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Review Article

Obstetrics and Gynaecology Section

Minerals in Pregnancy and Lactation: A Review Article

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ABSTRACT

Micronutrients (include vitamins and minerals) are essential for normal function, growth and development. Minerals have important effects on the health of the mother and foetus. But biological mechanisms of minerals are not completely understood. Micronutrient deficiency during pregnancy can lead to anaemia, hypertension, obstetric complications and even maternal death and in foetus lead to a fail in growth and development. Mineral deficiency during pregnancy, particularly exist in developing countries. During pregnancy due to the increased demands caused by physiological changes, deficiency is exaggerated and as a result its complications occur. Thus, ensuring to receive enough macronutrients and micronutrients before and during pregnancy, is important. Nevertheless, there are controversies regarding administrating supplements. There are not enough studies about some of the minerals and the challenges remain. Regarding the importance of minerals in pregnancy and lactation, in this review we will analyze the role of them in pregnancy and lactation.

Keywords: Breast feeding, Lactation, Micronutrients, Minerals, Pregnancy

INTRODUCTION

Minerals play different roles in the body among which, participation in the construction of the body and regulation of its function especially in bone construction, transport of oxygen, regulation of blood sugar, as a cofactor for the enzyme activity, regulation of chemical reactions, protection of cells from oxidative damage and regulation of immune system function [1]. Minerals constitute about 4% to 5% of body weight out of which, 50% is calcium and 25% is phosphorus [2].

During pregnancy, increased physiological changes to support body metabolism in the mother and growing foetus lead to an increased need for micronutrients [1, 2]. Therefore, it is of great importance to ensure whether women receive sufficient macro- and micronutrients prior to and during pregnancy [2, 3]. Micronutrient deficiency both during fertilization and pregnancy leads to some increased risks which include anaemia, pregnancy-induced hypertension and pre-eclampsia, foetal growth restriction, increased labor complications, and maternal and foetal mortality [2-4].

The mother's nutritional status affects embryonic genome expression and is associated with development of diseases in later life stages such as coronary artery disease, stroke, and conditions such as hypertension and non-insulin dependent diabetes [4].

Given the importance of mineral micronutrients in pregnancy and lactation, in this review, the role of minerals in pregnancy and lactation and their rate of consumption, as well as complications induced by their deficiency or excess use, are investigated. To this end, each of minerals is separately described and the recommended daily intake as well as maximum allowable daily intake of minerals for adults and pregnant and lactating women is presented in [Table/Fig-1,2].

Electrolytes

The amount of daily salt intake recommended for the average person is 3-5 grams, reaching 7-8 grams during pregnancy [Table/Fig-1] [1,5]. Daily salt intake by pregnant women is usually higher than this value [1,3,5,6]. However, except in cardiovascular diseases, daily salt intake should not be less than 7-8 grams since it may cause the risk of ion balance severe disruption [3,6]. Under normal circumstances, there is no need to reduce salt intake during pregnancy, even in pre-eclampsia [7].

A study indicated that manipulating sodium intake does not affect the frequency of pre-eclampsia [7]. In addition, a recent study also demonstrates the dietary implications of attempting to restrict sodium. Dietary histories of 68 women assigned to either a low-sodium or normal-sodium diet indicated that sodium restriction was associated with a reduced intake of protein, calcium and energy. Sodium restriction or supplementation has no place in the management of pre-eclampsia [7].

Another reason is that loss of high levels of sodium may result in the risk of exacerbation of hypertension by reducing blood volume, which in turn results in increased renin secretion and hypertension. Therefore, it is better to increase potassium intake parallel to reducing sodium intake and avoid consumption of coffee, alcohol and saturated fats. Potassium-rich foods include meat, fruits, grains (especially rice), vegetables, fresh and dried fruits and drinks [5].

Potassium consumption during pregnancy is necessary to keep blood pressure levels and also, to reduce complications of excess sodium intake on blood pressure [2,5,8].

Chloride is the main anion in extracellular fluids and plays an important role in nervous system development during pregnancy [5].

Calcium

Calcium plays different roles during foetus development among which, participation in different tissues construction and cell signaling [3, 9-11]. Food sources of calcium include milk, cheese, yogurt, tofu, legumes, green leafy vegetables and fish with edible bones, e.g., sardines. Calcium uptake varies at different stages of life and increases when the need for calcium increases, such as during pregnancy and lactation [Table/Fig-1] [9]. Adequate vitamin D is also important in calcium uptake during pregnancy [3,8].

There are many controversies about the amount of calcium uptake in pregnancy [6]. Some studies have suggested that increased calcium uptake during pregnancy is required in order to preserve maternal calcium balance and bone density, and its amount must increase from 1000 mg/day to 1300 mg/day [2,6,8,12]. However, most sources have expressed that calcium uptake does not need increase due to hormonal changes in pregnancy and thus, consuming 1000 and 1300 mg/day of calcium is sufficient for pregnant women older than 19 years and for teenage pregnancy [Table/Fig-1,2] [4,8,13].

While maternal calcium uptake increases across the intestine, the net effect of these hypercalcaemia-driven changes is foetal skeletal mineralization [14]. During pregnancy, approximately 30 grams of calcium is deposited in the foetal skeleton, while the rest of calcium is stored in the maternal skeleton, probably due to calcium demands during lactation [2,13,14]. On an average, in the last trimester of pregnancy, 300 mg of calcium is daily transmitted to the foetus [6, 14].

Hypocalcemia affects membrane permeability and smooth muscle contraction strength and thus, it can affect blood pressure and the onset of preterm uterine contractions [2,14]. The use of calcium supplementation in women with low calcium uptake reduces the risk of hypertension and pre-eclampsia [12,14,15].

However, improved maternal calcium status does not have a long-term positive impact on infant and maternal bone mass, the risk of stillbirth, infant mortality before hospital discharge, and maternal mortality and preterm birth [15,16]. Calcium supplementation is not routinely recommended during pregnancy, and is only prescribed by a doctor in women who refrain from dairy consumption or have deficient vitamin D levels [12,14,16].

Dietary calcium recommendations in lactating women are the same as other women [6,16]. Calcium content of the mother's breast milk is not correlated with maternal calcium uptake, and it contains sufficient calcium due to maternal physiological changes such as bone transient analysis [2,16]. Increased calcium uptake does not prevent maternal bone demineralization [2,6,16].

Phosphorus

There are a variety of phosphorus containing foods such as grains, meat, poultry, fish, eggs, milk, milk products, nuts and beans [8, 14,17]. The deficiency of this mineral, although rare, but if occur may have symptoms such as anaemia, myasthenia, bone pain, rickets, Genu varum, anorexia, vertigo, confusion and possibly can cause death [14,17]. High levels of phosphorus are caused by excessive use of phosphorus containing food additives and threaten bone health [9, 17]. The recommended amount of phosphorus uptake in pregnancy is similar to non-pregnant women [Table/Fig-1] [6,8,9,17].

Magnesium

Magnesium is there in a variety of foods such as meat, grains, bread, beans and vegetables and thus, is rarely deficient; however, hypomagnesemia may occur in people with alcoholism, malnutrition or intestinal and kidney diseases [5,18]. Symptoms of hypomagnesemia include nausea, myasthenia and muscle cramps, irritability, mental disorder, blood pressure and heart rate changes [5,18].

Magnesium plays an important role in regulating blood pressure, and through affecting calcium channels in arterial muscle, causes relaxation of muscles within the vessel walls and thus, vasodilatation and decreased vascular resistance as well as decreased vasospasm and blood pressure which are beneficial during pregnancy [5, 9, 19]. Hypomagnesemia leads to hypertension, preeclampsia and preterm birth in pregnancy [19]. Therefore, use of magnesium sulfate is common for pre-eclampsia treatment and preventive treatment against preterm delivery [19].

Several studies on pregnancy dietary have shown that magnesium intake is often less than the recommended amount [Table/Fig-1] [19 21]. In various studies, magnesium supplementation has shown to reduce preterm births, number of cases of maternal hospitalization, pre-delivery bleeding and low birth weight newborns [14,20]. Ninety percent of magnesium is excreted by the kidneys and as a result, magnesium toxicity is rare when using oral supplements [Table/Fig-1,2] [18,19]. However, intramuscular or intravenous administration should be done with care and renal function must be ensured to prevent an increase in serum magnesium [5,12,14]. Complications of maternal magnesium toxicity include death, increased bleeding time, excessive blood loss during childbirth, slow cervical dilation and increased pulmonary oedema [18].

Iron

Iron deficiency anaemia is the most common nutritional deficiency worldwide, affecting maternal and child health [22]. The overall iron needed during pregnancy significantly increases from 15-18 mg/day throughout non-pregnancy to 27 mg/day during pregnancy period [Table/Fig-1,2]. However, there are lower intakes for most women in diets [23].

Despite the iron absorption increase throughout the pregnancy, the blood is diluted due to blood volume increase (50%) [22,24]. Iron status of women at the time of conception is of concern for a healthy pregnancy, preventing postpartum and breast-feeding anaemia up to six months after delivery [24,25]. The newborns also store about 270 mg of iron in their body, which is totally obtained from their mothers [22,24,25]. Iron deficiency is related to some maternal and foetal pregnancy disorders, including pre-eclampsia, preterm labour and premature rupture of membranes [25]. Maternal iron deficiency anaemia is associated with the behavioral and neural development of changes in white matter myelination, striatal monoamine metabolism and hippocampal function [22,26,27]. As a result, adequate intake of iron is essential for the normal growth and development of foetus [26].

Iron supplements are routinely used during pregnancy; however, the potentially harmful effects of iron intake in women with sufficient iron status are raising debates [26]. The iron supplement dose is a critical issue associated with its potential side effects [25,27]. Due to the production of reactive active oxygen species by iron, the excess iron results in cell and tissue damages and is toxic [22,26,27].

In an observational study, it was reported that the prevalence of gestational diabetes, high blood pressure, and metabolic syndrome in mid-pregnancy is more than twice among iron supplement intake groups; thus, the excess iron should not be recommended [22,26,27]. It seems that selective prevention for iron deficiency anaemia is the most effective and appropriate method. The recommended intake of iron during lactation period is 9-10 mg/day, which is significantly lower than the pregnancy period (27 mg/day) [23]. Iron is present at low concentrations in breast milk; however, the iron concentration of breast milk is not influenced by maternal iron status changes, such as supplement intakes [23].

Copper

Copper is biologically involved in building connective tissues, iron metabolism, production of melatonin, heart function, immune system function and development of the central nervous system [4, 18]. Copper is a vital cofactor of antioxidant enzymes [18]. These enzymes are expressed in mother and foetus tissues and play an important role in removing pregnancy oxidative stress. Without this protective mechanism, oxidative stress may lead to poor pregnancy outcomes such as pre-eclampsia, foetal growth restriction, and abortion [14,18].

Recent studies have approved the effective role of copper in neuro-behavioral and neuro-cognitive development during the last two-third period of pregnancy [13]. The balance between copper and iron is also important to ensure proper brain development [4,6]. Copper deficiency in the human diet affects the foetus development [13]. Copper deficiency is teratogenic in animals [13]. Copper deficiency is rare, observed in premature babies and in patients who are receiving parenteral nutrition without copper [13]. In addition to iron deficiency, copper deficiency anaemia may lead to skeletal disorders, growth disorders, heart muscle degeneration, nervous system degeneration, changes in hair colour and structure, reduced immune response and increased incidence of infection [9].

Because copper deficiency has not been noticed in human pregnancy, its supplement is not of essence [Table/Fig-1,2] [9]. Copper toxicity from food is rare [9]. Studies have shown that there is relationship between high levels of copper and preterm birth and low birth weight and serum concentration of zinc and copper in preterm infants' plasma is significantly higher compared to term infants' [9]. Further prospective studies should be designed to well investigate the benefits.

Zinc

Zinc regulates function of nearly 100 different enzymes, DNA and RNA synthesis, carbohydrate metabolism, acid–base homeostasis, folate absorption, vitamin A and vitamin D activating, and maintaining cell membrane stability [9].

The richest sources of zinc are shellfish, meat, eggs, grains, peanuts, dairy products, whole grains, and dark green and dark yellow vegetables [9]. Because grain has low zinc concentration, zinc deficiencies in populations that have grain protein-based diets have been reported [5,9,18].

Severe zinc deficiency symptoms are, poor growth and development, exanthem, impaired reproduction and reduced immune function [9]. Periods of rapid growth such as infancy, puberty and late pregnancy are more vulnerable to zinc deficiency [28].

Zinc plays an important role in pregnancy and lactation, including foetal development and milk secretion. Depending on the bioavailability of zinc in diets, 2-4 mg of excessive zinc is required during pregnancy to meet the physiological needs [Table/Fig-1,2] [28]. It is estimated that mothers' required zinc at the third trimester of pregnancy doubles compared to non-pregnant women [2,5,29]. As a result of blood dilution and increased transfers to the developing foetus, the maternal serum zinc concentration decreases [2,29].

Severe zinc deficiency is associated with long-term labour, teratogenicity and foetal or embryonic mortality [29,30]. Acrodermatitis enteropathica is an autosomal recessive genetic disorder affecting the zinc metabolism and inhibits the absorption of zinc [29,30]. Pregnancy in individuals suffering from this disorder is accompanied with abortion, anencephaly, achondroplastic dwarfism, and infants with low birth weight; however, normal pregnancy outcomes will be observed if they receive high doses of oral zinc and the normal serum zinc concentration is maintained throughout pregnancy [29,30]. Inspite of these findings, no strong evidence has been found to recommend zinc supplements during normal pregnancy [29,30]. Studies indicated that zinc supplement with increasing the pregnancy duration reduces preterm deliveries and increases average birth weight [29,30]. The zinc supplement during pregnancy is also associated with reduced incidence of pregnancy-induced hypertension and increased head circumference in infants [30,31].

Selenium

Selenium plays an antioxidant role in cell functions, restoring and maintaining muscles, fertility and cancer prevention [5, 9]. It also fights against infection and regulates the growth and development [5,9]. The main sources of selenium in diets are as follows: seafood, poultry, eggs, kidney, liver and plant foods (including cereals, nuts, garlic, and radish) [5,13,24]. The body absorbs 55%-70% of selenium from foods [3,14].

Selenium deficiency is uncommon [9]. Selenium deficiency is related with recurrent pregnancy loss, pre-eclampsia and intrauterine growth restriction [31]. In low-weight newborns umbilical cord serum selenium concentration is lower than that in newborns with normal weight [24]. Cord serum selenium concentration is directly correlated with the infant head circumference [2,24].

The breast milk selenium represents the amount of maternal selenium intake [9]. Additionally, the recommended selenium level

Micronutrient	Age	Non pregnancy	Pregnancy	Lactation
Calcium	14-18 years	-	1300 mg/day	1300 mg/day
	19-50 years	1000 mg/day	1000 mg/day	1000-1200 mg/day
Chromium	14-18 years	-	29 mcg/day (AI)	44 mcg/day (AI)
	19-50 years	25-35 mcg/day	30 mcg/day (AI)	45 mcg/day (AI)
Copper	14-50 years	900 mcg/day	1 mg/day	1.3 mg/day
Fluoride	14-50 years	3-4 mg/day	3 mg/day (AI)	3 mg/day (AI)
Iodine	14-50 years	150 mcg/day	220 mcg/day	290 mcg/day
Iron	14-50 years	8-18 mg/day	27 mg/day	9 mg/day
Magnesium	14-18 years	-	400 mg/day	360 mg/day
	19-30 years	310-420 mg/day	350 mg/day	310 mg/day
	31-50 years	-	360 mg/day	320 mg/day
Manganese	14-50 years	1.8-2.3 mg/day	2 mg/day (AI)	2.6 mg/day (AI)
Molybdenum	14-50 years	45 mcg/day	50 mcg/day	50 mcg/day
Phosphorus	14-18 years	-	1.250 mg/day	1.250 mg/day
	19-50 years	700 mg/day	700 mg/day	700 mg/day
Potassium	14-50 years	At least 4.700 mg/day	4.700 mg/day (AI) At least 4.700 mg/day	5.100 mg/day (AI)
Selenium	14-50 years	55 mcg/day	60 mcg/day	70 mcg/day
Sodium	14-50 years	1500-2300 mg/day	1500 mg/day (AI)	1500 mg/day (AI)
Zinc	14-18 years	-	12 mg/day	13 mg/day
	19-50 years	8-11 mg/day	11 mg/day	12 mg/day

[Table/Fig-1]: The recommended daily intake of minerals for adults and pregnant and lactating women [3,6,8,9,14,15,17,18,21,24,25,29,31,34].

Micronutrient	Age	Non pregnancy	Pregnancy	Lactation
Calcium	14-18 years	-	1300 mg/day	1300 mg/day
	19-50 years	2500 mg/day	2500 mg/day	2500 mg/day
Chromium	14-50 years	ND	ND	ND
Copper	14-18 years	-	8 mg/day	8 mg/day
	19-50 years	10 mg/day	10 mg/day	10 mg/day
Fluoride	14-50 years	10 mg/day	10 mg/day	10 mg/day
Iodine	14-18 years	-	900 mcg/day	900 mcg/day
	19-50 years	1100 mcg/day	1100 mcg/day	1100 mcg/day
Iron	14-50 years	45 mg/day	45 mg/day	45 mg/day
Magnesium	14-50 years	350 mg/day	350 mg/daye	350 mg/daye
Manganese	14-18 years	-	9 mg/day	9 mg/day
	19-50 years	11 mg/day	11 mg/day	11 mg/day
Molybdenum	14-18 years	-	1700 mcg/day	1700 mcg/day
	19-50 years	2000 mcg/day	2000 mcg/day	2000 mcg/day
Phosphorus	14-50 years	ND	3500 mg/day	4000 mg/day
Potassium	14-50 years	ND	ND	ND
Selenium	14-50 years	400 mcg/day	400 mcg/day	400 mcg/day
Sodium	14-50 years	2300 mg/day	2300 mg/day (AI)	2300 mg/day (AI)
Zinc	14-18 years		34 mg/day	34 mg/day
	19-50 years	ND	40 mg/day	40 mg/day

[Table/Fig-2]: The maximum allowable daily intake of minerals for adults and pregnant and lactating women [3, 6, 8, 9, 14, 15, 17, 18, 21, 24, 25, 29, 31, 34].

for lactating women is slightly higher than that for other women [2, 13]. Dose required for toxicity has not yet been specified [Table/Fig-1,2] [9]. Symptoms of selenium toxicity include brittle hair and nails, hair and nail loss and gastrointestinal disorders [9].

Manganese

Food sources of manganese include whole grains, legumes, nuts, tea, wheat, rice, spinach, pineapple and soy beans [Table/Fig-1,2] [9,20]. In adults, approximately 1%-5% of consumed manganese is absorbed and the intake rate is significantly higher in women than in men [20]. Manganese is a key component of enzymes involved in the metabolism of amino acids, carbohydrates, and cholesterol, formation of cartilage, synthesis of urea and protection of cells against oxidative damage and also, plays a role in activating other enzymes [12].

Naturally occurring manganese deficiency has never been reported in humans [8]. Manganese toxicity causes nerve damage [9]. Manganism is caused more by industrial exposure than by food consumption [9]. Manganese plays an important role in the process of pregnancy and normal foetal development [13]. Serum levels of manganese increases throughout pregnancy [32]. Few studies have been conducted on manganese, and no information on manganese supplements in human pregnancy has been published so far.

Assessment of blood manganese concentration in women has shown that in women with intrauterine growth restriction infants have lower serum levels of manganese than those with normal pregnancy and therefore, manganese may play an important role in foetal growth and development [32].

Iodine

Among the key priorities for the World Health Organization is to ensure optimal iodine nutrition in women of reproductive age, especially for communities in iodine deficient regions [33].

Iodine uptake by the thyroid gland increases during pregnancy [33]. Sufficient iodine intake is necessary to support the mother and foetus [33]. The need for iodine increases to more than 45% in pregnancy, reaching from 150 to 220 micrograms/day [Table/Fig-1,2] [23,33]. The World Health Organization recommended daily iodine intake during pregnancy and lactation is 200-250 mg [34]. Sufficient amount of iodine is essential for the production of thyroid hormones in the mother's body, and also normal development of foetal brain [33,34]. It has been shown that even mild maternal iodine deficiency may have adverse effects on foetal cognitive development [33]. Maternal iodine deficiency is associated with an increased incidence of miscarriage, stillbirth, and abnormalities [33]. Currently, iodine deficiency is regarded as the most common cause of preventable brain damage worldwide [35,36]. Therefore, adequate iodine intake throughout pregnancy is very important [35]. Iodine deficiency-induced disorders can be prevented using supplements prior to or during the first three months of pregnancy [35,36]. Studies on iodine supplements during pregnancy have shown its positive impact on maternal and neonatal outcome such as significant reduction in the rate of prematurity and stillbirth [35,36]. American Thyroid Association has recommended daily use of 150 mg of iodine in pregnant women [37].

Moreover, the need for iodine increases during lactation [37]. Accordingly, lactating women are reported to need 290 micrograms of iodine per day [Table/Fig-2] [35,37]. Lactating women with iodine deficiency may not be able to provide their babies (who are vulnerable to the effects of iodine deficiency) with enough iodine [35,37].

Chromium

Chromium is required for normal functioning of the insulin hormone [9,38]. Chromium deficiency affects the body's ability to regulate blood glucose and causes symptoms such as diabetes, including high blood sugar and increased levels of insulin [38,39]. Chromium food sources include liver, nuts, and whole grains [38,39]. Chromium deficiency has been reported in patients receiving chromium-free parenteral nutrition and malnourished children [9,38,39].

However, no study has reported toxicity of orally-administered chromium, although chromium supplementation at high doses by athletes and weightlifters leads to some complications, especially skin lesions [Table/Fig-1,2] [14,38,39]. Two observational studies have shown that serum chromium level in pregnant women is not associated with gestational diabetes [39]. An eight-week clinical trial on 24 women with gestational diabetes showed that taking chromium supplements reduces fasting blood glucose levels and insulin [35]. However, more research, especially randomized controlled trials, are required to determine whether taking chromium supplements can be a tool in the treatment of gestational diabetes.

Fluoride

Fluoride obviously plays a role in increasing tooth resistance to caries and maintaining bone structure [5,14]. During odontogenesis, fluoride is incorporated in the enamel crystal and makes teeth more resistant to caries [9]. Fluoride can be also found in bones and is important for bone health [9]. Natural sources of fluoride in the diet include tea and marine fish, especially fish with edible bones [9, 14].

Fluoride crosses the placenta and is incorporated in deciduous teeth [14]. Data of double-blind prospective interventional studies have not shown any association between low levels of caries and prenatal fluoride exposure, that is why fluoride supplementation is not recommended during pregnancy [14]. Excess fluoride intake during pregnancy is not associated with increased susceptibility to fluorosis [14]. Adequate fluoride intake in pregnancy is necessary to increase tooth resistance and maintain bone health in the mother and also, to help proper foetal bone development [Table/Fig-1,2] [5,14].

Molybdenum

Molybdenum is required for the activation of enzymes involved in the metabolism of sulphur-containing amino acids and nitrogen-containing compounds contained in DNA and RNA, production of uric acid and detoxification [24]. Molybdenum plays a role in the synthesis of red blood cell [24]. Food sources of molybdenum include milk, meat, bread, grains and legumes [Table/Fig-1,2] [21]. Molybdenum deficiency, although rare, has been reported in patients receiving pure parenteral nutrition without molybdenum for a long time [21]. Any probable complications resulting from molybdenum deficiency and toxicity are yet to be discovered [21,24]. Molybdenum deficiency symptoms include mental changes and sulphur and purine metabolism disorders [21,24].

Boron

Boron requirement for humans has not been proven, but its necessity is widely accepted for plants and animals [21]. Boron is obtained from sources such as sodium borate and rapidly and almost completely (90%) absorbed [13, 21]. All plant foods and their byproducts, such as seeds, nuts, vegetables and fruits contain boron [13, 21]. Boron affects the activity of many enzymes and is important in metabolism of nutrients such as calcium, magnesium, and vitamin D [21]. The recommended daily intake of boron has not been suggested, but its maximum daily intake in adults older than 19 years along with pregnant and lactating women is 20 mg [Table/Fig-1,2] [21].

DISCUSSION

During pregnancy, increased metabolic needs lead to increased need for macro- and micronutrients [1,3,14]. Daily intake of micronutrients is essential to minimize potential pregnancy-associated risks and enhance foetal development outcomes [14]. Micronutrients play various important roles in pregnancy, and lack of each one causes irreversible complications in both the mother and foetus [14]. Some of these complications include anaemia, aggravate malnutrition, hypertension, pre-eclampsia, labour complications and even maternal death, miscarriage, preterm delivery, and foetal growth restriction, and even diabetes and cardiovascular diseases [1,14]. During pregnancy, most women usually have undesirable nutrition [14]. According to unwanted pregnancies, awareness-raising attempts in the area of healthy diets and lifestyles should be made both prior to and during pregnancy [14,40].

Given the importance of micronutrients, especially minerals during pregnancy, numerous studies have been carried out to investigate their deficiency complications and also their supplementation; however, contradictions are seen in the results [24,25]. Moreover, further investigation is required regarding elements such as manganese and boron, as comprehensive studies have not yet conducted on their effects during pregnancy. Due to the effect of minerals in major complications such as pre-eclampsia, gestational diabetes, preterm or low birth weight, greater number of interventional, prospective and observational studies is required.

CONCLUSION

Proper use of minerals during pregnancy and lactation can reduce maternal and fetal complications.

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