PROCEEDINGS OF
WORKSHOP ON PREVENTION AND CONTROL OF MICRONUTRIENT DEFICIENCIES IN THE ARAB GULF COOPERATION COUNCIL COUNTRIES

(Kuwait, 30 June - 2 July, 1996)

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and

Samir Salem Miladi

FOREWORD

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

During the last three decades, the nutritional status of the population of the Arab Countries of the Gulf have improved. However, micronutrients deficiency has been a long-standing food related public health problem, which is spread among different population groups. The prevalence of a particular deficiency can vary considerably between different geographic locations and socio-economic groups.

The studies which have been reported in this publication showed that the lack of adequate amounts of iron, iodine and vitamin D in the foods we eat are especially important because of their serious health consequences, wide geographic distribution, and their implication on economic stagnation. Other micronutrient deficiencies could exist, however they have not yet been investigated.

The main causes of micronutrient deficiencies in the Arab Countries of the Gulf are due to inadequate intake of foods containing essential micronutrients and their impaired utilization. This is often associated with infections that can reduce their absorption and increase their metabolic consumption. Micronutrient deficiencies have a negative impact on society, they reduce working capacity, cause mental and growth retardation, reduce resistance to disease and can lead to death of women in pregnancy and during 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, 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 be of benefit to all those who are working in this field. This publication is the fruit of cooperation with The Arab Nutrition Society and the private sector.

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

CONTENT

RECOMMENDATIONS

1. All the GCC countries are aware of the deleterious health impact of micronutrient deficiencies, especially nutritional anaemia in women and children caused by iron/folate deficiency and iodine deficiency disorders. The effect of vitamin A deficiency on children are being increasingly realised. The awareness has not yet produced any political commitment with high priority.

It is suggested that a properly designed problem-definition study be conducted to asertain the extent and magnitude of these micro-nutrient deficiencies, and at the same time to identify the underlying determinants of each of these deficiencies. Efforts should be made to design and undertake such studies in all the GCC countries in a cross-country manner using a standardised uniform method and using comparable study tools and laboratory procedures. This work will generate comparable data from all the GCC countries.

2. It is suggested that a micronutrient surveillances system be established along with this problem definition, to monitor on a continuing basis, the extent of these deficiencies over time and the impact of the ameliorative measures. The indicators of such surveillance should be simple and reliable and which could be easily collected by health workers in the peripheral health infrastructure. Such surveillance system will be useful to conduct evaluation of the ameliorative measures at periodic intervals focusing on both process and impact evaluation.

3. It is recommended that the measures for the control of these deficiencies, when appropriately implemented nation-wide, will need additional financial resources and in-service training of medical and health workers at all operational levels of the health care system.

4. Education for nutrition promotion is a major responsibility of the health ministry but not done effectively at all operational level. Special attention should be given through the following approaches:

- through the ante-natal care of pregnant women through the MCH centres.
- through health education as a component of school-health services.

School health education is now receiving increasing attention in view of its great potential in establishing health-related behaviours including good dietary habits in the impressionable age of school children.

5. Mass-awareness campaign should be systematically designed for nutrition promotion with special focus on micronutrient deficiencies and the means to overcome through proper diets. Mass-media including audio-visual and printed materials, should be widely used for this purpose. However person-to-person approach and group discussion should be also mobilised whenever and where ever possible.

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 different geographic locations and socio-economic groups. Most of the 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 intrauterine 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 contributor 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-

6. Measures for oral supplementation of iron/folate and vitamin A should be carefully designed after reviewing the results of the nation-wide situation analysis of the problems and especially the underlying determinants.

7. Control of IDD through salt-iodization should be started as soon as reliable evidence of the problem is available based on clinical and laboratory data. In case the government policy is to adopt universal iodization of salt, uniodised salt should not be made available to the consumers, for which appropriate legislation will have to be adopted.

8. In order to provide high priority to the control of micronutrient deficiencies all steps should be taken to obtain political commitment of the highest level decision makers, for which advocacy measures have to be taken. Since micronutrient deficiencies are basically public health problems, the health ministry will have to spearhead such advocacy measures.

9. However, control and prevention of micronutrient deficiencies connot be done only by the health sector, since the problem is of multi-face nature. A comprehensive strategy will have to be designed in collaboration with other concerned government sectors, non-governmental organizations and others.

An Intersectoral Committee or Council charged with the responsibility of implementing the strategy, be established by the government in which the following should be represented:

- Ministry of Health
- Ministry of Education
- Ministry of Social Welfare
- Ministry of Agriculture
- Ministry of Commerce and Industry
- University and Research Institutions
- Municipality
- Food Industry
- Non-governmental Organizations
- Others concerned

10. There are numerous determinants of nutritional anaemia, VAD and IDD, which could be controlled by a number of health measures of which the following are important:

- Immunization of children
- Control of diarrhoeal disorders
- Malaria control in endemic area
- Promotion and protection of breast-feeding and appropriate complementary feeding

- Promotion of environmental sanitation and provision of safe water
- Birth spacing advice and services

Steps should be taken to implement these measures to get full benefit of specific measures for the control of micronutrient malnutrition.

11. Food fortification is one of important measures to combat micronutrient deficiencies. It is recommended that the GCC countries which have adequate and reliable information on prevalence and causes of one or more of micronutreint deficiencies, should establish food fortification programme, after careful cost-benefit study.

12. Food fortification programmes in some GCC countries should be evaluated to find out whether or not these programmes achieved its objectives and participated in the reduction of micronutrient deficiencies.

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 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 14% 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 out on children who are not enrolled in schools and on populations who are not visiting health centers.

Action 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 combatting 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 stunting, 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 the 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 showed 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 goiter 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 constitute 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 foods 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 eyes, 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 Skim 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 supplement, 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 DEFICIENCIES

Very limited studies and surveys were carried out in the Arab countries on other micronutrient deficiencies such as zinc. In the Morocco 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 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 deficiencies 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 deficiencies 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

FACTORS ASSOCIATED WITH MICRONUTRIENT DEFICIENCIES IN THE GCC COUNTRIES

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INTRODUCTION

Micronutrient deficiencies are among the most nutritional problems worldwide. The common micronutrient deficiencies of public health significant are iron deficiency anaemia, iodine deficiency disorders and vitamin A deficiency. In the Gulf Cooperation Council (GCC) Countries, despite the marked improvement in socio-economic and health status during the past 20 years, micronutrient deficiencies such as iron deficiency anaemia and vitamin D deficiency are common nutritional disorders. Vitamin A deficiency and iodine deficiency disorders are reported in some regions in the GCC countries (1).

Studies on factors associated with micronutrient deficiencies in these countries are at most scanty. The aim of this paper is to highlight some of factors that may be associated with occurrence of iron deficiency anaemia, iodine deficiency disorders and deficiencies in vitamins A and D in the GCC countries, based on the available data.

IRON DEFICIENCY ANAEMIA

Studies in the GCC countries show that iron deficiency anaemia is one of the main public health problems, especially among pregnant women, preschool children and adolescent girls. The prevalence among pregnant women ranged from 30% to 60%. Among teenage girls the prevalence was 26% - 50% (2). 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.

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 (3) 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 (4). Another study in Kuwait (5) 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.

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 is 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 (6). Among adults, only 46% of men and 52% of women aged 20-60 years reported early consumption of fresh fruits. The corresponding percentages for fresh vegetables were 60% and 65%, respectively (7).

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.

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 (8). 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 therefore seem to be essential that health education should focus on reducing the intake of tea, particularly with meal. However, the inhibition effect of tannins in tea can be counteracted by adding vitamin C to the meal.

Infection, especially intestinal parasitic infection

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

Intestinal parasites were prevalent among young and school children in the Gulf. Sebai et al (9) showed that 35% of Saudi preschool children had intestinal parasitic infection, but no schistosoma eggs were observed. Musaiger and Gregory (10) found that intestinal parasites were prevalent among children 6-11 years (14%) although hookworms were not detected. In Saudi Arabia, El-Hazmi (11) 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.

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 haemolglobin level in women because closely spaced pregnancies deplete the iron stores of the women, especially when there is no iron supplementation during pregnancy (12). In the UAE, Hossain et al (13) found that the prevalence of anaemia was significantly higher in women who had seven or more pregnancies than in those who 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 (11).

IODINE DEFICIENCY DISORDERS (IDD)

Few studies were carried out for determination of iodine deficiency disorders in the GCC countries. A national survey is Saudi Arabi showed that 22% of school children had urinary iodine concentration below 10 µg/dl. Children living in rural areas have significantly higher median urinary iodine concentration compared to children living in urban areas. In general, the prevalence of goiter was 28% and the majority of children had mild degree of the disease (grade 1) (14). A study among 3068 school children in Oman reported that the goiter was prevalent in 10% of the children, and most of the cases were grade 1 (15).

There were no studies on the factors responsible for the prevalence of IDD in the GCC countries. Possible factors are low iodine in foods consumed, especially by the children, and using of non-iodized salt for the purpose of preparation and cooking the foods. The Oman survey showed that of 69 salt brands available in the market, only 35% were iodized (15).

VITAMIN A DEFICIENCY (VAD)

Indicators form limited studies carried out in the GCC countries showed that vitamin A deficiency is not a major public health problem.

The national survey in Oman found that 20.8% of those surveyed had serum retional levels less than 0.70 umol/l, indicating a moderate to serve subclinical problem. Children aged 18 months were mostly affected (22.8%) having serum retinol levels less than <0.70 μmol/l (16). Results of a biochemical study in Riyadh, Saudi Arabia, revealed that 10% of the population surveyed had serum retinol levels less than 0.70 μmol/l, and that 1.1 had serum values less than 0.33 μmo/l, indicating that VAD is not a severe problem (17).

Unsound food habits may be one of the most important factors responsible for the occurrence of VAD in the GCC countries, especially low intake of foods rich in vitamin A. Several studies in the Gulf reported low intake of fresh fruit and vegetables and milk and milk products by preschoolers, school children, adolescents and pregnant women (18). For example, a study on food habits of mothers in Oman showed that the daily intake of yellow fruits (rich in vitamin A) raged from 13% to 91% (19). Unsound weaning habits and introduction of food poor in nutritive value in the first year of life are also important factors.

VITAMIN D DEFICIENCY

All the studies on vitamin D deficiency in the GCC countries were carried out in Saudi Arabia. Despite abundant sunlight in this part of the world, vitamin D deficiency was found to be a public health problem. Several studies in Saudi Arabia, suggest low levels of vitamin D in mothers 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. Even among Saudi adults, vitamin D deficiency is frequently seen (20). 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 specially calcium. The use of non-fortified baby foods, especially weaning foods and milk was also reported as a factors associated with vitamin D deficiency in this region.

REFERENCES

1. Musaiger, A. O. Iron deficiency anaemia among children and women in the Arab Countries of the Gulf. In Musiager, A O and Miladi, S. (editors). *Micronutrient Deficiencies in the Arab Middle East Countries*, FAO/RNE, Cairo, 1996, 11-15.
2. Sawaya, W. N., Tannous, R. I. and Othiameen, A. I. Dietary intake of Saudi infants and preschool children. *Ecol. Food Nutr.* 1988; 20: 171-184.
3. Eid, N., Al-Houti, S., Bourilly, N., *et al. Nutritional Satus in Kuwait* 1. Nutritional Assessment of school children. Kuwait Institute for scientific Research, Kuwait, 1984.
4. Prakash, P., Shubber, K. M. and Abdul-Ghani, Z. A. *Food Habits During Pregnancy and Lactation in Kuwait.* Nutrition Unit, Ministry of Public Health, Kuwait, 1984.
5. Musaiger, A. O. and Radwan, H. Food frequency intake of university female students in the United Arab Emirates. In Musiager, A. O. and Milad, S. S. (editors) *Food Consumption Patterns and Dietary Habits in the Arab Countries of the Gulf.* FAO, RNE, Cairo, 1985.
6. Musaiger, A. O. and Abuirmeileh, N. Food consumption patterns of adult population in United Arab Emirates, *J. R. S. H.*, 1997 (in press).

7. DeMayer, E. M. *Preventing and Controlling Iron Deficiency Anaemia*. World Health Organization Geneva, 1989.
8. Musaiger, A. O. and Miladi, S. (editors). *Food Consumption Patterns and Dietary Habits in the Arab Countries of the Gulf.* FAO/Regional Office, Cairo, 1995.
9. Sebai, Z. A., El-Hazmi, M. A., Froid and Sernius, F. Health profile of preschool children in Tamnia villages, Saudi Arabia. *Saudi Med. J. Suppl.* 1981, 1.2, 68-71.
10. Musaiger, A. O. and Gregory. Intestinal parasitic infection among school children in Bahrain. *J. Trop. Ped.* 1989, 35, 45-55
11. El-Hazmi, M. A. F. The red cell genetics and environmental interactions, a Tenamat - Asser profiles. *Saudi Med J.* 1988, 6, 101-112.
12. Kuizon, M. D., Cherong, R. L. Anchesta, L. P. *et al.* Effect of anaemia and other material characteristic on birth - weight *Human Nutrition Clinical Nutrition*, 1985, 39 C, 419-426
13. Hossain, M. M., Bakier, M., Pugh R. N. H. *et al.* The prevalence and correlates of anaemia among young children and women of child bearing age in Al Ain, United Arab Emirates. *Annals Trop Ped*, 1995, 15, 227-235.
14. Al-Nuaim A. *et al.* Mapping Saudi Arabia for Iodine Deficiency. In: Musaiger AO and Miladi, S (editors). *Micronutrient Deficiencies in the Arab Middle East Countries.* FAO/RNE, Cario, 1996.
15. MOH/ SQU/WHO/UNICEF. *National Study on Prevalence of Iodine Deficiency Disorders.* Muscat, 1994.
16. WHO. *Global Prevalence of Vitamin A Deficiency,* Geneva, 1995,
17. MOH/WHO/UNICEF. *National Study on the Prevalence of Vitamin A Deficiency (VAD) Among Children 6 months to 7 years.* Muscat, 1996.
18. Madani, K. and Khashoggi, R. Micronutrient status in Saudi Arabia. In: Musaiger AO and Miladi, S. (editors). *Micronutrient Deficiencies in the Arab Midle East Countries.* FAO/RNE, Cairo, 1996.

MICRONUTRIENT DEFICIENCIES IN THE SULTANATE OF OMAN

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INTRODUCTION

National data on prevalence of some micronutrient deficiencies in the Sultanate of Oman have been recently carried out. Results revealed that anaemia, particularly iron deficiency anaemia, is one of the major nutritional problems in the country. Iodine deficiency disorders (IDD), and vitamin A deficiency (VAD) were also reported but in mild to moderate degrees.

The present paper summarizes the main findings of the national surveys on anaemia, IDD and VAD in the Sultanate of Oman.

EVALUATION OF THE NUTRITIONAL ANAEMIA CONTROL PROGRAMME (1)

The national nutritional anaemia control programme in Oman has been operated for a few decades. The programme was implemented through antenatal care services of hospital and health centres by the Ministry of Health. The pregnant women are the beneficiaries of the programme and they are provided with Green Maternal Health Card in which details of examination including haemoglobin levels are recorded. The supplements given are Fefol; Fersolate and Folic acid and/or multivitamin tables.

The prevalence of anaemia among pregnant women being high in the country, a systematic evaluation study was planned and initiated with the objective to identify the weaknesses of the programme and to evolve a more effective strategy for the control of anaemia since in a package of Safe Motherhood Programme, management of anaemia has an important place.

The study covered 1310 pregnant women in 7 out of 8 regions in the country who were mostly below 40 years of age with 21% below 20 years. Literacy rate among them were 61.7%. Around 52% of the women had sketchy and incomplete knowledge of anaemia, its causes and symptoms. The women considered the Green Card to be useful and perceived it as information card. Supplement distributed to pregnant women was almost universal (97%), though reported compliance rate was around 77%. The three major reasons of non-compliance were side effect, forgetfulness, and wrong belief. Around 47% of the women reported to have received multivitamin tablets. It is likely that iron tablet was also distributed along with this as envisaged in the programme. Forty two percent of women had no knowledge of what type of tablets they consume. Health education component of the Programme was not adequate.

Prevalence of anaemia among the subject was 48.5%, with 43.3% mild anaemia and 5.7% moderate anaemia. No severe anaemic women (<7 g/ dl) were found.

Analysis has shown a few factors contributing significantly to the haemoglobin status of women. These are literacy level, watching health programmes on TV, early contact with health centre, knowledge of symptoms of anaemia, and number of doses taken per day.

In the 7 regions, 18 medical officers and 30 nurses/midwives were interviewed, who were all expatriates, serving in the country for 1-13 years. Their perceptions of mild and severe anaemia, in terms of haemoglobin level differ. However, majority of them defined cut off point of haemoglobin for mild anaemia between 9 and 10 g/dl and for severe anaemia between 6 and 8 g/dl. All of them were prescribed iron tablets for anaemia between 6 and 8 g/dl. All of them were prescribed iron tablets for anaemia through the types of tablet prescribed were not uniform. It was either single dose of Fersolate, Felol, Folic acid or any combination of them to be taken after, meal. Majority of the functionaries judged Feiol as most effective supplement.

The women complained nausea, (35.8%), constipation (16.7%) vomiting (14.6%) and diarrhea (14.6%) as side effect of supplementation for which the functionaries advised either to take the tablets along with meals (40%) or stop the treatment (33.3%). A few of them changed the tablet (17.8%), referred to doctors (2.2%) and gave some other advice (6.7%).

Around 48% of functionaries interviewed, estimated that 90-100% of the beneficiaries consumed tablets, 30% estimated that 70-89% consumed tablets and the rest estimated that less than 70% consumed tablets. They also observed that non-compliance was generally due to side effects forgetfulness and wrong belief. The functionaries believe that education of women, appropriate training of functionaries and better follow-up can improve the programme.

The programme needs streamlining by standardizing the programme for all its parameters, primarily for definition of anaemia, introducing only one type of tablet duration and dose of the supplementation. Early recognition and registration of pregnancy by issuing Green Card for anatenatal care services should be promoted. Iron supplement may be given from second trimester onward. Initially lower dose for month may help in tolerating the side-effects and reduce dropout rate. Continuing training system is strongly advocated for sustained motivation of functionaries. Monitoring system by visiting the beneficiary and checking the compliance has to be introduced. Health education needs to be planned in an effective manner, suitable to local ethos and culture. Role of all levels of functionaries needs to be clearly defined.

NATIONAL STUDY ON PREVALENCE OF IODINE DEFICIENCY DISORDERS (2)

To determine if IDD is a problem of public health significance in Oman, the Ministry of Health (MOH), in collaboration with the Sultan Qaboos University (SQU), the World Health Organization (WHO), and the United Nations Children's

Fund (UNICEF), agreed to undertake a survey of goiter prevalence and assessment of urinary iodine levels in school children aged 8-11 years during the period September 1993 to July 1994. The UNICEF provided the equipment to upgrade the laboratory at the Sultan Qaboos University and the supporting costs for the study were borne by MOH, SQU and UNICEF.

Of 3068 school children who were assessed for goiter, the total goiter rate was approximately 10% (cut off 5%). About 2911 urine samples were collected of with 400 randomly selected urine samples were initially analysed at the Sultan Qaboos University; 20 samples were sent to Bios Analytic Laboratory in Germany (WHO / UNICEF recommended reference laboratory for quality control). The results of the former were inconclusive due to larger volume of urine required by the laboratory technique used (direct measurement). Therefore 951 urine samples were sent to Bios Analytic Laboratory for urinary iodine measurement. The overall national median value was between 9-10 mcg/dl, indicating a mild IDD problem, according to WHO criteria (> or = 10 mcg/dl is no deficiency).

About 3.6% of the urine samples were less than 2 mcg/dl and 11% were less than 5 mcg/dl representing severe and moderate iodine deficiency, respectively. Overall, 49.8% of the children in the 10 regions had median urinary iodine values less than 10 mcg/dl indicating that half of the country has mild IDD, making it a strong case for universal salt iodization. Even mild IDD in a population suggests that there is inadequate iodine available for the normal development of the brain in utero for at least some part of that population.

Based on this study and the findings of international studies, it is urged that Universal Salt Iodization be adopted by the Sultanate of Oman for the elimination of existing Iodine Deficiency Disorders.

NATIONAL STUDY ON THE PREVALENCE OF VITAMIN A DEFICIENCY (3)

To determine if Vitamin A Deficiency (VAD) of Public health importance exists in Omani children 6 months to below 7 years of age, a joint collaborative national study was undertaken by the Ministry of Health (MOH), WHO, UNICEF, Programme Against Micronutrient Malnutrition (PAMM) Laboratory at CDC, Atlanta, Georgia and Iowa State University at Ames, Iowa, during the period October 1994 - February 1995. WHO Nutrition Unit, Geneva, provided the technical support; and the UNICEF provided technical and financial support. The ultimate objective of the investigation was to establish strategies to ensure virtual elimination of VAD, including subclinical forms, among Omani children 6 months to below 7 years by the year 2000.

A national sample of 902 children representative of four age groups - 7 months, 18 months, 3 years and 6 + years was randomly drawn from catchment records of 24 Ministry of Health Institutions. Blood samples were obtained from all children enrolled in the study and, on a 25% sub-sample (236), a second blood sample was obtained for determining the Modified Relative Dose Response (MRDR) test. From the serum distribution curves and the MRDR results, the prevalence of vitamin A deficiency (VAD) was estimated nationally and regionally by several variables including sex, age group and region. Dietary information was also obtained on the frequency of intake of various vitamin A containing foods.

The distribution of serum vitamin A values for the national sample revealed that just over 2% were below the critical cut off of 10 µg/dl and 20.8 percent were below the cut off of 20 µg/dl that distinguishes between a moderate and severe subclinical public health problem (Table 3) concentrations varied from 21.6 in Muscat to 35.6 in North Sharqiya (Table 4). There was little difference in the frequency distribution or in the mean serum retinol values attributable to sex or by age group. No association was found between the prevalence of low serum values that could be attributable to relative economic strata.

The MRDR showed that about one-fourth of infants at 7 months of age had evidence of inadequate liver store of vitamin A. The prevalence of decreased with advancing age but a percentage of children continued to be at high risk through 3 years of age. In the 6+ year age group there is no evidence of critically depleted liver stores although some in this age group showed evidence that their vitamin A status could be improved. It is likely that subclinical VAD contributes to increased severe morbidities and mortality in 8 to 25% of the Omani children under 3 years of age.

The data show that VAD is a moderate public health problem among children below three years of age. The problem is nation wide and not related to sex or relative economic strata as defined for the purposes of this investigation. The likely cause of the problem is poor eating practices that result from lack of information of what foods are needed to provide a nutritionally adequate diet, particularly for women of reproductive age and young children during the period of complementary feeding and post-weaning.

A series of recommendations for ensuring achievement of the year 2000 goal of virtual elimination of VAD in Oman are given including: 1) an intensive advocacy programme among the medical profession and general population; 2) supplementation of mothers immediately postpartum and infants and young children together with immunizations at 9 and 15-18 months of age; 3) dietary diversification through nutrition education; and 4) monitoring the programme using indicators that can be periodically applied to track progress.

REFERENCES

1. WHO/EMRO. *Evaluation of Nutritional Anaemic Control Programme in the Sultanate of Oman.* Alexandria, Egypt, 1993.
2. MOH/SQU/WHO/UNICEF. *National Study on Prevalence of Iodine Deficiency Disorders.* Muscat, Oman, 1994.
3. MOH/WHO/UNICEF. *National Study on the Prevalence of Vitamin A Deficiency among Children 6 months to 7 years.* Muscat, Oman, 1995.

Table 1.Prevalence of goiter in school children (8-11 years) in Oman

Grade	Classification	No.	%
	Goiter		
0	No Goitre	2697	88.00
1A	Thyroid lobes larger than ends of thumbs	221	7.2
1B	Thyroid enlarged, visible with head tilted back	74	2.4
2	Thyroid enlarged, visible with neck in normal position	12	0.4
3	Thyroid greatly enlarged, visible from about 10 meters	0	0.0
Unknown		64	2.0
Total		3068	100

Table 2. Urinary idoine levels of school children (8-11 years) in Oman

Interpretation	MCG/DL	Number	Percentage
	Urinary Iodine Levels		
Severe	<2	34	3.6%
Moderate	2-4.9	105	11%
Mild	5-9.9	335	35.2%
Normal	>10	477	50.2%
	Total	951	100%

Table 3. **Frequency distribution of serum vitamin A of national sample in Oman**

Serum vitamin A (μg/dl)	Prevalence (%)	Cumulative frequency (%)
> 0 - ≤ 10*	2.1 (16)#	2.1
> 10 - ≤ 20	18.7 (142)	20.8
> 20 - ≤ 30	44.9 (341)	65.7
> 30 - ≤ 40	27.1 (206)	92.8
> 40 - ≤ 50	5.9 (45)	98.7
> 50	1.1 (8)	99.8

* One sample had no detectable vitamin A
#( )= number of samples in each grouping

Table 4. **Regional frequency distribution (%) and mean concentration of serum retinol (μg/dl) compared to the national distribution in Oman**

Region	>0-≤10	>10-≤20	>20-≤30	>30-≤40	>40-≤50	>50	Serum retinal (±SD)
National (579)*	2.1	18.7	44.9	27.1	5.9	1.1	26.8±9.7
Muscat (191)	6.3	33.5	41.9	15.2	1.0	0	21.6±8.7
Dhofar (73)	2.8	12.5	43.1	34.7	5.5	1.4	28.2±9.4
Dhakiliya (121)	0	1.7	46.3	43.8	7.4	0.8	31.3±6.7
North Sharqiya (60)	0	1.7	30.0	41.7	20.0	6.7	35.6±9.7
South Sharqiya (69)	0	4.3	52.2	30.4	11.6	1.4	31.2±7.9
North Batinah (130)	1.5	25.4	47.7	17.7	3.1	0.8	24.1±9.3
South Batinah (64)	0	20.4	29.6	35.2	11.1	0	27.9±10.7
Dhahira (61)	0	26.2	55.7	16.4	0	0	23.7±6.8

*()= number of samples analyzed.

IRON DEFICIENCY ANAEMIA IN BAHRAIN

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INTRODUCTION

Iron deficiency anaemia (IDA) is still one of the commonest nutritional disorders in Bahrain, and affect a high percentage of people, especially children and pregnant women. Investigations on IDA in this country are limited in their scopes and objectives. Most of the studies focus on determination of the haemoglobin in blood as indicator for IDA. The determination of haemoglobin level, perse, for identification of IDA has some limitations. Although assessment of haemoglobin defines a more advanced stage of iron deficiency, it lacks sensitivity and specificity, which may misclassify subjects as normal or anaemic. In addition, anaemia due to chronic infection, protein energy malnutrition, or certain haemoglobi-nopatries may be wrongly attributed to iron lack in the health surreys (1). However, it is worth noting that some studies which focused on determination of IDA using other blood parameters, demonstrate a high prevalence of this nutritional disorder.

The aim of this paper is to review the current situation of anaemia, particularly IDA in Bahrain.

IRON DEFICIENCY ANAEMIA IN CHILDREN AND ADOLESCENTS

A survey by the UNICEF in 1980 reported that 34% of preschool children were anaemic CHD<11g/dl), while the percentage was 32% among school children aged 6-18 years (Hb<12 g/dl). The prevalence among females (42.8%) was almost double that of males (21%). Urban children were less susceptible to anaemia compared to rural children (2,3). In general, the prevalence of anaemia decreased with age in males, while increase with age in females (Table 1).

The situation with regard to iron deficiency anaemia in school children seems to have improved as the prevalence has declined. Blair and Gregory (4) showed that 24% of school girls aged 6-18 years in Bahrain were anaemic, decreased by 18.8% during the period 1980-1985. Similar findings were reported by Musaiger (5) in 1986, as 23.9% of school boys aged 6-18 years were anaemic, compared to 31% of females at the same age group. The higher prevalence of anaemia among school girls in the later study is mainly due to the criteria used to determine the anaemia . The study by Blair and Gregory (4) used various blood parameters, while that of Musaiger (5) used only the heamoglobin concentration.

Table 1. Prevalence of anaemia among preschool and school children according to geographical area in Bahrain (1980)

Geographical area	Male (%)	Female (%)
Preschool		
Urban	33.8	25.4
Rural	44.8	33.8
Total	39.2	29.6
Primary school		
Urban	24.1	23.1
Rural	38.5	41.5
Total	30.1	29.7
Intermediate school		
Urban	26.7	43.3
Rural	18.3	56.7
Total	22.5	50.3
Secondary school		
Urban	8.4	31.7
Rural	16.7	66.7
Total	12.5	49.0

Amine; 1980 (2).

Table 2. **Abnormal haematological findings in Bahraini School Girls by Age group (N=121)**

Blood condition	7-10 years (N=40) No. (%)	11-13 years (N=38) No. (%)	15-18 years (N=43) No. (%)
Anaemia			
Iron Deficiency[1]	7.5	5.3	20.9
Microcytic, Hypochromic (possible thalassemia minor)[2]	12.5	5.3	18.6
Normocytic normochromic with sickle cell trait	0.0	2.6	0.0
Non Anaemic			
Sickle cell trait	10	5.3	4.7
Possible thalassaemia minor[3]	5.0	5.3	9.3
Iron deficiency[4]	5.0	13.2	20.9
Total anaemia	20	13.2	39.5
Total iron deficiency	12.5	18.4	41.9

1. Low hemoglobin, MCV, MCH and Transferring saturation.
2. Low hemoglobin, MCV, MCH, Normal serum iron and transferring saturation.
3. Normal hemoglobin ≤ 72; normal transferring saturation
4. Transferring saturation low for age.

Blair and Gregory, 1986 (4).

Blair and Gregory (4) reported that mean Hb values for school girls were 12.2 ± 2.01 g/dl and ranged from 9.3 to 14.4 g/dl. No macrocytic anaemia was observed. Microcytic, hypochromic anaemia with low transferrin saturations indicative of iron deficiency anaemia was found in 13% of the samples, while 15% of the sample had normal Hb with abnormally low serum iron and low transferrin saturations indicating an earlier stage of iron deficiency. A total of 28% of the sample were iron deficient based on trasferrin saturations. Slightly more than 7% had sickle cell trait and 21% had an MCN ≤ 72 without low transferrin saturation, suggesting thalassemia minor (Table 2).

The abnormal blood values by age group were also reported in Table 2. Iron deficiency with or without anaemia increases with age and is 44% in the 15-18 year old group of girls. The incidence of microcytic, hypochromic anaemia without low transferrin saturation also increases with age indicating that this category of anemia is not completely of a genetic origin and may be heterogeneous.

For the sake of comparing this broadly derived sample of Bahraini girls to a more privileged sample. Data from 92 children ages 6-13 years attending a private after-school children's activities club were obtained. Blood data on this group was collected and analyzed in identical fashion and at the same time as was the girls study. The privileged sample is broken down by sex. Only 10% of this total sample and 9% of the females are iron deficient compared to 15% of the Bahraini school girls in the same age group. Total anaemia, particularly microcytic, hypochromic anaemia, is also lower (Table 3). The prevalence of sickle cell trait is similar in this privileged sample (8%) to that found in the school girls study.

IRON DEFICIENCY ANAEMIA IN PREGNANT WOMEN

In 1995, a survey of 633 pregnant women representing all four health regions in Bahrain carried out with the objectives of determining the prevalence rates of iron deficiency anaemia among pregnant women and their dietary intakes. Of the women interviewed, 547 (86.4%) provided blood samples for the determination of haemoglobin, hematocrit, and other parameters of iron status. Of the total sample who completed the interviews, 484 (76.5%) provided blood specimens for the serum ferritin assay. Dietary intake data was completed for 576 (91%) of women.

The majority of the women were young (median age 22 years) with a range of 16-55 years. About 18% of the women were illiterate, while the majority (84.8%), although well educated were unemployed housewives at the time of the survey.

The prevalence rates of iron deficiency anaemia was estimated using single (Hb, HCT, MCV, and MCH) and dual criteria (Hb<11 and serum ferritin <17 ng/ml) (Table 4). Screening by haemoglobin only revealed that 33.5% of the women had Hb levels below 11 g/dL, thus were anaemic. When screened by serum ferritin (<17 ng/ml), 40% of the women had iron deficiency anaemia or were at risk. Therefore, 60% of them had no iron deficiency. However, of these, 45.6% were completely normal, and the rest (14.4%) were either having G6PD or sickle cell trait. The iron

Table 3. Abnormal blood conditions by sex in privileged Bahraini children, ages 6-13 years.

Blood condition	Male (n=47) %	Female (n=45) %
Anaemia		
Iron deficiency[1]	4.3	2.2
Microcytic hypochromic (possible thalassemia minor)[2]	12.8	2.2
Microcytic, normochromic with sickle cell trait	0.	2.2
Normochromic, normocytic	0.	4.4
Non Anaemic		
Possible thalassemia minor[3]	6.4	2.2
Sickle cell trait	8.5	4.3
Iron deficiency[4]	6.4	6.7
Total anaemia	17.1	11.0
Total iron deficiency	10.7	8.9

1. low hemoglobin, MCV, MCH and transferring saturation.
2. low hemoglobin, MCV, MCH, normal serum iron and transferring saturation.
3. Normal hemoglobin, MCV ≤ 72; normal transferring saturation.
4. Transferring saturation low for age.

Blair and Gregory, 1986 (4).

Table 4. Summary descriptive statistics of haematological parameters for pregnant women in Bahrain.

Indices	Mean (+/-s.d)	Range	Skewness
HB (n=547)	11.7 (1.2)	7.3 - 14.7	-0.02
HCT (n=547)	0.34 (0.03)	0.23 - 0.44	0.00
MCV (n=547)	78.1 (9.0)	51.4 - 99.0	-0.29
MCH (n=547)	25.7 (3.5)	15.1 - 34.0	-0.24
MCHC (n=547)	32.8 (0.9)	29.4 - 36.0	-0.12
Ferritin (n=484)	42.9 (50.7)	1 - 414	3.27

Table 5. Prevalence of anaemia by pregnancy trimesters using single criterion in Bahrain

Indices	Trimester I (n = 165)		Trimester II (n = 315)		Trimester III (n = 67)		All trimesters (n = 547)	
	No.	%	No.	%	No.	%	No.	%
HB<11 g/dl	40	24.2	144	45.7	44	65.7	228	41.7
HCT < 0.33	29	17.7	135	43.0	35	52.2	202	36.9
MCV < 80 fl	88	53.3	158	50.2	38	56.7	282	51.9
Ferritin <17ng /ml[1]	34	22.6	100	35.0	27	54.0	161	33.3

[1]. The total sample size for serum ferritin (n=484) by trimesters are: I = 150, II = 284, III = 50

Mosa and Zeine, 1996 (6).

status also worsened with the progression of pregnancy trimesters. There were statistically significant associations between the prevalence of iron deficiency and health regions as well as among MCH centers (Table 5).

Results revealed that the energy intake was lowest (1899 Kcal/day) during the first trimester, increasing by 28% during the third trimester to 2423 Kcal/day, but falls short of the recommended dietary allowance (RDA) proposed by WHO/FAO. About 56% of the daily energy was derived from carbohydrates, 16% from proteins and 28% from fats. About half of the interviewed women reported a deliberate reduction of food intake during pregnancy.

The intakes of vitamin A were inadequate across pregnancy trimesters. Although the intakes of folic acid were near optimum during the third trimester, about 37% of women had intakes below the RDA. Except for ascorbic acid vitamin intakes were generally suboptimal. While dietary iron intakes increased after the first trimester, about 50% of the women reported intakes below the RDA.

CONCLUSION

Although the prevalence of anaemia, especially IDA, in school children has declined during 1981-1986, the current percentage of anaemia in Bahrain does not match with the high socio-economic status and high coverage of health care. IDA among pregnant women is still problem of concern and little declines its prevalence has been observed. Programmes to prevent and control of IDA in Bahrain should be given a high priority in any health plan. Indepth studies on the prevalence of IDA and factors affecting its prevalence are highly recommended.

REFERENCES

1. Cook, J. D., *et al.* Iron deficiency and the measurement of iron Status. *Nutrition Research Review*. 1992; 5: 189-20
2. Amine, E. K. *Nutrition Status Survey, Bahrain,* UNICEF Gulf Area Office, Abu Dhabi, 1980.
3. Mobayed *et al. A Study of the Needs of Childhood in Bahrain.* UNICEF/High Council for Youth and Sports, Bahrain, 1980; (in Arabic).
4. Blair, D. and Gregory, W. B. *The Nutritional Status of Bahraini School Girls Aged 7-18 years.* Bahrain Sport Institute Bahrain, 1986.
5. Musaiger, A. . and Gregory, W. B. Blood Parameters for School Children in Bahrain, 1986. (unpublished).
6. Mosa, K. and Zein Z. A. *The Iron Status and Dietary Intake of Pregnant Women in Bahrain.* Ministry of Health, Bahrain, 1996.

ANAEMIA IN QATAR

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INTRODUCTION

Anaemia, especially iron deficiency anaemia, is one of the main nutritional problems in Qatar. Epidemiological studies on prevalence and factors responsible for occurrence of anaemia are very limited. However, indicators show that anaemia is more prevalent among pregnant women and preschool children. The present paper aims to explore the information available on anaemia in Qatar.

ANAEMIA IN WOMEN

A study on factors affecting new-born babies showed that 44.5% of mothers had haemoglobin level between 6.7-10.9 g/dl, after delivery (1). A recent study on anaemia among pregnant women indicates that the prevalence of anaemia (Hb < 11g/dl) was 30%. This low prevalence (compared to other GCC countries) is mainly due to estimating the anaemia in the first trimester (1). It is well documented that the requirements for iron during the first trimester are relatively small, but rise considerably during the second and third trimester (2).

Social and health factors associated with anaemia in pregnant women were studied (Table 1). There was no significant difference between Qatari and non-Qatari pregnant women in the prevalence of anaemia. The prevalence of anaemia was higher among employed (37%) than unemployed pregnant women (29%). Middle education women had higher prevalence of anaemia, than low and high education women. Anaemia was common among pregnant women aged 35 years and above, had more than 9 pregnancies and had more than one abortion. Infection with intestinal parasite was also associated with anaemia, as the prevalence was about 37.1% in infected women compared to 29% in non-infected women.

ANAEMIA IN PRESCHOOL CHILDREN

Recent study on nutritional status of preschool children in Qatar indicates that 26% of preschoolers aged 6-36 months were anaemic (3). Of the children, 6.6% had haemoglobin level less than 10 g/dl, 19.6%, 32.6% and 41.2% had haemoglobin level 10-10.9 g/dl, 11-11.9 g/dl and 12+ g/dl, respectively. Anaemia was prevalent among 28% of male and 24% of female. Children aged 12-23 months were more susceptible to anaemia, compared to other age groups. Late order children had higher prevalence of anaemia that early order children (Table 2).

CONCLUSION

- Anaemia, especially iron deficiency anaemia, is still highly prevalent among women and children in Qatar.
- There are several social and health factors associated with anaemia in women. Among these factors are physiological status and multideliveries.
- Although not investigated, dietary habits may be one of the main factors associated with anaemia in preschool and school children.
- Indepth studies on prevalence of anaemia, particularly iron deficiency anaemia, and factors affecting anaemia should be given a high priority by health authority in Qatar.

REFERENCES

1. Abu-Abbass, A. A. *et al. Incidence of sickle - cell Anaemia and Factors Affecting Health Parameters in Newborns in Qatar*. Arabian Gulf University, Manama, Bahrain, 1989.
2. Awad, A. *et al. Iron Deficiency Anaemia in Pregnancy*. Arabian Gulf University, Manama, Bahrain, 1992.
3. Amine, E. K. *Nutritional Status of Preschool Children in Qatar*. Ministry of Health, Qatar, 1995.

Table 1. Some social and health factors associatd with anaemia in pregnant women in Qatar

Factor	Anaemic Hb<11 g/dl		Non-anaemic Hb≥11 g/dl	
	No	%	No	%
Nationality				
Qatari	45	30.0	105	70.0
Non-Qatari	44	29.5	105	70.5
Employment				
Non-Employed	76	28.8	188	71.2
Employed	13	37.1	22	62.9
Educational level				
Low education	23	28.8	57	71.2
Middle education	24	32.4	50	67.6
High education	42	29.0	103	71.0
Age (years)				
15-19	2	9.1	20	9.9
20-24	28	30.8	63	69.2
25-29	27	31.4	59	68.6
30-34	18	30.5	41	69.5
35+	14	34.1	27	65.5
No. of pregnancies				
1-3	41	24.8	124	75.2
4-6	30	35.3	55	64.7
7-9	13	34.2	25	65.8
10+	5	45.5	6	54.5
No.of abortion				
None	61	29.3	147	70.7
1	20	29.4	48	70.6
2+	8	34.8	15	65.2
Infection with parasite				
Non infected	82	29.3	198	70.7
Infected	7	36.8	12	63.2
Total	89	29.8	210	70.2

Awad *et al.*, 1992 (2).

Table 2. Some factors associated with anaemia among preschool children in Qatar.

Factor	Anaemic Hb<12 g/dl		Non Anaemic Hb≥12 g/dl	
	No	%	No	%
Age (months)				
<12	181	26.9	492	73.1
12-23	159	30.5	363	69.5
≥7,24	39	15.4	215	84.6
Sex				
Male	210	28.3	532	71.7
Female	169	23.9	538	76.1
Birth order				
1	75	22.2	263	77.8
2	54	22.9	182	77.1
3	68	26.4	190	73.6
4	51	30.5	116	69.5
5+	129	29.5	307	70.5

Adapted from Amine, 1995 (3).

IRON DEFICIENCY ANAEMIA IN SAUDI ARABIA

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INTRODUCTION

Iron deficiency anaemia is a major public health problem of multiple factors in Saudi Arabia (1-3). This paper reviews the current situation of iron deficiency anaemia in Saudi Arabia. For the purpose of this review the WHO definitions, based on haemoglobin concentrations are used (4). The degree of anaemia is often graded as mild anaemia (above 10 g/100ml), moderate (7 to ≤ 10 g/100ml) or severe (below 7 g/100ml) (5).

ANAEMIA AMONG PREGNANT WOMEN

Iron deficiency anaemia in pregnancy is still a health problem in Saudi Arabia (6-12). The prevalence of iron deficiency anaemia ranges from 4.6% to 31.9% (table 1). The reason for this wide range may be due to the difference in the cut-off points of haemoglobin used.

Age of the mothers has negative effects on the haemoglobin level (7,10,13). In Jeddah (7), by the end of pregnancy, haemoglobin levels for 40 years old women were found to be significantly lower than their counterparts who were less than 20 years of age. In another study (13), it was found that the risk of iron deficiency anaemia among pregnant women, who were above 35 years of age was double compared to younger women. The older aged women were apparently subjected to repeated pregnancies and deliveries that could have resulted in the significant reduction in haemoglobin levels by the end of pregnancy.

On the other hand, in one study, Mohfouz et al. (12) found that age of the mothers has positive effects on the haemoglobin level. The overall prevalence of anaemia was found to be 31.9%. It was found that the prevalence was affected by age (37.3% among those who were less than 20 years old), parity (44.9% among those who had 7 and more deliveries), inter-pregnancy spacing (35.2% among those whose birth spacing was less than 1 year), gestational age, and education (35.1% among illiterates). The investigators (12) recommended the need to revise health education programme at primary health care levels in the region in order to stress the importance of balanced diet, compliance with iron medication and sufficient spacing between subsequent pregnancies.

Table 1. Iron deficiency anaemia in Saudi pregnant women

Study and City	Sample size	% Anaemia	Cut-off
Ante-natal Clinic at King Faisal Hospital in Khamis Mishayt (6)	436	4.6	Hb<10 g/dl
Armed Forces Hospital in Jaddah (7)	217	6.5	Hb<10 g/dl
Al-Shati Hospital in Jeddah (8)	119	10.1	Hb<10.3 g/dl
Maternity Hospital in Taif (9)	952	22.9	Hb<11 g/dl
Primary Health Care Centres in Jeddah (10)	272	25.6	Hb<11 g/dl
Primary Health Care Centres in Bisha (11)	710	26.5	Hb<11 g/dl
Primary Health Care Centres in Asir Region (12)	6539	31.9	Hb<11 g/dl

There is generally a very poor relationship between serum ferritin concentration in the newborn and that of the mother at term (14). Hawa et al. (15) in a study to determine the haemoglobin level and iron status of mothers and their babies at delivery in King Fahd National Guard Hospital in Riyadh, suggested that it is the fetus which largely controls the movement of iron across the placenta with only a little control exerted by maternal serum iron level. In another study, Ghafouri et al. (16) in Jeddah area, reported that the level of haemoglobin was high at birth and reaches maximum levels during the first few days of life of the infant. It was found that there is no mean haemoglobin difference based on sex during the first year of life.

Anaemia among infants and young children

Babiker et al. (17) carried out a cross-sectional study at King Abdul Aziz University Hospital and King Khalid University Hospital in Riyadh to determine the prevalence of iron deficiency anaemia among healthy Saudi children from birth to 15 months of age. The groups studied were the following ages: newborns, 3-4 months, 5-6 months, 7-8 months, 9-10 months and 12-15 months. The lower limits of normal were taken as transferring saturation of <10% and a serum ferritin of <12 ug/l. The age groups were determined by the vaccination schedule. A total of 333 serum samples was adequate for analysis. None of the newborns or the 3-4 months old infants had evidence of iron deficiency. At 5-6 months only 3.3 % of subjects had iron deficiency which increased significantly with age from 9.3% to 12.7% and reached 14.5% in the oldest age group. Babiker el. al. (17) recommended the screening for iron deficiency in children attending well-baby clinics and hospitals at ages of 12-15 months.

A total of 208 children at King Abdulaziz University Hospital in Riyadh, age ranged from 3 months to 5 years, were studied for haematologic profiles (18). The results of this study shows that 37.98% of the children were anaemic, 22.59% were borderline anaemic and 39.42% were found normal. The study confirms the relationship between child development and iron deficiency anaemia.

Healthy Saudi infants between 6 and 24 months of age were studied (19). They were attending the well baby clinic at King Khalid University Hospital in Riyadh for routine vaccinations of the 366 screened infants, 136 (37.2%) were anaemic (Hb<11 g/dl) (19). In another study (20), using the same criteria to define iron deficiency anaemia for 84 Saudi 9-month old infants attending the baby clinic, and another group of infants of the same age who were attending a primary care clinic in the direct encatchment area of the King Khalid Hospital in Jeddah, the prevalence of iron deficiency anaemia was 35.5%. In view of the high prevalence of iron deficiency in the population studied, it was recommended that all infants should be screened for iron deficiency at their routine visits for immunizations (20).

McNiel (21) also studied the infants and children age ranged from 3 to 29 months in a well baby clinic of Aramco Hospital in Ras Tenura. Out of 500 children examined, 198 (39.6%) were anaemic (Hb<10 g /dl). The investigator found that at least 98.4% of the anaemic children had iron deficiency which was due to inadequate dietary intake of iron.

The Turbab study (22), in western Saudi Arabia, found that the level of haemoglobin ranged between 6 to 10 g/100 ml in 34% of the Bedouin children under five years of age. Another study, in the region of Tamnia. Sebai et al. (23) showed 36% of the pre-school children (age ranged from 1 to 12 months) were having haemoglobin levels below normal.

It has been shown that in Saudi Arabia, the prevalence of iron deficiency anaemia is greater among pre-school children than school children (21, 24). El-Hazmi (24) indicated that there were statistically significant differences in the average haemoglobin level of pre-school and school children.

Anaemia among adolescents and school children

Rasheed et al. (25) reported a study of 285 primary school girls from the urban area of Al-Khobar, in the eastern province of Saudi Arabia. The haemoglobin estimations and laboratory stool examination for ova and cysts were performed. Of the study group, 26.4% had anaemia (haemoglobin levels below 11 g/dl), and 9.2% were infested with one parasite or more. Anaemia was common in those harbouring infestations (25).

In a survey conducted in western Saudi Arabia by Hammouda et al. (26), iron deficiency anaemia was found to be prevalent among primary school children of both sexes, in both rural and urban areas. It was found that the prevalence rate was 30.8% in those having haemoglobin levels below 12 gm/100 ml mainly due to parasitic infection.

We gathered preliminary results about some factors associated with iron deficiency anaemia from 518 adolescent girls aged 11 to 19 years in Taif Region of Saudi Arabia. First, physicians from the Directorate of the Health Affairs went to girl schools to campaign for student participation in the study. The examinations were conducted in 63 of the 97 primary health care Centres in the Taif Region. Each centre had used proper laboratory equipment to do the required haemoglobin test. The survey lasted for the entire month of January, 1993. The prevalence of iron deficiency anaemia was 21.2% (haemoglobin levels below 12 g/dl). Table (2) summarizes some socio-economic factors associated with iron deficiency anaemia among adolescent girls. Table (3) shows the relationship between age at menarche and iron deficiency anaemia among this group.

Boukary (27) carried out a survey to asses the nutritional status of pre preparatory school girls (age ranged from 12 to 19 years) in Jeddah for 100 girls, selected randomly from five schools, to represent the high, middle and lower socio-economic classes. The results on haemoglobin showed that 10.6% of the girls had iron deficiency anaemia (haemoglobin levels below 12 g/dl). It was found that haemoglobin levels were related to social class. It was higher in the upper class (13.7 gm) than the lower class (12.8 gm). The values of haemoglobin ranged from 12.3 to 17.3 in the upper class and although the range is large (5 gm), the minimum and maximum value in this class may be due to the small number of observations. Also, in the middle and lower classes, the minimum values were 7.3 and 7.6 grams, respectively, where as the maximum figures were 15.7 and 14.9 gm (27).

In reviewing the 48 cases of anaemia, 30 females and 18 males which were diagnosed from birth to 60 years old, between June 1981 and January 1982 in the primary care department of the Riyadh Armed Forces Hospital, it was concluded that 32 out of 48 cases were due to iron deficiency anaemia (<12g/dl in males, and <11g /dl in females) (28). The results also showed that iron deficiency anaemia was common among females of child bearing age, and no megaloblastic anaemia was reported.

Sejeny et al. (29) reviewed the 527 anaemic patients at King Abdul Aziz Hospital in Jeddah for both sexes, various ages and different social status. Data showed that 50.4% of the patients were normochronic, 47.4% hypochromic, and 2.2% were macrocytic. Infections, blood loss, and poor dietary intake were among the major aetiological factors (29).

Table 2. Some socio-economic factors associated with iron deficiency anaemia among adolescent girls (11-19 years) in Taif region, S. Arabia

Factors	Anaemic Hb<12 No.	Anaemic Hb<12 %	Non-anaemic Hb≥12 No.	Non-anaemic Hb≥12 %	P-Value
Age (years)					
11 - 13	31	20.3	122	79.7	
14 - 16	50	19.9	201	80.1	N.S.
17 - 19	29	25.4	85	74.6	
Marital status					
Single	97	19.7	395	80.3	0.0005
Currently Married	13	50.0	13	50.0	
Father's education					
Low	73	26.0	208	74.0	
Middle	32	15.0	181	85.0	0.01
High	5	20.8	19	79.2	
Father's occupation					
Service	20	14.6	117	85.4	
Business	34	24.8	103	75.2	N.S.
Others	56	23.0	188	77.0	
Mother's education					
Low	96	22.7	327	77.3	N.S.
Middle	14	14.7	81	85.3	
Mother's occupation					
Housewife	92	20.4	360	79.6	N.S.
Employed	18	27.3	48	72.7	
Total	110	21.2	408	78.8	

N. S. - Not significant

Table 3. **Relationship between age at menarche and iron deficiency anaemia among adolescent girls in Taif region, S. Arabia.**

Age at Menarche(years)	Anaemic Hb< 12		Non-anaemic Hb ≥ 12		Total	
	No.	%	No.	%	No.	%
Pre-menarche	17	14.7	99	85.3	116	22.4
< 12	8	25.0	24	75.0	32	6.2
12 - 13	61	25.2	181	74.8	242	46.7
14 - 16	24	18.8	104	81.3	128	24.7
Total	110	21.2	408	78.8	518	100.0

HAEMATOLOGY REFERENCE VALUES FOR SAUDI ARABIA

Several studies (16, 30-33) have been carried out to establish a haematology reference value for the Saudi Arabian population. In one study (30) haematological analyses were performed on 2433 (1202 males and 1231 females) clinically normal consecutive Saudi newborns, who were born at King Fahd National Guard Hospital in Riyadh. The haematological parameters were namely, 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 data of this study showed no statistically significant differences between male and female haematogloical values ($p<0.2$) and so 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.

However, in another study in Jeddah area similar haematological parameters were taken as a reference for the Saudi population from birth to adolescence (16). A total of 843 males and 830 females were investigated. There were significant differences in some of the values between the sexes at various periods of physiological development.

El-Hazmi et al. (31) studied the normal reference ranges of haematological parameters which students (226 females and 578 males aged 20-29 years) studying at King Saud University in Riyadh. Comparison of the results for males and females also revealed differences between the sexes in all values except for white blood cell counts.

Bacchus et al. (32) tried to establish normal reference ranges of haematological parameters in a representative Saudi population selected from the Al-Kharaj 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 ages 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 of this study conclude 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, a study (33) has been conducted 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 with the primary health center. Results showed that males had higher haemoglobin levels than females from the age of 15 years. These findings may help physicians to assess anaemia in patients living at high altitudes and administrators responsible for procurement of specific blood groups for hospitals.

FACTORS AFFECTING THE PREVALENCE OF IRON DEFICIENCY ANAEMIA

1. Several studies (1, 25, 34-36) reported that parasites were prevalent among children and adults in Saudi Arabia. The incidences of anaemia was higher in parasitic-infected individuals than in parasite-free ones (1, 36), indicating that parasitic infections may be one of the causes of iron deficiency anaemia in Saudi Arabia.
2. Chronic or acute systemic and focal bacterial infections are usually associated with anaemia in Saudi Arabia (37).
3. Mothers with increased number of gravid and parity are at risk for the development of iron deficiency anaemia (8, 11). In Saudi Arabia grand multiparity (the birth of 5 or more viable infants) is a common occurrence(38, 39).
4. Short birth intervals between subsequent pregnancies in Saudi Arabia (38), does not allow enough time to reserve iron stores in the body (8, 11).
5. Lower daily dietary intake of iron (40, 41) is also an important factor in infancy. Human milk is poor in iron (42) and breast feeding is the first choice for infant feeding in Saudi Arabia (43).
6. Lower daily dietary intake of vitamin C which can improve absorption.
7. Heavy consumption of tea and coffee by adults during the day, especially after meals. It is known that tea and coffee inhibit the absorption of iron.

CONCLUSION

The high prevalence of anaemia in an affluent country calls for an in-depth study for the determination of factors associated with iron deficiency anaemia. The diagnosis of iron deficiency anaemia in Saudi Arabia becomes more complicated with the high incidences of haemoglobin disorders such as thalassemias. Studies (44, 45) showed that haemoglobinopathies are widespread in Saudi Arabia and are considered a serious health problem among children. The high incidences of haemoglobin disorders has been related to isolation, natural selection and inbreeding for generations (45-47). In addition, during pregnancy there is an increase in blood volume and haemodilution which makes the diagnosis of iron deficiency anaemia difficult, when based exclusively on hemoglobin values. Intervention action programs to combat iron deficiency anaemia in Saudi Arabia should be given a high priority.

RECOMMENDATIONS

Several measures must be taken into consideration when dealing with iron deficiency anaemia. This includes the following recommendations:

1. Supplementation of iron and folic acid to pregnant mothers, motivation of pregnant mothers to attend prenatal clinics regularly, and assessment of haemoglobin concentrations.

2. Sufficient spacing between subsequent pregnancies.
3. Supplementation of breast feeding with infant's formula fortified with iron after the first six months.
4. Blood screening for children.
5. Prevention and treatment of intestinal parasitic infections.
6. Prevention and treatment of chronic or acute bacterial infections.
7. Iron fortification of some common foods.
8. Different nutrition education programmess should be conducted especially for the mothers to increase the intake of iron rich foods and vitamin C, and to reduce intake of other substances which inhibit iron absorption such as phytates, tannins and other polyphenols.

REFERENCES

1. El-Hazmi, M. A. The red cell genetics and environmental interactions - A Tehamat - Aseer profile. *Saudi Med. J.* 1985; 6: 101-112.
2. El-Hazmi, M. A. Incidence and frequency of haemoglobinopathies and thalassamia in the north-west sector of Arabia. *Saudi Med. J.* 1985; 6: 149-162.
3. Kanawati, A. K. and Al-Jassir, M. S. Nutritional anaemia in Saudi Arabia, (Abstract). Second Saudi Symposium on Food and Nutrition, King Saud University, November 7-10, 1994.
4. Nutritional Anaemias. Report of World Health Organisation Scientific Group. WHO Technical Report Series No. 405, Geneva, 1968.
5. De Maeyer, E. M.; Dallman, P.; Gurney, J. M. *et al Preventing and Controlling Iron Deficiency Anaemia Through Primary Health Care:* A guide for health administrators and programme managers. World Health Organization, Geneva, 1989.
6. Hartley, D. R. One thousand obstetric deliveries in the Asir province, Kingdom of Saudi Arabia: A review. *Saudi Med. J.* 1980; 1: 187-196.
7. Smart, I. S.; Duncan, M. E. and Kalina, J. M. Hemoglobin levels and anaemia in pregnant Saudi women. *Saudi Med. J.* 1983; 4: 263-268.
8. Khoja, S. M., Baroum, S. H. and Salem, S. I.; Nasrat, H. A. Iron status in pregnant Saudi Arabian women in Jeddah area. *Saudi Med. J.* 1994; 15: 43-47.
9. Madani, K. A., Nasrat, H. A.; Al-Nowaisser, *et al.* Low birth weight in Taif Region, Saudi Arabia. *East. Mediter. Health J.* 1995; 1: 47-54.
10. Ghaznawi, H. I.; E. E. and Hussein, M. M Anaemia in pregnancy in Jeddah, Saudi Arabia. An epidemiological study. Bull. *High Inst. Publ. Health.* 1988; 18: 541-553.
11. Al-Amoudi, S. M. Anaemia in pregnancy in Bisha region. *Bahrain Med. Bull.* 1996 (in press).
12. Mahfouz, A. A.; El-Said, M. M.; Al-Akija, W. *et al.* Anaemia among pregnant women in the Asir Region, Saudi Arabia. *Southeast Asian J. Trop. Med. Public Health.* 1994; 25: 84-87.
13. Dawood, J. S.; Prakash, P. and Shubber, K. M. Iron deficiency anaemia among pregnant Arab women in Kuwait. *J. Kuwait Med. Asso.* 1990; 24: 167-172.
14. Hussain, M. A. and Gaafer, T. H.; Laulight, M. and Hoffbrand, A. V. : Relation of maternal and cord blood serum ferritin. *Arch. Disease Chil.* 1977; 52: 782-784.
15. Hawa, L.; Rowland, H. and Ahmed, G.; Dery, J. Hemoglobin and iron status in mothers and their babies at delivery. *Saudi Med. J.* 1993; 14. 110-115.
16. Ghafouri, H.; Al Fores, A.; Islam, S. *et al.* Hematological reference values assessed from birth to adolescence in Saudi subjects in the area of Jeddah. *Saudi Med. J.* 1987; 8: 582-585.
17. Babiker, M. A.; Bahakim, H. M.; Al-Omair, A. C. et al. Prevalence of iron deficiency in Saudi children from birth to 15 months of age. *Ann. Trop. Paediater.* 1989; 9: 111-114.

18. Al-Naquib, N. and Sadek, A. A. Child development and iron deficiency anaemia: A screening study on Middle Eastern children using the Denver developmental screening test. *Ann. Saudi Med.* 1988; 8: 414A.
19. Al-Fawaz, I. Surveillance for iron deficiency anaemia at a well baby clinic in Riyadh, Saudi Arabia. *Saudi Med. J.* 1993; 14: 27-31.
20. Stevens, D. W.; Wainscoat, J. S.; Ketley, N. et al. The pathogenesis of hypochromic anaemia in Saudi infants. *J. Trop. Pedi.* 1989; 35: 301-305.
21. McNiel, J. R. Variations in the response of childhood iron-deficiency anaemia to oral iron. *Blood.* 1968; 31: 641-646.
22. Sebai, Z. A. *Health in Saudi Arabia*, Vol. 1 Riyadh, Tihama Publications, 1985; 39-72.
23. Sebai, Z. A.; El-Hazmi, M. A. and Serenius F. Health profile of pre-school children in Tamnia villages, Saudi Arabia. In: Priorities in Child Care. *Saudi Med. J.* 1981; 2 (Supple. 1): 68-71.
24. El-Hazmi, M. Survey of laboratory variables in Qassim children. In: Community health in Saudi Arabia, a profile of two villages in Qassim region. *Saudi Med. J.* 1982; (Monograph No. 1): 19-23.
25. Rasheed, P.; Al-Yousef, N. and Al-Dabal, B. Nutritional profile of Saudi primary school girls in an urban region. *Ann. Saudi Med.* 1989; 9: 371-377.
26. Hamouda, A. and Lebshtein, A. Effect of Parasitic Infection on the Nutritional Status of School Children in Jeddah and Wadi Fatma. King Abdul Aziz City for Science and Technology. Final Report, 1987: 174-176.
27. Boukary, A. A. Assessment of the nutritional status of preparatory school girls in Jeddah, Saudi Arabia. Al-Zahar University, Cairo, Egypt, 1988 (unpublished Ph.D. dissertation).
28. Hafez, A. and Marshall, I. A survey of anaemia from June 1981 to January 1982 in the department of primary care: Riyadh Al-Kharj hospital programme. In: Proceedings of the 7th Saudi Medical Conference, Dammam: King Faisal University, 1982: 503-505.
29. Sejeny, S. A.; Khurshid, M.; Kamil, A. and Khan, F. A. Anaemia survey in the south-western region of Saudi Arabia In: proceedings of the 4th Saudi Medical Conference. Dammam: King Faisal University Press, 1980; 124-128.
30. Nazi, G. A. Hematological profile of Saudi newborn. *Saudi Med. J.* 1994; 15: 243-249.
31. El-Hazmi, M. A.; Al-Faleh, F. Z. and Al-Mofles, A. S. Establishment of normal reference for hematological parameters for healthy Saudi Arabians. *Trop. Geogr. Med.* 1982; 34: 333-339.
32. Bacchus, R.; Garner, E.; Madkour, M. M. and Haque, S.; Hurdle, A. The hematology reference range for Saudi Arabians. *Saudi Med. J.* 1986; 7: 46-52.
33. Khan, M. U.; Amir, S. E. and Aggerwal, S. Hemoglobin levels and blood groups in living at a high attitude. *Ann. Saudi Med.* 1989; 9: 458-462.
34. Al-Madani, A. A.; Omar, M. S.; Abu-Zeid, H. A. and Abdulla, S. A. Intestinal Parasites in urban and rural communities of Abha, Saudi Arabia. *Ann. Saudi Med.* 1989; 9: 182-185.
35. Ahmed, M. M; Hady, H. M. A preliminary survey of parasitic injectors and nutritional status among school children in Riyadh, Saudi Arabia. *J. Egypt. Soci. Parasitology.* 1989; 19: 101-106.
36. Hammouda, N. A.; Wasfi, A. S.; Fattah, M. M. *et al.* Parasitic infectious and nutritional states of school children in the Western Region of Saudi Arabia. *J. Egypt. Soci. Parasitology.* 1986; 16: 675-688.
37. Bahakim, H. M. Anaemia of acute focal infection in children in the area of Riyadh.. *Ann. Saudi Med.* 1990; 10: 508-510.
38. Madani, K. A.; Khashoggi, R. H.; Al-Nowaisser, A. A. et al. Lactation amenorrhea among Saudian Women. *J. Epi. Community Health.* 1994; 48, 286-289.
39. Cochran, T. E. Faqeera F. Demograph data: Saudi obstetric patients. *Saudi Med. J.* 1982; 3: 25-30.
40. Editorial. Iron deficiency in children in Saudi Arabia. *Nutr. Rev.* 1979; 27: 6-7.
41. Al-Othaimeen, A. I.; Kipps, M.; Thomson, J. and Villanueva, B. P. Nutrition intake and weight/height of Saudi patients at King Faisal Specialist Hospital in Riyadh, Saudi Arabia. *Nutr. Health.* 1992; 8: 195-206.
42. Stevens, D. W. and Ayoub, D. Development of nutritional adequacy and health status in Saudi Arabia. *Saudi Med. J.* 1991; 12: 164-165.

43. Madani, K. A.; Al-Nowaisser, A. A. and Khashoggi, R. H. Breast-feeding patterns in Saudi Arabia. *Ecol. Food Nutr.* 1994; 31: 239-245.
44. El-Hazmi, M. A.; Jabbar, F. A.; Al-Faleh, F. Z. et al. Patterns of sickle cell, thalassemia and glucose-6 phosphate dehydrogenase deficiency gene in north-western Saudi Arabia. *Hum. Hered.* 1991; 4: 26-34.
45. El-Hazmi, M. A. Incidence of frequency of haemoglobinopathies and thalassemia in the north-west sector of Arabia. *Saudi Med. J.* 1985; 2: 149-162.
46. Warsy, A. S. and El-Hazmi M. A. F. Glucose-6 phosphate dehydrogenase deficiency in Saudi Arabia - a review. *Saudi Med. J.* 1987; 8: 12-20.
47. Gelpi A. P. Agriculture malaria human evolution: A study of genetic polymorphisms in the Saudi Oasis population. *Saudi Med. J.* 1983; 4: 229-234.

IRON DEFICIENCY ANAEMIA IN THE UNITED ARAB EMIRATES

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INTRODUCTION

Anaemia, and mainly iron deficiency anaemia, remains an important public health problem of young children and women of childbearing age worldwide (1). In young children, iron deficiency anaemia impairs both physical and mental health and development (1,2,3,4). The negative health consequences of anaemia and its common occurrence in preschool children in both developing and developed countries have lead to the recommendation of anaemia screening programs for this age group (5,6). In women of childbearing age, the most important adverse health consequences of iron deficiency anaemia are reduced physical ability, increased morbidity and mortality associated with pregnancy and childbirth, and a higher risk of having low birth weight babies (1). Prevention and control of anaemia in women of reproductive age are important objectives of maternal health programs in many countries.

In the United Arab Emirates (UAE), only limited published data on the current prevalence, causes, and correlates of anaemia in young children and in women of childbearing age are available. We conducted this cross-sectional study in these two high risk groups in Al Ain, UAE, to: define their blood haemoglobin levels; estimate the prevalence of anaemia; examine the role of iron deficit in causing anaemia; identify the correlates of anaemia prevalence; and assess the acceptability to parents of an anaemia screening test for their young children.

METHODS

Study area

This study was conducted in Al Ain city, Abu Dhabi Emirates, UAE. In 1994, the multinational population of Al Ain was estimated at 282,500. About 30% of Al Ain residents are UAE citizens and the rest are expatriates, mostly from the Arabian Gulf area, the Middle East, South Asia, and South-East Asia.

Study populations, sites and designs

Two population groups in two different settings were chosen for this cross-sectional study: young children and their mothers visiting a government immunization center where all vaccines are provided free of charge (Immunization Centre Study), and women who had delivered babies at a non-government hospital where obstetric care is available for a nominal fee (Hospital Study). The Immunization Center Study was done prospectively whereas the Hospital Study was done retrospectively.

Study subject selection

For the immunization Center Study, children aged 1-22 months brought for routine vaccinations and their mothers were the target study subjects. We used a convenience sampling method to identify potential participants thereby ensuring that the routine activities of the immunization center were not impeded and that enrolled study subjects did not have to wait to undergo the study procedures. Data were collected during a defined period (6 p. m. through 8 p.m.) on preselected days. At the beginning of the data collection period each day, the first available eligible and consenting child-mother pair was enrolled. After the study personnel had finished interviewing and testing this child-mother pair, they enrolled the next available eligible and consenting pair. This procedure was repeated till the end of the data collection period for the day. If a mother had two children aged 1-22 months with her, then only the younger child was enrolled.

For the Hospital Study, we selected a simple random sample (n= 750) of all the 1,945 women who had delivered babies at the study hospital during January through December 1991.

Data collection

For the Immunization Center Study, socio-demographic and anaemia risk factor data were collected between May 1992 and April 1993 by specially trained study personnel who used a protested structured questionnaire to interview the mothers. For the Hospital Study, such data were systematically abstracted from the obstetric records of each randomly selected women. Data abstraction was done by one of the investigators who used a specially designed structured from.

For the Immunization Center Study, the blood haemoglobin level of each study subject was determined with a HemoCue Photometer (HemoCue, HemoCue AB, Sweden) using capillary blood obtained by the finger prick method. To determine the serum ferritin level, a venous blood sample collected in an EDTA tube was sought from all anaemic children aged ≥ 6 months and all nonpregnant women with blood haemoglobin < 11 g/dl. Serum ferritin levels were determined by the enzyme immunoassay method (Ferritine EIA, bioMerieux, France). For the Hospital Study, blood haemoglobin levels during pregnancy were abstracted from laboratory reports included in the obstetric records of each selected women.

Definitions

For the Immunization Center Study, haemoglobin levels that we considered as indicative of anaemia in children were: <9 g/dl in those aged <3 months, <10 g/dl in those aged 3-5 months, and <11 g/dl in those aged ≥ 6 months. A nonpregnant women was considered anaemic if her haemoglobin level was <12 g/dl. For pregnant women the corresponding level was < 11 g/dl. Any tested subject with a serum ferritin level of < 12 μg/l was classified as iron depleted.

For the Hospital Study, the blood haemoglobin cut off levels that we have used to define anaemia during pregnancy were < 11 g/dl for the first or third trimester and <10.5 g/dl for the second trimester.

Data analysis

Personal computers and the Stata (7) programme package were used for data analysis. Computed descriptive statistics included means and proportions. Statistical significance in the difference between two subgroups in the distribution of blood haemoglobin levels was assessed by the Student's t-test.

Associations between anaemia (dependent variable; 1= present, 0 = absent) and its potential correlates were first examined univariately by logistic regression analyses. Variables identified as significant or strong univariate correlates of aneamia were then entered simultaneously into a multivariate logistic regression model to assess their independent effects. Point estimates of Odds Ratios (ORs) and their 95% Confidence Intervals (CIs) were derived through the logistic regression analyses. An OR was considered significant if its 95% CI did not include 1.

RESULTS

Immunization Center Study

A total of 525 eligible child-mother pairs visited the study immunization center throughout the data collection periods for this study. Of these, 342 (65%) child-mother pairs were invited to participate in the study. The remaining 183 (35%) pairs were not invited because of our study subject selection strategy. Of all invited child-mother pairs, 309 (90%) pairs were finally enrolled and the remaining 33 (10%) could not be enrolled because of refusal by one or both parents of the child. Because of refusals, venous blood samples could be obtained from only 19 (28%) of the 67 eligible children and from only 5 (36%) of the 14 eligible women.

The characteristics of the studied children and women are summarized in Table 1 and Table 2, respectively. The mean blood haemoglobin levels in children of different ages are shown in the Figure. In children, the mean (range: 11.2-11.7 g/dl) blood haemoglobin levels did not vary substantially with age. The mean blood haemoglobin level in pregnant women (12.4 g/dl) was significantly lower than that in nonpregnant women (13.1 g/dl) (Student's t-test, P= 0.0021).

Of the 309 study children, 73, (24%) were anaemic. The prevalence of aneamia in children increased with age from 3% in those aged 1-2 months to 39% in those aged 18-22 months (Figure). Univariate associations between anaemia in children and the characteristics of the children and their mothers are summarized in Table 1 and Table 2, respectively. Compared with children aged 1-5 months, those aged 6-22 months were significantly more likely to be anaemic (unadjusted OR: 9.75; Table 1). Children of currently pregnant women were suggestively more likely to be anaemic than were children of currently nonpregnant women (unadjusted OR: 2.18; Table 2). None of the remaining variables listed in Tables 1 and 2 were significantly or suggestively associated with anaemia in children. However, we detected notable inverse associations between anaemia in children and two maternal characteristics, namely, age and the number of pregnancies. In a multivariate logistic regression model including all significant, suggestive, or notable univariate correlates of anemia in children, only older age of the children (6-22 months v 1-15 months) was significantly and positively associated with anaemia (multivariate OR: 9.51, 95% CI: 3.92-23.08).

In the 19 examined children, serum ferritin levels ranged from 1 μg/l to 60 μ g/l with a mean of 14.4 μg/l (SD: 13.8). Ten (53%) of these children were iron depleted.

Overall, 50 (16%) of the 309 study women were anaemic. The prevalence of anaemia in nonpregnant women (16%) was quite similar to that in pregnant women (14%). Also, the correlates of anaemia in women remained generally unaltered when current pregnancy status was adjusted for. Therefore, findings about nonpregnant and pregnant women are presented jointly in this paper unless indicated otherwise.

Univariate associations between anaemia in women and their characteristics are shown in Table 2. The prevalence of aneamia was significantly higher in women who had ≥ 7 pregnancies than in those who had 1-3 pregnancies (univariate OR= 4.17). Also, those women whose menstrual periods usually lasted ≥ 7 days were significantly more likely to be anaemic than were their counterparts whose periods usually lasted ≤ 4 days (univariate OR = 4.00). None of the remaining variables listed in Table 2 were significantly associated with anaemia in women. However, we detected a notable inverse association between the prevalence of aneamia and the levels of education in women. Also, relative to the women of UAE nationality, non-Arab women were notably less likely to be anaemic. In a multivariate logistic regression model including all significant or notable univariate correlates of anaemia in women, anaemia was significantly associated with only greater number (≤ 7 v 1-3) or pregnancies and suggestively associated with only longer duration (≥8 v ≤ 4 days) of menstrual periods (Table 2).

In the 5 examined nonpregnant women, serum ferritin levels ranged from 1 μg/l to 64 μg/l with a mean of 21.4 μg/l (SD: 28.6). Three (60%) of these 5 women were iron depleted.

Table 1. The characteristics of the study children and their associations with the prevalence of anemia[a]

Children's characteristic	Total No. (%)	% Anemic	Unadjusted OR (95% CI)[b]
Age (months)			
1-5	116 (38)	5	1.00
6-22	193 (62)	35	9.75 (4.07-23.35)[c]
Gender			
Female	150 (49)	22	1.00
Male	159 (51)	25	1.19 (0.70-2.02)
Ever breast-fed			
No	5 (2)	20	1.00
Yes	304 (98)	24	1.24 (0.14-11.28)
Current feeding mode			
Age 1-5 months			
Exclusively breast-fed	33 (28)	9	1.00
Partially breast-fed	74 (64)	4	0.42 (0.08-2.21)
Non-breast-fed	9 (8)	0	-
Age 6-22 months			
Exclusively breast-fed	1 (1)	100	-
Partially breast-fed	107 (55)	34	1.00
Non-breast-fed	85 (44)	35	1.08 (0.59-1.96)

[a] 309 children were studied.
[b] OR: odds ratio; CI: confidence interval.
[c] Significant.

Table 2. Associations between the characteristics of the study women and the prevalence of anemia in children and women[a]

		Children		Women		
Women's characteristic	Total No. (%)	% Anemic	Unadjusted OR (95% CI)[b]	% Anemic	Unadjusted OR (95% CI)[b]	Adjusted OR (95% CI)[b]
Education						
Up to primary	68 (22)	24	1.00	19	1.00	1.00
Preparatory or secondary	149 (49)	26	1.11 (0.57-2.18)	17	0.85 (0.41-1.80)	1.00 (0.40-2.47)
University	88 (29)	21	0.84 (0.39-1.79)	11	0.54 (0.22-1.33)	0.73 (0.24-2.21)
Nationality						
United Arab Emirates	30 (10)	27	1.00	23	1.00	1.00
Gulf Arab	8 (3)	25	0.92 (0.15-5.51)	38	1.97 (0.37-10.47)	1.28 (0.19-8.53)
Other Arab	215 (70)	24	0.88 (0.37-2.09)	16	0.62 (0.24-1.56)	0.83 (0.28-2.47)
Non-Arab	56 (18)	20	0.67 (0.24-1.91)	11	0.39 (0.12-1.31)	0.76 (0.21-2.80)
Currently pregnant						
No	279 (91)	22	1.00	16	1.00	
Yes	29 (9)	38	2.18 (0.98-4.87)	14	0.83 (0.28-2.52)	
Age (years)						
<30	162 (52)	27	1.00	17	1.0	
$\geq$30	147 (48)	20	0.66 (0.39-1.12)	16	0.93 (0.50-1.71)	
No. of pregnancies						
1-3	165 (53)	27	1.00	13	1.00	1.00
4-6	107 (35)	22	0.73 (0.41-1.30)	14	1.12 (0.55-2.29)	1.03 (0.47-2.25)
$\geq$7	37 (12)	14	0.42 (0.15-1.14)	38	4.17 (1.86-9.38)[c]	3.49 (1.33-9.15)[c]
Anemia						
No	259 (84)	23	1.00			
Yes	50 (16)	26	1.17 (0.58-2.33)			
Menstrual cycle (days)						
$\leq$28	188 (65)			16	1.00	
>28	103 (35)			18	1.12 (0.59-2.12)	
Menstrual period (days)						
$\leq$4	55 (19)			13	1.00	1.00
5-7	222 (75)			15	1.24 (0.52-2.98)	1.22 (0.49-3.05)
$\geq$8	19 (6)			37	4.00 (1.17-13.67)[c]	3.54 (0.95-13.12)

Hospital Study

The 750 randomly selected women that we have studied comprised 39% of the 1,945 women who had delivered babies at the study hospital during January through December 1991. Blood haemoglobin levels were determined in 280, 457, and 634 women during the first, second, and third trimester of pregnancy, respectively. The characteristics of the study women are summarized in Table 3.

The mean haemoglobin levels in the study women were 12.3 g/dl in the first trimester, 11.5 g/dl in the second trimester, and 11.4 g/dl in the third trimester. The prevalences of aneamia were 10%, 15%, and 34% in the first, second, and third trimesters of pregnancy, respectively. The pregnancy trimester-specific prevalences of anaema in different subgroups based on the characteristics of the women are shown in Table 3.

Significant univariate correlates of anaemia in the first trimester of pregnancy were age of the women when the index child was born, prior parity, and adequacy of prenatal care use (Table 4). Relative to women aged < 19 years, those aged ≥ 30 years were significantly less likely (unadjusted OR = 0.27) to be anaemic during the first trimester. Compared with women who had not had any previous childbirth, those of parity 2-3 were significantly more likely (unadjusted OR = 4.11) to be anaemic. Also, those women who had received adequate or intermediate levels of prenatal care were significantly less likely (unadjusted OR = 0.27) to be anemic than were their counterparts who had used inadequate levels of prenatal care.

None of the variable that were examined were found to be significant univariate correlates of anaemia in the second trimester of pregnancy (Table 4). In the third trimester, the only significant univariate correlate of anaemia was nationality with women of 'other' nationality being significantly less likely (unadjusted OR = 0.47) to be anaemic than were UAE women (Table 4).

The results of multivariate analyses of the association between anaemia and its significant univariate correlates are presented in Table 5. In the first trimester of pregnancy, prior parity (2-3 v 0; adjusted OR = 6.31) and adequacy of prenatal care use (adequate/ intermediate v inadequate; adjusted OR = 0.26) were the only multivariately significant correlates of anaemia. In the third trimester of pregnancy the only multivariaely significant correlate of anaemia was nationality ('Other' v UAE; adjusted OR = 0.48).

DISCUSSION

We have found that aneamia is widespread in young children and in women of childbearing age in Al-Ain. Also, our findings as to the correlates of aneamia indicate that iron deficiency is probably the main cause of anaemia in these two high risk groups. Our observations are generally comparable to those from other countries in the region (8).

About 90% of the parents whom we approached had their young children tested for aneamia by allowing a finger-prick blood sample to be taken. This indicates that a mass screening programme for anaemia in young children based at the immunization facilities in Al Ain is likely to be acceptable to most parents if blood samples are taken by the figure-prick method.

Further studies are needed to define the relative contributions of different risk factors for iron deficiency anaemia in our population. The identification of modifiable risk factors would allow targeted interventions. Also, the health impact of anaemia needs to be quantified both in young children and in women of reproductive age in Al Ain.

The prevention and control of aneamia in women of reproductive age would benefit both the women and their future children. Also, given the high prevalence, well recognized negative health impact, and apparent reversibility of anemia in young children, we feel that programs for the prevention, screening, and control of childhood aneamia would be worthwhile in Al Ain and similar populations elsewhere.

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REFERENCES

1. DeMayer, E. M. *Preventing and Controlling Iron Deficiency Anaemia Through Primary Health Care.* World Health Oganization, Geneva, 1989.
2. Pollitt E, Haas, Levitsky, D. A, (editors). International Conference on iron deficiency and behavioral development. Proceedings of a conference held in Geneva, October 10-12, 1988. *Am. J. Clin. Nutr.* 1989, 50 (suppl.): 565-705.
3. Chwang L. C., Soemantri A. G. and Pollitt E. Iron Supplementation and physical growth of rural Indonesian children. *Am. J. Clin. Nutr.* 1988, 47: 496-501.
4. Hussein M. A., Hassan H. A., Abdel-Ghaffar A. A, *et al.* Effect of iron Supplementation on the occurrence of diarrhea among children in rural Egypt. *Food Nutr. Bulletin.* 1988, 10: 35-39.
5. S. Preventive Services Task Force Guide to Clinical Preventive Services. An Assessment of the Effectiveness of 169 interventions. William & Wilkins, Baltimore, 1989.
6. Anonymous. Iron deficiency - time for a community campaign (Editorial). *Lancet.* 1987, I: 171-172.
7. Stata Crop. Stata Reference Manual: Release 4.0 College Station, Texas, 1995.
8. Musaiger A O. Nutritional status of mothers and children in the Arab Gulf countries. *Health Promotion Intl.* 1990 5: 259-268.

Table 3. Prevalence of anemia in pregnant women in different trimesters, by women's characteristics

Characteristic	Trimester 1		Trimester 2		Trimester 3	
	No. tested	% anemic	No. tested	% anemic	No. tested	% anemic
Nationality						
UAE	151	*8.6*	178	*14.6*	292	*34.9*
Oman	104	*12.5*	224	*17.4*	267	*37.1*
Other	25	*8.0*	55	*9.1*	75	*20.0*
Residence						
UAE	175	*7.4*	232	*12.5*	362	*32.9*
Oman	105	*14.3*	225	*18.2*	272	*35.7*
Age (yr) at childbirth						
<19	38	*21.1*	47	*21.3*	70	*31.4*
20-29	139	*9.4*	222	*13.5*	314	*35.0*
≥30	103	*6.8*	187	*16.0*	249	*33.3*
Prior parity						
0	39	*7.7*	46	*19.6*	71	*26.8*
1	39	*7.7*	42	*9.5*	74	*32.4*
2-3	51	*25.5*	79	*11.4*	110	*36.4*
4-5	50	*6.0*	88	*22.7*	118	*31.4*
≥6	101	*5.9*	202	*13.9*	261	*36.8*
Adequacy of prenatal care						
Inadequate	48	*22.9*	262	*17.2*	255	*35.3*
Adequate/intermediate	232	*7.3*	195	*12.8*	379	*33.3*
Prior abortion[a]						
No	146	*13.0*	300	*15.0*	384	*33.9*
Yes	95	*6.3*	111	*14.4*	179	*37.4*
Prior premature birth[a]						
No	208	*10.1*	344	*15.1*	486	*35.0*
Yes	33	*12.1*	67	*13.4*	77	*35.1*
Prior low birth weight baby[a]						
No	201	*10.5*	331	*14.5*	470	*34.9*
Yes	40	*10.0*	80	*16.3*	93	*35.5*
Prior neonatal death[a]						
No	231	*10.4*	389	*14.7*	535	*35.1*
Yes	10	*10.0*	22	*18.2*	28	*32.1*

[a]Only in women with at least one previous childbirth.

Table 4. Results of univariate logistic regression analysis of the associations between prevalence of anemia in pregnant women and their characteristics, by trimester of pregnancy.

	Trimester 1		Trimester 2		Trimester 3	
Characteristic	uOR	95% CI	uOR	95% CI	uOR	95% CI
Nationality						
UAE	1.00		1.00		1.00	
Oman	1.52	0.67-3.42	1.23	0.72-2.12	1.10	0.78-1.55
Other	0.92	0.20-4.36	0.58	0.21-1.60	***0.47***	***0.25-0.86***
Residence						
UAE	1.00		1.00		1.00	
Oman	2.08	0.95-4.56	1.56	0.93-2.61	1.13	0.81-1.58
Age (yr) at childbirth						
<19	1.00		1.00		1.00	
20-29	0.39	0.15-1.02	0.58	0.26-1.28	1.18	0.68-2.05
≥30	***0.27***	***0.09-0.82***	0.71	0.32-1.57	1.09	0.62-1.93
Prior parity						
0	1.00		1.00		1.00	
1	1.00	0.19-5.29	0.43	0.12-1.53	1.31	0.64-2.69
2-3	***4.11***	***1.08-15.61***	0.53	0.19-1.45	1.56	0.81-3.01
4-5	0.77	0.15-4.02	1.21	0.50-2.92	1.25	0.65-2.40
≥6	0.76	0.18-3.19	0.66	0.29-1.52	1.59	0.89-2.85
Adequacy of prenatal care						
Inadequate	1.00		1.00		1.00	
Adequate/intermediate	***0.27***	***0.12-0.61***	0.71	0.42-1.20	0.91	0.65-1.28
Prior abortion[a]						
No	1.00		1.00		1.00	
Yes	0.45	0.17-1.17	0.95	0.51-1.77	1.17	0.81-1.69
Prior premature birth[a]						
No	1.00		1.00		1.00	
Yes	1.23	0.39-3.83	0.87	0.41-1.87	1.00	0.61-1.66
Prior low birth weight baby[a]						
No	1.00		1.00		1.00	
Yes	0.95	0.31-2.94	1.14	0.59-2.23	1.03	0.64-1.63
Prior neonatal death[a]						
No	1.00		1.00		1.00	
Yes	0.96	0.12-7.89	1.29	0.42-3.96	0.87	0.39-1.97

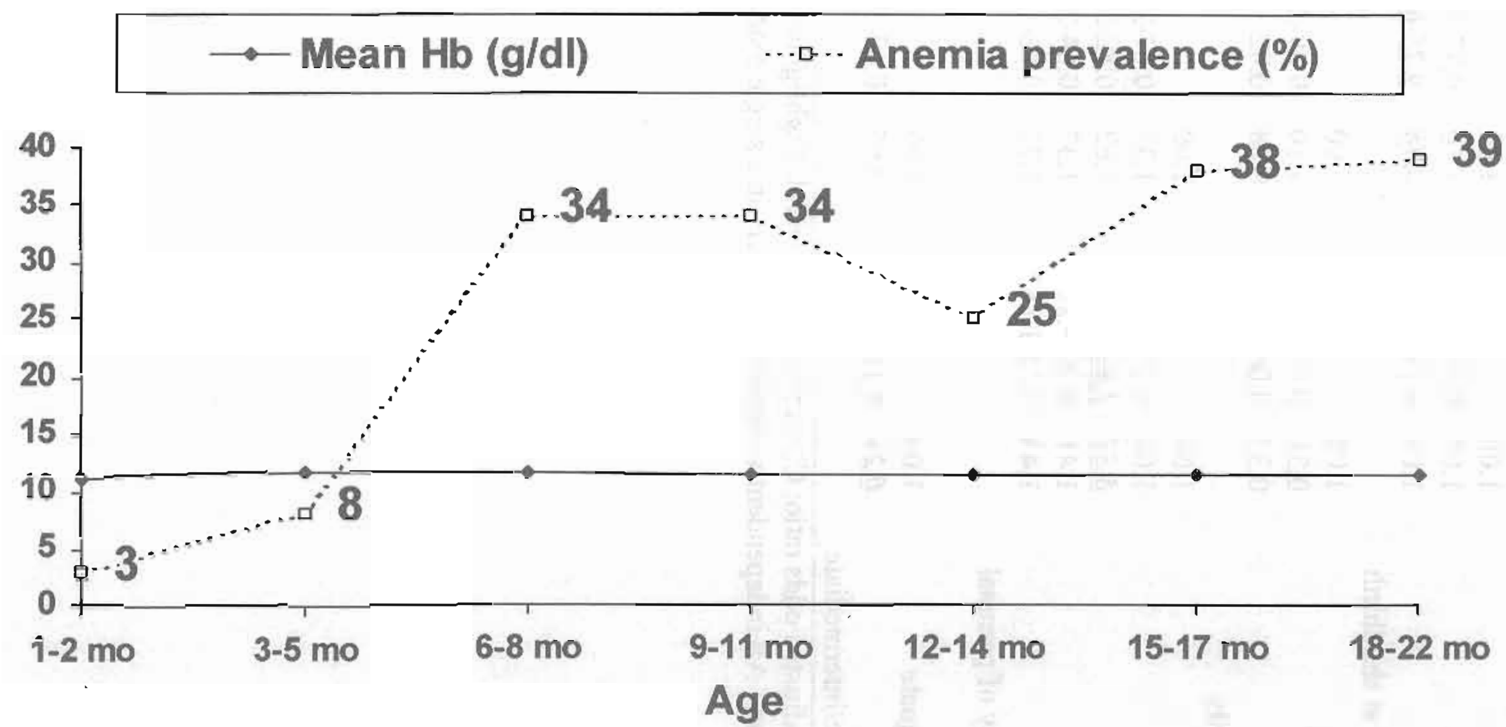
uOR = unadjusted odds ratio; CI = confidence interval. Highlighted ORs are statistically significant. Each independent variable listed was in a separate model.
[a]Only in women with at least one previous childbirth.

Table 5. Results of multivariate logistic regression analysis of the associations between prevalence of anemia in pregnant women and their characteristics, by trimester of pregnancy.

	Trimester 1		Trimester 3	
Characteristic	aOR	95% CI	aOR	95% CI
Nationality				
UAE	1.00		1.00	
Oman	1.03	0.41-2.60	1.10	0.77-1.57
Other	1.08	0.21-5.52	***0.48***	***0.25-0.90***
Age (yr) at childbirth				
<19	1.00		1.00	
20-29	0.31	0.09-1.06	1.10	0.59-2.04
≥30	0.32	0.06-1.77	0.88	0.42-1.87
Prior parity				
0	1.00		1.00	
1	1.06	0.19-6.09	1.39	0.67-2.90
2-3	***6.31***	***1.42-27.98***	1.62	0.82-3.22
4-5	1.41	0.20-9.80	1.33	0.64-2.76
≥6	1.48	0.21-10.57	1.71	0.83-3.52
Adequacy of prenatal care				
Inadequate	1.00		1.00	
Adequate/intermediate	***0.26***	***0.10-0.68***	0.95	0.67-1.35

aOR = adjusted odds ratio; CI = confidence interval. Highlighted ORs are statistically significant. All independent variables listed were in a single model simultaneously.

Figure. Blood hemoglobin levels and anemia prevalence in study children by age



IODINE DEFICIENCY IN SAUDI ARABIA

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INTRODUCTION

The term iodine deficiency disorders (IDD) covers a wide variety of clinical conditions affecting the health and well-being of human, starting in early fetal life and continuing throughout adulthood. At the relatively benign end of the spectrum is the widely prevalent condition of goiter, while at the opposite end is the relatively uncommon conditions of irreversible brain damage in the fetus and infants and retarded psychomotor development in the child. The intellectual and cognitive development of children is reduced by 5-15% as measured by I. Q (1). The cumulative consequences in iodine-deficient population could led to deminished performance for the entire economy of affected nations.

About one third of the world's population (1571 million people) live in iodine deficient environments and are thus at risk of IDD. More than 190 million people suffer from IDD, among them about 20 million are believed to be significantly mentally handicapped and over 3 million have cretinism. A large proportion of the severely deficient are women in their reproductive years whose babies are at high risk of irreversible mental retardation unless they receive adequate amounts of iodine. The hidden hunger, IDD, is a significant public health problem in 118 countries, most of them are from the third world (2).

Data on iodine excretion in the urine of adults, adolescents and newborns and on the iodine content of breast milk indicate a high prevalence of iodine deficiency (moderate in may cases and severe in a few) in many European countries (3). However, over the last five decades many European, American and Asian countries have already successfully eliminated IDD or achieved considerable progress towards their control (4). These successful efforts were largely due to salt iodination for eliminating IDD. This has been endorsed in numerous international forums, including the International Conference on Nutrition, Rome, 1992.

There is a number of countries in the Eastern Mediterranean region in which IDD, mainly endemic goiter, pose a major public health problem in certain localized areas (5). Goiter prevention and control programmes are frequently postponed in many developing countries. It is regarded as a low priority problem.

The three most important indicators that are used in IDD surveillance, as well as, in initial problem assessment are:

- goiter prevalence, which can be measured either through palpation (thyroid size) or through ultrasonography (thyroid volume).

- urinary iodine excretion in a population (6).
- thyroid function tests, especially TSH in neonates.

The World Health Organization advised researchers to combine at least two indictors, one morphological and one laboratory test. There was standardized definition of goiter and classification for its size endorsed by the Pan American Health Organization / World Health Organization (7). This was further simplified in meeting of the Experts of the International Council for Control of Iodine Deficiency Disorders (ICCIDD) in 1992 (8), where they adopted the following simplified classification: grade 0: no palpable or visible goiter, grade 1: palpable but not visible when neck is in normal position, grade 2: palpable and visible when neck is in normal position.

About 90% of the ingested iodine is exerted in urine, therefore, urinary iodine determination is accurate mean for assessing the iodine status (9). Twenty four hours urine collection is the best measure, however, not practical for epidemiological surveys and has been replaced by casual urine samples with the value expressed either as concentration (µg iodine / dl) or in relation to creatinine (µg iodine / g createnine). Bourdox (10) recommended relying on the concentration of iodine in casual samples of urine, in epidemiological surveys, since large population sample will neutralize the factor of the difference in individual urinary dilution.

ICCIDD has recommended using the median of urinary iodine concentration for assessment of iodine status (11) using the following classification: severe iodine deficiency with median > 2 µg/dl, moderate iodine deficiency with median 2-5 µg/dl, mild iodine deficiency with median 5-10 µg/dl. Forty to fifty samples from an area would be adequate to reflect the urinary iodine excretion of the population of that area.

School children is the most appropriate group for survey as they tend to be homogenous for any given district or region and reflect the current status of iodine deficiency and can be used monitoring response for any intervention programme.

We have conducted national cross-sectional epidemiological 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 of thyroid gland.

MATERIAL AND METHOD

Study Population

The sample included 4638 Saudi school children, aged 8 to 10 years old. They were randomly selected from different regions of the country. School children of this age category are useful target group for IDD surveillance because of their combined high vulnerability, easy access and usefulness for a variety of surveillance activities (11).

The probability proportionate to size (PPS) cluster, recommend by the WHO, was employed in this study (12).

Chemical Measurement

Casual urine sample of 10 ml was collected in a dry tube from the studied population. Upon completion of the target sample for each region, samples were flown to the central laboratory at College of Science, King Saud University, Riyadh.

Iodine determination was done by, Calorimetric Method (9), where urine was digested with Chloric acid solution (28% Potassium Chlorate in 21% Perchloric acid) the mixed ingredients were heated in the tubes for 50 to 60 minutes in a heating block at 110 to 115°C in a hood with Perchloric acid tap the cooled to room temperature. This was followed by adding 3.5 ml arsenious acid solution (1% Arsenic trioxide in 20% 5N sulfuric acid, plus 2.5% sodium chloride), 350 ul ceric ammonium sulfate solution (4.8% N, 3.5N sulfuric acid) was added, then, the absorbency was red at 405 nm in a colorimeter (Spectro photometer, Pharmacia LKB Biochrome Ltd., Cambridge, England) after 20 minutes.

Result were calculated through constructing standard curve on a graph paper by plotting iodine concentration of each standard against its Spectrophotometer reading. The iodine concentration for each sample was located through plotting each Spectrophotometer absorption on the standard curve and urinary iodine concentration was expressed as ug/dl.

Quality Control

Quality control of the analysis was checked using known iodine concentrations run after each 10 test samples. The intra and inter assay coefficient of variation (CV) were 11.7% and 11.2%, respectively and at a level below 2 μg/dl of iodine concentration the inter and inter assay CV were 5.5% and 5.2%, respectively.

Quality control and quality assurance for the method used were checked by analyzing 4.3% (200) of the total urine samples in the ICCIDD iodine reference laboratory in University of Virginia, School of Medicine, Division of Endocrinology. The obtained results from the reference laboratory were 90% close to the results obtained in our laboratory. The mean coefficients of variation CV were 10% for our analysis comparing with mean CV 11% for the reference laboratory for samples above 2μg/dl and for samples below 2 μg/dl. The mean CV was 5% in our laboratory, but in the reference laboratory the mean CV was 9%.

Clinical Assessment

After completion of the urinary iodine determination, a random sample of 1357 school children, aged 8 to 10 years was selected from areas with different geographical nature i.e. coastal, high altitude and deserts. Field visits to the randomly selected schools (by simple random method from the list of primary schools at the General Directorate of Education) were conducted. Clinical neck examination was done and goiter was ascertained and classified as per the modified WHO criteria for goiter assessment. Neck examination was done by one investigator (A. N) for all students.

RESULTS

There were 4638 school children, 2365 (51%) male and 2273 (49%) female subjects. The national median and mean (SD) urinary iodine concentration were 18 and 17 (8) µg/dl, respectively. The median and mean (SD) urinary iodine concentration for male and female subjects were 18, 17 (8) and 17, 17 (8) µg/dl, respectively (P=0.008). Majority of subjects had urinary iodine concentration > 10 µg/dl (Figure 1).

The sample size, median urinary iodine concentration and percentage of subjects with urinary iodine concentration < 10 µg/dl are shown in Figure 2 at the national level, about one quarter of the studied population (1043 students i.e. 22%) had urinary iodine concentration < 10µg/dl.

The Southern province had the highest percentage (45%) of students with low urinary iodine concentration (less than 10 µg/dl) followed by the Northern (17%). The lowest such percentage was observed in the Central and Western provinces (8%). 3200 (69%) students live in urban communities and 1438 (31%) students live in rural communities. The median and mean (SD) urinary iodine concentration for urban and rural subjects were, 17, 16 (7) and 20, 18 (8) µg/dl, respectively (P=0.0001).

Similarly, a statistically significant (P= 0.0001) difference was observed between the median urinary iodine concentration of students living in high and low altitudes (11 and 20 µg/dl, respectively). 1357 subjects from different geographical areas had their neck examined for the presence of goiter. Table 2 shows prevalence and grade of goiter in different geographical areas with their corresponding median urinary iodine concentration. The table demonstrates inverse relationship between median urinary iodine concentration and the percent prevalence of goiter in the sampled provinces (Figure 3). Assir region of Southern province had the highest and more advanced grade of goiter, the lowest corresponding median of urinary iodine concentration and the highest percentage of subjects with urinary iodine concentration < 10 µg/dl.

Table 1. **Percent distribution of the sample students according to their residence (province) and urinary iodine concentration (ug/dl), Saudi Arabia, 1994.**

Province	Sample size	Urinary Iodine Concentration (µg/dl)		
		(5) < 5 µg	(%) 5-10 µg	(%) >10 µg
Central	1148	2	6	92
West	716	2	6	92
East	736	4	11	85
North	475	5	12	83
South	1563	18	27	55
National	4638	8	15	77

Table 2. **Prevalence and grade 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 (µg/dl)
Riyadh	Central	Desert	306	92	8	0	104	19
Gizan	Southern	Coastal Non Mountainous	140	96	4	0	46	23
Fifa	Southern	Coastal Mountainous	181	75	25	0	45	11
Assir	Southern	High Altitude	730	70	22	8	255	10

Fig. 1

Frequency Distribution of Urinary Iodine Concentration for Saudi Subjects

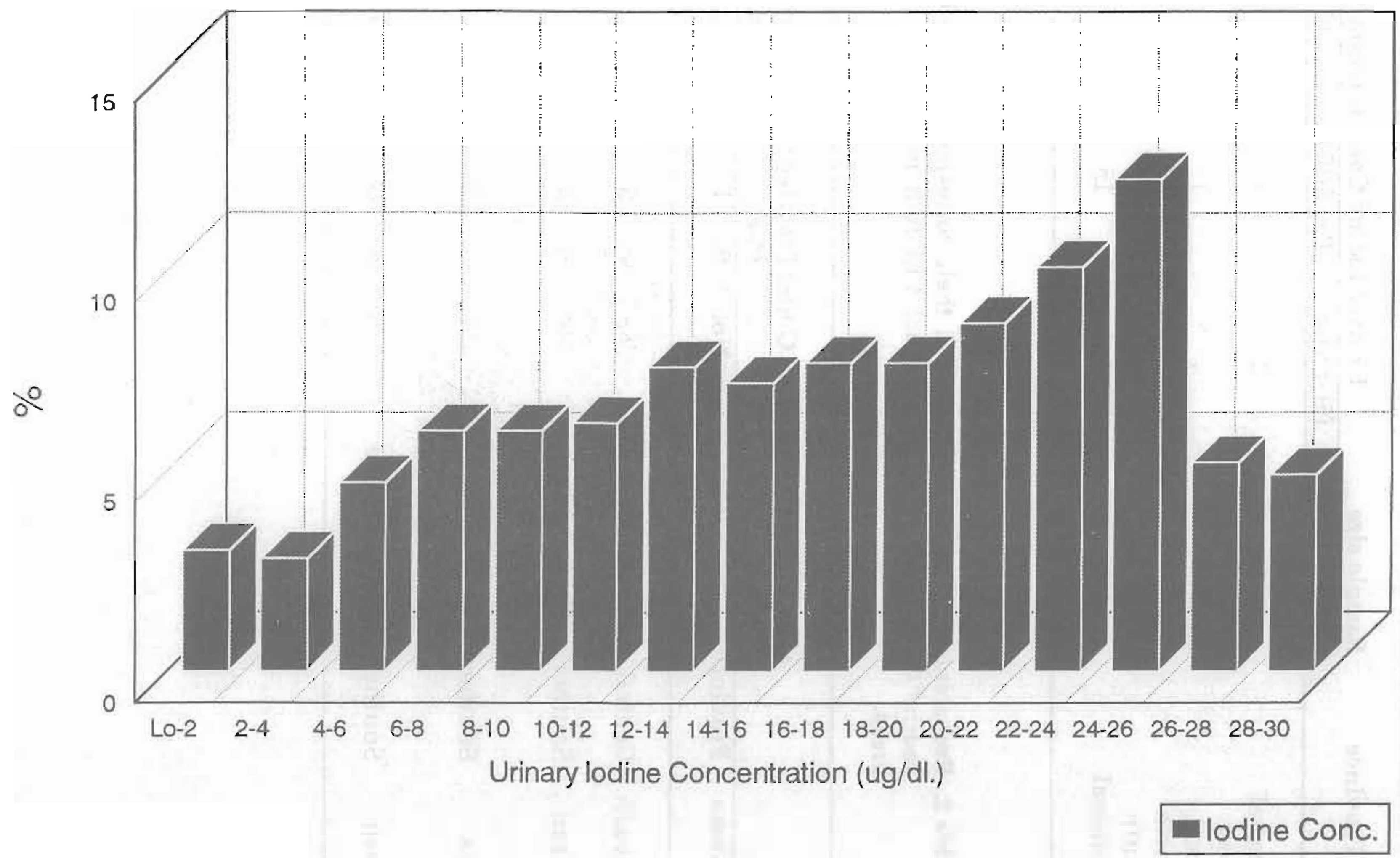


Fig. 2

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

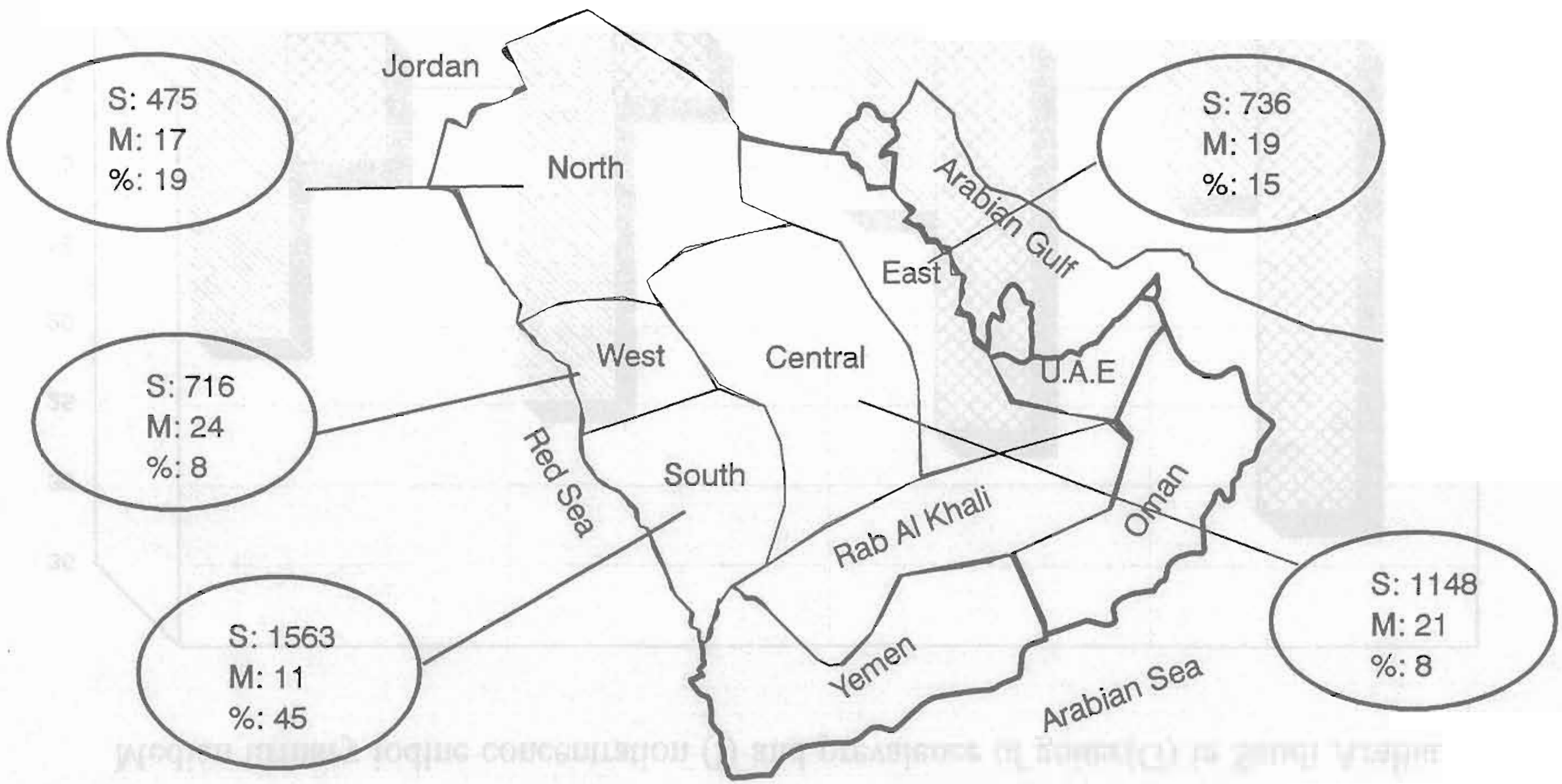
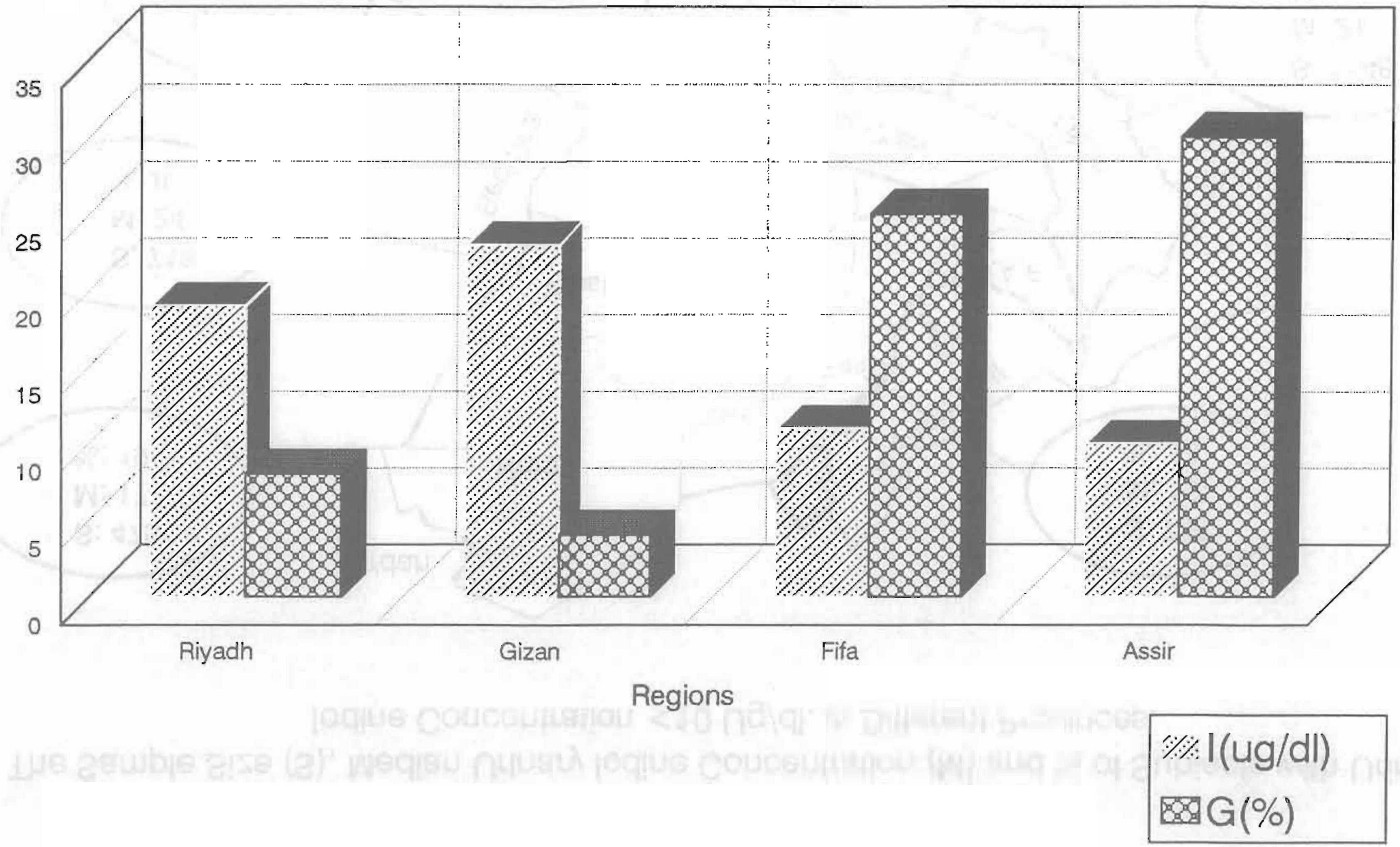


Fig. 3

Median urinary iodine concentration (I) and prevalence of goiter(G) in Saudi Arabia



DISCUSSION

In many countries of the Middle East, endemic goiter has been a familiar condition for decades and yet it has never attracted the particular attention of health managers and decision makers. This situation resulted in alarming prevalence rates in certain regions that have continued unchecked. Results of surveys indicated that the Eastern Mediterranean Region may have the largest number of countries (approximately 11 out of 23) in which iodine deficiency disorders pose a public health problem, although the precise extent of the problem in each of these countries is not yet known (5). It seems that the subject has neither stimulated the researchers in most of the countries, nor has it aroused the nutritional curiosity of epidemiologists. In Saudi Arabia this is the first documented national IDD survey.

The national median urinary iodine concentration is not in keeping with iodine deficiency, however, there is a provincial variation with respect to iodine status, where the Southern province has the lowest (11 µg/dl) median urinary iodine concentration and the highest percentage of subjects (18% and 27%) with urinary iodine concentration < 5 µg/dl and 5-10 µg/dl, respectively. On the other hand, the Western province has the highest (24 µg/dl) median urinary iodine concentration and the lowest percentage of subject (8%) with urinary iodine concentration < 10 µg/dl. The difference can be attributed to the special character of each of these province, where the Southern province is characterized by being of high altitude, low to medium income, and difficult access to high iodine content food such as fish and fresh food, compared with the Western province which of low altitude, medium to high income and easy access to food high iodine content.

Median urinary iodine concentration of male subjects is significantly higher than for female subjects. Median urinary iodine concentration for subjects living in rural communities is significantly higher than for subjects living in urban communities. This is likely related to the fact that there is no significant difference in the nature of food in Saudi Arabia between urban and rural communities. The less crowdeness in rural communities is contributing factor for higher level of urinary iodine concentration.

Media urinary iodine concentration of subjects living in low altitude areas is significantly higher than for subjects living in high altitude areas and this is related to the differential natural availability of iodine in high and low altitude.

Goiter prevalence in the studied areas ranged from 8% to 30%. These figures are much less than what reported by other countries in the Eastern Mediterranean Region. In Iran, the near-by Gulf country, the prevalence among school children reached 80% in Shahryar area southwest of Tehran. On the other side of the Red Sea, the prevalence of goiter among Sudanese school children reached 40-65%, especially in Darfur area. In Libyan Arab Jamahiriya and Tunisia, it ranged from 20-55% and 15-51%, respectively (15).

The clinical assessment showed good 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 is found in Assir region of Southern province, which has the lowest median urinary iodine concentration. Fifa, coastal mountainous region of the Southern province has similar over all prevalence, however, milder grade of goiter, when compared with Assir region. This difference can be attributed to the nature of food and accessibility to food of high iodine content. In general, the prevalence of goiter was 28%, the majority were in the grade 1. Finally, the relative increase in goiter prevalence in spite of mean urinary iodine concentration of ≥ 10 μg/dl, is probably reflecting the difficulties in sorting out normals vs. goiter grade 1, especially, among small children.

The two separate analytical studies on iodide concentrations in water and staple food (14,15) consumed by Saudi population revealed that a low iodide content in the water. This applies to both the water obtained by desalinization (Riyadh for example) (mean ± 0.00075 ± 0.0026 mmol/l) and to "mineral" bottled water (mean 0.0045 ± 0.0011 mmol/l). These levels are low compared with the average concentration of iodine in ground water of 5 μg/L (0.039 mmol/L) (16). On the other hand data on the iodide content in Saudi staple foods confirmed adequate iodine concentrations in most foods consumed by Saudis. The water iodide content has been noted to correlate with the incidence of endemic goiter in some part of the world. Kupiz (17) found that the iodide content in the water supplies in goitrous region in Latvia was only 0.1 to 0.2 μg/L (0.0008 - 0.0015 mmol/L), whereas it was 2 to 15 μg/L in nongoitrous area. Low water iodide content in water reflects the reverse in soil and rocks in particular geographical region.

CONCLUSION

Mapping Saudi Arabia for iodine deficiency through epidemiological survey of school children has revealed adequate iodine status in all provinces, except the Southern province. Within the Southern province, there are regions with adequate iodine status, such as: Gizan city and regions with variable degree of iodine deficiency. There is a need to combat iodine deficiency in the Southern province through iodization programme. The authors reviewed the official Saudi standards for salt manufacture and trading and noted that salt iodization is neither mandatory nor recommended. Universal salt iodization programme need to be instituted to control iodine deficiency in the affected areas and prevent IDDs in other parts of the country. Issues relating to the safety of universal salt iodization have been carefully examined by WHO and by FAO/WHO/ICCIDD/UNICEF expert groups (18). They agreed that universal salt iodization is feasible, cheap, safe, rapidly effective and sustainable.

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REFERENCES

1. Lamberg B A. Endemic goiter - iodine deficiency disorders. *Ann Med* 1991; 23: 367-72.
2. ICCIDD/UNICEF/WHO. *Global Prevalence of Iodine Deficiency Disorders.* MDIS working paper #1. Micronutrient deficiency information system, Geneva, World Health Organization, 1993.
3. Delange F and Burgi H. Iodine deficiency disorders in Europe. *WHO Bulletin,* 1989; 67(3) : 317-325.
4. Burgi H, Sapersaxo Z. and Selz B. Iodine deficiency diseases in Switzerland one hundred years after theodor goiter prevalence data. *Acta Endocrinologica,* 1990; 12(3): 577-590.
5. Bagchi K. and Rejeb H. Iodine deficiency disorders in the Eastern Mediterranean Region - Need for a Regional Strategy. *EMR Health Service Journal,* 1987; 3: 22-36.
6. World Health Organization. *Report on the Intercountry Training Workshop for IDD Laboratory Managers.* 1992; WHO - EM/Nut/130-E/L.
7. Delangei F, Bastani S, Benmiloud M, *et al. Definition of Endemic Goiter and Cretinism.* Classification of goiter size and severity of endemias, and survey techniques, 1986, towards the eradication of endemic goiter, creti D C, Pan Am. Health Organ, 1987.
8. Indicators for tracking progress in iodine deficiency disorders elimination, *Iodine Defic Disord Newl,* Nov. 1994; 10(4) : 37-41.
9. Dunn J. T., Crutchfield H E, Gutekunst R. and Dunn A D. Two simple methods for measuring iodine in urine. *Thyroid,* 1993; 3: 119-123.
10. Bourodoux P. P. Measurement of iodine in the assessment of iodine deficiency. *Iodine Defic Disord Newl,* Feb. 1988; 4 (1): 8-12.
11. World Health Organization. *Indicators for Assessing IDD and Their Control Through Salt Iodization.* WHO/NUT/94.6, 1994; 6-11.
12. Lwanga S K. and Lemesho S. *Sample Size Determination in Health Studies.* A practical manual, 1991; pp 26-71.
13. World Health Organization, Regional Office for the Eastern Mediterranean. *Guidelines for a National Program for the Control of Iodine Deficiency Disorders in the Eastern Mediterranean Region.* WHO, EMRO, 1988. Technical Publication No. 12: 1-8.
14. Al-Attas O S and Sulimani R A. Iodine concentrations in Saudi staple foods. *Saudi Med. J,* 1993; 14(4): 322-24.
15. Sulimani R. A., and Al-Attas O. S. Iodine concentration in Saudi waters: a case for concern. *Annals of Saudi Med,* 1991; 1196): 655-57.
16. Kout׳ ıs D. A., Matovinovic J. and Vought R. *The Ecology of Iodine.* In: Stanbury JB. Hetzel BS. eds. Endemic goiter and endemic cretinism. New York, Eviley, 1980; 185-195.
17. Kupiz J. Die jodfrage in Teltland in Zusammenhange, mit dem kropte. Zhg Infektionskr 1932; 113: 551-573
18. World Health Organization and United Nations Children's Fund. *World Summit for Children Mid Decade Goal: Iodine Deficiency Disorders (IDD).* JCHPSS/94/2.7, 1993; 3-5.

VITAMIN D STATUS IN SAUDI ARABIA

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INTRODUCTION

The major roles of vitamin D and its metabolites is to maintain calcium and phosphate homeostasis and the provision of minerals for bone formation (1, 2). Failure of calcification of cartilage and osteoid tissue in bone leads to their accumulation in abnormal form which results in rickets. Rickets are classified as vitamin D resistant rickets or vitamin D deficiency and this is caused by lack of sunshine or insufficient vitamin D content of the diet. Vitamin D is a sterol that is naturally present in two forms: cholecalciferol, or vitamin D3. This is obtained through the action of ultraviolet rays (β ray) on provitamin 7-dehydrocholesterol in the skin, and ergocalciferol, or vitamin D2, and this is of plant origin. However, the main source of vitamin D is through exposure to sunshine (3-5).

Vitamin D either source is hydroxylated in the liver to form 25-hydroxy-vitamin D, (25-OHD) (6), then to form the active metabolite in the kidneys, 1,25-dihydroxy-vitamin D [1, 25-(OH)2 D] (7) or 24, 25-dihydroxy-vitamin D [24, 25-(OH)2 D] depending on the physiological state of the person. This hormone regulates calcium and phosphorus homeostasis by promoting absorption of calcium and phosphate in the intestine and increasing renal tubular re-absorption of calcium. In bone, both 1, 25 (OH)2 D and the parathormone are needed in physiological concentrations to mobilize calcium as seen in Figure 1.

Measurement of the level of 25-OHD in the blood is used as an index of vitamin D status and stores (8,9), whereas the level of 1, 25 (OH)2 D is used as an index of its activity (8). The first effect of vitamin D deficiency is hypocalcemia, followed by hypophosphatemia then a rise of alkaline phosphatase. These effects are named biochemical rickets or osteomalacia. The hypocalcemia stimulates the parathormone which leads to re-absorption of calcium from bone in an attempt to maintain normal serum calcium, which will leave the bone in a demineralized form (10).

In growing bones, the bone matrix continues to be produced, causing impairment of the epiphyseal ends of bones especially in areas of fast bone growth, e.g., wrist, and costochondral junction, whereas, in the weight-bearing long bones, decalcification makes them bend.

Despite the level of ultraviolet rays available in the atmosphere of Saudi Arabia it is consistent with what is expected at such an altitude (11), and these rays that reach the usually exposed human skin are sufficient to maintain adequate circulating

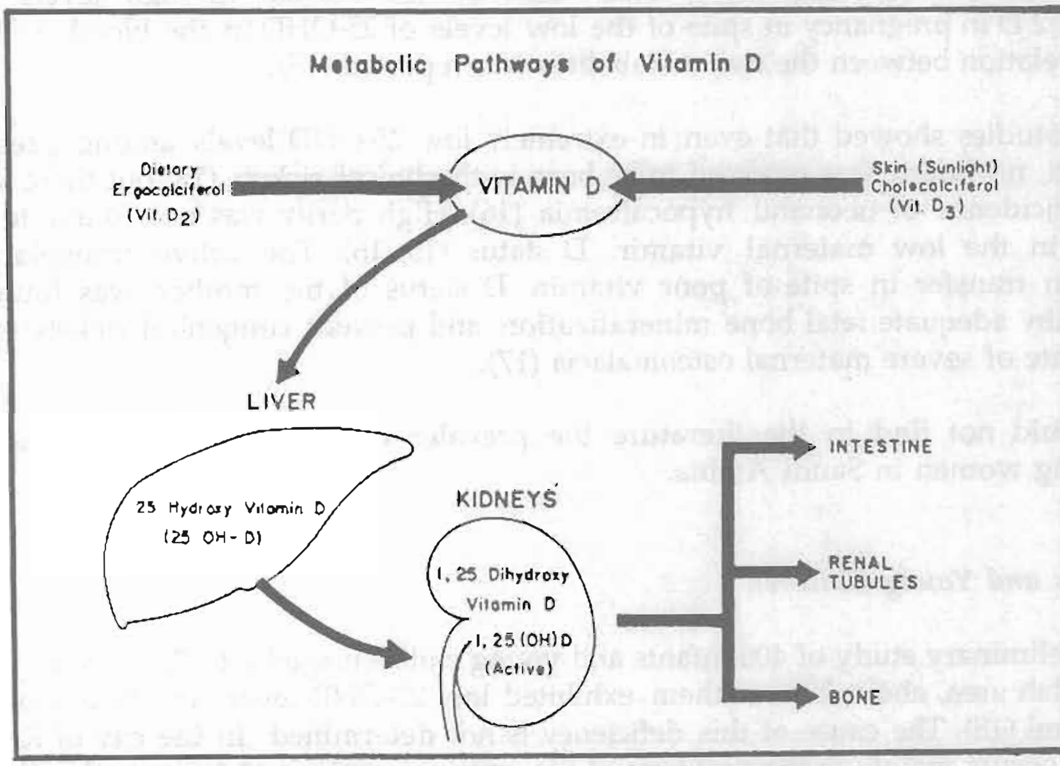

FIGURE 1. Metabolic pathways of vitamin D(49).

level of 25-OHD (12), however we see many cases of vitamin D deficiency in Saudi Arabia. This review will try to give some highlight in the deficiency status of vitamin D status in Saudi Arabia, causes, and preventive measures.

Pregnant and lactating women

Serenius and his co-workers (13), in a survey to assess the vitamin D nutritional status in 119 pregnant women at term, and their new borns, reported that 30 out of 119 maternal sera showed 4 ng/ml of 25-hydroxy vitamin D (25-OHD), and 11 out of 119 showed no detectable metabolite in the sera. The median concentration was around 5.7 ng/ml. They concluded that the high prevalence of marginal vitamin D level in those women may predispose babies to rickets during infancy.

Gaffar and his co-workers (14) have demonstrated normal to high levels of 1, 25(OH)2 D in pregnancy in spite of the low levels of 25-OHD in the blood, and lack of correlation between the two metabolites was reported (15).

Other studies showed that even in extremely low 25-OHD levels among pregnant women, no infant was reported to be born with clinical rickets (13) but there was a high incidence of neonatal hypocalcemia (16). High parity was not found to be a factor in the low maternal vitamin D status (15, 16). The active transplacental calcium transfer in spite of poor vitamin D status of the mother was found to maintain adequate fetal bone mineralization and prevent congenital rickets except in a state of severe maternal osteomalacia (17).

We could not find in the literature the prevalence of vitamin D deficiency for lactating women in Saudi Arabia.

Infants and Young Children

In a preliminary study of 400 infants and young children aged 4 to 72 months living in Jeddah area, about 20% of them exhibited low 25-OHD levels which is less than 10 ng/ml (18). The cause of this deficiency is not determined. In the city of Riyadh, rickets occurs mainly in the first year of life, with a mean age of ten months (19, 20). Although cases of congenital rickets have been reported (21, 22), the youngest infant was two month old, and presented with hypocalcemic convulsions associated with minimal bony changes (20). The mothers of rachitic infants were found to be vitamin - D deficient (23), and their maternal and cord blood vitamin D status were low (24, 25). In spite of this low 25-OHD, calcium levels in cord blood were maintained within normal values and were even higher than the corresponding maternal levels (13, 16). These findings conform to the active transplacental transport of calcium (26, 27), which could be explained by the high levels of 1, 25(OH)2D during pregnancy (28, 29), especially since the placenta (30) and the fetus (31) can act as additional sites for the metabolism of 1, 25(OH)2D. The maternal vitamin D deficiency state during pregnancy leads to delivery of infants with poor vitamin D stores. These infants are unable to maintain normal calcium levels due

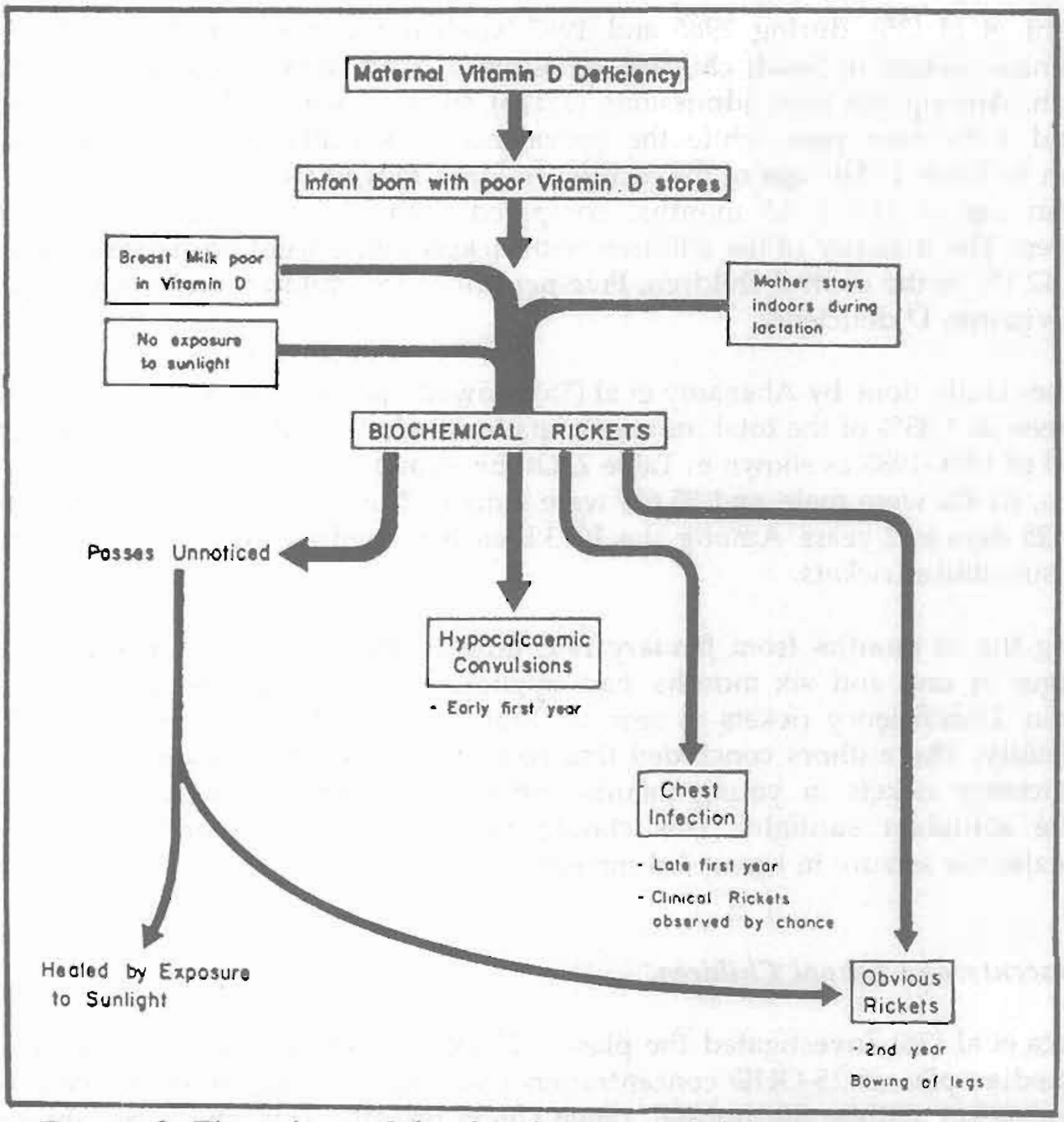

FIGURE 2. Flow chart of the development of rickets (49).

to the loss of the active transplacental calcium pump and a lack of vitamin D stores. This shows as neonatal hypocalcemia in some (16, 32). The others might show later, depending on vitamin D content of the milk and exposure to the sun (33). If these infants are breast-fed and not exposed to sunshine, development to rickets becomes inevitable, particularly in light of the mothers belief that the sun will hurt their infants (33). Infants born with adequate vitamin D stores do not need vitamin D supplements to breast-feeding for the first six months of life (34). From the available evidence, a conclusion could be drawn that maternal vitamin D deficiency could be contributory to rickets in infants (19) which can be demonstrated in Figure 2.

Sedrani et al (35), during 1986 and 1987, studied the prevalence of clinical and subclinical rickets in Saudi children admitted to Sulimania Children's Hospital in Riyadh. Among the total admissions (16125), the prevalence of clinical rickets was around 1.3% each year, while the prevalence of subclinical rickets was 3.1% as shown in Table 1. The age of the rachitic children ranged from 1 to 36 months with a mean age of 11.5 ± 4.5 months, compared with 11.6 ± 4.7 months in control children. The majority of the children with rickets (88%) were breast feed compared with 42.1% in the control children. Five percent of the children under 6 years of age were vitamin D deficient.

Another study done by Abanamy et al (36) showed that vitamin D deficiency rickets was seen in 1.83% of the total number of patients admitted during the three years, a period of 1986-1988 as shown in Table 2. Of this group of rachitic patients, 81% were Saudis, 64.4% were male and 35.6% were female. The age of those patients ranged from 25 days to 2 years. Among the 1213 breastfed children, 85 (7%) were found to have subclinical rickets.

During the 42 months from January 1985 through June 1988, five infants between the ages of one and six months had hypocalcemic convulsions associated with vitamin D deficiency rickets as seen in Table 3 (37). All were boys and of Saudi nationality. The authors concluded that convulsions is a manifestation of vitamin D deficiency rickets in young infants and are not uncommon in Saudi Arabia despite abundant sunlight. This should be considered as a probable cause for hypocalcemic seizure in breast fed infants.

Adolescents and School Children

Fonseca et al (38), investigated the plasma 25-OHD level in 31 adult Saudi women. The median plasma 25-OHD concentration was 6 ng/ml. Only three women, had a concentration within the normal range (10-55 ng/ml). This study recommended exposure to sun light.

Circulating 25-OHD levels were measured by Woodhouse and Norton (39) in 134 adults; 82 Saudi Arabian patients, 43 normal Saudi Arabian and nine Western persons living in the same area, as shown in Table 4. The mean circulating 25-OHD was much lower in the normal Saudis (3.6 ng/ml) and Saudi patients (3.2 ng/ml) than in Westerners (17.1 ng/ml). There was no significant difference between the mean, normal Saudi male (3.9 ng/ml) and female (3.2 ng/ml) values, but rural Saudi (4.18 ng/ml) were higher than urban Saudi (3.14 ng/ml). The authors concluded that the circulating level of 25-OHD is low in Saudi population, which might result from a poor dietary intake and reduced synthesis of vitamin D by the skin, since both men and women are avoiding sunshine exposure and completely cover their skin with clothing.

Sedrani et al (40), measured serum levels of 25-OHD in 59 university students, 26 males and 33 females, aged 18 to 26 years and in 24 elderly subjects, 13 males and 11 females, with a mean age of 62±13 years as seen in Table 5. The level of 25-OHD was significantly lower in the elderly than in young adults of both sexes, and was significantly higher in females than in males. They concluded that the low vitamin D status in Saudis is mainly due to avoidance of sunlight exposure.

Sedrani et al conducted a series of studies aimed to determine the vitamin D status of Saudis (9, 41-43). The first study (41) included (4078) males and females living in different regions in Saudi Arabia. The age of the volunteers ranged from <6 years up to 90 years, this is shown in Table 6. No significant difference was detected in the plasma levels of 25-OHD between overall children (16.5 ± 8.1 ng/ml), and overall adults (16.5 ± 7.8 ng/ml). Male children, <6 years of age, have significantly higher level than older subjects, whereas the female adolescents (age 13-18 years) and preschool children have the lowest plasma 25-OHD level in comparison with the other groups. No significant correlation was detected between plasma 25-OHD and age. Saudi males have significantly higher 25-OHD than females.

The studied population was divided next into five groups on the basis of their geographical location and lifestyles and this is shown in Tale 7. The lowest 25-OHD plasma concentrations were observed in the population living in the northern province (14 ± 7.7 ng/ml children, 11.4 ± 7.0 ng/ml adults) and the highest of the western province (19.5 ± 9.1 ng/ml children, 18.3 ± 8.0 ng/ml adults). This holds true whether the subjects are males, females, children or adults. Regardless of age and sex, comparison between the plasma 25-OHD levels in urban and rural population shows that the latter have significantly higher levels (17.5 ± 8.3 ng/ml) than urban people (16.3 ± 7.9 ng/ml).

Next, the frequencies of insufficient (below 5 ng/ml) and low (5-10 ng/ml) plasma concentrations of 25-OHD have been investigated by same authors and this is seen in Table 8. The frequency of low 25-OHD is high for children (21.9%) and for adults (20.4%), whereas the frequency of 25-OHD insufficiency in these two groups is 3.4% and 5.5% respectively. These proportions were unaffected by whether the populations were from an urban or rural background. The frequency of low 25-OHD levels was higher in females than in males at any given age. The most affected females were adolescents and adults. It was observed that on males the frequenc[illegible] 25-OHD insufficiency increased with age.

Finally, the plasma 25-OHD concentration in the Saudi population was s[illegible] in relation to seasonal variations in term of the amount of ultraviolet [illegible]ation reaching the earth's surface in Riyadh and this is shown in Figure 3. T[illegible] asma

Table 1. Plasma 25-(OH)D, 1,25-(OH)D, calcium, phosphorus and alkaline phosphatase activity in rachitic children and controls

Subject	No.	25-(OH)D (ng/ml)		$1,25(OH)_2D$ (pg/ml)		Ca (mg/dl)		P (mg/dl)		Alkaline Phosphatase acitivy (IU/litre)	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Males											
Rachitic	72	6.9	4.0	17.1	11.6	8.1	1.4	3.9	1.0	875	504
Control	45	16.7	10.5	32.4	16.0	9.4	0.5	5.9	1.4	302.6	87.1
Females											
Rachitic	25	7.4	4.9	17.4	9.8	8.8	1.2	4.2	1.4	854	506
Control	31	18.9	13.9	35.4	20.5	9.5	0.5	5.4	1.3	268.1	79.5

Sedrani, S. H., *et al*, 1992 (35)

Table 2. Vitamin D metabolites.

Patients	25 OHD_3 (nmol/L)			1.25 $DiOHD_3$ (pmol/L)	
	No.	Mean	Range	Mean	Range
Male					
Rachitic	78	17.2	7.2-27.2	7.1	2.2-11.9
Control	54	41.6	15.4-67.8	13.5	2.6-20.1
Female					
Rachitic	25	18.4	6.2-36.2	7.2	3.1-11.3
Control	31	47.1	12.4-81.8	14.7	6.2-23.2

25 OHD_3 = 25 hydroxy D_3; 1.25 $DiOHD_3$ = 1.25 dihydroxy D_3

Abanamy, A., *et al*, 1983 (36)

Table 3. Features at presentation of infants with vitamin D deficiency rickets and convulsions

Patient no.	Symptoms at admission	Age (mo)	Serum biochemical findings in infants						Maternal serum alkaline phosphatase (U/L)
			Calcium (mmol/L)	Phosphorus (mmol/L)	Alkaline Phosphatase (U/L)	25 OHD (nmol/L)	1,25 (OH)D (nmol/L)	PTH Cterm (ng/L)	
1	Fever, generalized seizures	3	1.33	1.29	968	12.48	276.0	2050	646
2	Apnea, seizures	4	1.30	1.71	980	19.97	-	587	98
3	Diarrhea, convulsions	4	1.75	1.84	608	5.00	--	--	--
4	Cyanosis, generalized stiffness	5	1.25	1.13	1372	5.00	213.6	1850	-
5	Fever, cough, generalized stiffness	5.5	1.60	0.93	3480	7.50	172.8	-	120
	Normal range		2.00-2.60	1.45-2.10	71-247	35-200	60-108	410-1760	28-149

Mathew, M.P. *et al*, 1991 (37).

Table 4. 25-OHD levels in normal subjects

Subjects	Mean 25-OHD ± S.D.	P-value
Western	17.1 ± 9.7	<0.01
Saudi:		
All	3.6 ± 2.3	
Females	3.2 ± 1.9	>0.1
Males	3.9 ± 2.5	
Urban	3.14 ± 2.12	
Rural	4.18 ± 2.82	<0.05

Woodhouse, N. J. Y, *et al*, 1982 (39)

Table 5. **Serum levels of 25-(OH)D_3 in young male, female, and elderly Saudi subjects and the concentrations of 1,25- and 24, 25-$(OH)_2D_3$ in normal adult Saudi males (mean ± SD)**

Parameter	Young males	Young females	Elderly subjects
25-(OH)D_3 (ng/ml)	8.4 ± 3.1 (26)*	11.5 ± 4† (33)	3.6 ± 1.3‡ (24)
24, 25-$(OH)_2D_3$ (ng/ml)	1.6 ± 1.0 (21)*		
1, 25-$(OH)_2D_3$ (pg/ml)	58.7 ± 17.4 (21)*		

* No of subjects

† Significantly different ($p<0.001$) from young male and elderly values.

‡ Significantly different ($p<0.001$) from young male and female values.

Sedrani, S. H., *et al.*, 1983 (40).

Table 6. The mean, standard deviation, min, max and normal reference ranges for 25-OHD (ng/ml) in relation to sex and different ages

Statistics	Age (years)									
	≤ 6		6 - 12		13 - 18		19 - 45		≥ 45	
	M	F	M	F	M	F	M	F	M	F
Sample size	52	38	679	425	707	496	821	580	121	159
Mean	20.1	15.2	16.6	16.6	17.4	14.4	16.5	16.3	18.4	19.3
SD	10.3	7.5	7.9	7.9	8.0	7.7	7.6	7.7	7.5	9.8
Minimum	2.4	4.1	1.1	2.0	2.1	1.0	2.2	1.3	2.9	2.3
Maximum	41.1	31.2	50.4	42.8	49.0	49.6	47.6	40.9	47.8	49.6
Reference range										
1. Mean ± 2 SD	20.1±20.6	15.2±15.0	16.6±15.8	16.6±15.8	17.4±16.0	14.4±15.4	16.5±15.2	16.3±15.4	18.4±15	19.3±14.6
2. Percentile 2.5th-97.5th	4.5-36.0	4.0-30.4	5.3-37.1	5.5-35.8	5.4-36.3	3.6-34.0	4.3-33.9	3.7-35.0	3.6-32.2	2.0-48.0
Level of significance	***		NS		***		NS		NS	

Comparisons significant at the 0.05 level are indicated by ***.

Sedrani, S. H., *et al*, 1992 (41)

Table 7. The mean, standard deviation, min, max, and normal reference ranges for 25-OHD (ng/ml) in males and females living in different geographical location

Statistics	Geographical location									
	Eastern province		Northern province		Middle province		Southern province		Western province	
	M	F	M	F	M	F	M	F	M	F
Sample size	147	205	193	71	1372	1122	206	55	462	245
Mean	16.2	15.5	14.7	10.4	16.8	15.6	15.6	17.6	19.4	18.1
SD	6.6	7.2	8.2	4.0	7.4	7.9	8.6	10.1	8.7	8.6
Minimum	2.2	2.0	1.7	2.9	2.3	1.0	1.1	2.3	2.3	3.4
Maximum	37.2	35.9	42.7	20.0	50.4	49.6	47.2	4.8	49	44.3
Reference range										
1. Mean ± 2 SD	16.2±4.4	15.5±14.4	14.7±16.4	10.4±8.0	16.8±14.8	15.6±15.8	15.6±17.2	15.6±20.2	19.4±17.4	18.1±17.3
2. Percentile 2.5th-97.5th	4.0-29.5	4.1-32.3	2.6-34.0	3.2-18.5	5.7-34.4	4.1-35.5	3.1-39.4	2.0-39	6.1-38.3	5.6-40.3
Level of significance	NS		***		***		NS		NS	

*** Comparisons significant at the p=0.05 level.

Male in middle province vs male in southern, western or northern ***. Male in northern province vs male in western***. Male in southern province vs male in western***. Male in eastern province vs male in western***.

Female in middle province vs female in western or northern***. Female in northern vs any other province***. Female in western province vs female in eastern***.

Sedrani, S. H. *et al*, 1992 (42).

Table 8. Frequency of insufficiency (< 5 ng/ml) and low levels (5-10 ng/ml) of 25-OHD in Saudi population in relation to age and sex

Population	Sample size	Cases with 25-OHD 5-10 ng/ml		Cases with 25-OHD <5 ng/ml	
		No.	%	No.	%
1. All children	2165	474	21.9	74	3.4
male children	1194	231	19.3	35	2.9
female children	805	206	25.6	33	4.1
2. All adults	1913	390	20.4	105	5.5
adult males	1110	183	16.5	45	4.1
adult females	823	217	25.8	61	7.4
3. Age (Years)					
<6 M	52	12	22.6	2	3.8
F	38	9	23.7	2	5.3
6-12 M	679	131	19.3	18	2.6
F	425	98	22.5	15	3.4
13-18 M	707	120	17.0	20	2.8
F	496	158	31.9	33	6.7
19-45 M	821	174	18.0	34	4.1
F	580	136	23.4	40	6.9
> 45 M	121	17	14.3	10	7.9
F	159	31	19.7	8	4.9
4. All males	2380	428	18.0	83	3.5
5. All females	1698	435	25.6	98	5.8

Sedrani, S. H., *et al*, 1992 (9)

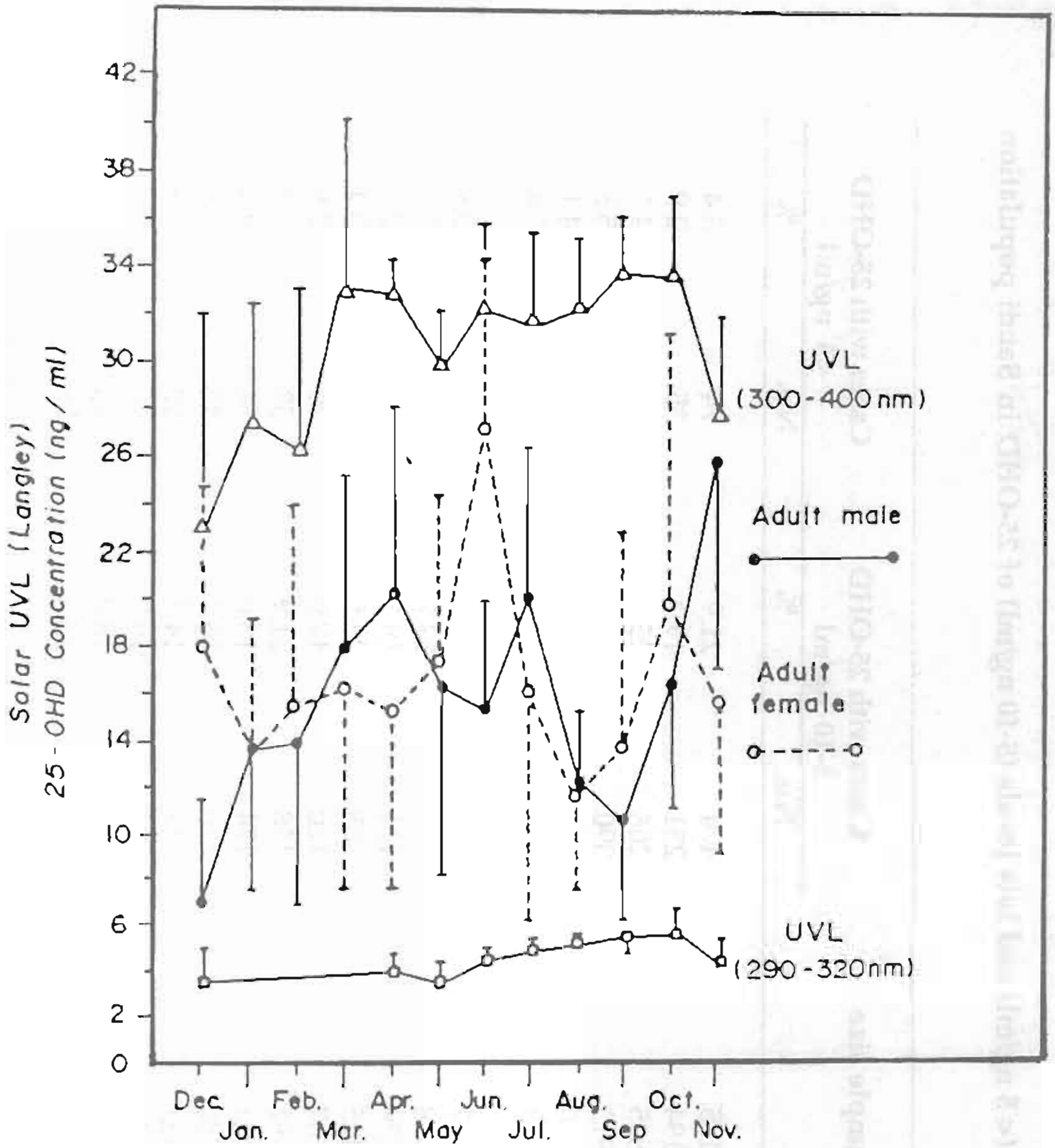

Figure 3. Plasma levels of 25-(OH)D in adult males and females in relation to UVL reaching the earth's surface. Note the solar UV radiation was monitored for the Riyadh region while populations are from the whole country. (43)

concentration of 25-OHD in adult males gradually increased from the lowest value recorded in December (6.6 ± 4.7 ng/ml) reaching a peak value in April (20.1 ± 7.6 ng/ml). After this, the concentration fluctuated during the summer months, reaching low value in September (10 ± 4.2 ng/ml). The variations in the concentration of 25-OHD in adult females showd relatively similar pattern to that of adult males. The authors concluded that the variations in the circulating concentration of 25-OHD in the Saudi population do not follow the seasonal variations in the amount of ultraviolet light.

FACTORS AFFECTING THE PREVALENCE OF VITAMIN D DEFICIENCY

By reviewing the literature, the existence of vitamin D deficiency in Saudi Arabia could be referred to the following factors:

- Overdressing of the babies with limited sunlight, and keeping them in badly illuminated houses (35, 40).
- 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 to start with (20, 36).
- Dietary vitamin D intake has been calculated at approximately one-tenth of the daily intake of that in the United States of America (39).
- Both men and women are deprived of sunlight as their traditional dress covers the skin almost completely (35).
- An increase in ultra-violet light insulation due to atmosphere dust particles could be one of the factors responsible for vitamin D deficiency in Saudi Arabia (11).
- Individuals whose foods contain excess phytate requires more vitamin D since the phytate combines with calcium and decreases its absorption (44). This could be another added factor producing deficiency in Saudis since whole wheat pita bread and cereals, which are rich in phytate, form an essential part of the Saudi diet.
- Genetic factors associated with rickets also exists in Saudi Arabia, either as familial vitamin D resistance rickets (45), vitamin D dependent rickets (46), or congenital hypoparathyroidism (47), and other forms of inborn errors of metabolism (48).

STRATEGIES FOR THE PREVENTION AND CONTROL OF VITAMIN D DEFICIENCY

Several measures must be taken into consideration when dealing with vitamin D deficiency:

1. The need for better illuminating of houses by sunlight, yet maintaining privacy.
2. Vigorous mass media campaigns against excessive and unnecessary wrapping of babies.

3. Educating the mothers about the importance and benefits of the sunshine in a land of plenty.
4. Health education, including dietary advice, should be given to the community.
5. Supplementation with vitamin D, or a diet adequate in calcium and phosphorus, effectively controls rickets.
6. Screen breast-fed children to detect subclinical forms of rickets.
7. Educate the public about the importance of sunlight exposure and diversification of intake of nutrients.

CONCLUSION

In conclusion, these studies have shown that vitamin D deficiency does exist in Saudi Arabia and further ameliorative measures are needed to eliminate this public health problem.

REFERENCES

1. Haussler, M. R. and McCain, T. A. Basic and clinical concepts related to vitamin D metabolism and action. *N. Engl. J. Med.* 1977; 297: 974-983.
2. DeLuca, H. F. Vitamin D and its Metabolites. In: *Modern Nutrition in Health and Disease.* M. E. Shils and V. R Young (editors). Philadelphia: Lea & Febiger; 1994
3. Haddad, J. G. Jr. and Hahn, T. Natural and synthetic sources of circulating 25-hydroxy-vitamin D in man. *Nature.* 1973;244: 515-516.
4. Lawson, D. E., Paul, A. A. and Black, A. E. Relative contribution of diet and sunlight to vitamin D status in the elderly. *Br. Med. J.* 1979; 2: 303-305
5. Poskit, E. M., Cole, T. J. and Lawson, D. E. Diet, sunlight, and 25-hydroxy-vitamin D in healthy children and adults. *Br. Med. J.* 1979; 1: 221-223.
6. Poncron, G., Kennan, A. L. and DeLuca, H. F. "Activation" of vitamin D by the liver. *J. Clin. Invest.* 1969; 48: 2032-2037.
7. Lawson, D. E., Fraser, D. R. and Kodicek, E. Identification of 1, 25-dihydroxy-cholecalciferol, a new kidney hormone controlling calcium metabolism. *Nature.* 1971; 230: 228-230.
8. Stamp, T. C. Factors in human D nutrition and in the production and cure of classical rickets. *Proc. Nutr. Soc.* 1975; 34: 119-130.
9. Sedrani, S. H., Al-Arabi, K., Abanmy, A. and Elidrissy, A. Vitamin D status of Saudi: III. Prevalence of inadequate plasma 25-hydroxyvitamin D concentrations. *Saudi Med. J.* 1992; 13: 214-219.
10. DeLuca, H. F. and Harrison, H. C. *Vitamin D Metabolism and Function.* Berlin: Springer Verlag 1979: 44.
11. Hannan, M. H., El-Yazigi, A., Al-Watban, F. A. and Feteih, N. Measurement of solar ultraviolet-β in Riyadh: its significance in studies of vitamin D deficiency in Saudi Arabia. *King Faisal Specialist Hosp Med. J.* 1983; 4(4): 307-312.
12. Sedrani, S. H. Low 25-hydroxyvitamin D and normal serum calcium concentrations in Saudi Arabia: Riyadh region. *Ann. Nutr. Metab.* 1984; 28(3): 181-185.
13. Serenius, F., Elidrissy, A. T. and Dandona, P. Vitamin D nutrition in pregnant women at term and in newly born babies in Saudi Arabia. *J. Clin. Pathol.* 1984; 37: 444-447.
14. Gaffar, T. H., Elidrissy, A. T. and Sedrani, S. H. Effect of pregnancy on the circulating level of 1, 25-dihydroxy vitamin D. (Unpublished data).
15. Mograhby, S. A., Al-Shawaf, T. and Akiel, A. The effect of parity on vitamin D metabolites. (Unpublished data).

16. Taha, S. A., Dost, S M. and Sedrani, S. H. 25-hydroxyvitamin D and total calcium: extraordinarily low plasma concentration in Saudi mothers and their neonates. *Pediatr. Res.* 1984; 18(8): 739-741.
17. Congdon, P., Horsman, A. and Kirby, P. A. Mineral content of the forearms of babies born to Asian and white mothers. *Br. Med. J.* 1983: 286: 1233-1235.
18. Bahijri, S. M., Ajabnoor, M. A. and Karim, A. Final Report for project 044/408, 1990.
19. Elidrissy, A. T. and Taha, S. A. Rickets in Riyadh. Proceeding of the 5th Saudi Medical Meeting. Riyadh, 1980: 409-418.
20. Elidrissy, A. T. Protein-Calori nutrional status of infants with deficiency rickets in Riyadh. *Ann. Saudi Med.* 1986; 6(2): 101-105.
21. Ford, J. A., Davidson, D. C. and McIntosh W. B. Neonatal rickets in Asian immigrant population. *Br. Med. J.* 1973; 3: 211-222.
22. Moncreiff, M. and Fadahunsi, T. O. Congenital rickets due to maternal vitamin D deficiency. *Arch. Dis. Child.* 1974; 49(10): 810-811.
23. Elidrissy, A. T., Sedrani, S. and Lawson, D. E. Vitamin D deficiency in mothers of rachitic infants. *Calcif. Tissue. Int.* 1984; 36(3): 266-268.
24. Belton, N. R., Elidrissy, A.T. and Gaffar, T. H. Maternal vitamin D deficiency as a factor in the pathogenesis of rickets in Saudi Arabia. In: Norman, A. W., Schefer, K., Herrath, D. V. and Grigoleit, H. G., eds. *Vitamin D Chemical, Biochemical and Clinical Endocrinology of Calcium Metabolism.* Proceeding of the fifth workshop on vitamin D; Williamsburg, Virginia, USA. Berlin: Walter deGruyter, 1982: 735-737.
25. Elidrissy, A. T., Serinius, F., Swailem, A. R. and Dandona, P. Low prenatal vitamin D level and its relation to infantile rickets in Saudi Arabia. Abstracts from Symposium on clinical disorders of bone and mineral metabolism. Dearborn, Michigan, 1983.
26. Pitkin, R. M. Calcium metabolism during pregnancy and its effects on the fetus and newborn. *Pediator. Adol. Endocrinol.* 1979: 5: 67.
27. Gertner, J. M., Glassman, M. S., Coustan, D. R. and Goodman, D. B. Fetomaternal vitamin D relationship at term. *J. Pediatr.* 1980; 97(4): 637-640.
28. Fleishman, A. R., Rosen, J. F. and Cole, J. Maternal and fetal serum 1,25-dihydroxy-vitamin D levels at term. *J. Pediatr.* 1980; 97(4): 640-642.
29. Kumar, R., Cohen, W. R. Silva, P. and Epstein, F. H. Elevated 1, 25-dihydroxy-vitamin D plasma levels in normal human pregnancy and lactation. *J. Clin. Invest.* 1979; 63(2) : 342-344.
30. Weisman, Y., Harell, A., Edelstein, S. and David, M. 1, 25-dihydroxy-vitamin D3 and 24, 25-dihydroxy-vitamin D3 in vitro synthesis by human decidua and placenta. *Nature.* 1979; 281: 317.
31. Kuoppala, T., Tuimala, R. and Parviainen, M. Can the fetus regulate its calcium uptake? *Br. J. Obstet. Gynaecol.* 1984; 91(12): 1192-1196.
32. Brooke, O. G., Brown, I. R. and Bone, C. D. Vitamin D supplements in pregnant Asian Women: Effects on calcium status and fetal growth. *Br. Med. J.* 1980; 280: 751-754.
33. Elidrissy, A. T., El-Swallem, A. R. and Belton, N. R. 25-hydroxyvitamin D in rachitic, nonrachitic and marasmic children in Saudi Arabia. In: Norman, A. W., Schaefer, K., Herrath, D. V. and Grigoleit, H. G., eds. *Vitamin D Chemical, Biochemical and Clinical Endocrinology of Calcium Metabolism.* Proceedings of the fifth workshop on vitamin D, Williamsburg, Virginia, USA. Berlin: Walter de Gruyter, 1982: 617-619.
34. Birkbeck, J. A. and Scott, H. F. 25-hydroxy-cholecalife-rol serum levels in breast-fed infants. *Arch. Dis. Child.* 1980; 55(9): 691-695.
35. Sedrani, S. H., Abanmy, A., Salman, H., *et al.* Vitamin D status of Saudis: Are Saudi children at risk of developing vitamin D deficiency rickets? *Saudi Med. J.* 1992; 13: 430-433.
36. Abanamy, A., Salman, H., Cheriyan, M. and Shuja, M. Vitamin D deficiency rickets in Riyadh. *Ann. Saudi Med.* 1991; 11(1): 35-39.
37. Mathew, P. M. and Imseeh, G. W. Convulsions as a possible manifestation of vitamin D deficiency rickets in infants one to six months of age. *Ann. Saudi Med.* 1992; 12(1): 34-37.
38. Fonseca, V., Tongia, R., El-Hazmi, M. and Abu-Aisha H. Exposure to sunlight and vitamin D deficiency in Saudi Arabian Women. *Postgraduate Med. J.* 1984; 60 (707): 589-591.

39. Woodhouse, N. J. Y. and Norton, W. L. Low vitamin D levels in Saudi Arabians. *King Faisal Specialist Hospital Med. J.*; 1982, 2(3): 127-131.
40. Sedrani, S. H., Elidrissy, A. T. H. and El-Arabi, K. M. Sunlight and Vitamin D status in normal Saudi subjects. *Am. J. Cin. Nutr.* 1983; 38: 129-132.
41. Sedrani, S. H., Al-Arabi, K., Abanmy, A. and Elidrissy, A. Vitamin D status of Saudis. I. Effect of age, sex and living accommodation. *Saudi Med. J.* 1992; 13(2): 151-158.
42. Sedrani, S. H., Al-Arabi, K., Abanmy, A. and Elidrissy, A. Vitamin D status of Saudis. II. Effect of regional and environmental location. *Saudi Med. J.* 1992: 13(3): 206-213.
43. Sedrani, S.H., Al-Arabi, K., Abanmy, A. and Elidrissy, A. Vitamin D status of Saudis. IV. Seasonal Variations. *Saudi Med. J.* 1992; 13(5): 423-429.
44. Commings, J. H., Hill, M. J., Houston, H., *et al.* The effect of meat protein and dietary fiber on colonic function and metabolism. I. Changes in bowel habit, bile acid excretion and calcium absorption. *Am. J. Clin. Nutr.* 1979; 32: 2086-2093.
45. Al-Ageel, A., Ozand, P., Sobki, S., *et al.* The combined use of intravenous and oral calcium for the treatment of vitamin D dependent rickets type II. *Clin. Endocrinol. Exp.* 1993; 39: 229-237.
46. Degheishem, S. M. Sedrani, S. H., Van-Baelem, H., *et al.* Distribution of group specific component/vitamin D binding protein subtypes in Saudi Arabia. *Hum. Hered.* 1991; 41: 53-56.
47. Sanjad, S. A., Sakati, N. A., Abu-Osba, Y. K., *et al.* A new syndrome of congenital hypoparathyrioidism, severe growth failure, and dysmorphic features, *Arch. Dis. Child.* 1991; 66: 193-196.
48. Mohammed, S., Addae, S., Suleiman, S., *et al.* Serum calcium, parathyroid hormone, and vitamin D status in children and young adults with sickle cell disease. *Ann. Clin. Biochem.* 1993; 30: 45-51.
49. Elidrissy, A. T. H. Vitamin D deficiency rickets in a sunny country: Pathogenesis, clinical pitcher and management. *Ann. Sadi. Med. 1987;* 7(2): 119-125.

THE NEED FOR FOOD FORTIFICATION TO COMBAT MICRONUTRIENT DEFICIENCIES IN KUWAIT

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INTRODUCTION

Under-nutrition does not pose a serious public health problem in Kuwait, but the nutritional problems arising out of affluence, such as obesity, diabetes, hypertension and heart disease, and those associated with iron deficiency (anaemia) have emerged. The Kuwaiti diet is rich in high-fat and high-sugar foods, and coupled with lack of physical exercise. This situation is now becoming more serious among women and even children. According to the Ministry of Public Health statistics, a high percentage of Kuwaiti women suffer from obesity and Kuwait comes in first place for the percentage of overweight women compared to other Gulf states. The obesity is said to be the main cause of other obesity-related diseases including diabetes, high blood pressure and ischemic heart disease.

But one should not get misguided by the abundance of food available in the supermarkets in any country. A significant proportion of population could have nutrients intake well below the RDA. This is true for USA, Australia, England, France, Germany, Switzerland and Canada (1) and the State of Kuwait has no exception. A small but significant percentage of the population is reported to have marginally low intake of few important nutrients like vitamins A, C, D, B1, B2, niacin, folacin and minerals like iron, magnesium, zinc, and calcium (2,3,4,5). In spite of higher proportion of animal products in Kuwaiti diet, the prevalence of iron deficiency anaemia in children, adolescents, pregnant and lactating women is a matter of concern. Recently, Dawood et al (5) reported the prevalence of anaemia in Kuwaiti pregnant women and other Arab women to be 36.8% and 43.9%, respectively. Their results showed the prevalence of anaemia increased as the gestation advanced and the prevalence was higher among multipara than among primigravida. Eid et al (6) found that 13% of the boys and 26% of the girls were anaemic.

In the last two decades, Kuwait has undergone great progress in all aspects of life and there has been an increased emphasis on the improvement of health standards and facilities. The information so far available on the nutritional status of Kuwait population indicates that anaemia is prevalent in children, pregnant and lactating mothers. This situation could result in nutritional deficiency diseases. In another survey on the assessment of nutritional status, 15% of men and 19% of women in Jahra area showed clinical deficiency signs of vitamin A, respectively (3, 7). Their findings were further supported by the biochemical and dietary history analysis. The presence of vitamin B deficiencies were also revealed by the clinical and dietary history analysis. Aneamia was reported in 9.4% of men and 17.9% of women. A low intake of iron among females was also revealed by their findings. Based on this, they suggested the fortification of staple foods with vitamins and minerals.

STRATEGIES TO COMBAT NUTRITIONAL PROBLEMS

The above studies carried out in Kuwait have recommended a number of intervention programmes directed towards the fortification of some commonly consumed foods to combat the nutritional deficiency diseases prevalent among infants, preschool children, adolescents, pregnant and lactating women. Two approaches are suggested to tackle these nutritional problems: The fortification of certain commonly consumed basic foods with important nutrients and nutrition education.

Food Fortification

The increasing use of convenience foods, refining and processing decrease the available nutrients unless they are added to the ingredients. For example, during white flour milling, most of the nutrient rich portions like germ and bran are removed. This reduces the thiamine by 77% and the niacin, riboflavin and iron by about 66-72% (8). The same is true in the processing of other foods like rice, fruit juices, vegetable juices, liquid milk and other products. To restore their nutritional status, nutrification is very important. Thus the production of nutrient-dense food products would be suitable for all the vulnerable sections of population. Instead of snacks rich in sugars and fats, these nutrient-dense foods could be made available in school canteens so that children could have better choice in selecting snacks during school recess.

The various foods which could be fortified with some of the important vitamins and/or minerals are wheat flour, milled rice, biscuits, potato chips, wafers, extruded snacks, liquid milks, fats and oils, butter, margarine, sugar salt, fruit juices and fruit-flavored milks. The food industry needs to think seriously to fortify these foods with appropriately selected nutrients like iron, calcium, iodine, copper, zinc, vitamin A, D, E, B_1, B_2, B_{12}, folic acid, pantothenic acid and niacin. The economic and nutritional considerations favour fortification of foods with multiple nutrients. Multiple micronutrient deficiencies tend to coexist in the same population, and a multiple nutrient fortification may be more cost-effective and attractive proposition under such situations. The Kuwait Institute for Scientific Research has the infrastructure and is in a position to provide the necessary support to the food industry to investigate the technological possibility of adding these nutrients to foods and their stability during processing, storage as well as distribution. The bioavailability of some of these nutrients (especially minerals), can also be studied, with the overall objective of eliminating or significantly reducing the occurrence of nutritional deficiency diseases among the vulnerable population. A note of caution is that we should not fortify those foods whose consumption we wish to discourage, but only those need to be fortified whose consumption is to be increased.

Advantages of food Fortification

Food fortification is affordable, has a small expense and can quickly reach large number of consumers. The major costs in processed foods comes from basic raw materials, energy consumption during processing, and the packaging materials, while the cost of vitamins and minerals required for nutrification usually represents a much smaller fraction of the total cost of nutrified products. The additional cost of fortifying a food product is commonly less than 2% of the retail price of the nufortified product. Fortification is effective and its ultimate effect on the micronutrient status of population can be detected and politically attractive. A major advantage of food fortification is that change in feeding pattern is not required. The consumer uses the fortified food in a normal way. The risk of toxicity is negligible.

When a person (who is either dieting or due to some physiological stress) takes lower amount of food, the requirements for most essential nutrients do not decrease in the same manner. Also the sedentary life styles and lack of physical exercise has lowered the daily caloric needs of Kuwaiti population. As one consumes lower quantity of food, it is necessary to increase the nutrient density of foods being consumed by such segment of the population. Fortification of foods is one means of increasing nutrient density (10). Many nutrition surveys in the developed and developing countries have shown that an appreciable proportion of the population, especially the young children, adolescents, elderly and women of child-bearing age can suffer from nutrient deficiencies. Fortification of foods with nutrients is a logical tool for the control of malnutrition prevailing in these countries and undoubtedly, fortification will increase in the future (11). It now seems reasonable that the science and technology of food nutrification will gradually be applied in all countries of the world and hopefully, this will promote an equitable distribution of world's food resources to provide a good healthy diet to everyone (12).

Success of Food Fortification

For the success of any food fortification programme in the State of Kuwait, motivation and commitment of the government and food industry are necessary. Simply passing a legislation or convincing a few food producers to fortify their products is not sufficient. Though the governments are more aware of the need of food fortification, but the food processors are still reluctant to improve the nutritional quality of their products. Preparation of suitable food standards for fortified foods, nutrition labeling guidelines for the food industry, and harmonization of food standards among GCC countries are a pre-requirement. Proper quality control and monitoring of fortified foods by the Ministry of Commerce and Industry, is essential. Lack of properly established quality control and monitoring systems is most often the cause of discontinued or poorly implemented food fortification programs. After implementing food fortification program, the Ministry of Health, needs to study the effect of such a program on consumer health.

There is a wide spread belief that food fortification technology is complex, but the reverse is true. Practically for all micronutrients, a simple fortification technology is available which can easily be adapted to suit local conditions and utilized at low cost. Appropriate legislation needs to be implemented effectively, of course with the active cooperation and commitment of food industry. Food subsidies need to be rationalized so as to encourage people to consume more of nutritious foods. As the extra cost of food fortification is practically negligible, all of the cost of fortification may either be borne by the Government or by the consumer. If the food industry is forced to bear this cost of fortification, it may prove a disincentive to them. By consuming nutritious foods, the consumers would reap the benefit of good health, thus increasing productivity and at the same time lowering his medical care costs.

CONCLUSION

Two major nutrition related problems in Kuwait are obesity and anaemia. Obesity is likely to be due to increased calorie intake coupled with decreased physical activity. Another serious nutritional problem is iron deficiency anaemia, for which the most vulnerable groups are adolescents girls, and pregnant and lactating women. To meet their increased nutritional needs for a number of micronutrients, the consumption of nutrient-dense foods needs to be encouraged so as to avoid unnecessary increase in body weight. Fortification of commonly consumed basic foods with appropriate micronutrients could meet this important requirement. The food fortification costs need to balanced against the cost of not implementing such a program, which may arise from health factors like disease, impaired physical and mental growth, medical care costs, dietary imbalances, and decreased productivity. Fortification is an emerging technology concerning the nutritional needs of the infants, adolescents, women of child bearing age and the elderly. Nutrition education and food fortification must go hand in hand, as we need to use both of these approaches for eradicating nutritional disorders from the society. Fortification is here to stay because there is a need and responsibility to apply the available knowledge, resources and technology in food science for the efficient production, processing, storage and distribution of food for the benefit of mankind.

REFERENCES

1. Brin, M. Marginal micronutrient deficiency, In: "Nutrition addition to foods" J.C. Bauernfeind and P. A. Lachance (eds.) *Food & Nutrition Press, Inc. Ct, USA,* 1991.
2. Al-Shawi, A. Nutrient intakes of university women in Kuwait. *J. Royal Soc. Health,* 1992.
3. Mostafa, S. and Nuwahed, H. *Nutrition Status Assessment of Adults.* I. Kuwaiti. Nutrition Unit, Dept. of Public Health & Planning, Ministry of Public health, Kuwait, 1981.
4. Kamel, B. S. and Martinez, O. B. Food availability for Kuwaiti and non-Kuwaiti household. *Ecol. Food Nut.* 1984, 15: 191-201.
5. Dawood, J. S., Prakash, P and Shubber, K. M. R. Iron deficiency anaemia among pregnant Arab women in Kuwait. *J. Kwt. Med. Assoc.,* 1990, 24(2): 167-172

6. Eid, N., Al-Hooti, S., Bourisl, N. and Khalafawi, M. Anaemia in school children: A preliminary study. *J. Kut Med. Assoc.* 1986, 20: 39-43.
7. Mostafa, S. and Nuwayhed, H. Nutrition status assessment of adults. I. Non-Kuwaiti. Nutrition Unit, Dept. of Public Health & Planning, Ministry of Public Health, Kuwait, 1982.
8. Nelson, J. H. Wheat: Its processing and utilization. *Am. J. Clin. Nutr.* 1985, 41: 1070-1076.
9. Mora, J. O. Issues in food fortification-lessons from Latin America. *Nutriview.* F. Hoffman-La Roche AG, Newsletter Issue No. 4, Basel, Switzerland, 1995.
10. Quick, J. A. and Murphy, C. W. *The Fortification of Foods:* A Review. Agr. Handbook No. 598. USDA, Washington, D. C., 1982.
11. Hegested, D. M. *Food fortification.* In "In the Community", D. S. McLaren (ed.) John Wiley & Sons, New Yourk, 1976.
12. Tepley, L. J. Food fortification. In "Man, Food and Nutrition", *M. rcheigl, Jr. (ed.). CRC Press, Boca Raton.*, 1974.

MICRONUTRIENT DEFICIENCIES IN WOMEN AND CHILDREN IN THE ARAB WORLD-STRATEGIES FOR CONTROL

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INTRODUCTION

Deficiencies of iodine, vitamin A and iron today affect millions of people all over the world, among which women and children are the worst sufferers because of socio-cultural and biological reasons. Considering monthly iron loss through menstrual blood, and their vastly increased demand during pregnancy and lactation, women are the worst victims of anaemia for almost 3 decades of their life. Anaemia in the reproductive age women is not only a major cause of morbidity or even mortality, but is a major cause for the low-birth weight of their offspring, thus perpetuating inter-generational malnutrition. Iron deficiency anaemia and the resulting impairment of cognitive function and learning performance in children is documented through numerous studies in different countries.

Vitamin A deficiency in children continues unabated in many regions of the world. Though keratomalacia causing blindness due to vitamin A deficiency has mostly been eliminated, xerophthaemia, night blindness and a high level of respiratory tract morbidities and mortality due to childhood infection are clear proof that vitamin A deficiency continues as a major malnutrition problem in children.

Environmental iodine deficiency causing iodine deficiency disorders in millions of people all over the world is possibly the most tragic form of micro-nutrient malnutrition with crippling life-long effect. A full-blown cretin is a glaring example of this tragedy. Again due to biological reasons, women and children are the major victims.

PAST EFFORTS TO CONTROL MICRONUTRIENT DEFICIENCY

One has to remember that the deficiencies of these micronutrients is not a new realization and has been known for decades. Certainly, the full magnitude of the impact of these deficiencies is being increasingly unraveled, but attempts to control these deficiencies did engage the attention of nutritionists and public health administrators in the last three to four decades.

The following are the major milestones during this period for the control of these deficiencies:

- Nutrition education for increased consumption of fruits and leafy vegetables was initiated in the 1950s in almost all developing countries to overcome iron and vitamin A deficiency;

- Supplementation with megadose vitamin A was implemented as a national prophylaxis programme in the 1970s in a large number of developing countries.
- Iodination of salt was initiated in many countries in the 1960s;
- Oral iron supplementation, with or without folate, was initiated in many developing countries in the 1970s as national programmes;
- Fortification of foods have been adopted as a common strategy in the developed countries for decades but rarely accepted in the developing countries as national programmes for controlling mirconutrient malnutrition.

THE PRESENT STRATEGIES

Considerable experiences have been gained during the last two to three decades in controlling micronutrient malnutrition with varying results. One must confess that even now these deficiencies continue as a dominant public health problem in most developing countries. The recent global commitment for their elimination confirms the present undesirable situation and a global concern for their elimination.

Experiences have shown that the most efficient direction for their control at a national level is a multisectoral approach to the problem in which the concerned government sectors, especially health, social welfare, food industry, education and information will have to closely interact with the private food industry and the non-governmental organisations.

The following approaches are in operation in most developing countries today :

Dietary diversification

The consumption of adequate and appropriate diet containing iron, carotene and vitamin A will undoubtedly be a permanent solution to these micronutrient deficiencies. This however may not be feasible in many situations, some of which are:

- Economically deprived population living mostly on vegetarian diet consume iron in a state which is marginally available to the body. They are unable or unwilling due to economic or cultural reasons, to consume haem-iron-containing animal foods.
- Green leafy vegetables, a rich source of iron and B carotene, has to be consumed in such large quantity to meet iron need that it will not be feasible in most cases, especially with children
- There are three other reasons why green leafy vegetables do not in reality play important ameliorative role: (a) the non-availability of green vegetables in many countries or regions (b) the general dislike of young children to consume leafy vegetables and (c) most procedures adopted for cooking leafy vegetables destroy its vitamin content.

Definite improvements can be made through the introduction of new crops, better cooking or preservation methods and the promotion of more varied diets through nutrition education. However these changes require modification of existing food behaviours and attitudes, some of which may have been part of the life-style for generations. Therefore making significant changes will take a long time. Nutrition education for inclusion of green leafy vegetables and carotene rich fruits have been conducted for decades in may developing countries with not very perceptible impact.

Recent studies have shown that the absorption of dietary iron from the gut is influenced by a number of factors, many of which interfere with its absorption. Whole wheat flour and above all the ubiquitous tea, are all interfering agents in the absorption of iron from the gastrointestinal tract. The benefit of consuming absorbic acid to promote iron absorption is a scientific fact but not practical in most cases. These facts are not adequately disseminated to the common man.

Supplementation measures

Nutrient supplementation has long been adopted as a measure for the prevention of several nutritional deficiencies for decades in many developing countries. Even for the treatment of deficiency diseases, large doses of nutrients are injected into the body, e.g. for the treatment of keratomelacia and iron deficiency anaemia. Over the years, oral supplementation of vitamin A against xerphthaemia, of vitamin D for rickets and of iron and folate for prevention of nutritional anaemia were recognized as methods of choice for national nutrition programmes.

Today, nutrient supplementation programmes to control micronutrient deficiencies include;

a. Megadose vitamin A prophylaxis by oral administration of a capsule or suspension of 200,000 International Unit of vitamin A every six months in young children, the age which is most vulnerable to avitaminosis A, is the most common approach. Several evaluations in recent years have shown that the major cause for its relative ineffectiveness is the low coverage of the target population who are pre-school age children. Inadequate supply of vitamin A capsules or suspension is another major reason for the faltering of this programme.

b. Iron supplementation with tablet consisting usually of 60 mgm of elemental iron, commonly with 0.5 mgm of folate, for 100 days in the third trimester of pregnancy is the usual approach to prevent nutritional anaemia. It not only replenishes the depleted iron stores in the pregnant women's body but at the same time meets her own increased iron requirement and the need for the growing foetus, thus greatly reducing the possibility of low birth weight offspring.

Several evaluations in many countries have revealed that in spite of the programme in operation in a given country for decades, the level of the prevalence of anaemia in pregnant women continue at a very high level. Lack of compliance is a major factor in most cases due to side effects of iron preparation. Lack of communication between the health workers and the recipients of the tablets regarding the dangers of anaemia and the benefits of taking the tablets and lastly inadequate supply of the supplements are the other major reasons.

In several South East Asian Countries, the present revised nutritional anaemia control strategy is to give oral supplementation of bubble-packed tablets of 100 mgm elemental iron with 0.5 mgm of folate throughout the period of pregnancy.

c. In areas of high endemicity of iodine deficiency disorders or in inaccessible areas, especially in mountainous regions, iodinated oil injection is given intramuscularly to serve as a depot from where iodine is released slowly over a period of 1-2 years. However, precautions are to be taken in injecting pregnant women since the iodine statue of the foetus might be affected. Moreover, the dangers of transmission of infections e.g. hepatitis and AIDS by using the same needle has made this procedure less popular.
Orally administered iodized oil has proved to be quite successful in several countries. However, a regular supply of this preparation is still a constraint in many cases.

FOOD FORTIFICATION IN DEVELOPING COUNTRIES-HOW FEASIBLE IN THE DEVELOPING COUNTRIES?

Fortifying staple foods with nutrients to overcome nutritional deficiencies in the diet is an approach adopted by the developed countries for decades thus making nutrient supplementation and dietary manipulation unnecessary. Fortified milk, butter, margarine, breakfast cereal and bread are almost always fortified with minerals and vitamins in most developed countries.

However, in the developing countries, even today this is not a common approach for overcoming nutrient deficiency for several reasons and infect indigenously produced fortified foods are conspicuous by their absence in the developing world.

Taking advantage of food technology for combating malnutrition is however not a novelty in the developing world. In the 60s, during the "so-called" global protein crisis, a number of developing countries started producing protein from non-conventional source like peanut, soybean and even leaves (leaf-protein), which was blended with wheat flour and other foods. Most countries embarking on such ventures, not only christened the product with different names e.g. Supramine, Incaparina, Balahar, but started intensive drive to popularize these products in order to control protein-energy malnutrition in the child population.

The life of plant protein products was very short for several reasons. The so-called "abysmal protein gap" for the developing world was "bridged over-night" by UN/FAO/WHO by reducing drastically protein requirement, an event which earned the term of "protein fiasco". However, the major factors for the unpopularity of such products were their taste and appearance and reluctance of the common man to eat unconventional foods however nutritionally rich they were. The popular decision was loud and clear. People don't prefer to consume "miracle scientifically nutritional products", but naturally occurring foods to which they are bound inextricably by culture, taste and quite often by religion for generations.

There are other important reasons why processed foods, including fortified foods, are not common in developing countries, excepting in those countries which are financially able to import such foods, along with significant changes in life style including food habits. The important reasons for their absence in the developing countries are:

a. Relative absence of indigenous food industries which have the technical and managerial competence to develop fortified foods ensuring quality control and at the same time promoting their consumption;
b. Absence of food standards, food regulation and food quality control machineries to ensure quality control of food products with declared levels of nutrient content of the fortified products and in many cases, discouraging their production by food industry.
c. Lack of awareness among consumers that fortified foods are based on good wholesome natural foods to which essential nutrients have been technologically incorporated especially with those nutrients which are usually lacking in the daily diet;

However some foods like milk and hydrogenated products like margarine are quite often fortified with vitamin A and D in many developing countries without creating any awareness among the consumers. The most common example of food fortification without consumers knowing about it is salt iodination for control of iodine deficiency disorders in earlier years. However, IEC is an important component of IDD control strategy. When the procedure was started in 1960s, it was directed at goiter control, but is now recognized as a preventive for a large number of iodine deficiency disorders.

POTENTIALS OF FOOD FORTIFICATION FOR MICRONUTRIENT MALNUTRITION CONTROL

The prevalence rate of micronutrient malnutrition being more or less the same over the years, and the absolute number of people affected getting more in number due to increasing population, it is imperative that a fresh look should be given to the potentials of food fortification in the developing countries. The following needs consideration:

Readiness to consume fortified foods

a. Varying segments of the population in most countries in this Region have achieved improved economic status, and according to the common global patterns, they have discarded their traditional dietary habits and adopted most often western world dietary habits which, to some extent, are based on processed fortified foods;

b. Children and adolescents in many developing countries are almost "addicted" to ready-to-eat foods commonly known as "snack-foods", which are processed foods. In most, if not in all cases, such foods are imported. Such foods produced indigenously are however not fortified.

c. Rapidly increasing number of women in economically affluent population are joining the workforce as professionals, white-collar workers and technicians. Of necessity, they are going in for "instant cooking" processed foods in place of day long work in the kitchen. The large scale use of noodles and macaroni as a staple in place of rice and wheat in most developing countries is a glaring example of cutting down on time-consuming cooking of cereals.

Economic status of consumers

The economic status of consumers of fortified foods plays an important role in deciding the type of fortification that will have to be adopted in the country. In general, there has to be three types of fortification;

a. Fortification of staple foods which everyone consumes, e.g. wheat, sugar, milk, oil, margarine, butter and salt;

b. Fortification of processed foods which are used for instant cooking, e.g. soups, noodles and macaroni;

c. Fortification of snack foods commonly known as "ready-to-eat" foods which are widely used by children and adolescents.

Achieving political commitment for food fortification

In most countries, food fortification is not on existing procedure for control of micro-nutrient malnutrition. The government in these countries prefer to adopt the long term solution based on diversification of diets and short-term nutrition supplementation through health intervention. It is quite often stated that food fortification can only be possible in the developed world. The experiences in Guatemala, Honduras and El-Salvador have indicated that this is an important intervention feasible in most developing countries. However, the last word is with the Government who are quite often confused with sometime critical views of the nutrition specialists regarding the possibility of food fortification in developing countries. Processed foods are imported in huge quantities in the affluent developing countries as "snack food" and "ready-to-eat food" and other products. In some other countries such foods are indigenously processed, and these could be easily fortified if the food industry is technologically and financially assisted and this will need strong political commitment.

Government set up necessary for the control of micronutrient malnutrition

Micronutrient malnutrition manifested mainly by iodine deficiency disorders like endemic goiter and cretinism, nutrition anaemia in women especially in reproductive years and vitamin A deficiency mostly in children are regarded as serious public health problems. The Ministry of Health is usually responsible for the prevention and control of these disorders and as such that Ministry has the leading role in initiating actions in this direction.

However, as indicated earlier, other sectors of the government are equally responsible for preventing and controlling these deficiencies and major ones are:

a. Government sector responsible for welfare of women and children.
b. Government sector responsible for food including food industries.
c. Government sector responsible for information and broadcasting.
d. Government sector responsible for legislations including food laws and its enforcement.

No government can control problems of micronutrient malnutrition through measures taken by the government sector alone, and as such NGOs, specially those responsible for women and child welfare, should be made equal partners in this endeavor.

Food industry in a country supported by appropriate food laws will have to be fully involved specially if decision is taken to have fortified foods in the country.

Need for an inter-sectoral coordinating mechanism

The health sector should also take the leading role in establishing an inter-sectoral coordinating committee or council specially charged with the responsibility of developing, implementing, monitoring and evaluating measures in the country for the control of micronutrient deficiencies. However, this should be an essential component of a national nutritional policy. In the past there has been considerable experiences in establishing inter-ministerial coordinating committees for nutrition in various developing countries, and wherever these are already in operation, a special Task Force should be charged with the responsibility of especially focusing on micro-nutrients malnutrition.

Information, Education and Communication

It is being increasingly realized that both under-nutrition including micronutrient malnutrition and over-nutrition manifested through diet related non-communicable clinical disorders like obesity, cardiovascular disorders, cerebral affections and non-insulin dependent diabetes can only be controlled if all people are made aware of the foods they are either encouraged to eat for nutrition promotion or to avoid eating some types of foods to prevent dangers of these clinical disorders. A mass awareness campaign should be a "must" in controlling nutritional disorders, both under and over, through various approaches, including use of mass-media like television and radio, person-to-person approach and other types of visual exposures.

It is now being realized that the best approach to establish good dietary habits is to start with children during their primary and secondary school period through a well-designed curriculum in health education. Children and adolescents in schools are therefore the best targets for inculcating sound dietary habits.

FOOD FORTIFICATION, QUALITY ASSURANCE AND CONTROL

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INTRODUCTION

Deficiencies of micronutrients may be divided into two main groups: Type 1 deficiencies for which specific clinical and biochemical markers allow the estimation of the prevalence of deficiency in a population or group. These include deficiencies of iron, vitamin A, iodine and some B vitamins. Multiple markers may allow differentiation of states of severity of certain micronutrient deficiencies (e.g. iron). Type 2 deficiencies for which there are no such specific markers and for which the estimation of prevalence is not possible. These include zinc and calcium.

The existence of status indicators for type 1 deficiencies has therefore allowed estimation of the prevalence of iron deficiency anaemia (IDA), iodine deficiency disorders (IDD) and of vitamin A deficiency (VAD), considered to be the 3 most widespread micronutrient deficiencies globally. Recent WHO statistics show that IDA is by far the most prevalent micronutrient deficiency world wide affecting over 2 billion people, mainly infants, children and women of child-bearing age. Over 1.5 billion people are at risk of IDD, of which 650 million show clinical manifestations of goiter. An estimated 43 million have some degree of mental defect including 11 million overt cretins. Of the 250 million children of preschool age considered to be at risk of VAD, 3 million are clinically affected. The prevalence of these 3 major micronutrient deficiencies in the WHO Eastern Mediterranean Region, and specifically in the Arab countries of the Middle East have been well documented in the proceedings of the workshop on micronutrient deficiencies in the Arab Middle East, held in Amman in June, 1995.

The consequences of IDA include decreased work capacity, impaired immune function, irreversible impairment of psycho-motor function in children, increased risk of premature birth, and maternal mortality during child birth. Iodine deficiency is the single greatest cause of preventable intellectual impairment in the world today, and VAD is the single most important cause of childhood blindness. The costs in terms of individual human development and of national health and productivity are obviously enormous.

PREVENTION OF MICRONUTRIENT MALNUTRITION

Strategies to prevent micronutrient deficiencies that can be part of a broad and comprehensive national plan are four-fold: dietary diversification, food fortification, supplementation and public health measures. The balance of these interventions in a given country will largely depend on the magnitude and severity of the problem, on the risk groups, and on available resources.

Food fortification

The rationale for food fortification is that increased intake of one or more nutrients may be beneficial in a population group. The choice of food carriers(s) or vector(s), the type(s) and amount(s) of nutrients to be added should be based on:

- Representative data on nutrient intakes, food consumption patterns and nutritional status of the population
- The existence of potential food vectors that are processed in a small number of strategically located plants, and that can be monitored
- The anticipated consumption of potential food vector(s)
- The stability of added nutrient(s) during shelf-life
- The effects of fortification on the organoleptic properties of the food vector
- The bioavailability of the added nutrients from the food vector, and their effects on the bioavailability of other essential nutrients
- The risk of excessive intakes of added nutrients

Where the risk groups select foods not typically consumed by the population as a whole, targeted processed foods may be the most effective strategy. Where the potential benefits of fortification may extend more widely in the population, fortification of staple foods will be more appropriate. Major advantages of food fortification include the very low risk of toxicity at fortification levels of micronutrients, that modification of dietary habits is not required, and low cost.

Fortification of staple foods

Some of the most widespread examples of the addition of micronutrients to staple foods are iron fortification of wheat or rice flour, iodization of salt, and vitamin A fortification of sugar, milk and margarine. Depending on the national context, multiple fortification may also be desirable and effective; examples are fortification of salt with iodine and iron, fortification of milk or margarine with vitamins A and D, and fortification of wheat flour with iron, vitamins A, D and B group vitamins.

Fortification of processed foods

The most widely consumed fortified processed foods are infant formulas and cereals. Since infant formulas are often the only food consumed by the growing infant, they are generally fortified so as to completely cover the requirements of all essential nutrients. Infant cereals generally provide about 10% to 30% of the total food intake of the older infant. Commercial infant cereals are therefore normally fortified in order to provide at least that proportion of all essential nutrients. Other processed foods that can be fortified include noodles, beverages, biscuits, condiments and sauces, etc.

Cost of food fortification

Fortification of appropriate food vectors has been shown to be an effective approach to the prevention of micronutrient deficiencies. The cost of food fortification is low. The annual cost of fortification per person is estimated at US $ 0.14 to 0.29 for vitamin A in sugar, US $ 0.10 to 0.84 for iron in salt or sugar, and US $ 0.04 to 0.10 for salt iodization. The additional cost of fortifying a food product is usually less than 2% of the retail price of the un-fortified product. Fortificants represent a large proportion (usually above 90%) of the total cost of fortification, since in most cases simple, inexpensive equipment is needed. Government costs related to fortification are generally restricted to quality monitoring.

Iron fortification

The history of the fortification of foods with iron has been long difficult, and many problems remain to be solved. The choice of an appropriate iron fortification compound depends on a number of factors including the nature of the food vector. The choice is nearly always a compromise between optimal bioavailability of the iron compound and minimal organoleptic modification of the food vector. More soluble iron compounds such as ferrous sulphate, which are well absorbed, often cause unacceptable colour and taste changes. Less soluble and insoluble compounds such as elemental iron and ferric pyrophosphate, do not cause organoleptic changes but are less well absorbed. The cost of iron compounds may vary up to five-to ten-fold.

FACTORS AFFECTING BIOAVAILABILITY OF FORTIFICATION IRON

There are a number of major factors which determine the amount of iron absorbed from an iron-fortified food. These are: the nature and the amount of the iron fortification compound used, the presence of inhibitors or enhances of iron absorption in the food, and the iron status of the consumer.

A number of studies have compared the relative bioavailability of various iron fortification compounds in laboratory animals and in man. Since absolute absorption of iron may vary from less than 1% to over 50%, depending on the above-mentioned factors and on the mode of administration, bioavailability is usually measured relative to a standard compound in the same subjects. Ferrous sulphate is generally used as the standard and is assigned a relative bioavailability (RBV) of 100. The haemoglobin repletion test in rats has been shown to be a good predictor of the RBV of iron compounds in man. All freely water soluble compounds have a RBV of about 100 in rats and in man, and can be used to fortify milks, including infant formulas without causing unacceptable organoleptic changes. Compounds that are poorly soluble in water but that are soluble in dilute acid, such as ferrous fumarate, have RBV of 75 to 100 and are used to fortify infant cereals. Ferrous sulphate, on the other hand, causes oxidation of unsaturated lipids in infant cereals during storage, and graying of chocolate beverages. Compounds such as elemental iron and ferric pyrophosphate, that are insoluble in water and dilute acids, have RBV ranging from less than 10 up to 90. They are commonly added to foods such as wheat flour, infant cereals and chocolate beverages which are subject to organoleptic alteration during storage and reconstitution.

Iron fortification compounds for infant cereals

In the specific case of infant cereals, studies on the bioavailability of iron fortification compounds have been carried out using isotopic tracer techniques in human subjects. Ferrous fumarate was shown to have an RBV equivalent to that of ferrous sulphate, whereas ferrous succinate, ferric saccharate and ferric pyrophosphate were less well absorbed. These results therefore allowed the improvement of the iron fortification of infant cereals, offering an alternative to the commonly utilized ferric pyrophosphate and elemental iron.

Enhances and inhibitors of iron absorption

There are several components of foods that are known to influence the bioavailability of dietary iron. The best known enhances of iron absorption are ascorbic acid and meat protein, whilst the most potent inhibitors are phytic acid and polyhenols.

Phytic acid

Phytic acid, or myoinisitol-hexaphosphate, the storage compound for phosphorus and minerals for germination in many cereals and pulses, strongly inhibits the intestinal absorption of iron and zinc by forming insoluble peptide-phytate-mineral complexes' in the gut. Typical levels of phytic acid in cereal and pulse products are about 1% of dry weight, but can be reduced by appropriate milling techniques.

A recently developed enzymatic technique allows the complete degradation of phytic acid in products such as infant cereals and soy products. A study on the effect of dephytinisation of soy-based infant formula, carried out using isotopic labeling of iron in human subjects, showed that iron bioavailability can be increased over two-fold. Further studies employing varying degrees of phytic acid degradation showed that the level of phytic acid must be reduced to near zero in order to optimise iron bioavailability.

Vitamin C: effect on iron absorption from infant cereals

However, since the use of such enzymatic techniques is not as yet permitted for infant nutritional products, other alternatives to improve iron bioavailability have been evaluated. Vitamin C or ascorbic acid has long been known to enhance iron absorption, and although it has been shown that the optimal ratio of vitamin C to iron in casein-predominant infant formulas is between 2:1 and 4:1, no such information was available for soya-based products. Isotopic labeling tests showed that iron bioavailability from such foods may also be doubled by increasing the molar ratio of vitamin C to iron from 2:1 up to 4:1, thereby offering an alternative strategy for enhancing iron bioavailability.

FORMULATION OF MICRONUTRIENT PREMIXES FOR INFANT FORMULAS AND CEREALS

The correct formulation of a micronutrient premix requires accurate information on the micronutrient content of the food raw materials used, on the homogeneity of the addition of the premix to the food, and on expected losses of individual micro-nutrients during processing and storage, especially of vitamins. When the vitamin premix is added by dry mixing, processing losses are generally insignificant, and storage losses of 10% to 30% may be expected. The vitamins most sensitive to storage losses are vitamins A, C and D. If the vitamin premix is added to the product prior to heating and/or drying, processing losses may be more substantial. The vitamins most sensitive to combinations of heat, moisture and oxygen are vitamins C and A. The composition of the premix to be added to the product in question may be calculated once all of these have been determined or estimated.

Preliminary production and storage trials are then needed in order to determine the actual losses during processing and the homogeneity of the distribution of micronutrients in the finished product. The final composition of the micronutrient premixes may then be calculated.

ROLE OF QC IN FOOD FORTIFICATION

Food fortification of staple or processed foods, whether it be a national programme or not requires properly designed and resourced quality control systems. Government legislation and guidelines, as well as industrial specifications for food fortification will be ineffective without adequate quality control, both at the production site and in central laboratories.

Quality Control: Validation of Analytical Methods

Reliable quality control of the addition of micronutrients to foods can only be obtained by the careful use of appropriate and validated analytical techniques in the hands of trained analysts. Validation of analytical methods involves the establishment of performance characteristics such as specificity, sensitivity, working concentration range, limit of detection, limit of quantitation, ruggedness, accuracy and precision.

Quality control of iron fortification

In order to ensure that the trace element premix is added to a processed food at the correct concentration, iron is often used as a tracer. Several methods can be used for iron determination; X-ray fluorescence spectroscopy which is rapid (10 min.) and can be used on production lines; atomic absorption spectroscopy (AAS) which is the reference method and generally used in QC laboratories (2 hrs.); inductively coupled plasma emission spectrometry (ICP-AES; 2 hrs.) and colorimetric methods (rapid test-kit, 20 min.).

The repeatability of the different methods varies from 5% to 10%, whilst reproducibility varies from 10% to 20%. The method used depends on available laboratory resources as well as on the desired precision. Quality control data on trace element addition to milk powder by dry mixing show that iron determination alone allows control of the addition of the trace element premix.

VITAMIN FORTIFICATION (VITAMIN A)

The fortification of foods is generally carried out by addition of retinol esters, such as the acetate or palmitate and /or by adding β-carotene. Little is known about the bioavailability of such compounds at normal fortification levels because, to date, bioavailability studies can only be carried out using supra-nutritional levels (5-10 times RDA). Enhances of absorption of vitamin A compounds include fat, protein and vitamin E.

Quality Control of Vitamin Fortification

The addition of vitamins to foods in a multi-vitamin premix may be controlled by determination of vitamin C as tracer in the food product. Methods commonly used include HPLC, titrimetry using a visual or calorimetric endpoint, or by rapid colorimetry (Merck RQ Flex). The latter may be used on production lines to ensure the presence of the premix in the product. HPLC and titrimetry are used in QC laboratories and have better repeatability than the rapid method.

Quality control data on stability of vitamins A, C and D show that determination of vitamin C only, can be used to check the levels of the vitamins in the product during prolonged storage. In many situations, vitamin C is the most sensitive to degradation and is therefore used to control vitamin fortification.

IODINE FORTIFICATION

Potassium iodide (Kl) and potassium iodate (KIO_3) are the compounds most often used to fortify staple and processed foods. The iodate may be preferable in some situations given that it is less volatile than the iodide. The bioavailability of inorganic iodine added to foods is high (50 to 100%). In regions where the diet contains appreciable quantities of goitrogens, iodine requirements may be higher.

Quality Control of Iodine Fortification

Methods for the determination of iodine added to salt include semi-quantitative rapid test kits which may be used on production lines to verify the presence of iodine in the salt. More accurate titrimetric methods are used in the QC laboratory to verify the correct levels of fortification.

In order to verify the correct fortification level of iodine in processed foods, wet or dry ashing is necessary to liberate the iodine from the food matrix. Colorimetric or AAS detection techniques may used for the final determination.

ADVANTAGES OF FOOD FORTIFICATION: CONDITIONS FOR SUCCESS

Finally, food fortification present a number of advantages over other strategies for the prevention of micronutrient malnutrition. They are: low cost, possibility of multiple fortification, proven to be effective and cost effective, does not require modification of dietary habits, achieves high population coverage, and is safe. Proper consideration of the aspects presented above, namely: nutritional and regulatory aspects, choice of vectors and fortificants, and quality control together with demonstrated advantages just described will ensure that food fortification is a sustainable strategy for the prevention of micronutrient malnutrition.

REFERENCES

1. Bauernfeind JC and Lachance PA. *Nutrient Additions to Foods.* Food & Nutrition Press, Inc. USA, 1991.
2. British Nutrition Foundation. *Food Fortification.* BNF Briefing paper, London, 1994.
3. Clydesdale FM and Weimer KL (editors.). *Iron fortification of foods.* Academic Press, 1985.
4. Davidsson L, Galan P and Kastenmayer P. Iron bioavailability studied in infants: The influence of phytic acid and ascorbic acid in infant formulas based on soy isolate. *Pediatr Res.* 36, 1994, 816-822.
5. DeMaeyer E and Adiels-Tegman M. The prevalence of anaemia in the world. *World Health Statistics Quarterly* 38, 1985, 302-316.
6. Hurrell RF, Furniss DE and Burri J, *et al.* Iron fortification of infant cereals: a proposal for the use of ferrous fumarate or ferrous succinate. *Am J Clin Nutr* 49, 1989, 1274-1282.
7. Hurrell RF. Iron Deficiency, causes and prevention. In: Musaiger, A. O. and Miladi, S. (editors) *Micronutrient Deficiencies in the Arab Middle East Countries.* FAO/RNEA, Cairo, 1996.
8. Musaiger, A. O. and Miladi, S. (editors) *Micronutrient Deficiencies in the Arab Middle East Countries.* FAO/RNEA, Cairo, 1996.
9. Kastenmayer P, Davidsson L, and Galan P. *et al.* A double stable isotope technique for measuring iron absorption in infants. *Br J Nutr* 71, 1994, 411-424.
10. PAMM/MI/ICCIDD. *Monitoring Universal Salt Iodization Programmes;* 1995.
11. Prodoillet J. Validation of analytical methods for establishing food composition data. In: Musaiger AO and Miladi S (editors) *Proceedings of Workshop on Establishing Food Composition Data for the Arab Countries of the Gulf (Gulfoods).* FAO/RNEA, Cairo, 1996.

12. WHO/UNICEF/ICCIDD. *Global Prevalence of Iodine Deficiency Disorders*. WHO, Geneva, 1993.
13. WHO/UNICEF. *Global Prevalence of Vitamin A Deficiency*, WHO, Geneva, 1995.

ECONOMIC ASPECTS OF FOOD FORTIFICATION

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INTRODUCTION

Food fortification is a complex issue. It certainly will be of help to elucidate why fortification is carried out; which micronutrients are used are added to what type of foods; what is the history of fortification especially looking into the staple food fortification; then to touch on fortification of special diet, which is very often used to improve the nutritional status of a certain group in the population; outlining the international practices in elaborating the cost involved, both the cost of fortification as well as the cost of malnutrition which occurs if the population is living on a deficient diet. Legal aspects and safety of fortification will be explained and a conclusion, does it really pay to carry out food fortification?

WHY FOOD FORTIFICATION

Micronutrient deficiencies continue to be a significant public health problem in both industrialized and developing countries. Despite of substantial progresses the micronutrient goals established for the year 2000 by the WHO will not be achieved unless renewed efforts will be made to implement effective intervention programmes.

Food fortification has been identified as the most effective intervention programme. The recognized potential of the food fortification to overcome micronutrient deficiencies however has not been fully utilized yet.

Which Micronutrients

Generally such micronutrients are used in food fortification programmes which are widely lacking in the whole population. This might be iodine, vitamin A, iron, vitamin C, some of B vitamins etc. However, since we know that this micronutrients are involved in specific metabolic processes and at the same time they also interact with each other, it is important to maintain a broader view when it comes to decide which micronutrients should be used for fortification programmes. Some of the mostly missed micronutrients may just represent the peak of the iceberg. Some other micronutrients interacting with these and/or acting synergistically may not directly be visible. Nonetheless it is very important that they are also present in adequate quantity in the daily diet. Complex biological metabolic processes can only function properly, if all the needed micronutrients are present in the food we consume.

Which Foods

If food fortification has to benefit everybody in the nation, the fortificants have to be added to staple foods, foods which are consumed by everybody in the society. This ensures that the micronutrients added to them will be carried everyday to everybody consuming the staple foods.

Staple Food Fortification

Staple foods are not necessarily identical comparing the eating habits in one country to another. However it can be said that generally cereal based foods represent a staple food practically all over the world. It might be bread based on wheat flour, it could be corn based foods made out of corn flour and of course rice. Apart from this cereals and other starch based foods edible fats and oils are also widely used and can be regarded in many countries are real staple foods. Beverages, generally juice containing beverages are representing in today's modern society widely consumed products and thus they can be addressed as staples. Nonetheless staple foods have to qualify to be used in food fortification. The following criteria of staple foods is essential to be fulfilled:

- It has to be consumed regularly and universally.
- The staple food has to be processed industrially.
- The daily intake should not vary greatly.
- It has to be compatible with the fortificant i.e. the addition of micronutrients should not change it's properties.
- It must be economically feasible.

Fortification of Special Diets

The staple food fortification is to cater for the need of the whole society. Micronutrients are added in an economically sustainable way and concentrations which means, that the additionally required intake of some micronutrient by certain segment of the population might not necessarily be fulfilled. In order to offer help here, special diets are enriched according to the identified requirement of micronutrients by certain generally vulnerable segment of the population. Special example is school lunch or diets in institutions which have to carry certain micronutrients above of that what is used in staple food fortification.

History of Food Fortification

The addition of nutrients to foods was first practiced as a public health measure to prevent the development of the deficiency diseases in large segments of the population. Examples are the addition of iodine to salt to prevent goiter and the addition of vitamin D to milk and margarine to prevent rickets. The addition of nutrients primarily for the purpose of restoring nutrients lost in processing such as the restoration of wheat flour and bread with reduced iron, thiamin, riboflavin and niacin has been a similar measure in preventing deficiencies and improving the nutritional status nationwide. Salt iodization was first practiced in the 1920s. Attempts to restore nutrients lost during the processing of wheat were made as early as 1930. However, due to the fact that pure micronutrients were not yet available at that time wheat flour fortification started only in the early 1940s. Since that date iodization of salt, fortification of wheat flour, better to say restoration of what flour with the micronutrients mentioned, and fortification of margarine and other edible fats and oils as well as beverages have been established in many countries. This fact demonstrates that standardized fortification of certain widely used economically priced staple foods is highly desirable.

Legal Aspects

Food fortification as one of the most widely accepted measures to improve the nutrition status of the population is carried out in many countries either voluntarily or implemented by respective food regulations. There are great number of countries which are requiring the restoration of wheat flour with micronutrients equally a number of countries requiring the fortification of fats and oils with vitamins A and D by law and also there are countries prescribing the mandatory iodization of salt.

COST OF FORTIFICATION

The cost of fortification of staple food is very modest. Wheat flour for example can be fortified (actually restored) with reduced iron, vitamin B1, B2 and niacin at an average cost of 1.2 US Dollars per ton of flour. This means that added costs for these fortificants in the daily serving of 200 g wheat flour will be about 0.023 US Cents and the added cost per person and year will not exceed 8.5 US Cents. Equally fats and oils can be fortified with vitamin A and D, for 2.76 US Dollars per ton, this means an added cost per day of about 0.0083 US Cents; while the added cost per person and year will be 3 US Cents. The cost of fortificant for beverages (vitamin C) per 10000 it amounts only to US Dollars 3.50. The added cost per 1 dl fortified beverage per day equals to 0.035 amounts to 13 US Cents (see appendix).

The Fortification of Special Diet

The fortification of special diets with a large number of micronutrients used e.g. in school lunch programmes generate somewhat higher costs but nonetheless also here the daily serving of the involved food such as biscuits, juice, milk, yoghurt or snacks generally carry an added cost for the micronutrients between one third to one US Cents per person per day.

Cost of Malnutrition

In contrast to the cost of fortification stands the cost of malnutrition that is the costs caused directly and indirectly by a diet which is lacking in some of the micronutrients. This cost has been calculated by the World Bank and can be assessed that depending on these countries salary levels, national income etc. it may amount to hundreds or even thousands of US Dollars per person and year, especially due to loss of productivity. So the comparison between the cost of fortification and the cost of malnutrition is very much in favour of starting and carrying out such a fortification programme.

Safety of Fortification

The fortificants used in different programmes are added as part of the RDA (Recommended Daily Allowance) of the micronutrients. Thus an oversupply practically cannot occur. This is prevented generally with the bulkiness of the fortified products which exclude an overeating and with that an oversupply of micronutrients. Nonetheless the limit of safety of the micronutrients is so high, that even accidental overdosing at point of production of the fortified foods cannot cause a dangerously high oversupply of the micronutrients.

CONCLUSION

It can be concluded, that food fortification with micronutrients is the most cost effective measure in modern preventive medicine. The addition of micronutrients can be carried out today at micro-costs at the same time offering macro-benefits to the whole population. The total cost of fortifying bread (8.5 US Cents), fats/oils (3 US Cents) and juice containing beverages (13 US Cents) would amount to about 25 US Cents per person and year. For the mentioned 25 US Cents these 3 staples will provide a substantial percentage of the RDA of vitamin A, iron, vitamin B1, vitamin PP (niacin), vitamin C and vitamin D to every consumer every day for one whole year. Therefore it is strongly advocated by nutritionists that food fortification should be implemented in countries where it is not yet practiced.

APPENDIX

Cost of Fortificants

Biscuits

Price of premix (US $ per kg):	36.- -
Addition rate (kg per ton biscuits):	2.00
Added cost (US $ per ton biscuits):	72.00
Added cost (US Cents per kg biscuits):	7.20
Added cost (US Cents per serving [50g biscuits]):	0.36

Snacks

Price of premix (US $ per kg):	34.---
Addition rate (kg per ton snacks):	5.20
Added cost (US $ per ton snacks):	177.---
Added cost (US Cents per kg snacks):	17.70
Added cost (US Cents per serving [30 g snacks]):	0.54

Yoghurt

Price of premix (US $ per kg):	40.---
Addition rate (kg per ton yoghurt):	0.40
Added cost (US $ per ton yoghurt):	16.00
Added cost (US Cents per kg yoghurt):	1.60
Added cost (US Center per serving [200 g yoghurt]):	0.32

Juices

Price of premix (US $ per kg):	38.---
Addition rate (kg per 1'000 it juice):	1.20
Added cost (US $ per 1'000 it juice):	46.---
Added cost (US Cents per it juice):	4.60
Added cost (Us Cents per serving [2 dl juice]):	0.92

Milk

Price of premix (US $ per kg):	28.---
Addition rate (kg per 1'000 lt. milk):	0.60
Added cost (US $ per 1'000 lt. milk):	16.80
Added cost (US Cents per lt. milk):	1.68
Added cost (US Cents per serving [3 dl milk]):	0.50

Beverages

Price of vitamin C (US $ per kg):	14.---
Addition rate (kg per 1'000 lt. beverages):	0.25
Added cost (US $ per 1'000 lt. beverages):	3.50
Added cost (US Cents per it beverages):	0.35
Added cost (US Cents per serving [1 dl beverages]):	0.035
Added cost (US Cents per person and year)	13.00

Wheat/Corn Flour

Price of premix (US $ per kg):	15.50
Addition rate (kg per ton wheat/corn flour):	0.075
Added cost (US $ per ton wheat/corn flour):	1.16
Added cost (US Cents per kg wheat/corn flour):	0.116
Added cost (US Cents per serving [200 g wheat/corn flour]):	8.50

(Ex-work prices: June 1996)

NUTRITION AND HEALTH ASPECT OF FORTIFIED FOODS

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INTRODUCTION

There are several words used to describe the addition of nutrients to food. They are fortification (or enrichment), restoration, standardisation and supplementation. This paper discusses the nutrition and the health aspects of fortified foods.

The definition of fortification

The current CODEX definition of fortification is: "fortification or enrichment means the addition of one or more essential nutrients to a food over and above the levels normally contained in the food or the levels after restoration, for the purpose of preventing or correcting a demonstrated deficiency of one or more nutrients in the population or specific population groups".

However in todays nutritional environment, fortification may also be recognized as a way of ensuring that populations have access to nutrients to ensure adequate intakes for the maintenance of health and wellbeing (1).

Nutritional status in the Arab Speaking Countries

Iron deficiency anaemia is a well documented public health problem in many Arab countries such as Bahrain. Amine (2) reported 34% of pre-school and 32% of 6-18 year old Bahraini children to be anaemic. In Kuwait iron deficiency anaemia prevalence has been reported to be 47% among pre-school children (3). These figures are worrying given that iron deficiency anaemia has been shown to be associated with poor development and educational achievement (4).

In terms of other micronutrients, inadequate intakes of calcium, zinc, iodine, vitamin A, and riboflavin have been reported in adults in Jordan (5). Inadequate intakes of vitamin A and D, folic acid, calcium, iron and zinc were reported in Kuwaiti adults (6,7), and in particular females college students (8). Similar findings have been reported in Saudi Arabian children (9). Clinical vitamin A deficiency has also been reported in Kuwait (7). Rickets has been reported in Saudi children. While depreviation of sunlight among infants is the likely reason, adequate diet through vitamin D intake maybe a way of combating this problem, given the mothers opinion that the sun is harmful on children under two years (10).

CONSIDERATIONS FOR ADDITION OF NUTRIENTS TO FOODS

In general, the main criteria for selecting nutrients to be added to foods are that they are shown to be safe, effective and beneficial, or that for certain at risk population groups there is a demonstratable need. The addition of nutrients also requires careful attention to food regulations, labeling, nutritional rationale, cost, and the acceptability of the product to consumers.

Fortified breakfast cereals

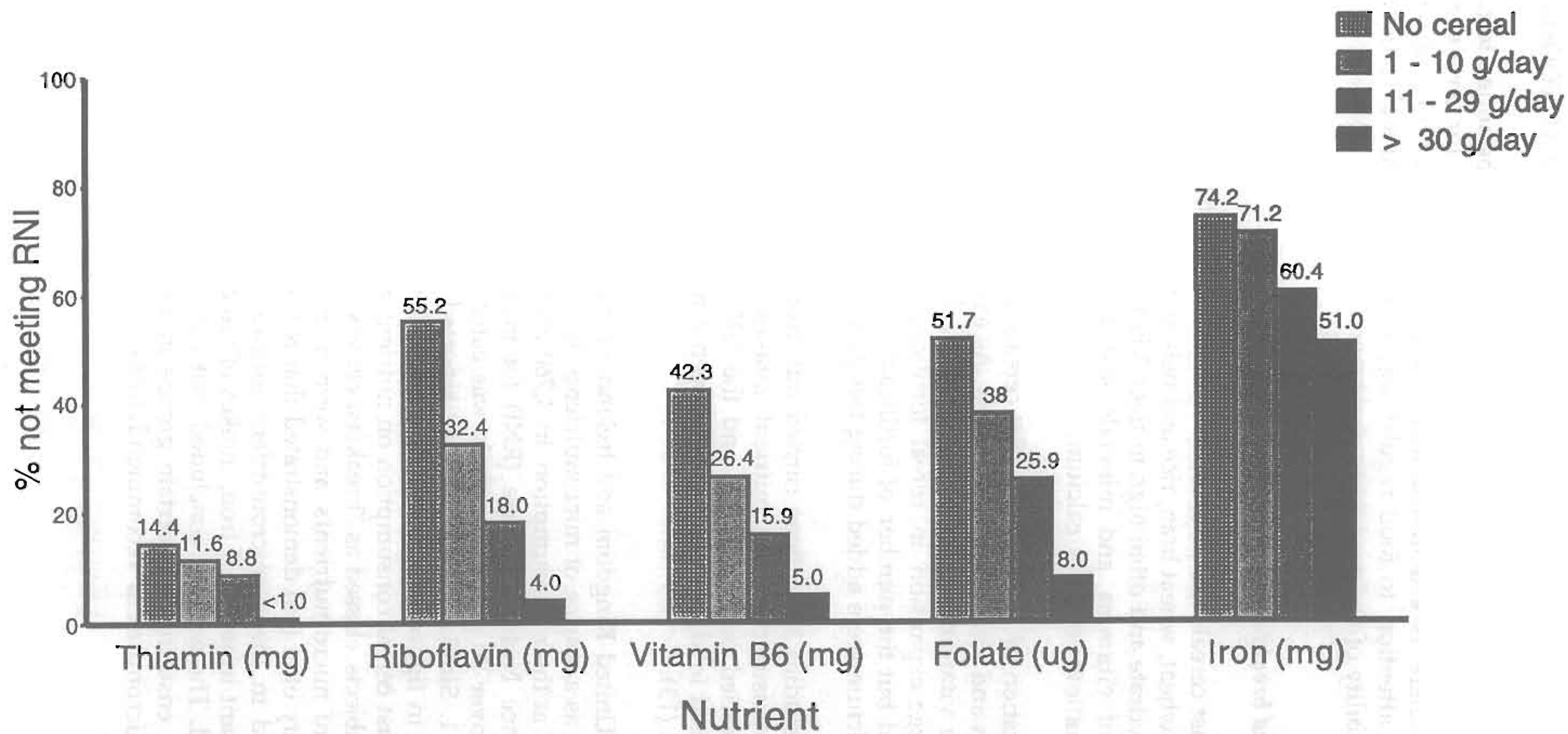
Breakfast cereals are an ideal vehicle for food fortification. They are based mainly on maize, wheat, wheat bran, rice and oats and as a consequence are low in fat, high in carbohydrate and often high in fiber. Most are fortified to provide 17-50% RDA for a range of vitamins and minerals and as they are typically eaten with milk the combination provides calcium.

Fortification of Kellogg breakfast cereals, for example, began in the late 1930's; both thiamin and vitamin D were added. As early as 1954, fortification was broadened to include vitamin C, niacin, iron, folic acid, and vitamin B_{12}. The 1970's saw a rapid and large expansion in cereal fortification, not only in the number of products fortified but the number of fortificants as well. Vitamin A, and the minerals zinc and calcium were added during this period.

Many studies have been carried out investigating the effect of fortified breakfast cereal consumption on nutrient intakes. Although the majority of the work has been carried out in the US and the UK where breakfast cereals are a commonly consumed food, studies have also been conducted in Australia (11), Canada (12), and Ireland (13).

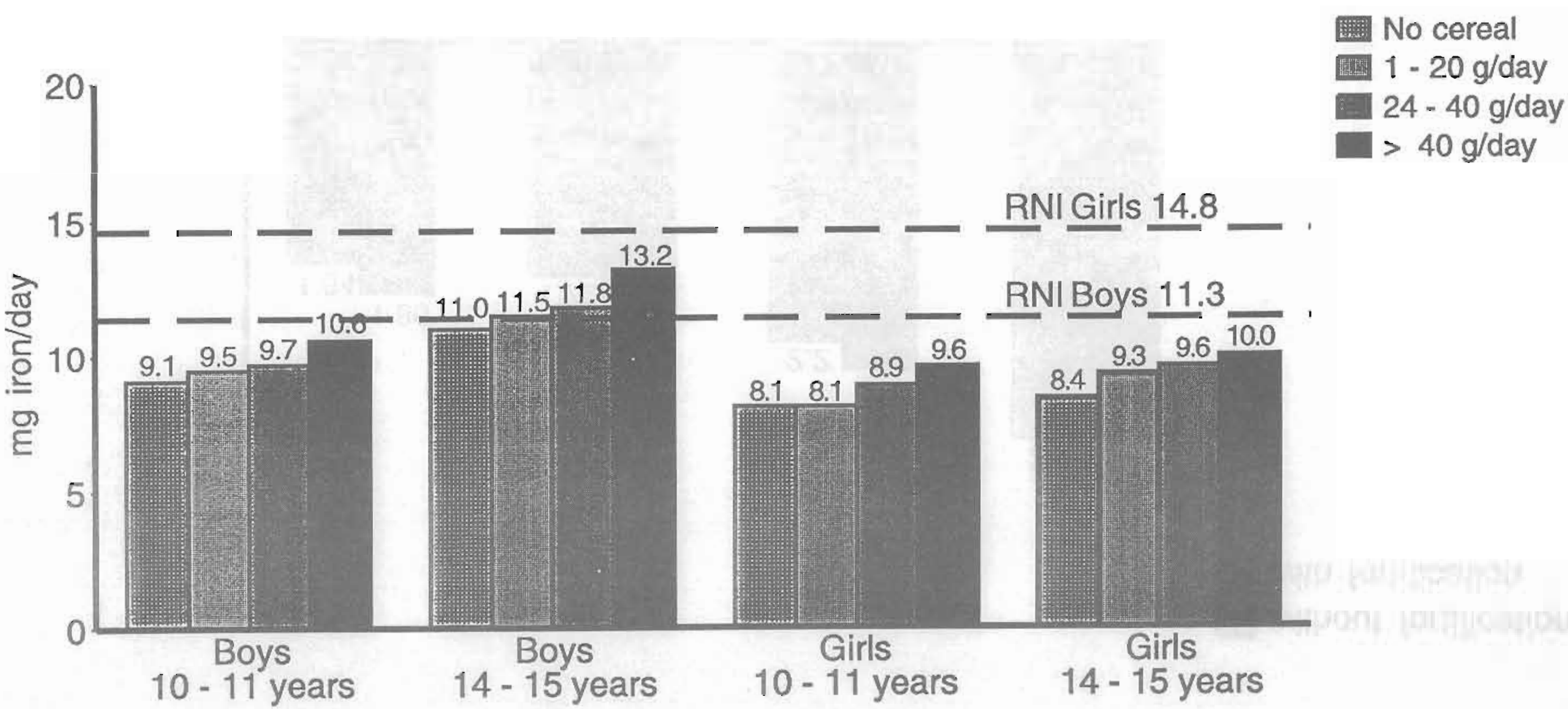
In the United Kingdom and Ireland, studies have investigated the role of breakfast cereals as a source of micronutrients in a range of population groups. Crawley (14) looked at their consumption in 4,760 children 16-17 year olds, and found that the Reference Nutrient Intake (RNI) for micronutrients were more likely to be met when over 30 grams of cereals was eaten daily. Results for females are shown in figure 1. Similar findings were reported by Gibson and O'Sullivan (15) and are shown in figure 2. Sommerville and O'Reagan (13) investigated the contribution of breakfast cereal consumption on nutrient intakes in a group of 1, 213 Irish 8-80 year old. Subjects classed as "breakfast cereals consumers" had higher daily intakes of a range of micro-nutrients and were more likely to have intakes which met RNI. McNulty et al (16) demonstrated that removal of fortification from breakfast cereals resulted in lower micronutrient intakes (figures 3 and 4). These were especially important in terms of iron, intakes of which were below RNI in most of the women studied. The authors concluded that fortified breakfast cereals played an important role in ensuring that certain groups in the population particularly young women met micronutrient recommendations.

Figure 1. Percentage of British female teenagers not meeting the RNI for selected micronutrients according to breakfast cereal consumption



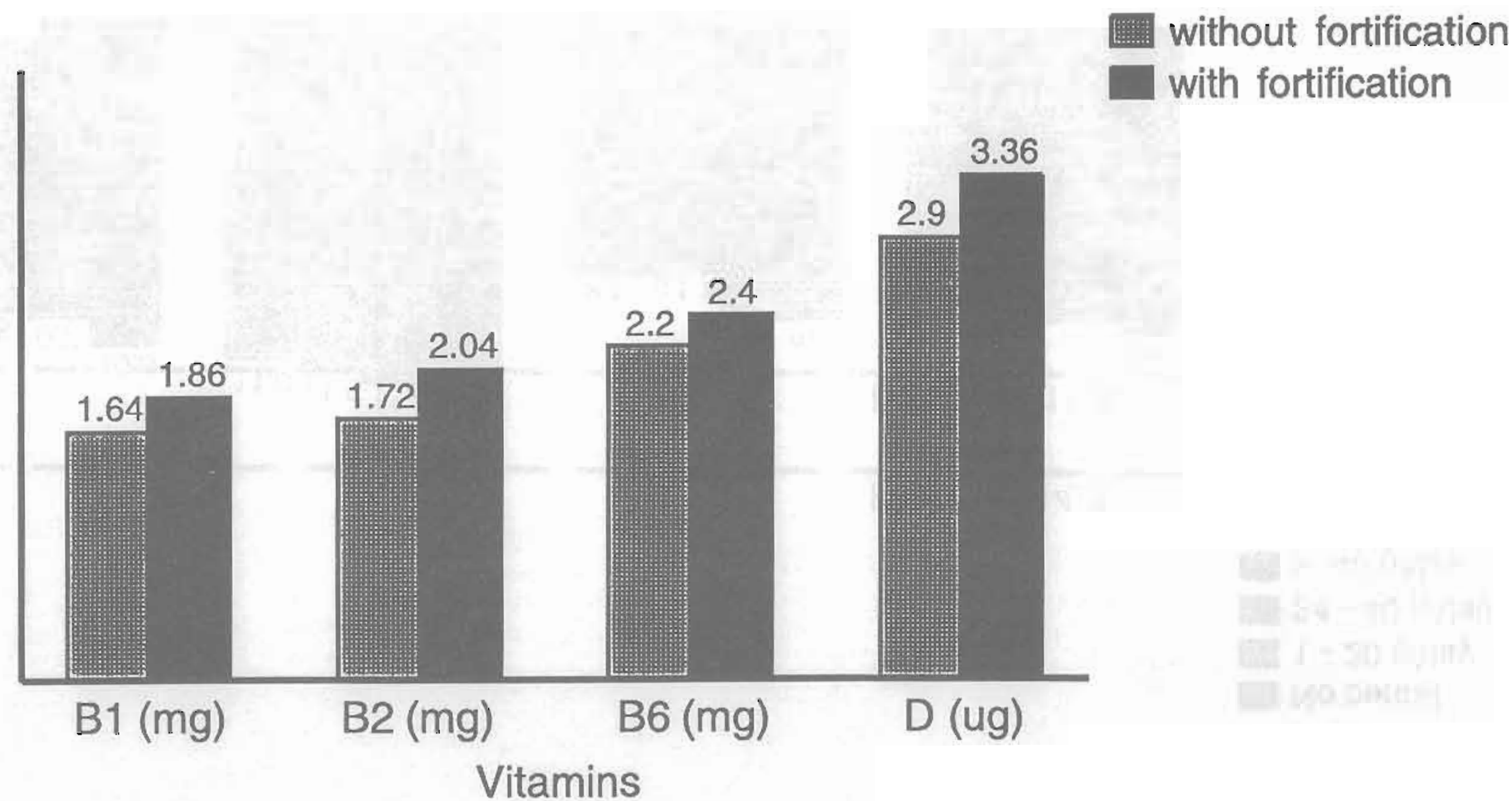
Crawley, (1993)

Figure 2. Mean daily Iron intake according to cereal consumption in British school children



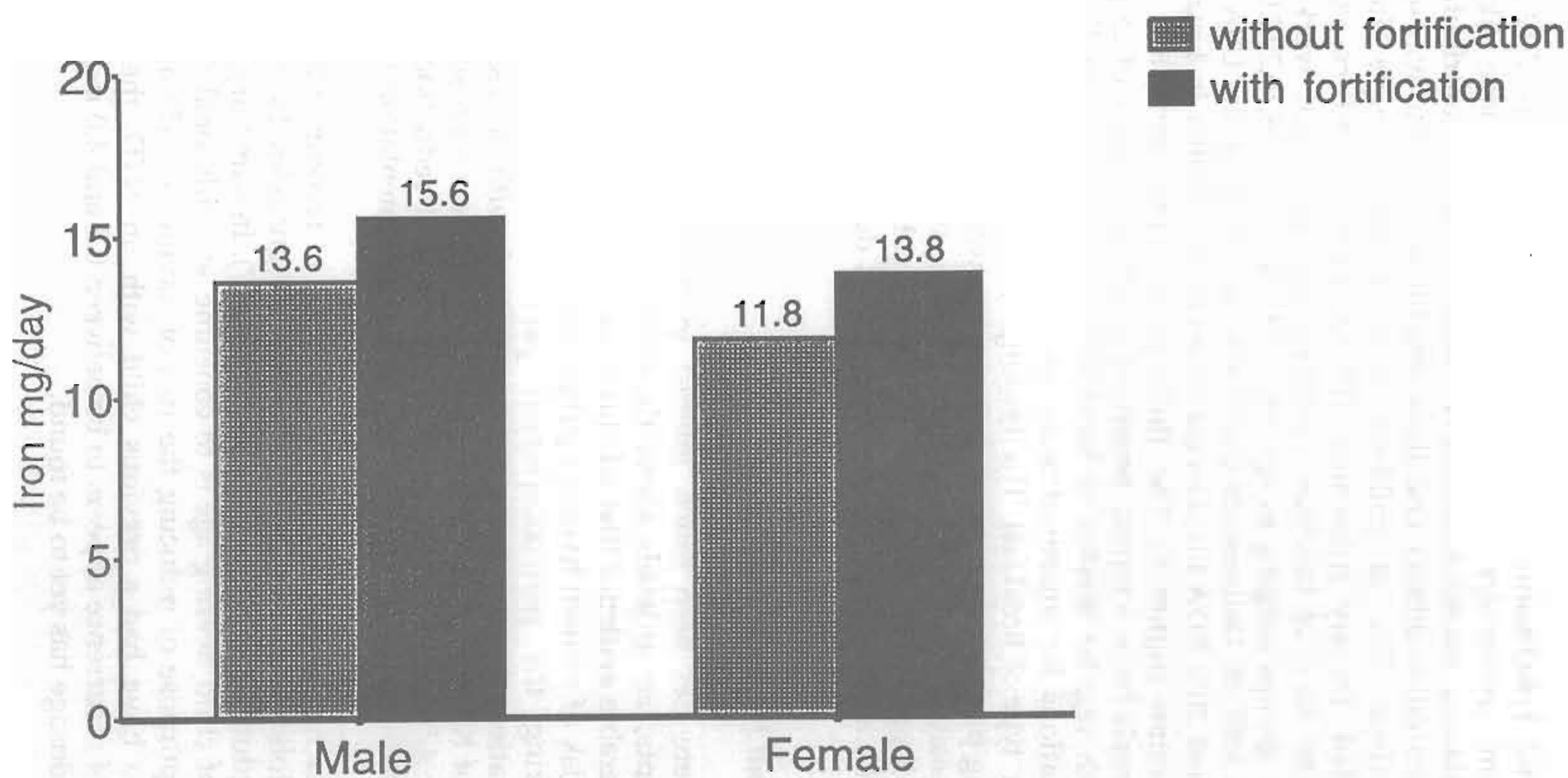
Gibson & O'Sullivan 1995

Figure 3. Effect of fortification on nutrient intakes of adult female breakfast cereal consumers in UK



McNulty et al 1994

Figure 4. Effect of fortification on Iron intakes of adult breakfast cereal consumers in UK



McNulty et al 1994

Albertson and Tobelmann (17), in a study of 824 children, 7-12 year old observed that frequent consumers of breakfast cereal were more likely to meet US recommendations for micronutrients. Breakfast cereals contributed around 25% of daily micronutrients intakes and their contribution to zinc was seen as particularly important since 75% of children were found to have intakes below the Recommended Dietary Allowance (RDA). Morgan and co-workers have been prolific in the field of breakfast nutrition and published work on a number of populations groups ranging in age from 5 to 80 years (18,19,20,21). In reanalysis of the USDA's 1987-88 Nationwide Consumption survey in the USA, the percentage of children below 70% RDA for selected vitamins was higher in breakfast skippers and on cereals eaters (figure 5). The findings are fairly consistent and suggest that breakfast cereals have a strong beneficial effect on intakes of important nutrients. Subjects with regular intakes of breakfast cereals were more likely to meet daily recommendations for micronutrients compared to breakfast skippers or those who had another type of breakfast. The findings of improved miconutrient intake was seen as being particularly important for young women, some of whom were found to have excessively low intakes of iron, calcium, vitamin B6, zinc, magnesium and coper (21). Hoppner and Verdier (22) also showed breakfast cereals are an important source of folic acid, a vital nutrient during fetal development.

Folic acid and Neural Tube Defects

Recently there has been much interest in the benefits of additional intakes of micronutrients, i.e. at levels above those which prevent deficiency signs. There is now considerable evidence that adequate intakes of folic acid before conception can reduce the risk of women having a pregnancy affected by neural tube defects (NTD). Studies during the periconceptional period have concluded that folic acid supplementation in this period is associated with a decrease in the risk of occurrence of NTD (23, 24). Another study, which was a prospective placebo control trial of over 4,500 pregnancies in Hungary showed reduction in the risk of NTDs among the patients who received folic acid supplementation (25).

These studies have resulted in the publication of recommendations with respect to the use of folic acid by women planning pregnancies by relevant bodies in the United Kingdom (26), and the United States (27). In summary, the recommendation to women of child bearing age is to consume an additional 0.4 mg of folic acid per day for the purpose of reducing the risk of having a NTD affected pregnancy. For women who have had a previous child with an NTD, the daily dose range for prevention of recurrence appears to be between 0.8 and 4.0 mg of folic acid, although the optimal dosage has yet to be found.

In a very recent study in Ireland where NTD incidence is particularly high, Cuskelly et al (28) demonstrated the importance of fortified foods. This study assessed the effectiveness of providing extra folic acid in the diet in the following ways: folic acid supplementation (as a pill), folic acid fortified foods (in the form of breakfast cereals and bread), foods rich in naturally occurring folate, dietary advice alone, and a control group with no intervention. Red blood cell folate status was measured before and after three months on the various diets (see table 6). The scientists concluded that only the supplementation and fortified food groups showed significant increases in red blood cell folate status. By contrast, although aggressive intervention with dietary folate (fruit and vegetables) or diet advice significantly increased intake of food folate (table 7), there was no significant change in red blood cell folate status. The authors concluded that increased intakes of folic acid, either as a supplement or as fortified foods, seem to be very effective in increasing folate status, and hence in reducing the prevalence of NTDs.

CONCLUSION

Regular consumption of breakfast cereals has been shown to result in lower dietary fat intakes, body mass index (15) and blood cholesterol levels (29). Coupling this with the beneficial effects of fortified breakfast cereals on micronutrient intakes and status, demonstrates that they are an ideal food for today's modern lifestyles.

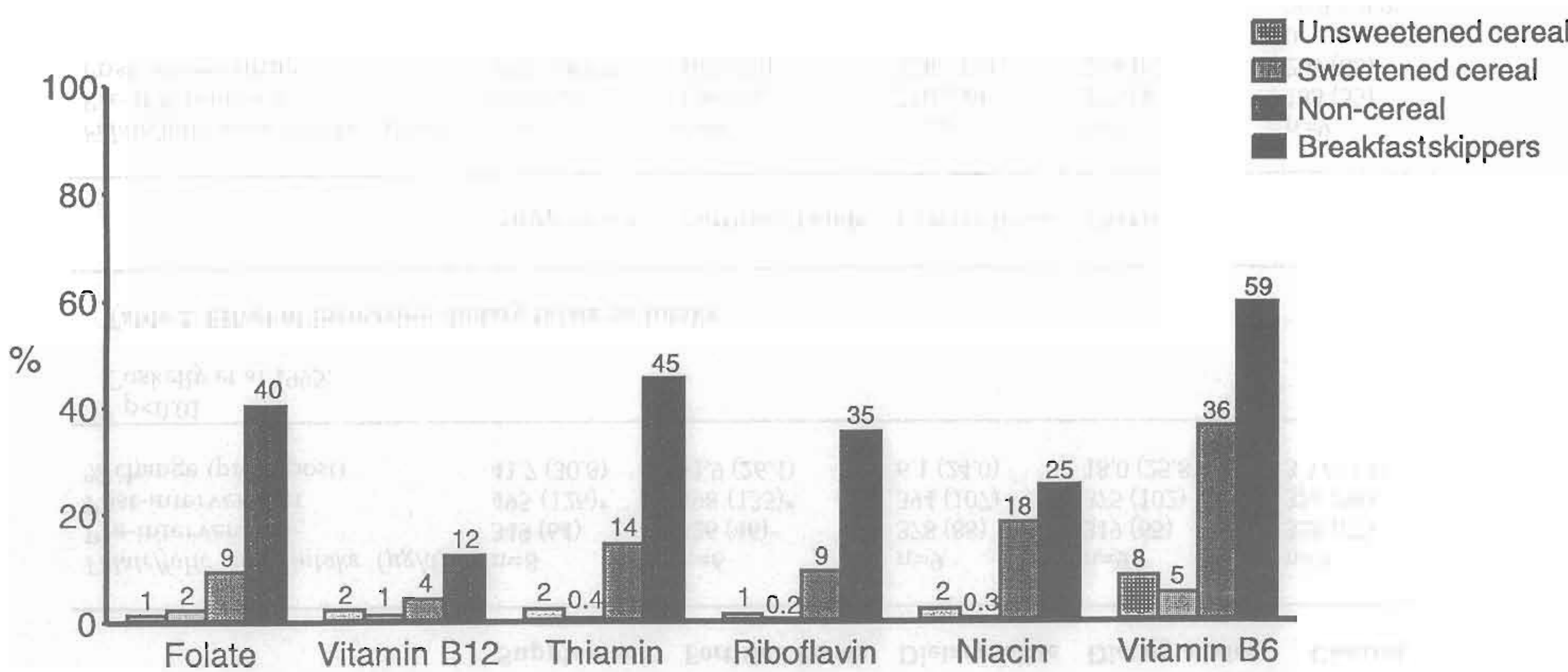
The World Bank stated in 1995 "The control of vitamin and mineral deficiencies is one of the most extraordinary development related scientific advances of recent years. Probably no other technology available today offers as large an opportunity to improve lives and accelerate development at such low cost and in such a short time".

REFERENCES

1. Stanek K *et al.* Diet quality and eating environment of pre-school children. *J. Am. Diet. Assoc.*, 1990, 90: 1582-1584.
2. Amine EK. *Bahrain Nutrition Status Survey.* UNICEF Gulf Area Office. Abu Dhabi, UAE, 1980.
3. Mostafa SA, and Nuwayhed Ht. *Gross Pattern of Kuwaiti Children From Birth to 60 Months.* Nutrition Unit, Preventive Health Division, Ministry of Public Health, Kuwait, 1979.
4. Soemantri AG *et al.* Iron deficiency anaemia and educational achievement. *Am. J. Clin. Nutr.*, 1985, 42, 1211-1228.
5. Tukan S. Availability of micronutrients in Arab diet: example from Jordan. In Musaiger AO and Miladi S (editors) *Micronutrient Deficiencies in the Arab Middle East countries,* FAO/RNEA, Cairo, 1996.
6. Kamel B. S and Martinez, O. B. Food habits and nutrient intake of Kuwaiti males and females. *Eco. Food. Nutr.*, 1984, 15: 261-272.
7. Kuwait Country Paper. Joint FAO-WHO International Conference on Nutrition, Rome, 1992.
8. Al-Shawi A. N. Nutrient intakes of university women in Kuwait. *J. Royal Soc. Hlth.*, 1992, 112 (3): 114-8.
9. Sawaya WN *et al. Dietary Survey on Infants and Pre-school Children in Saudi Arabia.* Ministry of Health/Ministry of Agriculture and Water, Saudi Arabia, 1985.
10. Sedrani SH. Are Saudi's at Risk of Developing Vitamin D Deficiency? *Saudi Medical Journal,* 1986, 7(5): 427-433.
11. Wang CY *et al.* Contribution of breakfast cereals to Australian intakes of trace elements. *Food Australia,* 1992, 44: 70-72.
12. Hammond G. K. The nutritional role of breakfast in the diets of college students. *J Can Diet Assoc.*, 1994, 55: 69-74.

13. Sommerville J, and O'Reagan M. The contribution of breakfast to micro-nutrient adequacy of the Irish diet. *Journal Human Nutrition & Dietetics*, 1993, 6: 223-228.
14. Crawley, H. The role of breakfast cereals in the diets of 16 to 17 year old teenagers in Britain. *Journal Human Nutrition & Dietetics*, 1993, 6: 205-215.
15. Gibson S. A and O'Sullivan, K. R. Breakfast cereal consumption patterns and nutrient intakes f British schoolchildren. *J. Royal Soc. Hlth*, 1995, 115: 366-370.
16. McNulty H. *et al.* The effect of fortification on daily micronutrient intakes of breakfast cereal consumers in Great Britain. *Proc Nut Sco*, 1994, 53: 143A
17. Albertson AM, Tobelmann RC. Impact of ready to eat cereal consumption on the diet of children 7-12 years old. *Cereal Foods World*, 1993, 38: 48-434.
18. Morgan K. J. *et al.* The role of breakfast in nutrient intake of 5 to 12 year old children. *Am. J. Clin. Nutr.* 1981, 34: 1418-1427.
19. Morgan K. J., and Zabik M. E. The influence of ready to eat cereal consumption at breakfast on nutrient intakes of individuals 62 years and older. *J. Am. College Nutr.*, 1994, 3: 27-44.
20. Morgan K. J. *et al.* Breakfast consumption patterns of older *Am. J. Nutr. Elderly*, 1988, 4: 19-44.
21. Morgan K. J. *et al.* Breakfast consumption patterns of US children and adolescents. *Nutrition Research*, 1986, 6: 635-646.
22. Hoppner K, and Verdier, P. Contribution of breakfast cereals to the daily intake of folacin, pantothenic acid and biotin. *Canadian Institute of Food Science Technology Journal*, 1984, 17: 121-124.
23. Smithells RW *et al.* Further experience of vitamin supplementation for prevention of Neural Tube Defects recurrences. *Lancet* 1983, 1(8332): 1027-31.
24. MRC vitamin Study Research Group. Prevention of Neural Tube Defects: results of the medical research council vitamin study. *Lanacet*, 1991, 338 (8760): 13-7.
25. Czeizel EA and Dudas, I. Prevention of the first occurrence of neural tube defects by periconceptional vitamin supplementation. *New England Journal Medicine*, 1992, 327 (26): 1832- 5.
26. Department of Health. *Folic acid and the prevention of neural tube defects.* Report of an Expert Advisory Group for the Department of Health, 1992.
27. CDC (Centre for disease control). Recommendations for the use of folic acid to reduce the numbers of cases of spina bifida and other neural tube defects. *Morbidity & Mortality Weekly Report*, 1991, 41: 1-7.
28. Cuskelly, G. J. Effect of increasing dietary folate on red cell folate: implications for prevention of neural tube defects. *Lancet*, 1996, 347: 357-359.
29. Resnicow K. The relationship between breakfast habits and plasma cholesterol levels in schoolchildren. *J Sch Health*, 1991, 61: 81-85.
30. Saldanha L *et al.* Vitamin and mineral status of Americans. The impact of breakfast. Presented at the XV International Congress Nutrition, Adelaide, Australia P7: 259, 1993.

Figure 5. Percentage of American children (6-11 years) below 70% RDA



USDA's 1987-88 Nationwide Consumption Survey

Table 1. Effect of increasing dietary folate on red-cell folate

	Supplement	Fortified Foods	Dietary folate	Dietary advice	Control
Folate/folic acid intake (μg/d)	n=8	n=6	n=9	n=9	n=8
Pre-intervention	349 (64)	326 (46)	378 (88)	319 (65)	325 (77)
Post-intervention	495 (126)*	498 (135)*	394 (107)	375 (102)	326 (58)
% change (pre v post)	41.7 (30.8)	51.9 (26.4)	6.1 (24.0)	18.0 (25.8)	3.3 (15.8)

* $p<0.01$
Cuskelly et al 1995.

Table 2. Effect of increasing dietary folate on intake

	Supplement	Fortified Foods	Dietary folate	Dietary advice	Control
Folate/folic acid intake (μg/d)	n=8	n=6	n=10	n=7	n=9
Pre-intervention	204 (36)	186 (35)	216 (66)	175 (40)	183 (53)
Post-intervention	593 (38)***	407 (76)**	426 (124)***	268 (67)*	209 (63)
(of which folic acid)	400	269 (67)	0	48 (15)	0
% change (pre v post)	-4.3 (16.9)	127.2 (65.1)	108.6 (76.3)	58.9 (48.3)	20.9 (39.0)

*** $p<0.001$, ** $P<0.01$, * $P<0.05$
Cuskelly et al 1995

TEACHING AND LEARNING NUTRITION WITH REFERENCE TO THE PREVENTION OF MICRONUTRIENT DEFICIENCY

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INTRODUCTION

There are many reasons why children should be taught about nutrition. From a biological perspective, it is important for everyone to eat a diet which provides adequate nutrients to ensure healthy growth and development.

But health and well-being involve more than absence of disease and an understanding of food and nutrition can have a positive impact on social interaction, too. Food is a pleasure to be enjoyed and sharing meals with friends or in a family setting has social as well as physiological benefits. Furthermore, while cooking may be a hobby for some people, and an everyday chore for most, for others it may provide a valuable route into employment.

Any form of dietary imbalance, whether related to excess or deficiency of particular nutrients, give cause for concern; but micronutrient deficiency may pose particular problems in young children.

Iron deficiency anaemia is the most common form of dietary deficiency among children in the UK. It is also a common problem worldwide. What makes the prevalence of iron deficiency anaemia among young children a particular worry for parents and teachers is that research has shown a clear overlap between the incidence of iron deficiency anaemia and psychomotor delay. At critical stages in a child's physical development, and of their education, iron deficiency anaemia may interfere with their capacity to learn.

There are well established strategies for combating nutrient deficiency. A health screening programme would identify those children at particular risk of iron deficiency anaemia, for example, and allow appropriate intervention to be focused towards those individuals. A more general strategy would involve modifying the diet of the whole population by adopting measures such as national fiscal policies, to subsidise the cost of foods which are good sources of iron, fortification of foods to 'enrich' the quantity of iron naturally present. The distribution of supplements to large sections of the population is also an effective short term measure. Any of these would be likely to produce tangible, quantifiable improvements in health in the relatively short period of time. However, another approach to modifying the diet of the whole population would involve a programme of education.

In planning any such programme, a number of questions need to be addressed. First, what is the purpose of the programme? The rationale needs to be clear - for example, there are differences between nutrition education, primarily concerned with developing knowledge skills and values and health education which aims to influence specific attitudes and behaviours. What sort of outcomes are anticipated? Is the programme to e very general, or does it have a specific focus? Is it necessary for everyone, or is it only appropriate for a particular target group?

In the case of the British Nutrition Foundation in the UK, the starting point for our schools education programme was the establishment of our Education Working Group, drawn from all areas of education including colleagues from universities, examination groups and practicing teachers. Their task was to define the objectives for a food and nutrition programme for children, throughout their compulsory education from 5-16 years of age. They agreed five objectives for the programme.

Objectives for 'Food-a fact of life'

1. To help individuals to recognise that food is a basic requirement and should be enjoyed.
2. To help develop an understanding of the underlying scientific principles upon which current issues in nutrition are based.
3. To inform about methods of food production and food processing in domestic and commercial situations.
4. To encourage an awareness of social, economic and cultural aspects of food choice.
5. To enable individuals to demonstrate and apply appropriate and relevant knowledge of concepts and principals when planning and preparing meals, and making choices related to food.

Attitudes towards food are formed early, even before the start of formal education children develop attitudes about food within their home and family. They know what they do or do not like. Some foods have special meaning - only eaten on special occasions or religious festivals, for example.

It may be important for basic knowledge about food to be taught to quite young children - with more abstract concepts such as nutrients being introduced at a later stage.

The model on which the British Nutrition Foundation's 'Food - a fact of life' food and nutrition programme is built on a grid, or framework with five themes which run through each stage - progressively extending the level of detail of content and expected depth of understanding. A similar model presented in the draft European Guide 'Nutrition Education in Schools' is called a spiral curriculum. The underlying principle of this model is that children revisit topic areas at later stages in their education, constantly extending their level of knowledge and understanding.

In determining the content of any education programme it is important to define the long term aims - which might be along the lines of 'to improve children's understanding of the relationships between lifestyle, diet, and health'. Equally important is the clarification of objectives which state what children will know, understand and be able to do at the end of the course.

As an illustration, the resources the British Nutrition Foundation produced for 5-7 years olds and their teachers were based on seven key facts, which contain the basic concepts of food and nutrition which pupils are required to know;

1. There is a variety of foods for humans but there are two main sources: plants and animals.
2. People around the world choose food according to: availability, need, preference.
3. Food can be combined in many different ways. The actual combinations will be influenced by race, religion and custom and will also depend on other factors.
4. Food is need to grow, be active and maintain health.
5. Food has to be actively acquired or produced.
6. Most food has to be changed in some way before it can be eaten. This is food processing.
7. Food hygiene - dirty food is dangerous because it contains large numbers of microbes which can cause food poisoning.

Views differ as to where nutrition education fits into the school curriculum. In the UK, primary schools (for 5-11 year olds) often work on a theme, such as 'Ourselves', relating most of the term's work to the theme. However, in secondary schools (for 11-16 year olds) the curriculum is divided into discrete subject areas, taught be subject specialists.

So, the theoretical aspects of nutrition might be taught in Science, while the practical food handling takes place in Home Economics or Food Technology lessons - and Health Education is taught elsewhere.

Everyone knows something about food - but who should take responsibility for nutrition education in school? The teacher is an obvious choice - whether a primary school teacher, who teaches every subject in the curriculum or a specialist secondary school teacher. Of course, the messages children pick up from seeing teachers eating around the school should not contradict what they learn in formal classroom lessons. Any food provided in school - in a school canteen, tuck shop or vending machine should support this, too. But teachers are not the only people who can be involved.

In some cases, a course on nutrition may be given by an outside 'expert', perhaps a dietitian or nurse. This gives a special interest to the course, but does it imply that nutrition is not a normal part of everyday life? Against this, should be weighed the role of parents or other family members, whose immediacy to the children could increase the impact of nutrition messages when first learned and help to reinforce them over time.

Children themselves may be involved in peer-tutoring. One approach adopted by Centro de Estudios sobre la Nutrición Infantil of Argentine involves young children teaching others of the same age, using role play and a puppet to make the work lively and capture the children's attention.

Other techniques for teaching the content of a nutrition course include the use of symbols, characters and colours to guide the children. One example of this is drawn from the work currently being developed by Kelloggs, in collaboration with educationalists and nutritionists from the Middle East. The character of 'Crescent Man' demonstrates the concept of food groupings in a lively way, likely to appeal to the 8-10 year old target audience.

The use of the crescent shape and green colour were developed following concept research with children. The green crescent, as an Islamic symbol, was thought to be familiar and reliable. The colour was seen to evoke images of wellness, life and positive health benefits. The shaped jigsaw pieces show how different foods fit together to make the total diet. And the animation of the character makes him an excellent vehicle for holding the children's attention.

Taking an example for the British Nutrition Foundation's 'Energy and Nutrients' unit, it is possible to show how resources can be differentiated to offer different levels of information. The simplest sheet, called Key Facts, introduces the term minerals, and discusses ways in which they function in the body. Iron is given as an example of a mineral. In the foundation level information sheet, the link between iron and haemoglobin is introduced, along with references to bioavailability of iron from plant and animal sources. The extension level sheet extends this information further, introducing the concept of fortification.

Another resource in the pack is a set of 44 colourful cards, showing a photograph of 100g of the food and a graphical representations of selected nutrients. These have been successful as pupils sometimes find the relationship of produce size and nutrient content difficult. For example, a pupil may know that 100g of parsley is a good source of vitamin C, yet would they actually eat 100g? The data sheet shows sources of iron in the British diet in a pie chart, which encourages the students to interpret and use cross curricular skills eg maths.

Finally, a case study on the 'Diets of British School Children' provides a real-life context in which the information about iron has particular relevance. The resources link together, gradually developing understanding.

The major problems with nutrition education are that it may take years to show any positive effect, and it is not absolutely clear what criteria to use for evaluation. It is clear that changes in knowledge do not necessarily lead to corresponding changes in behaviour. However, equipping children with a sound understanding of the scientific principles underlying nutrition and an enjoyment of food must be an investment in the long-term health and well-being of children.

List of Participants in Workshop on Prevention and Control of Micronutrient Deficiencies in the Arab Gulf Cooperation Council Countries Kuwait, 30 June - 2 July, 1996.

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Prevention and Control of
MICRONUTRIENT DEFICIENCIES IN
THE ARAB GULF CO-OPERATION COUNCIL COUNTRIES
30 June - 2 July, 1996
(Kuwait city, Kuwait)

Scientific Programme

Sunday, June 30 1996

8:00 - 9:00	**Registration**
9:00 - 9:30	**Opening ceremony**
9:30 - 10:00	Coffee break

First session (10:00 - 12:00) : Background papers

Chairman: Z.Al-Mousa*(Ministry of Health/Kuwait)*

10:00 - 10:30	Micronutrient deficiencies in the Arab countries : An overview **S.Miladi(FAO/RNE)**
10:30 - 11:00	Factors associated with micronutrient deficiencies in the GCC countries **A.Musaiger (UAE University/ Al-Ain)**
11:00 - 11:30	Strategies for controlling micronutrient deficiencies **K.Bagchi(New Delhi/India)**
11:30 - 12:00	The role of UNICEF in combating micronutrient deficiencies:Example of Oman **S.Rawas(UNICEF/Oman)**
12:00 - 12:15	Coffee Break

Second Session (12:15 - 2:15 pm)
Intervention Programmes

Chairman: K.Bagchi *(NewDelhi/India)*

12 :15 - 12:45	Food fortification, quality assurance and control **D.Barclay (Nestle' Research Centre/ Switzerland)**
12 :45 -13 :15	Economic aspect of food fortification **K.Nagy (F.Hoffman/Switzerland)**
1 :15 - 1:45	Nutrition and health aspects of fortified food **K.Yates (Kellogg's/UK)**
1 :45 - 2 :15	Teaching and learning nutrition to overcome micronutrient deficiencies **S.Valentine(British Nutrition Foundation/UK)**
2 :15 - 5 :00	Lunch Break

Third Session (5:00 - 7:00 pm)
Iron deficiency anaemia in GCC countries

Chairman: H. Dashti *(Kuwait University/ Kuwait)*

5 : 00 - 5 :30	Iron deficiency anaemia in Bahrain **A.Musaiger(UAE University/Al-Ain)**
5 : 30 - 6 :00	Iron deficiency anaemia in Saudi Arabia **K.Madani(Ministry of Health/S.Arabia)**
6 : 00 - 6 :30	Iron deficiency anaemia in Qatar **H.Al-Ansari(Ministry of Health/Qatar)**
6 : 30 - 7 :00	Iron deficiency anaemia in Kuwait **F.Al-Awadi (Ministry of Health/Kuwait)**

Monday, July 1st,1996

Fourth Session (9:00 - 10:30)
Micronutrient deficiencies in GCC countries

Chairman: S. Valentine ***(British Nutrition Foundation/ UK)***

9:00 - 9:30	Iodine deficiency in Saudi Arabia **O.Al.-Attas(King Saud University/S. Arabia)**
9:30 - 10:00	Iron deficiency anaemia in UAE **M. Hossain (UAE University/ Al-Ain)**
10:00 - 10:30	Trace element status in Kuwait **H.Dashti(Kuwait University/Kuwait)**
10:30 - 11:00	Coffee Break

Fifth Session (11:00 - 1:00)
Micronutrient deficiencies in GCC countries - continue

Chairman: O. Al-Attas ***(King Saud University/S.Arabia)***

11:00 - 11:30	Vitamin D staus in Saudi Arabia **T.Kumosani (King Abdulaziz University/S.Arabia)**
11:30 - 12:00	Vitamin A status and nutritional rickets in Kuwait **A.Molla(Kuwait University/Kuwait)**
12:00 - 12:30	Some aspects of micronutrient deficiencies in Oman **S. Rawas(UNICEF/Oman)**
12:30 - 1:00	Challenges in food fortification research in Kuwait **J.Sidhu(KISR/Kuwait)**
1:00 - 4:00	1:00 - 4:00 - Lunch Break

Sixth Session (4:00 - 7:00pm)
Working groups

Chairman: A.Musaiger (*UAE University/Al-Ain*)

Group 1. Dietary diversification and fortification for overcoming micronutrient deficiencies.

Group 2. Public health measures for prevention of micronutrient deficiencies.

Tuesday, 2 July, 1996.

Seventh Session (9:00 - 11:00)
Conclusion and Recommendations

Chairman: S.Miladi (*FAO/RNE*)

Reports of working groups.

Conclusion and recommendations.