Cereal-based dietary iron intervention for improvement of iron status in female runners

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Introduction

Iron is an important component of haemoglobin and plays a critical role in oxygen utilisation within body cells. Compromised iron status is associated with suppression of aerobic work capacity(1).

Female athletes, especially runners, are at greater risk of iron deficiency due to increased iron loss in the gastrointestinal tract, sweat, urine and menstruation, also due to increased haemolysis during endurance training(2). Furthermore, inadequate dietary iron intake, coupled with limited bioavailability of iron in the diet, may present even a greater risk of iron-deficiency in female athletes(2). Although, anaemia is rare in athlete and general population, depleted iron stores are common in female athletes, especially runners. Researchers reported marginal iron deficiency (defined as serum ferritin <20 μg/L; haemoglobin >12 g/dl) to be present in between 30- 50% of female runners, more than twice compared to control population(4).

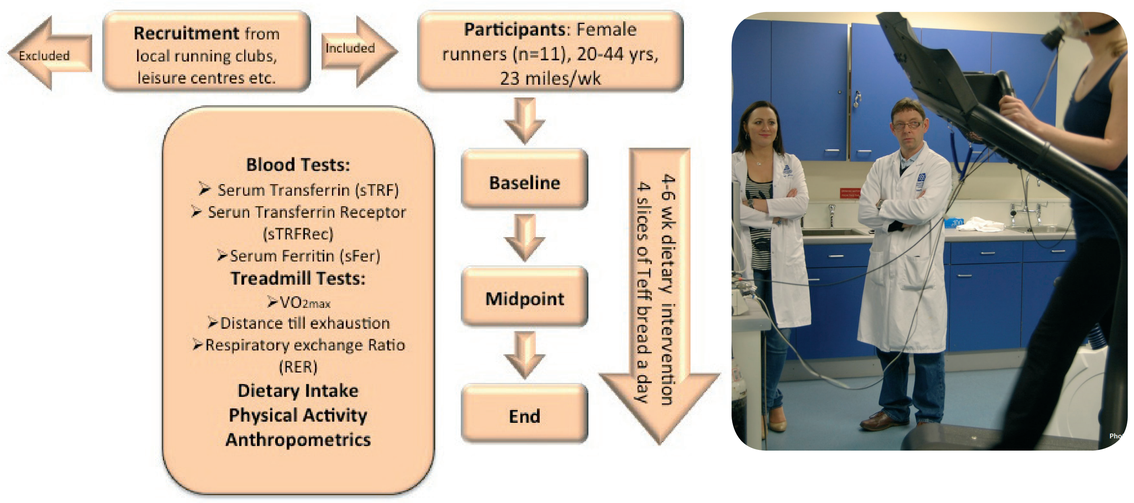
Good nutrition to achieve adequate iron balance has been suggested as the first line of action in the prevention of iron deficiency in the female athletes' population(2).

Hence, modifying dietary intake of iron through a staple food offers a good opportunity to improve iron status of physically active females for both iron deficiency prevention aspect and possible improvement in sports performance.

Aim

The aim of the study was to evaluate the effects of incorporating developed Teff cereal bread(4) into daily diets on dietary iron intake and iron status of recreational female runners.

Methods



Results

- Female runners reported inadequate daily dietary iron intake of 10.7 mg/day at baseline, which was associated with reduced iron stores (sFer r=0.7, P<0.05).
- 36% of participants showed depleted bodily iron stores (sFer<12μg/L) at baseline.
- Dietary intervention resulted in significantly higher total iron intakes (18.5 mg/day, P<0.05) and non-significant improvements in iron tissue supply (sTRF 5.4% change, sTfsR 12.8% change, NS) and iron stores (sFer 5.3% change, NS).
- The improvements in iron tissue supply indices were strongly associated with prolonged dietary intervention (ΔsTRF r=-0.7, P<0.05; ΔsTfsR r=-0.6, P<0.05) and compromised initial iron status (ΔsTRF r=-0.7, P<0.05; ΔsTfsR r=-0.6, P<0.05), whilst enlarged iron stored were associated with increased dietary iron intake (ΔsFer r=0.8, P<0.05).

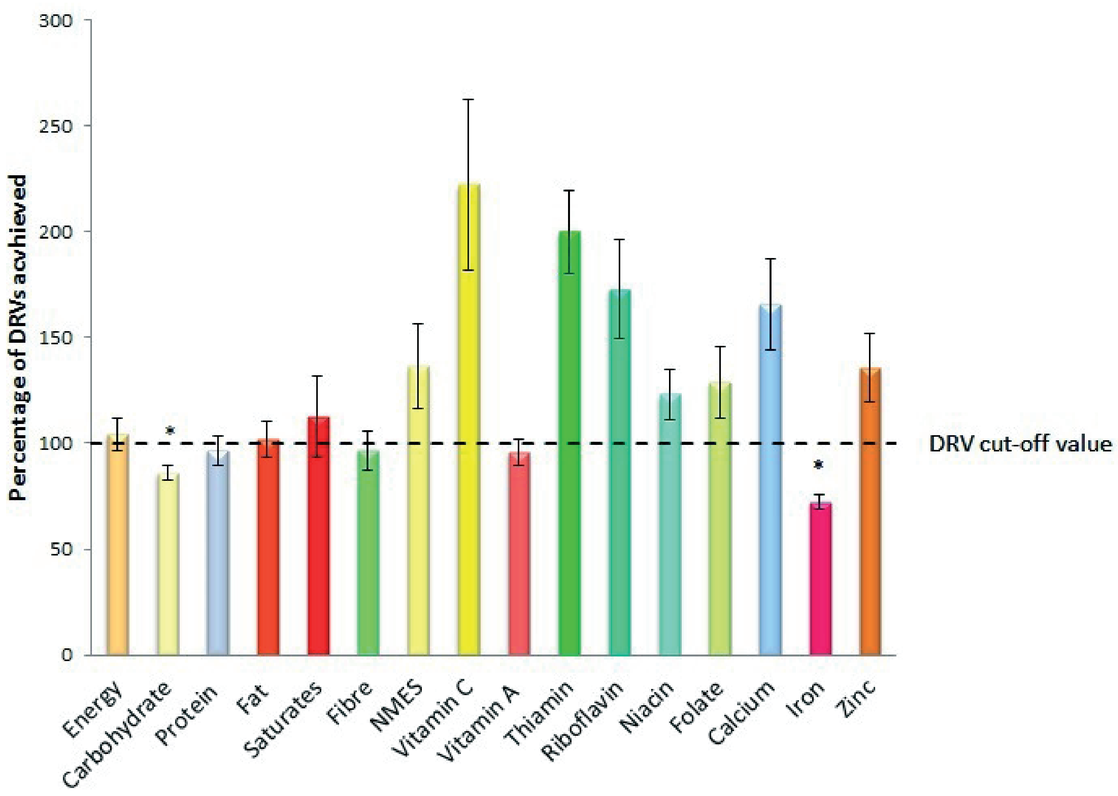


Figure 1. Comparison of mean daily energy, macro- and micro-nutrient intake of female runners and dietary reference values.

Key: DRVs – Dietary Reference Values, TEI – total energy intake, NMES – non-milk extrinsic sugars.
* represent significantly (P<0.05) lower observed value compared to that of recommended intake.
DRVs used: carbohydrate - 60% TEI, protein – 15% TEI , fat - <35% TEI, saturates - <10 TEI, fibre – 18g/day, NMES - <10% TEI, vitamin C – 40 mg/day, vitamin A - , thiamin - , riboflavin - , niacin - , folate, calcium – 700 mg/day, iron – 14.8 mg/day, zinc - .

Table 1. Teff bread nutritional composition

Nutrients in Teff bread	Amount per 100g	Total daily contribution to nutrients[1]	Percentage daily contribution to DRVs [1,2]
	Mean ± SD	Mean ± SD	Mean ± SD
Carbohydrate (g)	43.2 ± 2.32	54.1 ± 16.14	15 ± 5.9
Protein (g)*	11.0 ± 0.02	13.8 ± 4.11	16 ± 5.8
Fat (g)*	3.7 ± 0.16	4.6 ± 1.38	5 ± 1.9
Fibre (g)*	4.5 ± 0.32	5.6 ± 1.68	31 ± 9.3
Iron (mg)*	5.62 ± 0.22	7.0 ± 3.32	45 ± 19.0

Key: DRVs – Dietary Reference Values, TEI – total energy intake
*experimentally determined as previously described (4)
[1] Based on reported consumption of average daily portion of 125 ± 37g of Teff bread by the participants.
[2] DRVs used: carbohydrate - 60% TEI (5), protein – 15% TEI (6), fat - <35% TEI (6), fibre – 18g/day (6), iron – 14.8 mg/day (6).

Table 2. Changes in iron status related parameters during the intervention

		Subjects below cut-off value*	
Iron status parameter	Change during the intervention	Baseline	End
Serum Transferrin (sTRF) (g/L)	-5.4%	45%	18%
Serum Transferrin Receptor (sTsfR) (mg/L)	-12.8%	18%	9%
Serum Ferritin (sFer) (μg/L)	+5.4%	36%	18%
Total iron binding capacity (TIBC) (μmol/L)	-6.2%	55%	45%
sTsfR-F index	-16.7%	55%	45%

* indicates individual values below the cut-off points (sFer) <12 μg/L; sTRF >3.3 g/L, sTsfR >4.4 mg/L, TIBC >72 μmol/L; sTsfR-F index >1.5).

Table 3. Relationships between incremental haematological data and intervention variables

Changes in haematological indices	% change	Correlations with	r value, P value
ΔsTRF (g/L)	-5.4	Baseline sTRF	r= - 0.7, P<0.05
		Baseline sTsfR	r= - 0.8, P<0.01
		Baseline TIBC	r= - 0.7, P<0.05
		Baseline sTsfR-F index	r= - 0.8, P<0.005
		No of days of intervention[1]	r= - 0.7, P<0.05
ΔsTsfR (mg/L)	-12.8	Baseline sTsfR	r= - 0.8, P<0.05
		Baseline sTRF	r= - 0.6, P<0.05
		Baseline TIBC	r= - 0.6, P<0.05
		Baseline sTsfR-F index	r= - 0.8, P<0.005
		No of days of intervention*	r= - 0.6, P<0.05
ΔsFer (μg/L)	+5.4	Δ sTsfR-F index	r= - 0.6, P<0.05
		Δ dietary iron intake[†]	r= 0.8, P<0.05

Key: sTRF - serum transferring, sTsfR - serum transferrin receptor, sFer - serum ferritin
[1] partial correlations controlling for corresponding baseline haematological parameter
[†] partial correlations controlling for changes in dietary calcium and vitamin C intake
Δ represents an incremental change

Conclusion

Dietary iron interventions using staple food products offer a promising way of improving dietary iron intake and overall iron status of female runners. Teff bread could be used as an iron-rich staple food alternative. It offers the opportunity to improve habitual dietary iron intakes. Favourable trends were observed between improved iron intakes and iron status in this study. The effect seems to be the greatest with already compromised iron status and prolonged intervention.

References

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