Chi Eung Danforn Lim
MBBS, MMed, MAppMgt(Health), MRACMA, is Conjoint Appointee, South Western Sydney Clinical School, Faculty of Medicine, University of New South Wales.
celim@unswalumni.com

Ming Fong Yii
is a fifth year medical student, Faculty of Medicine, University of New South Wales.

Nga Chong Lisa Cheng
MBBS, DCH, GradDipPH, MRACMA, is a paediatric registrar, Sydney Children's Hospital, Faculty of Medicine, University of New South Wales.

The role of micronutrients in pregnancy

Background
The antenatal shared care model has become increasingly popular among Australian women as the preferred mode of pregnancy care. General practitioners are often asked by their pregnant women patients about the nutrients needed during pregnancy.

Objective
This article discusses the role of various micronutrients and trace elements needed in pregnancy, and provides daily intake recommendations of these nutrients as a reference point.

Discussion
Much attention has been given to micronutrients such as folate and iron, but less regard to other trace elements that are also important in pregnancy. Encouraging a balanced diet and ensuring the adequacy of these micronutrients is essential for minimising pregnancy complications. However, GPs should also be aware of the maximum level of recommended intakes and any possible adverse effects.

Micronutrients and trace elements have an important influence on the health of both mother and fetus. Deficiency of micronutrients during pregnancy may give rise to complications such as anaemia and hypertension, as well as impairing fetal function, development and growth.[1,2] A recent meta-analysis evaluating the effects of antenatal multimicronutrient supplementation on pregnancy outcomes has revealed a significant reduced risk of low birth weight and improved birth weight in comparison to iron/folic acid supplementation only.[3] (It should be noted that the majority of included studies were in low or middle income countries[3].)

With the increasing trend of antenatal shared care, general practitioners need to be aware of the potential role of micronutrients in pregnancy. General practitioners should also take the factors that can prevent absorption of these micronutrients into consideration when developing a nutrition plan for pregnant women in their care. These factors may include poor diet, gene polymorphisms, malabsorption syndromes, and in certain populations, diseases such as malaria or intestinal parasites.[1] *Table 1* compares the recommended daily requirements of micronutrients for pregnant and nonpregnant women aged 19–50 years as well as showing the upper level of recommended intake. Food sources of these nutrients are outlined in *Table 2*. *Table 3* provides information on some common brands of micronutrient products available on the market.

Iron

Iron is one of the major trace elements required during pregnancy.[4] It is suggested that a lack of iron in pregnancy can result in preterm delivery and maternal anaemia.[4] Adequate iron is required from conception, throughout the pregnancy and during lactation. Iron deficiency during lactation may be associated with mental retardation.[4,5] The recommended daily iron intake for pregnant women is 27 mg/day.[6] Good dietary sources of iron (ie. more than 2 mg/serve) include liver, beef, fortified cereals, cashew nuts and baked beans. Although it is believed that iron excess can hinder the absorption of other vitamins, this hypothesis has yet to be fully substantiated.[7]

Yui Kwan Maria Chow
BSc, MPhil, MIPH, is a research officer, NCIRS,
University of Sydney, New South Wales.

Table 1. Recommended daily micronutrient intake for women aged 19–50 years[25]

Micronutrient	Pregnant women	Nonpregnant women	Upper level of intake
Iron	27 mg/day	18 mg/day	45 mg/day
Zinc	10–11 mg/day	8 mg/day	35–40 mg/day
Calcium	1000 mg/day	1000 mg/day	2500 mg/day
Phosphorus	1000 mg/day	1000 mg/day	3500 mg/day (pregnant women) 4000 mg/day (nonpregnant women)
Iodine	220 µg/day	150 µg/day	1100 µg/day
Selenium	65 µg/day	60 µg/day	400 µg/day
Vitamin A	800 µg/day	700 µg/day	3000 µg/day
Vitamin B			
– thiamin	1.4 mg/day	1.1 mg/day	Not available
– riboflavin	1.4 mg/day	1.1 mg/day	Not available
– niacin	18 mg/day	14 mg/day	35 mg/day
– vitamin B6	1.9 mg/day	1.9 mg/day	50 mg/day
– vitamin B12	2.6 µg/day	2.6 µg/day	Not available
– folate	600 µg/day	400 µg/day	1000 µg/day
Vitamin C	60 mg/day	45 mg/day	1000 mg/day
Vitamin D	5 µg/day	5 µg/day	80 µg/day
Vitamin E	7 mg/day	7 mg/day	300 mg/day

Note: For some micronutrients there are different recommendations for young women (aged 14–18 years)

Calcium

Calcium is required for the maintenance of skeletal, neuromuscular, and cardiac function.[8] Studies have shown the maternal skeleton is not the source for fetal calcium needs, thus adequate calcium supplementation during pregnancy and lactation (~1000 mg/day) is essential for fetal bone mineralisation.[8] In pregnant women who are vegetarians, calcium absorption can be poor from foods rich in oxalic acid (beans and spinach) or phytic acid (nuts and grains). In comparison to dairy milk, calcium absorption from soy milk may be as efficient, while calcium absorption from dried beans is about 50% and from spinach only about 10%.[8]

Zinc

Zinc is an important constituent of various enzymes that help maintain structural integrity of proteins and regulate gene expression.[9] It is recommended that pregnant women take 11 mg/day,[9] and 12 mg/day during lactation.[10] Nevertheless, it is important to be aware that dietary intake of iron at levels found in some supplements may impair zinc absorption.[9]

Phosphorus

Phosphorus, in the form of phosphate, is thought to regulate acid base balance in the bloodstream and activate catalytic proteins.[11] Deficiency in this mineral, although rare, may result in symptoms such as anaemia, muscle weakness, bone pain, rickets, parenthesis, anorexia, ataxia, confusion, and possibly death.[11] Phosphorus is available in a wide range of foods and the recommended intake in pregnancy is similar to that of nonpregnant women.

Iodine

Iodine is essential for fetal and neonatal growth and development. Severe iodine deficiency may result in abortion or stillbirth, congenital anomalies, neurological cretinism, or mental deficiency with deafness, spastic diplegia, squint and myxoedematous cretinism.[12,13] It is recommended that pregnant women consume no less than 220 µg/day.[12]

Selenium

Selenium is thought to have an antioxidant property as well as a role in cellular function, muscle maintenance, fertility and cancer

prevention.[14] Deficiency in selenium can result in osteoarticular disorder, cardiac enlargement, heart failure, arrhythmia and premature death.[14] In conjunction with iodine deficiency, selenium deficiency has also been reported to increase the risk of cretinism.[14] It is recommended that pregnant women increase their daily intake of selenium to 65 µg/day and to 70 µg/day during lactation.[14]

Vitamin A

Deficiency in vitamin A has been associated with intrauterine growth retardation, preterm birth, low birth weight, placental abruption, and increased mortality of the mother.[15] Research has also ascertained that vitamin A supplementation can increase haemoglobin concentrations by about 4 g/L in marginally deficient maternal populations.[16] Daily intake of 800 µg is recommended in pregnant women.[17] Breast milk is a good source of vitamin A.[1] However, adequate maternal dietary vitamin A is essential to maintain adequate levels in breast milk.

Vitamin B group

The group of B vitamins, which consists of thiamine (B1), riboflavin (B2), niacin or nicotinic acid (B3), B6, folate (B9) and B12, is essential for enhancing the immune system as well as reducing the plasma concentration of homocysteine.[18] Elevated maternal plasma homocysteine levels as a result of vitamin B deficiency may lead to pre-eclampsia, premature birth and low birth weight.[19] Most cases

Table 2. Food sources for micronutrient intake (recommended daily intake for pregnant women aged 19–50 years)[25–27]

Nutrient	Food source	Milligrams per serve
Iron (27 mg)	Chicken liver (cooked, 85 g)	12.8
	Fortified cereal (250 mL)	18.0
	Instant oatmeal (250 mL)	4.5
	Other food sources rich in iron: red meat, baked beans, soy beans, oysters	
Calcium (1000–1300 mg)	Yoghurt (plain, low fat, 227 g)	415
	Sardines (canned in oil, with bones, 85 g)	324
	Cheddar cheese (43 g)	306
	Other food sources rich in calcium: milk, orange juice, tofu, salmon	
Zinc (11 mg)	Oysters (6 medium)	76.7
	Beef shanks (cooked, 85 g)	8.9
	Crab (cooked, 85 g)	6.5
	Other food sources rich in zinc: meat, shellfish, dairy foods	
Phosphorus (1000 mg)	Red meat, dairy foods, fish, poultry, bread, rice, and oats	
Iodine (0.22 mg)	Sea fish, shellfish, cereals and grains, fortified salt	
Selenium (0.065 mg)	Brazil nuts (dried, 28 g)	0.544
	Tuna (canned in oil, 85 g)	0.063
	Beef (cooked, 100 g)	0.035
	Other food sources rich in selenium: bread, fish, meat, eggs	
Vitamin B6 (1.9 mg)	Cereal (100% fortified)	2.0
	Baked potato (1 medium)	0.7
	Banana (raw, 1 medium)	0.68
	Other food sources rich in vitamin B6: pork, chicken, cod, bread	
Vitamin B12 (0.0026 mg)	Molluscs, clams (cooked, 85 g)	0.084
	Liver, beef (braised, 1 slice)	0.048
	Fortified breakfast cereal (185 mL)	0.006
	Other food sources rich in vitamin B12: meat, salmon, cod, milk, eggs	
Vitamin C (60 mg)	Various fruits and vegetables	
Vitamin D (0.005 mg)	Cod liver oil (1 tbsp)	0.034
	Salmon (cooked, 100 g)	0.009
	Milk (vitamin D fortified, 250 mL)	0.0025
	Other food sources rich in vitamin D: oily fish, eggs, cereals	
Vitamin E (7 mg)	Wheatgerm oil (1 tbsp)	20.3
	Almonds (dry roasted, 28 g)	7.4
	Sunflower seeds (dry roasted, 28 g)	6.0
	Other food sources rich in vitamin E: soya, corn, olive oil	

Table 3. Micronutrients (recommended daily intake pregnant women aged 19–50 years, some preparations have other ingredients not listed in this table)

Brand name	Nutrients	Amount (per tablet)	Recommended daily intake	Fulfils recommended daily intake? (✓/×)
Blackmores Pregnancy and Breastfeeding Gold	Vitamin B6	750 µg	1.9 mg	×
	Vitamin B12	1.5 µg	2.6 µg	×
	Vitamin C	30 mg	60 mg	×
	Vitamin D3	6.3 µg	5 µg	✓
	Vitamin E	3.5 mg	7 mg	×
	Calcium	59 mg	1000 mg	×
	Iron	5 mg	27 mg	×
	Zinc	8 mg	11 mg	×
	Phosphorus	45.6 mg	1000 mg	×
	Iodine	125 µg	220 µg	×
	Folic acid	250 µg	600 µg	×
Blackmores Balanced B Complex	Vitamin B6	11 mg	1.9 mg	✓
	Vitamin B12	25 µg	2.6 µg	✓
	Folic acid	200 µg	600 µg	×
Blackmores Bio Iron	Iron	5 mg	27 mg	×
	Vitamin C	100 mg	60 mg	✓
	Vitamin B12	50 µg	2.6 µg	✓
	Folic acid	166.5 µg	600 µg	×
Cenovis Pregnancy & Breastfeeding formula	Vitamin B6	20 mg	1.9 mg	✓
	Vitamin B12	2 µg	2.6 µg	×
	Vitamin C	440 mg	60 mg	✓
	Vitamin E	5 mg	7 mg	×
	Calcium	137.7 mg	1000 mg	×
	Iron	5 mg	27 mg	×
	Zinc	6 mg	11 mg	×
	Phosphorus	106.3 mg	1000 mg	×
	Folic Acid	225 µg	600 µg	×
Centrum tablets	Vitamin B6	2.4 mg	1.9 mg	✓
	Vitamin B12	1 µg	2.6 µg	×
	Vitamin C	60 mg	60 mg	✓
	Iron	4 mg	27 mg	×
	Calcium	162 mg	1000 mg	×
	Zinc	5 mg	11 mg	×
	Iodine	100 µg	220 µg	×
	Selenium	25 µg	65 µg	×
	Folic acid	200 µg	600 µg	×
Elevit	Vitamin B6	2.6 mg	1.9 mg	✓
	Vitamin B12	4 µg	2.6 µg	✓
	Vitamin C	100 mg	60 mg	✓
	Vitamin D	12.5 µg	5 µg	✓
	Vitamin E	15 mg	7 mg	✓
	Calcium	125 mg	1000 mg	×
	Iron	60 mg	27 mg	✓
	Zinc	7.5 mg	11 mg	×
	Phosphorus	125 mg	1000 mg	×
	Folic acid	800 µg	600 µg	✓
Nature's Own Pregnancy Platinum Multivitamin	Vitamin B6	50 mg	1.9 mg	✓
	Vitamin B12	50 µg	2.6 µg	✓
	Vitamin C	62 mg	60 mg	✓
	Vitamin D3	5 µg	5 µg	✓
	Calcium	20 mg	1000 mg	×
	Iron	5 mg	27 mg	×
	Zinc	12 mg	11 mg	✓
	Iodine	250 µg	220 µg	✓
	Selenium	16.25 µg	65 µg	×
	Folic acid	500 µg	600 µg	×

of B12 deficiency in infants are related to maternal veganism or malabsorption, such as pernicious anaemia.[20] Vitamin B12 is found exclusively in animal products including meat, eggs, fish and milk. Excessive vitamin B consumption may result in weight gain, which can potentially complicate labour.[21]

Vitamin C

Vitamin C stimulates better absorption of iron[13] and therefore helps to reduce the risk of maternal anaemia. As an oxidant, it also guards the body against injurious free radicals. Combined with other factors, deficiency of vitamin C is thought to result in difficult labour, but this is yet to be established.[13] The recommended daily intake of vitamin C in pregnancy is 60 mg/day.[22]

Vitamin D

Vitamin D is a group of fat soluble prohormones that help to absorb calcium and phosphorous from dietary intakes, which are required for stimulating skeleton formation of the fetus.[1] Deficiency of vitamin D during pregnancy may result in an infant with rickets or type 1 diabetes mellitus.[13] The recommended daily intake of vitamin D during pregnancy and lactation is 5 µg/day.[23] However, excessive supplementation may be detrimental as it is associated with maternal fatigue and loss of appetite.[2]

Vitamin E

Vitamin E acts as an antioxidant in the lipid phase of cell membrane by protecting polyunsaturated fatty acid from free radical damage.[24] Higher intake of vitamin E has been found to be associated with a decrease in cardiovascular risk, diabetic complications, and certain cancers and cataracts. Vitamin E deficiency may lead to peripheral neuropathy, spinocerebellar ataxia, skeletal myopathy and pigmented retinopathy; however this has only been reported in association with other genetic or malabsorption syndormes, not simply with a diet low in vitamin E.[24] The recommended daily intake for pregnant women is equivalent to the normal requirement in women (7 mg/day), but higher during lactation (11 mg/day).[24]

Summary

The role of the GP in encouraging a balanced diet and ensuring the adequacy of micronutrients in pregnant women is essential for minimising pregnancy complications. However, GPs should also be aware of the maximum level of micronutrient intake and the possible adverse effects in order to optimise care for pregnant women.

Conflict of interest: none declared.

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AFP CORRESPONDENCE afp@racgp.org.au