Nutrient Requirements and Recommendations

Key points

- Dietary Reference Values (DRVs) comprise a series of estimates of the amount of energy and nutrients needed by different groups of healthy people in the UK population.
- Included within this definition are three types of estimates: Reference Nutrient Intakes (RNIs), Estimated Average Requirements (EARs) and Lower Reference Nutrient Intakes (LRNIs).
- RNIs are used for protein, vitamins and minerals, and are an estimate of the amount that should meet the needs of most of the group to which they apply. They are not minimum targets.
- The EAR is used in particular for energy.
- Intakes below the LRNI are almost certainly not enough for most people.

What are nutritional requirements?

Today, nutritionists have a wide knowledge of the role of nutrients in health and disease. We know that people need many different nutrients if they are to maintain health and reduce the risk of diet-related diseases. The amount of each nutrient needed is called the nutritional requirement. These are different for each nutrient and also vary between individuals and life stages, e.g. women of childbearing age need more iron (link) than men.

Why do nutritional requirements vary?

Each nutrient has a particular series of functions in the body and some nutrients are needed in larger quantities than others. For example, protein is needed in gram (g) quantities. Vitamin C is needed in milligram (mg) quantities (1/1000 gram) and vitamin B_{12} is needed in microgram (µg) quantities (1/1000000 gram). Individual requirements of each nutrient are related to a person's age, gender, level of physical activity and state of health. Also, some people absorb or utilise nutrients less efficiently than others and so will have higher than average nutritional requirements, e.g. among older people, vitamin B12 (link) absorption can be relatively poor.

How are nutritional requirements estimated?

In the UK, estimated requirements for particular groups of the population are based on advice that was given by the Committee on Medical Aspects of Food and Nutrition Policy (COMA) back in the early 1990s. COMA examined the available scientific evidence and estimated nutritional requirements of various groups within the UK population (Table 1). These were published in the 1991 report *Dietary Reference Values for Food Energy and Nutrients for the United Kingdom*. Since this time, COMA has been superceded by the Scientific Advisory Committee on Nutrition (SACN). It is likely that SACN will review the UK nutritional requirements in the near future, as they are now

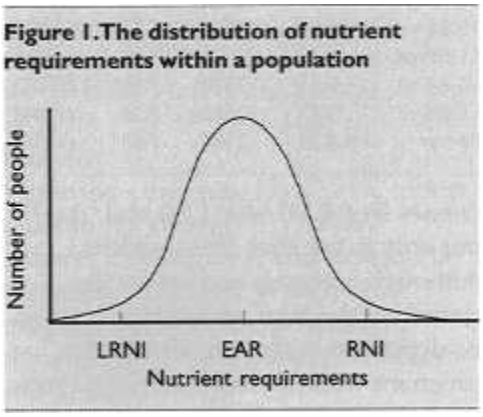
over 10 years old. Meanwhile, SACN is focusing on nutrients about which there is cause for concerns, e.g. iron (link), folate (link) and selenium (link).

Population groups for which dietary reference values have been set include:

- Boys and girls (aged 0-3 months; 4-6 months; 7-9 months; 10-12 months; 1-3 years; 4-6 years; 7-10 years)
- Males (aged 11-14 years; 15-18 years; 19-50 years; 50+ years)
- Females (aged 11-14 years; 15-18 years; 19-50 years; 50+ years; pregnancy and breastfeeding)

Dietary Reference Values (DRVs)

Meaningful estimates of nutritional requirements must take account of the distribution of requirements within a population or group. To achieve this, the COMA panel used four Dietary Reference Values (DRVs) (Figure 1). DRVs are estimates of the requirements for groups of people and are not recommendations or goals for individuals.



Estimated Average Requirement (EAR): This is an estimate of the average requirement for energy or a nutrient - approximately 50% of a group of people will require less, and 50% will require more. For a group of people receiving adequate amounts, the range of intakes will vary around the EAR.

Reference Nutrient Intake (RNI): The RNI is the amount of a nutrient that is enough to ensure that the needs of nearly all the group (97.5%) are being met. By definition, many within the group will need less.

Lower Reference Nutrient Intake (LRNI): The amount of a nutrient that is enough for only the small number of people who have low requirements (2.5%).The majority need more.

Safe intake: This is used where there is insufficient evidence to set an EAR, RNI or LRNI. The safe intake is the amount judged to be a level or range of intake at which there is no risk of deficiency and is below the level where there is a risk of undesirable effects. There is no evidence that intakes above this level have any benefits - and in some instances they could have toxic effects.

The COMA panel set EARs for energy, an EAR for dietary fibre for adults, and desirable (adult) population average intakes for fat and carbohydrate. EARs and RNIs were set for

protein, whilst LRNIs, EARs and RNIs were set for 9 vitamins and 11 minerals. Safe intakes were set for a further four vitamins (pantothenic acid, biotin, vitamin E and vitamin K) and four minerals (manganese, molybdenum, chromium and fluroride).

How should DRVs be used?

For practical purposes, the RNI should be used when assessing the dietary intake of a group. The nearer the average intake of the group is to the RNI, the less likely it is that any individual will have an inadequate intake. The nearer the average to the LRNI, the greater the probability that some individuals are not achieving adequate intakes. For example, if 20% of a group is typically consuming less than the LRNI, it is likely that most have an inadequate intake. When planning a diet for a group the aim should be to provide the RNI.

Energy requirements

The EARs for energy are based on the present lifestyles and activity (link) levels of the UK population. Although an increase in energy expenditure might have desirable health benefits for many people, the COMA panel did not believe this should be used as an argument for raising the DRVs for energy intake. (If people increase their energy intake *without* increasing energy expenditure they will become overweight).

Energy requirements are related to age, gender, body size and level of activity. Energy requirements tend to increase up to the age of 15-18 years. On average, boys have slightly higher requirements than girls and this persists throughout adulthood. After the age of about 18 years energy requirements tend to be lower, but this depends on the individual's level of activity. By the age of 50 years, energy requirements are lower still which is partly due to a reduction in the basal metabolic rate (BMR) and to a reduced level of activity.

The EARs for various groups are shown in Table 2 (see attached pdf). The EARs for adults are based on the current lifestyle in the UK which is fairly sedentary. The EARs were calculated by multiplying BMR by a factor – the Physical Activity Level or PAL – which reflects current levels of physical activity.

Energy EAR = BMR x Physical Activity Level (PAL).

A factor, or multiple of BMR, of 1.4 reflects the lifestyle of most adults in the UK. This factor is suitable for people who do little physical activity at work or in leisure time. If people are more active, larger factors (PALs) are used. For example a PAL of 1.9 would be appropriate for very active adults.

Table 2. Estimated Average Requirements for Energy

EAR - MJ/day (kcal/day)					**EAR - MJ/day (kcal/day)**				
Age	*Males*		*Females*		*Age*	*Males*		*Females*	
	(MJ)	*(kcal)*	*(MJ)*	*(kcal)*		*(MJ)*	*(kcal)*	*(MJ)*	*(kcal)*
0-3 mo	2.28	(545)	2.16	(515)	11-14 yr	9.27	(2220)	7.72	(1845)
4-6 mo	2.89	(690)	2.69	(645)	15-18 yr	11.51	(2755)	8.83	(2110)
7-9 mo	3.44	(825)	3.20	(765)	19-50 yr	10.60	(2550)	8.10	(1940)
10-12 mo	3.85	(920)	3.61	(865)	51-59 yr	10.60	(2550)	8.00	(1900)
1-3 yr	5.15	(1230)	4.86	(1165)	60-64 yr	9.93	(2380)	7.99	(1900)
4-6 yr	7.16	(1715)	6.46	(1545)	65-74 yr	9.71	(2330)	7.96	(1900)
7-10 yr	8.24	(1970)	7.28	(1740)	74+ yr	8.77	(2100)	7.61	(1810)

Special note

The EAR for women who become pregnant increases by 0.8 MJ/day (200 kcal/day) but only in the final three months. Although energy is needed for the growth of the fetus and to enable fat to be deposited in the mother's body, pregnant women can compensate for these extra demands by becoming less active and using energy more efficiently.

Breastfeeding (link) mothers have increased requirements for energy but this will depend on the amount of milk produced, the fat stores that have accumulated during pregnancy and the duration of breastfeeding.

Does the UK diet provide too much energy?

Many people in the UK manage to match their energy intake to their energy expenditure. But people who take in more energy than they require become overweight and if this continues will become obese (link). In 2001, 46% of men and 34% of women in England were overweight, and 17% and 21% respectively were obese. People who are obese have a shorter life expectancy and are at a greater risk of developing diseases such as coronary heart disease (link) and type 2 diabetes (link).

How do nutrient needs vary?

Nutritional requirements alter during a lifetime and the COMA panel reviewed the evidence on which the current estimates of nutritional requirements are based. The report set RNIs for each of the groups described above for the following nutrients:

- Protein – (link to protein section)
- **Vitamins -** thiamin, riboflavin, niacin, vitamin B_6, vitamin B_{12}, folate, vitamin C, vitamin A and vitamin D (add links).
- **Minerals -** calcium, phosphorus, magnesium, sodium, potassium, chloride, iron, zinc, copper, selenium and iodine (add links).

The major changes in the estimated nutritional requirements at different life-stages are highlighted in the following paragraphs.

Infants (link)

The first 4-6 months of life is a period of rapid growth and development. Breast milk (or infant formula) contains all the nutrients required during this period. Mothers should be encouraged to breastfeed and *not* to give solid foods to infants before the age of 4 months. Recent Department of Health advice recommends exclusive breastfeeding until 6 months of age. During the early months of life, babies can draw upon iron (link) stores they have accumulated before birth but these stores are rapidly depleted and it is important that the diet given during weaning (link) contains enough iron to meet the baby's needs for growth and development. Requirements for protein (link), thiamin (link), niacin (link), vitamin B_6 (link), vitamin B_{12} (link), magnesium (link), zinc (link), sodium (link)and chloride (link)also increase between 6 and 12 months.

Children 1-3 years (link to preschoolers)

Energy requirements increase because children are active and growing rapidly. Protein requirements do not increase much. There is an increased need for all the vitamins, except vitamin D (some of which will now be synthesised in the skin, following sunlight exposure). Slightly lower amounts of calcium, phosphorus and iron are needed. There is an increased requirement for all the other minerals except for zinc.

In the second year of life, children continue to need energy-dense diets. They should be given whole milk (link), not skimmed or semi skimmed, and care needs to be taken over the amount of fibre (non-starch polysaccharide or NSP) (link) eaten. If the diet is too bulky due to too many high fibre foods, there is a danger the child will be unable to eat enough food to satisfy its energy needs. After the age of 2 years, semi-skimmed milk may be given provided adequate energy intake is assured, although skimmed milk should not be introduced before 5 years of age.

4-6 years

Energy requirements continue to increase and there is a greater need for protein, all the vitamins (except C and D) and all the minerals (except iron). The RNI figure for vitamin C remains the same as for younger children. No value is given for vitamin D since the action of sunlight on the child's skin will now be the major source of this vitamin.

7-10 years (link to schoolchildren)

There is a marked increase in requirements for energy and protein. There is no change in the requirement for thiamin, vitamin C or vitamin A but the requirements for the other vitamins and minerals are increased.

11-14 years (link to schoolchildren)

Energy requirements continue to increase and protein requirements increase by approximately 50%. By the age of 11**,** the vitamin and mineral requirements for boys and girls start to differ.

Boys: There is an increased requirement for all the vitamins and minerals.

Girls: There is no change in the requirement for thiamin, niacin, vitamin B_6, but there is an increased requirement for all the minerals. Girls have a much higher iron requirement than boys (once menstruation starts).

15-18 years (link to adolescents)

Boys: Energy and protein requirements continue to increase as do the requirements of a number of vitamins i.e. thiamin, riboflavin, niacin, vitamins B_6, B_{12}, C and A; and magnesium, potassium, zinc, copper, selenium and iodine. Calcium requirements remain high as skeletal development is rapid.

Girls: Requirements for energy, protein, thiamin, niacin, vitamins B_6, B_{12} and C, phosphorus, magnesium, potassium, copper, selenium and iodine all increase. Boys and girls have the same requirement for vitamin B_{12}, folate, vitamin C, magnesium, sodium, potassium, chloride and copper. Girls have a higher requirement than boys for iron (due to menstrual losses) but a lower requirement for zinc and calcium.

Adults (link)

19-50 years

In comparison to adolescents, energy requirements are lower for both men and women, as are requirements for calcium and phosphorus. There is also a reduced requirement in women for magnesium, and in men for iron. The requirements for protein and most of the vitamins and minerals remain virtually unchanged in comparison to adolescents (except for selenium in men which increases slightly).

Pregnancy (link)

During pregnancy, there are increased requirements for some, but not all, nutrients. Women intending to become pregnant and for the first 12 weeks of pregnancy are advised to take supplements of folic acid (link) to help reduce the risk of their child having a neural tube defect. In addition, all women of child bearing age are advised to choose a diet that supplies adequate amounts of folate (link) (Department of Health,

1992.) Additional energy and thiamin are required only during the last three months of pregnancy. Mineral requirements do not increase.

Lactation (link)

During lactation, there is an increased requirement for energy, protein, all the vitamins (except B_6), calcium, phosphorus, magnesium, zinc, copper and selenium.

50+ years

Energy requirements decrease gradually after the age of 50 in women and age 60 in men as people typically become less active. Protein requirements decrease for men but continue to increase slightly in women. The requirements for vitamins and minerals remain virtually unchanged for both men and women. There is one exception - after the menopause, women's requirement for iron is reduced to the same level as that for men. After the age of 65 the RNI for vitamin D (link) is 10 µg/day. The reduction in energy needs, coupled with unchanged requirements for vitamins and minerals, means that the nutrient density of the diet becomes even more important. Nutrient density means the quantity of vitamins and minerals in relation to the amount of energy supplied by the foods and drinks consumed.

UK Recommendations

Fat, protein, carbohydrate and alcohol provide energy (link). There is evidence to suggest that the energy mix of the diet can influence the risk of developing various diseases, such as coronary heart disease (e.g. too much fat) and certain cancers (e.g. too much alcohol). The COMA panel reviewed the evidence and concluded that it would be useful to set DRVs for total fat (fatty acids and glycerol), fatty acid subclasses, sugars and starches (see Table 3 in the attached pdf). Guidelines also exist for alcohol intake (link).

The Committee also suggested that the average intake of fibre or NSP should be 18g/day (individual range 12-24g/day) for adults but recommended that children's intakes of NSP should be less than this. Alcohol should provide no more than 5% of energy in the diet, but as some people do not drink, DRVs were calculated for diets containing alcohol (total energy) and not containing alcohol (food energy).

Surveys such as the National Diet and Nutrition Survey series (Links) compare current intakes of nutrients with the various DRV values to assess where problems exist and to assist in forming government policy.

Table 3. DRVs (population averages) for protein, carbohydrate and fat as a percentage

	% of daily total energy intake (including alcohol)	% of daily food energy intake (excluding alcohol)	2000/2001 Average British adult intakes	
			Men	**Women**
Protein	15	15	16.5	16.6
Total Carbohydrate	47	50	47.7	48.5
Of which non milk extrinsic sugars*	10	11	13.6	11.9
Total fat	33	35	35.8	34.9
Of which saturated fatty acids	10	11	13.4	13.2
polyunsaturated fatty acids	6**	6.5	6.4	6.3
trans fatty acids	2	2	1.2	1.2
monounsaturated fatty acids	12	13	12.1	11.5

*NMES - free sugar not bound in foods, e.g. table sugar, honey and sugars in fruit juices, but excluding milk sugar.

** An individual maximum of 10% applies (with an individual minimum of 0.2% from linolenic acid, and 1% linoleic acid).

Alcohol should provide no more than 5% of energy in the diet.

Sources:

Department of Health (1991) Dietary Reference Values for Food Energy and Nutrients in the United Kingdom. HMSO, London.

Henderson et al (2003) The National Diet and Nutrition Survey: Adults Aged 19-64 years, Volume 2: Energy, Protein, Carbohydrate, Fat and Alcohol Intake. London, HMSO.