選擇性的補鋅鐵和或對青少年

鐵離替補營養的影響

補充鐵可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鐵和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鐵和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鐵和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鐵和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鐵和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鐵和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鐵和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鐵和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鐵和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鐵和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鐵和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鐵和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鐵和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鐵和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鐵和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鐵和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鐵和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鐵和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鐵和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鐵和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鐵和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鐵和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鐵和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鐵和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鐵和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鐵和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鐵和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鐵和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鐵和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鐵和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鐵和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鐵和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鐵和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鐵和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鐵和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鐵和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鉄和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鉄和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鉄和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鉄和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鉄和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鉄和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鉄和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鉄和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鉄和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鉄和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鉄和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鉄和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鉄和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鉄和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。如果鉄和鋅的補充可以改善貧血的指標，但對青少年的影響仍需進一步研究。
Factors affecting iron status in 15-30 year old female students

Table 3. Factors associated with low iron stores in students aged 15-30 year old

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std Error</th>
<th>OR</th>
<th>95% C.I.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social status (per unit change)</td>
<td>-0.59</td>
<td>0.21</td>
<td>0.56</td>
<td>0.37-0.85</td>
</tr>
<tr>
<td>Calcium density (per 100 mg/1 mg change)</td>
<td>1.13</td>
<td>0.53</td>
<td>3.10</td>
<td>1.10-8.75</td>
</tr>
<tr>
<td>Exercise frequency (per 0.1 mg/1 mg change)</td>
<td>-0.45</td>
<td>0.23</td>
<td>0.64</td>
<td>0.41-1.00</td>
</tr>
<tr>
<td>Donation (compared to no donation)</td>
<td>19.06</td>
<td>8.20</td>
<td>8.20</td>
<td>1.13-8.40</td>
</tr>
<tr>
<td>Donation x BMI (compared to low/medium)</td>
<td>-0.79</td>
<td>0.37</td>
<td>0.46</td>
<td>0.29-0.73</td>
</tr>
</tbody>
</table>

Logistic regression analysis: deviance=150.3, df=160, r=1.67

A higher social status was associated with greater chances of low iron stores. Haem iron density was protective of iron stores. A diet containing 0.1 mg haem iron/MJ of the equivalent of 0.8 mg of haem iron in a 8000 kJ (Western diet) decreases the odds of low iron stores by 35% compared to a vegetarian diet which contains no haem iron. A diet containing 1.6 mg of haem iron (approximately 100g lean beef) and 8000 kJ would reduce the odds of low iron stores by 69%. Dietary calcium density is a positive predictor of iron deficiency in this model, with the odds of low iron stores being increased three-fold, with a decrease in calcium density of 100 mg calcium/MJ.

In practical terms, this is the equivalent of a change in calcium intake from 400 mg to 1200 mg, assuming a constant energy intake of 8000 kJ per day. An interesting effect observed between recent blood donation and BMI. A BMI greater than 24 was found to be protective against low iron stores for blood donors only, while a BMI below 24 increased the risk of low iron stores in blood donors. BMI was not associated with iron stores in non-donors. A high menstrual score (menstruating for more than 65 days per year) was associated with an increase in the odds of low iron stores of over 2.5 times compared with women who menstruated fewer days per year.

Factors which were not found to be associated with iron deficiency in this study included age, vitamin and mineral supplementation use, oral contraceptive use, alcohol intake, exercise levels, energy intake, protein intake, total iron intake and vitamin C intake.

Discussion

The results of this study report the iron status and the predictive factors of low iron stores in a group of 15-30 year old female students in Perth. Anthropometric data were comparable to Australian data of similar populations. The social status of the sample is relatively high when compared to the general population due to the large number of university students in the sample. The prevalence of iron deficiency (TS<16 and SF<12) in this sample of female students was 7.2% and iron deficiency anaemia (Hb<12; TS<16 and SF<12) was present in 4.5% of students. These results are comparable to Australian studies of iron status in women (Table 4). The prevalence of iron deficiency is lower in the present study (7.2%) compared to 15 year old schoolgirls (9.2%) but higher when compared to 20-69 year old women (4%).

Factors associated with low iron stores

Social status, as assessed by parental occupational prestige, was found to be inversely related to iron status, after controlling for other known factors. This is in contrast to the study by Leggett et al. [1], who found higher social status to be associated with lower iron stores in populations of high socio-economic status. Social status is difficult to measure in university students, as university life is often a transient stage with many students leaving home for the first time, and being required to organise their own meals and become responsible for their finances. Parental occupational prestige may thus not be the ideal measure of socio-economic status in the student, but was chosen due to the lack of alternative measures. A possible reason for an adverse association between social status and serum ferritin concentrations may be a greater pre-occupation with body weight and image compared to higher status family backgrounds and/or who are achievers [8].

The number of studies showing significant associations between diet and iron status is extremely small. This is probably due to the difficulties of evaluating dietary intake over an appropriate period of time as iron status is the balance between iron absorption and loss, usually over several months. Methods to assess intake over short periods of time, for example 24-hour recall, do not take into account the high day-to-day variability of food consumption. The FFQ, which evaluates dietary intake over a longer period of time, may be more appropriate for investigating the relationships between diet and iron status. Indeed, in the present study, two nutrient variables (haem iron density and calcium density) were found to significantly influence iron status. No relationship was found with vitamin C intake, a known enhancer of iron absorption.

Low haem iron densities were found to increase the chances of becoming iron deficient, after controlling for other co-variables (social status, calcium intake, BMI, blood

Table 4. Iron status of Australian women (data on 15-30 year old where available).

<table>
<thead>
<tr>
<th>Reference</th>
<th>Subjects</th>
<th>Criteria used</th>
<th>Prevalence (%)</th>
<th>Mean level</th>
</tr>
</thead>
<tbody>
<tr>
<td>NHF</td>
<td>20-69 y women</td>
<td>SF&lt;16</td>
<td>8</td>
<td>14.9</td>
</tr>
<tr>
<td>Australia</td>
<td>1989</td>
<td>SF&lt;16</td>
<td>9</td>
<td>14.1</td>
</tr>
<tr>
<td>Leggett et al.</td>
<td>17-65 y female employees</td>
<td>SF&lt;10 and TS&lt;20</td>
<td>5.5</td>
<td>19.3</td>
</tr>
<tr>
<td>1990</td>
<td>5.5</td>
<td>SF&lt;10</td>
<td>8.9</td>
<td>19.3</td>
</tr>
<tr>
<td>England and Bennett</td>
<td>15 y schoolgirls</td>
<td>SF&lt;12 and TS&lt;16</td>
<td>9.9</td>
<td>19.0</td>
</tr>
<tr>
<td>1992</td>
<td>20</td>
<td>SF&lt;12</td>
<td>21</td>
<td>18.2</td>
</tr>
<tr>
<td>Australia</td>
<td></td>
<td>SF&lt;12</td>
<td>21</td>
<td>18.2</td>
</tr>
<tr>
<td>This study</td>
<td>15-30 y students</td>
<td>SF&lt;12</td>
<td>12.5</td>
<td>19.0</td>
</tr>
<tr>
<td>Perth</td>
<td>20-69 y women</td>
<td>SF&lt;10</td>
<td>8.7%</td>
<td>19.3</td>
</tr>
</tbody>
</table>

*geometric mean
Data analysis
Prior to statistical analyses, skewed distributions were log-transformed (serum ferritin). A retransformation back to original units was made before reporting the results. The 95% confidence interval of the mean (95% CI) and percentile ranges are reported for iron status parameters. Logistic regression was used to determine the factors predictive of low iron stores (serum ferritin <20 μg/L) and to estimate the magnitude of the relationship between predictor variables and outcomes. Predictors of interest were entered into the model as nutrient densities, together with energy intake. This model, termed the multivariate nutrient density model, was developed by Miller et al. It controls for confounding by energy intake, allowing the coefficient for the nutrient density variable to represent the relation of the nutrient composition of the diet while holding total energy intake constant. All statistical analyses were computed using SPSS-Windows, Version 6.1, Chicago 1995.

Results
Descriptive data
The age range of the students was 15-30 years with a mean of 20.7 years (SD 3.5 years). Most students (35%) were classified in the healthy weight range (BMI 20.0-25.0), 32% were underweight (BMI <20.0) and 13% were overweight (BMI >25.0). These percentages are comparable to Australian data. The mean prevalence rate was 3.9 (SD 1.1) using Daniel’s scale, corresponding to semi-professional and middle-management groups.

The FFQ was satisfactorily completed by 167 subjects after excluding under- and over-reporters. The median daily nutrient intake was 16.1 mg iron (16.1 mg iron from (μg) E) protein, 52.2% E carbohydrate, 30.2 % E fat, 1.9% E alcohol, 7.1% E meat, fish and poultry (MFP), 1.07 mg haem iron, 380 mg calcium, 156 mg vitamin A. Nearly 25% of subjects reported never drinking alcohol. The median daily alcohol intake was 4.8 g per consumer, with 4% of consumers consuming in excess of 20 g alcohol daily.

A large proportion of subjects classified themselves as vegetarian (13%) or semi-vegetarian (17%), and consumed minimal amounts of red meat. The use of vitamin and mineral supplements was common, with 41% of subjects taking supplements on a regular basis. Thirty-five percent of subjects were currently using the OCP and none reported the use of an IUD. Most subjects had regular cycles (73%) and menstruated 4-5 days per cycle (60%). Using menstrual scores, the following percentages were obtained: 17% for low score, 48% for medium and 35% for high score. Thirteen percent of subjects had donated blood at least once in the past six months. The majority of students (66%) reported no or low levels of exercise and only 10% reported high levels of exercise, based on frequency, duration and intensity of activities undertaken.

Table 1. Haematological and biochemical indicators of iron status in female students in Perth, aged 15-30 (n=266)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean ± SD</th>
<th>90% CI</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hb (g/dL)</td>
<td>13.3 ± 1.3</td>
<td>12.2-14.4</td>
<td>12.9-14.8</td>
</tr>
<tr>
<td>MCHC (pg/μL)</td>
<td>33.4 ± 0.6</td>
<td>32.3-34.5</td>
<td>33-34.3</td>
</tr>
<tr>
<td>MCH (fl)</td>
<td>83.2 ± 8.9</td>
<td>77.5-88.9</td>
<td>80.3-87.1</td>
</tr>
<tr>
<td>Mean corpuscular protein concentration (g/dL)</td>
<td>14.9 ± 1.3</td>
<td>13.5-16.3</td>
<td>14.1-16.9</td>
</tr>
<tr>
<td>Platelet count (10^9/L)</td>
<td>225 ± 53</td>
<td>206-246</td>
<td>213-237</td>
</tr>
</tbody>
</table>

| *geometric mean for SF (serum ferritin) |

Table 2. Prevalence of iron deficiency in 15-30 year old female students in Perth measured by various criteria (n=261).

<table>
<thead>
<tr>
<th>Criteria</th>
<th>% (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron deficiency Anemia</td>
<td>0.4 (10)</td>
</tr>
<tr>
<td>Multicriteria (Hb&lt;12.0, SF&lt;12, TS&lt;16)</td>
<td>4.5 (12)</td>
</tr>
<tr>
<td>Iron deficiency Serologic criteria</td>
<td>19.8 (51)</td>
</tr>
<tr>
<td>SF&lt;12</td>
<td>19.8 (51)</td>
</tr>
<tr>
<td>SF&lt;16</td>
<td>19.8 (51)</td>
</tr>
<tr>
<td>TS&gt;16</td>
<td>19.8 (51)</td>
</tr>
<tr>
<td>Multicriteria (SF&lt;12, TS&lt;16)</td>
<td>7.2 (19)</td>
</tr>
</tbody>
</table>

* criteria according to Hallberg et al

Multivariate analysis
Multivariate analysis was undertaken to examine the factors independently associated with iron status in this population. The predictor variables entered in the logistic regression model were: age, BMI, social status, recent blood donation, menstrual score, OCP use, vitamin/mineral supplement use, alcohol levels, energy intake, protein intake, total iron intake and vitamin C intake.

Discussion
The results of this study report the iron status and the predictive factors of low iron stores in a group of 15-30 year old female students in Perth. Anthropometric data were comparable to Australian data of similar populations. The social status of the sample is relatively high when compared to the general population due to the large number of university students in the sample. The prevalence of iron deficiency (TS<16 and SF<12) in this sample of female students was 7.2%, and iron deficiency anaemia (HB<12, TS<16 and SF<12) was present in 4.5% of students. These results are comparable to Australian studies of iron status in women (Table 4). The prevalence of iron deficiency is lower in the current study (7.2%) compared to 15 year old schoolgirls’ (9.2%) but higher when compared to 20-69 year old women (4%).

Factors associated with low iron stores
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The number of studies showing significant associations between diet and iron stores, especially in older adults, is small. This is probably due to the difficulties of evaluating dietary intake over an appropriate period of time as iron status is the balance between iron absorption and loss, usually over several months. Methods to assess intake over short periods of time, for example 24-hour recall, do not take into account the high day-to-day variability of food consumption. The FFQ, which evaluates dietary intake over a longer period of time, may be more appropriate for investigating the relationships between diet and iron status. Indeed, in the present study, two nutrient variables (haem iron density and calcium density) were found to significantly influence iron status. No relationship was found with vitamin C intake, a known enhancer of iron absorption.

Low haem iron densities were found to increase the chances of becoming iron deficient, after controlling for other co-variables (social status, calcium intake, BMI, blood...
An increased number of menstruating days per year (> 65 days) was associated with a 2.5 times increased likelihood of iron deficiency, compared to fewer menstruating days (< 65 days). Evidence of an inverse association between serum ferritin concentration and the duration of menses has been provided by other investigators (2-4). OCP use was found not to be significantly associated with iron deficiency in the present model. However, as the OCP reduces the duration of menstruation, its effect may have already been accounted for in the menstrual score.

The iron status of students was found to be comparable to the iron status of premenopausal women surveyed in recent Australian studies. However, a relatively large proportion of women (one in five) had low iron stores as defined by a serum ferritin < 20 µg/L. The factors affecting the social status, haem iron intake, calcium intake, BMI, recent blood donation, and menstrual score. Haem iron intake decreased the likelihood of becoming iron deficient, whereas a high calcium intake, high social status, high menstrual score and a recent history of blood donation by subjects with BMI >24 increased the likelihood of becoming iron deficient. Of all these factors, increasing haem iron intake is the most appropriate and easily modifiable factor for public health intervention. In order to decrease the prevalence of iron deficiency in this population, haem iron consumption (mest, chicken fish) should be increased, but separately from the main calcium containing meals. Further research is necessary to determine whether iron stores are affected by separating calcium meals from high iron meals.

Acknowledgement. This research was conducted at the School of Public Health, Curtin University of Technology, Perth, where the first author is undertaking doctoral research. This research was supported in part by a grant from Kellogg (Aus) Pty Ltd. The authors would like to thank the staff at the Health Service. Curtin University of Technology for their valuable assistance.

References
Factors affecting iron status in 15-30 year old female students

References