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DIETARY REFERENCE VALUES – HISTORY AND THE PRESENT – A REVIEW

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This report focuses on the development of dietary reference values and nutrient recommendations, the existing categories and the possibility of applying reference values in nutritional assessment at the individual and population level. The report also proposes modifications to the Polish Dietary Reference Values.

INTRODUCTION

The recent years have brought an increased number of new publications on energy and nutrient intake, referred to as dietary reference values, due to the need to account for the results of the latest research on genetic factors, the bioavailability of nutrients ingested from food, their physiological effect and interactions with other components (enzymes, hormones), which frequently modified the existing views on human nutrition.

Dietary reference values are the main instrument in diet planning and nutritional assessment [Berger, 1992; Szotowa, 1994; DRI, 2000; Barr *et al*., 2003; Gronowska-Senger, 2003]. As quantitative standards of nutrient intakes, they are used in dietary education and as dietary reference intake (DRI) values [Hegsted, 1975; Harper, 1978; Health Canada, 1990]. Dietary reference values also supply the information necessary for the development of food and nutrition programs in national nutrition policies [Dietary..., 1991]. They are also of key significance for the consumers and producers of food in view of the food labeling procedure, food marketing and the safety of enriched and modified food products [Brussard *et al*., 1999; Reference…, 2002; The European Commission, 2003; Gronowska-Senger, 2005].

By determining the required nutrient intake levels, dietary reference values minimize the risk of various diseases, including civilization-related diseases [WHO Report, 1990, 2003] which are caused by deficient or excessive nutrient intakes. Recent scientific data verify not only the recommended dietary allowances of nutrients, but also the approach to the development of reference values as discussed in this report.

HISTORICAL OVERVIEW

The first dietary reference values (DRVs) were developed to determine the recommended intake levels for energy, protein and carbohydrates. They were introduced by Voit (1880), Rubner (1895) and Atwater (1901) for the worker population based on survey results. In 1935, the International Expert Group, the Technical Committee (Physiologists Committee) of the League of Nation's Hygiene Section developed nutrient recommendations for 11 population groups. Those standards determined intake levels for energy and protein and proposed general guidelines for meeting the requirements for vitamins and minerals recognized at the time (as cited in Szczygieł *et al*. [1987]).

On the initiative of the US Food and Nutrition Board (FNB), the concept of the Recommended Dietary Allowances was introduced in 1941. This term was used to describe the proportion of nutrients determined in view of scientific data. The ultimate nutrient quantities and the minimum or optimum nutrient requirements of the human body were not defined. In 1974, the so called "provisional" RDA was introduced in respect of nutrients for which detailed reference values could not be determined due to insufficient data [Recommended..., 1974; Deutsche Gesellschaft..., 1991; Dietary... 1991, 1997, 1998ab, 2000a,b,c, 2001, 2002]. In the following years, RDA continued to be modified as new scientific data on human nutrition became available.

The developed DVRs were described as the Recommended Daily Allowances, Recommended Dietary Intakes (RDI) as well as Nutrient Reference Values (NRV). They accounted for a "normal" distribution of nutrient requirements by

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assuming that the average plus two standard deviations are sufficient to meet the nutrient requirements of nearly all healthy individuals in a given population. Those values were usually set in view a "margin of safety" which was determined for a given nutrient and accounted for the "preventive intake level" which offered additional protection against the adverse effects of deficient nutrient intake [Helsing, 1996].

A more precise definition of the nutrient recommendations was developed in 1989. It was defined as intake levels of basic nutrients which satisfy the requirements of practically all healthy individuals [Recommended..., 1989]. The lower (diagnostic) average nutrient intake levels satisfied the requirements of only half of a given population, indicating with a nearly 100% certainty that deficient intake levels will be reported in the long term [European..., 1977; Energy..., 1985; Helsing, 1996; Ziemlański *et al*., 1997].

In the 1980s, the term "adequate and safe intake" was introduced for nutrients in respect of which RDA standards had not been set to determine upper intake levels which are safe for health [Wretlind, 1982; Lachance, 1995; Mertz, 2000]. The term "safe intake" was introduced to account for food supplementation and the resulting risk of excessive intake which could lead to the danger of toxicity. Food enrichment [Quinlivan *et al*., 2003] additionally maximized that risk which is why the concept of tolerable upper intake levels (UL) was introduced to mark the highest levels of intake which do not pose negative health consequences for nearly the entire population even when applied on a long-term basis [Dietary..., 1998b; Brussaard *et al*., 1999; Murphy *et al*., 2002; Murphy, 2003; The European Commission..., 2003].

New DRVs were developed for the European Union countries in 1992 [Nutrient..., 1993]. This effort was required to produce reference values for the purpose of labeling food products and to standardize the relevant legislation of the EU Member States. To indicate that the new DRVs were designed for population groups rather than individuals, it was proposed that the term "Recommended Dietary Allowances" is replaced with "Population Reference Intake". This modification was an attempt to employ RDA values for the purposes of food product labeling.

In 1997, US and Canadian experts [Dietary..., 1997] introduced the concept of Dietary Reference Intakes (DRI) which consisted of: Recommended Dietary Allowances (RDA), Adequate Intakes (AI), Estimated Average Requirements (EAR), and Tolerable Upper Intake Levels (UL).

This concept was indicative of a new approach to the creation of reference values and was oriented towards body functions.

In 2002, Germany, Switzerland and Austria issued common nutrient recommendations under the abbreviated name of DACH [Referenzwerte..., 2002]. This effort was undertaken to harmonize and standardize the highly diverse and often incomparable nomenclature, terminology, definitions and criteria of developing reference values.

In Poland the first provisional DRVs for 16 population groups, specifying the recommended intake levels for energy and 9 nutrients (carbohydrates, protein, fat, calcium, iron and vitamins C, B_1, B_2, A) were developed in 1950 and revised in 1957 [Szczygieł *et al*., 1959]. They stipulated the recommended intake levels for 18 population groups as regards energy and 11 nutrients (total protein and animal protein, fat, carbohydrates, calcium, iron and vitamins A, D, B_1, B_2, PP, C). The second, revised edition was published in 1963 [Szczygieł *et al*., 1965].

The successive provisional standards were developed in 1970 [Szczygieł *et al*., 1970] and specified intake levels for energy, total protein, animal protein, fat and carbohydrates, with an indication of a "from-to" reference range, as well as for minerals (calcium, phosphorus, iron, iodine and magnesium) and ten vitamins (A, D, C, E, thiamine, riboflavin, niacin, pyridoxine, folic acid and cobalamin) for 18 population groups. The subsequent revision, also modeled on US standards (RDA), took place in 1980 to indicate intake levels for energy and 19 nutrients for 22 population groups [Szczygieł *et al*., 1983].

In 1984 (part I) and 1987 (part II), a group of experts from the Human Nutrition Committee of the Polish Academy of Sciences developed Dietary Reference Values for the Polish Population [Dietary..., 1984; Dietary..., 1987] which contained the recommended and practical intake levels. The recommended physiological intake levels satisfied the requirements of 95% of the given population. Practical intake levels were higher because they were designed as dietary guidelines. The reference values set intake levels for energy and 18 nutrients (protein, fat, essential fatty acids, nutrients: calcium, phosphorus, iron, magnesium, zinc, and vitamins: A, E, D, B_1, B_2, B_6 ,B_{12}, C, folacin and niacin) for 36 population groups.

The last revision of Polish DRVs took place in 1994 and 1995, and the subsequent editions, partially supplemented in 1998 and 2001, focused mostly on the practical applications of nutrient recommendations [Ziemlański *et al*., 1994, 1995, 1998]. The new reference values distinguished 19 population groups (based on the following criteria: age, sex, physiological condition) with a division into three levels of physical activity and the recommended daily intake levels for energy, protein, fat and essential fatty acids, 7 selected minerals and 11 vitamins. The new reference values also determined the recommended daily intakes for copper and fluoride and the minimum intake levels of potassium, sodium and chloride [Ziemlański, 2001].

CRITERIA FOR THE DETERMINATION OF DIETARY REFERENCE VALUES

Dietary reference values indicate the amount of energy and essential nutrient intakes for an individual which, in accordance with present knowledge, should be ingested from a daily (standard) diet to ensure a desirable level of physical and psychological development and good health. DRVs are determined based on the average requirements for energy and nutrients, where such requirements should correspond to the lowest intake level at which the risk of deficient intake of a given nutrient is practically nil.

In 1985, WHO experts [Energy..., 1985] introduced new nutrient requirement concepts, including basal requirement, normative storage requirement and safe level of intake, where the term "requirement" covered both basal and normative storage requirement. The basal requirement was the amount of nutrient needed to prevent clinically detectable impairment of bodily function and it did not account for additional intake levels as reserves. The normative storage requirement was the amount of nutrient needed to maintain a desirable nutrient reserve in tissues. The safe level of intake, *i.e.* intake level at which the risk of deficient intake is low in randomly selected individuals, accounted for the normative storage requirement.

The following concepts appear in other proposed DRVs [Szczygieł *et al*., 1959, 1965, 1970, 1987; Dietary..., 1991; European..., 1977]: (1) average requirement, which is the amount needed to maintain a desirable energy and nutrient balance in around 50% of the people in a given group; (2) group requirement, which is the physiological requirement of a group, namely the amount needed to cover the needs of 97.5% of the people in a given group; (3) recommended intake, which is the amount needed to satisfy the physiological requirements of a group which is sufficient to meet higher requirements of some group members; and (4) safe intake of essential nutrients, which corresponds to the average requirement for a given nutrient plus two standard deviations to ensure that the requirements of 97.5% of the people in a given group are satisfied.

The above concepts accounted for individual differences in nutrient requirements within a group. When the distribution of individual differences was similar to standard distribution, it was assumed that the average requirement for essential nutrients in view of their bioavailability should be increased to account for double standard deviation, which corresponds to intake levels at which the requirements of 98% of the people in a given group are met at a level which ensures protection against the adverse consequences of deficient intake. When the distribution of nutrient requirements in statistical terms deviated from the standard or when sufficient data on differences in average requirements were not available, the relevant intake values were determined in view of the results of long-term research carried out for the nutritional assessment of a group. Due to various sources of data, scientists adopted a coefficient of individual variation at 10–15% and a margin of safety at 20–30% instead of two standard deviations (numerical value comparable with the double standard deviation). In consequence, the nutrient recommendations developed by various countries contained different definitions of intake levels, the most popular ones being:

- deficient nutrient intake levels, below which symptoms of nutritional deficiency of clinical, physiological and functional nature will be observed in all healthy individuals after some time;
- average nutrient intake levels, *i.e.* the average requirement which sustains the biochemical and physiological processes in a given group;
- recommended or reference intake levels, which correspond to the amount of nutrient needed to satisfy (with a large margin of safety) the requirements of nearly all healthy individuals in a given group, including people with very high requirements, according to the Gaussian distribution, with additional consideration given to two standard deviations. These values are characterized by a higher margin of safety. They are "optimal" values – the ingestion of the recommended nutrient amounts not only prevents malnutrition in the entire healthy population, in view of age, sex, physical activity and special physiological condition of group members, but may also be of profound significance in general prevention, including against certain civilization-related diseases. The reference values developed at this level are used to assess diet quality and to plan diets for selected population groups [DRI, 2000; Dietary..., 2000b,c; Murphy, 2003; Murphy *et al*., 2002]. The results of research investigating nutrient intakes of population groups have to be interpreted in view of safe intake level values. It is assumed that nutrient recommendations will prevent the risk of deficient intake because the intake levels of all members of a given group will correspond to their actual requirements.
- safe intake levels, describing the amount of nutrient for every group which is practically sufficient to meet the requirements of 97.5% of the people of a given group, *i.e.* healthy individuals classified according to age, sex, physical activity and physiological condition (pregnancy, lactation). Safe intake levels are determined for a group rather than individuals. The resulting values are used to evaluate diet quality [Dietary..., 2000b] and to investigate intake levels of particular groups. The safe intake level includes a certain margin of safety and may be used as an indicator of adverse nutritional trends [Dietary..., 2000c]. Deviations of minus 10% do not pose a significant health hazard. In respect of children, adolescents, pregnant and lactating women, deviations of 10% below the average safe intake level could pose a serious health and developmental hazard. Deviations of up to 20% below the average safe intake level are tolerated in adults or elderly people;
- estimated intake levels, *i.e.* accounting for a certain reserve (excluding energy) which protects the body against the adverse consequences of nutrient deficiency and guarantees optimal efficiency [Deutsche..., 1991; Wolfram, 1995, 2000]. The risk of deficient intake grows proportionally to the decrease in nutrient intake levels. Estimated intake levels do not apply to ill people, convalescents, persons suffering from malnutrition, digestive disorders, metabolic disorders, alcoholics, drug addicts, users of medication, *etc*.;
- upper safe intake levels, indicating the amount of nutrient which is safe for most healthy individuals but, if exceeded, could lead to symptoms of toxicity after some time [Dietary..., 1984, 1987; Dietary..., 1991; Ziemlański, 2001].

The term “safe intake level” applied in Great Britain is referred to as “adequate intake” in the US, while the concept of “acceptable intake” is deployed by WHO/FAO experts. The above differences stem from the fact that until now, dietary guidelines were set mostly in the context of prevention of diseases resulting from deficient nutrient intakes. For this reason, the applied criteria [Recommended..., 1974; European..., 1977; Dietary..., 1991; Nutrient..., 1993; Ziemlański *et al*., 1994, 1995, 1998; Nielsen, 1996] accounted for: prevention of classical diseases resulting from deficient nutrient intake, prevention of physiological symptoms of deficient nutrient intake, maintenance of a dietary status quo, and minimization of the risk of the above diseases.

In the light of present knowledge, the increased incidence of degenerative diseases, such as myocardial ischemia, type II diabetes, hypertension and ageing processes necessitated [Dietary..., 1997–2002; Ziemlański *et al*., 1997; Ziemlański, 2001; Gaßmann, 1997, 2001, 2003a, b] the need to modify the approach to the above criteria. The prevention of degenerative diseases was adopted as the starting point by relying on: changes in the method of expressing nutrient requirements – not in the form of a single value but as a range of the reported requirements for every nutrient; diversified bioavailability of nutrients from food, subject to country and the standard dietary ration [Halberg, 1981, Reference…, 2002, Referenzwerte, 2000, Castenmiller *et al*., 1998; The bioavailability..., 1999]; daily intake variability, new method of evaluating intake adequacy [Dietary..., 1997–2002; Hages, 1999]; and evaluation of excessive intake.

The main difference introduced with the new approach was that in addition to physiological factors, intake criteria were determined also in view of lifestyle (smoking, alcohol consumption, frequency of weight-loss diets), the environment (temperature, location, UV radiation, gas emissions), genetic variations and the related changes in nutrient intake levels.

The emerging scientific data [Dietary..., 1997-2002] postulated the need to express the recommended intake levels, in particular for nutrients and energy, in terms of "from-to" requirement ranges rather than a single value. An additional criterion of nutrient density was also introduced [Referenzwerte, 2000; Ziemlański, 2001; Forshee *et al*., 2004] to express the nutritive value and the daily recommended allowances for nutrients per energy unit.

In addition to the above criteria, nutrient intake levels are determined in view of population groups based on age, sex, type of performed physical activity and physiological condition as well as in view of different nutrient groups [Recommended..., 1974, 1989; European..., 1977; Dietary..., 1991, 1997-2002; Referenzwerte, 2000; Kappler *et al*., 2001; Reference..., 2002].

The diversity of the applied criteria prompted scientists to standardize the relevant nomenclature [Hages, 1999, Dietary..., 1997–2002]. The need for harmonization is particularly observed in research investigating nutrient requirements which should: be conducted solely for the purpose of determining nutrient requirements and should be subject to detailed control; in addition to surveying intake levels, should also involve biometric, biochemical and clinical tests; involve a larger number of research subjects to ensure that the selected group is the most representative sample; account for individual variation; and cover a longer period of investigation.

Until now, due to the absence of sufficient data on the impact of genetic variations on the determination of nutrient requirements, the relevant research was based on nutrient requirements of the entire population and accounted for variations between particular groups based on criteria such as age, sex, physiological condition and physical activity [Dietary..., 1997–2002].

An additional criterion applied in the determination of contemporary DRVs is the supplementation and fortification of food [Olney & Mulinare, 2002; Quinlivan & Gregory, 2003]. This criterion has to be taken into account to avoid situations in which undesirably high or even toxic levels of nutrient intake are observed [Pennington, 1990]. For this reason, the concept of biologically tolerable upper intake level (UL) was introduced. It is especially important for practical application of DRVs in food production and nutrition planning, evaluation of intake adequacy and nutrition education.

TERMINOLOGY RELATED TO DIETARY REFERENCE VALUES

The terminology applied to describe nutrient recommendations is vastly differentiated. The term "dietary reference values" (DRVs) was introduced by British experts for the correct interpretation of nutrient intake values which were generally understood as recommended or adequate intake levels [European Nutrition..., 1977]. This term covered the concepts of LRNI, EAR and RNI.

LRNI (Lower Reference Nutrient Intake) is the amount of nutrient and two standard deviations below the average requirements, *i.e.* the lowest allowable amount of nutrient in the daily ration which covers the basal requirement of a small number of individuals in a group characterized by lower requirements. Therefore, it indicates the lowest intake level which could satisfy the requirements of selected individuals.

EAR (Estimated Average Requirement) is the intake level which satisfies the requirement for a given nutrient of around one half of a healthy population in view of sex, age and physiological condition. EAR can be used to determine and evaluate the frequency of deficient intake in a given group (number of people whose intake levels are below EAR values). EAR is also applied to plan diet requirements for population groups.

RNI (Reference Nutrient Intake) is the reference amount of nutrients (protein, vitamins and minerals) which is sufficient to cover the requirements of 97.5% of people of a given group.

RNI corresponds to the average requirements of a group plus two standard deviations, *i.e.* the amount of nutrient sufficient to meet the requirements of the majority of healthy individuals in a given group. According to the definition of RNI, if the average intake of a given group falls within the indicated RNI range, the risk of deficient intake in that group is very low (in theory, 2.5% of the people in the group have a deficient intake level in respect of a given nutrient). In practice, this implies that extreme intake values are unlikely to be reported by selected individuals in that group due to varied intake levels, therefore the risk of deficient intake in that group is very low.

Recommended Dietary Allowances are defined as daily intake which satisfies the requirements of 97–98% healthy group individuals in view of sex, age and physiological condition. RDA is a basal value which guarantees adequate intake levels for an individual. RDA is developed based on EAR in view of the standard deviation (SD) in EAR and its distribution which approximates the normal distribution.

If sufficient data on differences in nutrient requirements of a given group are not available to determine SD, a 10% coefficient of variation is adopted which roughly corresponds to standard deviation. The value of the coefficient is determined based on an evaluation of various data concerning basal metabolism values and a similar coefficient of uncertainty of protein requirements for adult individuals (12.5%).

If nutrient intakes approximate RDA values, the risk that the requirements for a specific nutrient will not be met is very low (2–3%). Nutrient intake values at RDA level are sufficient to ensure adequate concentration of a given nutrient in the blood and guarantee the correct growth rate of a healthy individual.

When group requirements do not follow the Gaussian distribution or when the available data are not sufficient to determine RDA, adequate intake (AI) values which determine individual nutrient intake levels are stated. Individual intake levels are based on estimated or experimentally obtained values of intake levels for a given nutrient which are sufficient for a healthy individual's nutritional needs to be met.

AI (adequate intake) values are determined mostly for infants and children and are calculated in view of the composition and consumption of female milk as well as body weight. AI values cannot be used as recommended intake levels in therapy, in patients suffering from malnutrition or in health prevention where the required intakes are above the physiological level. AI can be used to evaluate intake levels of individuals and groups but only on the assumption that the data applied in its determination is more subjective than that applied in the determination of other intake levels.

Tolerable Upper Intake Levels (UL) account for the entire daily nutrient intake (food, supplementation, enriched food products) at a given time interval which does not cause adverse health effects. In this context, nutrient intakes which exceed RDA and AI values are not indicative of increased health benefits.

Two new concepts have been introduced to facilitate the planning of individual nutrient intake. They are the Energy Efficiency Ratio (EER), which is the average energy intake required to maintain the correct body weight in view of individual criteria such as age, sex, height, body weight and physical activity, and the Acceptable Macronutrient Distribution Range (AMDR), which is the range of intake of main energy sources which minimizes the risk of chronic disease while ensuring the supply of adequate amounts of essential nutrients [Dietary..., 1997–2002; Barr *et al*., 2003]. The above nutrient intake levels apply mostly to energy (EER) and macronutrients (AMDR), *i.e.* carbohydrates, protein, fat, n-6 fatty acids and α-linoleic acid. EAR, RDA, AI, UL, EER and AMDR intake levels were set by US and Canadian experts as dietary reference intakes (DRI).

The following terms are applied in Polish nutrient recommendations [Dietary..., 1984]:

- minimum nutrient intakes (requirements), which define the minimum amount of energy and nutrients required to maintain a metabolic balance and to provide the human body with short-term protection against the adverse effects of nutrient deficiency,
- recommended (physiological) nutrient intakes, which are higher than the minimum intakes and define the amount of nutrients at a level which covers the requirements of 95% of the people in a given group,
- practical nutrient intakes, which are higher than the recommended intakes and account for technological loss. Following the most recent revision of Polish nutrient recommendations in 1994 and the publication of the second supplemented edition in 1998, two reference values were introduced, *i.e.* "safe intake level" and "recommended level of intake", which differ with regard to the application and value of the safety margin.

The Polish concept of safe intake level corresponds to the British Reference Nutrient Intake (RNI) which is equivalent to the US concept of RDA or the Population Reference Intake (PRI) term applied in EU legislation. In Polish terminology, "lower" (diagnostic) average nutrient requirements refer to "minimum nutrient intakes" and apply to sodium, potassium and chloride due to their excessive intake in the population and the associated health hazards.

The latest DACH recommendations [Reference..., 2002] as well as the reference values developed by the Nordic countries rely on the concept of nutrition density [Hegsted, 1975; Wretlind, 1982], which is a reference value for the required amount of nutrients supplied with a given amount of energy (1000 kcal, 1 MJ, 10 MJ) on a daily basis. In this approach, the nutritive value and the daily recommended intake levels are a practical reference for comparing reference values in various countries or for planning and analyzing product composition and dietary rations [Castenmiller *et al*., 1998].

PRACTICAL APPLICATIONS OF TERMINOLOGY

Contemporary nutrient recommendations are used as reference values to evaluate intake adequacy, develop dietary guidelines, label food products and enrich food intended for various population groups (Table 1). Reference values are employed to evaluate the probability of adequate intake within a sufficient time frame (one week on average). To determine deficient or excessive intake, it has been proposed that group intake is evaluated based on the probability of inadequate intake [Dietary..., 1997–2002; Barr *et al*., 2003; Stumbo & Murphy, 2004; Gronowska-Senger, 2005] by relying on the "average group intake" which corresponds to the sum total of average group requirements and double standard deviation from the requirements of a given group.

TABLE 1. Application areas of DRI.

Area	Category	
	evaluation	planning
Nutrient intake	+	+
Nutrition education, dietary guidelines	+	+
Food and nutrition programs	+	+
Nutrition policies	+	+
Institutional intakes	+	+
Risk of disease	+	–
Food labeling, food marketing	–	+
Clinical nutrition	+	+
Enriched and modified food	+	+
Food safety	+	–

Nutrient intake can be evaluated at individual or group level (Table 2) by relying on the respective reference values. It should be noted, however, that the results of this evaluation are indicative only of the risk of deficient intake and should not be regarded as the only criterion in nutritional assessment. Intake values below the RDA level sustained over longer periods of time increase only the probability of deficient intake, proportionally to the level of such deficiency, and biochemical or clinical tests are required to determine the actual intake values.

EAR reference values can be employed to determine the frequency of deficient intake in a given population group.

TABLE 2. Application of DRI in nutritional assessment.

Type	Level	
	individual	group
EAR	+	+ (assessment of inadequacy within a group)
RDA	+	–
AI	+ (only when RDA is not available)	+
UL	+	+

AI values should be applied moderately because they are determined with the use of subjective data. AI is used when average or median intake values are reported. Based on AI values, the probability of adequate intake within a sufficient time frame (one week on average) can be determined.

As regards nutrition planning and nutritional assessment of population groups, *e.g*. for the purpose of determining deficient or excessive intakes in risk groups [Dietary..., 2000b], the "average required group intake" has to be determined which corresponds to the sum of the average group requirement and double standard deviation from the requirement of a given group because the variation in the group's intake is higher than individual variations within that group.

UL is applied to evaluate the quality of a group's diet based on reviews of nutrition reference values and it can be expressed in quantitative terms (percentile intake levels in excess of UL values).

All reference values (DRI) can be used to detect deficient intakes, develop improvement scenarios and prevent chronic diseases through adequate nutrition planning for groups and individuals and the development of nutrient recommendations and dietary guidelines. Intake evaluation algorithms have been developed for groups and individuals, where algorithms at the individual level account for intake levels and the variance in daily intake [Murphy, 2003; Gronowska-Senger, 2005]. Yet as regards high daily intake variance which does not correspond to normal distribution (*e.g.* research was conducted on a small scale, limited availability of data, *etc*.), statistical methods independent of statistical parameters such as high dispersion and distribution of data are required.

In Polish DRVs, safe intake level values are applied to evaluate group intakes and are an indicator of adverse dietary trends. Recommended intake values are characterized by a higher margin of safety than safe intake level values and are applied to evaluate the quality of the diet and to plan the diet for specific population groups.

EU reference standards [European..., 1977] apply the term of Population Reference Intake (PRI) to evaluate intake levels and nutritional status, and in respect of individuals, this concept is used only to determine the probability of deficient intake. In general, PRI is deployed for the purpose of planning diets and dietary guidelines. Average dietary requirements (ADR), on the other hand, are used to evaluate intake levels and nourishment standards in reference to PRI, and to label food products. The only exception is vitamin D. The Lowest Threshold Intake (LTI) is yet another reference value used in the evaluation of intake levels and nourishment standards in combination with PRI.

In DACH nutrient recommendations [Referenzwerte..., 2002], the "recommended", "estimated" and "guiding" values are used to plan and evaluate intake levels for individuals and groups.

Some recommendations make a reference to nutrient density [The Food..., 1992; Reference..., 2002; Forshee *et al*., 2004; Gronowska-Senger, 2005] which is a helpful concept in evaluating the nutrient balance of food, food enhancement and food safety policies.

CONCLUSIONS

Despite enormous progress in the development of dietary reference values, there are still vast differences in the relevant terminology, the underlying criteria and practical applications. These disparities show a need for harmonization on the international area to ensure that the related terminology and definitions are comparable and can be applied on a broad scale. In view of the above, Polish nutrient recommendations should be modified by: revising reference values for selected nutrients and introducing reference values for new nutrients in view of current scientific data; stressing the role of nutrients in the prevention of diseases such as cancer, chronic degenerative diseases (arteriosclerosis, osteoporosis) and other; placing greater emphasis on the bioavailability and quantity of nutrients in food and their possible precursors (*e.g.* carotenes); introducing reference values for average energy and nutrient requirements of a group to determine the reasons for and the magnitude of the margin of safety which was applied to develop those reference values; determining tolerable upper intake levels (UL) to account for the growing share of supplementation and enriched food in nutrition; and determining the range of nutrient intake in terms of a "from-to" requirement rather than a single value.

The advances in nutrigenomics and nutrigenetics are expected to permit the determination of the genetic and molecular factors responsible for the response of the human body to ingested food as well as to support the development of individual nutrient intake reference values.

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NORMY ŻYWIENIA – HISTORIA I TERAŹNIEJSZOŚĆ – ARTYKUŁ PRZEGLĄDOWY

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Artykuł omawia normy żywienia w kontekście ich rozwoju, kryteriów tworzenia, rodzajów oraz możliwości praktycznego zastosowania w ocenie żywienia na poziomie indywidualnym jak i populacji. Porusza też kwestie kierunku nowelizacji polskich norm.