**ANSES Opinion**
**Request No 2018-SA-0238**
**Related Request No 2012-SA-0103**

The Director General

Maisons-Alfort, 2 March 2021

# OPINION
# of the French Agency for Food, Environmental and Occupational Health & Safety

## on the "Updating of the French dietary reference values for vitamins and minerals"

*ANSES undertakes independent and pluralistic scientific expert assessments.*
*ANSES primarily ensures environmental, occupational and food safety as well as assessing the potential health risks they may entail.*
*It also contributes to the protection of the health and welfare of animals, the protection of plant health and the evaluation of the nutritional characteristics of food.*
*It provides the competent authorities with all necessary information concerning these risks as well as the requisite expertise and scientific and technical support for drafting legislative and statutory provisions and implementing risk management strategies (Article L.1313-1 of the French Public Health Code).*
*Its opinions are published on its website. This opinion is a translation of the original French version. In the event of any discrepancy or ambiguity the French language text dated 2 March 2021 shall prevail.*

On 2 November 2018, ANSES issued an internal request to conduct the following expert appraisal: Updating of the French dietary reference values for vitamins and minerals.

## 1. BACKGROUND AND PURPOSE OF THE REQUEST

### 1.1. Background

In 2016, ANSES proposed an update of the dietary reference values for the adult population (women aged 18 to 54 years and men aged 18 to 64 years) as part of its revision of the food-based dietary guidelines (Request 2012-SA-0103). Reports on food-based dietary guidelines for specific populations (the elderly, children, pregnant and breastfeeding women) were subsequently published in 2019, but no new dietary reference values were defined by the Agency.

Moreover, the 2016 update only covered essential vitamins and minerals for which consumption data were available. Therefore, vitamin B8, vitamin K, chromium, molybdenum, chlorides and fluoride were not addressed.

### 1.2. Purpose of the request

The goal of this current work was therefore to:

- reassess all the dietary reference values for vitamins and minerals for specific populations (infants, children, adolescents, pregnant and lactating women, and the elderly).
- complete the update of dietary reference values for vitamins and minerals for the adult population, taking new data into account where appropriate.

In terms of methodology, the work consisted in carrying out a critical analysis of the dietary reference values defined for vitamins and minerals in order to meet the population's requirements. This involved listing the reference values defined by other authorities, in particular EFSA (which has been conducting a full reassessment of dietary reference values since 2010), and then identifying for each nutrient the most appropriate dietary reference value for the target population. For dietary reference values based on food consumption, the assessment took into account the observed intakes for the population living in France. For the risk associated with high nutrient intakes, the Tolerable Upper Intake Level determined by EFSA has been provided for information.

## 2. ORGANISATION OF THE EXPERT APPRAISAL

### 2.1. Expert appraisal procedure

The expert appraisal was carried out in accordance with French standard NF X 50-110 "Quality in Expert Appraisals – General Requirements of Competence for Expert Appraisals (May 2003)".

The collective expert appraisal was carried out by the Expert Committee (CES) on "Human Nutrition". Its work began with the definition of the working method at the meeting of 8 November 2018, and continued from December 2018 to October 2020 with regular discussions on the dietary reference values for each vitamin or mineral. Lastly, the entire document was adopted by the CES at its meeting of 19 November 2020.

The response to the formal request was coordinated by the Nutritional Risk Assessment Unit (UERN). Nutrient intakes were estimated by the Methodology and Studies Unit based on the INCA3 study.

ANSES analyses interests declared by experts before they are appointed and throughout their work in order to prevent risks of conflicts of interest in relation to the points addressed in expert appraisals.

The experts' declarations of interests are made public via the ANSES website (www.anses.fr).

### *2.2. Method of defining dietary reference values for vitamins and minerals*

#### 2.2.1.Terminology

The definitions of the terms used in nutrition vary according to the authors and over time (see Table 1). As part of this work, the following definitions were adopted by the CES. Concerning the "nutritional requirement", the definition is, in principle, very broad: it is the minimum quantity of a nutrient to be consumed by an individual to promote their health. This definition is in

keeping with those of the FAO (2005) and AFSSA (2001), but its simple formulation and the reference to the broad term "health" enable all of the roles to be incorporated with a view to optimal nutrition. This covers the classical roles attributed to nutrients, relating to their essential nature and metabolic use, but also their physiological consequences, or their possible implication in long-term pathophysiological phenomena. This definition is consistent with other broad definitions that have been proposed, including by the WHO (2004), which defined the nutritional requirement (for a micronutrient) as “an intake level which meets a specified criteria for adequacy, thereby minimizing risk of nutrient deficit or excess”. The nutritional requirement is not the same as the net requirement, which is defined as the amount of nutrient used in the tissues, after intestinal absorption. The net requirement is divided by the absorption rate of the nutrient to define the nutritional requirement (AFSSA 2001).

Practical assessment also depends on the method used, with two distinct approaches: the experimental approach, which involves assigning different intake levels to individuals in order to study the impact on the criteria of adequacy, and the observational (also referred to as "epidemiological") approach, which consists in observing the relationships between intake and satisfaction of the criterion in a real situation.

Thus, the terms relating to dietary reference values, i.e. the **average requirement (AR), the population reference intake (PRI) and the adequate intake (AI)** have essentially been defined by the approaches implemented to assess them. The **reference intake range (RI)** and the **upper intake level (UL)** are also used. For these terms, the following definitions and approaches were chosen:

*Average Requirement (AR)*

The AR is the average requirement within the population, as estimated from individual intake data in relation to a criterion of nutritional adequacy in experimental studies.

These data are often obtained from a small number of individuals. Experimental studies are conducted for different intake levels. The criteria used often relate to nutrient balance[1], metabolic renewal, change in the state of reserves, or markers of functions associated with the nutrient in depletion-repletion studies. In certain physiological situations (growth, pregnancy), the requirement can be calculated by the factor method[2] on the basis of the criteria previously described and taking into account additional components related to these situations.

*Population Reference Intake (PRI)*

The PRI is the intake that theoretically meets the requirement of almost the entire population under consideration (97.5% in most cases), as estimated from experimental data.

The PRI is calculated from an estimate of the parameters of distribution of the requirement. Most often, the requirement in the population is assumed to follow a normal distribution. The PRI is estimated from the AR, to which are added two standard deviations, in order to determine the intake that meets the requirements of 97.5% of the population. As the standard deviation is most often estimated at 15% of the AR, the PRI therefore equates to 1.3 times the AR.

[1] The nutrient balance method is based on measuring losses at different nutrient intake levels. The criterion for establishing the requirement is the minimum intake that equalises the balance.
[2] The factor method assesses separately the body's various nutrient loss items that are factors in the net requirement, and takes into account the average absorption rate of the nutrient in the food. Depending on the situation, the net maintenance, growth, gestation or breastfeeding requirements can therefore be estimated.

There is a general consensus on this definition. It corresponds to that of the French term *apport nutritionnel conseillé* (ANC), which is no longer used today and which was also used by extension for different types of dietary reference values. In the interests of precision, the term ANC has been abandoned in favour of three types of dietary reference values: the PRI, the adequate intake (AI) and the reference intake range (RI).

*Adequate Intake (AI)*

The AI is defined as the average intake of a population or sub-group whose nutritional status is assumed to be adequate.

The AI is the dietary reference value selected when:

- the AR – and therefore the PRI – cannot be estimated due to insufficient data; in this case the AI corresponds to EFSA's definition of "adequate intake" (EFSA 2010b);
- the value of the PRI can be estimated but is not considered adequate in view of long-term observations of the population establishing that this PRI cannot meet health criteria that would be more appropriate than those used to estimate the AR. In this case – unlike EFSA's AI – the French AI is not solely intended as a substitute for the PRI in cases where there are insufficient data to calculate it. This extension is also due to the fact that there are more and more data available on the relationships between intake and modulation of disease risk in the long term.

The data used to estimate nutritional status are often obtained by observational studies but sometimes come from experimental studies. The criteria may often be metabolic (e.g. the normal or desirable concentration of nutrients or indicator metabolites), sometimes clinical (e.g. growth rate) or more rarely physiological, and may directly or indirectly take into account the risk of disease in the long term.

*Reference Intake range (RI)*

The RI is defined as a range of intakes considered adequate for maintaining the population in good health.

*Tolerable Upper Intake Level (UL)*

The UL is defined as the chronic maximum daily intake of a vitamin or a mineral considered unlikely to present a risk of adverse health effects for the entire population. Here, the CES members defined the UL as a value derived either from toxicity studies, such as the tolerable upper intake level (UL) defined by EFSA or the Health and Medicine Division (HMD), or from epidemiological data on prevention of the risk of chronic non-communicable diseases, such as the chronic disease reduction risk (CDRR) proposed by the HMD (2019).

**Table 1. Terminology of dietary reference values according to the different countries**

| | **Dietary reference values** | | | | | |
|---|---|---|---|---|---|---|
| **France (ANSES, 2016)** | ***Référence nutritionnelle pour la population* (RNP) – Population reference intake (PRI)** | ***Besoin nutritionnel moyen* (BNM) – Average requirement (AR)** | **-** | ***Apport satisfaisant* (AS) – Adequate intake (AI)** | ***Intervalle de référence* (IR) – Reference intake range (RI)** | ***Limite supérieure de sécurité* (LSS) – Upper intake level (UL)** |
| France (2001) | *Apport nutritionnel conseillé* (ANC) | *Besoin nutritionnel moyen* (BNM) – Average requirement (AR) | - | *Apport nutritionnel conseillé* (ANC) | *Apport nutritionnel conseillé* (ANC) | *Limite de sécurité* – Upper Intake Level |
| Europe (EFSA 2010a) | Population Reference Intake (PRI) | Average Requirement (AR) | Lower Threshold Intake (LTI) | Adequate Intake (AI) | Reference Intake Range (RI) | Tolerable Upper Intake Level (UL) |
| United States (IOM 2000) | Recommended Dietary Allowance (RDA) | Estimated Average Requirement (EAR) | - | Adequate Intake (AI) | Acceptable Macronutrient Distribution Ranges (AMDR) | Tolerable Upper Intake Level (UL) |
| D-A-CH region | Recommended intake | Average requirement | | Estimated intake | | Tolerable maximum total intake |
| Nordic countries (NCM 2004) | Recommended Intakes (RI) | Average Requirement (AR) | Lower Limit of Intake (LI) | - | - | Upper Intake Level (UL) |
| WHO (WHO/FAO 2003) | Recommended Nutrient Intake (RNI) | Estimated Average Requirement (EAR) | - | Recommended Safe Intake | - | Upper Tolerable Nutrient Intake Level (UL) |
| Australia / New Zealand (NHMRC 2006) | Recommended Dietary Intake (RDI) | Estimated Average Requirement (EAR) | - | Adequate Intake (AI) | Acceptable Macronutrient Distribution Ranges (AMDR) | Upper Intake Level (UL) |

Since the same term, ANC, was used in AFSSA's 2001 report to refer to values obtained by different methods, in this report the choice was made to adopt the term consistent with the method (for example, an ANC established as a PRI will be referred to as a PRI).

#### 2.2.2. Approach

In order to maintain methodological continuity with our earlier work on adult men and women, a method similar to the one used in 2016 was adopted by the CES on "Human Nutrition" to set the new dietary reference values for infants, children, adolescents, pregnant women, lactating women and the elderly (ANSES 2016).

It was decided to systematically compare, for each specific population, the dietary reference values for vitamins and minerals proposed in international reports and opinions published by the following organisations:

- SCF (Scientific Committee on Food, 1993);
- EFSA (European Food Safety Authority, from 2013 to 2019);
- AFSSA (French Food Safety Agency, 2001);
- WHO (World Health Organisation, 2004 and 2014);
- IOM (Institute of Medicine, now known as the Health and Medicine Division (HMD), series of opinions between 1997 and 2011);
- HMD (Health and Medicine Division of The National Academies of Sciences, Engineering and Medicine (NASEM), 2019);
- NHMRC-MoH (Australian National Health and Medical Research Council – New Zealand Ministry of Health, 2006 and 2017).
- NCM (Nordic Council of Ministers, Nordic Nutrition Recommendations, 2014);
- D-A-CH (Germany – Austria – Switzerland, from 2015 to 2019);
- DGE (*Deutsche Gesellschaft für Ernährung* – German Nutrition Society, 2012 to 2017).

These reports were chosen because they were issued by international (WHO, SCF, EFSA, NCM, D-A-CH, NHMRC) or national (IOM, HMD, DGE) agencies addressing (at least in part) populations following a Western-type diet.

However, ANSES decided to give priority consideration to the reference values proposed by EFSA (which has been conducting a full reassessment of dietary reference values since 2010), adapting them if necessary and, on the basis of explicit considerations, to the specific conditions of the French population.

- Cases where EFSA's approach was adopted:
  - **Proposal for an AR and a PRI**: the value, after analysis of the approach followed by EFSA and comparison with the French situation, was endorsed by the CES.
  - **Proposal for an AI**:
    - on the basis of data on markers or epidemiological studies: the value, after analysis of the approach followed by EFSA and comparison with the French situation, was selected;
    - on the basis of an average consumption observed at European level. In this case, the principle and the approach followed were taken into account by the CES but a value derived from the average consumption in France (excluding consumption of food supplements) for each population was selected and presented to the CES for validation;
- Cases where EFSA's approach was not adopted: here, the CES set out its comments and objections raised by the analysis of EFSA's opinions. The choice of dietary reference value

was made according to the various reports and opinions mentioned above, on a case-by-case basis. In the case of infants under the age of 6 months, EFSA did not establish dietary reference values (EFSA 2013b) but considered that the average intake from human milk was adequate for the majority of infants in this group. The CES considered that this average intake could be used to establish the AI for infants under the age of 6 months.

Regarding the dietary reference values relating to excess intakes, the tolerable upper intake levels set at European level by the SCF and then by EFSA were the only ones considered, except in the case of sodium.

Among the vitamins and minerals studied for this opinion, manganese was the only one for which both dietary reference values (EFSA 2013a) and an oral toxicity reference value[3] were available. EFSA is currently working to harmonise the upper intake levels set for nutrients that can be used as additives (the health-based guidance values)[4]. This work seems necessary in order to be able to define dietary reference values. In the meantime, manganese has not been addressed in this opinion.

#### 2.2.3. Methods

- Populations

In this report, the entire healthy population was considered, apart from populations with regular high-intensity physical activity.

The organisations setting dietary reference values do not all express the age groups in the same way, particularly for infants and the elderly. In the final expression of the dietary reference values selected by the members of the CES, the population was divided into the following age groups, expressed in completed months or years. For example, for children aged from 1 to 3 years, this age group is expressed by a range excluding the 4-year mark (i.e. up to the day before the fourth birthday) in the following form: [1-4[. Where necessary, gender distinctions have been made:

- Infants: under the age of 6 months ([0-6[) and aged 6 months and over ([6-12[);
- Children: from 1 to 3 years ([1-4[) and from 4 to 10 years ([4-11[);
- Adolescent boys and girls: from 11 to 14 years ([11-15[) and from 15 to 17 years ([15-18[);
- Men and women, including pregnant and lactating women: from 18 to 64 years ([18-65[);
- Elderly people aged 65 and over (≥ 65 years).

The age groups reported in the organisations' summary tables have been adapted in order to be expressed in this way.

For infants, the proposed dietary reference values are for full-term infants of normal weight.

For pregnant or lactating women, the dietary reference values may sometimes be adapted according to the trimester of pregnancy or the age of the mother (adult or adolescent woman).

[3] https://www.anses.fr/en/content/list-anses-toxicity-reference-values-trvs, consulted on 3 November 2020

[4] https://www.efsa.europa.eu/sites/default/files/consultation/consultation/Draft-statement-on-HBGV-for-PC.pdf, consulted on 3 November 2020

For the elderly, the data proved insufficient to give specific values, and therefore the adult value applies by default.

Depending on the specificity of the vitamin or mineral in question, the age group may be adjusted to better reflect the physiological reality, as with calcium for example. For this mineral, the adult group was split into two sub-groups: from 18 to 24 years ([18-25[) and over 24 years ([25-65[).

- Determination of the dietary reference value for infants under the age of 6 months

The CES on "Human Nutrition" chose to define the AI for most vitamins and minerals as the average nutrient intake of healthy, full-term, exclusively human milk-fed infants, following the example of the IOM (IOM 2001).

- Method of extrapolating ARs and PRIs

For most vitamins and minerals, the studies used to estimate ARs, and therefore PRIs, were conducted in adult subjects. Thus, the dietary reference values for children (apart from those based on observed intakes) were, depending on the agency, defined by extrapolation from the value defined for the adult population, or by interpolation between the value defined for the adult population and the one defined for infants under the age of 6 months.

- Extrapolation

This can be done by either isometric or allometric adjustment. Isometric adjustment assumes that the requirement for a given nutrient is proportional to the individual's weight, in contrast to allometric adjustment, which assumes that the requirement for that nutrient is proportional to the individual's metabolic weight, i.e. their weight raised to the power of 0.75 (EFSA 2010b; Kleiber 1947). Allometric adjustment is based on the fact that a body's basal metabolism is an exponential function of body weight[5],[6] (EFSA 2010b).

Thus, to define the AR of children based on that of adults:

- an isometric adjustment is made from the equation (EFSA 2010b):

$AR_{Child} = AR_{Adult} \times [\text{ Body weight}_{Child} / \text{Body weight}_{Adult} ]$.

- an allometric adjustment is made from the equation (EFSA 2010b):

$AR_{Child} = AR_{Adult} \times [\text{ Body weight}_{Child} / \text{Body weight}_{Adult} ]^{0.75}$

Moreover, when extrapolating from adult to child dietary reference values, corrections are sometimes made to account for the additional requirements specifically related to growth, i.e. the quantity of nutrients deposited in newly-formed tissues. One way to do this is to include an age-specific growth coefficient in the equations. For example, in the case of an allometric adjustment with a growth factor taken into account (as in the case of folates, by EFSA (EFSA 2014b)), the AR of children is determined according to the equation (EFSA 2010b):

$AR_{Child} = AR_{Adult} \times [\text{ Body weight}_{Child} / \text{Body weight}_{Adult} ]^{0.75} \times (1 + \text{growth coefficient})$.

[5] Kleiber (1947) showed that the logarithm of basal metabolism of ten mammalian species was linearly related to the logarithm of body weight with a slope of 0.75. Hence the term metabolic body weight for body weight to the power of 0.75. He also predicted that nutrient requirements should be proportional to metabolic body weight.
[6] Body weight refers here to body mass, to follow common usage

The growth coefficients may differ between agencies. Those defined by the FAO and WHO and used by the IOM (IOM 1998) are based on the increased protein requirement for growth (FAO/WHO/UNA 1985). EFSA has defined growth coefficients based on the proportionality between the protein requirement for growth and that for maintenance (EFSA 2012).

- Interpolation

This is done from the two population age groups on either side of the study group. This method assumes that the requirement for a nutrient increases linearly with age between these two populations (EFSA 2010b).

- Determination of AIs from estimated intakes of the population living in France

As mentioned above (2.2.2), in cases where an AI was based on an average consumption observed at European level, the CES members decided to set a value derived from the average consumption among people living in France. These means were derived from the INCA3 Individual and National Study on Food Consumption, including under-reporting individuals, as recommended by EFSA (EFSA 2014a). The INCA3 Study was conducted between February 2014 and September 2015 among 5855 individuals in metropolitan France, broken down into 2698 children aged from birth to 17 years, and 3157 adults aged from 18 to 79 years. It is representative of all individuals living in metropolitan France.

When statistically different intakes ($p < 0.05$) were observed between adolescent boys and girls aged from 15 to 17 years, different AIs were set.

## 3. ANALYSIS AND CONCLUSIONS OF THE CES

### 3.1. Summary tables of the dietary reference values

Applying the approach and methods described above, the CES on "Human Nutrition" defined French dietary reference values in order to meet the vitamin and mineral requirements of infants, children, adolescents, men and women, pregnant or lactating women and the elderly. The considerations that led to the dietary reference values are described, for each vitamin and mineral, in the report "Updating of the French dietary reference values for vitamins and minerals" (ANSES 2021).

For the risk associated with high nutrient intakes, the UL determined by EFSA has been provided for information.

The tables summarising the selected dietary reference values for vitamins (Table 2) and minerals (Table 3) for all the populations considered are presented below.

**Table 2. Selected dietary reference values for vitamins**

| | Vitamin A (µg RE/d) | | | Vitamin B1 (mg/MJ of energy consumed)[a] | | Vitamin B2 (mg/d) | | Vitamin B3 (mg NE/MJ of energy consumed)[b] | | Vitamin B3 (mg/d) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Population groups** | **AR** | **PRI** | **UL** | **AR** | **PRI** | **AR** | **PRI** | **AR** | **PRI** | **UL** Nicotinic acid | **UL** Nicotinamide |
| Infants under the age of 6 months | | 350* | | | 0.2 mg/d* | | 0.3* | | 2* | | |
| Infants aged 6 months and over | 190 | 250 | | 0.072 | 0.1 | | 0.4* | 1.3 | 1.6 | | |
| Children aged from 1 to 3 years | 205 | 250 | 800 | 0.072 | 0.1 | 0.5 | 0.6 | 1.3 | 1.6 | 2 | 150 |
| Children aged from 4 to 6 years | 245 | 300 | 1100 | 0.072 | 0.1 | 0.6 | 0.7 | 1.3 | 1.6 | 3 | 220 |
| Children aged from 7 to 10 years | 320 | 400 | 1500 | 0.072 | 0.1 | 0.8 | 1.0 | 1.3 | 1.6 | 4 | 350 |
| Adolescents aged from 11 to 14 years | 480 | 600 | 2000 | 0.072 | 0.1 | 1.1 | 1.4 | 1.3 | 1.6 | 6 | 500 |
| Adolescent boys aged from 15 to 17 years | 580 | 750 | 2600 | 0.072 | 0.1 | 1.4 | 1.6 | 1.3 | 1.6 | 8 | 700 |
| Adolescent girls aged from 15 to 17 years | 490 | 650 | 2600 | 0.072 | 0.1 | 1.4 | 1.6 | 1.3 | 1.6 | 8 | 700 |
| Men aged 18 years and over | 580 | 750 | 3000 | 0.072 | 0.1 | 1.3 | 1.6 | 1.3 | 1.6 | 10 | 900 |
| Women aged 18 years and over | 490 | 650 | 3000 | 0.072 | 0.1 | 1.3 | 1.6 | 1.3 | 1.6 | 10 | 900 |
| Pregnant women | 540 | 700 | 3000 | 0.072 | 0.1 | 1.5 | 1.9 | 1.3 | 1.6 | | |
| Lactating women | 1020 | 1300 | 3000 | 0.072 | 0.1 | 1.7 | 2.0 | 1.3 | 1.6 | | |

* Adequate intake
[a] The PRIs expressed in mg/d are presented in Annexes 1 to 4 for infants, children, adults, and pregnant and breastfeeding women respectively.
[b] The PRIs expressed in mg/d are presented in Annexes 5 to 8 for infants, children, adults, and pregnant and breastfeeding women respectively.
NE: niacin equivalent; RE: retinol equivalent

**Table 2. Selected dietary reference values for vitamins (cont.)**

| | Vitamin B5 (mg/d) | Vitamin B6 (mg/d) | | | Vitamin B8 (µg/d) | Vitamin B9 (µg/d DFE) | | Folic acid (µg/d) | Vitamin B12 (µg/d) | Vitamin C (mg/d) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Population groups** | **AI** | **AR** | **PRI** | **UL** | **AI** | **AR** | **PRI** | **UL** | **AI** | **AR** | **PRI** |
| Infants under the age of 6 months | 2 | | 0.1* | | 4 | | 65* | | 0.4 | | 20* |
| Infants aged 6 months and over | 3 | | 0.3* | | 6 | | 80* | | 1.5 | | 20* |
| Children aged from 1 to 3 years | 4 | 0.5 | 0.6 | 5 | 20 | 90 | 120 | 200 | 1.5 | 15 | 20 |
| Children aged from 4 to 6 years | 4.5 | 0.6 | 0.7 | 7 | 25 | 110 | 140 | 300 | 1.5 | 25 | 30 |
| Children aged from 7 to 10 years | 5 | 0.9 | 1.0 | 10 | 25 | 160 | 200 | 400 | 1.5 | 40 | 45 |
| Adolescents aged from 11 to 14 years | 6 | 1.2 | 1.4 | 15 | 35 | 210 | 270 | 600 | 2.5 | 60 | 70 |
| Adolescent boys aged from 15 to 17 years | 6 | 1.5 | 1.7 | 20 | 35 | 250 | 330 | 800 | 2.5 | 85 | 100 |
| Adolescent girls aged from 15 to 17 years | 5 | 1.3 | 1.6 | 20 | 35 | 250 | 330 | 800 | 2.5 | 85 | 100 |
| Men aged 18 years and over | 6 | 1.5 | 1.7 | 25 | 40 | 250 | 330 | 1000 | 4 | 90 | 110 |
| Women aged 18 years and over | 5 | 1.3 | 1.6 | 25 | 40 | 250 | 330 | 1000 | 4 | 90 | 110 |
| Pregnant women | 5 | 1.5 | 1.8 | 25 | 40 | | 600*[a] | 1000 | 4.5 | 100 | 120 |
| Lactating women | 7 | 1.4 | 1.7 | 25 | 45 | 380 | 500 | 1000 | 5 | 140 | 170 |

* Adequate intake
[a] Applies to women who could become pregnant and pregnant women. Value may be overestimated for the 2nd and 3rd trimesters
DFE: dietary folate equivalent

**Table 2. Selected dietary reference values for vitamins (cont.)**

| | Vitamin D (µg/d) | | Vitamin E (mg/d) | Vitamin K1 (µg/d) | Choline (mg/d) |
|---|---|---|---|---|---|
| **Population groups** | **AI** | **UL** | **AI** | **AI** | **AI** |
| Infants under the age of 6 months | 10 | 25 | 4 | 5 | 120 |
| Infants aged 6 months and over | 10 | 25 | 5 | 10 | 160 |
| Children aged from 1 to 3 years | 15 | 50 | 7 | 29 | 140 |
| Children aged from 4 to 6 years | 15 | 50 | 7 | 42 | 170 |
| Children aged from 7 to 10 years | 15 | 50 | 9 | 45 | 250 |
| Adolescents aged from 11 to 14 years | 15 | 100 | 10 | 45 | 340 |
| Adolescent boys aged from 15 to 17 years | 15 | 100 | 10 | 45 | 400 |
| Adolescent girls aged from 15 to 17 years | 15 | 100 | 8 | 45 | 400 |
| Men aged 18 years and over | 15 | 100 | 10 | 79 | 400 |
| Women aged 18 years and over | 15 | 100 | 9 | 79 | 400 |
| Pregnant women | 15 | 100 | 9 | 79 | 480 |
| Lactating women | 15 | 100 | 9 | 79 | 520 |

* Adequate intake

**Table 3. Selected dietary reference values for minerals**

| | Copper (mg/d) | | Iodine (µg/d) | | Magnesium (mg/d) | | Molybdenum (µg/d) | | Phosphorus (mg/d) |
|---|---|---|---|---|---|---|---|---|---|
| **Population groups** | **AI** | **UL** | **AI** | **UL** | **AI** | **UL** | **AI** | **UL** | **AI** |
| Infants under the age of 6 months | 0.3 | | 90 | | 25 | | 2 | | 100 |
| Infants aged 6 months and over | 0.5 | | 70 | | 80 | | 30 | | 160 |
| Children aged from 1 to 3 years | 0.8 | 1 | 90 | 200 | 180 | | 35 | 100 | 250 |
| Children aged from 4 to 6 years | 1.0 | 2 | 90 | 250 | 210 | 250 | 65 | 200 | 440 |
| Children aged from 7 to 10 years | 1.2 | 3 | 90 | 300 | 240 | 250 | 75 | 250 | 440 |
| Adolescents aged from 11 to 14 years | 1.3 | 4 | 120 | 450 | 265 | 250 | 80 | 400 | 640 |
| Adolescents aged from 15 to 17 years | 1.5 | 4 | 130 | 500 | 295 | 250 | 80 | 500 | 640 |
| Adolescent girls aged from 15 to 17 years | 1.1 | 4 | 130 | 500 | 225 | 250 | 80 | 500 | 640 |
| Men aged 18 years and over | 1.9 | 5 | 150 | 600 | 380 | 250 | 95 | 600 | 550 |
| Women aged 18 years and over | 1.5 | 5 | 150 | 600 | 300 | 250 | 95 | 600 | 550 |
| Pregnant women | 1.7 | | 200 | 600 | 300 | 250 | 95 | 600 | 550 |
| Lactating women | 1.7 | | 200 | 600 | 300 | 250 | 95 | 600 | 550 |

**Table 3. Selected dietary reference values for minerals (cont.)**

| | Potassium (mg/d) | Selenium (µg/d) | |
|---|---|---|---|
| **Population groups** | **AI** | **AI** | **UL** |
| Infants under the age of 6 months | 400 | 12.5 | |
| Infants aged 6 months and over | 750 | 15 | |
| Children aged from 1 to 3 years | 800 | 15 | 60 |
| Children aged from 4 to 6 years | 1100 | 20 | 90 |
| Children aged from 7 to 10 years | 1800 | 35 | 130 |
| Adolescents aged from 11 to 14 years | 2700 | 55 | 200 |
| Adolescent boys aged from 15 to 17 years | 3500 | 70 | 250 |
| Adolescent girls aged from 15 to 17 years | 3500 | 70 | 250 |
| Men aged 18 years and over | 3500 | 70 | 300 |
| Women aged 18 years and over | 3500 | 70 | 300 |
| Pregnant women | 3500 | 70 | 300 |
| Lactating women | 4000 | 85 | 300 |

**Table 3. Selected dietary reference values for minerals (cont.)**

| | Calcium (mg/d) | | | | Iron (mg/d) | |
|---|---|---|---|---|---|---|
| **Population groups** | **AR** | **PRI** | **UL** | **Population groups** | **AR** | **PRI** |
| Infants under the age of 6 months | | 200* | | Infants under the age of 6 months | | 0.3* |
| Infants aged 6 months and over | | 280* | | Infants aged 6 months and over | 8 | 11 |
| Children aged from 1 to 3 years | 390 | 450 | | Children aged from 1 to 2 years | 4 | 5 |
| Children aged from 4 to 6 years | 680 | 800 | | Children aged from 3 to 6 years | 3 | 4 |
| Children aged from 7 to 10 years | 680 | 800 | | Children aged from 7 to 11 years | 5 | 6 |
| Adolescents aged from 11 to 14 years | 960 | 1150 | | Adolescents aged from 12 to 17 years | 8 | 11 |
| Adolescent boys aged from 15 to 17 years | 960 | 1150 | | Adolescent girls aged from 12 to 17 years who have not started menstruating or have light to moderate menstrual bleeding | 7 | 11 |
| Adolescent girls aged from 15 to 17 years | 960 | 1150 | | Adolescent girls aged 12 to 17 with heavy menstrual bleeding | 7 | 13 |
| Men aged from 18 to 24 years | 860 | 1000 | 2500 | Men over 18 years of age | 6 | 11 |
| Women aged from 18 to 24 years | 860 | 1000 | 2500 | Women over 18 years of age with light to moderate menstrual bleeding | 7 | 11 |
| Men aged 25 years and over | 750 | 950 | 2500 | Women over 18 years of age with heavy menstrual bleeding | 7 | 16 |
| Women aged 25 years and over | 750 | 950 | 2500 | Pregnant women | 7 | 16 |
| Pregnant women | 750 | 950 | 2500 | Lactating women | 7 | 16 |
| Lactating women | 750 | 950 | 2500 | Postmenopausal women | 6 | 11 |

**Table 3. Selected dietary reference values for minerals (cont.)**

| | Fluoride (mg/d) | | |
|---|---|---|---|
| **Population groups** | **AI** | **Population groups** | **UL** |
| Infants under the age of 6 months | 0.08 | Infants under the age of 6 months | |
| Infants aged 6 months and over | 0.4 | Infants aged 6 months and over | |
| Children aged from 1 to 3 years | 0.6 | Children aged from 1 to 3 years | 1.5 |
| Boys aged from 4 to 6 years | 1.0 | Boys aged from 4 to 8 years | 2.5 |
| Girls aged from 4 to 6 years | 0.9 | Girls aged from 4 to 8 years | 2.5 |
| Boys aged from 7 to 10 years | 1.5 | Boys aged from 9 to 14 years | 5 |
| Girls aged from 7 to 10 years | 1.4 | Girls aged from 9 to 14 years | 5 |
| Adolescent boys aged from 11 to 14 years | 2.2 | Adolescent boys aged from 15 to 17 years | 7 |
| Adolescent girls aged from 11 to 14 years | 2.3 | Adolescent girls aged from 15 to 17 years | 7 |
| Adolescent boys aged from 15 to 17 years | 3.2 | Men aged 18 years and over | 7 |
| Adolescent girls aged from 15 to 17 years | 2.8 | Women aged 18 years and over | 7 |
| Men aged 18 years and over | 3.4 | Pregnant or lactating women | 7 |
| Women aged 18 years and over | 2.9 | | |
| Pregnant or lactating women | 2.9 | | |

**Table 3. Selected dietary reference values for minerals (cont.)**

| | Chloride (mg/d) | Sodium (mg/d) | | | | Zinc (mg/d) | | |
|---|---|---|---|---|---|---|---|---|
| **Population groups** | **AI** | **AI** | **UL** | **Population groups** | **Phytate intake levels (mg/d)** | **AR** | **PRI** | **UL** |
| Infants under the age of 6 months | 170 | 110 | | Infants under the age of 6 months | | | 2* | |
| Infants aged 6 months and over | 570 | 370 | | Infants aged 6 months and over | | | 2.9* | |
| Children aged from 1 to 3 years | 1200 | 800 | 1200 | Children aged from 1 to 3 years | | 3.6 | 4.3 | 7 |
| Children aged from 4 to 8 years | 1500 | 1000 | 1500 | Children aged from 4 to 6 years | | 4.6 | 5.5 | 10 |
| Children aged from 9 to 13 years | 1900 | 1200 | 1800 | Children aged from 7 to 10 years | | 6.2 | 7.4 | 13 |
| Adolescents aged from 14 to 17 years | 2300 | 1500 | 2300 | Adolescents aged from 11 to 14 years | | 8.8 | 10.7 | 18 |
| Men aged 18 years and over | 2300 | 1500 | 2300 | Adolescent boys aged from 15 to 17 years | | 11.8 | 14.2 | 22 |
| Women aged 18 years and over | 2300 | 1500 | 2300 | Adolescent girls aged from 15 to 17 years | | 9.9 | 11.9 | 22 |
| Pregnant women | 2300 | 1500 | 2300 | Men aged 18 years and over | 300 | 7.5 | 9.4 | 25 |
| Lactating women | 2300 | 1500 | 2300 | | 600 | 9.3 | 11.7 | 25 |
| | | | | | 900 | 11.0 | 14.0 | 25 |
| | | | | Women aged 18 years and over | 300 | 6.2 | 7.5 | 25 |
| | | | | | 600 | 7.6 | 9.3 | 25 |
| | | | | | 900 | 8.9 | 11 | 25 |
| | | | | Pregnant women | 300 | | 9.1 | 25 |
| | | | | | 600 | | 10.9 | 25 |
| | | | | | 900 | | 12.6 | 25 |
| | | | | Lactating women | 300 | | 10.4 | 25 |
| | | | | | 600 | | 12.2 | 25 |
| | | | | | 900 | | 13.9 | 25 |

* Adequate intake

### 3.2. Limitations and uncertainties

The dietary reference values are aimed at a healthy population with a low to moderate level of physical activity. The scope of this opinion has therefore been restricted to this population.

Uncertainties are mainly due to the scientific resources available, i.e. related to the studies' representativeness and methods: small numbers of participants, short duration, old, involving subjects of the same sex, etc.

When the data were deemed sufficient, an AR and a PRI were determined. If not, an AI was set. Depending on the data available, the AI was based either on intakes observed in the population or primarily on observational studies. Some limitations are therefore inherent to the type of dietary reference value. The AR and PRI are determined while assuming that the requirement follows a normal distribution. However, the studies available to date rarely confirm or refute this hypothesis. One known exception is the iron requirement of menstruating women, which has a skewed distribution. Another uncertainty concerns the variability of the requirement, which is often arbitrarily set at around 15% of the coefficient of variation, whereas it has not been possible to deduce a precise estimate of this variability from the available studies.

Furthermore, although all the data led the CES to set a dietary reference value for each age group and each physiological situation, it is now accepted that requirements do not evolve in stages but progressively along a continuum.

In addition, for some age groups (mainly children), dietary reference values can be obtained by extrapolation when specific data are missing. The calculation assumptions and correction factors used therefore add uncertainty.

The dietary reference values should also be able to take into consideration a nutrient's bioavailability, which varies according to several different factors:

- the food matrix (e.g. provitamin A carotenoids are more bioavailable in fruit than in green vegetables (EFSA 2015a));
- the composition of the food bolus (e.g. in the case of a vegan diet), in particular due to competition or synergy between nutrients (as in the case for zinc, whose bioavailability is reduced by phytates (EFSA 2014c));
- the form of intake (e.g. folic acid is more bioavailable than folates (EFSA 2014b));
- the individual's physiological situation (pregnancy, nutritional status), or even a combination of these situations (as is the case for calcium (EFSA 2015b)).

However, because of shortcomings in the data currently available, it is not possible to include this level of precision in the establishment of dietary reference values, which have been set on the basis of studies carried out most often in a Western-type dietary context.

### 3.3. Conclusion of the CES

ANSES reassessed all the dietary reference values for vitamins and minerals for specific populations (infants, children, adolescents, pregnant women, lactating women and the elderly). It also supplemented the work to update dietary reference values for vitamins and minerals for the adult population, taking into account new data available since 2016 where appropriate.

These dietary reference values have been established, on the basis of the data available to date, for a healthy population with a low to moderate level of physical activity and consuming a Western-type diet. They have been classified into four types, as defined in 2016: AR, PRI, AI and UL. The AR, PRI and AI can be used to qualify the extent to which intakes meet requirements.

The AR is a dietary reference value for the individual requirement because it is estimated from individual intake data in relation to a criterion of nutritional adequacy. Thus, as a centring value of the requirement distribution, it can be used in a simplified approach to statistically assess the prevalence of inadequate intake in a population (i.e. by estimating that the number of individuals whose requirements are not met is equal to the number whose intakes are below the AR). Among the dietary reference values, only the AR is suitable for this approach. Nevertheless, if there is no AR, the observed average intakes of a population can be situated with respect to the AI. Thus, according to a qualitative approach, if the average intakes are above the AI, it can be assumed that the intake is adequate; if the average intakes are below the AI, no conclusions on inadequate intake can be drawn.

However, in order to establish a single reference consumption target for the population, it is not possible to use the AR, which corresponds to the value that meets the requirements of only half the population. Therefore, the PRI, or failing this the AI when not based on intake data alone, should be used as the nutritional target. The PRI covers the requirements of virtually all the population, and statistically, centring the population's consumption at the level of the PRI corresponds approximately to a situation of low risk of prevalence of inadequate intake.

At an individual level, the nutritional requirement is not known. With regard to establishing individual food rations or optimisations, targeting the PRI provides a 97.5% guarantee that the requirements are met for that individual, but for most individuals leads to intakes far higher than their actual requirements. Moreover, failing to achieve the AR or even more so the PRI does not presuppose a nutritional deficiency (estimated by a biomarker) and even less so a clinical deficiency (reflected by a clinical manifestation). Using dietary reference values for the purpose of interpreting nutritional status in clinical or biological terms is therefore not appropriate.

Lastly, with regard to the risk of excess intake, a fourth type of reference has been defined: the UL, based on toxicological considerations, or more rarely, the risk of chronic non-communicable diseases. For intakes above the UL, the risk of adverse effects cannot be ruled out.

In terms of outlook, the CES believes that this work highlights the need for further research on:

- the interactions between nutrients, or between nutrients and other food constituents, as has been suggested for zinc, in order to obtain data on the bioavailability of nutrients

according to diet, with a view to adapting the dietary reference values to different diet types;

- children and adolescents, for whom values are often obtained by extrapolation;
- the distribution of nutrient requirements, with priority given to those for which the PRI is difficult to achieve, in order to refine the method of setting these references, as has been done with the definition of the PRI of iron for women;
- storage, mobilisation of reserves and bioavailability according to nutritional status. Indeed, there is a critical lack of information on this type of data, for example for vitamin A, iron and vitamin D.

## 4. AGENCY CONCLUSIONS AND RECOMMENDATIONS

ANSES adopts the conclusions and recommendations of the CES on "Human Nutrition".

This work supplemented and updated the work on defining dietary reference values previously undertaken as part of the formal request on the updating of food-based dietary guidelines (Request 2012-SA-0103), published in 2016. By carefully examining different approaches proposed throughout the world to set dietary reference values, the Agency updated its dietary reference values for vitamins and minerals, in particular for the entire population living in France (infants, children, adolescents, adult women and men, pregnant or lactating women and the elderly). The values presented in this opinion for vitamins and minerals therefore constitute new references for the French population that are invaluable for assessing nutrition-related health risks – including estimating the prevalence of inadequate intakes – in support of public decision-making. Even if it appears necessary to update the prevalence of inadequate intakes due to changes in consumption and dietary reference values, meeting the requirements for certain nutrients identified in 2015 (Request 2012-SA-0142) such as iron, vitamin B9, iodine and vitamin D, remains a public health issue. In fact, more than 70% of French adults have a vitamin D deficiency, and 6.5% have a clinical deficiency, as measured by the 25 hydroxy-vitamin D test (Équipe de surveillance et d'épidémiologie nutritionnelle (Esen) 2019). Given the wide variability in vitamin D requirement between individuals (particularly due to age and skin colour), time spent outdoors and the latitude where the individual lives, an individualised approach to meeting the requirement would be better. Various non-exclusive management measures could be considered:

- personalised supplementation through the healthcare system directed at the adult population;
- specific recommendations on exposure to the sun, compatible with skin cancer prevention;
- fortification of foodstuffs in vitamin D overseen by the public authorities, assuming a detailed analysis of the health issues and the expected benefits and risks.

For vitamin B9, the main health issue is to prevent neural tube closure defects. Considering this issue only during the preconception period does not seem to be sufficiently protective with regard to unplanned pregnancies. Particular emphasis should therefore be placed on meeting vitamin B9 requirements in the population of women likely to become pregnant.

In view of the body of available data, the Agency believes that research is needed to clarify the values of certain dietary references for which the distributions of the requirement are not known or are insufficiently known, and to better characterise the bioavailability of certain nutrients according to the dietary context in order to adapt the references to different types of diets. This dietary context may differ according to any disparities introduced by cultural and regional practices in metropolitan France and even more so in the overseas territories.

Moreover, this work did not address the issue of variation in nutritional requirements in relation to energy expenditure. With regard to specific populations, some initial work on high-energy expenditure populations was carried out in France in 2001. The updating of the dietary reference values for these populations should therefore be considered as an extension of this current work in order to complete the updating of the dietary reference values for the French population.

Lastly, as the absence of intake levels does not mean the absence of risk for intakes above a certain as yet unknown threshold, research is needed to compensate for the lack of identified tolerable upper intake levels for some nutrients.

Dr Roger GENET

## KEYWORDS

Besoin, référence nutritionnelle pour la population, besoin nutritionnel moyen, apport satisfaisant, limite supérieure de sécurité, nutriments, vitamines, minéraux, nourrissons, enfants, adolescents, femmes, hommes, femmes enceintes, femmes allaitantes, personnes âgées

Requirement, population reference intake, average requirement, adequate intake, tolerable upper intake level, nutrients, vitamin, mineral, infants, children, adolescents, women, men, pregnant women, breastfeeding women, elderly

## REFERENCES

Afssa. 2001. *Apports nutritionnels conseillés pour la population française.* (Paris).

ANSES. 2021. *Rapport de l'ANSES relatif à l'actualisation des références nutritionnelles françaises en vitamines et minéraux (Saisine n°2018-SA-0238).* (Maisons-Alfort : ANSES).

EFSA. 2010a. "Panel on Dietetic Products, Nutrition and Allergies (NDA) ; Scientific Opinion on establishing Food-Based Dietary Guidelines. ." *EFSA Journal* 8 (3): 42. https://doi.org/doi:10.2903/j.efsa.2010.1460.

EFSA. 2010b. "Panel on Dietetic Products, Nutrition, and Allergies (NDA); Scientific Opinion on principles for deriving and applying Dietary Reference Value." *EFSA Journal* 8 (3): 1458.

EFSA. 2012. "Panel on Dietetic Products, Nutrition, and Allergies (NDA); Scientific Opinion on Dietary Reference Values for protein." *EFSA Journal* 10 (2): 2557.

EFSA. 2013a. "Panel on Dietetic Products, Nutrition and Allergies (NDA); Scientific Opinion on Dietary Reference Values for manganese." *EFSA Journal* 11 (11).

EFSA. 2013b. "Panel on Dietetic Products, Nutrition and Allergies (NDA); Scientific Opinion on nutrient requirements and dietary intakes of infants and young children in the European Union." *EFSA Journal* 11 (10): 103.

EFSA. 2013c. "Panel on Dietetic Products, Nutrition, and Allergies (NDA); Scientific Opinion on Dietary Reference Values for energy." *EFSA journal* 11 (1): 112.

EFSA. 2014a. "Guidance on the EU Menu methodology." *EFSA Journal* 12 (12): 77.

EFSA. 2014b. "Panel on Dietetic Products, Nutrition, and Allergies (NDA); Scientific Opinion on Dietary Reference Values for folate." *EFSA journal* 12 (11): 59.

EFSA. 2014c. "Panel on Dietetic Products, Nutrition, and Allergies (NDA); Scientific Opinion on Dietary Reference Values for zinc." *EFSA journal* 12 (1): 76.

EFSA. 2015a. "Panel on Dietetic Products, Nutrition and Allergies (NDA) ; Scientific Opinion on dietary Reference Values for vitamin A." *EFSA Journal*.

EFSA. 2015b. "Panel on Dietetic Products, Nutrition, and Allergies (NDA); Scientific Opinion on the Dietary Reference Values for Calcium." *EFSA Journal* 13: 4101.

Équipe de surveillance et d'épidémiologie nutritionnelle (Esen). 2019. *Étude de santé sur l'environnement, la biosurveillance, l'activité physique et la nutrition (Esteban), 2014-2016. Volet Nutrition. Chapitre Dosages biologiques : vitamines et minéraux. .* (Saint-Maurice : Santé publique France).

FAO/WHO/UNA. 1985. *Energy and Protein Requirements Report of a joint FAO/WHO/UNA Expert Consultation.* World Health Organization (Geneva).

IOM. 1998. *Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Pantothenic Acid, Biotin, and Choline.* (Washington (DC)). https://www.ncbi.nlm.nih.gov/pubmed/23193625.

IOM. 2000. *Dietary Reference Intakes: Applications in Dietary Assessment.* (Washington (DC)).

IOM. 2001. *Dietary reference intakes for vitamin A, vitamin K, arsenic, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium and zinc.* (Washington (DC)).

Kleiber, M. 1947. "Body size and metabolic rate." *Physiol Rev* 27 (4): 511-41. https://doi.org/10.1152/physrev.1947.27.4.511.

NCM. 2004. *Nordic Nutrition Recommendations. Integrating nutrition and physical activity* Nordic Council of Ministers (Copenhagen, Denmark).

NHMRC. 2006. *Nutrient Reference Values for Australia and New Zealand Including Recommended Dietary Intakes.* National Health and Medical Research Council, Australian Government Department of Health and Ageing.

WHO/FAO. 2003. Expert Report: Diet, nutrition and prevention of chronic diseases. Report of a Joint WHO/FAO Expert Consultation. : WHO Technical Report.

## ANNEX 1: PRIS DEFINED FOR VITAMIN B1, EXPRESSED IN MG/D FOR INFANTS AGED 6 MONTHS AND OVER

| Age | PRI[a] | |
|---|---|---|
| | Boys | Girls |
| 7 months | 0.27 | 0.24 |
| 8 months | 0.28 | 0.25 |
| 9 months | 0.29 | 0.26 |
| 10 months | 0.30 | 0.27 |
| 11 months | 0.31 | 0.28 |

[a] The ARs for vitamin B1 expressed in mg/d were calculated from the AR of 0.072 mg/MJ, considering the ARs for energy corresponding to infants aged 6 months and over, defined by EFSA (EFSA 2013c). The PRIs were calculated from these ARs by applying a coefficient of variation of 20%.

## ANNEX 2: PRIS DEFINED FOR VITAMIN B1, EXPRESSED IN MG/D FOR CHILDREN AND ADOLESCENTS, ACCORDING TO PHYSICAL ACTIVITY LEVELS (PALS)

| Age | PRI for a PAL of 1.4[a] | | PRI for a PAL of 1.6[a] | | PRI for a PAL of 1.8[a] | | PRI for a PAL of 2.0[a] | |
|---|---|---|---|---|---|---|---|---|
| | Boys | Girls | Boys | Girls | Boys | Girls | Boys | Girls |
| 1 year | 0.33 | 0.30 | | | | | | |
| 2 years | 0.43 | 0.40 | | | | | | |
| 3 years | 0.49 | 0.46 | | | | | | |
| 4 years | 0.53 | 0.49 | 0.60 | 0.56 | 0.69 | 0.64 | | |
| 5 years | 0.56 | 0.52 | 0.65 | 0.59 | 0.73 | 0.68 | | |
| 6 years | 0.59 | 0.55 | 0.68 | 0.64 | 0.77 | 0.72 | | |
| 7 years | 0.64 | 0.58 | 0.73 | 0.68 | 0.82 | 0.76 | | |
| 8 years | 0.38 | 0.62 | 0.77 | 0.72 | 0.87 | 0.80 | | |
| 9 years | 0.71 | 0.67 | 0.82 | 0.76 | 0.92 | 0.85 | | |
| 10 years | | | 0.82 | 0.77 | 0.92 | 0.87 | 1.02 | 0.96 |
| 11 years | | | 0.86 | 0.81 | 0.97 | 0.91 | 1.08 | 1.01 |
| 12 years | | | 0.92 | 0.85 | 1.03 | 0.95 | 1.15 | 1.06 |
| 13 years | | | 0.99 | 0.89 | 1.11 | 1.00 | 1.23 | 1.11 |
| 14 years | | | 1.06 | 0.92 | 1.19 | 1.03 | 1.32 | 1.15 |
| 15 years | | | 1.14 | 0.94 | 1.28 | 1.06 | 1.42 | 1.18 |
| 16 years | | | 1.20 | 0.96 | 1.35 | 1.07 | 1.50 | 1.19 |
| 17 years | | | 1.24 | 0.96 | 1.39 | 1.08 | 1.55 | 1.20 |

[a] The ARs for vitamin B1 expressed in mg/d were calculated from the AR of 0.072 mg/MJ, considering the ARs for energy corresponding to children and adolescents, defined by EFSA (EFSA 2013c). The PRIs were calculated from these ARs by applying a coefficient of variation of 20%.

## ANNEX 3: PRIS DEFINED FOR VITAMIN B1, EXPRESSED IN MG/D FOR ADULT MEN AND WOMEN, ACCORDING TO PHYSICAL ACTIVITY LEVELS (PALS)

| Age | PRI for a PAL of 1.4[a] | | PRI for a PAL of 1.6[a] | | PRI for a PAL of 1.8[a] | | PRI for a PAL of 2.0[a] | |
|---|---|---|---|---|---|---|---|---|
| | Men | Women | Men | Women | Men | Women | Men | Women |
| 18-29 years | 0.99 | 0.80 | 1.13 | 0.91 | 1.27 | 1.02 | 1.41 | 1.13 |
| 30-39 years | 0.96 | 0.77 | 1.09 | 0.88 | 1.23 | 0.99 | 1.36 | 1.09 |
| 40-49 years | 0.94 | 0.76 | 1.08 | 0.87 | 1.21 | 0.98 | 1.35 | 1.08 |
| 50-59 years | 0.93 | 0.76 | 1.06 | 0.86 | 1.20 | 0.97 | 1.33 | 1.08 |
| 60-69 years | 0.85 | 0.69 | 0.97 | 0.79 | 1.10 | 0.89 | 1.22 | 0.98 |
| 70-79 years | 0.84 | 0.69 | 0.96 | 0.78 | 1.08 | 0.88 | 1.20 | 0.97 |

[a] The ARs for vitamin B1 expressed in mg/d were calculated from the AR of 0.072 mg/MJ, considering the ARs for energy corresponding to adult men and women, defined by EFSA (EFSA 2013c). The PRIs were calculated from these ARs by applying a coefficient of variation of 20%.

## ANNEX 4: PRIS DEFINED FOR VITAMIN B1, EXPRESSED IN MG/D FOR PREGNANT OR BREASTFEEDING WOMEN

| | PRI |
|---|---|
| **Pregnant women** | |
| 1st trimester | +0.03 |
| 2nd trimester | +0.11 |
| 3rd trimester | +0.21 |
| **Breastfeeding women** | |
| 0-6 months postpartum | +0.21 |

[a] The ARs for vitamin B1 expressed in mg/d were calculated from the AR of 0.072 mg/MJ, considering the ARs for energy corresponding to pregnant and breastfeeding women, defined by EFSA (EFSA 2013c). The PRIs were calculated from these ARs by applying a coefficient of variation of 20%.

## ANNEX 5: PRIS DEFINED FOR VITAMIN B3, EXPRESSED IN MG NE/D FOR INFANTS AGED 6 MONTHS AND OVER

| Age | PRI[a] | |
|---|---|---|
| | Boys | Girls |
| 7 months | 4.2 | 3.7 |
| 8 months | 4.4 | 3.9 |
| 9 months | 4.5 | 4.0 |
| 10 months | 4.7 | 4.2 |
| 11 months | 4.8 | 4.4 |

[a] The ARs for vitamin B3 expressed in mg NE/d were calculated from the AR of 1.3 mg NE/MJ, considering the ARs for energy corresponding to infants aged 6 months and over, defined by EFSA (EFSA 2013c). The PRIs were calculated from these ARs by applying a coefficient of variation of 10%.

NE: niacin equivalent

## ANNEX 6: PRIS DEFINED FOR VITAMIN B3, EXPRESSED IN MG NE/D FOR CHILDREN AND ADOLESCENTS, ACCORDING TO PHYSICAL ACTIVITY LEVELS (PALS)

| Age | PRI for a PAL of 1.4[a] | | PRI for a PAL of 1.6[a] | | PRI for a PAL of 1.8[a] | | PRI for a PAL of 2.0[a] | |
|---|---|---|---|---|---|---|---|---|
| | Boys | Girls | Boys | Girls | Boys | Girls | Boys | Girls |
| 1 year | 5.1 | 4.6 | | | | | | |
| 2 years | 6.7 | 6.2 | | | | | | |
| 3 years | 7.7 | 7.2 | | | | | | |
| 4 years | 8.2 | 7.6 | 9.4 | 8.7 | 10.5 | 9.8 | | |
| 5 years | 8.7 | 8.1 | 9.9 | 9.2 | 11.2 | 10.4 | | |
| 6 years | 9.2 | 8.6 | 10.5 | 9.8 | 11.8 | 11.0 | | |
| 7 years | 9.8 | 9.1 | 11.2 | 10.4 | 12.6 | 11.7 | | |
| 8 years | 10.4 | 9.6 | 11.9 | 11.0 | 13.4 | 12.4 | | |
| 9 years | 11.0 | 10.2 | 12.6 | 11.7 | 14.1 | 13.1 | | |
| 10 years | | | 12.6 | 11.9 | 14.2 | 13.4 | 15.8 | 13.4 |
| 11 years | | | 13.3 | 12.5 | 15.0 | 14.0 | 16.7 | 14.0 |
| 12 years | | | 14.2 | 13.1 | 16.0 | 14.7 | 17.7 | 14.7 |
| 13 years | | | 15.2 | 13.7 | 17.1 | 15.4 | 19.0 | 15.4 |
| 14 years | | | 16.4 | 14.2 | 18.5 | 16.0 | 20.5 | 16.0 |
| 15 years | | | 17.6 | 14.5 | 19.8 | 16.4 | 22.0 | 16.4 |
| 16 years | | | 18.6 | 14.7 | 20.9 | 16.6 | 23.2 | 16.6 |
| 17 years | | | 19.2 | 14.9 | 21.6 | 16.7 | 24.0 | 16.7 |

[a] The ARs for vitamin B3 expressed in mg NE/d were calculated from the AR of 1.3 mg NE/MJ, considering the ARs for energy corresponding to children and adolescents, defined by EFSA (EFSA 2013c). The PRIs were calculated from these ARs by applying a coefficient of variation of 10%.

NE: niacin equivalent

## ANNEX 7: PRIS DEFINED FOR VITAMIN B3, EXPRESSED IN MG NE/D FOR ADULT MEN AND WOMEN, ACCORDING TO PHYSICAL ACTIVITY LEVELS (PAL)

| Age | PRI for a PAL of 1.4[a] | | PRI for a PAL of 1.6[a] | | PRI for a PAL of 1.8[a] | | PRI for a PAL of 2.0[a] | |
|---|---|---|---|---|---|---|---|---|
| | Men | Women | Men | Women | Men | Women | Men | Women |
| 18-29 years | 15.3 | 12.3 | 17.4 | 14.0 | 19.6 | 15.8 | 21.8 | 17.5 |
| 30-39 years | 14.8 | 11.8 | 16.9 | 13.5 | 19.0 | 15.2 | 21.1 | 16.9 |
| 40-49 years | 14.6 | 11.7 | 16.7 | 13.4 | 18.7 | 15.1 | 20.8 | 16.8 |
| 50-59 years | 14.4 | 11.6 | 16.4 | 13.3 | 18.5 | 15.0 | 20.6 | 16.6 |
| 60-69 years | 13.2 | 10.6 | 15.0 | 12.1 | 16.9 | 13.7 | 18.8 | 15.2 |
| 70-79 years | 12.9 | 10.5 | 14.8 | 12.0 | 16.6 | 13.5 | 18.5 | 15.0 |

[a] The ARs for vitamin B3 expressed in mg NE/d were calculated from the AR of 1.3 mg NE/MJ, considering the ARs for energy corresponding to adult men and women, defined by EFSA (EFSA 2013c). The PRIs were calculated from these ARs by applying a coefficient of variation of 10%.

NE: niacin equivalent

## ANNEX 8: PRIS DEFINED FOR VITAMIN B3, EXPRESSED IN MG NE/D FOR PREGNANT OR BREASTFEEDING WOMEN

| | PRI |
|---|---|
| Pregnant women: | |
| 1st trimester | +0.5 |
| 2nd trimester | +1.7 |
| 3rd trimester | +3.3 |
| Breastfeeding women: | |
| 0-6 months postpartum | +3.3 |

[a] The ARs for vitamin B3 expressed in mg NE/d were calculated from the AR of 1.3 mg NE/MJ, considering the ARs for energy corresponding to pregnant and breastfeeding women, defined by EFSA (EFSA 2013c). The PRIs were calculated from these ARs by applying a coefficient of variation of 10%.

NE: niacin equivalent