



Dietary intake and anthropometric reference values in population studies

Victoria Arija¹, Carmen Pérez Rodrigo², Emilio Martínez de Vitoria³, Rosa M. Ortega⁴,
Luis Serra-Majem^{5,6,7}, Lourdes Ribas⁶ and Javier Aranceta^{2,8}

¹Unidad de Nutrición y Salud Pública, Facultad de Medicina y Ciencias de la Salud, Universidad Rovira i Virgili. Reus. ²Fundación FIDEC, Bilbao. ³Institute of Nutrition and Food Technology, Department of Physiology, University of Granada. Granada. ⁴Departamento de Nutrición, Facultad de Farmacia, Universidad Complutense de Madrid. Madrid. ⁵Instituto de Investigaciones Biomédicas y Sanitarias, Universidad de Las Palmas de Gran Canaria. Las Palmas de Gran Canaria. ⁶CiberOBN, Instituto de Salud Carlos III. Madrid. ⁷Fundación para la Investigación Nutricional. Barcelona. ⁸Department of Preventive Medicine and Public Health, University of Navarra. Pamplona. Spain.

Abstract

In nutritional epidemiology it is essential to have reference values for nutrition and anthropometry in order to compare individual and population data.

With respect to reference nutritional intake, the new concept of Dietary Reference Intakes is generated based more on the prevention of chronic diseases than on covering nutritional deficiencies, as would occur in the early Recommendations. As such, the more relevant international organizations incorporated new concepts in their tables, such as the Adequate Intake levels or the Tolerable Upper Intake levels. Currently, the EURRECA recommendations (EUROpean micronutrient RECommendations Aligned) are generating reference values for Europe in a transparent, systematic and scientific manner. Using the DRI, health-care authorities formulated nutritional objectives for countries or territories and Dietary Guides to disseminate the dietary advice to the population.

Anthropometric assessment continues to be one of the most-used methods for evaluating and monitoring health status, nutritional state and growth in children, not only individuals but also communities. Different organizations have established anthropometric reference patterns of body mass index (BMI) with cut-off points to define overweight and obesity. In children, growth curves have been revised and adapted to the characteristics of healthy children in order to obtain anthropometric reference standards that better reflect optimum growth in children. The Growth Standards for children below 5 years of age of the WHO are a response to these principles, and are widely accepted and used worldwide.

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Correspondence: Victoria Arija, MD.
Unidad de Nutrición y Salud Pública.
Facultad de Medicina y Ciencias de la Salud.
Universitat Rovira i Virgili.
C/ Sant Llorenç 21.
43201 Reus, Spain.
E-mail: victoria.arija@urv.cat

VALORES DE REFERENCIA DE INGESTA DIETÉTICA Y DE ANTROPOMETRÍA EN ESTUDIOS POBLACIONALES

Resumen

En epidemiología nutricional son fundamentales las referencias nutricionales y antropométricas para comparar los datos de individuos o colectivos.

En relación a las ingestas nutricionales de referencia, el nuevo concepto de Ingestas Dietéticas de Referencia se realizó basándose más en la prevención de las enfermedades crónicas actuales, que en cubrir deficiencias nutricionales, como ocurría con las primeras Recomendaciones. Así, las Organizaciones Internacionales más relevantes han incorporado nuevos conceptos en sus tablas, como el de Ingestas Adecuadas o el Límite Superior de Ingesta Tolerable. Actualmente, la (EUROpean micronutrien RE-Comendations Aligned) (EURRECA) está creando valores de referencia para Europa, de manera transparente, sistemática y científica. A partir de las IDR, las autoridades de salud formulan los objetivos nutricionales para un país o territorio y las Guías Alimentarias, que transmiten el consejo alimentario para la población.

La valoración antropométrica sigue siendo uno de los métodos más utilizados para evaluar y vigilar el estado de salud, el estado nutricional y el crecimiento de los niños, tanto en los individuos, como en las comunidades. Diferentes organismos establecen los patrones de referencia antropométrica del IMC y definen los puntos de corte para definir sobrepeso y obesidad. En los niños, se han revisado las curvas de crecimiento adaptándolas a las características de niños sanos desarrollados en ambientes saludables para obtener estándares antropométricos de referencia que reflejen mejor el crecimiento óptimo de los niños. A estos principios responden los Estándares de Crecimiento para niños menores de cinco años de edad de la OMS, los cuales han sido ampliamente aceptados y utilizados a nivel mundial.

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Dietary reference Intakes for individuals and populations; concepts and definitions

The first Recommended Nutrient Intakes (RNIs) tables were collated in 1938 for the Canadian and United Kingdom populations (Daily Recommended Nutrient Intakes); in 1941 for the population of the USA (Recommended Dietary Allowances; RDAs); by the Institute of Medicine (*IOM*); and, in the 50s, for the world population under the auspices of the Food and Agriculture Organization (FAO) and the World Health Organization (WHO). The recommendations were originally defined to avoid nutritional deficiencies.

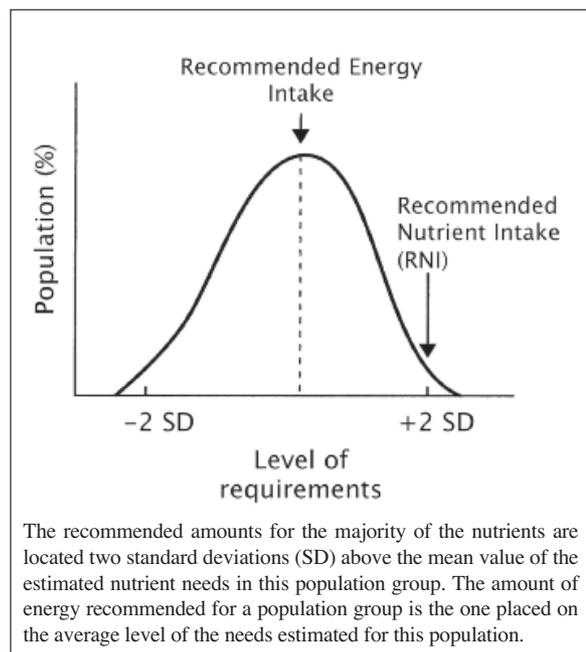
In 1994 the Food and Nutrition Board with the support of the government of the US and Canada initiated the revision of the RNIs and RDAs and generating, with the use of new scientific knowledge and statistics, the Dietary Reference Intakes (DRIs). The difference from the original tables was that each nutrient was given several values for different circumstances, as well as a unique reference value. This new concept is based, on the one hand, on the observation that, currently, the diseases to be prevented are, mostly, chronic i.e. they are more severe and more prevalent than deficiency diseases; the latter having been used in generating the original recommended intakes. In addition, advancing knowledge highlighted the convenience of incorporating new reference values such as that of certain food components (fat or fiber, among others) which, despite not being essential nutrients, their intake is also related to health status. Further, reference values for some nutrients can be used even when the information required to calculate the recommended intake is lacking or when the extremes of values of nutritional intake can cause adverse health effects.

Thus, the new tables of DRI include the following concepts^{1,2,3,4,5} (Fig. 1).

The Estimated Average Requirement (*EAR*) is the average daily nutrient intake level that is estimated to meet the nutrient needs of half of the individuals in a life-stage or gender-group. In the case of energy, an Estimated Energy Requirement (*EER*) is provided.

Recommended Dietary Allowance (*RDA*) is the average daily dietary nutrient intake level that is sufficient to meet the nutrient requirements of nearly all (97-98 percent) healthy individuals in a particular life-stage and gender-group. *RDAs* are established for each age group and gender, or physiological status (pregnancy and lactation). For nutrients with a statistically normal requirement distribution, these are calculated from the *EAR* of each nutrient + 2 standard deviations of its distribution. The standard deviation is estimated from the coefficient of variation of the nutrient in the population (for those nutrients with an estimation of the coefficient of variation) (Fig. 2).

The Acceptable Range of Intake (*ARI*) or Acceptable Intake (*AI*) is the amount of nutrient intake that is recommended when there are not enough data to estimate



The recommended amounts for the majority of the nutrients are located two standard deviations (SD) above the mean value of the estimated nutrient needs in this population group. The amount of energy recommended for a population group is the one placed on the average level of the needs estimated for this population.

Fig. 1.—Recommended Energy and Nutrient Intakes.

the (*EAR*) due, mainly, to lack of awareness of the variability of requirements and, therefore, the impossibility of calculating its standard deviation. These values should be considered a provisional value, prior to *RDA*.

The Tolerable Upper Intake Level (*UL*) of intake is the maximum amount of a nutrient that individuals can ingest daily without any health risk. This new value is gaining interest, given the increasingly frequent use of nutrient concentrates, fortified foods, and functional foods, all of which can lead to an excessive intake.

The Lowest Threshold Intake (*LTl*) is the value below which a nutritional deficiency would emerge in most of the population group. It is the mean of Nutritional Requirements minus 2 standard deviations.

The Acceptable Macronutrient Distribution Range (*AMDR*) is the range of intake for a particular nutritional source that is associated with a reduced risk of chronic disease, while providing intakes of essential nutrients. If an individual consumes in excess of the *AMDR*, there is a potential for increasing the risk of chronic diseases and/or insufficient intakes of essential nutrients.

Recommended Safe Intake (*RSI*) is set to prevent possible clinical signs of deficiency, and to allow normal growth. It is not suitable for prolonged periods of infections or stress.

Protective Nutrient Intake (*PNI*) has been introduced in some cases to refer to an amount that is greater than the recommended intake but which may be protective against a specified health or nutritional risk relevant to public-health (folic acid to lower the risk of fetal neural tube defects, for example).

In addition, another term that should not be confused with the *DRI*, is the concept of Reference Labeling Values (*RLV*). This concept is used to describe the

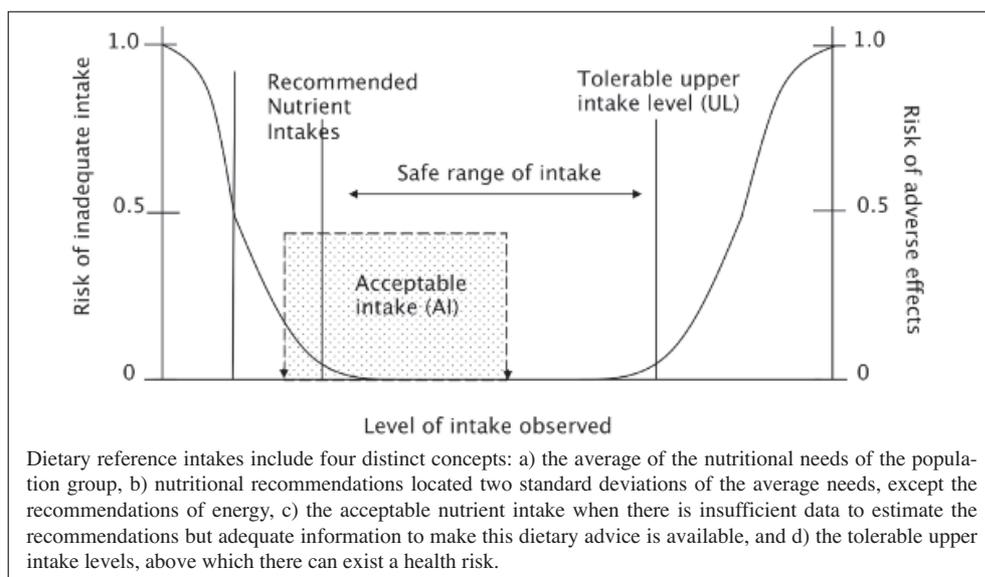


Fig. 2.—
Dietary reference intakes.

Table I.I
Recommended Allowances and Adequate Intakes () for the US population*

Category	Age years	Water L	Energy kcal	kJ	Pr g	CH g	Fiber g	Lipids g	LFA G	LnFA G	Ca Mg	Fe mg	Zn mg	Se µg	Fl mg	I mg	Mg mg
Infants	0.0-0.5	0.7*	650	2,720	9.1*	60*	ND	31	4.4*	0.5*	210*	0.27*	2*	15*	0.01*	110*	30*
	0.5-1.0	0.8*	850	3,556	11	95*	ND	30	4.6*	0.5*	260*	11	3	20*	0.5*0	130*	75*
Boys/ Girls	1-3	1.3*	1,300	5,439	13	130	19*	ND	7*	0.7*	700	7	3	20	0.7*	90	80
	4-8	1.7*	1,800	7,531	19	130	25*	ND	10*	0.9*	1,000	10	5	30	1*	90	130
Males	9-13	2.4*	2,500	10,460	34	130	31*	ND	12*	1.2*	1,300	8	8	40	2*	120	240
	14-18	3.5*	3,000	12,500	52	130	38*	ND	16*	1.6*	1,300	11	11	55	3*	150	410
	19-30	3.7*	2,900	12,133	56	130	38*	ND	17*	1.6*	1,000	8	11	55	4*	150	400
	31-50	3.7*	2,900	12,133	56	130	38*	ND	17*	1.6*	1,000	8	11	55	4*	150	420
	51-70	3.7*	2,300	9,623	56	130	30*	ND	14*	1.6*	1,000	8	11	55	4*	150	420
	>70	3.7*	2,300	9,623	56	130	30*	ND	14*	1.6*	1,200	8	11	55	4*	150	420
Females	9-13	2.1*	2,200	9,200	34	130	26*	ND	10*	1.0*	1,300	8	8	40	2*	120	240
	14-18	2.3*	2,200	9,200	46	130	26*	ND	11*	1.1*	1,300	15	9	55	3*	150	360
	19-30	2.7*	2,200	9,200	46	130	25*	ND	12*	1.1*	1,000	18	8	55	3*	150	310
	31-50	2.7*	2,200	9,200	46	130	25*	ND	12*	1.1*	1,000	18	8	55	3*	150	320
	51-70	2.7*	1,900	7,450	46	130	21*	ND	11*	1.1*	1,200	8	8	55	3*	150	320
	>70	2.7*	1,900	7,450	46	130	21*	ND	11*	1.1*	1,200	8	8	55	3*	150	320
Gestating	14-18	3.0*	+300	+1,250	71	175	28*	ND	13*	1.4*	1,300	27	12	60	3*	220	400
	19-30	3.0*	+300	+1,250	71	175	28*	ND	13*	1.4*	1,000	27	11	60	3*	220	350
	31-50	3.0*	+300	+1,250	71	175	28*	ND	13*	1.4*	1,000	27	11	60	3*	220	360
Lactating	14-18	3.8*	+500	+2,100	71	210	29*	ND	13*	1.3*	1,300	10	13	70	3*	290	360
	19-30	3.8*	+500	+2,100	71	210	29*	ND	13*	1.3*	1,000	9	12	70	3*	290	310
	31-50	3.8*	+500	+2,100	71	210	29*	ND	13*	1.3*	1,000	9	12	70	3*	290	320

Table I.II
Recommended Allowances and Adequate Intakes () for the US population*

<i>Infants</i>	<i>Age years</i>	<i>Vit. A µg ER¹</i>	<i>Vit. D µg Cole²</i>	<i>Vit. C mg</i>	<i>Vit. E mg ET³</i>	<i>Vit. K µg</i>	<i>Vit. B1 mg</i>	<i>Vit. B2 mg</i>	<i>Niacin mg NE⁴</i>	<i>Vit. B6 mg</i>	<i>Folate µg DFE⁵</i>	<i>Vit. B12 mg</i>
Infants	0.0-0.5	400*	10*	40*	4*	2*	0.2*	0.3*	2*	0.1*	65*	0.4*
	0.5-1.0	500*	10*	50*	5*	2,5*	0.3*	0.4*	4*	0.3*	80*	0.5*
Boys / Girls	1-3	300	15*	15	6	30*	0.5	0.5	6	0.5	150	0.9
	4-8	400	15*	25	7	55*	0.6	0.6	8	0.6	200	1.2
Males	9-13	600	15*	45	11	60*	0.9	0.9	12	1.0	300	1.8
	14-18	900	15*	75	15	75*	1.2	1.3	16	1.3	400	2.4
	19-30	900	15*	90	15	120*	1.2	1.3	16	1.3	400	2.4
	31-50	900	15*	90	15	120*	1.2	1.3	16	1.3	400	2.4
	51-70	900	15*	90	15	120*	1.2	1.3	16	1.7	400	2.4
	>70	900	20*	90	15	120*	1.2	1.3	16	1.7	400	2.4
Females	9-13	600	15*	45	11	60*	0.9	0.9	12	1.0	300	1.8
	14-18	700	15*	65	15	75*	1.0	1.0	14	1.2	400	2.4
	19-30	700	15*	75	15	90*	1.1	1.1	14	1.3	400	2.4
	31-50	700	15*	75	15	90*	1.1	1.1	14	1.3	400	2.4
	51-70	700	10*	75	15	90*	1.1	1.1	14	1.5	400	2.4
	>70	700	20*	75	15	90*	1.1	1.1	14	1.5	400	2.4
Gestating	≥18	750	15*	80	15	75*	1.4	1.4	18	1.9	600	2.6
	19-30	770	15*	85	15	90*	1.4	1.4	18	1.9	600	2.6
	31-50	770	15*	85	15	90*	1.4	1.4	18	1.9	600	2.6
Lactating	≥18	1,200	15*	115	19	75*	1.4	1.6	17	2.0	500	2.8
	19-30	1,300	15*	120	19	90*	1.4	1.6	17	2.0	500	2.8
	31-50	1,300	15*	120	19	90*	1.4	1.6	17	2.0	500	2.8

Pr: Proteins; CH: Carbohydrates; LFA: Linoleic Fatty Acid; LnFA: Linolenic Fatty Acid; ND: Not Determined; (*) The indicated value is the Adequate Intake (AI). For healthy children breastfed the AI concern the mean intakes. ¹ RE= Retinol Equivalents; ² Cole: Cholecalciferol, in the absence of adequate sunlight exposure, 1 µg of cholecalciferol = 40 IU of Vit D; ³ TE=Tocopherol Equivalents; ⁴ RE= Retinol Equivalents; NE = Niacin Equivalents; ⁵ DFE = Dietary Folate Equivalent

Sources: Food and Nutrition Board. Institute of Medicine. National Research Council (FNB/IOM/NRC). Dietary Reference Intakes (DRI): for Thiamine, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Pantothenic acid, Biotin, and Choline. Washington DC: National Academy Press, 2000. FNB/IOM/NRC. DRI: for Vitamin C, Vitamin E, Selenium and Carotenoids. Washington DC: National Academy Press, 2000. FNB/IOM/NRC. DRI: A risk assessment models for establishing Upper Intake Levels for Nutrients. Washington DC: National Academy Press, 2000. FNB/IOM/NRC. DRI: for Calcium and Vitamin D. Washington DC National Academy Press, 2001. FNB/IOM/NRC. DRI: for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc. Washington DC: National Academy Press, 2001. FNB/IOM/NRC. DRI: for Energy, Carbohydrate, Fibre, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids. Washington DC: National Academy Press, 2002. FNB/IOM/NRC. DRI: for Water, Potassium, Sodium, Chloride, and Sulphate. Washington DC: National Academy Press, 2005

nutrient content of a food product. It can be expressed as a percentage of the DRI in adults. This information allows comparison of the nutritional values of food products.

The most relevant international organizations incorporate some of these new concepts into their tables. In the USA, the Food and Nutrition Board (FNB) of the National Research Council includes the values of AI, UL, and AMDR in various publications^{3,4,5} (Table I). In 2002, the Committee of Experts of FAO-WHO incorporated the values of AI, UL, RSI and PNI⁶. At the European level,

the Scientific Committee on Food (SCF) included, in 1993, the values of ARI, LTI⁷. However, most countries have developed their recommendations based on the specific characteristics of their population. In Europe there are recommendations in the Nordic countries (Denmark, Finland, Iceland, Norway and Sweden), in the Germanic countries (Germany, Austria and Switzerland) while the United Kingdom, Ireland, France, Belgium, Italy and in Spain have their own recommendations⁸.

The European Commission recognized the need to align the procedures used to obtain European micro-

nutrient recommendations within a globalized society. In 2007 the Commission funded the EURRECA (EU-European micronutrient REComendations Aligned) Network of Excellence coordinated by International Life Sciences Institute (ILSI) of Europe. The aim was to create a standard process for collecting and using the dietary reference values for micronutrients in a transparent, systematic and scientific manner. Their goals focus on the specific needs of vulnerable groups such as infants, children and adolescents, adults, pregnant and lactating women, the elderly, low-income individuals and immigrants, and to evaluate the impact on intake of various related situations such as socioeconomic status, ethnicity, inter-individual variability and vulnerability due to genetics, environmental factors and epigenetic phenomena⁹.

Uses, applications and expression of the nutritional intake of populations in relation to the DRI

Among its many uses, the *DRI* helps in planning menus and diets, developing new dietary products by the food industry, labelling of foodstuffs, designing programs of nutritional education, or for estimating nutritional adequacy.

Nutritional adequacy assesses intake in relation to the recommended intakes. It is useful both collectively and individually. For example, at a collective level, reports evaluate the percentage of subjects below the *EAR* (only for those nutrients that comply with certain conditions). Since the *DRI* is presented as 97.5 percentile, when an individual or group of individuals have an intake below the recommended amounts, this does not indicate real deficiencies but, rather, a risk of deficit since it may be less than the amounts recommended but not lower than the individual's needs.

AI cannot be used to assess the prevalence of inadequate intakes, while *UL* is useful in assessing the percentage within a group who are at risk of adverse effects.

Nutrient intake adequacy at the individual level

If we have the real nutrient requirement of an individual and his/her true intake, we can compare those values: when the intake is equal to or above the requirement the intake is adequate, and when a given intake is below the requirement, it is considered as inadequate. Although neither the individual's requirements nor the true intakes are known with certainty, a qualitative or a quantitative evaluation can be made. The qualitative evaluation compares the individual's usual intake with the *RDA*; if it is above or equal to the *RDA*, there is a low probability that such an intake is inadequate. If the individual's usual intake is between the *RDA* and the *EAR*, there is considerable uncertainty whether the intake is adequate or not. There is a high

probability of inadequacy when the nutrient intake is below the *EAR*. The quantitative approach calculates a confidence of adequacy based on the number of days that intake is measured, day-to-day variation in intake of the nutrient under study, variability of the requirement, and how far the intake value is above or below the *ANR* (*EAR*). The result of such an equation is a *Z* score from which a probability value is derived that reflects the degree of confidence that the individual's usual intake is adequate.

Nutrient intake adequacy at the group level

To calculate the proportion of the population with intakes that are below the requirements, a joint distribution of the nutrient requirement and the nutrient intake for each individual in the group would enable the calculation of the percentage of individuals with inadequate intakes. Unfortunately, the nutrient requirement for each individual in a group is not known, and no joint distribution can be calculated. In these circumstances, two approaches are used to calculate the prevalence of inadequate intakes: the probability approach or, when certain conditions are accomplished, a shortcut of that method i.e. the cut-off point method. Both methods are recommended for use only under the following conditions: the mean and the variance of the requirement distribution are known; intakes and requirements are not correlated; the form of the requirement distribution (normal or log-normal) must be known or must be assumed. To apply both methods, intake distributions need to be adjusted to remove the effect of day-to-day variation.

The probability approach is a statistical method that combines the distribution of the intakes and the risk-curve of the requirement distribution. Using the probability approach, the probability of inadequacy is assessed for each individual and the average probability is the group prevalence of inadequate intakes. The probability of inadequacy for each individual is defined by comparing the individual's intake with the requirement for that nutrient: if the intake is below that value, the individual's intake will be defined as inadequate.

The cut-off point method, proposed by Beaton¹⁰, estimates the prevalence of inadequate intakes as the proportion of the population with usual intakes below the average requirement (*EAR* or *ANR*). The cut-off point method will be used when:

1. The requirement distribution is symmetrical.
2. The distribution of usual intakes is more variable than the distribution of requirements (the coefficient of variance for the distribution of requirements for most nutrients is set at 10%).

If these conditions are not met, then the probability approach will be used

For those nutrients with an *AI* value as requirement, it is not possible to determine the prevalence of ina-

adequate nutrient intakes in a group. The only assumptions that can be made are that if the mean intake of a group is at or above the AI, and the variance of intake is similar to the variance of intake from the population used to set the AI, then prevalence of inadequate intake for that population is likely to be low. Nothing can be concluded if the group median intake is below the AI.

From RDI to nutritional goals; Establishing concepts and comparison tables of nutritional goals in developed countries.

Promoting appropriate eating habits, which follow healthy dietary models, constitutes one of the most important components within health-promotion strategies. To achieve improvements in collective food intake, health authorities count on two tools of considerable value in public health: nutritional objectives and food guidelines^{11,12}.

Nutritional objectives are quantitative and qualitative, with nutritional recommendations based on scientific evidence and framed in the nutritional policy of the country. They are aimed at the general population in order to achieve an optimal health status, considering the specific characteristics and the mean intakes of the population for which they are intended while taking into account eating and nutritional behavior patterns, or the most frequent health problems¹³.

Nutritional objectives for the Spanish population were developed based on a consensus meeting of the Spanish Society of Community Nutrition (*Sociedad Española de Nutrición Comunitaria; SNEC*) held in Bilbao in 2000 and sponsored by the WHO. Intermediate and final nutrition objectives were defined at this time^{11,12}, and have been modified by subsequent consensus meetings¹³ (Table II). The table II summarizes the nutritional objectives established by various organizations, with special attention being paid to those issues having a high impact on health. These include aspects such as fat intake, which has been the subject of priority concern in most nutritional objectives because of its role in cardiovascular disease risk. Most populations in developed countries have an unbalanced energy profile, and concerns have been raised regarding reducing saturated fat while increasing PUFAs intake (where an insufficient contribution was most frequently noted and where the contribution of omega-3 fatty acids is particularly low). Results indicate that the quality of the fat needs to be improved and, in this respect, nutritional objectives can be used for guidance.

Dietary fiber intake in Spanish populations is quite far from the recommended nutrient intake goals. It is evident that a low consumption of vegetables and cereals (especially whole grains) contributes to this finding¹². A study that evaluated the sodium intake in a representative sample of Spanish young and middle-aged adults aged 18–60 years highlighted, by mea-

suring 24h urinary sodium excretion, that mean dietary salt intake (9.8 ± 4.6 g/day), exceeded the recommended intake of 5 g/day in 88.2% of the subjects studied. These results can be used as the baseline to design nutrition policies for reducing salt consumption¹⁴.

Healthy weight maintenance is achieved by choosing a nutritious diet balanced by daily physical activity¹⁵. Almost half of European adults are overweight. For example, in representative samples of the Spanish population, 47.4% of adults and 30.8% of children were found to be overweight¹⁶. To maintain body weight in the population, recommendations for daily physical activity and BMI ranges should be included in the national nutritional goals and dietary guidelines. Moderate physical activity should be made an easy choice and part of everyday life¹⁵ (Table II) (Fig. 3). Also, it is advisable to promote breast-feeding programs, not only among pregnant women, but also among pediatricians, obstetricians and maternity ward staff¹³. A moderate consumption of beverages with low alcoholic content (wine, beer, cider) is considered permissible, if limited to < 2 glasses/d if taken with meals. The consumption for women should be somewhat lower than for men¹³ (Table II).

From nutrient intake goals to dietary guidelines; Establishing concepts and examples of dietary guidelines.

Part of an action policy to combat non-communicable diseases (NCD) and to meet nutritional goals should include the translation of the goals into food-based dietary guidelines (FBDG) at the national level^{11,14}.

Dietary guidelines are recommendations on food consumption to the population, in pursuit of the nutritional goals. The guidelines need to be relatively simple documents of nutritional health promotion addressed to the population, in order to promote nutritional well-being. The goals need to be easily achieved, written in appropriate language, using a positive approach. Designed by government agencies and/or scientific organizations, a system of food groups is used and includes advice on healthy lifestyles¹⁷.

A survey conducted by the WHO¹⁵ analyzed food-based dietary guidelines in member states of the European Union, illustrated important discrepancies between sub-regions and between countries in national food-based dietary guidelines. The Guide, distributed as a food guide by the Spanish Ministry of Health was shown as a prism, from which different graphics have been derived (pyramid, wheel, semicircle, etc.). Nevertheless, the pyramid proposed by the *SENC*, which was based on consensus documents, has become widespread as a guide for proper application in the Spanish population^{11,13} (Fig. 3).

Food guidelines should be adapted to a country's specific needs to ensure that the nutrient needs of the population are covered, and which would contribute to

Table II
Nutritional objectives in developed countries

	FAO/WHO, 2003, 2008	EFSA, 2010	SENC, 2011*	
			Intermediate objectives ^a	Final objectives ^b
Breast-feeding	Promotion of exclusive breast-feeding		4 months (exclusive breast-feeding)	≥6 months
Dietary fiber	High dietary intake of dietary fiber		>12 g/1000 kcal (> 22 g/day in women and 30 g/day in men)	>14 g/1000 kcal (> 25 g/day in women and 35 g/day in men)
Salt (g/day)	<5	<6	< 7	< 5
Physical activity ¹⁰	Regular physical activity		PAL >1.60 (> 30 min/day)	PAL >1.75 (45-60 min/day)
BMI (kg/m ²)	21 – 23		21- 25	21 – 23 23-26 (>65 years)
Total fat (% of energy)	20-35%	20-35%	≤ 35%	30 – 35%
SFA (% of energy)	<10%	As low as possible	≤ 10%	7-8%
MUFA (% of energy)	By difference		20%	20%
PUFA (% of energy)	6-11%		4%	5%
n-6 (% of energy)	2.5-9%	4% (Linoleic FA)	2% (Linoleic FA)	3% (Linoleic FA)
n-3 (% of energy)	0.5-2%		1-2%	1-2%
Trans FA (% of energy)	<1%	As low as possible		<1%
Cholesterol	<300 mg/day	No reference value	<350 mg/day <110 mg/1000 kcal	<300 mg/day <100 mg/1000 kcal
Total carbohydrates (% of energy)	55-75%	50-55%	>50% Low glucemic index	50-55% Low glucemic index
Sweets	Sugar-free <10% of energy	Added sugars <10% of energy	<4 per day	<3 per day <6% of energy
Beverages with low alcoholic grade (wine/beer) (glasses/day)	Moderate alcohol		<2 (taken with meals)	<2 (taken with meals)

^a Corresponds essentially to the 75th or 25th percentile, depending on the findings (favorable or unfavorable) of population-based nutrition studies carried out in Spain, or, when referring to micronutrients, to nutrient reference values. To be evaluated by the end of 2015. ^b Final nutrition objectives, in accordance with current scientific evidence and based on nutrient reference values. To be evaluated by the end of 2020. BMI: Body mass index, PAL: physical activity levels, SFA, saturated fatty acid, MUFA, monounsaturated fatty acid; PUFA, polyunsaturated fatty acid; FA: fatty acids

Sources: FAO-WHO. Diet, Nutrition and the Prevention of Chronic Diseases: Report of a Joint WHO/FAO Expert Consultation. WHO Technical Report Series No. 916 (TRS 916). World Health Organization: Geneva. 2003. <http://www.fao.org/docrep/005/AC911E/AC911E00.htm>. FAO-WHO. Fats and Fatty Acids in Human Nutrition. Rome: FAO Food and nutrition paper # 91. Report of an expert consultation. Geneva, November 10–14, 2008. EFSA Panel on Dietetic Products, Nutrition, and Allergies (NDA). Scientific Opinion on Dietary Reference Values for fats, including saturated fatty acids, polyunsaturated fatty acids, monounsaturated fatty acids, trans fatty acids, and cholesterol. The EFSA Journal 2010; 8, 1461. *Aranceta J, Serra Majem LI, Grupo Colaborativo para la actualización de los Objetivos Nutricionales para la Población Española (2011). Nutritional objectives for the Spanish population. Consensus from the Spanish Society of Community Nutrition. Rev Esp Nutr Comunitaria 17: 178–99.

reducing the risk of NCD. In addition, they should be in accord with public policies on food safety and physical activity, while promoting a healthy environment and a local food economy¹⁵. Most food guidelines include similar information aimed at achieving healthy eating habits. These include:

- Eating a varied diet consisting mainly of food-items derived from plants
- Eating bread, grains, pasta, rice or potatoes several times a day

- Daily intake of fresh, local vegetables, legumes, and fruits (at least 400 g/d)
- Maintaining a healthy BMI by taking moderate levels of exercise, preferably daily
- Controlling fat intake (total and saturated)
- Eating lean meat, poultry, fish
- Using low-fat milk and low-fat dairy products
- Low sugar intake
- Low salt intake
- If alcohol is consumed, the intake should be limited

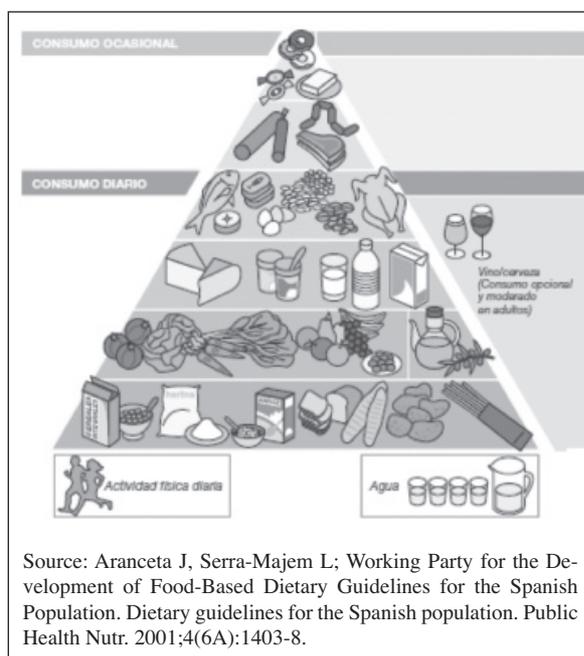


Fig. 3.—Food-Based Dietary Guidelines for the Spanish Population.

to no more than 1 drink for women and 2 drinks for men (each containing 10 g of alcohol) per day.

- Preparing food in a safe and hygienic manner

- Promoting breastfeeding exclusively for the first 6 months followed by the gradual introduction of safe and appropriate complementary foods. Supplementary breastfeeding can be continued over the first years of life.

Developing national dietary guidelines is an important part of generating nutrition policies, and disseminating consistent information on healthy diets and lifestyle. A set of consistent dietary guidelines should help the population and the health-care professionals achieve a better health status in the population¹⁵.

National and international reference data on anthropometric indices

In practical terms, anthropometric indices are compared across populations in relation to an acceptable set of reference values. In population studies, anthropometric indices can be evaluated by comparison with the distribution of the reference data using Z-scores or percentiles¹⁸.

Reference standards for the ‘normality’ of BMI have been defined to classify various degrees of overweight and obesity, but universal cut-off points have been challenged. There are a number of recent studies showing that the relationship between BMI and percentage body fat (BF%) is not only age and sex dependent, but also differs among ethnic groups. Similarly, low levels of BMI have been used to classify chronic energy deficiency.

Currently, there is no need for adult reference data for BMI, and interpretation should be based on pragmatic BMI cut-offs¹⁹; albeit international reference data from the WHO and the National Centre for Health Statistics are available²⁰.

The WHO BMI classifications of overweight and obesity are intended for international use. They reflect risk for type 2 diabetes and cardiovascular diseases, which are rapidly becoming major causes of death in adults in all populations, even in those that still have substantial malnutrition. The current WHO BMI cut-off points should be retained as international classification, but additional cut-off points need to be added for public health action. Wherever possible, countries should use all categories for reporting purposes, with a view to facilitating international comparisons (Table III). However, some authors maintain that universal BMI cut-off points for overweight and obesity are not appropriate due to important ethnic differences in distributions²¹.

WHO has a global BMI database where BMI distributions in different countries can be consulted (<http://apps.who.int/bmi/index.jsp>)

The Spanish Society for the Study of Obesity (SEEDO) published a consensus document for the evaluation of overweight and obesity, and established BMI cut-off points for the classification of overweight and obesity in Spanish populations (Table III).

Where possible, in populations with a predisposition to central obesity and related increased risk of developing the metabolic syndrome, cardiovascular diseases and type 2 diabetes, waist circumference (WC) and waist-to-hip circumference ratio (WHR) should also be used²². In a consensus of the International Diabetes Federation, country- and ethnic-specific values for waist circumference (as a measure of central obesity) have been published²³.

In Spain, the SEEDO published cut-off points for WC (>102 cm for males and >88 cm for females) (Table III). Other international organizations such as the WHO also have reference cut-off points than coincide with the values of SEEDO. The International Diabetes Federation has different cut-off points (>94 for males and >80 for females)²³. Canadian Health surveys propose cut-off points for WC, BMI and WHR for each risk factor.

Reference standards of anthropometry during growth

Anthropometry remains one of the most-used methods for assessing and monitoring health status, nutritional status, as well as child growth in individuals and in communities.

Anthropometric measurements describe body size, proportions, and even composition. The most-used direct measurements are weight, linear growth (height or length), circumferences (head, mid-upper arm, waist,

Table III
Body Mass Index (BMI) cut-off points; Comparison of WHO and SEEDO data

Classification	WHO BMI (kg/m ²)		SEEDO BMI (kg/m ²)
	Principal cut-off points	Additional cut-off points	Cut-off points
Underweight	<18.50	<18.50	< 18.5
Severe thinness	<16.00	<16.00	-
Moderate thinness	16.00 - 16.99	16.00 - 16.99	-
Mild thinness	17.00 - 18.49	17.00 - 18.49	-
Normal range (normal weight)	18.50 - 24.99	18.50 - 22.99 23.00 - 24.99	18.5-24.9
Overweight	≥25.00	≥25.00	-
Pre-obese	25.00 - 29.99	25.00 - 27.49	25.0-26.9
(Grade I overweight)			
(Grade II overweight)		27.50 - 29.99	27.0-29.9
(Pre-obese)			
Obese	≥30.00	≥30.00	-
Obese class I	30.00 - 34.99	30.00 - 32.49 32.50 - 34.99	30.0-34.9
Obese class II	35.00 - 39.99	35.00 - 37.49 37.50 - 39.99	35.0-39.9
Obese class III (morbid obesity)	≥40.00	≥40.00	40.0-49.9
Obese class IV (extreme obesity)	-	-	≥ 50

Adapted from: WHO. Obesity: preventing and managing the global epidemic. Report of a WHO Consultation. WHO Technical Report Series 894. Geneva: World Health Organization, 2000. WHO expert consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. The Lancet, 2004; 157-163. Salas-Salvadó, J, Rubio MA, Barbany M, Moreno B and the Collaborative of SEEDO. SEEDO 2007 Consensus for the evaluation of overweight and obesity and the establishment of therapeutic intervention criteria. Med Clin (Barc) 2007;128(5):184-196.

hip...), skinfolds (triceps, biceps, suprailiac, subscapular...) or various body sizes. Its measurement is easy and inexpensive and applicable worldwide. However it should be performed with precise instruments and accepted methodological procedures²⁴.

Anthropometric indices are derived from relationships observed between some of the previously-direct measures (see above) or by a combination of an anthropometric measurement and age.

The anthropometric indices most commonly used in pediatrics are the ones related to age and those associated with weight and height. From a nutritional point of view each index describes a different body size and enables a type of deficit or excess to be characterized.

Weight-for-age and height-for-age reflect, respectively, body mass and linear growth relative to chronological age. They are sensitive parameters in detecting changes during monitoring of the child. For example, low weight-for-age may indicate overall under-nutrition, usually acute while low height-for-age estimates the degree of chronic or secular malnutrition. The weight/height index (the BMI) provides information

on body proportionality. It is important that these indices, in children and adolescents, are described by age group. A low value on these indices reflects recent weight loss rather than chronic under-nutrition which would be reflected in both height and weight and would not affect the index. Conversely, a high value is indicative of overweight²⁴.

Anthropometric measurements, apart from being expressed in their units (g, cm, ...), can also be expressed in other units that provide insight into the anthropometric level relative to the whole population or relative to a benchmark. These include the percentage of adequacy, the percentile, or the Z score. The percentage of adequacy, with respect to the median of the reference population, is the individual value to reference value ratio, expressed as a percentage. The percentiles express the normal distribution of the frequencies from a given measure in the population. A value of 94% of a population comprises the values between the 3rd and 97th percentiles, which are considered as the limits of normality. The z score is the distance to the center of the normal distribution. It ranges from -6 to +6 and

represents the number of existing standard deviations between the measured value and the median. Of all measurements, the Z score is the most useful because it provides a greater amount of information, and can be used in more complete statistical analyses²⁴.

Knowledge of the dynamics of different anthropometric measures enables standards, norms, or benchmarks, of child growth to be constructed and expressed as graphs and tables segregated by age and gender. Reference standards of anthropometry have been published by various organizations as well as national and international institutions based on population samples that are local, national or international.

One of the most widely used references worldwide has been the percentiles for different anthropometric measurements (weight, length, head circumference and upper-arm circumference) that the National Center for Health Statistics (NCHS) of the United States published in 1977, based on data of child populations in different parts of the world²⁵. These curves were adopted by the WHO for international use. Later, with the help of 100 experts from around the world, the WHO organized a comprehensive review of these patterns. An important conclusion was that the previous patterns did not represent the growth of early childhood, adequately. Hence, new growth curves were required²⁶.

More recently, the Centers for Disease Control and Prevention (CDC) in the United States published an improved version of the growth curves in 2000²⁷. In these new standards, data were corrected to fit into the demographics, and other determinants, of child growth. Hence, very-low-birth-weight infants and recent data of children over 6 years of age were excluded so as to avoid including the increase in obesity seen in children in these years. The high numbers of children fed with infant formula that had been included previously, as well as some very local aspects, were corrected. Of note is that the curves for BMI for individuals up to 20 years of age were incorporated. However, despite these improvements, the references for growth data of the CDC were inappropriate in other population groups, particularly in developing countries.

In general, anthropometric reference values were developed on the basis of representative samples of one or more populations and, as such, the values obtained could not show optimal growth patterns.

Hence, the WHO Child Growth Standards for children under 5 years of age have been created recently with the aim of producing a standard generated with a selected sample of healthy children. Longitudinal data from birth to 24 months of age, and cross-sectional studies of children aged 18-71 months were combined. Children from diverse ethnic and cultural backgrounds participated (Brazil, Ghana, India, Norway, Oman and the United States) so as to be as representative as possible of children throughout the world. Various anthropometric measures were included: length/height-for-age, weight-for-age, weight-for-length, weight-for-height, BMI-for-age, head

circumference-for-age, arm circumference-for-age, triceps skinfold-for-age and subscapular skinfold-for-age. Healthy children living in conditions favoring the development of their full genetic potential for growth, and born from mothers with healthy habits such as breastfeeding or not smoking, were represented. The growth patterns, as described by the WHO, detect both under-nutrition and obesity and are useful in developed as well as developing countries. The data introduce new reference concepts that focus on how children should grow, rather than merely describing how they grew in a specific time and place^{28,29}.

Five years after the introduction of the WHO Child Growth Standards, a survey was performed to assess their use and interpretation in national programs of 178 countries worldwide. The results showed that these growth charts have been used universally in pediatric care³⁰.

To correct for the gap that exists for children between the ages of 5 and 19 years, the WHO collated growth references for children of this age group based on international data from NCHS/WHO 1977²⁵. Reference values for height-for-age, weight-for-age and BMI were generated and are considered appropriate (as provisional data) for this age group.

Some anthropometric references have focused on the detection of overweight and obesity, as is the case of the standards of the IOTF³¹ created from representative national databases of children and adolescents aged 2 to 18 years from 6 countries (Brazil, Britain, Japan, Netherlands, Singapore, and the United States). Later, the reference values to define thinness were generated based on the same databases from these 6 nations.

The importance of early detection of growth deficit in early life is so that the adverse consequences, which can continue throughout life, can be addressed. These include cognitive or performance deficits in childhood or in adulthood. Also, excessive weight gain during infancy is associated with increased risk of chronic diseases in adulthood.

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