Ironing out the Facts

Why Plant Iron is Best

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One of the commonest food myths is that vegetarians and vegans have a higher risk of iron deficiency anaemia because they don't eat meat. This is simply not the case and many major health organisations agree – the British Medical Association, the World Health Organisation and the American Dietetic Association. However, some so-called 'health' organisations, health professionals and food writers persist in promoting red meat as the best source of iron. They invariably fail to mention the health risks associated with the type of iron found in meat as opposed to iron from plants. This fact sheet debunks the Western myth of promoting meat as a good source of iron and explains why plant iron is best.

What is Iron and Why Do We Need It?

Iron is an essential component of the pigment haemoglobin, found in red blood cells. It helps carry oxygen to all parts of the body and is essential for life. If iron intake is low, the amount of haemoglobin in the red blood cells can fall leading to iron-deficiency anaemia. Symptoms include tiredness, weakness, feeling cold and an inability to concentrate.

How Much Iron Do We Need?

The UK recommended nutrient intake (RNI) for iron in adult males is 8.7 mg per day and for women up to the age of 50 it is 14.8 mg per day (Department of Health, 1991). Women have higher requirements as they lose iron during menstruation. The RNIs for younger and older groups are given below.

Recommended daily intakes in the UK

Age	mg iron
0-3 months	1.7
4-6 months	4.3
7-12 months	7.8
1-3 years	6.9
4-6 years	6.1
7-10 years	8.7
Men aged 11-18	11.3
Men aged 19 and over	8.7
Women aged 11-50	14.8
Pregnant women	27.0
Postmenopausal women (50+ years)	8.7

Source: Department of Health, 1991.

Supplements

Supplementing the diet with too much iron can lead to constipation, nausea, vomiting and stomach pain and very high doses can be fatal, particularly in children (FSA, 2003). Furthermore, not all supplements are the same. For example, iron (ferrous) sulphate (which many GPs prescribe) can cause nausea and constipation and may interfere with vitamin E absorption. However, other forms are much better-tolerated such as iron picolinate, iron citrate and iron bisglycinate. Plant forms of iron supplements such as Floradix and Floravital, sold in health food shops, are gentle on the system. The VVF recommends that you seek the advice of a nutritional therapist before taking supplements. Most people can get all the iron they need by eating a varied and balanced diet.

Types of Iron

There are two types of iron in food:

Haem Iron is found in animal tissue. It is a component of haemoglobin (an oxygen-carrying protein in the blood) and myoglobin (oxygen-carrying molecules in muscle) and makes up around half the iron found in red meat, poultry and fish.

Non-Haem Iron makes up the other half of the iron in animal tissue and all of the iron found in plant foods, dairy foods (which contain a very small amount) and eggs. Around 90 per cent of the iron in the average British diet is non-haem iron; the other 10 per cent comes mainly from the haemoglobin of meat (Bull and Buss, 1980).

The UK's Food Standards Agency (FSA) looked at sources of iron in their 2003 *National Diet and Nutrition Survey* and found that 17 per cent of total (haem and non-haem) iron came from meat, three per cent from fish, three from eggs and one per cent from dairy foods. The vast majority (over 75 per cent) of iron in the diet came from plant-based foods. Cereals (such as wholegrain pasta, brown rice and wholemeal bread) made the single biggest contribution at 44 per cent (FSA, 2003a). This demonstrates the important contribution plant foods make to iron intake in meat-eaters and veggies alike.

The Iron Content of Plant Foods

The table below shows that there is no shortage of iron in plant foods. Pulses (peas, beans and lentils) and soya bean products (such as soya milk and tofu) provide an excellent source. As do dark green leafy vegetables (such as broccoli, pak choy and watercress), fortified breakfast cereals, wholegrains (such as wholemeal bread, brown rice and wholemeal pasta), dried fruits (such as raisins, prunes, apricots and figs) black treacle and plain dark chocolate.

The Iron Content of Selected Plant Foods

Food (medium portions)	mg iron	Percentage of daily RNI	
		Men (8.7 mg)	Women (14.8 mg)
Baked beans (135g)	1.9	22	13
Bran flakes (40g)	9.7	111	66
Tofu (100g)	3.5	40	24
Kidney beans (90g)	1.8	16	12
Red lentils (120g)	2.9	33	20
Spaghetti (220g)	3.1	36	21
Brown rice (180g)	0.9	10	6
Curly kale (95g)	1.9	22	13
Broccoli (85g)	0.9	10	6
Sesame seeds (12g)	1.3	15	9
Pumpkin seeds (12g)	1.8	21	12
Prunes (six dried fruits 48g)	1.2	14	8
Figs (three dried fruits 60g)	2.5	29	17

Source: FSA, 2002.

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Iron Absorption

Both haem and non-haem iron are absorbed in the small intestine, but by different mechanisms. It is thought that haem iron is transported across the intestinal membrane (gut wall) into the blood intact where the iron component is removed to enter a common pool of iron along with non-haem iron (Geissler and Powers, 2005). This process occurs regardless of how much iron there already is in the body (iron status) and what else is in the diet. This is why haem iron is more easily absorbed than non-haem iron; estimates vary from 15-35 per cent for haem iron and two-20 per cent for non-haem iron (Monsen, 1988).

The amount of non-haem iron absorbed in the gut varies widely as it is subject to a range of influences including iron status and other foods present in the diet. A range of dietary factors influence non-haem iron absorption.

A high absorption rate is not necessarily a good thing as the body has no mechanism for disposing of excess iron. In other words, iron from plant foods is more beneficial to the body because its absorption remains safely regulated. Whereas iron from animal sources can accumulate to levels which could be harmful (see below).

Factors that Decrease Iron Absorption

Phytate

Phytate (inositol hexaphosphate) is found in unrefined grains, seeds and pulses (which are also a rich source of iron); bran is a particularly rich source. It is a strong binder of iron and other minerals (including calcium, magnesium and zinc) and can contribute to mineral deficiencies in people whose intake of these nutrients is low. For example, low iron absorption from porridge made from rice, maize, wheat, oat or sorghum, contributes to the high prevalence of iron deficiency in infants from Third World countries (Hurrell *et al*., 2003).

There are various ways you can combat the effects of phytate. Eating foods rich in vitamin C with iron-rich food can help (see below). Also, cooking can increase the amount of iron available (Viadel *et al*., 2006; Bishnoi *et al*., 1994). One study showed that 37 out of 48 different vegetables provided more iron after being cooked (Yang *et al*., 2002). The available iron in broccoli increased five-fold and in cabbage, three-fold.

Increasing the amount of time bread is fermented also lowers the phytate content (Nävert *et al*., 1985). Sprouting grains, seeds and pulses is another effective way of reducing phytate as it is released on germination. Studies show that germinating and dehusking can reduce phytate in rice and mung beans by 92 per cent (Marero *et al*., 1991), and increase iron absorption from various grains and pulses by between 20 and 62 per cent (Hemalatha *et al*., 2007).

Remember though, wholemeal bread and brown rice contain around two to three times the amount of iron found in white bread and rice (Craig *et al*., 1994). So even though the percentage of iron absorbed from wholegrain foods may be lower, the total amount of iron absorbed is similar, making wholegrain foods the healthier option as they also contain more vitamins, minerals and fibre.

Polyphenols and Tannins

Polyphenols are a group of chemical substances found in plants that possess antioxidant properties that may offer potential health benefits such as a reduced risk of cardiovascular disease (CVD) and cancer. Tannins are a type of polyphenol found in tea and red wine that bind with non-haem iron to form complexes that may reduce iron absorption (Brune *et al*., 1989). The effect of tannins may be a concern for those who regularly consume wine with food. However, alcohol may enhance iron absorption (by stimulating gastric acid secretion) and some researchers conclude that the inhibitory effect of phenolic compounds in red wine is unlikely to affect iron balance significantly (Cook *et al*., 1995).

There has been conflicting evidence on the effect of tea-drinking on iron status. However, the research appears to show that tea consumption does not influence iron status in healthy people who eat a well-balanced diet and have adequate iron stores (Temme and Hoydonck, 2002; Nelson and Poulter, 2004). If you are concerned about your iron levels and are used to drinking tea with meals (or just breakfast) try switching to freshly squeezed orange juice instead (because its vitamin C content increases the absorption of iron) and wait at least one hour after eating before drinking tea.

Calcium

Some studies show that serving cow's milk with a meal can reduce iron absorption. This inhibitory effect is thought to be related to the milk protein casein (Hurrell *et al*., 1989) and calcium (Hallberg *et al*., 1991). Unlike phytate and tannin, calcium reduces non-haem and haem iron absorption (Fairweather-Tait, 2004) and this inhibitory effect is not negated by vitamin C or other acids.

Calcium is thought to inhibit iron absorption by reducing phytate breakdown. In one study as little as 40 mg of calcium added to 80 grams of flour reduced phytate degradation by 50 per cent (Hallberg *et al*., 1991). Calcium also has a direct inhibitory effect on iron absorption. In the same study, giving 165 mg of calcium (as milk, cheese or calcium chloride) reduced iron absorption by 50-60 per cent. The authors concluded that the inhibitory effect of calcium in amounts frequently encountered in normal meals has important nutritional implications. This doesn't mean you should limit your calcium intake; calcium is a very important mineral. However, to limit the negative effects of calcium on iron absorption avoid drinking cow's milk and taking calcium supplements with food.

Oxalic Acid

Oxalic acid is a compound found in many plants such as spinach, Swiss chard and beetroot leaves. It also occurs in tea, chocolate and other cocoa products. It can bind with calcium and magnesium to form insoluble salts which reduce the absorption of these important minerals. Some work suggests that oxalic acid may also compromise iron absorption. However, recent evidence suggests that oxalic acid in fruits and vegetables is of minor relevance in iron nutrition (Bonsmann *et al*., 2008).

Factors that Increase Iron Absorption

Vitamin C

Vitamin C (ascorbic acid) found in abundance in fruit and vegetables, can increase the amount of iron absorbed considerably (Hunt *et al*., 1990; Sharma and Mathur, 1995). It does this by two mechanisms: converting iron into a soluble, more readily absorbable form and by binding to it, preventing it from forming complexes with phytate or tannin (Fairweather-Tait, 2004). The amount of vitamin C in eight strawberries or 200 ml of orange juice (75 mg) can increase iron absorption three- to four-fold (Craig, 1994). To increase your iron absorption substitute your morning cup of tea or coffee with a glass of freshly squeezed orange juice. If you are concerned about low iron levels, try to combine vitamin C-containing foods with your iron-rich meal. See suggestions below.

Meat

Small amounts of meat (around 50 grams) have been shown to increase non-haem iron absorption from meals that contain high levels of phytate and are low in vitamin C (Baech *et al*., 2003). Several groups have tried to identify the elusive 'meat factor.' Potential candidates include certain amino acids (the building blocks of protein) found in meat, which may convert non-haem

iron into a more absorbable form. Alternatively, it may be a component of muscle tissue called L-alpha-glycerophosphocholine that helps (Armah *et al*., 2008). However, vitamin C seems to be a stronger enhancer of non-haem iron absorption than meat (Baech *et al*., 2003) and if vitamin C intake is adequate then meat may have little effect.

Measuring Iron Status

There are several different ways of assessing the body's iron status. Two of the most common methods involve measuring haemoglobin and serum ferritin. Ferric is a term that means containing or having to do with iron, derived from the Latin word *ferrum*, meaning 'iron'. Ferritin is a protein that stores iron for later use by your body. So the amount of ferritin in your blood reflects the amount of iron you have tucked away for future use. You can have normal haemoglobin levels, yet low ferritin. Ferritin levels are low in long-term iron deficiency, or if your body's protein levels are very low, as in some cases of malnutrition. Conversely, ferritin levels are high in states of long-term iron overload.

If you think that you might have too little (or too much) iron in your blood you can ask for a blood test. In the West, low iron levels and anaemia are usually due to long-term or heavy bleeding (in menstruation for example), pregnancy or rapid growth in children rather than a poor diet. High iron levels can be due to a genetic condition, extensive blood transfusions or an overdose of iron supplements.

Status indicator	**Normal range (per litre of blood)**
Serum ferritin	30-300 micrograms
Haemoglobin	120-180 grams

Source: Sharp, P. 2005.

Iron Deficiency

A lack of iron in the body is the most common nutritional problem worldwide (Sharp, 2005). In fact a quarter of the world's population may be iron deficient and approximately 500 million people suffer from iron deficiency anaemia (Cook *et al*., 1994). Symptoms include fatigue, pale skin and a weakened immune system. A reduced ability to concentrate can also lead to problems at school for children with iron deficiency anaemia (Grantham-McGregor and Ani, 2001).

The FSA states that groups that are vulnerable to iron deficiency include: infants over six months, toddlers, adolescents and pregnant women because of their increased requirements (FSA, 2003). Older people and those consuming foods that inhibit iron absorption may suffer due to poor absorption. Menstruating women and individuals with pathological blood loss may also be at risk due to high blood losses. For example, one study looking at menstrual blood loss and diet among women in the UK concluded that menstrual blood loss was the most significant factor affecting iron status, although the type of diet did affect iron stores (Harvey *et al*., 2005). The FSA does not identify vegetarians and vegans as a vulnerable group.

Veggie Diets and Iron

Vegetarian diets have been described as being deficient in iron, although numerous studies show that when this occurs, it is usually due to poor meal planning (Leitzmann, 2005). A well-balanced vegetarian or vegan diet provides plenty of iron. In fact, in Western countries, vegetarian diets can contain as much or more iron than mixed diets containing meat (Harvey *et al*., 2005; Hunt, 2003). Vegetarians and vegans, even with a high dietary fibre (and hence phytate) intake, have been found to have a similar amount of iron in their diets compared to meat-eaters (Craig, 1994). A recent study compared iron intake among 33,000 meat-eaters, 10,000 fish-eaters, 18,000 vegetarians and 2,500 vegans and found that the vegans had the highest intake, followed by the fish-eaters and the vegetarians; the meat-eaters had the lowest intake (Davey, *et al*., 2003).

Vegetarians tend to have lower iron stores (serum ferritin) than meat-eaters. This may be because haem iron is more readily absorbed than non-haem iron, because meat enhances non-haem iron absorption or because vegetarian diets may contain higher levels of inhibitors of iron absorption such as phytate, tannins and calcium (Harvey *et al*., 2005). However, vegetarians have no greater incidence of iron deficiency anaemia. The British Medical Association and the American Dietetic Association agree that vegetarians are no more likely to suffer from iron deficiency than meat eaters (BMA, 1986; American Dietetic Association, 2003).

Although vegetarians have lower iron stores, adverse health effects have not been demonstrated with varied vegetarian diets in developed countries. In fact, moderately lower iron stores reduce the risk of some chronic diseases (Hunt, 2003). It is well known that many meat eaters are oversupplied with iron, increasing the risk of cardiovascular disease (CVD) and certain cancers (Leitzmann, 2005).

Too Much of a Good Thing?

Excessive iron in the body is toxic. Despite this, there exists a widespread conviction that the more iron in the diet the better. This is what is still written in some nutrition and dietetic textbooks. Numerous studies now show that people with high iron stores suffer a higher incidence of cardiovascular disease (CVD), certain cancers and other health problems.

Iron overload can be caused by an inherited genetic condition (hereditary haemochromatosis), which affects one in 250 people (of Northern European descent) (Burke *et al*., 2000). Normally the liver stores a small amount of iron to provide new red blood cells with it. If you absorb excessive amounts of iron (as some people with this condition do) it builds up in the liver and is deposited in other tissues and organs. Iron overload may cause uncomfortable symptoms such as nausea, abdominal pain, constipation and joint pain. It can also lead to liver damage, heart failure and diabetes (NHS Direct, 2008). Men are more at risk from haemochromatosis because women regularly lose blood (and therefore iron), during menstruation. This condition illustrates how you can have too much of a good thing.

Iron-Rich Recipes

Iron-Rich Recipes

The following meals will help to boost your iron intake as they combine iron-rich foods with foods that help increase iron absorption.

Breakfast

- Baked beans and/or scrambled tofu on wholemeal toast
- Porridge oats with rice, soya or oat milk and topped with dried fruit (such as figs or prunes) and ground flaxseeds
- Freshly squeezed orange or grapefruit juice with the above

Lunch

- Watercress salad with dates, toasted pumpkin seeds and slices of orange
- Bean salad (canned mixed beans, celery, olive oil, garlic, lemon juice, parsley and thyme) with a green salad, cherry tomatoes and a wholemeal roll
- Wholemeal pitta bread stuffed with houmous, red onion and red pepper slices
- Fruit juice and/or fruit

Dinner

- Vegetable stir-fry (broccoli, green pepper, pak-choy, sugar-snap peas, sesame, sunflower and pumpkin seeds and cashew nuts served on a bed of quinoa
- Wholemeal spaghetti Bolognese made with soya mince, kidney beans, courgettes, onions, tomatoes, peppers, mushrooms, basil and oregano
- Spinach and chick pea curry with lentil dhal and a wholemeal chapatti
- Fruit juice and/or fruit

Iron and Heart Disease

The idea that high iron stores can increase the risk of heart disease was first proposed in the *Lancet* in 1981 (Sullivan, 1981). Sullivan proposed that menstrual blood loss could be responsible for the lower risk of heart disease observed among pre-menstrual women compared to men of the same age. Since then, other studies have confirmed that high iron stores are a risk factor for CVD (Salonen *et al*., 1992).

As well as menstruation in women, voluntary blood donation is an important cause of blood loss that can affect iron stores. In 1997, three different studies showed that regular blood donation reduced the risk of heart disease and strokes (Tuomainen *et al*., 1997; Meyers *et al*., 1997; Kiechl *et al*., 1997). The loss of iron associated with giving blood could be the reason for the observed reduction in risk. More recently another study showed that high-frequency blood donation was associated with lower iron stores, improved vascular function and reduced oxidative stress in blood donors (Zheng *et al*., 2005). The theory is that iron promotes the production of harmful molecules called free radicals that can cause (oxidative) damage to the lining of the arteries. This, in turn, increases the risk of CVD. These findings lend further support to the hypothesis linking high iron stores to CVD.

However, some studies have concluded that there is no association between iron status and CVD. In a letter to the *British Medical Journal*, researchers from Finland countered this argument by asserting that all of the negative studies used unreliable measurements of iron status (such as serum iron concentration, transferrin iron saturation) or other design problem (Hemilä and Paunio, 1997).

So convinced of the link are some researchers that they have suggested reducing iron stores to reduce the risk of CVD. Some say the evidence may even be strong enough to recommend ending iron fortification and supplementation and to start advising people to donate blood to reduce their stores of iron. However, others caution that, given the extent of iron deficiency, any decision to reverse iron fortification and supplementation policy should be based on extremely sound science (Sempos, 2002). Clearly more research is needed. The sensible approach is to eat a well-balanced vegetarian or vegan diet containing plenty of iron-rich plant-based foods.

Iron and Diabetes

Up to 65 per cent of patients with haemochromatosis develop diabetes (Adams *et al*., 1991). As people with this condition accumulate iron stores in the body, this has led to speculation that iron overload may cause diabetes. An investigation into iron intake and diabetes revealed that while total iron intake was not related to diabetes, haem-iron intake from red meat was (Jiang *et al*., 2004).

Haem-iron is absorbed in an unregulated way and so accumulates in the body over time. As stated above, iron can catalyse the formation of free radicals. These harmful molecules are implicated in the development of diabetes (Oberley, 1988; Wolff, 1993) and other diseases. New research also indicates an association between high iron status in pregnant women and gestational diabetes. The authors of this study conclude that the role of iron excess from iron supplementation in the development of gestational diabetes needs to be examined (Afkhami-Ardekani and Rashidi, 2008). Taken together, the research indicates that insulin resistance and diabetes is directly related to excessive iron stores.

The good news is that vegetarians and vegans have less insulin resistance and diabetes than meat-eaters (Kuo *et al*., 2004). Remember, a vegan diet provides iron in its non-haem form, which is absorbed in a more regulated way than haem-iron. A study comparing 30 vegetarians and 30 meat-eaters showed that vegetarians had adequate but lower body iron stores compared with meat-eaters. The vegetarians also had less insulin resistance (Hua *et al*., 2001).

In summary, vegetarians and vegans tend to have lower iron stores than meat-eaters, but have no greater incidence of iron deficiency anaemia. Conversely, it is well known that many meat-eaters are oversupplied with iron, increasing the risk of CVD and cancer (Leitzmann, 2005).

Baby Blues

For the first six months of life, infants require only breast milk, which contains appropriate amounts of iron (or specially formulated milk). At around six months of age their nutritional requirements increase and they need more than milk alone. For example, the daily iron requirement of an infant rises from 4.3mg at four to six months, to 7.8mg at six months. A primary cause of anaemia in infants is therefore inappropriate weaning – too early, too late or an unbalanced diet.

To make matters worse, cow's milk allergy can lead to gastrointestinal bleeding and is a well-recognised cause of rectal bleeding in infancy (Willetts *et al*., 1999). Gastrointestinal bleeding from milk allergy often occurs in such small quantities that the blood loss is not noticed, but over time these losses can cause iron deficiency anaemia in infants. In a trial of 52 infants (31 of whom had been breast fed and 21 fed formula milk), the introduction of cow's milk rather than formula milk was associated with an increased blood loss from the intestinal tract and a nutritionally important loss of iron (Ziegler *et al*., 1990). Frank Oski, former paediatrics director at Johns Hopkins School of Medicine, estimates that half the iron deficiency in infants in the US results from cow's milk-induced gastrointestinal bleeding (Oski, 1996). This represents a staggering figure since more than 15 per cent of US infants under the age of two suffer from iron deficiency anaemia.

Summary

- Iron is an essential part of the haemoglobin in red blood cells which helps carry oxygen to all parts of the body.
- The UK recommended nutrient intake for iron in adult males is 8.7 mg per day and for women up to 50 it is 14.8 mg per day.
- Most people can get all the iron they need by eating a varied and balanced diet.
- Too much iron can lead to constipation, nausea, vomiting and stomach pain and very high doses can be fatal, particularly in children.
- Ferrous sulphate as a supplement can lead to constipation and nausea.
- There are two types of iron in food: haem iron from meat and non-haem iron from plant foods.
- Most iron in the diet (over 75 per cent) comes from plant-based foods.
- Good sources of iron include pulses (peas, beans and lentils), soya bean products (soya milk and tofu), dark green leafy vegetables (parsley, broccoli, pak choy and watercress), fortified breakfast cereals, wholegrains (wholemeal bread, wholemeal pasta), dried fruits (raisins, prunes, apricots and figs) black treacle and plain dark chocolate.
- Haem iron is absorbed regardless of both iron status and what else is in the diet.
- Non-haem iron absorption is subject to a range of influences including iron status and other foods in the diet.
- Iron from animal sources and supplements can accumulate to harmful levels.
- Phytate from unrefined grains, seeds and pulses binds iron and can reduce absorption. Phytate can be reduced by fermenting, cooking and sprouting.
- Tannins in tea may reduce iron absorption. Avoid drinking tea with meals.
- Cow's milk (casein and calcium) can reduce iron absorption. Avoid drinking cow's milk and taking calcium supplements with food.
- Oxalic acid in spinach, Swiss chard and beetroot is of minor relevance in iron nutrition.
- Soya protein may decrease iron absorption although this effect can be reduced by lowering the amount of phytate present.
- Vitamin C in fruit and vegetables can increase iron absorption considerably; the amount of vitamin C in 200 ml of orange juice can increase iron absorption three- to four-fold.
- Small amounts of meat may increase non-haem iron absorption from high-phytate, low-vitamin C meals that contain high levels of phytate, but vitamin C is a stronger enhancer of non-haem iron absorption than meat.
- Iron status is assessed by measuring haemoglobin and serum ferritin.
- In the West, low iron levels and anaemia are usually due to long-term or heavy bleeding (in menstruation for example), pregnancy or rapid growth in children rather than a poor diet.
- High iron levels can be due to a genetic condition, extensive blood transfusions or (more rarely) an overdose of iron supplements.
- Low iron in the body is the most common nutritional problem worldwide. Symptoms include fatigue, pale skin, a weakened immune system and a reduced ability to concentrate.
- Vulnerable groups include: infants over six months, toddlers, adolescents and pregnant as well as older people and those consuming foods that inhibit iron absorption. Menstruating women and people with pathological blood loss may also be at risk.
- A well-balanced vegetarian or vegan diet provides as much or more iron than mixed diets containing meat.
- Vegetarians tend to have lower iron stores than meat-eaters but have no greater incidence of iron deficiency anaemia.
- Moderately lower iron stores may reduce the risk of some chronic diseases.
- Excessive iron in the body is toxic; symptoms include nausea, abdominal pain, constipation and joint pain. It can also lead to liver damage, heart failure and diabetes.
- High iron stores may be a risk factor for CVD, insulin resistance and diabetes.
- Anaemia in infants may be caused by inappropriate weaning or cow's milk allergy induced gastrointestinal bleeding.

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