How is the adequacy of micronutrient intake assessed across Europe? A systematic literature review

1Institute of Physiology and Human Nutrition, University of Palermo, Palermo, Italy
2Noncommunicable Diseases and Environment, World Health Organization Regional Office for Europe, Scherfigsvej 8, DK-2100 Copenhagen Ø, Denmark
3Department of Nutrition for Health and Development, World Health Organization, Avenue Appia 20, CH-1211, Geneva 27, Switzerland
4Community Nutrition Research Centre of the Nutrition Research Foundation, University of Barcelona Science Park, Baldiri Reixac 4, 08028 Barcelona, Spain
5University of Las Palmas de Gran Canaria, PO Box 550, 35080 Las Palmas de Gran Canaria, Spain
(Received 7 January 2009 – Revised 23 April 2009 – Accepted 1 June 2009)

EURocean micronutrient RECommendations Aligned is a network of excellence funded by the European commission, and established to address the problem of differences between countries in micronutrient recommendations as well as to understand how nutritional information including requirements and adequacy of intake is processed among different population groups. The aims of the present paper were to review the methods used for the adequacy assessment of the intake of six micronutrients of public health concern (vitamin A, folate, vitamin B12, Fe, Zn and iodine) in non-European and European nutrition surveys carried out on the apparently healthy population and to compare in particular the adequacy across surveys for folate intake. A systematic literature review was conducted to identify nutrition surveys that assessed micronutrient intake adequacy. The search yielded 9049 records, out of which 337 were eligible for the selected micronutrients. The majority (83.9%) of the European surveys compared the adequacy of the nutrient intake against the Recommended Dietary Allowances (RDA); only a few surveys (8.0%) used the estimated average requirement cut-point method, while none of them used the probability approach. The comparison of folate inadequacy across eight countries revealed that about 25% of the adult female population had inadequate intakes when judged against the different recommendations used by the respective investigators, but nearly 75% had inadequate intakes when compared against the estimated average requirement cut-point value of 320 μg/d. The present review showed that different methods were applied across Europe to estimate the adequacy of micronutrient intake, which led to different prevalence estimates of micronutrient inadequacy.

Dietary intake: Adequacy: Micronutrients: Folate: Adequacy assessment: Micronutrient intake

The dietary requirement for a micronutrient is defined as an intake level that meets specific criteria for adequacy, thereby minimising the risk of nutrient deficit or excess. These criteria cover a gradient of biological effects related to a range of nutrient intakes, which, at the extremes, include the intake required to prevent death associated with nutrient deficit or excess as well as other biological responses. The latter includes clinical disease as determined by signs and symptoms of nutrient deficiency, and subclinical conditions identified by specific biochemical and functional measures. Measures of nutrient stores or critical tissue pools may also be used to determine nutrient adequacy(1).

One of the aims of nutritional assessment both at the individual and at the population level is to evaluate to what extent food and nutrient intake is ‘adequate’. Ideally, the comparison between the requirement and the intake for every nutrient of interest for a certain individual or population should allow one to conclude whether the diet of that individual/population was adequate. As neither the real intake nor the real requirement for one individual is known, the evaluation of nutrient intake adequacy of an individual or population is based on the probability of adequacy. The calculation of the probability of adequacy is based on the assumption that intake is independent of requirement; although this assumption

Abbreviations: EAR, estimated average requirement; IOM, Institute of Medicine.


* Corresponding author: Trudy M. A. Wijnhoven, fax +45 39 17 18 18, email twi@euro.who.int
is not valid for energy intake, it is most likely applicable for vitamins and minerals\(^{(1,2)}\).

There are different statistical approaches that can be used to estimate the prevalence of adequate usual intakes from the distribution of intakes and requirements. The method used depends on the subject (individual or population), on the nutrient under study and the type of distribution of the intakes. These methods include the ‘probability approach method’ and the ‘estimated average requirement (EAR) cut-point method’. The probability approach method requires the calculation of the probability of inadequacy of intake for each individual in a population subgroup, averaging the probabilities, and then using this average as an estimate of the prevalence of inadequacy. The EAR corresponds to the average daily nutrient intake level estimated to meet the requirement of half of the healthy individuals in a particular life stage and sex group. The EAR cut-point method is a short cut method of the probability approach and can be applied when the nutrient requirement is distributed symmetrically and the distribution of usual intakes is more variable than the distribution of requirements. If these conditions are met, the prevalence of inadequate intakes corresponds to the proportion of intakes that fall below the EAR. Other methods are the comparison to the cut-off values of the Recommended Dietary Allowances (RDA) or the comparison of the mean intake value of the population to the RDA, although they are inappropriate to define the population at risk of inadequacy\(^{(1,3,4)}\). Other methods used are the scores of nutrient intake adequacy such as the nutrient adequacy ratio, which is calculated by dividing the estimated usual nutrient intake by the RDA, and the mean adequacy ratio, which is calculated by taking the sum of nutrient adequacy ratio of all micronutrients under study and then dividing it by the total number of nutrients. The percentage of the population with nutrient intakes below the Lowest Requirement Nutrient Intake is another calculation applied to estimate inadequacy.

EURopean micronutrient RECommendations Aligned is a network of excellence funded by the European commission, and established to identify and address the problem of differences between countries in micronutrient recommendations as well as to understand how nutritional information including requirements and adequacy of intake is processed among different population groups. The collected information will be used for the development of web-based computerised software to assess nutrient adequacy from dietary data collected in Europe. For its development, it will be necessary to have a clear framework of the methods being used to assess the micronutrient intake adequacy in Europe\(^{(5)}\).

To the authors’ knowledge, a review of these methods has not been carried out yet. The aims of the present paper were to review the methods that have been used for the adequacy assessment of the intake of six micronutrients of public health concern – vitamin A, Fe, iodine, folate, vitamin B\(_{12}\) and Zn – in non-European and European nutrition surveys carried out on representative samples of an apparently healthy population. As an illustration, the estimated adequacy of folate intake found across surveys in adult women was compared.

Vitamin A deficiency, Fe deficiency anaemia and iodine deficiency disorders represent the three major micronutrients deficiencies in the world. Vitamin A deficiency is common in preschool-aged children throughout the world, but hardly any data were available in 1995 for the countries of the WHO European Region\(^{(6)}\). Anaemia currently affects 22 % of the pre-school-aged children and 25 % of the pregnant women in the WHO European Region\(^{(7)}\). Insufficient iodine intake was found in 57 and 60 % of the general population and school-aged children, respectively\(^{(8)}\). While the global prevalence of folate deficiency is still uncertain, data suggest that low folate status is apparent among teenage girls in some European countries such as the United Kingdom (about 40 % of 15–18 year olds were found to have marginal folate status), and common among elderly people\(^{(9)}\). Furthermore, it is known that folate deficiency in women in childbearing age is associated with a higher risk of giving birth to infants with neural tube defects and other birth defects. A deficiency of folate in adults is in general associated with an increased risk of cardiovascular disease (CVD), cancer and impaired cognitive functions\(^{(1)}\). In the United Kingdom 31 % of the elderly and in Germany 15 % of the women of reproductive age are reported to be vitamin B\(_{12}\) deficient\(^{(9)}\). About 20 % of the world’s population is at risk of Zn deficiency\(^{(3)}\) and in Europe Zn intake among elderly is generally low\(^{(10)}\).

**Methods**

**Search strategy and eligibility criteria**

The present paper focuses on six micronutrients that represent public-health challenges and concerns\(^{(3)}\): vitamin A, Fe, iodine, folate, vitamin B\(_{12}\) and Zn. The search for surveys on the intake adequacy of micronutrients was carried out at the global level. European surveys included those conducted in one of the twenty-seven European Union countries (Austria, Belgium, Bulgaria, the Czech Republic, Cyprus, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the United Kingdom) or the four European Free Trade Association countries (Iceland, Liechtenstein, Norway and Switzerland).

A systematic literature search was performed in the PubMed database\(^{(1,11)}\) (1990 to 30 March 2008; human studies only) on combinations of both medical subject headings and free-text keywords. It involved the use of each individual micronutrient key terms combined with searches about the concept of nutrient adequacy (e.g. (in)adequacy, (in)adequate intake, threshold intake, cut point) and dietary intake (e.g. nutrition requirements, dietary intake, RDA). No language restrictions were applied at the search of studies in the PubMed database. Owing to limited translation possibilities, however, the final eligibility evaluation of full-text documents was restricted to publications in Dutch, English, French, German, Italian, Portuguese or Spanish only.

The first review stage involved the screening of titles, keywords and abstracts of the identified articles, to determine their appropriateness for inclusion. The reviewers were not blinded to the names of the authors, institutions or journal of publication. Observational (cross-sectional or cohort) studies carried out in apparently healthy population groups (children, adolescents, adults, elderly, pregnant and lactating women) and methodological papers on dietary intake and adequacy measurement were considered. Articles were excluded when the information given in the title or available abstract
suggested that the intake of micronutrients was not measured, the macronutrient intake adequacy was estimated only or that the survey was carried out in sick or institutionalised populations. Citations without an abstract or articles published in a language other than Dutch, English, French, German, Italian, Portuguese or Spanish were also excluded. The second screening stage involved the exclusion of articles, whose abstract did not provide descriptive information on the method used for the estimation of nutrient intake adequacy.

Surveys that fulfilled the first- and second-stage inclusion criteria were nevertheless excluded if they did not estimate the adequacy for any of the six selected micronutrients. The full text of the surveys identified to be potentially eligible was obtained and further evaluated during the last stage of the review. If more than one article was found for the same study, the article that provided the most relevant information was kept in the review.

Data analysis

All identified citations were downloaded into Reference Manager Version 10.0\(^{12}\) and assigned a unique identification number and subsequently transferred into a database created with Microsoft Office Access 2003\(^{13}\), which was used for the screening and analysis. Extracted data were additionally entered into this database.

For each of the six micronutrients, the data of the surveys found eligible were tabulated by study design, population group and method used to assess intake adequacy. A distinction was made between the surveys that used the recommended methods as the EAR cut point or the probability approach method and the surveys that used the comparison against the cut-off value of the RDA. Other methods were also evaluated, such as the nutrient intake adequacy scores or the use of the percentage of the population with nutrient intakes below the lowest requirement nutrient intake.

For the comparison of the estimated folate intake adequacy across European surveys, the mean prevalence of folate inadequacy in European adult women was estimated with the use of the statistical software ‘R’, version 2.7.1\(^{14}\). Surveys with information on mean folate intake and standard deviation were selected and the proportion of the population with an intake below the recommended national level was compared to the proportion of the population below the recommended EAR of 320\(\mu\)g/d, which is recommended by WHO and the FAO\(^{1}\).

Results

The search of the PubMed database yielded an initial 9049 records, out of which 8215 did not meet the first-stage inclusion criteria and were thus excluded from the review.

Fig. 1. Flow diagram of the process of identifying and including studies for the systematic literature review.
During the second and third screening phase, another 162 and 335 studies were excluded respectively, which resulted in a total of 337 articles included in the review that were related to the six selected micronutrients (Fig. 1). The full list of these references can be provided upon request.

Global surveys

Table 1 shows the number of articles included in the review for each micronutrient, and distinguishes reviews from original articles, European and non-European surveys, and studies that focus on only one micronutrient.

The majority of the studies targeted adults, followed by children, adolescents, elderly, pregnant/lactating women and infants (Table 2).

Results on the specific method used for the estimation of the adequacy of intake of the selected micronutrients are given in Table 3. The main reference value used was the RDA, but some authors have also applied the EAR. The probability approach was used in five studies (15–21). Some studies used other methods. For instance, four surveys applied the nutrient adequacy ratio and mean adequacy ratio (22–25) and three studies used the Lowest Requirement Nutrient Intake (26–28). A study conducted in the United States on folate intake used the following other definition of ‘adequacy’: folate intake was defined as adequate when one consumed at least one folate-rich food at least 4–6 times/week, and as ‘inadequate’ when one folate-high/ rich/excellent food was consumed fewer than 2–3 times/week (29).

European surveys

Out of the 121 European articles, nine methodological reviews were not considered in the present paper as they did not include original data, so that a total of 112 original articles were analysed.

The majority of studies (83·9 %) compared micronutrient intakes against the RDA for the estimation of adequacy. The probability approach method was never used. Only one study used another reference, the recommended values of the Caroline Walker Trust nutritional guidelines for primary schools (30). Nine European studies (8·0 %) used the EAR/AR (average requirement) method, out of which two used it in combination with the RDA (Table 4); however, the EAR values applied differed across studies (30–48).

Adequacy of folate intake

Eight European surveys were identified that estimated the prevalence of adequacy or ‘inadequacy’ of folate intake in European adult women and that provided a mean and sd intake (Table 5) (44,48–54). Folate intake in Europe was inadequate in 25·1 % of the adult female population, according to the comparison with the different recommendations used by the authors of the studies (Table 6). If the authors would have used the corresponding respective national recommendations, the percentage obtained would have been slightly higher (34·6 %); when using the national EAR as a reference, the proportion of the population having inadequate folate intake would have been 17·1 %. Compared with the WHO/FAO recommendations of 400 μg/d and an EAR of 320 μg/d, 92·1 % and 74·8 % of the adult female population would have an inadequate intake of folate, respectively.

Discussion

For the assessment of the adequacy of micronutrient intake in Europe, it is important to consider that the methods used for
data collection and analysis can vary throughout the different steps taken that lead to the estimation of adequacy. This can potentially result in an over- or underestimation of the usual intake and, as a consequence, of the adequate intake. The use of different methods for the collection of dietary intake data across surveys is an important source of variation in the estimate of micronutrient intake and thus in the estimate of micronutrient adequacy. In the second step, the food composition tables used to translate food intake into micronutrient intake might be another source of variation. Finally, the intake data analysed have to be compared against reference values. The main reference value used to assess adequacy was the RDA, both in non-European and in European studies. The latest dietary reference intakes published by the US Institute of Medicine (IOM) in 2000(4) were accompanied with new suggestions about how the proposed updated references to nutritional assessment should be applied, including the application of nutritional requirements to assess nutrient intake adequacy. Despite that, from 2000 onwards, many studies (163 out of 199) still used the RDA value as a reference for estimating intake adequacy. Consequently, the use of this approach will lead to an overestimation of the prevalence of inadequacy compared to the use of the EAR cut-point value. A few studies compared the intake with the mean group intake, assuming that if that value is approximate to the RDA, only 2–3 % of the group members would have inadequate intakes. IOM does not recommend such an approach, as the RDA for a nutrient takes into account the individual variability of requirement and thus exceeds the requirement of almost all individuals. Comparing the mean intake of a group of individuals with the RDA underestimates the prevalence of individuals at risk of inadequate intake.

### Table 3. Number of articles indicating the reference used for estimating the intake adequacy, by micronutrient

<table>
<thead>
<tr>
<th>Micronutrient</th>
<th>RDA</th>
<th>RNI</th>
<th>RI</th>
<th>RDI</th>
<th>EAR</th>
<th>AR</th>
<th>Probability approach</th>
<th>RDA + EAR</th>
<th>RNI + EAR</th>
<th>RDI + EAR</th>
<th>Others</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin A</td>
<td>104</td>
<td>14</td>
<td>3</td>
<td>9</td>
<td>26</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>5</td>
<td>175</td>
</tr>
<tr>
<td>Folate</td>
<td>81</td>
<td>17</td>
<td>3</td>
<td>5</td>
<td>30</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>5</td>
<td>151</td>
</tr>
<tr>
<td>Vitamin B₁₂</td>
<td>37</td>
<td>7</td>
<td>1</td>
<td>2</td>
<td>16</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>74</td>
</tr>
<tr>
<td>Zn</td>
<td>88</td>
<td>14</td>
<td>4</td>
<td>1</td>
<td>35</td>
<td>4</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>6</td>
<td>161</td>
</tr>
<tr>
<td>Iodine</td>
<td>11</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>Fe</td>
<td>108</td>
<td>13</td>
<td>7</td>
<td>9</td>
<td>28</td>
<td>4</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>9</td>
<td>187</td>
</tr>
<tr>
<td>Total for six micronutrients</td>
<td>251</td>
<td>66</td>
<td>9</td>
<td>11</td>
<td>337</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RDA, Recommended Dietary Allowances; EAR, estimated average requirement; RNI, recommended nutrient intake; RI, recommended intake; RDI, recommended dietary intake; AR, average requirement.

### Table 4. Selected European studies that applied the EAR/AR reference values

<table>
<thead>
<tr>
<th>Reference value</th>
<th>First author</th>
<th>Publication years</th>
<th>Survey years</th>
<th>Country</th>
<th>Population group (age range)</th>
<th>Sample size</th>
<th>Sex</th>
<th>Selected micronutrients</th>
</tr>
</thead>
<tbody>
<tr>
<td>EAR (IOM 2000(4))</td>
<td>Manios(40)</td>
<td>2008</td>
<td>2003–2004</td>
<td>Greece</td>
<td>Infants, children (1–5 years)</td>
<td>2374</td>
<td>NA</td>
<td>Folate, Fe, Zn</td>
</tr>
<tr>
<td>EAR and RNI (United Kingdom 1991(31))</td>
<td>Cowin(41)</td>
<td>2007</td>
<td>1994</td>
<td>United Kingdom</td>
<td>Children (18 months)</td>
<td>1026</td>
<td>NA</td>
<td>Vitamin A, folate, Zn, iodine, Fe</td>
</tr>
<tr>
<td>EAR (United Kingdom 1991(31) and United States 2001(38))</td>
<td>Pynaert(42)</td>
<td>2007</td>
<td>NA</td>
<td>Belgium</td>
<td>Young adult women (NA)</td>
<td>NA</td>
<td>NA</td>
<td>Fe</td>
</tr>
<tr>
<td>EAR (France 2001(35))</td>
<td>Touvier(43)</td>
<td>2006</td>
<td>2000</td>
<td>France</td>
<td>Children, adolescents, adults, elderly (4–92 years)</td>
<td>2373</td>
<td>NA</td>
<td>Vitamin A, folate, Fe</td>
</tr>
<tr>
<td>AR (EC 1993(37))</td>
<td>Michaelson(46)</td>
<td>1994</td>
<td>1987–1988</td>
<td>Denmark</td>
<td>Infants (0–12 months)</td>
<td>91</td>
<td>NA</td>
<td>Zn</td>
</tr>
<tr>
<td>AR (EC 1993(37))</td>
<td>Kiely(47)</td>
<td>2001</td>
<td>1997–1999</td>
<td>Ireland</td>
<td>Adults (18–64 years)</td>
<td>1379</td>
<td>662 M, 717 F</td>
<td>vitamin A, folate, vitamin B₁₂, Fe, Zn, Folate</td>
</tr>
<tr>
<td>EAR and RDA (Dutch 1992–1993(38))</td>
<td>Brussaard(48)</td>
<td>1997</td>
<td>NA</td>
<td>The Netherlands</td>
<td>Adults, elderly (20–79 years)</td>
<td>444</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

AR, average requirement; EAR, estimated average requirement; NA, not available.
The EAR cut-point method was not frequently used. The probability approach method was only applied in seven non-European surveys, while it was not used at all in Europe. Other methods such as nutrient adequacy ratio and mean adequacy ratio were used in very few non-European studies.

Among the surveys that used the RDA as a reference, a wide range of reference values was used in Europe to assess nutrient intake adequacy. This means that the estimation of adequacy can also differ between countries.

The present paper presented the folate intake in European adult women as an example to illustrate how the use of different methods can lead to different prevalence estimates of nutrient inadequacy. Most health authorities recommend a daily intake of 200 μg dietary folate for women, while WHO/FAO(11) recommends a minimum intake of 400 μg/d. Few studies have shown that present dietary folate intake of adults in European countries meets the average RDA of 200 μg/d, but not the recommended WHO/FAO value of 400 μg/d.(58,59) One study showed that weighed mean intake for women was 247 μg/d with a range of 168–320, and median values lower than 200 μg/d were not frequently found to be inadequate in folate was normally distributed and therefore needs to be interpreted with caution. Furthermore, no correction for other factors was made. Nevertheless, the results give an indication of the variation that can occur when different methods are applied to estimate intake adequacy.

### Table 5. Selected European studies on inadequacy of folate intake in adult women

<table>
<thead>
<tr>
<th>First author</th>
<th>Publication year</th>
<th>Survey year</th>
<th>Country</th>
<th>Reference value for adequacy</th>
<th>Cut-off folate (μg)</th>
<th>Population inadequate (%)</th>
<th>Adult female population (n)</th>
<th>Mean intake (μg)</th>
<th>sd (μg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hatzis(50)</td>
<td>2006</td>
<td>NA</td>
<td>Greece</td>
<td>RNI (EC(37))</td>
<td>400</td>
<td>86-5</td>
<td>236</td>
<td>247</td>
<td>138</td>
</tr>
<tr>
<td>Sofi(50)</td>
<td>2005</td>
<td>2002–2003</td>
<td>Italy</td>
<td>RDA (IOM(11))</td>
<td>400</td>
<td>89-0</td>
<td>309</td>
<td>338</td>
<td>121</td>
</tr>
<tr>
<td>Planelles(51)</td>
<td>2003</td>
<td>NA</td>
<td>Spain</td>
<td>RDA (Varel(36,37))</td>
<td>2/3 of 200</td>
<td>23-5</td>
<td>1715</td>
<td>196</td>
<td>105</td>
</tr>
<tr>
<td>Aranceta(52)</td>
<td>2001</td>
<td>1990–1998</td>
<td>Spain</td>
<td>RDI (Varel(36,37))</td>
<td>2/3 of 200</td>
<td>10-0</td>
<td>5480</td>
<td>252</td>
<td>103</td>
</tr>
<tr>
<td>O’Brien(53)</td>
<td>2001</td>
<td>1997–1999</td>
<td>Ireland</td>
<td>AR (EC(37))</td>
<td>140</td>
<td>8-9</td>
<td>717</td>
<td>260</td>
<td>144</td>
</tr>
<tr>
<td>Schroder(44)</td>
<td>2004</td>
<td>1994–1996</td>
<td>Spain</td>
<td>EAR (US IOM(34,35))</td>
<td>320</td>
<td>70-0</td>
<td>662</td>
<td>285</td>
<td>66</td>
</tr>
<tr>
<td>Rasmussen(54)</td>
<td>2000</td>
<td>1998</td>
<td>Denmark</td>
<td>RI (NNR 1996(57))</td>
<td>300</td>
<td>64-8</td>
<td>258</td>
<td>276</td>
<td>90</td>
</tr>
<tr>
<td>Brussaard(48)</td>
<td>1997</td>
<td>NA</td>
<td>The Netherlands</td>
<td>EIR and RDA (source not provided)</td>
<td>400</td>
<td>95-0</td>
<td>300</td>
<td>270</td>
<td>79</td>
</tr>
</tbody>
</table>

RNI, recommended nutrient intake; RDA, Recommended Dietary Allowances; NA, not available; AR, average requirement; EAR, estimated AR; RI, recommended intake.

### Table 6. Percentages of folate intake inadequacy in European adult women compared against different reference values

<table>
<thead>
<tr>
<th>Total adult female population (n)</th>
<th>According to survey results</th>
<th>Compared to national RDA</th>
<th>Compared to national EAR</th>
<th>Compared to WHO/FAO RNI(1)</th>
<th>Compared to WHO/FAO EAR(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Population inadequate (%)</td>
<td>Cut-off folate (μg)</td>
<td>Population inadequate (%)</td>
<td>Cut-off folate (μg)</td>
<td>Population inadequate (%)</td>
</tr>
<tr>
<td>236</td>
<td>86-5</td>
<td>400</td>
<td>36-7</td>
<td>200</td>
<td>21-9</td>
</tr>
<tr>
<td>309</td>
<td>89-0</td>
<td>400</td>
<td>12-7</td>
<td>200</td>
<td>5-1</td>
</tr>
<tr>
<td>1715</td>
<td>23-5</td>
<td>2/3 of 200</td>
<td>51-5</td>
<td>200</td>
<td>29-7</td>
</tr>
<tr>
<td>5480</td>
<td>10-0</td>
<td>2/3 of 200</td>
<td>30-7</td>
<td>200</td>
<td>13-8</td>
</tr>
<tr>
<td>717</td>
<td>8-9</td>
<td>140</td>
<td>33-8</td>
<td>200</td>
<td>20-2</td>
</tr>
<tr>
<td>662</td>
<td>70-0</td>
<td>320</td>
<td>9-9</td>
<td>200</td>
<td>1-4</td>
</tr>
<tr>
<td>258</td>
<td>64-8</td>
<td>300</td>
<td>60-5</td>
<td>300</td>
<td>30-5</td>
</tr>
<tr>
<td>300</td>
<td>95-0</td>
<td>400</td>
<td>64-8</td>
<td>300</td>
<td>30-6</td>
</tr>
<tr>
<td>9677</td>
<td>25-1</td>
<td>400</td>
<td>34-6</td>
<td>17-1</td>
<td>92-1</td>
</tr>
</tbody>
</table>

RDA, Recommended Dietary Allowances; EAR, estimated average requirement; RNI, recommended nutrient intake.
Conclusions
The present review showed that different methods have been applied across Europe to estimate the adequacy of micronutrient intake, which has led to different prevalence estimates of micronutrient inadequacy. The harmonisation of methods and the development of a software tool are important steps that can lead to a standardised way of estimating the adequacy of micronutrient intake in Europe. European micronutrient recommendations aligned has the potential to provide guidance to develop the proper tool that would enhance harmonisation of nutrient intake adequacy assessment across Europe.

Acknowledgements
This work was carried out within the framework of EUROPean micronutrient RECommendations Aligned, a Network of Excellence, project No. FP6 036196-2, funded by the European Commission. The present report does not necessarily reflect the Commission’s views or its future policy in this area.

G. T. screened the literature, undertook analysis and wrote the first draft of the paper. T. M. A. W. supervised the work, developed the literature search strategy, screened part of the literature and wrote the final draft of the paper. F. B. managed the project and commented on drafts of the paper.

B. R.-V. contributed to the literature search strategy and commented on drafts of the paper. L. R.-B. contributed to the design of the review and commented on drafts of the paper. J. N. contributed to the literature search strategy and commented on drafts of the paper. A. G.-A. contributed to the design of the review and commented on drafts of the paper. L. S.-M. contributed to the design of the review and commented on drafts of the paper. T. M. A. W. supervised the work, will produce the evidence-based EURRECA toolkit to support the Commission’s views or its future policy in this area.

There is no conflict of interest.

References


