



AIS SPORTS SUPPLEMENT FRAMEWORK

IRON

What is it?

- > Iron is a fundamental mineral involved in energy metabolism, oxygen transport, cognitive function and immunity.
- > Almost two-thirds of the body's iron is found in haemoglobin in circulating erythrocytes, with smaller amounts in ferritin and myoglobin.
- > The body cannot produce its own source of iron and therefore it relies on absorbing the iron we consume as part of our diet or supplements. The recommended daily intakes of iron for adults are:
 - ♂ - 8 mg per day
 - ♀ - 18 mg per day (pre-menopause)
- > Athletes are more susceptible to iron deficiency due to the greater iron demand associated with exercise, and the finite opportunity they have to replenish stores from food sources. Some high-risk athlete populations include:
 1. Female athletes (due to additional iron lost during menses)
 2. Endurance athletes, including those training at altitude (perhaps due to the greater demand on oxygen transport mechanisms)
 3. Vegetarian and Vegan athletes (since less iron is absorbed from plant sources)
 4. Athletes in Low Energy Availability
- > Compromised iron levels are typically associated with symptoms of lethargy and fatigue. In athletes, it may also manifest in reduced training and performance outcomes or a suppressed ability to respond/adapt to training stimuli.
- > Iron deficiency is an issue that progresses in severity because of a negative iron balance. Early stages, known as iron deficiency non-anaemia (IDNA), occur when ferritin stores are depleted without significant impact on haemoglobin concentrations. The most severe stage, iron deficiency anaemia (IDA), presents when both iron stores and haemoglobin are depleted.

What does it look like?

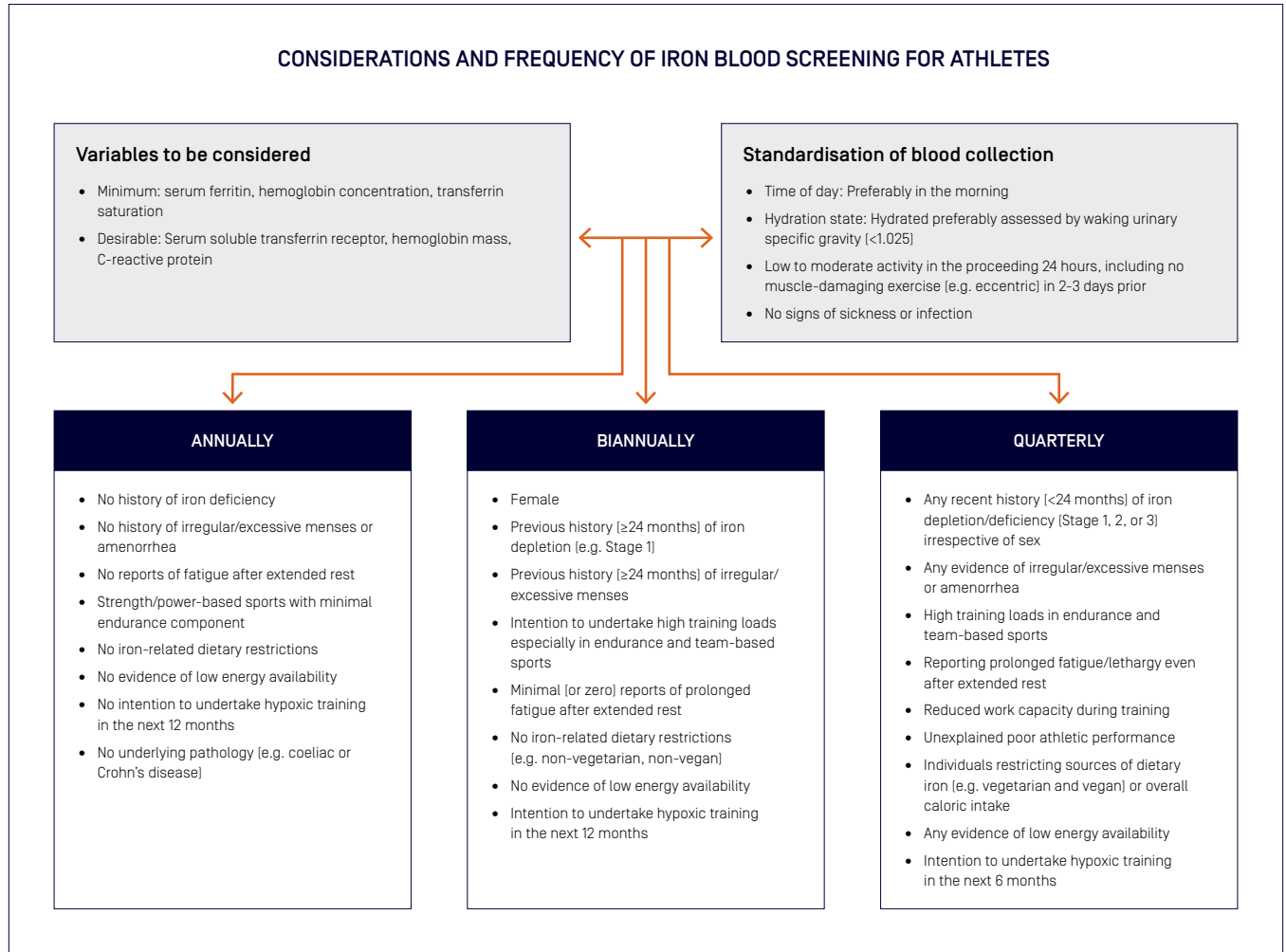
- > Treatments for an iron deficiency range from nutritional support, oral iron supplementation, and intravenous iron approaches, depending on the severity of the issue and the athlete patient history. Increasing dietary iron intake is the initial and most conservative treatment for iron deficiency. Some examples of haem (animal derived) and non-haem (plant derived) sources of dietary iron.¹
- > Oral iron supplements are the following avenue of treatment and are typically provided as ferrous salts: ferrous fumarate, ferrous sulphate or ferrous gluconate.
- > Ferrous sulphate preparations [e.g. FerroGrad®] containing ~100 mg elemental iron are the established and standard treatment for depleted iron stores. The total amount of elemental iron contained in the supplement should be checked to ensure that the specific target dose is achieved.
- > Controlled-release iron formulations [e.g. Maltofer®] may be used if ferrous salts are not well tolerated by the athlete.
- > Intravenous iron should only be considered in consultation with a sports physician. The efficacy of this approach appears best when IDA is present – i.e. when both ferritin stores and haemoglobin are compromised.



How and when do I use it?

- > Physicians are guided by the following outline when considering the frequency of iron blood screening for athletes (See Figure 1).²
- > Early identification of compromised iron stores (in the IDNA phase) is important since it allows athletes to consider nutritional and supplementation options with their physician and/ or accredited sports dietitian to prevent progression to IDA.

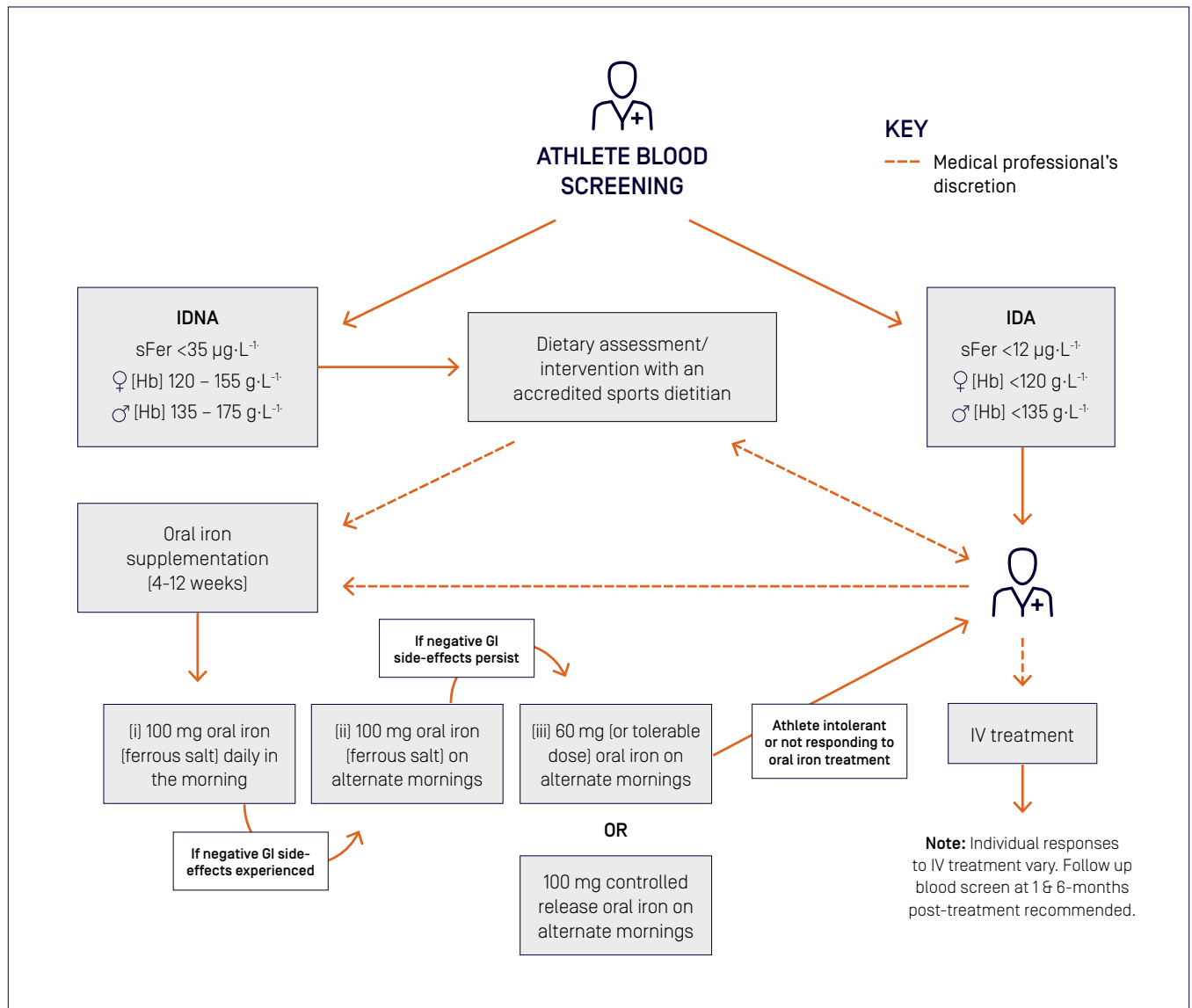
Figure 1. Framework of considerations for the frequency of iron blood screening in athlete populations.



This figure has been adapted from Sim et. al.²

- > Below is a framework to guide practitioners towards optimal treatment protocols for iron deficient athletes (See Figure 2), diagnosed via haematological indices.¹
- > Iron supplements should only be taken under medical supervision as part of an integrated iron management program, which includes dietary assessment and enhancement of dietary iron intake.
- > Current research suggests that a daily dose of 100 mg of elemental iron (or every second day if GI upset is present) for 8-12 weeks can significantly improve ferritin stores.^{3,4,5} This should be confirmed via a subsequent blood test.
- > Consuming the oral iron supplement in the morning, as close to exercise as possible, may result in a greater level of iron absorption.⁶

Figure 2. Framework to guide practitioners towards optimal treatment protocols for iron deficient athletes, diagnosed via haematological indice



This figure has been adapted from McCormick et. al.¹

- > The absorption of oral iron supplements is enhanced by consuming it with a source of vitamin C (~50-100 mg). This can be achieved by choosing a supplement in which Vitamin C is also provided, or by consuming it with an appropriate (e.g. citrus) fruit or juice. Factors that interfere with iron absorption such as calcium (dairy) and tannins (tea and coffee) should be avoided for an hour each side of the time of consumption of the supplement.
- > Examples of both inhibitors and promoters of non-haem iron absorption¹ are presented in Table 1

Table 1. Dietary factors that either enhance or inhibit iron absorption.

Inhibitors of non-haem iron absorption		Promoters of non-haem iron absorption	
Phytates	Found in whole-grain cereals, legumes, nuts and seeds	Vitamin C (ascorbic acid)	Aim 50+ mg. Found in citrus fruit (e.g. oranges, kiwifruit), broccoli, tomato, capsicum
Polyphenols/phenolic compounds	Found in tea (herbal and non-herbal), coffee, red wine and chocolate (cocoa)	Carotenoids	Found in pumpkin, carrots, grapefruit and apricots
Calcium	Found in dairy products (e.g. yoghurt, milk, cheese) and multivitamin supplements	Fermented foods	Fermentation reduces the presence of phytates; e.g. sauerkraut, kimchi and miso
Other minerals	Zinc and manganese (compete for intestinal absorption)	Cooking your food	Reduces the phytates present in food

- > If an athlete is undertaking specific altitude training, a pre-training screen of iron status is advised. This should be done with enough time (i.e. 8-12 weeks prior) to allow correction of iron depletion (IDNA or IDA) to be achieved prior to the start of the altitude training program.
- > Athletes who have ferritin levels of 50-100 µg·L⁻¹ (i.e. just above the levels traditionally considered to represent iron depletion) might consider taking an oral iron supplement (~100 mg daily or alternate day, as above) for two weeks prior to the start of altitude training and throughout the training program, since there is evidence that this supports greater adaptation to the altitude stimulus. Note: IV iron supplementation does not appear to improve the benefits of altitude adaptation more than oral supplementation.^{4,7,8}

Are there any concerns or considerations?

Failure to address dietary issues or other underlying causes of the iron deficiency

- > Iron supplementation does not address dietary issues. Dietary counselling in the early investigation phase of treatment should be provided via a referral to an accredited sports dietitian.
- > Where possible, the underlying cause for iron deficiency should be established so that it can be addressed. In some circumstances, a medical issue may need to be corrected.

Risk of iron overload or other medical issues

- > Excessive iron intake in some athletes may lead to iron overload. People with haemochromatosis should avoid iron supplementation, since extremely high iron levels can be toxic to the body's organs. Further information can be obtained from a sports doctor.
- > Intravenous and intramuscular iron supplementation carries a risk of anaphylactic shock, and problems due to the use of needles.

Risk of gastrointestinal upset

- > Some oral iron preparations cause gastrointestinal upset including constipation. Supplementation strategies such as 'every second day' approaches have been shown to reduce this gastrointestinal response, without compromising the supplements efficacy⁵ over time (8-12 weeks).

Where can I find more information?

Sports Dietitians Australia

www.sportsdietitians.com.au/iron

Supplement safety information

www.sportintegrity.gov.au/what-we-do/anti-doping/supplements-sport



References

1. McCormick R, Sim M, Dawson B, Peeling P. (2020). Refining treatment strategies for iron deficient athletes. *Sports Med*, 50(12), 2111-2123.
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7. Garvican-Lewis LA, Govus AD, Peeling P, Abbiss CR, Gore CJ. (2016). Iron Supplementation and Altitude: Decision Making Using a Regression Tree. *J Sports Sci Med*, 15(1), 204-205.
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The Australian Institute of Sport (AIS) Supplement Framework is an initiative of the Australian High Performance Sport System. The AIS acknowledges the support of members of the National Institute Network (NIN) and National Sporting Organisations (NSO) and their staff in delivering content expertise. This information is intended to help athletes, coaches and scientists make evidence-based decisions about the use of supplements and sports foods. Before engaging in supplement use, we recommend that each individual refer to the specific supplement policies of their sporting organisation, sports institute or parent body, and seek appropriate professional advice from an accredited sports dietitian (www.sportsdietitians.com.au).

Athletes should be aware that the use of supplements may have doping implications. Athletes are reminded that they are responsible for all substances that enter their body under the 'strict liability' rules of the World Anti-Doping Code. Some supplements are riskier than others. The Sport Integrity Australia (SIA) app is a useful resource to help mitigate the risk of inadvertent doping by helping to identify supplements that have been batch-tested. The SIA App provides a list of more than 11,000 batch-tested products. We recommend that all athletes consult the educational resources of SIA regarding the risks associated with supplements and sports foods.. While batch-tested products have the lowest risk of a product containing prohibited substances, they cannot offer you a guarantee that they are not contaminated (www.sportintegrity.gov.au/what-we-do/supplements-sport).

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