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REVIEW

Nutritional deficiencies in the pediatric age group in a multicultural developed country, Israel

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Core tip: In view of the wide nutritional deficiencies in Israel, we encourage local health, education and industrial ministries to expand efforts to study and document those deficiencies with the vision of fortifying basic commonly used foods in order to fight the deficiencies and prevent their occurrence in the future.

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Abstract

Nutrient deficiencies are prevalent worldwide. Diseases and morbid conditions have been described to result from nutritional deficiencies. It is essential to address nutrient deficiencies as these may lead to chronic long-term health problems such as rickets, iron deficiency anemia, goiter, obesity, coronary heart disease, type 2 diabetes, stroke, cancer and osteoporosis. In the present review we surveyed the extent and severity of nutritional deficiencies in Israel through a selective and comprehensive Medline review of previous reports and studies performed during the last 40 years. Israeli populations have multiple nutritional deficiencies, including iron, calcium, zinc, folic acid, and vitamins B12, C, D and E, spanning all age groups, several minorities, and specific regions. In Israel, some of the nutrients are mandatorily implemented and many of them are implemented voluntarily by local industries. We suggest ways to prevent and treat the nutritional deficiencies, as a step to promote food fortification in Israel.

INTRODUCTION

Despite some reductions in world income-related poverty in recent years, malnutrition remains widespread. Nutrient deficiencies of iron, vitamin A, folic acid and zinc are prevalent worldwide, especially in children from low income areas[1].

The lack of sufficient amounts of micronutrients affects health, function, and physical and cognitive development throughout the life cycle[1-4]. Many diseases and morbid conditions have been described to result from nutritional deficiencies. These include developmental defects, such as birth defects, physical and cognitive development delays, increased risk of infectious diseases, as well as increased risk of poor health in adulthood. Almost two-thirds of deaths of young children around the world are related to nutritional deficiencies[5-7].

The discovery of essential nutrients and their roles in disease prevention has been instrumental in reducing

nutritional deficiency diseases such as goiter, rickets, pellagra and others in many places such as the United States, Canada, European countries and third world regions. In Israel, a state of massive immigration, where a substantial part of the population lives below the poverty line, there is a relatively high percentage of unemployment, and also aging of the population. These aspects contribute to the relatively high prevalence of essential nutrient deficiencies in various parts of the Israeli population, including iron-deficiency anemia, goiter and vitamin D deficiency[8-11]. Low vitamin B12 levels, low folic acid levels and consequently high homocysteine levels, and increased risk of coronary heart disease have also been observed in the Israeli population[12,13]. The regulatory authorities in Israel have been planning to implement food fortification for many years. Few of the nutrients are mandatorily implemented, and many are implemented voluntarily by local industries.

The goal of the present review was to survey the severity of nutritional deficiencies in Israel, and to suggest ways to prevent and treat this problem. Our hypothesis is that, in view of the special characteristics of Israel, despite being a developed country, with massive immigration, poverty and low social conditions, a high rate of nutritional deficiencies exist.

The present review is also aimed to summarize the subject, as a step to promote food fortification in Israel.

RESEARCH

The extent and severity of nutritional deficiencies in Israel were reviewed through a selective and targeted Medline survey of previous reports and studies performed during the last 40 years.

The key words for the Medline search were combinations of the words: children, pediatrics, Israel, nutrients, nutrition, deficiency, fortification, as well as of specific nutrients such as iron, vitamins A, B, C, D, E, B12, Folic acid, calcium, phosphorus, magnesium, zinc and iodine.

NUTRITIONAL DEFICIENCIES IN THE MODERN WORLD: CAUSES AND OUTCOME

The food consumption habits of the children changed during the last few decades, and they now consume too much fat, especially saturated fats, and sweetened beverages. They do not eat enough fruits or vegetables and consequently do not consume enough fiber. Most schoolchildren of low socioeconomic families consume less milk, cheese, meet, vegetables and fruits. Only a fifth of children consume the recommended daily amount of fruits and vegetables[5-8]. The calcium and iron intake among children is also low. One of the main reasons for the pediatric pandemia of obesity is the consumption of large amounts of soft drinks rich in sugar, accompanied by a lack of physical activity. It is essential to address nutrient and activity deficiencies as these may lead to chronic long-term health problems, such as obesity, coronary heart disease, type 2 diabetes, stroke, cancer, and osteoporosis. It is well documented that overweight children are more likely to become obese adults[1-3,5]. The most common nutrient deficiencies among school children are: calcium, fiber, folate, iron, magnesium, potassium and vitamin E. It has been reported that the 2 most common deficiencies seen in generally healthy children are iron and vitamin D deficiencies[3]. Classical nutrient deficiencies lead to stunting (energy, protein and zinc), rickets (vitamin D) and other bone abnormalities (copper, zinc, vitamin C)[7,8]. Iron deficiency anemia, as a public health problem, has been well recognized in recent years in developing countries and even in developed ones, and has received considerable attention by the World Health Organization (WHO)[2,8]. Vitamin D deficiency and osteoporosis are common in northern climates, but even in sunny countries such as Israel, Australia and southern Europe. It is especially common among the elderly, veiled, dark skinned, and other at-risk population groups, who are also regularly warned to avoid sunlight to prevent skin cancers[7-9,11].

The prevalence of endemic goiter and other iodine deficiencies has been reduced since the use of iodination of salt[8]. MacDonald[14] has reported that zinc deficiency in animals is characterized by growth inhibition and decreased food intake. Liu *et al*[15] indicated that malnutrition predisposes to neurocognitive deficits, which in turn predispose to persistent externalizing behavior problems throughout childhood and adolescence. Their findings suggest that reducing early malnutrition may help reduce later antisocial and aggressive behavior.

NUTRITIONAL DEFICIENCIES IN ISRAEL

In Israel, nutritional deficiencies have been documented throughout the last years in many reports.

Deficiencies in special ethnic minorities

In the Bedouin population[16-29], short stature, iron deficiency, vitamin A deficiency (15%-26% of infants), B12 deficiency, and vitamin E deficiency have been reported. In Ethiopians living in Israel, there are several reports of vitamin D deficiency and rickets[30,31].

Regional deficiencies

There were several reports on nutritional deficiencies in specific regions in Israel, including iron deficiency in children from central regions such as Hadera[32]; iron deficiency in Jewish children from a new immigrant town[33]; anemia in Jewish and Arab children from Akko[34]; iron deficiency anemia in infants from southern Israel[35]; and iron and folate deficiencies in children from a city in the North of Israel (Kyriat-Shmona)[36].

Special populations have demonstrated specific nutritional deficiencies

In adolescents, several deficiencies were reported, includ-

Table 1 Summary of the main nutritional deficiencies in the Israeli population

Israeli sub-population	Nutritional deficiency	Ref.
Bedouins	Iron, vitamin A, vitamin B12, vitamin E	[16-29]
Ethiopians	Vitamin D	[30,31]
Specific regions	Iron, folic acid, vitamin B12	[32,36,69]
Adolescents	Iron, vitamin D, calcium, phosphor, magnesium, zinc	[9,38-40]
Toddlers	Vitamin D, Iron, Calcium	[41,42]
Overweight children	Iron, vitamin B12, folic acid, phosphorus, calcium, vitamin D	[43-45]
Military recruits	Iron, magnesium	[46-48]
Infants	Iron	[32,49-53]
Vegetarians	Vitamin D, vitamin B12, vitamin B1, iron, zinc	[54-57]
Pregnant women	Iron	[58,59]
Helicobacter pylori gastritis	Iron	[60]
Celiac disease patients	Vitamin D	[10,61]
Gaucher patients	Vitamin B12	[68]
Anorexia nervosa patients	Zinc	[70,71]

ing iron deficiency (especially in athletes)[37], and deficiencies in vitamin D[9,38,39], calcium, phosphor, magnesium and zinc[40]. Toddlers and adolescents in Israel, as in other Western countries, are using "energy drinks", which can cause nutritional deficiencies such as vitamin D and iron[41]. A study of children from central Israel[42] revealed a lack of calcium in their food and decreased bone density. Children with overweight demonstrated iron deficiency[43] and vitamin B12 deficiency[44]. In bariatric surgery candidates, deficiencies in iron, folic acid, ferritin, B12, phosphor, calcium and vitamin D were reported[45].

In military recruits and in soldiers, iron deficiency[46,47], and low magnesium levels[48] were noted.

A high percentage of the infant population in Israel has iron deficiency anemia[32,49-52]. It can badly affect their learning achievements and behavior[53].

In the vegetarian population, there was a lack of calories and proteins, rickets, osteoporosis, B12 and B1 deficiencies, iron and zinc deficiencies, and increased risk of infections[54-57]. A high incidence of iron deficiency was noted in pregnant women[58,59]. Iron deficiency anemia was reported also in people with *Helicobacter pylori* (*H. Pylori*) gastritis[60]. Children with celiac disease had low bone mineral density. Their average serum vitamin D level was 25.6 ng/L, suggestive of osteopenia[10,61].

Specific deficiencies

Iron deficiency anemia has been extensively documented in Israel, especially in infants[8,33,35,49-52], adolescents[47], pregnant women[58], adults and the elderly[8].

Vitamin D deficiency is common in the Israeli population. In 2009, 87% of the adult population and 52% of the pediatric population had low vitamin D levels[11,62-65]. Rickets in infants is attributable to inadequate vitamin D intake and decreased exposure to sunlight. It seems that vitamin D leading to osteoporosis is common in the elderly even in sunny countries such as Israel[63]. Vitamin D deficiency is also associated with autoimmune diseases[64]. Orthodox mothers after delivery had low levels of vitamin D[66].

Vitamin B12 and folate deficiencies has been noted in Israeli children, especially as a result of low intake of vegetables[44,67]; 22% of Ashkenazi Jews and 40% of Gaucher patients in Israel were reported to have B12 deficiency[68]. In Beer Sheva, a city in the south of Israel, 37% of the population had B12 deficiency[69]. Recent reports by Kark *et al*[12] have shown high homocysteine levels among Israelis, and despite vast reductions in mortality rates, the rates of coronary heart disease are still very high. Folic acid, as an antagonist to homocysteine, is increasingly accepted as a major preventive factor in coronary heart disease[13].

Zinc deficiency was noted, among other nutrient deficiencies, in anorexia nervosa patients in Israel[70,71]. Zinc deficiency was also reported in children[72], and in attention deficit hyperactivity disorder patients[73]. Table 1 summarizes the nutritional deficiencies in Israel described in our study.

In summary, Israeli populations have multiple nutritional deficiencies including iron, calcium, zinc, folic acid, and vitamins B12, C, D and E, spanning all age groups, several minorities, and specific regions. The most common nutritional deficiencies in the pediatric age group in Israel are iron and vitamin D. These deficiencies are mostly common in special populations, such as Bedouins, vegetarians, Ethiopians, obese children, pregnant women and their babies, gluten-sensitive populations, children with *H. Pylori*, children with behavioral problems and anorexia, diabetics, but deficiencies span the whole Israeli population.

FOOD FORTIFICATION

Fortification of commonly eaten foods with micronutrients offers a cost-effective solution that can reach large populations[74].

It is the responsibility of public health authorities to ensure that the general population, and especially those under in poverty are assured of an adequate basic daily intake of minerals and vitamins. This can only be achieved through appropriate vitamin and mineral enrichment of basic foods. Food fortification can reach many people who either do not or cannot comply with the individual approach of health education and healthy diet, due to its higher cost, or due to a lack of knowledge or access[75,76]. The addition of micronutrients to food for health reasons has been known for many years[8,77,78].

Food fortification was adopted in the United States during the 1920s and the 1930s, by enriching flour in order to eliminate pellagra in the southern states. In 1942, a program to enrich flour with vitamins and iron was adopted by the United States government[76]. In the beginning it included enriching flour with vitamin B1 (thiamin) to prevent beriberi, niacin to prevent pellagra, riboflavin for efficient use of vitamin B6, and iron to prevent anemia. Later, it was decided to also add vitamin

D and calcium, and it was expanded to enrich corn flour in 1943, pasta in 1946, and rice in 1958. The success of this program led to additional fortification of breakfast cereals with B-vitamins and iron in 1969[75].

In Canada, food fortification has been mandatory since 1979, including iodine in salt, iron and vitamin B complex in flour, and vitamin A and D in milk products. In 1998, folic acid was additionally added to flour, with positive effects in reduction of neural tube defects within 2 years[79]. Fortification of flour and grains with folate was adopted also in the United States in 1998, and was followed by a decline in the total prevalence of neural tube defects[80].

In Europe, food fortification has encountered considerable opposition over the past 2 decades (especially in Scandinavian countries). Nevertheless, it has recently been put into practice, with most countries fortifying salt with iodine to prevent iodine deficiency[81].

In 1996, the WHO has renewed its call for the universal iodization of salt, since iodine deficiency was considered the greatest cause of preventable brain damage and mental retardation worldwide[82]. In addition, the WHO also promotes fortification and supplementation for reduction of iron deficiency anemia, vitamin A deficiency and others, although referring usually to developing countries.

Regarding vitamin D deficiency, it has been widely recognized, not only with reference to infants and children, but also for other age groups, including adolescents and older age groups. In 2003, the American Academy of Pediatrics emphasized the importance of milk fortification with vitamin D supplementation throughout childhood and adolescence, with consideration of subclinical vitamin D deficiency in many population groups[83].

Israel is working towards food fortification, but it is on a voluntary basis for some vitamins and minerals, while mandatory for others, such as fortification of salt, milk products and flour. Nevertheless, most salt sold to the Israeli population is still un-iodized[78]. As previously mentioned, although Israel is a sunny country, vitamin D deficiency is well recognized among the elderly[10,19,66], partly related to the advice to avoid sunlight exposure for fear of skin cancer. This fact makes vitamin D fortification of milk products a necessity.

The successful experience of food fortification in many countries emphasizes the safety and efficacy of this approach. Food fortification is vital in prevention of chronic diseases, and its implementation will bring long-term economic savings in health costs and will contribute to the health and nutritional habits of the population. In addition to fortification of breakfast cereals and some milk products, the recommendations of health ministries should include fortification of basic foods with iodine, iron, folic acid, vitamin A, vitamin B complexes (including B12), and vitamin D, in order to prevent birth defects as well as chronic diseases. National school feeding programs can be one of the means for nutritional education and food fortification as well as a means of alleviating food insecurity among children.

The limitations of our study are embedded in the methodology of the literature search, since some publications could have been missed or were unavailable in Medline. There is also a possibility of publication bias since negative or non-significant studies tend not to be published.

In summary, in view of the wide nutritional deficiencies in Israel, we encourage local health, education and industrial ministries to expand efforts to study and document these deficiencies with a view to fortifying basic commonly used foods in order to combat the deficiencies and prevent their occurrence in the future.

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