

# Vitamins and minerals: dietary sources, supplements and deficiencies

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The New Zealand National Nutrition Survey in 1997 indicated that half of adults consumed a vitamin or mineral supplement in the past year, with 28% doing so regularly and 23% occasionally.<sup>1</sup>

In the US in 2006, it was reported that the highest users of multivitamin supplements were women, elderly people, those who are better educated, wealthier, have a healthier lifestyle, disease survivors, chronic disease sufferers and people with lower BMI. Smokers, African Americans, Hispanics and Native Americans used the least.\*

## Key concepts

- In most cases, nutrient needs should be met primarily through consuming a well balanced diet.
- When a nutrient is unable to be consumed through diet in recommended amounts, fortified foods can provide an alternative source.
- Supplements may be appropriate only when nutrients cannot be derived from any other source or in cases where nutrient needs are higher than normal.

The quality of clinical trials for most vitamin and mineral supplements is poor. There is presently no conclusive evidence that supplementation of a single nutrient or combination of nutrients is significantly effective in reducing the risk of cancer, cardiovascular disease or neurological syndromes. Some in fact may increase risk.

The following article focuses on the necessity for use of four common vitamins and minerals.

\* NIH (National Institutes of Health) State-of-the-Science Conference on Multivitamin/Mineral Supplements and Chronic Disease Prevention', Bethesda, MD, 2006. Panel chair: J. Michael McGinnis

## Folate

- Folate is especially important during pregnancy. A folic acid supplement of 800 mcg/day is recommended for at least four weeks before and 12 weeks after conception.
- Some medications can affect folate metabolism, supplementation can be considered.
- Folate deficiency is often accompanied by vitamin B12 deficiency. If folate deficiency is suspected in a person aged over 50 years, vitamin B12 status should also be checked.

### What is it?

Folate is a term which includes naturally occurring food folate and synthetic folic acid, which is used in supplements and fortified foods. The human body requires folate for cell division, especially during foetal development and infancy. Folate is also required to make new red blood cells and prevent anaemia.<sup>2,3</sup>

### Who needs it?

Most people who eat a balanced diet consume an adequate amount of folate for their needs. However, there are some situations where people require more.

Medical conditions that increase the need for folate or result in increased excretion of folate include:<sup>3</sup>

- Pregnancy and lactation
- Alcohol abuse
- Malabsorption
- Kidney dialysis
- Liver disease
- Anaemia
- Smoking

## The role of folate and B vitamins in cardiovascular disease

Some observational studies have reported that raised homocysteine levels are directly associated with an increase in cardiovascular risk. Daily supplementation with folic acid, vitamin B6, vitamin B12, or a combination can reduce homocysteine levels. Based on this, several randomised trials were designed to test the hypothesis that supplementation with folic acid, B vitamins or both would prevent cardiovascular disease. However, published trials on patients with pre-existing vascular disease have not demonstrated a benefit of folic acid or B vitamins on cardiovascular risk.<sup>6</sup>

This strongly suggests that homocysteine is not an instigator but merely an indicator of cardiovascular disease.<sup>7</sup>

Medications that reduce the availability of folate include:<sup>3</sup>

- Methotrexate
- Anticonvulsants
- Metformin
- Sulphasalazine
- Some other chemotherapeutic agents

### Folate deficiency

One of the most critical times for adequate folate intake is during pregnancy and lactation, because deficiency results in a greater risk of giving birth to a premature or low birth weight infant, or an infant with neural tube defects (spina bifida, anencephaly). Research shows that these risks are reduced with the use of folic acid supplements, in conjunction with a healthy diet, both before and after conception.<sup>4</sup>



Signs of folate deficiency may include diarrhoea, loss of appetite, weight loss, weakness, tiredness, sore tongue, headaches, heart palpitations, irritability, forgetfulness and behavioural disorders.<sup>5</sup> In infants and children, folate deficiency can slow overall growth rate.

### Folate and vitamin B12 deficiency

Certain processes in the body are dependent on the presence of both folate (substrate) and vitamin B12 (coenzyme). Older people with low levels of folate have a greater risk of also having a vitamin B12 deficiency. It is important that adults do not exceed the recommended upper level of intake of 1000 mcg/day of folic acid because if there is a concurrent untreated vitamin B12 deficiency, irreparable damage to the nervous system can occur.<sup>2,3</sup>

 If folate deficiency is suspected in a person aged over 50 years, also check their B12 status.

### Adverse effects of excess folate

No adverse effects have been reported from consuming foods naturally rich in folate. With the exception of concurrent vitamin B12 deficiency, the risk of adverse effects from folic acid supplements and fortified foods is also low, although this is the subject of current debate.

### Tests for folate status

Symptoms of folate deficiency are general and can also result from a variety of other medical conditions. Other causes should be considered.

Serum folate is generally regarded as the primary indicator of folate deficiency. Red cell folate is theoretically a

more accurate measure of folate, but this test is time consuming, has poorer precision and is not offered by all laboratories.

### Dietary sources and supplements

Good sources of folate include leafy green vegetables (e.g. spinach), citrus fruits and juices, dried beans and peas. As well as the recent requirement for fortification of bread with folic acid, many juices, cereals and cereal products (e.g. biscuits, cereal flours and pasta) are enriched with folic acid. Cows' milk can aid the absorption of folate derived from foods.<sup>2</sup>

### Folic acid supplements

Folic acid supplements should be considered for people using **methotrexate**. Supplements could also be considered for people with medical conditions or using other medications that increase their need for folate. Vitamin B12 levels should be checked before beginning folic acid treatment.<sup>8</sup>

Folic acid supplements taken prior to and during **pregnancy** can reduce the occurrence and recurrence of neural tube defects. In New Zealand the Ministry of Health recommends that all women planning pregnancy and those who are in the early stages of pregnancy take 800 mcg folic acid daily for at least four weeks before, and twelve weeks after, conception.

Supplementation with 400 mcg is sufficient to reduce the risk of neural tube defects, but folic acid tablets currently available as registered medicines in New Zealand contain either 800 mcg or 5 mg.<sup>9</sup> Women with a higher risk of giving birth to infants with neural tube defects are usually advised to take 5 mg folic acid tablets. This includes women using anticonvulsants who may become pregnant.

Both 800 mcg and 5 mg folic acid tablets are available funded on the pharmaceutical schedule.

 Also see page 4 "What side is your bread buttered on?".

## Iodine

- Many people in New Zealand have low iodine levels.
- Dietary sources of iodine include dairy products and iodised salt.
- Supplements are not generally recommended, although women who are planning a pregnancy, are pregnant or are lactating, may require supplementation.

### What is it?

Iodine is an essential nutrient that plays an important role in thyroid hormone production. Thyroid hormones maintain metabolic state and support normal growth and development.<sup>10</sup>

### Who needs it?

Everybody needs a small amount of iodine in their diet to maintain normal growth and metabolism, however iodine is especially important for pregnant and breastfeeding mothers. Pregnancy alters thyroid function due to an increase in hormone requirements, beginning in the first trimester.<sup>11</sup>

### Iodine deficiency

Most table salt in New Zealand is fortified with 25–65 mg/kg iodine. However, recent evidence shows that many New Zealanders have low iodine levels. A study in 2005 found that babies who had been breastfed had lower levels of iodine (due to the low concentration of iodine in their mother's milk) than babies who had been bottle fed.<sup>12</sup> The 2002 Children's Nutrition Survey found that most New Zealand children aged 5–14 years had mild iodine deficiency (assessed by urinary iodine excretion).<sup>13</sup>

The re-emergence of iodine deficiency is thought to be due to:<sup>10</sup>

- Increased consumption of commercially prepared foods which are manufactured with non-iodised salt
- Declining use of iodine sanitisers (iodophores) in the dairy industry (opportunistic source of iodine)
- Less salt being used due to healthy eating messages
- Increased use of non-iodised sea salt or rock salt

### Symptoms of iodine deficiency

Iodine deficiency causes thyroid dysfunction, resulting in stunted growth, developmental brain damage and adverse effects on hearing, motor and cognitive function.<sup>10</sup>

Iodine deficiency during pregnancy can cause impaired mental development of the foetus and in severe cases may result in miscarriage, still birth or congenital abnormalities.<sup>14</sup>

### Adverse effects of excess iodine

The primary adverse effect of excess iodine is inhibition of thyroid hormone production. Adverse effects have been observed at iodine levels of 1700 mcg/day but people with thyroid disorders or a long history of iodine deficiency may experience adverse effects at lower levels.<sup>14</sup>

### Tests for iodine status

Laboratory testing of iodine status on an individual basis is not usually indicated when iodine deficiency is suspected.

A normal TSH level may be used as a "rule out" test for hypothyroidism caused by iodine deficiency.



## Dietary sources and supplements

Dairy products are the main source of iodine in the typical New Zealand diet. Iodised salt should be used in preference to non-iodised salt, however overall consumption of salt should not be increased. It is difficult to obtain adequate iodine from a normal diet. Good dietary sources of iodine include seafood (fish, shellfish, seaweed), seameal custard, milk and eggs.

The iodine content in New Zealand soil is low, therefore plants grown locally are not a good source of iodine. Brassica vegetables (cabbage, broccoli, brussel sprouts), kumara, cassava and lima beans can impair iodine absorption. The iodine content of foods can also be depleted by cooking.<sup>10, 14</sup>

### Iodine supplements

The World Health Authority and other researchers recommend that women who are considering a pregnancy, are pregnant or are lactating, consume a supplement of potassium iodide, 150 mcg/day.<sup>15, 16</sup> Prenatal vitamin supplements usually contain potassium iodide.

Routine use of iodine supplements is not indicated for other groups of people. Iodine supplements such as kelp tablets are not recommended as the iodine content is variable and not subject to control.

### Fortification

In March 2008 a proposal to recommend the use of iodised salt in all bread making in New Zealand was accepted (excluding organic breads). The bread making industry has been given 18 months to prepare for iodine fortification. The standard will become enforceable in September 2009. This also coincides with the implementation date for mandatory fortification of bread with folic acid.

 See [www.nzfsa.govt.nz](http://www.nzfsa.govt.nz) for more information.

## Iron

- Many New Zealand children may be iron deficient.
- Most people can derive enough iron from a healthy, well-balanced diet.
- Supplements may be appropriate for some groups of people. They are not necessary in the absence of iron deficiency.
- Short-acting supplements given in divided doses may be most appropriate.

### What is it?

Iron is a component of many important proteins in the body including haemoglobin, myoglobin, cytochromes and enzymes. It is essential for oxygen transport and cell function.

### Who needs it?

Everyone needs iron, however requirements are higher during phases of rapid growth and development in early childhood, adolescence and during pregnancy. Adult men and post-menopausal women have the lowest risk of iron deficiency.

- Medical conditions which increase the risk of iron deficiency include kidney failure, chronic malabsorption, gastrointestinal disorders and menorrhagia.
- People who engage in regular, intense exercise may also have a greater need for iron, especially female, vegetarian or endurance athletes.<sup>17</sup>
- Frequent blood donation may also increase risk, especially in women of child-bearing age.

### Iron deficiency

The 2002 Children's Nutrition Survey found that the prevalence of iron deficiency in school-age New Zealand children was 1.6% and iron deficiency anaemia 0.3%.

The highest prevalence was found in females aged 11–14 years and Māori and Pacific peoples – 11% of Māori females aged 11–14 years were iron deficient.<sup>13</sup>

Other studies in New Zealand have reported rates of iron deficiency in children aged 6–24 months ranging from 8% to 14%.<sup>18 19</sup> Prevalence appears to vary with ethnicity (non-Europeans had serum ferritin levels 30% lower than Europeans) but not with socioeconomic status.

Less iron is absorbed from a vegetarian diet, so dietary intake of iron needs to be 80% higher than non-vegetarians who can derive their iron from meat.<sup>20</sup>

Healthy, full term babies are born with a supply of iron that lasts for 4–6 months. Lactating women do not need additional iron requirements as it is assumed that menstruation does not resume until after six months of exclusive breast feeding.

### Symptoms of iron deficiency

Iron deficiency develops gradually and may eventually result in iron deficiency anaemia. Symptoms of iron deficiency anaemia include reduced physical work capacity, fatigue, light headedness, weakness, breathlessness, impaired cognitive function, difficulty maintaining body temperature, impaired immunity, adverse pregnancy outcomes and delayed psychomotor development in infants.<sup>17 20</sup> Less severe iron deficiency has been associated with fatigue, poorer learning and memory.

### Adverse effects of excessive iron

Adverse effects of excessive iron range from gastrointestinal irritation to systemic toxicity. Iron is potentially dangerous if taken in overdose, especially in children, therefore it should be stored safely.

Iron overload can occur when excess iron in the blood is stored in the liver and heart. Up to 0.5% of the population of Northern European descent is homozygous for hereditary **haemochromatosis** and therefore particularly susceptible to iron overload, even with normal dietary intake. These

people should avoid supplements and excessive use of iron fortified foods.

People with blood disorders that require frequent transfusions are also at risk of iron overload.<sup>20</sup>

### Tests for iron status

Many people with iron deficiency will present with tiredness as the predominant symptom. Serum ferritin and complete blood count are the most appropriate tests for iron deficiency. Note that a normal ferritin level in a patient with inflammation or infection does not rule out iron deficiency (ferritin is raised during this time).

### Dietary sources and supplements

#### Dietary iron

There are two types of dietary iron – haem and non-haem. Haem iron is more easily absorbed and can also increase the absorption of non-haem iron.

Haem iron is found in foods that originally contained haemoglobin and myoglobin such as red meat, fish and poultry.

Non-haem iron is found in plant based foods such as beans, lentils, nuts, whole grain cereals and some vegetables and fruits. This is also the type of iron that is added to fortified foods such as breakfast cereals. Absorption of non-haem iron is influenced by other dietary factors.

- Vitamin C, citric, lactic or malic acid (apples) can increase the absorption of iron.
- Calcium, zinc, tannin (tea) and phytates (legumes, rice, grains, seeds and nuts) can inhibit iron absorption.
- Conversely, high iron intakes can affect the absorption of other nutrients such as zinc and calcium.

People who have diets low in iron, vegetarian diets, at times of iron loss (e.g. heavy menstruation) or when iron

Iron	Strength	Approximate elemental iron	Additional ingredient	Trade name
Ferrous fumarate	200 mg	65 mg		Ferro-tab
Ferrous fumarate	310 mg	100 mg	Folic acid 350 mcg	Ferro-F-Tabs
Ferrous gluconate	170 mg	20 mg	Ascorbic acid 40 mg	Healtheries
Ferrous sulphate	150mg/5ml	30 mg/5ml		Ferodan
Ferrous sulphate*	325 mg	105 mg		Ferro-gradumet
Ferrous sulphate*	325mg	105 mg	Folic acid 350 mcg	Ferrograd-Folic

\* not fully subsidised, long-acting tablets

requirements are high (e.g. pregnancy) should ensure that foods which enhance iron absorption are consumed with meals (e.g. vitamin C) and that tea is not consumed with meals.<sup>17, 20</sup>

### Iron supplements

Most people are able to achieve an adequate iron intake with a healthy, balanced diet. Iron supplementation in the absence of deficiency should be avoided.

However, there are three groups of people who may require supplementation:<sup>17</sup>

- Those with a greater need for iron e.g. pregnant women, teenage girls
- Those who lose more iron than normal e.g. heavy menstruation
- Those who do not absorb iron normally e.g. renal failure, malabsorption

The iron supplements (see table) are available on the medicines schedule in New Zealand. There is no particular advantage of one ferrous salt type over another, provided adequate elemental iron is given, so choice of medicine is dependent on the incidence of side effects and cost.

- Supplementation is usually required for less than three months.
- The amount of iron absorbed from tablets decreases with increasing doses, therefore it may be beneficial for people to take an iron supplement, in two or three equally spaced doses per day.

- Taking iron supplements with food may help to minimise gastrointestinal side effects.
- Enteric coated or delayed release preparations have fewer side effects, however they are not as well absorbed and are not usually recommended.<sup>17</sup>
- Ferodan is the only option available for children if tablets are unable to be swallowed.

### Prophylaxis or mild iron deficiency:

65–130 mg elemental iron per day for adults and children aged over 12 years.

### Moderate iron deficiency or iron deficiency anaemia:

100–200 mg elemental iron per day for adults and children aged over 12 years.

### Children:

30–120 mg elemental iron per day for children aged 6–12 years.

< 30 mg elemental iron per day for children aged 2–6 years.

Iron supplements should only be given to children aged under two years on specialist advice.

### “Over the counter” supplements

There are many iron supplements available over the counter. People should be cautious about unwarranted use and carefully read labels for iron content and consider whether dietary iron may be a better alternative.

## Vitamin B12

- Elderly people and people with gastrointestinal disorders or anaemia have a higher risk of vitamin B12 deficiency.
- Unexplained neurological symptoms in people at higher risk of vitamin B12 deficiency would warrant testing of vitamin B12 status. Supplementation may then be required.
- Vitamin B12 status could be checked in people who have taken a PPI or H<sub>2</sub>RA medication for more than three years.

### What is it?

Vitamin B12 refers to the group of cobalamins including hydroxycobalamin and cyanocobalamin. It is required for the synthesis of DNA and the formation of red blood cells and is also essential for neurological function.

### Who needs it?

The most common cause of vitamin B12 deficiency is pernicious anaemia.

Elderly people also have an increased risk of vitamin B12 deficiency due to a higher incidence of atrophic gastritis and reduced gastric acid secretion. Vitamin B12 requires gastric acid and pepsin to release it from food.

People with coeliac disease, Crohn's disease or other stomach and small intestine disorders may be unable to absorb enough vitamin B12 from a normal diet.

Higher dietary levels of vitamin B12 are required throughout pregnancy and breast feeding. Breastfed infants receive their daily intake of vitamin B12 through breast milk, dependent on the mother's intake.

Some drugs are associated with a higher risk of vitamin B12 deficiency:

- Metformin due to its effect on calcium metabolism which is required for vitamin B12 absorption.<sup>21, 22</sup>
- Long term use of H<sub>2</sub>RA's (e.g. ranitidine) or PPIs (e.g. omeprazole) due to reduced gastric acid secretion  
 See BPJ 5, May 2007 "Can proton pump inhibitors cause vitamin B12 deficiency")

Vitamin B12 levels take approximately two years to deplete so deficiency is unlikely to result from short term changes in diet. Long term strict vegetarian or vegan diets (i.e. no animal products) are associated with a higher risk of vitamin B12 deficiency.<sup>23, 24</sup>

Women taking oral contraceptives may have falsely low vitamin B12 levels, possibly as a result of low vitamin B12 binding proteins in serum. This is not associated with other markers of impaired B12 status and treatment is unwarranted.<sup>25</sup>

### Vitamin B12 deficiency

Vitamin B12 deficiency can produce haematological, neurological or gastrointestinal symptoms.

Signs and symptoms are those generally associated with anaemia – skin pallor, low energy and exercise tolerance, fatigue, shortness of breath, palpitations and sore mouth or tongue.

Neurological symptoms include peripheral neuropathy, motor disturbance, cognitive changes ranging from memory loss to dementia, mood change, visual disturbances and depression.

Gastrointestinal symptoms include constipation, loss of appetite, weight loss, impaired bladder and bowel control.

Signs of vitamin B12 deficiency in an infant include failure to thrive, movement disorders, delayed development and megaloblastic anaemia.<sup>23, 24</sup>

### Adverse effects of excessive vitamin B12

No adverse effects have been reported with excess vitamin B12 intake from food or supplementation in healthy individuals. It is thought that the body is able to decrease absorption in response to high intakes.<sup>23</sup>

### Tests for vitamin B12 status

The presence of unexplained symptoms in a person at greater risk of vitamin B12 deficiency would indicate that testing was required. Vitamin B12 could also be checked in older people with poor nutrition.

Vitamin B12 status may be checked in people who have been taking PPIs or H<sub>2</sub>RAs for more than three or four years, especially if there are any signs and symptoms, or if the patient is older.

Complete blood count should be performed first followed by serum vitamin B12 if the results are suggestive of deficiency. Low vitamin B12 levels reflect a long-term deficiency or chronic low intake, as serum B12 has low sensitivity and often remains normal for weeks or months after a negative balance has occurred.

### Multivitamin and mineral supplements

Multivitamin and mineral supplements do not correct poor diets, do not contain calories, proteins, essential fatty acids or fibre and often do not contain enough essential vitamins and minerals. People who take these supplements are at higher risk of nutrient drug interactions and toxicity. There is insufficient evidence of their benefit and safety. Encouraging people to concentrate on eating nutrient-dense healthy meals, and improving access to reliable evidence based nutrition advice, is a much better approach to health and wellbeing.<sup>26</sup>

Normal serum B12 levels do not necessarily exclude deficiency and low levels do not necessarily indicate deficiency. Low levels without deficiency may particularly be seen in pregnancy. However, the lower the level, the greater the likelihood of a true B12 deficiency. It is important to interpret results in the clinical context and specialist advice may be needed to guide further investigation in situations where the diagnosis is not clear.

### Dietary sources and supplements

#### Dietary vitamin B12

Natural sources of vitamin B12 include red meat, seafood, poultry, milk and dairy products. Spirulina, seaweed and soy products may contain vitamin B12 but are not a reliable source. Many other foods, especially vegan foods, contain vitamin B12 as an additive.

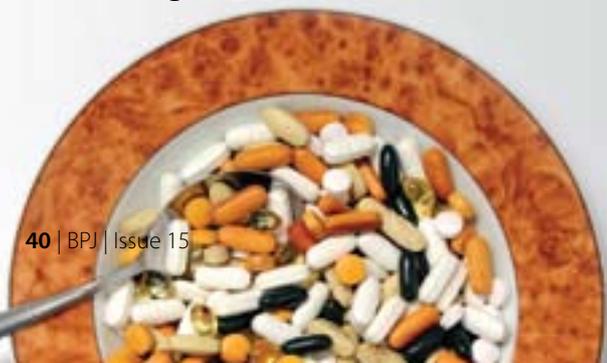
#### Vitamin B12 supplements

Vitamin B12 supplements are usually not necessary in healthy adults and children, however it is important to maintain recommended daily intakes through diet or fortified food products.

- People with pernicious anaemia require parenteral injections of vitamin B12, three times a week for two weeks, then once every two to three months.<sup>8</sup>
- People with gastrointestinal disorders and older adults (over 50 years) who cannot obtain enough vitamin B12 in the diet or through fortified foods may also require supplementation. If the deficiency is due to diet, twice yearly injections of vitamin B12 can be given. Treatment can be stopped when vitamin B12 levels have corrected and if the diet has been improved.<sup>8</sup>
- People with a vegan diet may need vitamin B12 supplementation. This is especially important throughout pregnancy and lactation.

#### Metformin and vitamin B12 deficiency

Calcium is essential for the absorption of vitamin B12. Metformin is known to affect calcium metabolism, therefore some people who use metformin may have reduced vitamin



B12 absorption, leading to megaloblastic anaemia. A small study found that 1200 mg/day calcium carbonate limited the negative effect of metformin on vitamin B12 levels.<sup>22</sup> However, a more recent study concluded that while vitamin B12 levels are depleted in people taking metformin (the greater the dose, the larger the deficiency), calcium supplements are not necessary. There was no evidence that calcium reduced the prevalence of vitamin B12 deficiency.<sup>27</sup>

In light of conflicting evidence, best practice would be to monitor vitamin B12 status once per year in people taking continuous metformin, especially older people and those who have taken metformin for several years. Vitamin B12 supplements could be considered in the presence of deficiency.

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