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# Micronutrients Status in Saudi Arabia

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**In the last three decades, Saudi Arabia witnessed rapid changes in health, education, social services, and agriculture. These changes had a profound impact on food consumption patterns, health and nutritional status, particularly on the micronutrients status of Saudis. We have reviewed the available literature on the micronutrients status in Saudi Arabia. The results reveal the need of formulated studies to determine the prevalence and causes of vitamin A deficiency and there are very few studies on the zinc status in the Kingdom. Data shows that iron deficiency anemia, vitamin D deficiency and iodine deficiency (in few areas) do exist in Saudi Arabia. Ameliorative measures are presented to combat this public health problem.**

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Micronutrient deficiencies are among the most common nutritional problems worldwide. In the Arab region the micronutrient deficiencies especially iron, iodine zinc, vitamin A and D deficiencies are highly prevalent. However, the magnitude of the problems varied from country to country. Saudi Arabia underwent rapid changes during the last three decades in health, education, social services, and agriculture. These changes had a profound impact on food consumption patterns, on health and nutritional status, particularly on the micronutrient status.

The aim of this paper is to review the available literature on the micronutrients status in Saudi Arabia, namely iron, iodine, zinc, vitamin A and vitamin D. This paper is considered to provide physicians, nutritionists, and policy makers with a reference source on the status of micronutrients in Saudi Arabia. This paper may also stimulate investigators to carry out further studies on micronutrients.

## IRON STATUS

Iron deficiency anemia is a major public health problem of multi-factional origin in Saudi Arabia.

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Generally, there is a very poor relationship between serum ferritin concentration in the newborn and that of the mother at term[1]. Hawa et al[2] in a study to determine the haemoglobin level and iron status in mothers and their babies at delivery in King Fahad National Guard Hospital in Riyadh suggested that it is the fetus which largely controls the movement of iron across the placenta with only a marginal control exerted by maternal serum iron level. Ghafouri et al[3] in Jeddah area reported that the level of haemoglobin was high at birth and reached maximum levels during the first few days of life. The same authors[3] reported that no sex differences could be demonstrated in the mean haemoglobin level during the first year of life.

Healthy Saudi infants between 6 and 24 months of age who were attending the Well Baby Clinic at King Khalid University Hospital in Riyadh for routine vaccinations were studied[4]. Of the 366 screened infants, 136 (37.2%) were anaemic (Hb<11 g/dL). In another study[5] using the same criteria to define iron deficiency anaemia for 84 Saudi 9 month old infants attending the baby clinic in King Khalid Hospital in Jeddah, the prevalence of iron deficiency anaemia was 35.7%. In view of the high prevalence of iron deficiency in the population studied, it is recommended that all infants should be screened for iron deficiency during their routine visits for immunizations.

In another study of haematologic profile[6], a total of 208 children aged 2 months to 5 years were studied. The results show that 38% of the children were anemic, 22.6% were borderline and 39.4% were normal.

The Turaba study[7], in western Saudi Arabia, found that the level of haemoglobin ranged between 6 to 10 g/dL in 34% of the Bedouin children under five years of age. Another study, in the region of Tamnia, also showed 36% of the pre-school children were having haemoglobin levels below normal[8].

The prevalence of iron deficiency anaemia in Saudi Arabia is more among preschool compared to school children[9]. The haemoglobin level and laboratory stool analysis for ova and cysts were performed for 285 primary school girls from the urban area of Al-Khobar, in the eastern province of Saudi Arabia[10]. Of the study group, 26.4% had anaemia (haemoglobin levels below 11 g/dL), and 9.2% were infested with one parasite or more. Those with parasites had a significantly higher (38.8%) prevalence of anaemia as compared to those (21.8%) without infestations ($p < 0.001$).

In a survey conducted in western Saudi Arabia by Hammouda et al[11], iron deficiency anaemia was found to be prevalent among 3,762 primary school children of both sexes in both rural and urban areas. The prevalence rate was 30.8% in those having haemoglobin levels below 12 g/dL due to parasitic infection.

A recent study[12] determines the prevalence of iron deficiency anaemia among 1210 school girls aged 7-14 year old in Riyadh, Saudi Arabia. Severe anemia is found among 1.4% of all children who showed haemoglobin level below 8 g/dL while 8.5% showed a level of 8 to < 10 g/dL and 20.1% of them have Hb level of 10 to < 11 g/dL, making a total of 11.8% having Hb level below 10 g/dL while 30% have Hb level below 11 g/dL. An in-depth investigation of the etiological factors of iron deficiency is urgently needed and meanwhile a suitable iron supplementation program is recommended.

El-Hazmi and Warsy[13] determined the overall prevalence and types of anaemias in Saudi adults and children. The study was conducted in 17 different areas in four provinces of Saudi Arabia. A total of 17,574 individuals (males: 5938; females: 6255 and children (<14 years) 12,193) were screened. Haematological parameters and red cell indices were determined. Anaemia was further classified as hypochromic-microcytic, normochromic-normocytic and normochromic-macrocytic based on the values of red cell indices. The prevalence of each type of anaemia was separately determined in the adult males, females and children. The results showed that anaemia occurred at a high frequency ranging from 7.2-16.5% in the males, 10.8-23.5% in the females and 16.5-41.3% in the children, in the different provinces. Significant differences were encountered within each province in different cities (areas). Hypochromic-microcytic anaemia was frequent in several of the areas while in others normochromic-normocytic anaemia occurred at a higher prevalence. The investigators described that anaemias are of frequent occurrence in Saudis.

Iron deficiency anaemia in pregnancy is still a health problem in Saudi Arabia. Many researches[14-16] indicated that the prevalence of iron deficiency anaemia among pregnant women ranges from 4.6% to 26.5%. The reason for this wide range may be because of the different cut-off points of haemoglobin used which is ranged from Hb < 10g/dL to Hb < 11g/dL.

Age of the mothers has negative effects on the haemoglobin level. In Jeddah[14], by the end of pregnancy, haemoglobin levels for 40 year olds were significantly lower than their counterparts who were less than 20 years of age.

The diagnosis of iron deficiency anaemia in Saudi Arabia becomes more complicated with the high incidences of haemoglobin disorders such as sickle cell traits and thalassaemias. Studies[17,18] showed that haemoglobinopathies are widespread in Saudi Arabia and are considered as a serious health problem among children. The high incidences of haemoglobin disorders has been related to isolation, natural selection and inbreeding for generations. 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 haemoglobin values.

Although factors responsible for the incidences of iron deficiency anaemia in Saudi Arabia were not well investigated, the factors that could be cited for this deficiency are as follows:

1. Several studies[19,20] reported that parasites were prevalent among children and adults in Saudi Arabia. The incidence of anaemia was higher in parasite-infected individuals than in parasite-free ones[10,11], indicating that parasitic infections may be one of the causes of iron deficiency anaemia in Saudi Arabia.

2. Reducing the total number of pregnancies and increasing the time between them has a positive impact on the iron status of the mother[21]. In Saudi Arabia grand multiparity, and short birth intervals are common occurrences[15, 22, 23].

3. Lower daily dietary intake of iron[24] is also an important factor in infancy. Human milk is poor in iron and breast feeding is the first choice for infant feeding in Saudi Arabia[25].

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

5. 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.

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. Intervention action programs to combat iron deficiency anaemia in Saudi Arabia should be given a high priority. Several measures must be taken into consideration when dealing with anaemia. This includes supplementation of iron and folic acid to mothers, motivation of pregnant mothers to attend pre-natal clinics regularly, and assessment of haemoglobin concentrations. Sufficient spacing between subsequent pregnancies, supplementation of breast feeding with infant's formula fortified with iron after the first six months, blood screening for children, prevention and treatment of intestinal parasitic infections, iron fortification of some common foods. Different nutrition education programs should be conducted especially for the mothers to increase the intake of iron rich foods and vitamin C, and by reducing intake of other substances which inhibit iron absorption such as phytates, tannins and other polyphenols.

## IODINE STATUS

Data on iodine status from the Arabian Peninsula is limited. One cross-sectional epidemiological household study was conducted in Saudi Arabia to determine the iodine status for 4,638 children aged 8 to 10 years[26]. Clinical assessments for the presence of goiter and urinary iodine concentration were conducted in four areas with different geographical natures. The investigators found provincial differences with respect to urinary iodine concentration and the percentage of subjects with urinary iodine concentration <10 μ g/dL. The Southern province had the lowest median (11 μ g/dL) and the highest percentage (45%) of subjects with urinary iodine concentration <10 μ g/dL. On the other hand, subjects of the Western province had the highest median (24 μ g/dL) and the lowest percentage (8%) of subjects with urinary iodine concentration <10 μ g/dL. The difference can be attributed to the special character of each of these provinces where the Southern province is characterized by being of high altitude, low to median urine and difficult access to high iodine content food such as fish. This is in contrast to the Western province which is characterized by low altitude, medium to high income and easy access to food such as fish[26]. There is a need to launch a control program to ensure the exclusive availability of iodized salt in Saudi Arabia, especially in the Southern province.

Al-Attas and Sulimani[27] determined the iodine concentrations in Saudi Arabian staple foods. Foods in bread groups, dairy, eggs, vegetables, fruits, fish, soft drinks and Saudi mixed meals were analyzed for their iodine concentrations. Results revealed that iodine concentrations are comparable to those of Britain and the United States. Foods commonly consumed by Saudis appear to have an adequate iodine concentration. On the other hand, Sulimani et al[28] previously documented low iodine levels in samples of tap water and drinking mineral water from different regions of Saudi Arabia.

Hypothyroidism is one of the most frequently encountered endocrine diseases in childhood. Early detection and proper treatment of the disease prevents developmental retardation and other sequelae of the condition[29]. In Saudi Arabia, there is no precise data on the prevalence of the disease, however, there is an impression fostered by clinical experience and local neonatal screening programs for congenital hypothyroidism that this is not a rare disease[30].

**ZINC STATUS**

Data on the zinc status in Saudi Arabia are very limited. Bahijri et al[31] determined the zinc serum level in healthy infants and preschool children (aged 4-72 months) in Jeddah and Makkah areas, the subjects were randomly selected from nurseries, kindergartens and welfare centers, infants and children coming to the government maternity and children hospital to obtain a clearance vaccination certificate before registering at school. Zinc was estimated in 728 serum samples distributed amongst the various age groups. Table 1 shows the mean and the standard deviation of the serum zinc level[31]. The investigators concluded that mild (serum zinc ≥45 - <60 µg/100 ml) to moderate (serum zinc 23 - <45 µg/100 ml) zinc deficiency is present in the studied population of infants and children. No severe deficiency was encountered[31].

**Table 1 – Serum Zinc Level (Mean ± SD) For the Various Age Groups**

| Age (months) | No. of Samples | Mean ± SD µg/ 100 ml |
|---|---|---|
| 4 - <6 | 115 | 61.19 ± 18.60 |
| 6 - <12 | 165 | 57.13 ± 13.40 |
| 12 - <24 | 161 | 56.40 ± 13.51 |
| 24 - <36 | 88 | 52.31 ± 16.07 |
| 36-72 | 199 | 61.72 ± 24.52 |

Kumosani et al[32] determined the serum zinc level of 276 healthy subjects (138 males and 138 females) in a prospective, cross section study in the Western region of Saudi Arabia. The ages ranged from 1 month to seventy years. The subjects were divided into nine groups according to the recommended dietary allowances classification for both sexes. Serum zinc level were found to be different at different age groups, the highest were found to be at earliest stages of life and at the age of 15-50 years for both sexes. The investigation concluded that the serum zinc level range of all ages was 0.50 – 13.90 µ mol/L, which is lower than the international established standard (7.65 – 22.95 µ mol/L).

In another study[33] the zinc level was compared in the serum of 66 healthy non-pregnant subjects, and 57 healthy pregnant women in the Western region of Saudi Arabia. Serum zinc levels were found to be lower in pregnant women when compared to non-pregnant women. Zinc level was found to decrease as pregnancy advanced. The investigators concluded that the zinc is lower in pregnant women than non-pregnant women, and zinc decreases as pregnancy progress.

Although there are only few data on the zinc status in Saudi Arabia, the causes of the deficiency in children might be low intake of foods rich in readily absorbable zinc such as liver, red meat, poultry, fish, oysters, and crabs[31]. Traditional staple foods, such as cereals, legumes and tubers, contain zinc, but its bioavailability is poor. Phytate, fiber and lignin in these foods form insoluble complexes with zinc, preventing its absorption[31]. Cow's milk, because of its high levels of calcium and casein, and soy milk, because of its phytate content, may further reduce the absorption of zinc from the diet. In contrast, zinc in breast milk is well absorbed. Older children (>30 months) will be likely to obtain zinc from meat and other richer sources when available. However, because of diarrhoeal attacks and loss of zinc via sweat especially with hot climate and the poor housing available to lower classes, zinc deficiency might exist in older children. For these reasons and until more data on the epidemiology of zinc deficiency in Saudi Arabia is available, it is advisable to give zinc supplements to infants and children whose dietary history shows the absence or inadequate sources of zinc such as babies fed on powdered unfortified milk without any additional supplementation, and children getting rice and vegetable supplements, specially if short stature is noticed. Infants and children suffering from frequent attacks of diarrhea are also at risk, and zinc supplementation would also be advisable[31].

**VITAMIN A STATUS**

To the best of our knowledge, there is no sufficient data in Saudi Arabia on the prevalence of vitamin A deficiency. The only National Nutritional Survey of Saudi Arabia[34] shows that 1.2% of the 607 subjects living in Riyadh area having serum vitamin A levels lower than 10 ug/dL. In young adult males, a concentration of <10 μg/dL serum retinol was thought to indicate deficiency. This level has been found useful in many field surveys.

**VITAMIN D STATUS**

The available data indicates that vitamin D deficiency in Saudi Arabia does exist[35-37]. Elidrissy and Sedrani, as early as in 1981, reported 31 cases of rickets patients admitted to maternity and children's hospital of Riyadh, over a period of 14 months[36]. Other studies in Saudi Arabia[37] indicated low levels of vitamin D in mother's plasma and in their infants. This indicates the role of the pathogenesis of rickets in infants born to mothers with inadequate vitamin D status, and the disease has its origin in the prenatal period.

Sedrani et al[38], during 1986 and 1987, studied the prevalence of clinical and sub-clinical rickets in Saudi children admitted to Sulimania Children's Hospital in Riyadh. Among the total admissions (16,125) the prevalence of clinical rickets was 1.3 and

1.4% each year, respectively, and the prevalence of sub-clinical rickets was 3.1%. The majority of the children with rickets (88%) were breast fed compared with 42.1% in the control children. Five percent of the children under 6 years of age were vitamin D deficient. There is a continuing presence of radiologically proven rickets in Saudi infants. This situation can be improved by changes in public health policy.

Another survey[39] was carried out on 4,078 subjects to study the effect of regional and environmental location on vitamin D status of Saudis. The studied population was divided into five groups on the basis of their geographical location and lifestyle. The lowest 25-OHD plasma concentrations were observed in the population living in the Northern province. The highest levels were found in the Western province. Rural children have higher concentrations than rural adults. In the same geographical location, rural adult males and females had significantly higher 25-OHD than urban adult males and females. The concentration of 25-OHD in rural adult females is much greater than that of urban females[38]. This study had demonstrated several inter-regional, sex, and age differences, and had revealed that even in a country such as Saudi Arabia, with an abundance of ultraviolet light, deficiency of vitamin D is frequently seen.

Another survey[40] was conducted to study the vitamin D nutritional status in the Saudi population. The study included 4078 Saudi males and females living in different regions in Saudi Arabia. Volunteers were from <6 years up to 90 years of age. Male children, <6 years of age, have a significantly higher level than older subjects, whereas the female adolescents (age 13-18 years) and preschool children have the lowest plasma 25-OHD levels in comparison with the other groups. No significant correlation was detected between plasma 25-OHD and age. Saudi males have significantly higher 25-OHD than females. As for the house type, occupants of tents have significantly higher 25-OHD than those occupying mud houses, villas or brick houses. The people living in tents are usually urbanized Bedouins therefore, have more exposure to natural sunlight[40]. Sedrani et al[41] revealed that there is no significant difference between the plasma concentration of 25-OHD in January and August for adult females and males. These results may suggest that as the temperature increases during the summer, the exposure of the Saudi population to solar ultraviolet radiation is decreased, and hence, the concentration of plasma 25-OHD decreases.

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

1) Overdressing of the babies with limited sunlight, and keeping them in badly illuminated houses[38].

2) The low level of vitamin D in plasma of mother and infants with rickets indicates that mother's milk is already depleted and deficient in vitamin D to start with[37].

3) Dietary vitamin D intake has been calculated at approximately one-tenth of the daily intake of that in the United States of America[42].

4) Both men and women are deprived of sunlight as their traditional dress covers the skin almost completely[43].

5) An increase in ultra violet light insulation due to atmospheric dust particles could be one of the factors responsible for vitamin D deficiency in Saudi Arabia .

6) Individuals whose foods contain excess phytate require more vitamin D since the phytate combines with calcium and decreases its absorption. This could be another added factor producing deficiency in Saudis since whole wheat pita bread and cereals are rich in phytate, which form an essential part of the Saudi diet.

7) Genetic factors associated with rickets also exists in Saudi Arabia, either as familial vitamin D resistance rickets, vitamin D dependent rickets, or congenital hypoparathyroidism, and other forms of inborn errors of metabolism[44, 45].

In conclusion, these studies have shown that vitamin D deficiency exists in the Saudi population at a high frequency. It has also emphasized the need for better illumination by sunlight, yet maintaining privacy in houses, vigorous mass media campaigns against excessive and unnecessary wrapping up of babies, and educating the mothers about the importance and benefits of the sunshine in a land of plenty. Health education, including dietary advice should be given to the community. Supplementation with vitamin D, or a diet adequate in calcium and phosphorus, effectively controls rickets. A concerted effort must be made to screen breast-fed children to detect sub-clinical forms of rickets and to educate the public about the importance of sunlight exposure and diversified nutrients.

## CONCLUSION

**In this review, we have limited the discussion to the nutritional status of iron, iodine, zinc, vitamin A and vitamin D in Saudi Arabia. The results reveal lack of formulated studies that determine the prevalence and causes of vitamin A deficiency availability of and few studies on the zinc status in the Kingdom. Data shows that iron deficiency anemia, vitamin D deficiency and iodine deficiency (in few areas) exist in Saudi Arabia. Further ameliorative measures are needed to tackle this public health problem.**

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