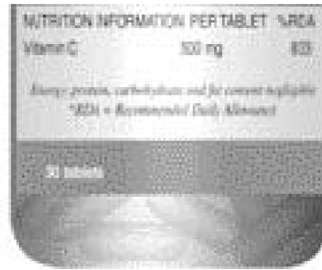
RDAs — WHAT DO THEY REALLY MEAN?

By Derek H. Shrimpton, PhD, FIBiol

This article outlines the evolution of nutritional thinking from the prevention of deficiency diseases to the optimisation of health with an explanation of the terminology used, including recommended daily amounts and their variants



Although terminology for dietary requirements was only introduced some 50 years ago, the concept is old, there being records of dietary planning in Britain in the 17th century. At the outset, the dominant concept in dietary planning was to avoid starvation and severe deficiencies of specific nutrients that led to health being seriously impaired. The occurrence of beriberi, pellagra and rickets is well documented, their cause and cure (through vitamin deficiency and therapy, respectively) being included in medical training in the first half of the 20th century. In nutrition, most of the fundamental nutrients and many of the mechanisms through which they are used were identified in the past century. Throughout this period two themes dominated research: the identification of the scientific processes through which food is used by plants and animals, and the identification and dietary quantification of the nutrients required to optimise health.

In the 21st century, the research continues, the pace is quickening and the scope is broadening, fundamentally to molecular biology and medically to sophisticated epidemiological studies. Against this background it is not surprising that the application of research conclusions has outstripped the terminology available, inevitably resulting in confusion for those not immediately involved.

EVOLUTION OF DIETARY RECOMMENDATIONS

In England, after the restoration of the monarchy in the 17th century, there was a pressing need for an effective navy at minimal cost. Samuel Pepys, the creator of the modern civil service, also created "victualling allowances" for sea captains so that they could provide sufficient food to keep their crews fit enough to man the ships. This theme of fitness for the task in hand was to continue for hundreds of years. In 19th century Britain, Dr Edward Smith was concerned by the cotton famine and devised standards to answer the question: "What is the least cost per head per week for which food can be bought in such quantity and in such quality as will avert starvation-disease from the unemployed population?" Dr Smith's standards of 1862 were expressed in terms of basic foods, for example, beef, potatoes and bread.

Another half century was to elapse before the transition could be made from food to nutrients, when during the 1914 – 1918 war, Dr Graham Lusk provided standards for energy and protein as a basis for feeding the army, many of whom were so poorly nourished that they were unable to march. Dr Lusk's nutritional standards were developed by the British Medical Association to maintain health and working capacity during the post-war depression and were further developed by the League of Nations, exploiting the rapid growth in nutritional understanding to include 12 nutrients. These were: energy, protein, fats, calcium, phosphorus, iron, iodine and vitamins A, B_1, B_2, C and D. In 1941 the National Research Council of the United States (NRC) asserted that the aim of nutrition was to "achieve buoyant health . . . and the building of our people to a level of health and vigour never before attained or dreamed of". In 1943 the NRC published its first list of dietary allowances which comprised nine nutrients. The 10th list was published in 1989 and by this time, the number of nutrients had increased to 19.

Dr Derek Shrimpton is Scientific Advisor to the Council for Responsible Nutrition

TERMINOLOGY

The term "recommended dietary allowance" (RDA) introduced by the NRC in 1941, is a recommendation for nutrient intake for a population group and should not be confused with requirements for specific individuals, which are usually unknown. The allowance is not what a population needs, but is the quantity that should be consumed in order to derive what is needed. RDA is expressed as the average daily amount that should be consumed over an unspecified period. The term recognises that particular groups of individuals (eg, infants and those over 60) have different needs and for each group, the intention was to be sufficiently generous to encompass the presumed (but unmeasured) variability in requirement among people. This meant that the value was usually set deliberately high. Thus if a population's habitual intake approximates or exceeds the RDA, the probability of deficiency is low. RDAs are calculated based on the expected intake of a population, taking account of its circumstances. They are influenced by patterns of eating, and particularly by the foods that make up the diet. Consequently RDAs vary from country to country. For example, the RDA for iron in India is higher than in the West because the Indian diet does not usually include meat and the bioavailability of iron from vegetables is less than that from meats.

There is also a calculation based on the minimum amount needed to prevent the development of a deficiency disease and this is the recommended dietary intake (RDI). Other significant factors include the time taken for body reserves to be depleted and national expert panels' opinions on the scientific literature available. For example, in the United States, the current RDA for vitamin C is twice that in the UK, mainly due to a difference in opinion on the size of body reserves that should be maintained. In practice the RDA and RDI are similar and can be regarded as alternative approaches to achieving the same objective.

The NRC recognised that RDAs could not be used for labelling because, for any one nutrient, there was a family of values depending on age and physiological condition (eg, puberty, menstruation, pregnancy, etc). The solution to this problem was to derive a set of "labelling RDAs" from the scientifically established RDAs to give a single value for all products intended for adults. The same values are even used when a product is also suitable for children. In the United States these are designated "US RDAs". Unfortunately in the UK there is no separate terminology for "labelling RDAs", although they are derived in a similar way.

Both RDAs and RDIs are sometimes incorrectly referred to as "daily" intakes. This has never been the intention of these terms. In the US, the interval over which the amount should be consumed is not defined. It is assumed that on average, the RDA will be consumed daily, but that on some days consumption will be more and on others it will be less. In the UK, RDA was interpreted as "recommended daily amount" and in 1991, the conclusions of a major review by the Committee on Medical Aspects of Food Policy (COMA) was published. Clearly the terms were giving rise to confusion and the British committee, recognising that the dietary recommendations were statistical observations, decided to reflect this in new terminologies to

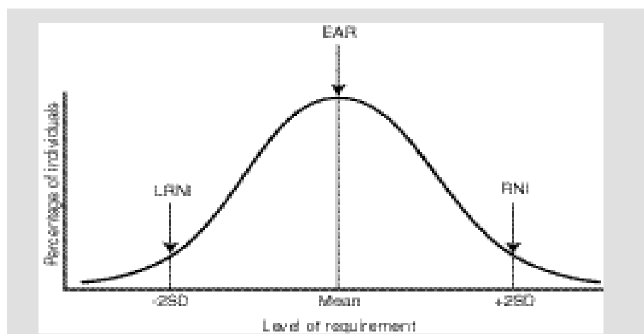


Figure 1: Normal distribution of nutrient requirements

replace RDAs and RDIs. The group assumed that requirement in a population is normally distributed and defined the mean as the "estimated average requirement" (EAR). Two standard deviations above the mean was defined as the "reference nutrient intake" (RNI) and two standard deviations below the mean as the "lower reference nutrient intake" (LRNI). This group of values was described as "dietary reference values" (DRVs). The panel set DRVs for energy, protein, sugars, fats, starches, non-starchpolysaccharides, 13 vitamins and 15 minerals. In a normal distribution, two standard deviations away from the mean accounts for 95 per cent of the population. Therefore RNIs are sufficient to meet the needs of 97.5 per cent of the population (see Figure 1). Like RDAs, RNIs are expressed as daily amounts intended to be consumed over an unspecified period. In practice, because the numerical differences between the main terms are small, we may assume that RDA, RDI and RNI are equivalent and, in most circumstances, interchangeable. The 1991 COMA report was followed by one from the European Union, also taking a similar statistical approach, and reaching essentially similar conclusions. Unfortunately this introduced yet another term, the population reference intake (PRI), paralleling the British RNI.

USE OF RDAS

It is important to remember that dietary recommendations are not intended to be applied to individuals. In the ninth edition of the NRC's dietary allowance list, published in 1980, the following uses for RDAs were considered to be appropriate:

- As standards or guides to serve as a goal for good nutrition
- To assess and interpret dietary surveys of populations
- As guidelines for planning and procuring food supplies
- As guidelines in establishing policies for health and welfare programmes
- In setting standards for new products
- In nutritional labelling
- In regulating the nutritional quality of foods
- In nutrition education

THE CURRENT POSITION

Since the above uses were listed there have been substantial advances in nutritional research and it is now recognised that there is a family of nutrient recommendations beyond those hitherto used solely to prevent deficiency diseases. In setting values, committees now also aim at health improvement. The concept that, in certain circumstances, a consumption greater than the RDA may be desirable has raised the issue of safety: is there a maximum desirable intake? And is there an intake so large that it is dangerous?

The National Academy of Sciences of the United States was the first to recognise safety issues from research in the 1960s and '70s, from which an understanding of the role of free radicals in nutrition and health started to emerge. The proposition, not yet proven beyond reasonable doubt but most strongly intimated, is that free radicals, needed to promote and facilitate oxidation in metabolic pathways, can promote ill health and premature ageing when present in excess. Free radicals are also unavoidable by-products of essential body processes but are associated with the destruction of critical physiological components. Destruction can be countered by antioxidants such as vitamin C, vitamin E, carotenoids, coenzyme Q10 and plant phenolics in general. Work on free radicals and antioxidants prompted the concept of a family of values:

- The minimum amount needed to prevent clinical deficiency
- The average amount needed to prevent clinical deficiency in a population (eg, RDA)
- The amount most likely to promote health
- The highest amount that can be consumed without harm ("tolerable upper intake" and "upper safe level")

This hierarchy has been proposed from an exhaustive and authoritative review performed under the auspices of the Academies of Sciences of the United States and of Canada. A less ambitious, but detailed, study is in progress in the UK. This is confined to establishing upper safe levels of intake. A similar, but less detailed, study is also in progress in the European Union. The expert groups have included safety in their remit, particularly in relation to the highest daily intake that could be consumed without harm. This recognises that more than the RDA will be desirable for many individuals to improve their health, but the precise amounts are unknown. In these circumstances, safety is the first and constant requirement for all products sold as foods. There is great disparity in the scope between dietary recommendations and toxic doses for different nutrients. Briefly, fat soluble vitamins and trace minerals (eg, vitamin A and selenium) are those for which most care must be taken partly because of the body's ability to store these micronutrients. Conversely, the water soluble vitamins (eg, B group and C) are not stored in the same way, and for these there is greater tolerance. Vitamin E, although fat soluble, is also without evidence of toxicity.

THE FUTURE

Currently, due to the element of unavoidable bias in measuring dietary intakes, nutritional standards only have relative validity. However, as techniques improve, reference values will be refined. The science of nutrition is still evolving. Recently, some nutrients have been shown to have pharmacological and prophylactic effects and these may become factors for consideration by future expert groups. The list of recommendations may expand further still.

CONCLUSION

It should be noted that RDAs etc, are for healthy populations only and people with chronic illnesses (eg, Crohn's disease) where absorption from the gut is impaired or where utilisation is impaired, would best be directed to consult a dietitian. For patients with health problems that do not change nutrient requirements, the reference values are a valid guide. In summary, one may assume that the recommendation that is sufficient to ensure that most of the population will not suffer a clinical deficiency may be described by any of the terms: RDA, RDI, RNI or PRI. Furthermore, one may assume that for labelling purposes there is one RDA for each nutrient for all populations. Lastly, whatever term is used, the recommended amount of nutrient should be met from a wide variety of foods because little is known about the possible harm or benefit of other components of food.

SELECTED BIBLIOGRAPHY

- Publications of the Food and Nutrition Board. Washington DC USA: National Academy Press; 2000/2001.
- Department of Health. Report on Health and Social Subjects No. 41: Dietary reference values for food energy and nutrients for the UK. London: HM Stationery Office; 1991.
- The technology of vitamins in food. P. Berry Ottaway (editor). Glasgow: Blackie Academic and Professional; 1993.
- Reports of the scientific committee for food, 31st series. Luxembourg: Office for the Official Publications of the European Community; 1993.