fortification of flour and grains with folate was adopted in 1998 in the United States, and was followed by a decline in the total prevalence of neural tube defects from a baseline of 2.0 per 1,000 births to 1.1 per 1,000 births in 1999 [10–12]. This success of a population-based approach raised issues in the longstanding debate on the role of governments regarding the addition of micronutrients to staple foods to prevent and eliminate this deficiency.

In Israel, there are high risk groups suffering from inadequate intake of certain micronutrients. These include infants and pregnant women with inadequate iron and calcium intake, women of childbearing age with low iron and folic acid intake, and the elderly with deficiencies in folate, iron, and vitamins B12 and D [13–15].

Alternative approaches

There are two possible approaches to improve micronutrient intake. One is through use of nutritional supplements consisting of medicinal intake of vitamins and minerals. The second, a "food-based" approach, includes dietary modification to increase dietary diversity as well as the addition of micronutrients to foods.

Promoting micronutrients consumption by the use of nutritional supplements requires long-term compliance and excellent outreach programs. Even in health-conscious populations it is largely successful, but among the middle class only. Modification of the population's dietary intake is also a long-term process that requires changes in knowledge, attitudes and practices of the risk groups. On the other hand, a program for the addition of micronutrients that is based on the current dietary habits of the population and its various sectors does not require compliance or changes in eating habits. Experience from many countries reveals that the addition of micronutrients to foods has resulted in the virtual elimination of such deficiencies [16].

The regulations governing the addition of vitamins and minerals to foods vary widely from country to country. In Austria, for example, the addition of micronutrients is uncontrolled, with only basic requirements for safety and labeling. In Italy, the addition is almost forbidden and tightly controlled by the authorities. In Canada, the Food and Drug Regulations list foods for mandatory fortification and foods with optional addition of micronutrients. The levels of the micronutrients are usually specified in the legistlation [17].

The *Codex Alimentarius* states five principle for the policy of addition of micronutrients to foods. These are aimed to prevent practices that may mislead or deceive the consumer and prevent random nutrient addition, which could lead to both excessive and inadequate intakes and create nutrient imbalances [18]. Restoration programs to return vitamins and minerals lost in food preparatrion provide the consumer with more food choices while maintaining nutritional adequacy.

In order for such a program to be effective the appropriate vehicles should be identified. A "vehicle" or a "matrix" is the food that is used for the addition of micronutrients. The consumption of the vehicle should be stable and uniform, and the amount added to it sufficient to correct the deficiency. The selection of vehicles for the purpose of fortification is based on the food consumption patterns of the population and target groups. The consumption of the vehicles should be either widespread (universal approach for the general population) or limited to a segment of the population (targeted approach). In each country food consumption is not homogeneous and differs with social economic status and with ethnic, age, gender and other subgroups. In Israel, due to vast immigration, the culinary habits are even more diverse. Therefore, Israel should tailor its own nutrition policy to meet the needs of the general population as well as different sectors and communities. The First National Health and Nutrition Survey (MABAT) provides the information for an evidence-based nutrition policy [19].

The Dietary Reference Intakes established by the U.S. National Academy of Sciences, and used worldwide, provide values that may be used for planning and assessing diets for healthy populations, and for many other purposes including judging the need for pubic health interventions, such as food fortification [20,21]. The DRIs encompass the Estimated Average Requirement, the Recommended Dietary Allowance, the Adequate Intake, and the Tolerable Upper Intake Level [22]. The use of nutrients in the treatment, mitigation or cure of a disease or disability is not considered when setting the DRIs and thus should not be a part of a national fortification program. The dosages for the fortificants should be tailored so that daily consumption will not exceed the Upper Intake Level and should be such that the general population will be able to consume safely even when having a high usual dietary intake of the vehicle without a need for special labelling or directions for use.

Concerns that manufacturers might add vitamins and minerals to many foods without regulation and public accountability led the American Medical Association and the United States Federal Government to support fortification under the following carefully defined conditions:

- Dietary consumption of a major part of the population is lower than the DRIs
- The selected vehicle is consumed in a sufficient and known quantity so that the addition will contribute in an important manner to the nutritional status of this population
- The food addition will not adversely affect the balance of other essential elements
- The added micronutritient will be sustained in the production and shelf life of the food
- The micronutirent will be biologically active in the chosen food
- Assurance that the added micronutrient will not result in excess intake and toxicity.

Fortification for the purpose of marketing and market share is not included in these criteria [23].

In 1979 Canada adopted food fortification as a part of mandatory regulations that are periodically updated, including supervision of the Federal Department of Health and Welfare. Mandatory addition of micronutrients include:

- Iodine in salt
- Vitamin D in all milk and dairy products, including evaporated milk and vitamin A in low fat milk
- Vitamins A and D in margarine

DRI = Dietary Reference Intake

- Folate, riboflavin, niacin, and iron in all flour and its products
- Vitamins and minerals in baby formulas and cereals and medical foods
- Vitamins and minerals in meat and egg substitutes to levels comparable to those foods they replace.

The Canadian regulations for food and drugs also include a list of foods to which it is permitted to add food elements and in what amounts. These include: vitamin B6, pantothenic acid, calcium and magnesium to white flour; thiamin, riboflavin, niacin, iron, calcium, zinc and iodine to baby cereals; thiamin, niacin, vitamin B6, folate, magnesium, iron and zinc to breakfast cereals; thiamin, riboflavin, niacin, vitamin B6, folic acid, pantothenic acid, magnesium and iron to pasta; thiamin, niacin, vitamin B6, folic acid, iron and zinc to fruit-flavored juices and drinks; vitamin C to fruit and vegetable juice; vitamin E to margarine, vitamin D to goats' milk, vitamin A and D to low fat goats' milk, vitamin C and D and folic acid to special goats' milk; and vitamin A, C, D and folic acid to low fat goats milk. The manufacturers are required to include fortified vitamins and minerals in the food label and to define the amounts added. The food labeling permitted includes wording such as: "A good source for..." or "an excellent source for..." as well as declaration of physiologic activities of the added elements. Health statements related to these additions or their medical effects are forbidden on the package and in advertisements [17].

Micronutrient deficiency conditions in Israel: the case-for action

Present Israeli legislation for the addition of micronutrients includes only a very limited number of food products: vitamins A and D to low fat (1%) milk and to margarine. Other micronutrients are added by manufacturers in an uncontrolled and unplanned manner, without an overall policy (including assessment, identification of the target population, selection of vehicles, laboratory testing, and detailed labeling), and without consideration of appropriateness. In many cases the additions are for marketing purposes. With increasing awareness of the fact that food fortification is an important tool in health promotion and that the recognition of the important role for the food manufacturers in promoting the health of the population, there is a call for formulation of a National Food Fortification Policy [24]. The evidence on micronutrient deficiency conditions in Israel is persuasive, such as the high rates of anemia of infancy and pregnancy, iodine deficiency in parts of the country, and vitamin D deficiency, especially in the elderly and seasonally [25]. A special committee, set up by the Ministry of Health in 1995, recommended food fortification for the country (Berry Committee, Department of Nutrition, 1996). Also, a Joint Israeli-Palestinian Conference on Micronutrient Deficiency Conditions, held in Jerusalem in January 2000, provided an opportunity for presentation and review of available local evidence, and for consulting with public health nutrition experts from other countries [26]. The data show a need for the addition of B-vitamins, vitamin D, iron and calcium to staple food, with special attention to the enhancement of folic acid intake by women in the preconception period [19,27]. To date, there is no evidence that iron fortification of foods is associated with increased risk for clinical disease due to hemochromatosis [28]. Also, folic acid has an excellent safety profile, and a daily intake of up to 15 mg has not been associated with significant side effects [29]. The only reported problem with excess folic acid is that it might mask the early stages of B12 deficiency, so that the neuropathy associated with more advanced B12 deficiency might be the first clinical sign [30]. The American Institute of Medicine has set the Tolerable Upper Intake Level for adults for folic acid at 1,000 μg per day, exclusive of that in food [20,30]. Since reports from Israel have shown that vitamin B12 levels might be low [13,31], it is suggested that the food policy demand the addition of both vitamins to flour.

Summary and conclusion

The case-for-action to prevent micronutient deficiency conditions is compelling. The action required is adoption and implementation of a strategic food fortification policy based on demonstrated deficiencies in Israel and the current standards of "good public health practice," i.e., mandatory fortification as follows:

- Vitamin A in skim milk and vitamin D in all milk and milk products
- Folic acid, iron, vitamins B1, B2, B6, B12 and niacin in all flour, grains and their products, and in baked goods, breakfast cereals and pastas
- Iodine in all salt
- Vitamin C in fruit drinks.

The steps needed for the application of a food fortification program include preparation of appropriate regulations and legislation and their processing through the standard channels. At the same time, discussions should be carried out by physicians and medical professionals with organizations of consumers and manufacturers as well as the media on the health damage done by failing to take the necessary steps for prevention of micronutrient deficiencies in our population. Food fortification is of public health importance and a priority of the first order. A review by the U.S. Centers for Disease Control noted that food fortification was one of the major achievements in public health in the 20th century [4]. It is now time to accomplish this in Israel.

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People say that life is the thing, but I prefer reading

Logan Pearsall Smith (1865-1946), U.S.-born British essayist and aphorist

Capsule

T cells and tolls

Leprosy occurs as distinct clinical phenotypes, with more resistant patients presenting localized skin lesions and susceptible individuals afflicted with a systemically disseminated form of the disease. Clear differences in the magnitude and type of immune response correlate with these two forms, suggesting a direct immunologic influence on how the disease advances. Krutzik et al. show that Toll-like receptors (TLRs) of the innate immune system are differentially activated in response to the leprosy bacillus, *Mycobacterium leprae*. Cellular activation by killed *M. leprae* required TLR2 but could be intensified by co-expression of TLR1, suggesting dual contributions from TLR2 homodimers and TLR1-TLR2 heterodimers. Two potential lipoprotein ligands for these TLRs, identified from a genome-wide scan of *M. leprae*, also elicited a response. Activation by a synthetic form of one of these ligands and TLR1-TLR2 expression were both enhanced by T helper cell type 1 (TH1)-associated cytokine, but diminished by TH2 cytokines. Increased TLR expression in leprosy skin lesions from resistant patients, who are known to express elevated levels of TH1 cytokines, was also apparent. Thus, the modulation of TLR expression and activation by cytokines may determine immunologic status and clinical outcome in this disease.

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