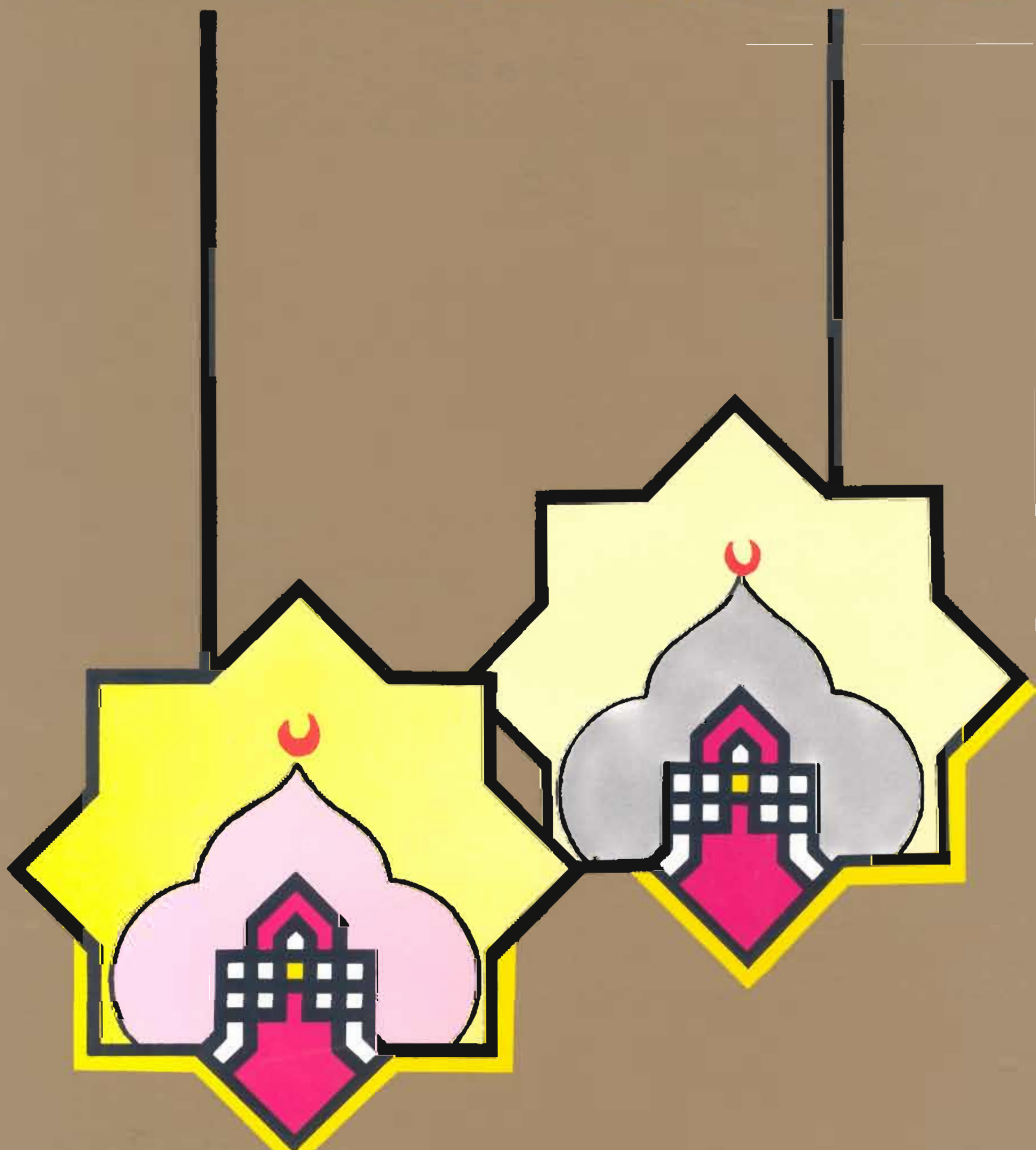
MICRONUTRIENT DEFICIENCIES IN THE ARAB MIDDLE EAST COUNTRIES



MICRONUTRIENT DEFICIENCIES IN THE ARAB MIDDLE EAST COUNTRIES

(Proceedings of the workshop on Micronutrient Deficiencies in the Arab Middle East, held in Amman, Jordan 27 - 29 June 1995)

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FOREWORD

Nutritional well-being is a prerequisite for the achievement of the full social, mental and physical potential of the population, so that all people can lead fully productive lives and contribute to the development of their community and the nation. Good nutritional status is dependent upon each person having adequate intake of micronutrients in addition having access to safe drinking water.

During the last three decades, the nutritional status of the population of the Arab Countries have improved. However micronutrient deficiencies have been long standing public health problems, which is widespread among both rich and poor Arab countries and among rural and urban population. The prevalence of a particular deficiency can vary considerably between different geographic locations and socio-economic groups.

Deficiencies of iron, iodine and vitamin A are especially important because of their serious health consequences, wide geographic distribution, and their implication on economic stagnation.

The main causes of micronutrient malnutrition are inadequate intake of foods containing these micronutrients and their impaired utilization. This is often associated with infections that can reduce their absorption and increase their metabolic consumption. Micronutrient deficiencies have negative impact on the society, they reduce working capacity, cause mental and growth retardation, reduce resistance to disease and can lead to death of women in pregnancy and childbirth.

The International Conference on Nutrition recommendations call upon countries to formulate and implement programmes to correct micronutrient deficiencies and to prevent their occurrence, through sustainable food-based approaches that encourage dietary diversification, the production and consumption of micronutrient rich foods, the supplementation, food fortification and nutrition education.

In order to increase awareness about the magnitude and extent of this problem and to suggest ways and means to prevent and control this situation, the FAO Regional Office for the Near East is pleased to put this publication at the disposal of its member countries, with the hope it would benefit to all those who are working and interested in this field. This publication is the fruit of cooperation with The United Arab Emirates University, The Arab Nutrition Society and private food companies.

A.Y. Bukhari
ADG/Regional Representative
for the Near East

FOREWORD

Micronutrient deficiencies are worldwide problems. Studies in the Arab countries indicate that these deficiencies are widely prevalent, although, their prevalence varies innumerously from country to country, and from disease to disease. The major micronutrient deficiencies reported in this part of the world are iron deficiency anaemia, iodine deficiency disorders, and vitamin A and D deficiencies.

Iron deficiency anaemia is a common nutritional problem in all Arab countries. Its prevalence ranges from 10% to 80% depending on age, sex and physiological status of the population. Iodine deficiency disorders are reported in many remote and mountain areas in this region. Studies on vitamin D deficiency are scarce. However, several studies from Saudi Arabia showed that even with the abundant sunlight in the country, the prevalence of vitamin D deficiency is relatively high. Indicators from some Arab countries, especially Sudan and Egypt showed that vitamin A deficiency is a problem of concern.

Information on micronutrient deficiencies in the Arab countries are limited. This is the first publication which deals with the prevalence and control of micronutrient deficiencies in these countries. The work was done in cooperation with FAO/RNEA/ Cairo, Arab Nutrition Society and Nestle Company.

We hope that this work will be valuable to those interested in micronutrient deficiencies in this part of the world.

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PREFACE

Micronutrient deficiencies are amongst the most nutritional problems worldwide. The common micronutrient deficiencies of public health significant are iron deficiency anaemia,iodine deficiency disorders and vitamin A deficiency. According to WHO about 149 millions are at risk and affected by iron deficiency anaemia in Eastern Mediterranean region. The corresponding figures for iodine deficiency disorders and vitamin A deficiency are 45 and 14 millions,respectively.

Studies on factors associated with these problems in the Arab Middle East countries are few and limited. In addition, the lack of training of health workers and lack of comprehensive programme to prevent and control of micronutrient deficiencies in these countries made the situation more complicated.

The Arab Nutrition Society in collobration with Food and Agriculture Orginization,Regional Office in Cairo and Nestle Company organized this workshop to achieve the following objectives:

1. To asses the current situation of micronutrient deficiencies in the Arab Middle East countries.

2. To review ongoing activities and programmes to combat these problems.

3. To recommend measures to overcome these problems.

We hope that the papers presented in this workshop and measures suggested to overcome micronutrient deficiencies in the Arab Middle East countries are useful for those intrested in these problems.

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RECOMMENDATIONS FOR PREVENTION AND CONTROL OF MICRONUTRIENT DEFICIENCIES IN THE ARAB COUNTRIES OF THE MIDDLE EAST

Micronutrient deficiencies is the term that usually referred to deficiency of vitamins and minerals of public health significant.The main micronutrient deficiencies in the Arab Middle East countries are iron deficiency anaemia, iodine and zinc deficiencies and vitamins A and D deficiencies.

Magnitude and causes of the problems

a. Iron deficiency anaemia: This deficiency is the main nutritional problem in all Arab Middle East countries.It is estimated that about 30%-70% of pregnant women in the region suffered from iron deficiency anaemia. The prevalence ranged from 10% to 50% among pre-school children, and from 20% to 70% among school children. Main causes of this problem are poor dietary intake of iron, low iron absorption, parasitic infection, malaria, vitamin A deficiency, multiparity and early age of marriage.

b. Iodine deficiency disorders: The prevalence of these disorders is less compared to iron deficiency anaemia. However, the problem is of public health significant in some countries and in mountain areas and Oasis in other countries . The prevalence ranged from 6% to 80% .The main countries reported these disorders are Egypt, Iraq, Jordan, Lebanon, Sudan, Syria, Algeria and Tunisia. Iodine deficiency disorders were also reported in some mountain areas in Saudi Arabia and United Arab Emirates, but these disorders are not common health problems. Low iodine in soil and in most foods commonly consumed are the main causes of iodine deficiency disorders in this region.

c. Zinc deficiency : Data on zinc deficiency in the Arab countries of Middle East are scarce. However , studies on dietary habits of preschool and school children revealed low dietary intake of zinc. It is highly believed that zinc deficiency has an important role in growth retardation of children and adolescents in this part of the world. Low intake of food rich in zinc is the main cause of zinc deficiency, especially among young and school children.

d. Vitamin A deficiency: Few studies were carried out on vitamin A deficiency in this region. Reports from Egypt, Jordan and Sudan show that this problem is exist. Unsound food habits, low intake of foods rich in vitamin A and infection (such as measles) are the main causes of vitamin A deficiency in these countries.

e. Vitamin D deficiency: Despite abundant sunlight in this part of the world, vitamin D deficiency was found to be a public health problem in some countries. Several studies in Saudi Arabia indicate low blood levels of vitamin D in children and adults. Factors responsible for prevalence of vitamin D deficiency are low exposure to sunlight, wrapping of infants for long time, low dietary intake of vitamin D and unavailability of other nutrients especially calcium.

Actions needed

1. Assessment: In spite of scarity of data on magnitude and factors associated with micronutrient deficiencies, it is highly recommended that each country should start carrying out a national survey to identify these problems. Target group should be clearly defined for each deficiency. Priority must be given to iron deficiency anaemia surveys, with emphasis to use two of the following parameters:Haemoglobin, PCV, serum ferritin, protoporphyrin and blood film.

2. Dietary Intervention: Dietary modification is an important approach to reduce the prevalence of micronutrient deficiencies in the communities. Encouragement and support intake of food rich in micronutrients such as green leafy vegetables, yellow fruits and vegetables should be done through various mass media and school feeding programmes. Consumption of goitrogenic foods should be reduced as possible.It is highly recommended that these countries should establish dietary guideline for healthy eating taking into consideration consumption of foods that are rich in micronutrients, and reducing intake of that contain constituents inhibit or interfere with absorption of the micronutrients especially iron, zinc, and calcium.

3. Fortification of Staple Foods: Food fortification is an important method to overcome micronutrient deficiencies. Fortification of salt with iodine and iron has proved in many countries to be one of successful method to control iodine deficiency disorders and iron deficiency anameia.Fortification of sugar with vitamin A has also given an encouraging results. However, it is very essential to study carefully the main food vehichle for fortification in each country. Wheat flours and rice are the main staple foods in the Arab countries of the Middle East.Fortification of these foods, especially wheat flour, with several micronutrients is a major intermediate startegy to control micronutrient deficiencies. Emphasis should also be put on the infant formula, weaning foods and other processed foods which are widely consumed by children.Most of imported whole powdered milk in the region is fortified with Vitamin A and D. This should be extended to other imported dairy products such as butter, margarine and yoghurt.

4. Nutrition Education: One of the main causes of micronutrient deficiencies in this region is the lack of nutrition information on sound dietary habit to prevent these deficiencies. Nutrition education and communication are an important supporting strategy to prevent any nutrient deficiency. Information on causes, consequences and measures to prevent and control these problems should be dessiminated through various mass media. Nutrition education material should be pretested and evaluted. Involvement of target groups in these process is highly recommened.

5. Public Health Measures: Several public health measures should be carried out by health and other related authorities in the region. These measures can be summarized as follows:

a. Supplementation with micronutrients.This can be done through maternal and child health centers and through schools or other local systems. Supplementation of iodized oil for iodine deficiency disorders, capsules (oil) in massive or small dose for vitamin A deficiency and iron folate tablets for iron deficiency anaemia are now carried out in many countries in the region suffered from these micronutrients.

b. Prevention and control of infections through environmental health programmes such as water sanitation, immunization, MCH services, control of endemic diseases, oral rehydration theraphy, antiparasitic measures and food hygiene.

c. Food legislation is another public health approach which should be enforced. Legislation regarding food additives, fortification and labelling are essential strategy to prevent these problems. Many countries in the region lack such legislation.

d. Training of health and community workers on management of micronutrient deficiencies.

e. Nutrition surveillance system should be established in health sector to provide essential indicators on micronutrient deficiencies.

6. Role of Private Sector : Private sector can play an important role in preventing and control of micronutrient deficiencies in the region. Private sector can provide assisstance in equipement, training of staff, laboratory facilities, conducting seminars and studies.

7. Role of International Organizations: International Organizations particularly FAO, WHO and UNICEF should provide the following support:

a. Conducting training courses in assessment, planning, implementation and evaluation of programmes related to prevent and control of micronutrient deficiencies.

b. Providing technical assistance in several aspects related to micronutrient deficiencies.

c. Strengthening the national programmes for preventing and control of micronutrient deficiencies.

d. Supporting research projects to study the magnitude and causes of these problems.

e. Supporting co-operation and co-ordination among countries in the region to overcome micornutrient deficiencis.

MICRONUTRIENT DEFICIENCIES IN THE ARAB COUNTRIES

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INTRODUCTION

Micronutrient deficiencies have been long standing public health problems in the Arab Region. It is estimated that over 100 million people in the Arab region are suffering from one or more of micronutrient deficiencies. These nutritional problems are widespread among both rich and poor Arab countries and among the rural and urban population. However, the prevalence of a particular deficiency can vary considerably between differnt geographic locations and socio-economic groups. Most of surveys previously conducted have been of a medical nature and have not been accompanied either by quantitative or qualitative food consumption patterns.

ANAEMIA

Anaemia, especially due to iron deficiency is the most common micronutrient deficiency in the Arab Region, especially among young children and women of reproductive age. Anaemia lead to learning disabilities, an increased risk of infection, diminished work capacity and to death of women during pregnancy and at child birth. Maternal anaemia also contributes to interuterine growth retardation and low birth weight.

The causes of anaemia in the Arab Region are due to low dietary iron intake, poor iron absorption due to dietary constituents such as phytates and iron loss associated with parasitic infections especially in Egypt, Sudan and Iraq. The endemicity of malaria in countries such as Sudan, Somalia and Mauritania is another significant contributory factor.

Data from certain Arab countries have indicated that the phytic (iron-binding) content of wheat which is grown locally is higher than that of imported wheat. It should be also noted that the high consumption of tea (intake of tea in Egypt is more than England) with its binding capacity reduce iron absorption, which is another factor very common through the Arab Countries. In Egypt, parasitic infection (Bilharzia and Ankylostoma) are considered important causes of the prevalence of anaemia especially among rural population and among urban low income groups. In most Arab countries anaemia range between 30% to 70% in preschool children and pregnant and lactating women. These findings were reported in several surveys which were carried out in Bahrain, Egypt, Jordan, Sudan, Tunisia, Morocco and Saudi Arabia. It is more prevalent among rural , low income groups and females. A study in Bahrain in 1980 indicated that 34% of pre-school children were anaemic. The prevalence in rural areas was double that in urban areas in children 6-11 years. It was more prevalent among adult females (42.8%) compared to only 21% in males. Later study showed that anaemia decreased with the decrease in the intestinal parastitic infections. A study in Oman indicated that 66% of pre-school children and 38% of school children suffered from anaemia. In Saudi Arabia it was found that 12-50% of the population are suffering from anaemia. In Yemen it is estimated that 90% of population suffer from anaemia. The rates were 41% in the West Bank and 67% in the Gaza strip among pregnant women (Osman, 1992).

In Egypt, data on anaemia showed that it is most common among child-bearing women, nursing mothers and children between birth and two years of age. Anaemia is more in Upper Egypt than in Lower Egypt. Also 58-73% of school children aged 6-12 years suffered from anaemia. A study in Morocco indicated that 22% of children (0-2 years) admitted to hospitals had anaemia. It was also prevalent (10-14%) among pregnant women. Similarly the survey in Syria showed that anaemia is wide spread (30%) among women of child bearing age (15-49) years.

Many of the reported studies on anaemia have been carried out on patients admitted to hospital or those visiting health centers or school children. Surveys should be carried on children who are not enrolled in schools and on populations who are not visiting health centers.

Actions Needed

The intervention required for the prevention and treatment of anaemia is relatively inexpensive. Iron supplementation for vulnerable groups is essential especially in pregnant and lactating women. Other groups that deserve high priority include premature and low birth-weight infants. For older preschool children and school children in areas of high anaemia prevalence, screening for anaemia and supplementation should be considered. Fortification with iron could be undertaken with a variety of food vehicles such as processed cereals, salt, sugar and infant foods.

Attempts to modify dietary intake of iron is also important. There are three ways in which diet can improve iron absorption: by increasing intake of haem iron (primarily meat sources); by increasing intake of food rich in ascorbic acid (Vitamin C); and by reducing inhibitors of iron absorption such as wheat and tea.

Programmes for combating iron deficiency are usually cost-effective, since the expenditures are later offset by a better economic performance of the population.

IODINE DEFICIENCY DISORDERS (IDD)

Iodine deficiency is a major risk factor for both the physical and mental development of a large number of the population in the Arab Region who live in iodine deficient environment. More than fifteen Arab Countries which were surveyed indicate the prevalence of iodine deficiencies. .Prevalence have been reported in the mountainous areas in Morocco, Algeria, Tunisia , Syria,Lebanon, Yemen and in the Oasis in Egypt.

In pregnancy, iodine deficiency causes spontaneous abortions, stillbirths and infant death. It interferes with brain development, and can result in brain-damage babies. In childhood, iodine deficiency can cause mental retardation, delayed motor development, growth failure or stunding, muscular disorders, paralysis, as well as speech and hearing defects. Data from Egypt indicate a prevalence of 38% in the New Valley and 14% in Upper Egypt. It is also common among school children and females. Goiter has been reported to be endemic in Algeria since 1912. An epidemiological survey included 4500 people indicated a prevalence of 51.3% and endemic cretinism of 1.1% In Lebanon, a study in 1961 indicated a prevalence of iodine deficiency of 49%, mainly among population living in mountains areas. IDD in Sudan was reported in 1952 mainly in Darfur areas and Western Sudan reaching up to 86% of school children. It was also found that iodine content in foods and drinking water was low in most endemic goitre areas and the presence of goitrogenic substance in millet which constitute the staple cereal in Western Sudan. In Syria, surveys showed the prevalence of IDD among school children(6 - 14 years) were 73%. The rate was higher in high rainfall areas compared to low rainfall areas.

Actions needed

The major control methods for IDD are fortification of salt with iodine compounds, and distribution of iodized oil. The cost of iodized salt is about $0.05 per person per year. A possible approach to consider is the supplementation of the diet of domestic animals with iodine, so that livestock products (e.g. milk, meat) contain the necessary nutrient. Another approach would be agricultural research which selects varieties of low goitrogenic grains such as sorghum and millet which contitute the staple of the diet in the rural areas in Sudan and Somalia.

VITAMIN A DEFICIENCY

The extent of vitamin A deficiency in the Arab countries is not clear, though a number of countries such as Djibouti, Sudan and Mauritania, have reported that vitamin A deficiency may be a significant public health problem . A recent study in Iraq indicates that vitamin A deficiency was prevalent as acute and chronic nutritional problems. Vitamin A deficiency, and its sad consequence of blindness, poor growth, increased severity of infections and death is a public health problem especially among the low income groups in some Arab countries. The intake of food which are poor in Vitamin A, or its precursors (Beta- carotene) coupled with increased requirement due to infection particularly measles, lead many children to xerophthalmia and blindness, particularly when the child is suffering from protein energy malnutrition. A survey in Sudan indicated that 14.8% of boys and 11.9% of girls showed signs of xerosis of the eye, while 2.3% of boys and 1.3% of girls showed Bitot's spots and xerosis.

In Egypt, the prevalence was reported among preschool children who are suffering from PEM (22%). In Saudi Arabia, isolated cases of vitamin A deficiency were observed in certain regions. The surveys conducted in Yemen indicated the prevalence of vitamin A deficiencies especially among school children. A study in Jordan on vitamin A deficiency in infant and young children revealed that 1.3% of children under six years of age suffered from night blindness and 0.6% suffered from Bitot's spots.

Actions needed

Vitamin A deficiency may be successfully attacked by relatively simple interventions. Short-term measures to prevent vitamin A deficiency among high-risk groups must be implemented because of the severe consequences of this deficiency. The fortification of commonly consumed foods, coupled with targeted distribution of high dose capsules every three to six months, may present the best interim measures. The cost of fortification is estimated to be around $0.5 per person per year. Sugar has been used as the vehicle in central America. Dried Skin milk (DSM) is commonly fortified with vitamin A and D. In Tunisia, reconstituted DSM was fortified with vitamins A and D. This milk was sold at a subsidized price. Unfortunately, this programme is presently abolished. There is greater coverage through fortification programmes which, however, require some investment and legislation. Health Services can be used for delivering vitamin A supplements, through immunization programmes. It has been estimated that the cost of the high dose of vitamin A supplement is around $0.04 per recipient per year. The long term solution lies in increasing the availability and consumption of vitamin A or Carotene-rich foods, including dark greek leafy vegetables, and deep yellow fruits and vegetables. Agricultural planners and extension field workers must be aware of the extent and the severity of vitamin A deficiency among the population, and how the agriculture sector can best address the problems. Nutrition education and social marketing techniques can be employed to improve dietary intakes of good sources of vitamin A.

VITAMIN D DEFICIENCY

Vitamin D deficiency has been reported in some countries. Studies in Yemen indicated that rickets is a major public health problem and Osteomalacia was observed in adult women. In a study in Northern Yemen, it was found that the prevalence of rickets among children under five years of age was 27%. Rickets were common at the end of the first year and had disappeared by the fifth year. In some Arab countries such as Saudi Arabia vitamin D deficiency was observed and was associated with wrapping infants for long periods, dietary factors and limited exposure to sunlight. Surveys in Morocco indicate vitamin D deficiency of 22% in children under four year of age. There has been a systematic preventive programme initiated by the Ministry of Health which may reduce the incidence of rickets.

Actions needed

This particular deficiency is mainly associated with the cultural habits of wrapping the infants for long periods. The actions needed are: education of mothers not to wrap infants for long periods,fortification programme when required and promotion of consumption of food rich in vitamin D.

OTHER MICRONUTRIENT DEFICIENCES

Very limited studies and surveys were carried in the Arab countries on other micronutrient deficiencies such as zinc. In the later country it was found that 29% of adult population had zinc deficiency. However, this deficiency require further investigation in several countries. Vitamin C deficiency (Scurvey) has been reported among displaced populations in Sudan and Somalia. The food rations which have low in vitamin C and the new environment where wild plants are absent, have lead to the appearance of vitamin C deficiency (Scurvey).

CONCLUSION

The number of people affected by micronutrient deficiences in the Arab Region is large. The consequences of these deficiencies on human health and productivities are serious. The elimination and the control of micronutrient deficiencies in the Arab Countries require the establishment of a system for linking policy action to human need. Micronutrient deficiencies would not be solved by the Ministry of Health alone but require an integrated approach and the involvement of other Ministries such as Agriculture,Supply, Industry, Education and Information as well as the Private sector and NGOS. The World Declaration and Plan of Action on Nutrition which were adopted by the International Conference on Nutrition (ICN) and nutritional goals for children adopted by the World Summit for Children give guidelines of action needed by the international, national and local communities for the monitoring, control and the elimination of these serious defficiencies which impair human development and nutritional well-being.

Table 1 : Micronutrient Deficiencies in the Arab Countries

Country	Anaemia	Goiter	A Vitaminosis
Algeria	19 - 42% C	23 - 71% b,c,d	NA
Bahrain	21 - 42% a,b	NA	NA
Djibouti	* a,c	NA	8 - 14% c
Egypt	20 - 70% b,c,d	12 - 43% b	* b,d
Iraq	* d	30 - 80% d	* d
Jordan	34% a	6 - 16% d	06 - 1.3% a,b
Lebanon	* b	12 - 70%	NA
Morocco	10 - 40% a,b,c	18 - 80%	NA
Oman	38 - 66% a,b	NA	NA
Saudi Arabia	21 - 50% a,b	* b	NA
Sudan	36% b,c	13 - 86% b,c,d	3 - 4% b,d
Syria	30% c	69 - 77% b	NA
Tunisia	50% b,c	15 - 51% b,d	NA
U.A.E.	28 - 43% a,b,c	NA	NA
West Bank/Gaza	25 - 50% a,c	NA	NA
Yemen	NA	NA	NA

a. pre-school children
b. school children
c.Women of child bearing age d.whole population.
* Common health problem.
NA : No available data.

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IRON DEFICIENCY ANAEMIA AMONG CHILDREN AND WOMEN IN THE ARAB COUNTRIES OF THE GULF

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INTRODUCTION

Despite the significant improvement in economic and health status in the Arab countries of the Gulf, iron deficiency anaemia is the commonest nutritional disorder and affects a high percentage of people, particularly reproductive women and preschool children. This problem, if uncontrolled, leads to anaemia of increasing severity, reduced work capacity, diminished learning ability, increased susceptibility to infection and greater risk of death associated with pregnancy and childbirth (Gilles- pie et al. 1991).

This paper highlights the current pravalence of iron deficiency anaemia in the Arab Countries of the Gulf and discusses factors associated with this problem.

PREVALENCE OF IRON DEFICIENCY ANAEMIA

Pregnant women

Studies in the Gulf countries demonstrated that iron deficency anaemia is one of the main public health problems among pregnant women. Using haemoglobin level less than 11g/dl the prevalence of anaemia ranged from 30% to 54% in these women (Table 1). The lowest prevalence was reported in Qatar, which is largely due to estimating the anaemia in the first trimester. The requirements for iron during the first trimester are relatively small, but rise considerably during the second and third trimester (DeMayer, 1989). A study in Kuwait showed that the prevalence of anaemia was 21% during the first trimester, increasing to 38% and 45% during the second and third trimester, respectively (Dawood et al., 1990)

Using other blood parameters, iron deficiency anaemia among pregnant women was also high. In Saudi Arabia, Khoja et al (1994) reported that 57% of pregnant women were anaemic, using transferrin saturation (<16%). When serum ferritin (<12mg/ml) was determined for the same women, the prevalence of anaemia was very close to that of transferrin saturation (54%).

Adults

Epidemiological studies on iron deficiency anaemia among adults in the Gulf are, at most, scanty. In the United Arab Emirates (UAE), Hossain et al, (1995) found only 16% of non-pregnant women were iron deficient (≤Hb<12 g/dl). The investigators attributed this low prevalence to the marked increase in the availability and use of antenatal care services in UAE during the last decade. However, this study has several limitations and therefore the results can not be generalised for non pregnant UAE women. The study focused on women who had children 1-22 months and attended immunization centers in one city in UAE (Al Ain).

Children and adolescents

Iron deficiency anaemia is a problem of interest among children in this region; especilly among preschool children and teenage girls. In general , the anaemia is more prevalent among preschool than school age children. From Table 1 we note that the prevalance of anaemia among preschoolers ranged from 29.5% to 67%, while that among school children ranged from 12.6% to 46%.

In Kuwait a cross-sectional study of 1208 school children aged 6-17 years was carried out to determine the prevalence of iron deficiency anaemia. Data revealed that anaemia was more prevalent among girls (26%) than boys (13%), but it was highly prevalent among younger boys (6-9 years) and adolescent girls compared with other age groups (Eid et al 1986). In Bahrain, Blair and Gregory (1986) demonstrated that 24% of school girls aged 7-18 years had signs of iron deficiency based on transferrin saturation and the anaemia was most prevalent among 15-18 years olds (42%). These findings confirm that teenage girls in the Gulf are among risk groups of anaemia.

FACTORS ASSOCIATED WITH IRON DEFICIENCY ANAEMIA IN GULF

Factors associated with anaemia in this part of the world have not been well investigated. Some factors which are suspected to be responsible for the high prevalence of iron deficiency anaemia in the Arab Countries of the Gulf are briefly discussed.

1. Inadequate intake of dietary iron

The intake of food rich in iron was found to be low in the Gulf, particularly by infants, preschoolers and pregnant women. In Saudi Arabia , Sawaya et al (1988) showed that the iron intake of children aged 0-6 years did not exceed 38% of FAO/WHO Recommended Dietary Allowances (RDA). In Kuwait , the intake of iron among school children was also found to be less than the RDA (Eid et al 1984). Another study in Kuwait (Prakash et al, 1984) demonstrated that the intake of calcium, iron and vitamin C by pregnant women was below 75% of US RDA, while among lactating women, all nutrients (except protein) were below the RDA.

2. Inadequate intake of food enhance iron absorption

Studies, both among children and adults, suggested that foods rich in vitamin C, which enhance iron aborption are poorly consumed in this region. Vitamin C is mostly found in some fresh fruits and vegetables. The daily consumption of fresh fruits and vegetables by university girls aged 18-20 years in UAE was 41% and 59%, respectively (Musaiger and Radwan, 1995). Among adults, only 46% of men and 52% of women aged 20-60 years reported daily consumption of fresh fruits. The corresponding percentages for fresh vegetables were 60% and 65%, respectively (Musaiger and Aburmeileh, 1995).

Among school children and adolescents the situation is worse, as many of them not only consumed fewer fresh fruits and vegetables, but also consumed less meat and fish, which are also enhancers of iron absorption.

3. High intake of foods contained compounds inhibit iron absorption

Many compounds are known to inhibit the absorption of iron, among them ; polyphenols (including tannins) which are present in tea and to a lesser extent in coffee ; and phytates which are present in wheat and other cereals (DeMayer, 1989). Several studies (Musaiger and Miladi, 1995) demonstrated that the preschool children , adolescents and adults in the Arab countries of the Gulf consumed tea in a high quantity, especially after the heavy midday meal, the lunch. A single cup of tea taken during a meal may cause iron absorption to drop from 11% to 2%. It would thereforeseem to be essential that health education should focus on reducing the intake of tea, particularly with meal. However , the inhibitory effect of tannins in tea can be counteracted by adding vitamin C to the meal.

4. Infection, especially intestinal parasitic infection

Infections interfer with food intake and the absorption, storage and use of many nutrients (including iron). In some rural areas in Arab countries of the Gulf where the environmental sanitation is poor , morbidity from viral and bactrial infection is high. The repeated episodes of infection may result in the development of anaemia particularly in young children.

Intrestinal parasites were prevalent among young and school children in the Gulf. Sebai et al (1981) showed that 35% of Saudi preschool children had intestional parasitic infection, but no schistosoma eggs were observed. Musaiger and Gregory (1990) found that intestinal parasites were prevalent among children 6-11 years (14%) although hookworms were not detected. In Saudi Arabia, El-Hazmi (1985) showed that the incidence of anaemia was significantly higher in parasite - infected individuals (21%) than in parasite-free ones (8%), indicating that parasitic infections may be one of the causes of anaemia in the region.

5. Other factors

Statistics showed that the fertility rate of Gulf women is relatively high (4.6 - 7.1 per 1000 women). Multiple deliveries tend to lower the haemoglobin level in women because closely spaced pregnancies deplete the iron stores of the women, especially when there is no iron supplementation during pregnancy (Kuitan et al, 1985) . In UAE, Hossain et al (1995) found that the prevalence of anaemia was significantly higher in women who had had seven or more pregnanceis then in those who had had 1-3 pregnancies (Odds Ratio = 4.17, 95% CI=1.86 -9.38). Also women whose menstrual periods usually lasted more than 6 days were significantly more likely to be anaemic than were counterparts whose periods usually lasted less than 5 days (Odds Ratio = 4.00, 95% CI=1.17 - 13.67).

There are certain beliefs and attitudes that are negatively associated with the anaemia in the Gulf. Among them is the widely spread belief that iron supplements, which are given to pregnant women, can cause enlargement of fetus or abortion to the women. Consequently, some women do not take these iron supplements.

Malaria which is prevalent in some parts of the Gulf is also another contributing factor. The diagnosis of iron deficiency anaemia in the Gulf becomes more complicated with the high incidence of inherited anaemia such as sickle cell trait and thalassaemia minor (El-Hazmi, 1985).

CONCLUSION

Iron deficiency anaemia is a serious public health problem in the Arab countries of the Gulf. However epidemiological studies on the prevalence of anaemia in various age groups in the Gulf communities as well as factors associated with anaemia are scarce. Such studies should be given a high priorities in any health research programmes. At the same time measures to prevent and control this nutritional disorder should be included in health and nutrition programmes. Iron tablets supplementation for pregnant women, blood screening for women and children, prevention and treatment of intestinal parasitic infections, iron fortification of some common foods, and dietary modification are among the measures that must be taken into consideration in preventive programmes.

Table 1 : The prevalence of iron deficiency anaemia in various ages and sex in the Arab Countries of the Gulf.

Country	Age (years)	Sex	Sample Size	% Anaemia	Cut-off point
Bahrain					
Amine(1980)	0 - 5 6 - 17	M / F M / F	151/149 334/360	39.1/29.5 21.0/42.8	Hb<11g/dl Hb<12g/dl
Bair & Gregory (1986)	7 - 18	F	121	24.0	Hb<11g/dl
Kuwait					
Al Awadi et al (1976)	Adult	F - Pregnant	900	31.0	Hb<11g/dl
Mostafa (1979)	0 - 5	Combined	1611	46.9	Hb<11g/dl
Eid et al (1986)	6 - 17	M / F	593/615	12.6/25.7	Hb<12g/dl
Dawood et al (1990)	Adult	F - Pregnant	1582	39.7	Hb<11g/dl
Oman					
Abdulfattah (1978)	7 - 17	M	568	67.5	Hb<11g/dl
Amine (1980)	0 - 5 6 - 17	M / F M / F	228/200 673/591	64.9/67.0 31.3/46.2	Hb<11g/dl Hb<12g/dl
Davidson (1986)	Adult 6m - 5	F - Pregnant Combined	1000 100	54.0 40.0	Hb<11g/dl Hb<10g/dl
Musaiger (1986)	6 - 12	M / F	626/444	30.7/50.9	Hb<12g/dl
Qatar					
Awad et al (1992)	Adult	F - Pregnant	299	30.0	Hb<11g/dl
Saudi Arabia					
Sebai et al (1981)	0 - 5	Combined	257	36.0	Hb<11g/dl
Smart et al (1983)	Adult	F - Pregnant	217	6.5	Hb<10g/dl
Al-Othimeen & Osman (1993)	7 - 14	F	1204	50.0	Hb<12g/dl
AlFawaz (1993)	6m-24m	Combind	366	37.1	Hb<11g/dl
Khoja et al (1994)	Adult	F.Pregnant	191	57.0	<16% Transferrin
United Arab Emirates					
Osman (1981)	6 - 17 Adult	M / F F - Pregnant	411/435 274	44.8/45.0 44.5	Hb<12g/dl Hb<11g/dl
Hossain et al (1995)	1 - 2	Combined	63	3.0	Hb< 9 g/dl
	3 - 5m	Combined	53	8.0	Hb<10g/dl
	6 - 22m	Combined	193	34.7	Hb<11g/dl

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IRON DEFICIENCY CAUSES AND PREVENTION

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INTRODUCTION

Of the 87 elements in the earth's crust, iron is number four at 56g/kg (5.6%), only oxygen (464g/kg) (amost 50%), silicon (284g/kg) and aluminium (83g/kg) occur in greater quantities. There is more Fe than Ca, Na or Mg, 1,000 times more than zinc and 100'000 times more than iodine which occurs at 0.5mg/kg. In spite of this, however, 1.3 billion people, that's 24% of the world population, are iron deficient, and iron is the micronutrient with the highest magnitude of deficiency world-wide. In comparison, 217 millon people are iodine deficient (4% of the world population) and 43 millon children under 5 are vitamin A deficient, 7% of the world's children under 5.

The prevalence of anaemia varies in different geographical regions of the world (Table 1) (DeMaeyer and Adiels-Tegman, 1985), being highest in infants (from birth to 4 years), children from 5-12 years and women of child-bearing age (15-49). In South Asia and Africa were some 50% of these population groups are anaemic compared to about 25% in countries of Latin America and 10% in industrialised countries in the West. World-wide, 43% of children from birth to 4 years, 37% of children 5-12 and 35% adult women are anaemic.

Table 1 : Prevalence of anaemia in different geographical regions

	Estimated percentage of anaemia		
	Infants 0-4 years	Children 5-12 years	Women 15-49 years
South Asia	56	50	58
Africa	56	49	44
Latin America	26	26	17
Industrialised Countries	12	7	11
World	43	37	35

FUNCTIONS OF IRON IN THE BODY

In the human body of 75kg, we find 4.8g Fe (Bothwell et al. 1979). All of it is bound to proteins as under normal circumstances there is no free iron in the body. The greatest part of the Fe (68%) is found in the haem molecule either as myoglobin in the muscle or haemoglobin in the blood with the function of oxygen transport. A further 5% is as enzymes, haem or non-haem, for electron transfer or oxidation reduction reactions, such as during energy metabolism with cytochromes or in the Krebs cycle, or in the immune system with neutrophiles or lymphocytes. The rest, normally around 27%, is stored as ferritin or as hemosiderin especially in the liver.

CONSEQUENCES OF IRON DEFICIENCY

The major consequences of iron deficiency are four-fold: less strength, decreased immune function, increased mortality and morbidity during pregnancy and birth and, probably most importantly reduced psychomotor and mental development in the child (Hercberget al. 1987). Iron deficient people have less strength because oxygen transport (haemoglobin) and energy metabolism (iron enzymes) are reduced, and work capacity is then decreased which might have increased mortality and morbidity during pregnancy and birth and, probably most importantly reduced psychomotor and mental development in the child (Hercberget al. 1987). Iron deficient people have less strength because oxygen transport (haemoglobin) and energy metabolism (iron enzymes) are reduced, and work capacity is then decreased which might have serious economic consequences in some Third World Countries (Basta et al. 1979). Secondly, there is decreased immune function with a possible increase in infection. In addition, there is increased mortality and morbidity during pregnancy and birth; 100'000 pregnant women die each year due to severe anaemia and there are increased numbers of premature infants with all the problems which follow. Finally, iron is essential during the formation of the brain until the age of about 24 months and, if there is not enough iron, there can be reduced psychomotor and mental development in the child. Perhaps more importantly, even if iron is given, the changes appear to be irreversible (Lozoff et al. 1991).

AETIOLOGY OF IRON DEFICIENCY

The question is: Why there so much Fe deficiency when there is so much iron around? The most probable answer is because of poor iron absorption. Firstly iron oxide in the soil is non-absorbable in addition, iron from plants is poorly absorbed because of absorption inhibitors, and although iron from meat is well-absorbed it is often little consumed (especially in the Third World). Finally, a fact which we often forget, iron absorption is naturally restricted because any free Fe in the body can generate free radicals which can lead to severe health problems.

However, low iron absorption is not the only cause of iron deficiency anaemia (Hercberg et al.1987). It may be aggravated by intestinal parasites such as hookworm which can cause a steady blood loss (Mahmoud 1966); by malaria where the protozoa destroys the red blood cells (Brabin1992); by a low vitamin A status which prevents erythropoesis (Suharno et al.1993); and finally by protein deficiency, as protein is necessary for the production of haemoglobin and the iron transport protein, transferrin. This review will concentrate on low iron absorption.

FACTORS INFLUENCING THE ABSORPTION OF FOOD IRON

There are two different forms of food Fe: haem Fe (from meats) and non-haem Fe. Haem Fe has a constant absorption of 20-30%. The haem molecule is absorbed intact and the Fe released in the mucosal cell. Its absorption is little influenced by iron status of the individual or by the diet (Bjorn-Rasmussen et al. 1974). Non-haem Fe on the other hand can vary in absorption from less than 1% to almost 100% and it is strongly influenced by iron status of the individual (the lower the status, the higher the absorption and vice versa); by solubility in the gastric juice (especially for fortification iron and contamination Fe) which have to dissolve before they can be absorbed (Hurrell 1992); and by the enhancers and inhibitors of absorption. We will now discuss the enhancers and inhibitors of non-haem Fe absorption.

As long ago as 1973, Layrisse and his group in S.America showed that iron absorption varied greatly between different foods. Iron absorption was lower from vegetable foods such as rice, black beans, corn and wheat , varying between 1% and 7%, compared to animal foods such as fish and veal where it varied from 12% to 22% (Martinez-Torres and Layrisse 1973). Many studies using the extrinsic tag radioiron technique (with 55 Fe and 59 Fe) have now confirmed that some foods inhibit Fe absorption, while other foods enhance it. The inhibitory foods include cereals (Hallberg et al. 1987), legumes such as soy (Hurrell et al. 1992), cow's milk (Hallberg et al 1991), beverages such as teas, coffee (Morck et al. 1983) and red wine (Cook et al. 1995) and some vegetables such as spinach (Gillooly et al. 1983). Fruits, other vegetables such as broccoli (Gillooly et al. 1983; Ballot et al. 1987), and meat enhance non haem Fe absorption. The inhibitory component in cereals and legumes is mainly phytic acid (Hurrell et al. 1992). although polyphenols in sorghum and soy protein are also involved (Lynch et al.1994). The inhibitory factor in beverages and spinach is polyphenols and in cow's milk the inhibitory factors are calcium and casein. Ascorbic acid (and other organic acids such as citric acid) are the enhancing factors in fruit and vegetables, whereas the peptides from partially digested muscle protein are the active component in meat (Taylor et al. 1986). The mechanism of action is quite simple. The inhibitors of iron absorption bind Fe in complexes in the duodenum from which Fe is unavailable for absorption. The enhancers reduce Fe from the ferrous to ferric state, and bind it in soluble complexes from which Fe is available for absorption.

INHIBITORS OF IRON ABSORPTION

Polyphenol compounds together with phytic acid are the major inhibitors of Fe absorption in our diet. There are many different phenolic acids and flavonoids, both as individual compounds or combined as polymers such as hydrolysable and condensed tannins. Polyphenol foods include cereals such as sorghum and oats, pulses (in the seed coat), vegetables such as spinach and various spices, but the most important are the beverages such as tea, herb teas, coffee, cocoa and wine. Tea contains mixed polymers of catechin and gallic acid with glucose; herb teas such verveine, and mint contain monomeric flavonoids; coffee contains chlorogenic acid (a combination of the phenolic acid caffeic acid with quinic acid), cocoa and red wine, like sorghum, contain polymerised catechins (condensed tannins).

The first demonstration of the strong inhibitory effect of tea was by Disler and colleagues in South Africa (Disler et al. 1975). This group fed Indian women a meal of rice with potato and onion soup followed by water or tea. Absorption from the meal with water was 10% compared to only 2.5% with tea, a 75% reduction in absorption. In our own extrinsic tag radioiron absorption studies with different beverages (Hurrell, Reddy and Cook, unpublished), when subjects consumed two Fe fortified bread rolls with water, Fe absorption was 10%. When water was replaced by camomile tea this fell to 5%, with cocoa, coffee and red wine to around 3%, with mint tea to 2% and with tea to 1%. With this more simple meal, tea reduced Fe absorption by 90%. The level of inhibition is dependent, to some extent, on the amount of polyphenols present, but black tea (with or without milk) was the most inhibitory, reducing Fe absorption by 90%.

Phytic acid, myoinositol-6-phosphate, is of widespread occurrence as the Mg, Ca, K salt in cereal grains and legume seeds where it is the source of phosphate and minerals during germination. It accumulates in the aleurone layer (the bran) of cereals but in the protein bodies in the endosperm of legume seeds. Its level in cereal and legume-based foods depends on the processing conditions which can remove or degrade phytic acid. It is a strong inhibitor of Fe and Zn absorption because in the gut it forms peptide-phytatemineral-iron complexes from which Fe is unavailable for absorption. Phytic acid binds to the amino groups of the partially digested peptides and Fe binds directly to the phosphate groups or via the phosphate groups with the carboxylic acid groups or peptides. It is a very highly bound complex.

Phytic acid occurs at about 1% in most cereal grains and legume seeds, in wheat, rice, maize, barley, oats, soybeans, navy beans and peas (Reddy et al. 1982). When flours are manufactured from cereals by taking away the bran, we reduce phytic acid by 50% in high extraction wheat, around 80% in low extraction wheat (white flour) and polished rice and higher still in degermed maize, however when we make protein isolates and concentrates from legume seeds, such as soy we can increase the phytic acid content upto 2%.

We have studied the influence of phytic acid on iron absorption in man from wheat products (Hurrell, Reddy and Cook, unpublished). In this study, three products were tested; a high extraction wheat porridge with 240 mg phytic acid/100g, a low extraction porridge with 120 mg phytic acid/100g and a bread roll made from the low extraction porridge in which the phytic acid was zero because it had been degraded during fermentation (Svanberg and Sandberg 1988). Mean Fe absorption from the high extraction porridge was 1%, from the low extraction porridge 5% and from the bread roll 14%. In other words, we saw a 14 fold increase in Fe absorption when phytic acid in wheat flour was degraded.

ENHANCERS OF IRON ABSORPTION

There are two enhancers of iron absorption: ascorbic acid and muscle tissue. They both reduce Fe and bind it in a soluble form protected from inhibitors. Ascorbic acid reduces Fe3 to Fe2 and binds it in a soluble chelate. Fe2 is more soluble at alkaline pH; it is less reactive with hydroxyl ions in the gut as well as phytic acid and polyphenols. Muscle protein, on digestion, forms cysteine-containing peptides which similarly reduce Fe3 to Fe2 and form a soluble Fe complex.

To demonstrate that the enhancing effect of meat was due to cysteine-containing peptides, Layrisse fed human subjects a meal of 300mg maize or beans intrinsically labelled with 55Fe with 100g veal meat or 533 mg glutathione (a tripeptide of glutamic acid, cysteine and glycine) and containing the same amount of cysteine as the meat (Taylor et al.1986). In the maize, study iron absorption from the maize meal alone was 4.1% and it increased to 7.6% with the meat. In a second experiment, absorption from the maize meal alone was 4.0% and with glutathione 6.8%, similar to the effect with meat. With black beans similar results were obtained so that glutathione, the tripeptide containing cysteine, when added to maize meal or black beans had the same enhancing effect as meat.

The enhancing effect of ascorbic acid has been well-studied. As an example, many fruit juices increase iron absorption because they are rich in ascorbic acid (24-30mg/100ml,which is often added as a fortification). In a study from Ballot et al. in 1987, mean iron absorption from a 200g rice meal was 2.5%. With the addition of 100ml apple juice, this increased to 11.1%, with orange juice to 12.3% and with pear juice 15.0% (6 fold higher). The fruits themselves however are often less rich in ascorbic acid and sometimes do not increase Fe absorption. In the same study, 100g of grapes, peaches and apples with ascorbic acid 4-7mg/100g caused a slight reducation in Fe absorption from the rice meal, may be due to their polyphenol content, and strawberry (60mg ascorbic acid/100g) had no effect despite its relatively high ascorbic acid level, banana and melon caused a modest increase 2 fold and only the exotic fruits guava and papaya with very high ascorbic acid levels (150-180mg/100g) increased absorption substantially up to 12.6% and 17.3%. It should be emphasised therefore, that many of the fruits which we regularly consume have little or no influence on iron absorption.

Non-haem iron absorption is thus determined as the balance between the enhancing and inhibitory factors in a meal. The enhancers of iron absorption, ascorbic acid and muscle tissue, tend to increase absorption and the inhibitors, phytic acid, polyphenols, Ca and some proteins, tend to decrease absorption. Unfortunately, mainly due to the high phytic acid and polyphenol content of cereal and legume-based diets in developing countries, Fe absorption is usually low and iron deficiency results.

CONTROL OF IRON DEFICIENCY

There are three main intervention strategies to correct for nutrient deficiencies. These are food fortification, supplementation (with tablets) and diet modification together with nutrition education. Food fortification is usually considered the best long term approach for prevention. It has moderate capital expenditure, low running costs, can have high population coverage and permanent benefit if continued. Supplementation, on the other hand, is ideal for short-term interventions of highly deficient population groups, such as pregnant women. It is therapeutic. It does, however, have high personnel and administrative costs, requires a high level of supervision and can have side effects, particularly with Fe. It requires a highly effective distribution system which does not always exist. Diet modification likewise has high personnel costs. It also has high community involvement, but is often judged to have only moderate impact.

Finally, the possible intervention strategies to correct for iron deficiencies would include first of all supplementation, where recently it has been shown that a tablet once or twice a week may be as effective as once a day (Schultink et al. 1995). We can add also treatment for intestinal worms which reduces Fe loss. As to diet modification, we can recommend to eat more fruit and vegetables (to increase vitamin C), no coffee or tea with meals and to reduce phytic acid in cereals and legumes by fermentation. Finally food fortification, through careful choice of the food vehicle is needed. Flour, salt, sugar for example, can be used for widespread coverage or chocolate drinks or infant cereals targeted at 'at risk' groups. The iron compound must be of high bioavailability with no organoleptic problems. This is not always easy (Hurrell 1992) and may be the reason why iron fortification programmes have not always been successful.

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THE ROLE OF FOOD FORTIFICATION IN COMBATING MICRONUTRIENT DEFICIENCIES

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INTRODUCTION

The fortification of food which is the enrichment of commonly consumed foodstuff with micronutrients in order to improve the nutritional quality of the diet offers considerable nutritional benefits to the population. Food fortification can be used to prevent micronutrient deficiencies in populations where nutritional problems are prevalent. The idea of food fortification is not new. The addition of iodine to table salt to prevent development of goiter was already suggested in France about 150 years ago. This practical and inexpensive way to prevent a nutritional disease is widely practiced today. Also other types of food fortification are carried out regularly in many countries. The focus is on both staple foods, as well as on any other food item produced and processed industrially. In the United States, for example, fortification of margarine with vitamin A, milk with vitamin D, the addition of vitamin B1, B2, niacin and iron to cereal products has been carried out for over 50 years and is practiced in many other countries too. The fortification of food becomes especially important in case of novel types of food products which are marketed to replace traditional foods. The increasing use of refined foods, introduction of engineered foods that are formulated from highly purified ingredients, may contribute to dietary micronutrient deficiency if not upgraded adequately.

There are about 50 chemically well defined substances which must be present in the diet of a healthy human being. However, the daily requirement for the different compounds vary widely. Macronutrients like carbohydrates, fats and proteins are needed in higher quantities than micronutrients such as minerals, vitamins and trace elements.

The food we consume should contain sufficient amounts of the nutritional compounds to meet all our requirements for normal metabolism. However, with the exception of mothers' milk no other food appears in nature for the sole purpose of feeding human beings. Our diet has to be balanced in order to provide a satisfactory combination of nutrients. Unfortunately this physiological demand for a balanced diet is not always satisfied. The quantity or the quality of the food intake may often be insufficient. There are several reasons for this phenomenon. The causes for inadequate nutrition can be attributed to different factors for example, primary food deficiency due to crop failure and heavy storage losses. Dental problems, infections, and other diseases may further impair nutrition. There exist groups or single persons in the population who for economic, cultural or misconceived health reasons and occasionally just out of carelessness and ignorance have adopted eating habits which are unreasonable from a physiological point of view. The social and economical development in our society favours the growth of urban settlements and causes crowded living conditions. The large amount of food required to feed urban populations have to be kept in stock and distributed through existing sales channels. The distance from producer to consumer coupled with treatments to prevent deterioration inevitably causes losses in nutritive value and often decreases the dietary value of foods significantly. Another factor is the increase in the use of refined processed convenience foods which are tasty and easy to prepare but may be poor or incomplete in essential micronutrients. The average daily diet may therefore be constantly lacking in certain essential nutritional compounds. The population in rural areas, on the other hand, often depends only on foods produced locally. Climatic conditions and economic aspects may considerably limit the variety of foods available. The daily diet of the rural population may therefore be similarly inadequate. The most important dietary components which have a marked tendency to fall below requirement levels belong to the group of micronutrients namely vitamins, minerals and trace elements (Thomas, 1968 and FAO,1970).

Vitamins are active substances which are essential for life. There is a well-defined need for vitamins, and the daily requirement for vitamins has been established by national and international authorities. It is worth noting that the the Recommended Daily Allowances for nutrients (RDAs) are recommendations established for healthy persons. Special needs for nutrients arising from inherited metabolic disorders, infections, chronic diseases, etc. are not covered by the RDA. The need for certain vitamins which play a role in the prevention of degenerative diseases also exceeds the quantities defined by the RDAs (Brubacher, 1988).

Unlike macronutrients which serve as building material and energy source for the organism, the vitamins exercise catalytic functions. The metabolic functions of the vitamins have been extensively studied. Vitamin B1, B2, B6, B12, Folic Acid, Niacin, Pantothenic Acid and Biotin are incorporated in the enzymes systems which are indispensable for normal metabolism of protein, carbohydrates and fats. In these metabolic processes the vitamins do not participate as cell building material and this explains why the daily requirement remains small compared to that of the macronutrients. Soluble vitamins play their role in metabolism either directly or in the form of metabolities. The biological efficacy, for example of vitamin D, is due to its metabolities and is comparable to that of hormones. Nevertheless, the human organism is dependent on an external supply of vitamin D or at least of its precursors.

If one or more vitamins are either not available at all or only in insufficient quantities certain metabolic processes are impaired leading to disturbances in metabolism growth inhibition and disease. The functions of the single vitamins in metabolism are very specific so that in case of deficiency one or more defined by chemical reactions in certain organs will be affected. (Schotach, C.J. 1988; Czeizel and Dudas,1992 and Czeizel, 1993). The disturbances of metabolism can show up in very characteristic deficiency symptoms, however, the pattern of disturbed health is frequently confused for example when the vitamin is required for several metabolic reactions or when other nutrients or other active substances are lacking simultaneously. (Brubacher , 1988 ; Bendich and Cohen, 1988 ; Chandra 1992).

FOOD FORTIFICATION

Food fortification is the addition of micronutrients to food in order to upgrade its nutritive value. Food fortification is recognized as being the most effective way to eliminate dietary micronutrient deficiencies. Food fortification is socially acceptable, does not change the characteristics of the food, it requires no changes in food habits, has readily visible benefits and can legally be enforced for a nationwide action. It is the least expensive nutrition intervention and its effect can easily be monitored and is sustainable.

The need for the addition (restoration) of micronutrients becomes especially evident in case of processed and reformed staple food e.g. white and semi-white flour. The removal of the germ and bran from wheat results in a flour which is very low in vitamins and minerals (figures 1 and 2). Since white and semi-white flour are widely used for staple food such as bread and pasta products, the fortification of flour has to be implemented to improve the otherwise poor micronutrient intake.

History of Food Fortification

The concept of fortifying food with nutrients had its beginning in the 19th century when the addition of iodine to table salt was recommended to prevent goiter. This practice was adopted first in Europe after 1900 and then in the United States. The best known example of fortification apart from iodized salt is the vitaminization of flour, by the addition of vitamin B1 (thiamin), vitamin B2 (riboflavin), vitamin PP (niacin) and iron. This practice was introduced in the USA in 1941 as a programme to prevent beriberi, ariboflavinosis, pellagra and iron-deficiency anaemia . Compulsory wheat flour fortification was implemented in many other countries too. A great number of countries followed the practice of flour fortification on optional basis (Table 1). Enrichment of maize, maize grits, rice and pasta products followed thereafter.

The last epidemic outbreak of manifest vitamin A deficiency in Europe, which led even to blindness and enhanced mortality, occurred in the early years of this century, when margarine was intorduced in Denmark as cheap replacement for butter. The disease disappeared with the mandatory vitaminization of margarine (Bloch 1931). The successful intervention in Denmark prompted many other countries to make the fortification of margarine with vitamins A and D mandatory.

Selection of Foods for Fortification

In order to make fortification programmes viable and implemented successfully nationwide certain conditions must be met.

The following characteristics of a food item to be used for fortification are considered necessary:

1. Widely consumed by the population.
2. The consumption per capita varies little from person to person and from day to day.
3. The fortification results in no change of organoleptic characteristics.
4. The cost and nature of the food make the process of fortification economically feasible on an industrial scale.

By this definition, it is obvious that staple foods should be given priority in fortification projects. The significance of food items in the daily diet differs considerably and one has to be pragmatic in selecting foods for fortification. In Table 2, some samples of fortified foods are given. In addition to the food items, the micronutrients and their quantities which are generally added are also mentioned.

Implementation of Food Fortification

For practical reasons and in order to achieve an immediate and significant effect in improving the nutritional status of the population, it is advisable to start with the fortification of wheat flour by adding per kg:

Vitamin B1	4.60 mg
Vitamin B2	2.75 mg
Vitamin PP	37.10 mg
Iron	30.50 mg

By doing so, the micronutrient content of the flour used for white and semi-white bread would be enhanced to the following quantities :

Vitamin B1	5.5 mg
Vitamin B2	3.2 mg
Vitamin PP	45.0 mg
Iron	35.0 mg

The flour fortification project should be accompanied by the enrichment of edible oils and fats. The proposal for the fortification of fats and oils per kg is as follows :

Vitamin A	40,000 I.U.
Vitamin D	4,000 I.U.

In order to comply with this specification, it has to be added to 1 kg of fat and oil:

Vitamin A	46,000 I.U.
Vitamin D	4,600 I.U.

Vitamin E in line with the content of PUFA should be added whenever possible.

The enrichment of beverages with the frequently missing vitamin C should also be a subject for serious consideration. The addition of 200 mg vitamin C per liter of fruit juices and juice containing beverages ensures a substantial vitamin C intake.

Impact of Food Fortification

Food fortification is in general terms a public measure to improve nutrition and to reduce or eliminate nutritional deficiencies. Very often it means the restoration of certain micronutrients in a food which during processing has lost most of its micronutrient content. Thus the restored, fortified, upgraded food can substantially contribute to the respective micronutrient supply.

In some cases this (additional) contribution was evaluated in detail in order to demonstrate the impact of food especially staple food fortification.

As a consequence of consuming restored/fortified bread a dramatic decrease in pellagra cases was found (Bauernfeind, 1991) practically eliminating this deficiency disease completely in the USA.

The history of beriberi in Canada was reviewed and showed that flour enrichment brought down beriberi cases virtually to nil (Bauernfeind and La Chance, 1991). Similar investigation was carried out by Salcedo et al.(1950) on beriberi in the Philippines. Here again a continuous and fast decrease of beriberi cases could be demonstrated. Due to the non-existence of an industrially produced/processed and widely consumed staple food in Guatemala sugar has been chosen as a carrier for vitamin A fortification. A nutrition survey made by Arroyave.et al. (1979 and 1981) impressively demonstrated the beneficial effect of this fortification scheme on the improvement of vitamin A supply to the population .

Cost of Food Fortification

The costs of food fortification include costs for the fortificant, capital and labour costs for blending operations, costs for premix transport and quality control. Depending on type of food to be fortified, the fortification technology applied, the cost of fortification varies. Average fortification costs for various foods fortified with different micronutrients are listed in Table 3. It is evident from this table the fortification of flour (bread), fats and oils and fruit juice beverages will cost per person per year 25 US cents only !

This calculation is based on current prices. It can be agreed that the implementation of the fortification scheme of staple foods mentioned can be regarded as feasible and the cost will be negligible compared to the benefits.

Cost of Malnutrition

The costs of malnutrition in general, and micronutrient malnutrition in particular are difficult to quantify. Only in recent years have some more sophisticated mathematical models for quantifying economic losses due to premature disability and death have been developed (The World Bank, 1993).

In order to quantify the total economic loss caused by malnutrition, the term disability-adjusted life years (DALY's) has been defined (The World Bank, 1994). DALY is an index of productive life years lost due to premature disability or death caused by malnutrition and preventable disease.

According to such calculations the average cost of malnutrition which is partly caused by micronutrient malnutrition can be assumed in the range of hundreds or even thousands of dollars per person per year (Table 4).

Safety of Food Fortification

More than 50 years of experience in food fortification in industrialized and developing countries confirm that food fortification is safe and efficacious. Vitamin levels applied in food fortification are typically in the range from 15% of the RDA to 25% of RDA per serving.

Generally fortification levels are designed such as not to exceed one RDA per day even in case the fortified food would be consumed inexcessive amounts. For safety reasons, fortification levels should be monitored on a regular basis. In order to avoid mixing errors or potency variations criteria for quality control should be defined and implemented. Fortification should be monitored by a qualified laboratory equipped with modern analytical technology and manned by experienced staff.

CONCLUSIONS

Micronutrient deficiencies remain an important health problem in many parts of the world. Four key strategies to solve micronutrient deficiencies, namely dietary diversification, supplementation, food fortification and nutrition education have been recommended. Each strategy has its strength and should be prioritized in the context of cultural factors, economics and maximum impact (FAO / WHO,1992).

Experience gained both in developing and industrialized countries has shown, that food fortification is safe, efficacious, inexpensive and sustainable. Suitable technologies for fortification of flour, vegetable fats and oils, fruit juice beverages, sugar and dairy products have been developed and are transferable to local food industries in developing countries.

Food fortification does not require active participation of the consumer and only minimally affects taste and appearance of foods. Economic studies by The World Bank and other institutions active in public health research have documented that food fortification is cost effective and can be maintained over decades if needed.

In order to improve the nutritional status of the population immediately it is suggested that flour and edible fats and oils (Figures 3 and 4) be fortified as proposed. As these food items are produced locally, the fortification has to be carried out in the flour mills, margarine plants and oil mills.

The cost of vitaminization outlined in details is reasonable and will be compensated by the improved nutritional situation in the country. Enrichment of staple foods can be regarded as one of the most effective measures in basic health service and preventative medicine.

Table 2 : Some Selected Fortified Foods

Food Item	Micronutrients	Quantities added (per kg or lt)
Flour	Vitamin B1 (Thiamin)	4.60 mg
	Vitamin B2 (Riboflavin)	2.75 mg
	Vitamin PP (Niacin)	37.10 mg
	Iron	30.50 mg
Edible Oil/Fats and Margarine	Vitamin A	46,000 I.U.
	Vitamin D	4,600 I.U.
	Vitamin E	250 mg
Beverages	Vitamin C	200 mg
Milk	Vitamin A	15,000 I.U.
	Vitamin C	150 mg
	Vitamin D	1,500 I.U.
	Vitamin E	25 mg
Salt	Iodine	100 mg
Biscuits	Vitamin A	50,000 I.U.
	Vitamin B1 (Thiamin)	16 mg
	Vitamin B2 (Riboflavin)	20 mg
	Vitamin B6 (Pyridoxine)	20 mg
	Vitamin B12	40 mcg
	Vitamin D	2,000 I.U.
	Vitamin E	120 mg
	Vitamin PP (Niacin)	200 mg
	Folic Acid	3 mg
	Pantothenate	60 mg
Baby Food	Vitamin A	15,000 - 30,000 I.U.
	Vitamin B1 (Thimin)	3-6 mg
	Vitamin B2 (Riboflavin)	4-8 mg
	Vitamin B6 (Pyridoxine)	3-5 mg
	Vitamin C	500-700 mg
	Vitamin B12	5-10 mcg
	Vitamin D	2,500-4,000 I.U.
	Vitamin E	45-70 mg
	Vitamin K1	250 mcg
	Vitamin PP (Niacin)	50-8 mg
	Folic Acid	0.5-1 mg
	Biotin	200-400 mcg
	Pantothenate	60 mg

Table 3 : Cost of Fortification (per person and year)

	Vitamins	Price/g	Cost/person & year
Flour (185g flour = 250g bread)	ROVIRARIN 955	X 1.6 = 8.8 US cents	9 US cents
0.185 X 365 = 73 kg X 75 = 5.5g Vitamins : B1, B2, PP + Iron			
Oils/Fats (30g)	Vit. A. Palm. 1MIU + Vit. D3 100'000 IU	X 6 = 3.00 US cents	3 US cents
0.03 X 365 = 11 kg X 46 = 0.50g Vitamins: A, D			
Beverages (0.1 lt)	Vit. C	X 1.75 = 12.77 US cents	13 US cents
0.1 X 365 = 3.65 lt X 200 = 7.3g Vitamin : C			
Vitamins A, D,B1, B2, PP, C + Iron			25 US cents

Table 4 : The Cost of Malnutrition

Conclusion :

An infant born in 1991 in Indonesia has a potential productivity of USD 11,135. He loses this productivity, partly or totally, if he becomes blind or suffers from other kinds of diseases because of malnutrition in childhood.

Total live bieth in Indonesia in 1991 : 4.6 million.
Malnutrition in children under 5 (1991): 14%
4,600,000 X 14% = 642,600
USD 11,135 X 642,600 = USD 7,160,000,000.

This shows that Indonesia may lose each year up to USD 7,160 million solely because of malnutrition of children. This represents 6.5% of the GNP in 1991.

The World Bank, (1993)

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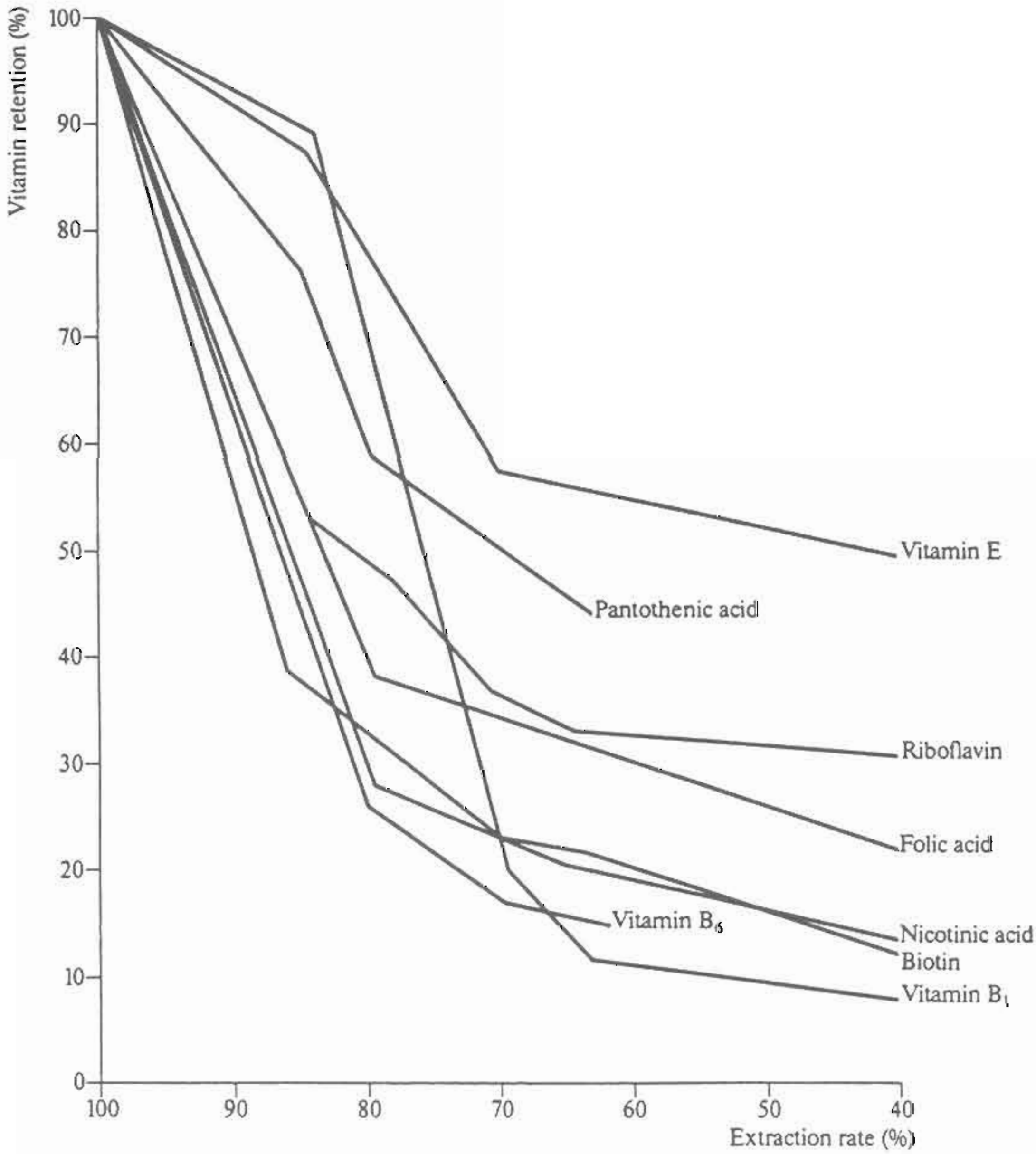
Figure 1

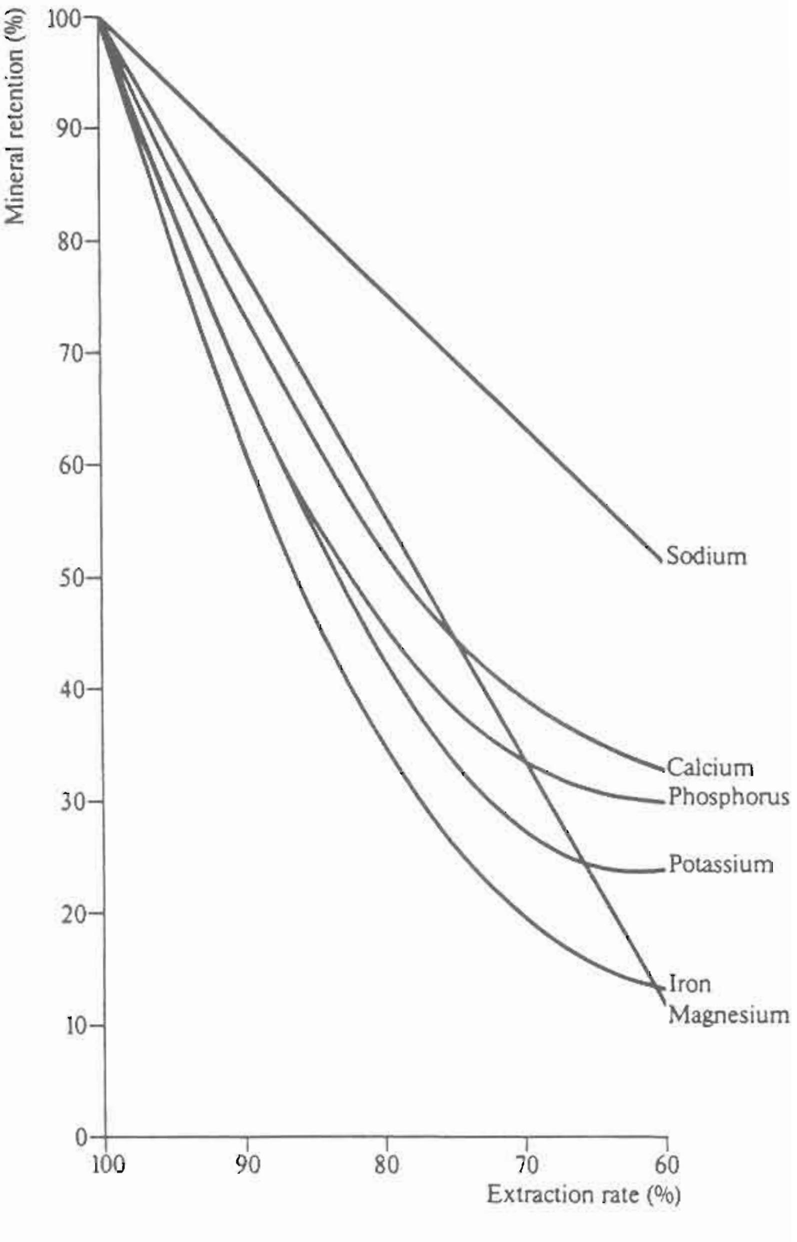
Changes in vitamin content of wheat grain with milling



Wheat in Human Nutrition: FAO, Rome (1970)

Figure 2

Changes in mineral content of wheat grain with milling



Thomas (1968)

Figure 3

Vitamins / Minerals Contained in 200g Bread

Vitamins/Minerals	Daily Requirements	200g unenriched white bread (70% ER)	200g whole wheat bread (95% ER)	200g enriched white bread (70% ER + 80g ROVIFARIN 955 / ton
		Percentage of daily requirements supplied	Percentage of daily requirements supplied	Percentage of daily requirements supplied
B1	1.2 mg	10%	50%	44%
B2	1.8 mg	2%	14%	25%
PP	15.0 mg	8%	40%	42%
Iron	15.0 mg	12%	30%	33%

Figure 4

Vitamins Contained in 30g Fats/Oils

Vitamins	Daily Requirements	30g unenriched vegetable fats/oils/margarine	30g Butter	30g enriched vegetable fats/oils/margarine
		Percentage of daily requirements supplied	Percentage of daily requirements supplied	Percentage of daily requirements supplied
Vitamin A	5000 I.U.	Traces	15%	24%
Vitamin D	400 I.U.	0%	13%	30%

NaFeEDTA AS A FOOD FORTIFICANT

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INTRODUCTION

Much of the information in this report is based on a recent monograph prepared by the International Nutritional Anemia Consultative Group (INAGG 1993) entitled 'Iron EDTA for Food Fortification'. This organisation believes that NaFeEDTA is the most suitable iron fortificant for iron fortification programmes in developing countries because it protects iron from the inhibitory ligand phytic acid. While it is at the moment about 6 times more expensive than ferrous sulphate per unit of Fe, it is 2-3 fold better absorbed and avoids the use of ascorbic acid addition. In relation to elemental Fe, which is often used to fortify wheat flour, NaFeEDTA is 6 times more expensive but at least 6 times better absorbed (see Hurrell (1992) for discussion of elemental Fe). In addition, using NaFeEDTA guarantees that a useful amount of Fe will be absorbed. It is not possible to guarantee that a useful amount of Fe will be absorbed when using some forms of elemental Fe.

REGULATORY ISSUES

In relation to the regulatory issues, JECFA (Joint WHO/FAO Expert Committee on Food Additives) in 1974 permitted the use of CaNa2EDTA and Na2EDTA at up to 2.5mg/kg body weight/day with a max. ADI (acceptable daily intake) at 150mg/person/day. The ADI was extrapolated from the rat study by Oser (1963) as the highest no-effect level (250mg/kg) and applying a safety factor of 100. Unfortunately this study did not include higher levels of EDTA. These EDTA compounds are now permitted by the local FDA's for use in many countries world wide in Asia, Africa, Middle East, Europe and America as a sequestering agent for metals to prevent offlavour, rancidity, discoloration, etc. It is most often added to foods such as mayonnaise, fish and beer and, in the USA for instance, it is permitted in 34 different foods although the estimated daily intake is only 25mg/person/day, 10 times less than the ADI/JECFA. In 1993, at the request of the International Life Science Institute (ILSI), INAGG gave provisional approval for the use of NaFeEDTA in monitored national fortification programmes but, as yet, not one has begun.

Table 1 gives examples of some of the foods to which Na2CaEDTA is added in the United States for colour, texture, flavour retention or as a preservative. There is a whole range of foods (beans, soft drinks, egg products, mushrooms) with beans (800mg/kg) and crab meat (250-340mg/kg) containing the highest amounts. Soft drinks, however, probably provide the highest daily intake because of their higher consumption.

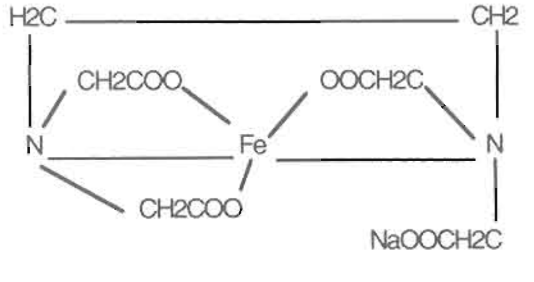
Table 1 : permitted use of CaNa2EDTA in the United States

FOOD PRODUCTS	PURPOSE	**Ca Na2 EDTA** Amount permitted (mg/kg)
Beans, pinto, dry	Retain colour	800
Cabbage; cucumber, pickled	Maintain color, flavor, texture	200
Carbonated beverage	Retain flavor	33
Crab meat, clams, and shrimp	Retain color	250-340
Egg products	Preservative	200
Margarine	Retain color	75
Mayonnaise	Retain color	75
Mushrooms, canned	Retain color	200
Potatoes, canned	Retain color	110
Sandwich spread	Preservative	200

CHEMISTRY

EDTA (ethylene diamine tetraacetic acid) is a hexadentate chelate (binding through its 4 negatively charged carboxlic acid groups and 2 amine groups). It can combine with virtually every metal in the periodic table. Its effectiveness as a chelate depends on the stability constant which is influenced by pH and molar ratio and any metal capable of forming a stronger complex with EDTA will at least partially displace another. Fig.1 is a schematic structure of sodium FeEDTA.

Fig. (1)Structure of NaFeEDTA



Of the nutritionally important metals, Fe^{3+} has the highest stability constant log k of 25.1, this is followed by Cu (18.4), Zn(16.1)and Fe^{2+} (14.6) with Ca at 10.7, Mg at 8.7 and finally Na at 1.7. The less desirable metals such as Hg (20.4), Pb (17.6) and Al (15.5) and perhaps Mn (13.5) also have fairly high stability constants. The situation is somewhat complicated by having an optimum pH for complex formation between 1 and 10. The optimum pH for complex formation between Fe^{3+} and EDTA is 1, Cu is pH3, Zn is pH 4 and Fe^{2+} is pH5, Ca is pH 7.5 and Mg is pH 10 (West & Sykes 1960)

Based on these pH optima, the predicted effect in the intestine of NaFeEDTA and $CaNa_2EDTA$ in the food would be as follows. In the stomach, Fe^{3+} from NaFeEDTA would remain firmly bound to EDTA, whereas Ca and Na from $CaNa_2EDTA$ would dissociate and the EDTA molecule would bind Fe from the common pool. Even with the addition of $CaNa_2EDTA$ therefore, iron EDTA would form in the stomach. In the duodenum, the iron would be released from NaFeEDTA and, if required, absorbed (Candela et al. 1984), and the EDTA would presumably bind in succession to Cu (pH3), Zn (pH4) and Fe^{2+} (pH5) but, most of the metals are released for absorption as <5% of the metal: EDTA complexes are absorbed (<1% FeEDTA (McPhail et al. 1981)) and excreted directly in the urine. More than 95% of EDTA molecule is excreted in stools. Theoretically, in the ileum and colon, EDTA could bind to Ca which has a pH optimum of 7.5 for complex formation. Mg, with a low stability constant and a high pH optimum of 10.5, probably would not react.

IRON ABSORPTION FROM MEALS FORTIFIED WITH NaFeEDTA

If we now compare the Fe absorption from inhibitory meals fortified with $FeSO_4$ or NaFeEDTA (Table 2,INAGG 1993), we see that Fe absorption is usually 2-3 fold higher from NaFeEDTA. Most of these meals contain a considerable amount of phytic acid. With less inhibitory meals such as potato and sweet manioc containing little or no phytic acid, there is no improvement in absorption with NaFeEDTA. In some cases, when no absorption inhibitors are present absorption from NaFeEDTA can be far worse than with ferrous sulphate (e.g. with sugar syrup where Fe from EDTA was 30% less well absorbed than from ferrous sulphate (INAGG 1993)).

Table 2 : Iron absorption (%) from meals fortified with NaFeEDTA

Meals Components	A Ferrous sulphate	B NaFeEDTA	Ratio B/A
Rice, Milk	1.7	4.5	2.6
Beans, Maize, Coffee	2.0	5.3	2.7
Bran	2.7	7.8	2.9
Rice	3.9	11.5	2.9
Maize	4.0	8.2	2.1
Beans, Plantain, Rice	4.3	9.6	2.2
Maize, Soy, Meat			
Wheat	6.2	14.6	2.3
Milk	10.2	16.8	1.6
Potato	5.9	7.3	1.2
Sweet Manioc	14.1	16.6	1.2
Sugar Cane Syrup	33.1	10.8	0.3

POSSIBLE REACTIONS OF EDTA WITH OTHER DIETARY MINERALS

If we now look at the possible impact of EDTA from NaFeEDTA (10mg fortification Fe/Day) with nutritional status of other minerals assumed to be in the diet at a level equivalent to their RDA, 2mg Cu, 15mg Zn, 350mg Mg and 800mg CA, we can calculate that on a molar basis there is 50 times more Mg and 80 times more calcium in the diet than EDTA, so there would be no likely impact of NaFeEDTA on Mg or Ca metabolism. With Cu and Zn, however, there could be a possible effect since on a molar basis there is 8 times more EDTA than Cu and equivalent amounts of EDTA and Zn. We have investigated this effect in both rats and adult women. In rats, increasing the level of EDTA in the diet increased zinc absorption and to a lesser extent copper absorption, but had no effect on calcium (Hurrel et al. 1994). In adult women fed bread rolls fortified with either NaFeEDTA or ferrous sulphate, zinc absorption was increased from 20% to 34% by adding NaFeEDTA with no effect on calcium. Zn excretion was also increased from 0.3 to 0.6% but this had little negative effect on zinc metabolism. The EDTA molecule, from added NaFeEDTA, can therefore increase both iron and zinc absorpotion from meals containing phytic acid.

INTERVENTION STUDIES

Intervention studies have been made with NaFeEDTA by Garby and Areekul (1974) in Thailand, Viteri et al. (1983) in Guatemala and Ballot et al. (1989) in South Africa. All were controlled studies, although only the Ballot et al. study was a double blind. The number of subjects varied from 600-1000 and the study time from 12-24 months. None of the vehicles themselves contained phytic acid. They were fish sauce, sugar and curry powder. The amounts of iron provided per day ranged from 4.3mg with sugar,7.7mg with curry powder to 10-15mg with fish sauce. All intervention produced an improvement of iron status. In the fish sauce study , packed cell volume (PCV) increased in men, women and children. In the sugar study, Hb increased in children and there was an increase in serum ferritin (iron stores) in adults. In the curry powder study, there was an increase in Hb and serum ferritin in all subjects and the prevalence of anaemia in women fell dramatically from 22% to 5%.

ORGANOLEPTIC PROPERTIES

Many soluble iron compounds cause unacceptable colour and flavour changes when added to foods and/or promote fat oxidation reactions (Hurrell, 1992) The organoleptic properties of NaFeEDTA have not been well-studied. It has been shown not to promote fat oxidation in stored wheat flour, although sodium EDTA plus ferrous sulphate added seperately do promote fat oxidation similarly to ferrous sulphate alone. NaFeEDTA, however, offers little protection against adverse colour reactions. Bananas and chocolate will turn blue as they do with all soluble iron compounds.

CONCLUSIONS

In conclusion, NaFeEDTA increases Fe absorption 2-3 fold compared to FeSO4 in phytic acid containing meals. It has improved Fe status in pilot studies and has been accepted as a food additive by the JECFA. Zn absorption is probably also increased especially from low bioavailability foods, but is has no effect on Ca balance. There is still some concern over the influence of NaFeEDTA on Mn, Al, Pb and Ca absorption and this should be evaluated. It can be added without organoleptic problems to wheat flour, but needs a more systematic evaluation in respect to other foods, particularly in relation to adverse colour reactions. NaFeEDTA would appear a very useful iron compound for wheat flour fortification.

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MICRONUTRIENT DEFICIENCIES IN EGYPT: A SITUATION ANALYSIS

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INTRODUCTION

Only recently, international organizations have paid increasing interest in micronutrient deficiencies. The World Summit for Children, convened in New York in September 1990, endorsed three goals and adopted a declaration and a plan of action calling for the virtual elimination of iodine deficiency disorders, the virtual elimination of vitamin A deficiency and its consequences including blindness; and the reduction by one third of 1990 levels of iron deficiency anemia among women of childbearing age, within this decade. This was followed in 1991 by a conference in Montreal, Canada, "Ending Hidden Hunger", which focused exclusively on micronutrient deficiencies.

The reasons for this increased attention to micronutrient deficiencies are that they affect a large number of people and have serious consequences. Infants, preschool-age children, school-age children, pregnant and lactating women are the most vulnerable groups exposed to micronutrient deficiencies. Those most affected are children in their first four years of life and pregnant women. Micronutrient deficiencies affect physical performance, learning ability, behaviour and psychosocial development - all of which are reflected in the physical and intellectual retardation of present and future generations.

The objective of this paper is to analyze the current situation of micronutrient deficiencies of public health significance in Egypt such as iodine deficiency disorders, iron deficiency anemia and vitamin A deficiency.

IODINE DEFICIENCY DISORDERS - ENDEMIC GOITER

The first time goiter was reported in Egypt in the present century was more than seventy years ago, when Dolbey and Omer (1924) drew attention to the occurrence of colloid adenomatous goiter among field labourers or farmers in Egypt. They found that villages along the Nile had no goiter, whereas goiter was frequently encountered in villages remote from the river where people used wells or canal water.

Later, most of the nutrition studies done on goiter in Egypt suggest the endemicity of goiter in certain areas especially in the New Valley governorate in the Western Desert (formally known as oases of El-Kharga, El-Dakhla and El-Farafra). The first one to mention the presence of endemic goiter in Egypt was Ibrahim (1932). An overall prevalence rate 7.6% (range 6- 18%) was reported in the oases of El-Kharga and El-Dakhla. Only males were available for examination at that time.

In the mid fifteis, Ghalioungui (1955) confirmed the occurrence of endemic goiter among males in El-Dakhla oasis. No cases were found in El - Kharga oasis. A total number of 476 males at different ages were examined with a prevalence rate of goitrous cases of 29.6% (range 12-43%) (Table 1). The condition occurs most frequently between the ages of 10 and 15 years. In the mid sixties, Ghalioungui (1965) studied goiter in different locations in Egypt along the Nile from Nubia in the south to the Mediterranean in the north and in the oases in the Western Desert (New valley governorate). He reported a prevalence varying between10-50%. However, there is some dispute in interpreting the results as regards the degree of thyroid enlargement (Patwardhan & Darby, 1972).

Table 1 : Prevalence of IDDs in New Valley governorate in various surveys.

Survey	Prevalence %	No. examined
Ibrahim, (1932) only males, different ages	7.6	381
Ghalioungui (1955) only males. different ages	29.6	476
Abdou, (1965) Different ages	52.0	1760
Nutrition Institute & WHO, (1991) all schoolers	52.0	1191
HIPH & UNICEF, (1993) Primary school children	82.3	600

In a nutrition survey carried out in New Valley in the late fifties, Abdou (1965) reported an overall prevalence rate of goiter of 52% among all age groups of both sexes (Table 1). The prevalence among individuals above 6 years ranged between 30-82%, while below 6 years of age it was 10%. The prevalence of goiter was higher among females (67%) than males (43%). The highest prevalence was among males in the age group 6-11 years, while for females it was in the age group 11-16 years (Table 2).

At the beginning of the nineties, interest in IDDs was raised the World Summit for Children in 1990 had included "The elimination of iodine deficiency disorders (IDDs) by the year 2000" in their plan of action. A national nutrition survey was carried out in Egypt in 1991 to study the prevallence of IDDs among schoolers (Nutrition Institute in collaboration with WHO, 1992). The study revealed an overall prevalence rate of 6.7%. Females suffered more than males (8.6% and 4.4%, respectively). The highest prevalence rate of IDDs was observed in the New Valley governorate (38%), followed by Soughag governorate (14.8%), while the lowest prevalence rate was noticed in Menoufia, a lower governorate of Egypt (0.3%). No significant difference was observed between urban and rural schoolers (6.1% and 6.9%, respectively). The prevalence was the highest among females in the age group 14-17 years, while for males there was no specific age. Although South Sinai is a desert area, it showed a very low prevalence of IDDs (1.5%).

Table 1 : Enrichment of flour - Legal Status in Various Countries

Australia :	flour enrichment optional
Bahrain :	flour enrichment optional
Brazil :	flour enrichment optional
Canada :	flour enrichment compulsory
Chile :	flour enrichment compulsory
Costa Rica :	flour enrichment compulsory
Denmark :	flour enrichment compulsory
El Salvador :	flour enrichment compulsory
Dominican Republic :	flour enrichment optional
Finland :	flour enrichment optional
Guatemala :	flour enrichment compulsory
Honduras :	flour enrichment compulsory
Japan :	flour enrichment optional
Jordan :	flour enrichment approved by the government
Nicaragua :	flour enrichment compulsory
Nigeria :	specific standard exists ; flour enrichment optional
Oman :	flour enrichment optional
Panama :	flour enrichment compulsory
Peru :	flour enrichment optional
Philippines :	flour enrichment optional
Portugal :	flour enrichment optional
Puerto Rico :	flour enrichment optional
Saudi Arabia :	specific standard exists ; flour enrichment optiona
Sweden :	specific standard exists ; flour enrichment optional
Switzerland :	flour enrichment optional
United Kingdom :	flour enrichment compulsory
U.S.A. :	specific standard exists ; flour enrichment compulsory in most states
Venezuela :	flour enrichment compulsory
Yemen :	flour enrichment optional

Table 2 : Prevalence of IDDs given by various surveys in Egypt according to sex and age groups.

Survey	Thyroid Enlargement			
	Sex	Grade I %	Grade II, III %	Total No. Examined
New Valley Oases, 1959 (Abdou, 1965)				
0-6 y	M	7		28
	F	6	4	29
6-11 y	M	34	17	463
	F	50	16	364
11-16 y	M	30	14	378
	F	49	30	168
More than 16	M	23	12	252
	F	26	29	78
Cairo school children, 1962 (Abdou et al., 1967)	M	1.4	0.3	1657
	F	15.9	1.9	1219
Follow-up survey, 197 (Said et al., 1980)	M	6.8	0.4	1612
	F	10.6	2.7	1848
Cairo school children, 1991 (El-sayed et al., 1995)	M	10.8		843
	F	16.2	0.1	805
IDDs among schoolers, 1991 (NI & WHO, 1992)				
Primary 6-11 y	M	4.4	0.1	5262
	F	6.0	0.1	4276
Preparatory 11-14 y	M	4.5	0.1	5705
	F	7.5	0.7	5761
Secondry 14-17 y	M	3.9	0.3	4947
	F	10.7	0.7	4907
IDD among primary school children New valley, 1993 (HIPH & UNICEF, 1993)	M	73.9	8.7	299
	F	70.1	12.0	301

The most recent study in New Valley governorate was carried out in 1993, to study the prevalence of IDDs among primary school children 6-12 years (HIPH in collaboration with UNICEF, 1993). The overall prevalence rate of goiter was 82.3%. No significant difference by sex was found. IDDs prevalence rate was higher in rural areas (85.2%) than in urban areas (72.9%). A fertilized pie enriched with iodine is distributed to school children in New Valley. The study revealved a relatively lower prevalence rate of IDDs (81.7%) among students taking the iodine enriched pie compared with those not taking this pie (86.2%).

Despite the difference in the prevalence rates between different surveys carried out in Egypt, it is apparent that IDDs is a public health problem in some areas in Egypt especially in the New Valley governorate. Lack of sufficient iodine in soil, water, salt and agricultural products is the cause of goiter edemicity in New Valley (Ghalioungui and Shawarby, 1959; HIPH / UNICEF, 1993). The situation is aggravated by the nature of drinking water. In New Valley, water supply is from artesian wells often 200-300 meters deep, with only traces of iodine but high calcium, magnesium sulfate, sodium and potassium contents. These minerals interfere with the availability of iodine in the human body. This hardness of drinking water was regarded earlier by Ibrahim (1932) to be the chief causative factor of goiter endemicity in New Valley. Contaminated drinking water was excluded as a causative factor (Ibrahim, 1932; Ghalioungui and Shawarby, 1956).

Although iodine deficiency is the primary etiological factor in causation of endemic goiter in New Valley, other factors may interplay a role. Among these are deficiency of vitamin A, vitamin C and riboflavin, low protein diet, or an excess of salt and onion intake (Abdou, 1965; Abdou and Awadallah, 1959, 1970). A hereditary predispostion was suggested as a high prevalence of goiter was noticed among several members of the same family (Abdou, 1965).

Action plans for iodine deficiency disorders

The situation analysis indicated that iodine deficiency is a major public health problem in some areas in Egypt. Data available indicated that goiter is endemic in New Valley governorate. Irrespective of whether the cause of IDDs is environmental deficiency or due to other factors, the most efficient and easiest way of eliminating the problem is by adding iodine to the diet. This can be done through the addition of iodine to salt, water, various sauces or in an oily form (WHO, 1993). However, prophylaxis with iodized salt has been mostly used.

Successful iodized salt programmes date from 1920s in the United States, Switzerland and Scandinavia are good examples of the effectiveness of iodized salt (Hetzal , 1993). Yet, the efficacy of iodized salt depends on several factors. The concentration used depends on the level of consumption of table salt, the climate, handling and distribution (Lamberg, 1993).
In Egypt, The El-Nasr Salt Company, a governmental company, started the process of salt iodination by dry mixing refined table salt with 100 ppm potassium iodine. Small quantities are imported through the private sector. The average salt consumption in Egypt is 10 gm/day range 3-15 gm/day, Although iodination of salt is a simple process, consistent monitoring of the iodine content of salt at the production, storage, sale, consumption levels and prevention of sale of uniodized salt are vital components of salt iodination programmes which should be adjusted to meet local conditions and requirements. Recently, experiments on iodized salt produced by El-Nasr Salt Company revealed that using potassium iodate instead of potassium iodine is preferable as it is more stable (Ismil, personal communication). Also, iodized salt should be transported under cool conditions, used post-cooking and used within one year of production.

A National Committee for "Eradication of IDDs" was founded in Egypt in late 1993. The committee includes representatives from the Ministry of Health, Nutrition Institute (Cairo), High Institute of Public Health (Alexandria), UNICEF, WHO, Ministry of Industry and El-Nasr Salt Company. In January 1995 the committee started an intervention iodine programme in New Valley governorate in which goiter is endemic - by distributing iodized oil (oriodol) given orally. A dose of 308 mg iodine is given to children below six years and pregnant women, while a dose of 616 mg iodine is given to lactating women, women at child bearing age, males and females between 6-18 years (El-Sayed, personal communication). Also, a training course for medical and paramedical personnel working at health centers was carried out in order to explain the problem, ways of examination and treatment.

One still has to stress that the surveillance system for IDDs must be strengthened in order to eliminate the IDDs. Continuous assessment of IDD prevalence, identification of high risk areas/groups, evaluation of programmes and social mobilization is needed in order to be able to achieve the goal of elimination of IDDs by the year 2000 in Egypt.

IRON DEFICIENCY ANAEMIA

Anaemia prevalence among preschool children

Anaemia is an important public health problem in preschool age in Egypt. In 1978, the National Nutrition Survey on preschoolers (6-72 months) revealed a prevalence rate of 38.4% of the total representative sample (Nutrition Institute and Central Disease Control, 1979). It is more prevalent among rural (39.2-44.6%) than urban populations (23.3-30.5%). A higher prevalence of anemia was shown among children of the underprivileged districts in Cairo and Alexandria (35.5 and 42.1% respectively). This is due to increased urbanization in these cities as result of the demand for employment.

According to geographic distribution, the highest prevalence of anaemia among preschool children was detected in Beheira governorate, El-Giza , El-Fayoum Beni-Suef and El-Menia (54%).The prevalence of severe anaemia (<9.5 gm/dl) was 12.2% of the total representative sample. It ranged from 3.3% in small cities to 15.7% in rural regions (Table 3).

Table 3 : Percentage distribution of preschool children by anemic status and geographic areas.

Geographic Area	Hb Level <9.5 gm/dl %	Anaemic %	Total No. Examined
Lower Egypt, rural	14.9	44.6	715
Upper Egypt, rural	16.5	43.4	358
Large villages	11.9	39.2	176
Small towns	8.3	30.5	180
Small cities	3.3	23.3	180
Total representive sample	12.2	38.4	1609
Cario-Giza	5.6	35.5	177
Alexandria	11.8	42.1	178
Advantaged group	1.9	16.9	359

According to age, anaemia prevalence was highest at 12-23 months (59.4%) and gradually diminishes till 12.8% at 60-71 months. This is expected as anaemia is prevalent among pregnant women. Chronic undernutrition was more common among anemic children(31.4%) than non anaemic (17.4%).

A follow up nutrition survey was conducted in 1980 (NI and CDC, 1980) in two of the six rural villages originally surveyed in 1978 National Nutrition Survey. The results of the study showed that the prevalence of anemia and the mean hemoglobin concentration were closely similar to the 1978 survey.

In 1986, another follow up survey was conducted in order to compare the status of preschool children after a nine-years lapse from that of 1978 National Survey. A total of 1020 school children in 34 sites previously surveyed in 1978 were included in the survey. The results revealed an increase in the prevalence of anaemia among all age groups (Table 4). The difference is mostly in severe anaemia (26.8% versus 14.8% in 1978) (CAPMAS, 1988).

Table 4 : Prevalence of anaemia among preschool children by age group in 34 sites and NS 1978.

Age	National Survey	34 Sites	
in months	1978	1978	1986
6-11	57.3	77.8	74.4
12-23	59.4	57.8	60.4
24-35	41.1	44.8	56.0
36-47	39.9	40.7	48.3
48-59	16.6	27.2	38.5
60-71	12.8	33.3	35.1
Total	**38.4**	**48.0**	**51.6**

Prevalence of anaemia among school children

Few studies have been carried out on schoolers, however, these studies have revealed that anaemia is a prevalent nutritional problem among school children. In 1962 a survey among Cario school children (6-19 years) showed a prevalence rate of 13% for boys and 11% for girls. The mean hemoglobin level was 12.7g/dl for boys and 12.5 g/dl for girls (Abdou et al, 1967). A follow up survey of Cario school children in 1975 revealed an increased prevalence of anaemia to reach 39% in boys and 45% in girls (Said et al, 1980). The mean hemoglobin concentration was lower than the previous study where it was estimated to be 11.6 gm% for boys and 11.4 gm% for girls (Table 5). This decrease in blood hemoglobin concentration and the increase in the prevalence of anaemia between the two surveys was attributed to the increased prices of animal food during this period (Said et al, 1980).

In Alexandria governorate a study of 2685 students aged 6-18 years representing the three educational levels in rural and urban areas revealed a prevalence rate of anaemia of 22.01% (Wasfy, 1979). The highest prevallence rates were among primary school children with a prevalence of 27.7%. The distribution of anaemia by age showed that the highest anaemia prevalence (36.4%) was seen in children aged 6-8 years. Anaemia was more prevalent among students from rural areas (70.2%) compared to urban school children (25.8%). The mean blood hemoglobin concentration was 10.16 gm% in rural areas, while in urban areas it was 10.79 gm%.

Parasitic infections were significantly higher in prevalence among anaemic students than among non anaemic group (Wasfy, 1979). Anaemia had its impact on physical growth as demonstrated in the heights and weights of anaemic children compared to non anaemic ones (Fahmy, 1979). More than 70% if anaemic students at the primary school level were below 50th percentile of Egyptian standards for weight and height.

Table 5 : Mean hemoglobin concentrations and percent anaemics among School Children from various surveys

Survey	Mean Hb Concentration		% Anaemic	
	Boys	Girls	Boys	Girls
Cairo school children (1962) 6-19 years (Abdou et al., 1967)	12.7	12.5	13.0	11.0
Follow up Cairo school children (1975) 6-19 years (Said et al , 1980)	11.6	11.4	39.0	45.0
Alexandria school children (1978), 6-18 years (Wasfy, 1979)	-	-	22.2	21.8

Prevalence of anaemia in women

Early studies carried out during the fifties and sixties indicated that anaemia was a major nutrition disorder during pregnancy (Mohi El-Din, 1954; Abdou et al., 1965). These studies demonstrated too that anaemia associated with pregnancy in Egypt was mostly due to iron deficiency.

The results of the National Nutrition Survey in 1978 (NI and CDC, 1979) revealed that the prevalence of anaemia among women was high in rural populations (24.3-35%), being highest in large villages followed by Lower Egypt rural and Upper Egypt rural (Table 6). The prevalence was generally lowest in urban populations (20.5-25.6%). The highest prevalence of anaemia (35.2%) was seen in women in lower socioeconomic population of Alexandria. It is worthwhile to note that the women included in this survey were not representative of Egyptian women since only those with at least one child 6-71 months of age were included in the survey.

Table 6 : Percentage distribtion of hemoglobin and prevalence of anaemia among mothers of preschool children by geographic area.

Geographic Area	Hb Level<9.5 g/dl %	Anaemic %	Total No. Examined
Lower Egypt rural	5.2	29.8	642
Upper Egypt rural	2.4	24.3	334
Large villages	8.6	35.0	163
Small towns	4.2	25.6	168
Small cities	0.6	20.5	171
Total representative sample	4.3	27.5	1478
Cairo-Giza	1.8	28.7	164
Alexandria	6.1	35.2	165

Taking hemoglobin cut off levels as defined by WHO (1972), anaemia among surveyed mothers at different physiological status is presented in table (7). Lactating women showed the highest prevalence of anaemia (25.3%), followed by pregnant women (22.1%). This may reflect the stress of pregnancy on the mother's iron stores and the concomitant increased requirements of iron, aggravated by low intake of iron enriched foods (DeMaeyer, 1989). Prologned breast feeding without adequate dietary iron replacement leads to serve maternal anaemia (Dakroury, 1979).

Field studies in Alexandria revealed a higher prevalence rate of anaemia among lactating and pregnant women attenting MCH centers, free and insurance hospitals (Table 7).

The available data indicated that iron deficiency anaemia was a crucial health problem in Egypt. Many factors interact in causation of anaemia among preschoolers, schoolers, pregnant and lactating women. The National Nutrition Surveys did not define the individual contributions of these factors. Yet, a major contributing factor in causation of iron-deficiency anaemia was low availabilty of dietary iron in the Egptian diet. This was due to the fact that cereals and legumes were the main contributors of energy as well as protein intake per day (Nasser et al., 1992). This was coupled with low contribution of animal protein in Egyptian diet. Dietary habits, economic considerations, as well as seasonal changes all affected food consumption patterns in Egypt which in turn may have played a role in causation of anaemia. Illiteracy, multigravidity, history of abortion and short birth interval are determinats that increase the risk of anaemia among pregnant women (Sherif et al, 1988). It has been reported that the prevalence and severity of anaemia is higher in infants born to anaemic mothers than non anaemic mothers (Amine et al, 1985). High prevalence of anaemia among lactating mothers is attributed to the stress of pregnancy, prolonged breast feeding coupled with low intake of dietary iron (Dakroury, 1979). High prevalence of parasitic infections especially among preschool children and schoolers could be another contributing factor in causation of anaemia (Wasfy, 1979).

Table 7 : Prevalence of anaemia and hemoglobin level among pregnant and lactating women reported by various surveys.

Survey	Pregnant			Lactating		
	Mean Hb	% Anaemic	Total No. Examined	Mean Hb	% Anaemic	Total No. Examined
National Nutrition Survey (NI & CDC, 1979)	11.8	22.1	253	12.8	25.3	823
MCH centers, Alexandria (El-Sayed & Al-Baghdadi) (1981)	-	-	-	11.4	74.0	154
Free & Insurance hospitals, Alexandria (Toppozada & Ghoneim,1983)	10.5	79.0	631	-	-	-
MCH centers, Alexandria (Sherif et al., 1988)	-	42.0	500	-	-	-

Action plan for iron-deficiency anaemia

It is apparent from the available data that iron deficiency anaemia is a major public health problem in Egypt which affects pregnant and lactating women , preschool children and schoolers. Measures to prevent or decrease prevalence of anaemia include supplementation with medicinal iron, education and associated measures to modify dietary practices, control of parasitic infections and fortification of a staple food with iron.

It is recommened that pregnant women should take iron/folate supplementation during the second half of pregnancy (DeMaeyer, 1989). This is important in order to prevent the development of anaemia in pregnant women and to maximize neonatal iron stores. In Egypt, MCH centers and primary health services are distributed throughout the country and are accessible. However, the utilization of these centers during antenatal care is low (EDHS, 1988; El-Sahn et al, 1992). Many reasons affect the utilization of antenatal services. First, the high rate of illiteracy among females in Egypt; secondly, women's attitudes and practices towards pregnancy and delivery; and thirdly, health facilities in these centers are mainly curative-based (ACC/SCN, 1993). The non utilization of antenatal services is more evident in rural than urban areas (EDHS, 1988). This may explain why anaemia is more prevalent in rural and underprivileged areas in large cities. Hence, pregnant women should be motivated towards regular attendance at MCH centers and primary health centers Also improving services given and provision of a regular supply of appropriate drugs and supplements will help in the acceptability of antenatal services.

As indicated, iron deficiency anaemia is the result of low availability of iron in the Egyptian diet coupled with increased requirements and the presence of parasitic infestations. Therefore, preventive measures should be directed towards improving the diet in respect to iron absorption and habits which affect its absorption. Nutrition education programmes for women attending MCH centers or primary health centers should be directed to modify dietary habits and introduce ways of preparing iron rich foods taking into consideration the economic status of the target population. Also, intestinal parasitic infestations should be controlled effectively.

Social mobilization through mass media such as television and radio proved to be effective in delivering messages regarding oral rehydration therapy, tetanus vaccine during pregnancy and immunization campaigns. Hence, mass media can play a role in delivering messages such as improving the dietary habits concerning iron absorption, regular attendance to MCH centers during pregnancy and personal hygiene.

VITAMIN A DEFICIENCY

The importance of vitamin A to ocular integrity, growth, resistance to infection and childhood mortality is well known (Sommer, 1994). Vitamin A reduces mortality by curtailing the incidence and/or severity of life threatening episodes of diarrhea and respiratory infections. Vitamin A status is relatively uninvestigated in Egypt. Signs suggestive of vitamin A deficiency such as Bitot's spots, corneal sears and pedal edema are uncommon among preschool children. In the National Nutrition Survey in 1978, a history of night blindness was noted in 0.4% of children who were 24 months or older, only 0.04% of children were found to have Bitot's spots, pedal edema was seen in 0.2% of children and comeal scars in 0.2% (Nutrition Institute and CDC, 1979). In the follow up survey 1980 only one child was found with pedal edema, no children had Bitot's spots, corneal scars or night blindness (Nutrition Institute and CDC, 1980).

Although vitamin A deficiency is not a public health problem in Egypt, the high prevalence of PEM (22%) in preschool age can point to deficiency of vitamin A as there is a remarkable relatonship between vitamin A deficiency and growth. So, a subclinical vitamin A deficiency may be a rule in Egypt (Nasser et al., 1992). Therefore, it is important to carry out studies to show the extent of subclinical vitamin A deficiency in Egypt especially among preschool children.

CONCLUSION

Iodine deficiency and iron deficiency anaemia are the two major micronutrient deficiencies of public health significance in Egypt. IDDs can be controlled through salt iodination. On the other hand, because the causes of iron deficiency anaemia are multifactorial, programmes aimed at reducing the prevalence of iron deficicncy anaemia should be delivered in an integrated package of interventions. Long term measures which may have direct or indirect impact on nutrition such as fortification of a staple diet with iron, improvement of sanitation, provision of safe water and education must be implemented at a national level. The surveillance system must be organized for continuous monitoring and evaluation of programmes aimed at controlling micronutrient malnutrition.

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PREVALENCE OF IRON DEFICIENCY ANAEMIA IN JORDAN

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INTRODUCTION

Malnutrition in its various forms is considered one of the most global problems today (UNICEF, 1990). One form of malnutrition is iron deficiency anemia (IDA). The most common nutritional disorder in the world which affects women of the reproductive age, infants and children, in particular.

PREVALANCE OF IRON DEFICIENCY ANAEMIA IN JORDAN

In Jordan, the only comprehensive national nutritional survey was conducted in 1962. It was found that the prevalence of anaemia among non-refugee pregnant and lactating women (Hb< 12 g/dl) was about 39% compared with 43% among refugee women. The prevalence of anaemia in children aged 5 - 9 years was 27.6% among non-refugees compared to 40.6% among refugees. Regarding adolescent girls and boys, the prevalence of anaemia (Hb < 12 g/dl) was markedly higher among non-refugee girls (31.4%) than among boys (7.7%). It was also noticed that the prevalence of anaemia (Hb < 12 g/dl) was higher among non-pregnant non-refugee females aged 15 - 44 years (29.3%) compared with only 7% of males in the same age group (Patwardhan and Darby, 1972).

In 1974, a cross-sectional study was carried on 3734 Jordanian preschool children in the rural part of Amman (Hijazi, 1977). Iron deficient children (Hb < 8 g/dl) constituted a relatively small proportion of about 7.4% of the total sample. Using a heamatocrit cut-off point of less than 30% a similar proportion for the prevalence of iron deficiency anaemia was observed (6.5%). The improvement in iron status of Jordanian preschool children may be due to improvement in socio-economic status as well as the better primary health care (Al-Tal,1977).

In 1984, a study on 192 preschool children of 3- to 6 month - old Jordanians was carried out (Madanat et al., 1984). It was observed that 11.5% of the sample had iron deficiency as indicated by microcytic and hypochromic blood film. About 34% of the sample had iron deficiency anaemia (Hb <10.5 g/dl).

A high prevalence of anaemia (58.5%) was observed in 6- to 36 - month-old Palestenian refugee children (n=1204) in a field camp in Jordan (Hb < 11g/dl), with the highest prevalence of 65.5% among 6- to 12 - month - old infants. Among Palestenian refugee women of child bearing age, the prevalence of anaemia was 53.7%, 29.5% and 13% during the 3rd, 2nd, and 1st trimesters as compared to 23.4% of non-pregnant women.

Jilani et. al. (1992) reported that 23.5% and 25.3% of pregnant Jordanian women attending maternity child and health centers were anaemic during 1990 and 1991, respectively (Table 1).

In 1991, a national nutritional survey was conducted on 8004 Jordanian preschool children, (0 - 5 years) using heamatocrit as the only biochemical indicator for assessing iron status on 1844

Table 1 : Iron Deficiency Anaemia in Pregnant Women Attending MCH Centers in Jordan (1991)

Area	Number of Pregnant Women according to Hemoglobin Levels		
	<11 g/dl (a)	>11 g/dl (b)	<11 g/dl (a/a+b)
Training Centre	729	2101	25.76%
Amman	3022	5615	34.99%
Madaba	360	1683	17.62%
Zarqa	1237	3310	27.20%
Balqa	288	978	22.75%
Mid-Jordan Valley	145	194	42.77%
Aqaba	159	489	24.54%
Ma'an	395	1205	24.69%
Irbid	1290	4980	20.57%
Kerak	219	1879	10.44%
Mafraq	287	761	27.39%
Tafileh	411	1436	22.25%
Kura	263	1207	17.89%
Ramtha	102	689	12.90%
N. Jordan Valley	421	1221	25.64%
Ajloun	416	1104	27.37%
Jerash	408	751	35.20%
Dir-Ala'	132	781	14.60%
TOTAL	10284	30384	25.29%

Source : Jilani et. al. (1992)

TABLE 2 : Proportion and percentage of exclusively breastfed Jordanian infants who developed nutritional anemia (NA) and iron deficiency anemia (IDA) at 3 and 6 months of age, according to sex

Sex		3 months		6 months	
		(NA)[1]	(IDA)[2]	(NA)[3]	(IDA)[4]
M	Proportion	2/41	0/41	17/41	7/41
	%	4.9%	0.0%	41.7%	17.1%
F	Proportion	1/37	0/37	3/37	0/37
	%	2.7%	0.0%	8.1%	0.0%
Combined sexes	Proportion	3/78	0/78	20/78	7/78
	%	3.9%	0.0%	25.6%	9.0%

1,3 NA as based ona deficient level of Hb<9.5 /dl in 3-month-old infantsand Hb <10.5 g/dl in 6-month-old infant.

2,4 IDA as based on a deficient level of Hb combined with a deficient level of plasma ferritin (<12 ng/ml.)

children. Whereas only 0.2% of the sample had iron deficiency (Hct < 28%), 8.6% of the sample had marginal iron deficiency, Hct: 28-30% (UNICEF,1993). Al-Qutob et. al. (1992) reported that 50% of pregnant women suffered from depleted iron stores at the time of delivery as revealed by low mean ferritin values. They also noted that iron supplementation during pregnancy improved the average ferritin level significantly, indicating the importance of enforcing iron supplementation among Jordanian pregnant women.

Recently, Daradkeh (1995) conducted a study on 6 - to 12 year - old school children (n=623) in Irbid city, North of Jordan. Anaemia (Hb<10.5 g/dl) was prevalent in 15.5% and 15.3% of 6 to 9 year old school boys and girls, respectively. The corresponding figures for 9 to 12 year old children were 12.7% and 16.9% for boys and girls respectively. The prevalence rate was the highest in public schools (20.2%), followed by UNRWA schools (15.6%), and then by private schools(8.2%). The overall prevalence of iron deficiency anaemia as diagnosed by blood smear as hypochromic micrcytic was 9% compared to 4.5% using transferrin saturation below 16% as an indicator.

In a longitudinal study on exclusively breastfed infants, nutritional anaemia (Hb< 10.5 g/dl) was prevalent in about 25% of infants at 6 months of age, with a markedly higher prevalence among boys (41.7%) compared to girls (8.1%) . Iron deficiency anaemia as indicated by deficient levels of both hemoglobin (<10.5g/dl) and plasma ferritin (<12mg/ml), was much less prevalent, with an overall average of 9.0%. It was markedly higher among boys (17%) compared to none among girls (Table 2). Whereas nutritional anaemia may be caused by a deficiency of one or more nutrients of iron, vitamin B6, vitamin C, protein, and copper, it is precipitated by iron deficiency in exclusively breastfed infants at 6 months of age as observed by Qazaq and Faqih in a community of developing countries and was attributed to a possibilty of maternal deficiency (Cohen et. al., 1993).

CONCLUSION

Although limited in size and scope, data available on iron status of Jordanians strongly suggest a high prevalence of iron deficiency to an extent that it constitutes a public health problem among the vulnerable groups including infants, preschool children and pregnant women.

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MAPPING SAUDI ARABIA FOR IODINE DEFICIENCY

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INTRODUCTION

It is estimated that 1000 million subjects live in iodine deficient areas, many suffer from the sequalae of iodine deficiency. There is a spectrum of clinical manifestation, which basically, relates to the severity and duration of exposure to iodine deficiency. Therefore, mild iodine deficiency can be asymptometic or present with a low prevalence of small goiter. On the other end of the spectrum, severe iodine deficiency can be present with high prevalence of severe goiter, hypothyroidism and mental and physical handicape for newborn and children.

Iodine supplement, commonest through salt iodization has been shown to eradicate iodine deficiency and related sequelae, the most quoted successful experience in iodine supplement is Switzerland.

There is a need to map the country for iodine deficiency, this can be done through urinary iodine measurements of school children, preferably between the age of 8 to 10 years old. Twenty four hour urine collection is the ideal method, however, for epidemiological purposes, casual urine samples assayed for iodine concentration, without creatinine measurement, have been shown to be practical, cost effective and meaningful. There is a need to supplement the iodine estimate with clinical assessment for presence of goiter using the modified WHO criterial (grade 1, palpable and visible only on deglutation; grade 2, visible when neck at resting position).

We have conducted a national cross-sectional epidemilogical household survey among Saudi school children, aged 8 to 10 years old for studying the iodine status in Saudi Arabia, through urinary iodine estimate and clinical assessment.

METHODS

A total sample of 4638 Saudi school children, aged 8 to 10 years old were randomly selected from different regions of the country. The sample was adjusted for gender and regional population distribution.

Chemical Measurement

Casual urine samples of 10 ml were collected in a dry tube from the studied population. Upon completion of the target sample for each region, samples were sent to the central laboratory at College of Science, King Saud University, Riyadh, for analysis. Iodine determination was done by Colorimetric Method , where urine was digested with chloric acid under mild conditions, then, iodine was determined manually by its catalitic rule and reduction of Ceric Ammonium Sulphate in the presence of Arsenios acid.

Clinical Assessment

After completion of the urinary iodine determination, random samples of 1357 school children, aged 8 to 10 were selected from areas with different geographical nature i.e. coastal, high altitude and deserts. Clinical neck examination was done and goiter was ascertained and classified according to modified WHO criteria for goiter assessment. The neck examination was done by the first author for all the students.

RESULTS

There were 4638 school children, 2365 (51%) male and 2273 (49%) female subjects. The national median and mean (SD) of urinary iodine concentration was 18, 17(8) Ug/dl, respectively.

There were 3154 (68%) subjects living in urban communities and 1484 (32%) subjects living in rural communities. Their median and mean (SD) of urinary iodine concentration were 17 and 16(7), and 20 and 18(8) Ug/dl for urban and rural subjects, respectively (P=0.0001) (Table1).

The sample size, median urinary iodine concentration and percentage of subjects with urinary iodine concentration <10 Ug/dl in different provinces is shown in Figure, 1, at national level, 1020 (22%) of subjects had urinary iodine concentration <10Ug/dl.

About 1357 students from different geographical areas had their neck examined for the presence of goiter. The prevalence, degree of goiter and their corresponding median urinary iodine concentration in different geographical areas is shown in Table 2.

DISCUSSION

There was a provincial variation with respect to median urinary iodine concentration with the lowest found in the Southern province (11 Ug/dl) and the highest in the Western province (24 U/dl). The difference can be attributed to the special character of provinces, where the Southern province is characterized as being at high altitude, with low to medium income, compared with the Western province which of low altitude and medium to high income.

Subjects living in rural communities have significantly higher median urinary iodine concentration, when compared with subjects living in urban communities. This is probably attributed to the crowded is nature of urban communities but be affected by other factors such as the type of food consumed.

The clinical assesment showed significant correlation between the prevalence of goiter and the median of urinary iodine concentration in different geographical areas, where the highest prevalence and advanced grade of goiter was found in the area with the lowest median urinary iodine.In general, the prevalence of goiter was 28%, the majority were of mild degree (grade 1).

Finally, it appears that the Southern province is the only province which had mild degree of iodine deficiency as detected by urinary iodine measurement and clinical assessment. There is a need to ensure that only iodized salt is used in the Southern province. This can be achieved through strict control on the imported and locally produced salt.

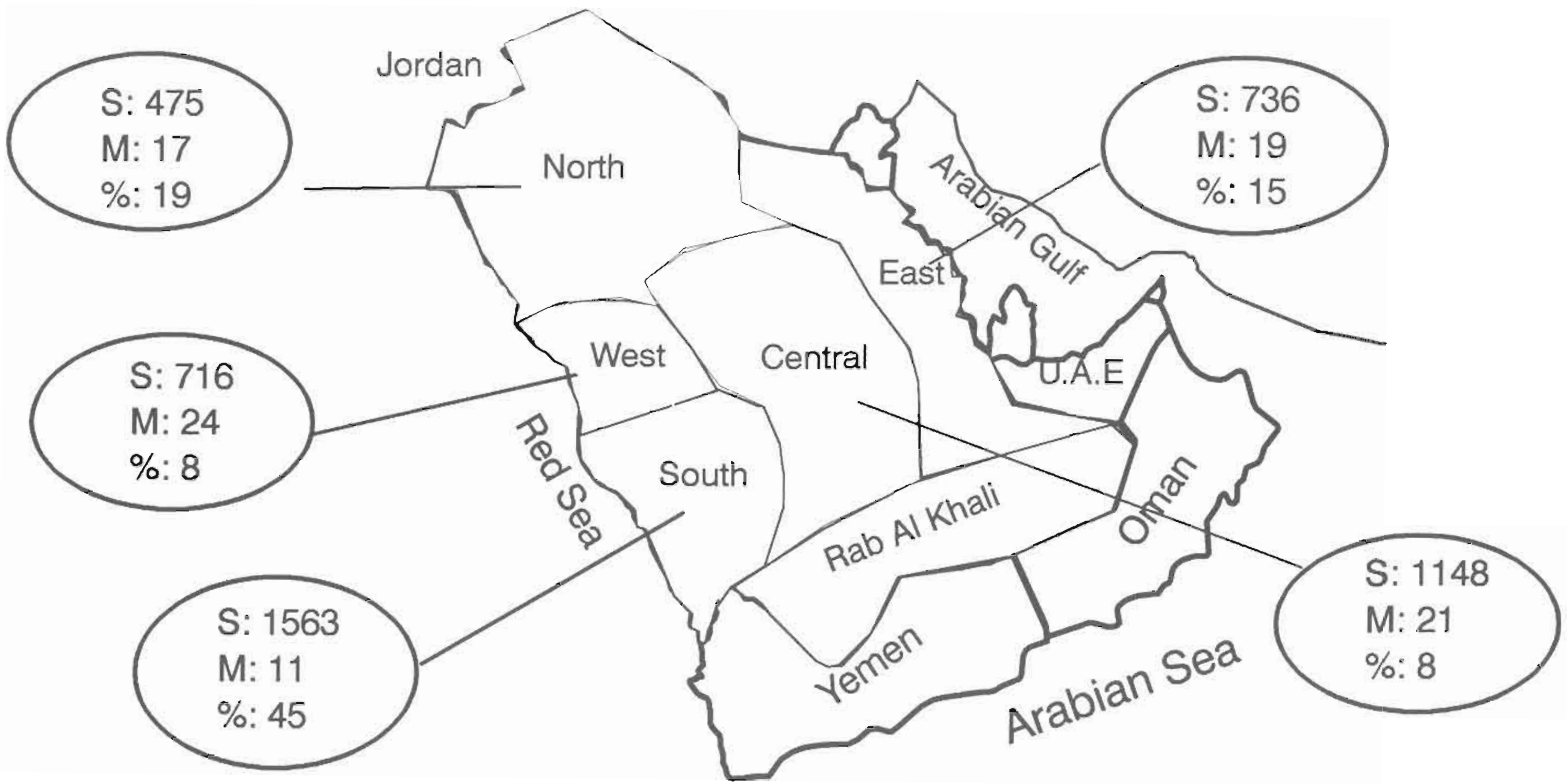
Table 1 : Percentage of subjects with low urinary iodine concentrations in differ provinces in Saudi Arabia

Province	Sample Size	% Urinary Iodine concentration (Ug/dl) < 5	5 - 10	>10
Central	1148	2	6	92
Western	716	2	6	92
Eastern	736	4	11	85
Northern	475	5	12	83
Southern	1563	18	27	55
Total	4638	8	15	77

Table 2 : Prevalence and degree of Goiter and their corresponding Median Urinary Iodine Concentration among School Children in different geographical areas.

Area				Goiter Prevalence %			Urinary Iodine Concentration	
Name	*Province*	*Nature*	*No.*	*0*	*1*	*2*	*No.*	*Median (Ug/dl.)*
Riyadh	Central	Desert	306	92	8	0	104	19
Gizan	Southern	CostalNon Mountaious	140	96	4	0	46	23
Fifa	Southern	Costal Mountiaous	181	75	25	0	45	11
Assir	Southern	High Altitude	730	70	22	8	255	10

The Sample Size (S), Median Urinary Iodine Concentration (M) and % of Subjects with Urinary Iodine Concentration <10 Ug/dl. in Different Provinces.



MICRONUTRIENT STATUS IN SAUDI ARABIA

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INTRODUCTION

In Saudi Arabia, development has advanced markedly in the last three decades, with major improvements in the health, agriculture, education, and social services. The effects of such development, however, on the nutritional status, particularly on the micronutrients status of Saudis, has not been well studied. Little is known about the prevalence of some forms of malnutrition of micronutrients present in the Kingdom. The purpose of this paper is to highlight the micronutrients status in Saudi Arabia, namely vitamin A, vitamin D, iodine, zinc and iron deficiencies.

IRON DEFICIENCY ANAEMIA

McNeil (1968) studied the infants and children in a well baby clinic of Aramco Hospital in the Eastern region of Saudi Arabia. Out of 500 children examined, 39.6% were anaemic. The prevalence of iron deficiency anaemia among infants aged 6 to 24 months was studied. They were attending the well baby clinic at King Khalid University Hospital in Riyadh for routine vaccinations (Al Fawaz, 1993). Of the 366 screened infants, 37.2% were anaemic (Hb<11 g/dl). In another study using the same criteria to define iron deficiency anaemia for 84 Saudi 9 month old infants attending the baby clinic in King Khalid Hospital in Jeddah, the prevalence of anaemia was 35.7% (Stevens et al., 1989). In view of the high prevalence of iron deficiency in infants studied, the investigators recommended that all infants should be screened for iron deficiency during their routine visits for immunizations.

The Turaba study in western Saudi Arabia (Sebai, 1985) found that the level of haemoglobin of the Bedouin children under five years of age ranged from 6 to 10 g/100 dl in 34% of them. Another study, in the region of Tamnia, showed 36% of the pre-school children had haemoglobin levels below the normal level (Sebai, 1981).

In Saudi Arabia iron deficiency anaemia is more prevalent among preschool children than school children. El-Hazmi (1982) indicated that there were statistically significant differences in the average haemoglobin level of pre-school and school children.

Rasheed et al. (1989) reported that 26.4% of primary school girls had anaemia (Hb< 11 g/dl) and 9.2% were infested with one parasite or more. Anaemia was common in those harboring infestations. This finding was also confirmed by Hammouda and Lebshtcin (1987) who found that anaemia was more prevalent among primary school children with parasitic infection compared to those with no infection.

Iron deficiency anaemia in pregnancy is still a health problem in Saudi Arabia (Hartley, 1980, Smart et al, 1983 Ghaznawi et al., 1988 Khoja et al.1994 and Madani et al., 1995). From Table (1) we note that the prevalence of iron deficiency anaemia among pregnant women ranges from 4.6% to 26.5%. The reason for this wide range is due to the different in the cut-off points used for haemoglobin.

Table 1 : Iron deficiency anaemia in Saudi pregnant women

Study	Sample size	% Anaemia	Cut-off
Hartley (1980)	436	4.6	Hb<10g/dl
Smart et. al. (1983)	217	6.5	Hb<10g/dl
Ghaznawi et. al. (1988)	272	25.6	Hb<11g/dl
Khoja et. al. (1994)	119	10.1	Hb<10.3g/dl
Madani et. al. (1995)	952	22.9	Hb<11g/dl
Al-Amoudi (1995)	710	26.5	Hb<11g/dl

Several studies (El-Hazmi et al, 1982, Bacchus et al, 1986 Ghafouri et al, 1987 Khan et al, 1989 and Nazi, 1994) have tried to establish a haematological reference value for the Saudi Arabian population. In one study (Nazi, 1994), haematological analyses were performed on 2433 (1213 males and 1202 females) clinically normal consecutive Saudi new borns who were born at King Fahd National Guard Hospital in Riyad. The haematological parameters determined were white blood count, red blood count, haemoglobin, haematocrit, mean cell haemoglobin, mean cell haemoglobin concentration, platelet count, red cell distribution width and reticulocyte count. The results revealed no statistically signifficant differences between the male and female haematological values ($p<0.2$) and consequently a single reference value can be used for both sexes. These observations provide detailed haematological parameters at birth and can serve as reference values for Saudi newborns.

The normal reference ranges of haematological parameters were obtained by the analysis of blood specimens of volunteer students (226 females and 578 males aged 20 - 29 years) studying at King Saudi University in Riyadh (El-Hazmi et al, 1982). Comparison of the results for males and females revealed that all values except for white blood cell counts were higher for the Saudi males than for the females.

Bacchus et al, (1986) tried to establish normal reference ranges of haematological parameters in a representative Saudi population selected from the Al-Kharji district, an agricultural area 80 Km from the capital city of Riyadh. Haematological analysis were performed on 1376 healthy Saudis (1266 males and 110 females), with age ranging from 18 to 60 years.The study showed that male subjects had significantly higher indices for haemoglobin red blood count and mean corpuscular volume than females. The authors concluded that their findings could be used as a reference range for haematological values for the Saudi population. However, the number of females was low in this study , when compared with males,and may not represent the female population in the country.

Since a large fraction of the Saudi population lives at high altitudes, Khan et al, (1989) conducted a study to determine the haemoglobin norms and blood groups of the people living at a high altitude. The study was done in Abha City, which is situated at an altitude of 2500 to 3000 meters above sea level. Haemoglobin levels and blood groups were obtained from healthy individuals coming for family registration in the primary health centre. Results showed that males had higher haemoglobin levels than females from the age of 15 years and above. These findings may help physicians to assess anaemia in patients living at high altitudes and help administrators responsible for procurement of specific blood groups for hospitals.

The high incidences of heamoglobin disorders such as sickle cell traits and thalassaemias affect the determination of iron deficiency anaemia. Studies (El-Hazmi et al, 1985, 1990) showed that haemoglobinopathies are widespread in Saudi Arabia. The high incidences of haemoglobin disorders have been related to isolation, natural selection and inbreeding for generations.

CAUSES OF IRON DEFICIENCY ANAEMIA

Although factors responsible for the incidences of iron deficiency anaemia in Saudi Arabia have not been well investigated, possible factors are as follows:

1. Several studies (Al-Madani et al., 1989 and Ahmed et al., 1989) reported that parasites were prevalent among children and adults in Saudi Arabia. The incidence of anaemia was higher in parasitic-infected individuals than in parasite-free ones indicating that parasitic infections may be one of the causes of iron deficiency anaemia in Saudi Arabia.

2. Mothers with high number of gravida and parity are at risk for the development of iron deficiency anaemia (Khoja et al, 1994). In Saudi Arabia grand multiparity, the births of 5 more viable infants, is common (Cochran and Faqeera , 1982 and Madani et al, 1994).

3. Low dietary intake of iron (Al-Othiameen et al, 1992) is also an important factor in infancy.

4. Low daily dietary intake of vitamin C, which can improve iron absorption.

5. Heavy consumption of tea and coffee by adults during the day, especially with meals. It is known that tea and coffee inhibit the absorption of iron.

The high prevalence of anaemia in Saudi Arabia calls for an in-depth study for the determination of factors associated with iron deficiency anaemia. Intervention programmes to combat iron deficiency anaemia in Saudi Arabia should be given a high priority. Several measures must be taken into consideration when dealing with anaemia. These include supplementation of iron and folic acid to mothers, motivation of pregnant mothers to attend pre-natal clinics regularly, and assessment of haemoglobin concentrations. Sufficient spacing between subsequent pregnancies, supplementation of breast feeding with weaning foods fortified with iron after the first six months, blood screening for children, prevention and treatment of intestinal parasitic infections, iron fortification of some common foods. Different nutrition education programmes should be conducted especially for the mothers to increase the intake of iron rich foods and vitamin C, and to reducing intake of other substances which inhabit iron absorption such as phytates, tannins and other polyphenols.

VITAMIN D DEFICIENCY

The available data indicate that vitamin D deficiency in Saudi Arabia is a public health problem (Serenius et al, 1984 and Abanamy et al, 1991). Several studies in Saudi Arabia (Elidrissy et al, 1981 and Abanamy et al, 1991) indicated low levels of vitamin D in mother's plasma and in their infants. This indicates the role of the pathogenesis of rickets in infants born to mothers with inadequate vitamin D status, and the disease has its origin in the prenatal period.

Sedrani et al (1992) studied the prevalence of clinical and subclinical rickets in Saudi children admitted to Sulimania Childrens' Hospital in Riyadh. Among the total admissions (16125) the annual prevalence of clinical and subclinical rickets was 1.3% and 3.1% , respectively. The majority of the children with rickets (88%) were breast fed compared with 42.1% in the control children. Five percent of the children under 6 years of age were vitamin D deficient. There is a continuing presence of radiologically proven rickets in Saudi infants. This situation can be improved by changes in public health policy.

Another survey (Sedrani et al, 1992 b) was carried out on 4078 subjects to study the effect of regional and environmental location on vitamin D status of Saudis. The studied population was divided into five groups on the basis of their geographical location and lifestyle. The lowest 25-OHD plasma concentrations were observed in the population living in the northern province. The highest levels were found in the western province. Rural children have higher concentrations than rural adults. In the same geographical location, rural adult males and females had significantly higher 25-OHD than urban adult males and females. The concentration of 25-OHD in rural adult females is much greater than that of urban females. This study suggested several inter-regional, gender, and age differences, revealing that even in a country like Saudi Arabia, with an abundance of ultraviolet light, deficiency of vitamin D is frequently seen.

Sedrani et al, (1992 c) studied the prevalence of vitamin D in the Saudi population. The study included 4078 Saudi males and females living in different regions in Saudi Arabia. Volunteers were from <6 years up to 90 years of age. Male children and children less than 6 years of age have a significantly higher plasma level than older subjects. Whereas the female adolescents (age 13-18 years) and preschool children have the lowest plasma 25-OHD levels in comparison with the other groups. No significant association was detected between plasma 25-OHD and age. Saudi males have significantly higher 25-OHD than females. Regarding the house type, occupants of tents have significantly higher 25-OHD than those occupying mud houses, villas or brick houses.

In some parts of the world such as in United States of America (Frager,1980). the peak incidences of vitamin D deficiency occurs in the winter and early spring when exposure to sunlight is at a minimum. This is not always the case in Saudi Arabia, as Sedrani et al (1992 d) found that there was no significant difference between the plasma concentration of 25-OHD in January and August for adult females and males. These results may suggest that as the temperature increase during the summer, the exposure of the Saudi population to solar ultraviolet radition is decreased, and hence, the concentration of plasma 25-OHD decreases.

CAUSES OF VITAMIN D DEFICIENCY

By reviewing the literature, the existence of a vitamin D deficiency in Saudi Arabia can be supported by the following clinical results:

1. Overdressing of the babies with limited exposure to sunlight, and keeping them in badly illuminated houses (Sedrani et al, 1992 a).

2. The low level of vitamin D in plasma of mother and infants with rickets indicates that mother's milk is already depleted and deficient in vitamin D (Elidrissy 1986 and Abanamy et al, 1991).

3. Dietary vitamin D intake has been calculated at approximately one-tenth of the daily intake of that in the United States of America (Woodhouse and Norton, 1982)

4. An increase in ultraviolet light insulation due to atmosphere dust particles could be one of the factors responsible for vitamin D deficiency in Saudi Arabia (Hannar et al, 1984).

5. Genetic factors associated with rickets also exists in Saudi Arabia, either as familial vitamin D resistance rickets (Al-Ageel et al, 1993), vitamin D dependent rickets (Degheishem et al, 1991) congenital hypoparathyroidism (Sanjad et al, 1991) and other forms of inborn errors of metabolism (Mohammed et al, 1993).

In conclusion, vitamin D deficiency exists in the Saudi population at a high frequency and has highlighted the need for better illuminating by sunlight, yet maintained privacy houses, vigorous mass media campaigns against excessive and unnecessary wrapping up of babies, benefits of sunshine for protecting against vitamin D deficiency. Nutrition educaton, including dietary advice should be given to the community. Supplementation with vitamin D, or a diet adequate in calcium and phosphorus, effectively controlls rickets. A concerted effort must be made to screen breast-fed children to detect subclinical forms of rickets and to educate the public about the importance of sunlight exposure and divesified nutrients.

VITAMIN (A) DEFICIENCY

In Saudi Arabia, there is no data on the prevalence of vitamin A deficiency. A recent National Nutritional Survey of Saudi Arabia (KACST, 1993) indicates that 1.2% of Saudi subjects had serum vitamin A levels lower than 10 ug/dl.

IODINE DEFICIENCY

Despite the importance of adequate iodine intake and the consequence of its deficiency, there is no data about the prevalence of endemic goiter in Saudi Arabia. Recently, Al-Attas and Sulimani (1993) detemined the iodine concentrations in Saudi Arabia staple foods. Bread and cereal, products, milk, eggs, vegetables, fruits, fish, soft drinks and some composite meals were analyzed for their iodine concentrations. The results revealed that iodine concentrations are comparable to those of Britain and the United States. Foods commonly consumed by Saudis appears to have an adequate iodine concentration.

On the other hand, Sulimani et al (1991) documented low iodine levels in samples of tap water and drinking mineral water from different regions of Saudi Arabia. There is no data on the prevalence of endemic goiter, therefore it may be wise, to recommend the routine use of iodized salt in the Kingdom.

Hypothyroidism is one of the most frequently encountered endocrine diseases in childhood. Early detection and proper treatment of the disease prevents developmental retardation and other sequelae of the condition (Malvanx, 1981). In Saudi Arabia, there is no precise data on the prevalence of the disease, however, there is an impression fostered by clinical experience and local nenonatal screening programmes for congenital hypothyroidism that this is not a rare disease (Bacchus et al,1988; Al-Nuaim et al, 1989 and Al-Jurayyan et al, 1992).

CONCLUSION

It can be concluded that studies on the prevalence and causes of iodine, zinc and vitamin A deficiencies in the Kingdom are lacking. However, studies showed that iron deficiency aneamia and vitamin D deficiency do exist in Saudi Arabia and further ameliorative measures are needed to prevent and control these public health problems.

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MICRONUTRIENT DEFICIENCIES IN SUDAN : A SITUATION ANALYSIS

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INTRODUCTION

Sudan is a large country of about 2.5 million square kilometers. It is characterised by diversity in its ecological zones and agricultural environments that range from the desert in the north to the tropical forests in the south. This diversity has resulted in a wide range of food crops and livestock produced under different farming systems. This coupled with a diversity in the population to varied food consumption patterns and dietary practices.

The Sudanese dietary patterns are based on the consumption of unbalanced diets particularly with regard to micronutrients. Therefore, there are nutritional deficiency problems in various parts of the country.

The prevalence of micronutrient deficiencies particularly those due to vitamin A, iron and iodine are on the increase in intensity. Hence their treatment, prevention and control are now receiving equal through efforts directed to decrease Protein Energy Malnutrition (PEM). The situation has become more difficult because of the existence of a large number of camps for displaced communities and refugees resulting from the civil conflicts within the Sudan and some of the neighbouring countries.

The prevalence of micronutrient deficiences in the Sudan has been reported by several workers in different parts of the country. Culwick (1951) reported on diets in the Gezira irrigated area and noted that diets consumed during infancy, childhood, pregnancy and lactation were low in calcium , vitamin A , riboflavin and vitamin C. A nutritional survey conducted by Khattab and El Hadari (1969) in the same area found that the diets consumed were still deficient in the same micronutrients reported by Culwick (1951), in spite of the intensification and diversification policies in the Gezira and Managils crop rotations and the introduction of dairy farms and poultry production in the scheme. This is an obvious case of deficiency in food and and nutrition education in that area. Another report by Khattab and El Hadari (1972) on diets in the Nuba Mountains, Kordofan, Western Sudan found that the diets were deficient in vitamin A and vitamin C in spite of the availability of fruits and vegetables and animal products in the region. This situation again indicated lack of proper nutrition education in that area.

Subsequently, several nutritional surveys were undertaken by the National Nutrition Department, Ministry of Health , Khartoum and some NGO's in different parts of the country indicated that the prevalence of deficiencies in vitamin A, iron and iodine are the most common nutritional disorders in the country.

VITAMIN A DEFICIENCY

Vitamin A deficiency is a long standing problem in the Sudan. In 1980/81 a survey was conducted by the National Nutrition department, Ministry of Health, Khartoum in collaboration with WHO in Kassala and Red Sea provinces. A total of 2148 children were seen. About 1559 were in the 0-6 years age group and 589 were over 6 years. Of the 1559 children (0-6 years old) 814 were males and 745 were females. All the children examined suffered from various degrees of vitamin A deficiency problems ranging from simple conjuctival xerosis to dryness of the conjectiva and Bitot's spots. Some exhibited corneal scars and opacities. The diet of the families of those children consisted of kisra (a thin pan cake made from fermented sorghum flour) eaten with mulah (stew made of meat and vegetables). A two meal pattern was most common: Breakfast in the morning consisting of wheat bread, fava beans or lentiles and tea, Lunch is the major meal of the day consisting of "kisra" and "mulah". The consumption of fresh fruits and vegetables was rare . There were no special diets for pregnant and lactating mothers apart from the use of "nasha" (a thin porridge made of sorghum flour).

Vitamin A deficiency assessment in North darfur (1988)

Five districts in North Darfur were surveyed by the National Nutrition Department, Ministry of Health, Khartoum in collaboration with HKI in 1988. The overall prevalence of vitamin A deficiency was found to be 0.73% of which 0.52% were affected by night blindness, 0.1% had Bitot's spots and 0.1% had corneal scars. That data suggested that active vitamin A deficiency did not consitute a major public health problem, although in certain areas children were at risk.

Double Blind Randomized vitamin A Trial (1988-1990)

A joint programme between Harvard Institute for international Development (HIID) and the National Nutrition Department, Ministry of Health, Khartoum was undertaken during the period 1988-1990. A sample of 30,000 children aged between 9-71 months was selected from four rural areas in Khartoum and one rural area in Gezira province; two-thirds of the children were from Khartoum and 1/3 from the Gezira. Preliminary results indicated that symptoms of vitamin A deficiency was high in all children from both locations.

Vitamin A survey in the Red sea Province

A survey on vitamin A deficiency was conducted by the National Nutrition Department, Ministry of Health Khartoum in 1989. The data included 2001 children all of whom showed positive signs symptoms of vitamin A deficiency . About 0.7% had night blindness, 0.3% had Bitot's spots and 0.1% had both night blindness and Bitot's spots.

The overall prevalence of night blindness was therefore 1.1% which exceed the WHO criteria. The results showed that vitamin A deficiency was a significant public health problem in the Red Sea province.

Vitamin A deficiency was identified in four districtrs, namely Sinkat (6.1%), North Toker (6.2%), rural Port Sudan (2.1%) and Hillat El Sharif (1.5%). The first three districts were rural and their overall prevalence of vitamin A deficiency was 2.5% while the prevalence in urban areas was only 0.1%.

IODIN DEFICIENCY DISORDERS (IDD)

Dietary studies in Darfur suggested that the high incidence of endemic goitre in the region was due not only to iodine deficiency, but due to other factors such as PEM, low Vitamin A intake, high sodium, potassium and iron contents of the drinking water coupled with high consumption of millet (pennistem typhoids). Millet, which is the staple cereal in the region, was further investigated and found to cause histological changes in the thyroid of millet fed rats which were similar to those that happen in humans.

During the period November 1981-January 1984 El Tom conducted goitre surveys in Darfur region, Kosti town and the cities of Khartoum and Port Sudan. A total of 27,830 school children of age 7-15 years were examined for goitre. In addition 1,249 inhabitants (of all age groups) of the Shakshako villages in Tawila on the northern foot of Jabal Marra (Darfur State) were also examined for goitre.

The goitre prevalence was high among school children in both rural and urban Darfur (87.7% and 86.7% respectively) and Kosti Town (74.9%), while it was low in Khartoum (17.5%) and Port Sudan (13.5%). About 78% of the inhibitants of Shakshako villages suffered from goitre. All age groups were affected, but the most affected were those between 7 and 19 years of age with a peak among women 15-19 years old. There was no gender prevalence of goitre until puberty. After puberty the rate of thyroid gland enlargement declined in both sexes. The iodine content in the food and drinking water was low in most endemic goitre areas and was inversely proportional to the prevalence of goitre. In most locations studied the iodine content of water was low.

Due to their inland location, iodine-rich marine foods were rarely eaten in Darfur and Kosti. Moreover, iodine was known to be poor in soils of Darfur region.

In November 1981, a goitre survey was conducted in Darfur region. The sample included 5,885 school children aged 7-15 years from the junior classes of 33 schools in the villages of rural Darfur and the town of Nyala. They were divided randomly into three groups which received either oral or intramuscular-iodized oil and the third group remained as control. Results showed that both oral and intramuscular iodized oil were effective in goitre prophylaxis and in providing adequate iodine supply for at least two years.

The two forms of iodized oil had an equal capacity to replenish the intrathyrodial iodine store and maintain adequate supply for hormone biosynthesis for at least two years. Thus oral iodized oil, being cheaper and simple to use, was suggested as the best altlernative for goitre prophylaxis in areas where iodization of salt was not feasible. As an alternative to the use of iodized salt, iodization of sugar was suggested. Sugar was suggested as a suitable vehicle for iodine supplementation in the Sudan based on the following reasons:

1) High consumption of sugar.
2) Central and systematic distribution of sugar to all families.
3) No appreciable change in the physical characteristics of sugar.
4) The additional of iodine is technically simple and economically feasible.

A national programme of endemic goitre control (EGCP) was launced in1989. In a mass prophylaxis campaign in Darfur region, 85% of the population received iodized oil treatment orally within a period of less than two years. The positive impact of iodine treatment was clearly demonstrated by examining randomly selected subjects from among those who received the iodine treatment about 72% of the goitrous resolution or definite repression of the goitre size. Ongoing studies using iodinated sugar showed encouraging results.

IRON DEFICIENCY ANAEMIA

Attempts to control iron deficiency aneamia among pregnant and lactating mothers had been practised through Melt centres for a long time. These centres continue to distribute iron and folic acid tablets for pregnant and lactating mothers together with health and nutrition education. Therefore, available records on this problem originate from hospital records. It was reported that nutritional aneamia is one of the ten major causes for hospital admission.

One of the adhoc studies conducted at El Shagara Health Centre (Khartoum) showed that 37% of the pregnant mothers attending the health centre suffered from nutritional aneamia.The causitive factors behind the widespread prevalence of iron deficiency aneamia in the Sudan may be summarized as follows:

1) dietary insufficiency.
2) poverty and low purchasing power.
3) illiteracy in general and lack of food and nutrition education in particular.
4) socio-cultural factors particularly food habits and taboos.
5) prevalence of infectious and parasitic diseases.
6) loss of iron due to excessive menstruation or postpartum haemorrhage.
7) depletion of iron stores as result of repeated pregnancies.
8) problems related to malabsorption.

In spite of the absence of enough information about the prevalence of iron deficiency anaemia in the Sudan, control measures have been going on for a long time through MCH centres as mentioned previously.

VITAMIN C DEFFICIENCY IN CAMPS FOR DISPLACED PEOPLE

Cases of scurvy were reported by an NGO (Medicine Sans Frontier MSF) from Belguim in camps of displaced people in South Darfur in May 1989. The patients were complaining from swollen and painful joints and of swollen gums which bled easily. All the cases were children and adult females. They were all from camps and more were reported from the neighboring villages.

A total of 26 cases were identified in Abu Karenka camp and 10 in Muhageria camp. Most of the cases were children and adult females. All were from the poorest families and showed signs of aneamia.Treatment started immediately with vitamin C tablets 250 mg/day for 10 days. The symptoms disappeared rapidly with treatment. The treatment was accompained by nutrition education.

The problem was caused by the fact that most displaced people in the camps were dependent on food distribution for all their nutritional needs. They were separated from their usual environment and lost their assets upon which the local population could rely. The only item in the food ration containing vitamin C was groundnuts (provided they were eaten fresh). Foodstuffs rich in vitamin C were scarce in the market during that period, and hence their price made them inaccessible to most displaced families.

Wild foods which could have replaced the cultivated ones were not known to the displaced persons as they came from parts of the country with different plant life.

CURRENT PROGRAMMES UNDERTAKEN BY THE MINISTRY OF HEALTH TO COMBAT MICRONUTRIENT DEFFICIENCIES IN SUDAN

The existing programmes for the elimination of the micronutrient deficiencies include:

1. Iodine supplementation in endemic areas by the administration of iodinated oil injections and tablets.

2. Iodization of common salt which has now been adopted as a Government policy and will be available in all parts of the country.

3. Fortification of sugar with iodine is being attempted at all the experimental level since sugar is consumed by virtually everyone in the Sudan. Sugar reaches the whole population with very few exceptions were security does not prevail. Hence sugar provides a very suitable vehicle for iodine.

4. Supplementation of vitamin A capsules in most affected areas.

5.Programmes of intensive nutrition and health education are being conducted to enhance consumption of locally available foods rich in vitamin A, iron and iodine.

6. Conduction of regular surveys at the state level to detect signs symptoms of micronutrient deficiences in different geographical locations and among different population groups.

FUTURE STRATEGIES AND PLANS TO PREVENT AND CONTROL MICRONUTRIENT DEFICIENCIES IN THE SUDAN

Vitamin A

Supplementation of vitamin A capsules will continue to ensure that at least 80% of the children under two years living in areas with inadequate vitamin A intake receive vitamin A through a combination of promotion of breast feeding, improvement of supplementary feeding and food fortification and supplementation. Plans are set to eliminate vitamin A deficiency by the year 2000.

IDD

Iodized salt for human and animal consumption, including salt for food processing and preservation will be made available in all parts of the country where IDD is a public health problem. Supplementation with oral or injected iodized oil will be adminstered where full salt iodization is not possible.

Research on the use of sugar as a vehicle for iodine and the double fortification of salt with iodine and iron will continue to achieve a practical and easy ways of distribution and storage. It is planned that by the year 2000, elimination of IDD is achieved.

Iron Deficiency Anaemia

Programmes for the reduction of iron deficiency anaemia among infants and children are now going on through determination of the haemoglobin level and the adminstration of iron in the form of ferrious sulphate tablets or injection to those who need it. It is planned that by the year 2000 iron deficiency anaemia will be reduced by one third compared to its level in 1990.

Future strategies for the prevention and control of micronutrient deficiencies in the Sudan also include the continuation of regular nutritional surveys for the detection, geographical distribution and the causes behind the prevalence of micronutrient deficiencies so that appropriate intervention and preventive measures can be taken.

In collaboration with the Ministries of Agriculture, Education and Health it is planned to promote the production and consumption of fruits and vegetables and animal products (both cultivated and wild green foods and domesticated and wild animals). It is also planned to intensify food, nutrition and health education through nutrition and health agencies, the agricultural extension services and the Ministry of Education with the objectives of promoting the consumption of adequate and balanced diets.

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AVAILABILITY OF MICRONUTRIENTS IN JORDANIAN DIET

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INTRODUCTION

Deficiency of micronutrients is common in many parts of the world. It has been estimated that between 5-10 million children die every year as a result of xerophthalmia due to vitamin A deficiency; it has also been reported that mild deficiency of this vitamin can lead to an increase in child mortality rate for those between 6 months and 6 years (UNICEF, 1993).

In the Near East region, anaemia, vitamin A deficiency and iodine deficiency disorders are reported to be common in many countries (Osman, 1992). However, little information is available on the prevalence or the etiology of such deficiencies.

Studies on nutrients deficiencies mainly focused on the clinical and /or biochemical signs of the diseases or disorders, which means studies took place at an advanced stage of the deficiency. This could lead to irreversible damage, and make intervention costly and slow. Recently, attention to hidden malnutrition is being focused upon as the number of those who suffer from it greatly exceeds that of those who suffer from severe deficiency. This is evident regarding energy malnutrition; whereas only 1-2% of children under 5 in developing countries suffer from severe malnutrition in which deficiency symptoms and signs appear, however, about 190 million were estimated to be undernourished and suffer from poor health and slow growth rate but without deficiency signs (UNICEF, 1994). Such persons are often considered healthy since it is difficult to detect hidden malnutrition.

Although the body can adjust to the low intake of micronutrients, this might be accompanied with physical, mental and behavioral changes that are usually neglected by health workers, the parents or the individual himself, or attributed to other factors. Studies have shown that iron deficiency with or without anaemia is associated with abnormalities in mental performance and unhapiness behaviour which improve with treatment with iron (Addy, 1986). Further more, low blood level of micronutrients attibuted to low intake of some foods was related to increased incidence of cancer. The people of Linxian Country in China have one of the world's highest rates of esophageal/gastric cancer and at the same time they are known to have a low intake of several micronutrients (Blot et. al. 1993).

Information on the quantities of food available and the food pattern of the country as well as the adequacy of the food supply to meet the needs of the population, is necessary for food and nutrition planning. It is especially useful for assessing energy and nutrients levels of the diet and their relationships with health. Such information may help in identifying nutritional problems and population groups at risk at an early stage, and guides in means of combating them.

This paper presents the supply and adequacy of energy, macro- and micronutrients in the diets of households in the various governorates of Jordan.

METHODOLOGY

Data on population structure and household food supply for the country as a whole and for the various governorates were obtained from the Jordanian Department of Statistics, particularly from the Household Food Consumption Survey (1992) and the Health, Nutrition Manpower and Poverty Survey (1986).

Energy, nutrients and dietary fiber contents of the household food supply, which included 191 food items, were calculated using pertinent food composition tables and other available data on the composition of local foods (Pellet and Shaderevian, 1970; Holland et. al., 1992; FAO, 1982 and Pennington and Chruch, 1985). The nutrients studied were protein, fat, the vitamins B1, B2, niacin, B6, vitamin C and vitamin A, and the minerals Ca, P, Mg, An, K, Fe, Zn, Cu and I. Averages of daily per capita supply of energy and nutrients were calculated for the country as a whole, and for each governorate. The contribution of household food production to total supply was also calculated.

Energy requirements and recommended or acceptable daily intakes (RDI) of nutrients were computed for Jordan on the basis of its population structure at the time of the study, and according to age-sex specific recommendations of the FAO/WHO Expert Consultation Groups (FAO/WHO, 1974; FAO, WHO,UNU, 1985), and the Recommended Dietary allowances (RDA) of the US National Academy of Sciences (NRC, 1989).

The nutrient content of the household food supply was adjusted to give 20% allowance for preparation losses, spoilage, late waste and food given away; and the average daily per capita intakes were then compared with the calculated RDIs for the country.

RESULTS AND DISCUSSION

Pattern of Food consumption

The contribution of main food groups to total energy supply in Jordanian diet in various governorates is presented in Table 1. It is clear that, for the country as a whole, about half the calories (50%) were obtained from the cereal group followed by sugars and sweets (14%), fats and oils (12%), and meat and eggs (9%). On the other hand, the contributions of both dairy products, and legumes and nuts (seeds) groups which have high nutritive value were relatively low (4% and 2% respectively). The annual consumption of these two groups was found to decline between 1980 - 1990 at a rate of 2.6% for dairy and 0.1% for legumes (FAO, 1994).

There were variations among governorates regarding total household supply of calories and the proportion from each food group (Table 1). The highest per capita supply of energy was found in Karak and the lowest in Zarka (4279 and 2775 Kcal/capita/d, respectively). The highest proportion of calories was obtained from cereals and ranged from 47% in Amman to 61% in Balqa and in Karak. The proportion of energy supplied by sugar and sweets group was 14% whereas the US dietary goals limit the consumption of this group to 10% of total daily energy intake (Nieman et al,1992). This food group supplies empty calories which means the remaining 86% of calories in the diet (in the case of Jordan) should supply all the vitamins and minerals needed by the body. Furthermore, sugar consumption is associated with dental caries, particularly when coupled with poor dental hygiene and frequent snacking, and with reactive hypoglycemia . Jordan was reported to have the highest per capita consumption of sugar among the Arab Middle Eastern countries. The consumption of sugar in Jordan during the period 1988-90 was 43.9 kg/capita/year compared to 28 kg in the Arab Near East (FAO, 1994). Sugar and sweets constituted 22% of total daily energy supply in Mafraq and the amount exceeded 600 kcal/capita/d in Mafraq and in Karak (Table 1).

Table1- Contribution of main food groups to total energy supply in Jordanian diet in various governorates.

Governo-rate	Population %	Tot.supply Kcal/caput/d	percent calories from: cereals	meat & eggs	dairy products	fats & oils	fruits & vegetables	sugar & sweets
Amman	38	3380	47	10	5	12	7	13
Irbid	25	3740	49	8	4	14	8	13
Zarqa	18	2775	49	10	4	10	9	12
Balqa	6	3488	61	7	3	8	4	15
Mafraq	4	3184	54	6	2	7	6	22
Karak	4	4279	61	6	3	8	3	16
Ma'an	3	3803	53	7	4	12	5	15
Tafila	2	2971	48	9	4	11	6	17
Kingdom	100	3400	50	9	4	12	7	14

Contribution of food groups to nutrients and dietary fiber

Protein, fat and dietary fiber: The average daily per capita supply of protein for the country as a whole and in the different governorates is shown in Table 2. It ranged from 80 g/caput/d in Mafraq to 124 g in Karak, and the highest proportion came from cereals, followed by meat; while the contribution of dairy products was low for most regions especially in Tafila (47%).

Meat and eggs group supplied 52% of the fat, and the group of fats and oils supplied another 29% the average daily suply was 150g/capita/d for the country as a whole, and ranged from 107g in Mafraq to 170 g in Irbid.

The supply of dietary fiber was 34 g/capita/d for the kingdom, ranging from 29g in Zarka to 44 in Karak. Cereals supplied 63-84%, while vegetables supplied 8-22% of the total dietary fiber in the household supply.

Vitamins : The contribution of food groups to vitamins is shown in Tables 3 and 4. The average daily per capita supply of vitamin A (Table 3) ranged from 342 mg RE in Mafraq to 1009 in Irbid. Vegetables contributed over half of the vitamin (55% of the total) followed by meat and dairy products groups (23% and 12% respectively). Over half of the vitamin contribution of dairy products came from whole powdered milk. All brands of this type of milk available on the local market, are fortified with the vitamin. However, the contribution of vegetables to vitamin A is probably higher than the obtained value since data on the consumption of wild edible plants were not available, this was also reported by Takruri and Hamdan (1989).

Vitamin C supply ranged from 172 mg/capita/d in Irbid to 86 mg in Karak, and for the country as a whole, it was 150g. About two thirds of the vitamin was obtained from vegetables and one third from fruits.

The average daily per capita supply for thiamine (B1) was 1.5 mg (Table 4) ranging from 1.3 mg in Zarka to 2.1 mg in Karak. Cereals, vegetables, and meat and eggs groups constituted 47%, 23% and 11% of the total supply respectively. The average supply of riboflavin (B2) for the country was similar to B1 (1.5 mg/capita/d) but lower in many regions. Meat, cereals, dairy products and vegetables groups supplied 28%, 21%, 21% and 17% of the total supply respectively. Niacin per capita supply ranged from 38 mg Niacin Equivalent (NE) in Zarqa to 67 mg NE in Karak, and the average for the country was 47 mg NE; most of the vitamin (44-67%) is derived from cereals. The supply of B1 in Amman and Irbid obtained in this study (1.5 and 1.7 mg, respectively) is much lower than what was obtained from a similar previous study (2.3 mg and 3.0 mg, respectively) conducted in 1982 . Average daily per capita supply for B6 was 2.9 mg with a large proportion derived from cereals (44-66%).

Minerals: The levels of the macrominerals Ca, P, Mg and K in the Jordanian diet are shown in Table 5. Average Ca supply was 797 mg/caput/d for the whole country with a range from 506 mg in Mafraq to 929 mg in Irbid. Ca supply obtained in this study for Amman and Irbid (831 and 929 mg/caput/day, respectively) are much higher than those obtained earlier by Tarkruri and Hamdan 1989 (about 647 and 547 mg/capita/d respectively). Most of the supply of Ca in this study came from plant origin indicating possible low absorption of this nutrient. The cereal group provided 31%, dairy products 32%, and fruits and 24% vegetables of the total supply. Cereals were also the main source of P and Mg in the Jordanian diet (41% and 59%, respectively). Cereals and vegetables groups each supplied about one third of the supply of K (31% and 30% respectively), whereas fruits which are rich in this nutrient contributed only 9%. Consumption of fruits declined at a rate of 2.9% per year during the period 1980-1990 (FAO,1994).

Table 2- Contribution of food groups to protein, and fat in Jordanian diet according to governerates .

Governo-rate	Nutrient	protein supply g/caput/d	% from: cereals	meat & eggs	dairy products	fats & oils	Total Calories
Amman	protein	99	44	32	11	---*	12
	fat	157	5	51	7	29	42
Irbid	protein	105	48	28	9	---	11
	fat	170	5	49	5	34	41
Zarqa	protein	83	46	32	8	---	12
	fat	128	5	55	5	25	41
Balqa	protein	99	62	23	6	---	11
	fat	114	7	56	5	26	29
Mafraq	protein	80	60	25	5	---	10
	fat	107	7	60	4	24	30
Karak	protein	124	64	22	7	---	12
	fat	143	8	56	6	26	30
Ma'an	protein	108	53	26	11	---	11
	fat	156	6	51	6	31	37
Tafila	protein	90	47	34	9	---	12
	fat	156	5	64	4	24	47
Kingdom	protein	98	49	29	9	---	12
	fat	150	6	52	4	29	40

* amount is negligible

Table 3 - Contribution of main food groups to vitamin A in Jordanian diet according to governerates .

Governorate	vitamin A	% from:				
	μg RE/ caput/d	meat	dairy	fats &oils	fruits	vegetables
Amman	931	23	14	3	4	53
Irbed	1009	21	10	2	3	59
Zarqa	930	29	9	1	3	55
Balqa	520	12	16	2	3	62
Mafraq	342	16	16	4	5	53
Karak	549	29	21	4	3	37
Ma'an	939	32	13	7	2	41
Tafila	679	29	12	6	4	45
Kingdom	882	23	12	2	3	55

Table 4 - Main food groups contributing to daily per capita supply of B_1, B_2, niacin equivalent (NE) and B_6 according to governorate in Jordan.

Governorate	Vitamin	Supply mg	Cereals %	Meat %	Dairy %	Fruits %	Vegetables %
Amman	B1(mg)	1.5	44	13	5	6	4
	B2 (mg)	1.6	19	30	17	6	20
	NE(mg)	47.3	44	35	4	1	11
	B6 (mg)	2.7	44	19	3	7	25
Irbid	B1(mg)	1.7	45	10	5	6	4
	B2 (mg)	1.7	20	26	23	6	17
	NE(mg)	49.3	47	17	5	2	17
	B6 (mg)	3.2	44	17	4	7	9
Zarqa	B1(mg)	1.3	41	12	4	6	28
	B2 (mg)	1.3	20	30	17	6	20
	NE(mg)	38.1	41	37	4	2	11
	B6 (mg)	2.5	40	20	3	7	25
Balqa	B1(mg)	1.6	65	8	3	3	15
	B2 (mg)	1.2	30	26	21	4	15
	NE(mg)	47.9	62	26	3	3	6
	B6 (mg)	2.8	60	15	3	4	16
Mafrq	B1(mg)	1.2	58	9	3	4	19
	B2 (mg)	1.0	29	24	18	5	17
	NE(mg)	47.9	63	23	2	1	8
	B6 (mg)	2.7	54	15	2	4	22
Karak	B1(mg)	2.1	73	7	4	3	9
	B2 (mg)	1.4	32	27	23	3	10
	NE(mg)	66.7	63	22	4	.....*	4
	B6 (mg)	2.7	54	14	3	3	12
Ma'an	B1(mg)	1.6	52	11	6	5	17
	B2 (mg)	1.5	23	26	25	5	14
	NE(mg)	61.9	61	25	5	1	5
	B6 (mg)	3.0	51	18	4	5	17
Tafila	B1(mg)	1.4	52	12	5	4	20
	B2 (mg)	1.3	21	31	22	5	16
	NE(mg)	47.0	46	37	5	1	8
	B6 (mg	2.7	44	22	3	5	23
Kingdom	B1(mg)	1.5	47	11	5	5	23
	B2 (mg)	1.5	21	28	21	7	17
	NE(mg)	47.3	48	33	5	1	8
	B6 (mg)	2.9	46	18	3	6	21

* amount is negligible

Table 5: Main food groups contributing to daily per capita supply of Ca, P, Mg and K according to governorate in Jordan.

Governo-rate	nutrient	mg	cereals %	meat %	dairy %	fruits %	vegetables %
Amman	Ca	797	31	5	32	4	20
	P	1527	41	22	15	2	8
	Mg	487	55	8	5	4	10
	K	3129	29	17	5	10	30
Irbid	Ca	929	30	5	32	4	23
	P	1641	41	21	16	2	9
	Mg	543	58	7	5	4	10
	K		29	14	8	10	30
Zarqa	Ca	703	32	5	26	4	24
	P	1288	38	23	13	2	10
	Mg	416	57	8	4	4	12
	K	2870	28	15	4	9	34
Balqa	Ca	650	40	5	30	3	16
	P	1442	56	18	12	1	6
	Mg	527	72	5	3	2	6
	K	2528	40	15	5	7	27
Mafraq	Ca	506	40	5	28	4	15
	P	1222	53	18	10	1	8
	Mg	424	69	6	3	3	9
	K	2640	36	13	4	7	32
Karak	Ca	661	35	6	37	3	11
	P	1911	61	16	12	1	4
	Mg	622	74	5	4	2	4
	K	2900	47	15	4	6	21
Ma'an	Ca	779	28	6	37	4	16
	P	1696	46	19	17	1	6
	Mg	552	63	7	5	3	7
	K	3031	36	15	5	8	25
Tafila	Ca	637	28	7	35	4	18
	P	1431	43	24	15	1	8
	Mg	423	59	9	5	3	10
	K	2895	31	18	6	7	32
Kingdom	Ca	797	31	5	32	4	20
	P	1527	41	22	15	2	8
	Mg	494	59	7	5	3	9
	K	3104	31	15	6	9	30

Table 6 shows the levels of the microminerals Fe, Zn, Cu and I in the Jordanian diet. The average daily per capita supply of Fe was 19 mg for the country as a whole, ranging from 14 mg in Mafraq to 21 mg in Irbid and in Karak. The proportions from cereals, meat and vegetables groups were 35%, 19% and 27%, respectively; and as the case of Ca, most of the sources of this mineral in the diet were from plant origin implying reduced absorption. As for Zn, the average daily per capita supply for the country as a whole was 15 mg. Values obtained for Amman and Irbid in this study (15 and 16 mg, respectively are higher than those obtained by Takruri and Hamdan (1989) (12.6 and 12.8 mg, respectively). More than half of the zinc supply (52-70%) came from cereals with a moderate contribution (14-24%) from meat and eggs. Similarly a large proportion of Cu supply was provided from cereals-77%. As for iodine, table salt in Jordan was found to contain traces of the element (HKJ, Minstry of Health,1993), therefore, the contribution of this commodity was negligible. The average daily supply of iodine from food sources was 145 mg/capita/day for the country as a whole, ranging from 110 mg in Mafraq to 175 in Irbid. Cereals, meat and dairy products groups provided 40%, 24% and 26% of the total supply respectively.

In general, the cereal group has been the most important in the Jordanian diet as in other countries of the region . It provided about half of the energy, protein, B1, niacin, B6, P, Mg, Zn and Cu. Vegetables provided more than half of vitamins A and C, and meat provided more than half of the fat supply. On the other hand, the contribution of dairy products, legumes and nuts can be generally considered low.

Geographical location did not seem to influence the pattern of food consumption, however, Karak which is located in the southern uplands had the highest supply of energy from cereals, while Irbid which is located in the northern uplands had the highest supply of energy from fats and oils, and fruits and vegetables. On the other hand, Amman governorate which is predominantly an urban area had the highest supply of energy from meat and dairy products. Ma'an which is in the arid region had the highest energy supply from dairy products

THE CONTRIBUTION OF HOUSEHOLD FOOD PRODUCTION TO TOTAL SUPPLY

Household food production is important for family food security and for improving the nutritional intake of household members. The contribution of household food production to total daily per capita energy and nutrients supply was generally very low for the country as a whole and in the various governorates. The highest contribution for the kingdom was 8% for fat and 7% for calcium. The contribution of household food production slightly exceeded 10% of the total supply for Ca and vitamin A in Balqa (10% and 12% respectively) and Mafraq (14% and 13% respectively, and for fat and Ca in Tafila (10% and 15% respectively). Dairy products were the main source of supply of these nutrients.

ADEQUACY OF ENERGY AND NUTRIENTS IN THE JORDANIAN DIET

The daily per capita energy and nutrients consumption were compared with the average calculated recommended daily intake (RDI) for Jordan (Table 7). The level of energy consumption usually reflects the adequacy of food intake while nutrient intake reflects the quality of the diet.

Energy: The diet covered 121% of the daily needs of energy for the country as a whole. The consumption in Zarka was the lowest (99%) among the various governorates; the deficit could be even higher due to maldistribution of food within the household and the governorate. Energy intake in Tafila considered marginal and a deficit due to maldistribution is also suggested.

Government subsidization of foods, particularly of some cereals and sugar, has undoubtedly contributed to adequate energy intake, it could also contribute to overconsumption.

Table 6: Main food groups contributing to daily per capita supply of iron, zinc, copper and iodine in according to governorate in Jordan.

	*Fe**	C	M	F	V	S	*Zn*	C	M	D	V	S	*Cu*	C	M	F/V	S	*I*	C	M	D
Governorate	mg	%	%	%	%	%	mg	%	%	%	%	%	mg	%	%	%	%	µg	%	%	%
Amman	19	33	21	5	27	9	15	52	24	8	6	5	2.4	60	14	10	9	145	38	27	24
Irbed	21	32	17	4	31	10	16	56	19	7	7	6	2.6	62	12	10	10	175	36	21	32
Zarqa	17	28	20	5	33	9	13	53	23	6	7	4	2.0	59	23	10	10	120	40	27	20
Balqa	16	52	16	3	18	7	15	70	15	5	4	3	2.5	76	9	5	5	132	53	21	20
Mafraq	14	53	14	3	20	5	12	65	15	5	7	3	2.0	71	10	8	5	110	52	19	20
Karak	21	62	15	2	10	5	18	72	14	6	3	3	3.1	77	9	4	5	148	54	23	16
Ma'an	19	45	19	4	17	9	14	57	19	9	5	6	2.5	63	13	7	9	149	43	25	24
Tafila	16	42	21	4	21	6	12	57	21	7	6	4	2.0	62	17	9	6	128	37	26	26
Kingdom	19	35	19	4	27	9	15	56	21	7	6	5	2.4	63	13	9	9	145	40	24	26

* C= cereals, M= meat, D= dairy products, F= fruits, V= vegetables, S= legumes & nuts

Table 7: Adequacy of energy and nutrients intakes for the kingdom and according to governorate.

Nutrient	RDI ref.*	kingdom	Amman	Irbid	Zarka	Balqa	Mafraq	Karak	Ma an	Tafila
						%				
energy	1	121	121	134	99	125	114	140	136	106
protein	1	145	147	156	123	146	118	183	160	133
fat	2	133	140	151	114	102	95	127	139	139
B_1	1	102	99	114	87	107	82	143	104	94
B_2	1, 2	85	88	95	75	68	57	80	84	75
Niacin	1,2	253	252	263	203	255	255	355	330	251
B_6	2	145	143	159	123	142	134	178	148	137
Vit. A	1	132	142	153	141	79	52	83	143	103
	2	88	93	101	93	52	34	55	94	68
Vit. C	2	219	299	250	221	143	151	126	185	188
Ca	1	118	123	137	104	96	75	98	115	94
	2	67	69	78	59	54	42	55	65	53
P	2	137	140	147	116	129	110	247	152	128
Mg	2	154	152	170	130	165	133	194	173	132
Na	3	154	163	179	119	155	102	137	154	137
K	2	44	45	50	41	36	38	41	43	41
Fe	1	122	122	138	108	103	94	138	126	105
Zn	2	90	91	98	78	94	71	113	87	76
Cu	2	191	190	207	162	197	160	244	196	163
I		91	91	109	75	88	70	93	93	80

* Recommended dietary intake references are : 1 for FAO expert groups , 2 for RDA or other American recommendations.

Protien, fat, cholesterol and dietary fiber: The per capita protein consumption was generally adequate in all governorates, it ranged from 118% in Mafraq to 183% of RDI in Karak. As in the case of energy, government subsidization of foods contributed to the adequacy of protein. In addition, the percent energy from protein (Table 2) was between 10-12% which is within the acceptable range (20).

As for fat, the Nutrition Committee of the American Heart Association (Nieman,1992) has recommended that total fat intake should be less than 30% of total energy intake and cholesterol less than 100 mg/1000 kilocalories. Accordingly, fat intake in Jordanian diet exceeded RDI by more than 10% in all governorates except Balqa and Mafraq (102 and95% respectively). The proportion of calories from fat FCal% (Table 2) was higher than the recommended one for the country as a whole (40%) and in all governorates except Balqa, Mafraq and Karak in which the proportion was within the acceptable range. High FCal% in the major three governorates (Amman, Irbid and Zarka) is probably linked with urbanization and vegetable oil production (In Irbid), whereas in Ma'an and Tafila, it could be attributed to prevalence of a nomadic lifestyle. Cholesterol intake, on the other hand, was acceptable, it ranged from 42 mg/1000 Kcal/d in Mafrak to 80 mg in Amman.

The consumption of dietary fiber was adequate and higher than what had been rcommended by Williams (1993). The daily per capita consumption was 151% of RDI for the country as a whole. Dietary fiber is known to interfere with mineral absorption (Hazell, 1985), but data on maximum safe level of intake has not been established yet.

Vitamins : Regarding B1, the intake ranged from 82% in Mafraq to 143% of the RDI in Karak. The intake can be considered adequate in Irbid and Karak, and marginal or inadequate in the remaining regions. As for B2, the deficit is even higher as the intake constituted 95-75% of RDI. Low intake of dairy products contributed to the deficit which could be even higher for household members who have poor preference to milk, or lactose intolerance. Cases of ariboflavinosis were reported among preschool children (UNICEF, 1992). On the other hand the consumption of niacin, B6 and vitamin C were adequate and exceeded the RDI.

On the basis of RDA, there was a deficit in the intake of vitamin A (34-101%) in all governorates, but on the basis of the FAO recommendations, there was a deficit in the intake of this nutrient in Balqa, Mafraq and Karak (79%, 52% and 83%, respectively), and marginal intake (103%) in Tafila. The intake of this vitamin is probably higher than what was obtained, as several edible plants rich in the vitamin such as vine leaves, mallow, garden rocket, garden cress, gundelia and other various wild plants are consumed but information on supply was not available. Although vitamin A deficiency was not reported as a public health problem, it is possible that mild deficiency exists in some areas but it might not be detected nor documented.

Minerals: The RDI for P, Mg and Cu were adequate in all governorates (Table 7). Na consumption, on the other hand, exceeded the recommended intake by 10-80% except in Mafraq (102%). On the other hand, a deficit in the intakes of Ca, K, Fe and I were obtained in some governorates. Calcium intake for the country as a whole was 67% of RDI when compared with RDA, with a range from 53-78%, but it was 118% based on FAO/WHO values with a deficit in Mafraq, Balqa and Karak (96%, 75% and 98% of RDI, respectively), and a marginal intake in Zarka (104%). Although drinking water in Jordan contributes to Ca intake, the deficit probably still exists as most of dietary calcium is derived from plant sources. Furthermore, Ca/P ratio was very low and did not exceed 0.6 implying adverse effects on the absorption of this mineral.

Studies on Ca status in Jordan are few, they mainly dealt with intake in Amman. In a recent study on a group of 39 obese female students aged 16-22 years, mean daily Ca intake was found to be 443 mg, it dropped to 369 mg after a weight reduction programme even though it was coupled with nutrition education (Qadri, 1995, unpublished). A study on 80 pregnant women during the third trimester of pregnancy showed that their mean total daily intake of Ca was 717.5 mg of which 594 from dietary sources and the remaining amount was supplemental Ca (Shalbak,1993,unpublished).

Inadequate Ca intake is a risk factor for osteoporosis, which is more common in females than in males. This disease is common in women after menopause,and it was reported to affect half of all the women over the age of 45, and 90% of all the women over the age of 75 years (Thomson, 1990). Modern techniques for early diagnosis of this disease, however, are still not widely used, while conventional X-ray method detects only severe bone loss (Thomson, 1990).

Regarding Na and K, no recommended intake has been established for these two minerals, however, the American Food and Nutrition Board (FNB) suggested 500 mg Na and 2,000 mg K as minimum requirements, and 3600 mg as desirable intake of K for healthy individuals aged 10 years and over (NRC, 1989). Accordingly the consumption of Na in Jordan which mainly comes from table salt, was more than 10 times higher than the minimum requirements, however the minimum recommended intake of Na for Jordanians is probably higher than the FNB recommendations due to prevalence of hot uncontrolled climatic conditions for the majority of the population for several months of the year. On the other hand, K intake was just above the minimum requirement in Balqa and Mafraq governorates (101% and 106% respectively). The intake of K was much below the desirable level, it was 124% of the minimum requirement for the country as a whole, and was highest (140%) in Irbid governorate which also has the highest energy supply from fruits and vegetables. A Na/K ratio of 0.6 has been recommended to maintain normal blood pressure (Nieman, 1992). In this study the Na/K ratio obtained was much higher than the recommended one, it was 2.0 for the country as a whole, and ranged from 1.6 in Mafraq to 2.5 in Balqa. These ratios are much higher than what was found in diets of adult Americans (less than 1.1) (Pennington, 1986).

The intake of Fe was 122% of RDI for the country as a whole, but it was low or marginal in Mafraq, Balqa, Tafila and Zarka governorates (Table 7). Some reports and studies, which were mostly conducted in Amman, have revealed the occurrence of deficiency of this micronutrient in Jordan among children, pregnant and non-pregnant women (Osman, 1992; UNICEF, 1992; FAO, 1994 , Yip, 1990). The mean daily intake of dietary Fe of a group of 80 Jordanian pregnant women 16.2 mg and the total intake including supplements was 33.7 mg . Data also showed that 14% of the sample had low hemoglobin (<10g/dl) and 18% were at marginal level (10.0-10.9g/dl)(Shalbak, 1993, unpublished). In this study, about 20% of Fe came from animal sources implying poor absorption. Poor intake is not the only factor contributing to Fe deficiency in Jordan, poor food habits and parasitic infections could also be contributing factors.

As for zinc, there was a deficit in the intake in all governorates except in Karak (113%), the average intake for the country as a whole, was 90% of RDI. Data on the status of this micronutrient in Jordan are scarce, however, cases of acrodermatitis enteropathica have been reported in Jordanian hospitals, which responded to zinc supplementation. In two studies on Jordanian pregnant women, both Zn intake and serum level were low. In one study mean daily consumption of Zinc of a group of 290 pregnant women was 7.3 mg and the mean serum zinc level was 66.9 mg/dl(Takruri, 1982, unpublished). In a more recent study on 80 pregnant Jordanian women, mean daily intake of Zn during the third trimester was 9.6 mg (65% of the RDA for that group) and mean serum Zinc was 60.7 mg/dl at the end of pregnancy (Shalbak, 1993. unpublished). Values below 68 mg/dl were considered low (Tuttle et. al. 1985). Poor absorption of this micronutrient is also expected as a large proportion (about 70%) of it came from plant sources.

Similarly, the average intake of iodine was 91% of RDI with a deficit in all governorates except in Irbid (109%). Iodine is considered a public health problem in Jordan ; a recent report has shown the prevalence of goitre in school children aged 8-10 years to be about 38% (HKJ, Ministrty of Health, 1993).

THE NUTRIENT DENSITY OF THE JORDANIAN DIET

The nutrient, as percent of RDI, divided by energy, as percent of requirement,is the index of nutritional quality (INQ) (Hansen et. al., 1979). This index is a good indicator of the quality of the diet in relation to both its energy content and the recommended intake. The diet is adequate if the index is 1 or more since, in this case, it supplies nutrients in the same proportion as energy needs; but if the index is below 1, the diet has a low nutrient density as it provides less nutrients than energy. Such diets, although adequate in energy, they can lead to deficiency diseases. Figure 1 gives the profile of Jordanian diet expressed as 100 INQ in comparison with the percent adequacy for selected nutrients. The index for Ca is below 1 although it is adequate when compared with RDI. This implies a decline in Ca intake is expected upon reducing food intake.

CONCLUSION AND RECOMMENDATIONS

The Jordanian diet was generally adequate in energy, protein , fat and dietary fiber. Fat intake was above the recommended level, it was 124% for the country as a whole, but cholesterol was within the suggested limits. The levels of fat and dietary fiber in the diet did not seem to have adverse effects on micronutrients availability. However, the diet was inadequate in B2, Zn, and iodine. Mafrak, Balqa and Tafila governorates had the highest nutrient deficits, while Amman and Irbid had the lowest. Low micronutrient intake is mainly attributed to the quality of diet rather than to total food intake which was generally adequate.

Food subsidisation is necessary for adequate energy supply, however, it should be modified to include more of the high nutrient density foods particularly from the dairy products group (to provide Ca, B2 and vitamin A) and legumes, but less of the low nutrient density foods, namely sugar. Furthermore, household production of fruits, vegetables and dairy products should be encouraged to supply these nutrients as well as potassium.

There is a need to increase awareness of policy makers regarding food and nutrition matters. Also, there is a need for well defined food and nutrition policies to ensure adequate food supply and subsequent balanced nutrition for all population groups and to avoid over consumption of food.

Nutrition intervention to improve the nutritional status of infants, children and women particularly from low socio-eonomic and low food availability areas, should be stressed and given priority. Increase in food availability for areas of deficient or low supply is required, particularly in Mafraq, Balqa, Zarka and Tafila governorates.

Foods rich in B2, Ca, Fe and Zn and vitamin A should be made available in all regions of the country, and their consumption should be encouraged particularly by children and women through nutrition education and feeding programmes. Iodized salt, should also be made available in all parts of the country.

Household food consumption data should be linked with clinical and / or biochemical data on nutrients for monitoring the nutritional status of Jordanians.

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VITAMIN A IN NUTRITION AND ITS INTERACTION WITH OTHER NUTRIENTS

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INTRODUCTION

Vitamin A is a fat-soluble vitamin which was the first to be identified early in this century (Moore, 1957). Although ocular symptoms of its deficiency, particularly night blindness, have known since antiquity, it is in this century that consequences of its deficiency in animals and humans were understood; poor growth, persistant infection, immune incompetence and dry eye (xerophthalmia) are known symptoms of vitamin A deficiency (VAD) (Sommer, 1995).

The term vitamin A applies to several biologically active compounds which are of the preformed vitamin (retinol, dehydoretinol and many chemically related derivatives) and the provitamin A or carotenoids. Of over than 100 carotenoids, only 9 compounds have been found to have vitamin A activity, with B - carotene being the most potent of them (Moore, 1957; Pike and Brown, 1984).

Vitamin A deficiency was eliminated in wealthier countries through dietary intervention in the fourties, however, it is still one of the main health problems in developing countries, particularly in Africa, Asia, Western Pacific, the Caribbean countries, Central and South America and the Eastern Mediterranean (WHO / UNICEF, 1994). It is estimated that 118-190 million young children, 1-5 years old, live in areas of VAD (WHO /IVACG, 1992). It is estimated that 5-10 million will develop xerophthalmia annually with 250-500 thousand becoming blind. (Humphrey et al.,1992; Sommer, 1995).

The rich food sources of preformed vitamin A are of animal origin and include liver (particularly fish liver), kidney, butter and egg yolk. The carotenoids, on the other hand, are obtained from foods of plant origin most important of which are dark green leafy vegetables, red palm oil, carrots and certain colored fruits.

PHYSIOLOGIC FUNCTIONS OF VITAMIN A

Carotenoids are absorbed and coverted to retinal then to retinol and esterified esters in the mucosal cells of small intestines.

The efficiency of conversion of B-carotene to retinol is 1/6 and that of other carotenids is 1/12. On the other hand, the absorption of retinol and its derivatives is much more complete and may reach 90%. However the bioavailability of both retinol and cartenoids depends on many factors and on interactions with other nutrients (Wise, 1980; Takruri, 1982).

Vitamin A, regardless of its sources, is transported after absorption and conversion to retinyl ester (mainly palmitate) via the lymphatic system and stored in the liver in the ester form to be mobilized from there upon need by peripheral tissues. It is mobilized from the liver as retinol attached to a protein synthesized in the liver named retinol-binding protein (RBP), which is further bound to another protein called transthyretin.

The most important functions of vitamin A are as follows:

1. Vitamin A is necessary for normal vision. Retinol and retinal prevent night blindness while retinoic acid does not (De Luca, 1978).

2. Vitamin A is necessary for reproductive functions. It is involved as retinol but not retinoic acid in reproductive actvities in the male where it is needed for spermatogenesis in males and in placental development and embryo development in females (Marks, 1980).

3. Cell membrane integration and cell differentiation. It seems that vitamin A is needed for the synthesis of specific glycoproteins which in turn act on RNA syhthesis and cell differentiation. It was found that vitamin A is needed for carrying mono-and oligo-saccharide units to an accepter site for the biosynthesis of glycoproteins situated in the cell membranes (De Luca and Wolf, 1970). It has also been postulated that vitamin A may be involved in electron transfer reactions in membranes (Sundaresan, 1972). Vitamin A deficiency is reflected in poor integration of epithelial tissues which renders them exposed to infection.

4. Normal growth: Since vitamin A has a role in cell integrity and membrane stability, its deficiency affects cell division and growth of growing animals.

5. Vitamin A seems to be necessary for the stability of membranes of mitochondria and lysosomes.

6. There is quite good evidence that vitamin A, and particularly carotenoids, provide protection against cancer (Madani, 1995; Rohan et al., 1993).

DEFICIENCY SYMPTOMS

Normal vitamin A status implies that an individual is free of symptoms and has sufficient stores to provide protection against metabolic demands in infection and stress. A normal well-nourished child has a serum level of 1.0-1.4 μmol/liter (30-40 μg/dl). Because vitamin A is stored, any vitamin A intake over needs is stored in the liver and thus it takes some time before hepatic stores of vitamin A are depleted (Sommer, 1995).

With continued VAD and/or low bioavailability of the vitamin, its hepatic stores become subnormal followed by reduced serum levels. Then a series of changes continue ending up with xeropthalmia and blindness which are accompanied by high mortalily anaemia, and reduced growth.

If the intake of vitamin A is so low that vitamin starts being depleted, the plasma level decreases. When the plasma level is <0.7 μmol/L (<20 μg/dl) symptoms start to appear (Sommer, 1995). Severe symptoms, particularly frank ocular symptoms, may be manifested at levels of < 0.35 μmol/L (<10μg/dl) (Sommer, 1982).

The following are clinical symptoms which develop in severely deficient persons (usually children 1-5 years old):

1. Retarded growth : The period needed depends on the stores in the liver and the rate of utilization of the vitamin and the dietary vitamin A ingested.

2. Abnormal spematogenesis in males and increased risk for abortion and still births in females with poor outcome of pregnancy including teratogenic developments.

3. Infections and poor immune competence. It is reported (Sommer, 1995) that:

   a. Mortality rates increase among children with VAD.
   b. Improving vitamin A status results in reducing the risk of mortality by 19-54%.
   c. Reduction in mortality from improvement of vitamin A status exceeds the reduction in mortality due to treatment of xerophthalmia.
   d. Improvement of VA status of the community decreases the risk of measles mortality.
   e. One million child death would be prevented with improvement of vitamin A status.

4. Xerophthalmia and ocular symptoms(Gibson, 1990):

a. Night blindness (NB). Inability of the retina to form sufficient rhodopsin would end up with impaired dark adaptation reflected by dark blindness which is the earliest manifestation of VAD. The child does not like to move after dusk. Night blindness responds rapidly, usually within 24-48 hours, to vitamin A therapy (Sommer,1995).

b. Conjuctival xerosis (X1A): The epithelium in VAD becomes of the stratified squamous type with a resultant loss of goblet cells and formation of granular cell layer. This leads to dryness of the entire conjunctiva. (Sommer, 1995).

c. Bitot's spots (X1B): These are foamy or cheesy lesions: they first appear in the temporal quadrant of the eye and later appears in the nasal quadrant usually of triangular shape.

d. Corneal xerosis (X2): This is a dryness of the cornea which usually starts in the nasal aspect of the cornea and spreads upward over the central cornea. At the beginning, and before other complications develop, corneal xerosis responds to vitamin A therapy within 2-5 days.

e. Corneal ulceration /keratomalacia (X3A &X3B): Ulcers resulting from VAD are round or oval "Punched-out" defects, whereas the keratomalacia is a rapidly progressive condition which affects the full thickness of the cornea. Usually if ulceration/Keratomalacia involves less than 1/3 of the corneal surface, therapy can preserve vision, but if more than 1/3 of cornea is involved the condition is irreversible and ends up with permanent blindness (Sommer, 1995).

f. Scars (Xs): Scars are opacities of varying densities which are healed sequelae indicating previous corneal disease.

g. Xerophthalmic fundus (XF): These are white retinal lesions which are of investigational interest only (Sommer, 1995).

CAUSES OF VAD

Many factors contribute to the development of VAD. The low dietary intake could be due to primary food shortage in general or to unavailability of food rich in the vitamin. Other factors include disease, local food habits and interaction with other nutrients. The following is a brief discussion of these factors:

1. The availability of food: Low VA intake could be due to :

   a. Poverty resulting in weak purchasing power.
   b. Ignorance: food may be available but the vitamin is not consumed due to the lack of knowledge of good sources of the vitamin. In any country, there are many vitamin A rich local foods (Takruri and Ahmad, 1995) some of them are wild plants but many people do not appreciate their value.
   c. Unavailability of food in markets: This could be either due to drought or famine or to a limited supply of rich sources of the vitamin. In many countries of the world the food variety is limited.

2. Local food habits: food taboos and fads may contribute to deficiency of vitamin A. Weaning food might be traditionally poor in vitamin A sources (Marks, 1980).

3. Infections and parasites: Parasites might adversely affect the absorbance of the vitamin or compete with the host for it. Measles is a good example of disease in which mortality increases with VAD and in which vitamin A requirement is increased. Other examples include meningitis, diarrhea, and tuberculosis. Also diseases of liver, gallbladder or pancreas which interfere with fat-soluble vitamins would reduce vitamin A absorption and precipitates its deficiency.

4. Increased requirement of the vitamin due to rapid growth, fever, infection, pregnancy and may be drug therapy (Marks, 1980).

5. Interactions with other nutrients. The interrelationships of a nutrient with other nutrients would determine the exact requirement of a nutrient (Wise, 1980). Many nutrients interact with vitamin A and have a role in the precipitation of VAD.

INTERACTION BETWEEN VITAMIN A AND OTHER NUTRIENTS

Zinc

Zinc is necessary for the synthesis of retinol-binding protein (RBP) that binds with retinol and mobilizes it from its hepatic stores, for activating certain vitamin A-metabolizing enzymes, and for carotene absorption and/or its utilization.

Zinc and RBP synthesis: The role of zinc in RBP synthesis is well-established and has been documented in many animal species including rats (Smith et al., 1974), lambs (Saraswat and Arora, 1972) and apes (Baly et al., 1984). It was found that vitamin A liver stores were not mobilized in zinc deficient animals and serum vitamin A was not raised with vitamin A supplementation but only with zinc supplementation. This was confirmed in man by Vilanueva et al. (1983) who found that the serum level of retinol was significantly increased with zinc supplementation.

The effect of zinc on carotene absorption and utilization: Zinc supplementation improved the carotene absorption in many species of animals (Vernicor et al., 1978; Arora et al., 1981; Takruri, 1982). The exact mechanism by which zinc deficiency could depress absorption of B-carotene is not understood. It was postulated that the effect of zinc deficiency could be due to poor absorption or to depressed conversion of the absorbed carotene to retinal (then to retinol).

In 3 groups of rats [zinc sufficient (ZS) or control group receiveing 30 ppm Zn, zinc deficient group (ZD) receiving 2.5 ppm Zn and a pair -fed group] a carotene balance test showed that zinc deficiency decreased cartotene absorption by 25% by comparing ZD with ZS and PF groups (Table 1). Measuring the stored vitamin A in the livers of these groups showed that the vitamin A liver stores of ZD rats were only 50% of those of ZS or PF rats. It was concluded that zinc deficiency leads to depression in carotene absorption as well as its overall utilization as indicated by vitamin A storage in different groups of rats (Table 2) (Takruri, 1982).

The effect of zinc deficiency on vitamin A metabolizing enzymes: It was found that zinc deficiency results in the suppression of retinal reductase (or retinol dehydrogenase (Solomons and Russel, 1980) which is responsible for the reversible reaction: (retinal---retinol).This was proved in the eye retina (Huber and Gershoff, 1975)liver (Kfoury et al., 1968), tests (Sundaresan et al., 1977) and intestinal mucosal cells (Takruri, 1982).

Table 1 : Effect of zinc deficiency on B-carotene absorption [1] (Takruri, 1982).

Group of rats	% carotence absorption
Zinc deficient ZD	46.5 ±4.82 [2]
Zinc sufficient ZS	76.2 ±1.1
Pair - fed PF	62.1 ± 3.2

1 ß-carotene was fed for 6 days as the only source of vitamin A to vitamin A - depleted rats.

2 Data expressed as mean ± SEM

Table 2 : Effect of zinc deficiency on vitamin A storage and weight gain of rats (Takruri, 1982).

Group of rats	Weight gain (g)	Liver retinol (µg) [1,2] /g liver	/whole liver
Zinc deficient ZD	18	8.1 ± 0.8	48.9 ± 3.4
Zinc sufficient ZS	55	11.7 ± 0.7	107.0 ± 5.1
Pair - fed PF	27	20.5 ± 3.3	100.7 ± 17.4

1 ß-carotene (410 µg/rat/day) was fed for 10 days as the only source of vitamin A to vitamin A - depleted rats.

2 Data expressed as mean ±SEM : a and b indicate significant differences from ZD rats at $p< 0.02$ and $p< 0.01$ respectively.

It can be concluded that zinc deficiency could result in poor vitamin A status through abnormalities in the above mention pathways. This poor status was proved in ZD liver cirrhosis patients in whom dark adaptation was poor and hypogonadism were reported although they had good stores of vitamin A (McLain et al., 1979).

Iron

A direct correlation has been found between plasma levels of vitamin A and levels of blood hemoglobin (Bloem et al., 1989, Sijtsma et al. A 1993). It was also proved that supplementation of iron to deficient children improves the iron (Fe) status and increases hematopoiesis (Bloem et al, 1989). It was suggested that VAD could inhibit Fe mobilization from tissues to bone marrow (Sijtsma et a., 1993); this was also suggested by Mejia et al. (1979) who found that VAD rats had higher Fe stores in spleen and liver. The iron utilization in man is affected by VAD before the appearance of frank symptoms of xerophthalmia (Sommer, 1995).

Other Nutrients

Vitamin E: Vitamin E works as an antioxidant. Its supplementation has been found to increase the in vivo absorption of vitamin A (Ames, 1969) and the utilization of carotenes (Moore, 1957).

Dietary fat: Low Dietary fat depresses the absorption and/or utilization of carotenoids (Moore, 1957, Roels et al, 1967).

Dietary proteins: Dietary protein seems to be important for vitamin A utilization; the poor quality and low quantity of dietary protein reduces the absorption of carotenes (Ahuja and Wagle, 1980).

Dietary fiber: High fiber in the diet reduces the absorption of the fat soluble vitamins A,D and E in man and other animal species (Kasper et al, 1979; Erdman et al, 1986). Also the absorption of B-carotene has been found to be adversely affected by high wheat bran in the diet of the rat (Takruri and Ahmad, 1995).

ASSESSMENT OF VITAMIN A DEFICIENCY

Vitamin A deficiency is still a serious public health problem in many countries of the world. The WHO now classifies countries according to clinical as well as subclinical evidence of deficiency. It is reported that 39 countries of the world have VAD as a clinically significant public health problem; 11 countries have it as a subclinically preventable public health problem; 27 countries have VAD as subclinical public health problem in certain regions; and 18 other countries are likely to have it as a public health problem but data is lacking (WHO/ UNICEF, 1994).

Formulation of an effective intervention program begins with characterization of the problem. Searching for active or healed cases of xerophthalmia is the most traditional, specific and efficient means of preliminary assessment. Searches should be concentrated and cases should be sought in urban slums, impoverished rural villages and in pediatric services dealing with ophthalmic disorders and infections (Sommer, 1995). Many indicators are used for the assessment of vitamin A status including clinical, biochemical and dietary indicators

A. Clinical parameters

WHO has classified xerophthalmia and established the following criteria to assess its public health importance (WHO / UNICEF, 1994) :

1. Night blindness (XN): The behaviour of children is observed after dusk. If ≥ 1% of population at risk have XN, then it is claimed that there is a public health problem.

2. Bitot's spots (X1B): It should be noted here that the Bitot's spots might not provide information on the magnitude or extent of ocular destraction or blindness. Anyway,If X1B is present in at least 0.5% of the population at risk, then VAD is a public health problem.

3. Active corneal lesions: (X2, X3 A , X3B): These are easily diagnosed and highly specific, to indicate a problem of VAD they should be prevalent in more then 0.01% of the population at risk.

4. Inactive corneal lesions: It is important to distinguish between those cases likely to be the result of and those due to other causes. This requires a detailed examination, a detailed history from a responsible person (adult) and interpretation by an ophthalmologist. At least 0.05% of population at risk should have corneal scars.

5. Impression cytology (CIC) to identify keratinizing metaplasia of the conjenctiva.

B.Biochemical parameters

Low serum retinol levels, low breast milk concentration or a high prevalence of abnormal relative dose response RDA (or modified relative dose response MRDA) among abnormals, as compared with controls, provide independant corroboration of the clinical diagnosis (Gibson, 1990; Sommer, 1995).

Relative Dose Response Test "RDR"

Retinol (R) is the preferred ligand for apo-RBP, but 3,4- didehydroretinol (DR) or vitamin A2 is "a suitable signal for RBP release"; thus the holo-RBP complex is released by the presence of any of the forms. After a suitable oral dose R or DR should appear in the plasma in significant amounts above baseline levels only when endogenous liver retinol concentrations are inadequate (when vitamin A liver reserves are below 0.07µmol/g).

The release of retinol - binding protein (apo-RBP) from the liver depends on the availability of vitamin A from dietary sources or endogenous body stores,serum vitamin A is reduced due to many factors other than dietary deficiency such as fasting and starvation, zinc deficiency and depletion of body stores. Therefore, RDR tests or MRDR tests are used as biochemical indicators of VA status although we still use the serum VA data.

Two samples of blood are taken, one before and one 5 hours after a test dose of 450-1000 ug retinyl ester is taken orally. The retinol is determined in the blood at pre-dosing (A0) and 5 hours later (A5) and the relative dose response RDR is calculated as a percentage as follows:

$$RDR = \frac{A5 - A0}{A5} \times 100$$

The interpretation of RDR is as follows: A value of 20% or higher is indicative of inadequate liver reserves (of ,0.07 umol/g liver). However, the relationship between RDR liver stores above a critical level is not necessarily linear. Sometimes, negative values occur with adequate vitamin A status (WHO / UNICEF, 1994).

Modified Relative Dose response Test (MRDR): This involves giving children a single oral dose of (100ug/kg bodyweight or 1.5 mg standard dose) of 3,4 didehyoretiny1 acetate (DR) followed by a single venous blood smaple 4-6 hours later. R and DR in serum are measured by HPLC and a molar ratio of DR to R is calclulated:

$$MRDR = \frac{DR}{R}$$

In this test two advantages are obained (WHO / UNICEF, 1994):

(1) The ratio DR/R in a single serum sample minimizes the variability of storage effects on vitamin A stability and variability of sample extraction efficiency.

(2) Prolonged waiting of children at the clinic is avoided.
The interpretation of MRDR is as follows: The ratio DR/R of ≥0.06 suggests poor vitamin A status. Also if ≥ (20%-30%) of the general population studied have this value there is a moderate public health problem, and if ≥30% of the preschool children in a population have this value, there is deficiency of vitamin A status (See Table 3).

C. Dietary parameters

Dietary histories cannot alone indicate the prevalence and severity of VAD in the community. The list of foods consumed should include all locally available major sources of vitamin A and provitamin A, potentially fortifiable foodstuffs, staple food and major sources of protein. Trained nutritionists, scales and food samples are needed (Sommer, 1995).

INTERVENTION METHODS

The following intervention methods which were found to alleviate the problem and /or control its occurrence in the community.

1. Treatment of cases: 110 mg of retinyl palmitate are given to VAD cases. These are repeated on the second day and 1-4 weeks later. If PEM is exist, then other doses are needed every 4 weeks. Half of this quantity is given to infants 6-11 months old and its quarter to infants below 6 months (Sommer, 1995). In children suffering from mouth ulceration, half of the above dose is given intra muscularly using water miscible preparations.

Table 3 : Biological indicators of subclinical vitamin A deficiency in children 6-17 months of age. (Ref. WHO and UNICEF, 1994)

Indicator (cut-off)	Prevalence below cut-offs to define a public health problem and its level of importance		
	Mild	Moderate	Severe
FUNCTIONAL Night blindness (present at 24-71mo)	> 0 - < 1%	≥ 1% - < 5%	≥5%
BIOCHEMICAL	≥2 - <10%	≥10% - <20%	≥20%
Serum retinol (≤0.70 µmol/	<10%	≥10% - <20%	≥20%
Breast milk retinol (≤1.05µmol/1	<20%	≥20% - <30%	≥30%
RDR (≤20%)	<20%	≥20% - <30%	≥30%
MRDR (ratio≥0.06)	<20%	≥20% - <30%	≥30%
+S30DR (≥20%)			
HISTOLOGICAL CIC/ICT3 (abnormal)	<20%	≥20% - <40%	≥40%

There is a public health problem either when at least two of the above biological indicators of vitamin A status are present in a population and below the cut-off, or when one biological indicator of deficiency is supported by at least four of a composite of demographic and ecological risk factors such as: high mortality rate, poor immunizadion coverage, low dietary intake and prevalence of diarrhea.

2. Prophylaxis: This is achieved through periodic supplementation in communities at risk. Doses of 110 mg retinyl palmitate (200,000 i.u.) are administered every 4-6 months (Sommer, 1995). This could be done through immunization contacts to give doses of vitamin A as early as 6 months of age. The advantage of this early administration of the vitamin gives chance for educating mothers and guiding them to use vitamin A rich sources in their diet and in weaning foods of their children. (WHO/ IVACG, 1992).

3. Increased intake of dietary sources of vitamin A: This is achieved by:

a. Prolongation of the breast-feeding period to make sure that the child is getting at least the minimum quantity of the vitamin that protects him against deficiency.

b. Giving rich sources of vitamin A in the diet. The vitamin A-rich vegetables used in feeding of infants and young children should be acceptable to the child. It is preferable to boil them in order to increase their digestibility and combine with them a small amount of oil to improve the absorption of carotenes.

c. Encouragement of home gardening and any other horticultural programmes which increase the production of vitamin A rich foods. The plants grow should be within the food habits of the people and appropriate for children. An evaluation of the reasons of low intake of vitamin A rich sources should be done.

4. Education and counseling of people through mass media (radio, video, television, news-papers) lectures, and counseling at immunization contacts and MCH visits should be provided.

5. Fortification: Vitamin A (and other nurients) should be added to staple foods or commonly consumed foods. The vitamin A used for fortifications should be stable, undetectable in the food vehicle and inexpensive (Sommer,1995). Examples of vitamin A carriers in different communities include vegetable ghee which has been used in Jordan, MSG which was used in the Philippines and sugar which was applied in Central and South America.

6. Evaluation: This is necessary for the assessment of the progress and success of any programme. We should start with baseline data before the intervention programme and compare the achivements obtained in reference to the original data.

VITAMIN A STATUS IN JORDAN

Data available on vitamin A status in Jordan are contradictory. Early surveys and nutritional studies revealed that VAD had been probably the most common deficiency accompanying PEM (Pellett, 1976; ICNND, 1963; ICNND 1964). In the first general nutritional survey which was conducted in the sixties the low dietary intake was confirmed by biochemical and clinical findings (ICNND, 1963). However later studies showed that VAD was no longer a serious problem (Hijazi, 1977) . Dietary data, which are by no means adequate and don't give an absolute indication of the nutritional status, have not shown that VAD is likely to be a problem (Takruri and Hamdan, 1989). It seems that the fortification of vegetable ghee with vitamin A and the fact that many herbs are traditionally consumed by people would minimize the probability of a serious problem of VAD (Takruri and Hamdan, 1989, Takruri and Ahmad, 1995).

The incompleteness of dietary data extracted from FAO Balance Sheet and other consumption data would make it uneasy to reach any conclusion on VAD in this country and call for surveillance and investigation of the magnitude of the problem.

CONCLUSIONS

1. Vitamin A deficiency is still a problem in many parts of the world.

2. The problem can be treated through intervention programmes which take into consideration the interaction with other nutrients.

3. Education and counseling to increase the dietary intake of the vitamin and to change food habits are of utmost importance.

4. Further investigation and surveillance are needed to asses the exact status of the vitamin A in the Arab countries.

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