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Nordic Nutrition Recommendations

2012 · Part 1

Summary, principles and use


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5th edition

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Preface

The 5th edition of the Nordic Nutrition Recommendations, NNR 2012, has been produced by a working group nominated by the Working Group on Food, Diet and Toxicology (Nordiska arbetsgruppen för kosthållning, mat och toxikologi (NKMT)) under the auspices of the Nordic Committee of Senior Officials for Food Issues (Nordiska ämbetsmannakommittén för fiske och vattenbruk, jordbruk, livsmedel och skogsbruk (ÄK-FJLS Livsmedel). The NNR 2012 working group was established in 2009 and consisted of Inge Tetens and Agnes N. Pedersen of Denmark; Ursula Schwab and Mikael Fogelholm of Finland; Inga Thorsdottir and Ingibjorg Gunnarsdottir of Iceland; Sigmund A. Anderssen and Helle Margrete Möltzer of Norway; and Wulf Becker (Chair), Ulla-Kaisa Koivisto Hursti (Scientific secretary), and Elisabet Wirfält of Sweden.

More than 100 scientific experts have been involved in this revision. Existing scientific evidence has been reviewed for setting dietary reference values (DRVs) that will ensure optimal nutrition and help prevent lifestyle-related diseases such as cardiovascular diseases, osteoporosis, certain types of cancer, type-2 diabetes, and obesity as well as the related risk factors for these diseases. The experts have assessed the associations between dietary patterns, foods, and nutrients and specific health outcomes. The work has mainly focused on revising areas in which new scientific knowledge has emerged.

Systematic reviews (SR) were conducted by the experts, with assistance from librarians, for the nutrients and topics for which new data of specific importance for setting the recommendations has been made available since the 4th edition. Less stringent updates of the reference values were conducted for the other nutrients and topics.

Peer reviewers for each nutrient and topic have also been engaged in the process of reading and commenting on the SRs and the updates conducted by the expert groups. A reference group consisting of senior experts representing various fields of nutrition science both within and outside the Nordic countries has also been engaged in the project. A steering group with representatives from national authorities in each country has been responsible for the overall management of the project.

All chapters were subject to public consultations from October 2012 to September 2013. The responses and actions to the comments by the NNR working group are published separately.

The SRs and the updates form the basis for deriving the DRVs. In the process of deriving the NNR 2012, emphasis has been put on the whole diet and the current dietary practices in the Nordic countries. This evaluation was performed by the NNR 2012 working group and was not part of the SRs conducted by the expert groups. The SRs were used as major and independent components – but not the only components – for the decision-making processes of the working group that was responsible for deriving the NNR 2012.

The SRs are published in the Food & Nutrition Research journal and the other background papers can be found on the Nordic Council of Ministers (NCM) website.

The 5th edition, the Nordic Nutrition Recommendations 2012, is published by the NCM and is also available in electronic form.

The following experts and peer reviewers have been engaged in performing SRs and chapter updates.

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Calcium experts: Christel Lamberg-Allardt, Kirsti Uusi-Rasi and Merja Kärkkäinen, Finland.
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Fat and fatty acids experts: Ursula Schwab and Matti Uusitupa, Finland, Thorhallur Ingi Halldorsson, Iceland, Tine Tholstrup and Lotte Lauritzen, Denmark, Wulf Becker and Ulf Risérus, Sweden.

Peer reviewers: Jan I Pedersen, Norway, Ingibjörg Hardardottir, Iceland, Antti Aro, Finland, Jorn Dyerberg, Denmark, Göran Berglund, Sweden.

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Peer reviewers: Helle Margrete Meltzer, Norway, Peter Lauerberg, Denmark

Iron experts: Magnus Domellöf, Sweden, Ketil Thorstensen, Norway, Inga Thorsdottir, Iceland.
Peer reviewers: Olle Hernell, Sweden, Lena Hulthén, Sweden, Nils Milman Denmark.

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Vitamin D experts: Christel Lamberg-Allardt, Finland, Magritt Brustad, Norway, Haakon E Meyer, Norway, Laufey Steingrimsdottir, Iceland.
Peer reviewers: Rikke Andersen, Denmark, Mairead Kiely, Ireland, Karl Michaëlsson, Sweden, Gunnar Sigurdsson, Iceland.

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Peer reviewers: Morten Grønbæk, Denmark and Satu Männistö Finland.

Fluid and water balance expert: Per Ole Iversen, Norway.

Vitamin B6, Vitamin B12: Revised by the NNR5 working group.

Thiamin, Riboflavin, Niacin, Biotin, Pantothenic acid: Hilary Powers, United Kingdom. Evaluation of need for revision. Revised by the NNR5 working group.

Vitamin K expert: Arja T Erkkilä, Finland. Peer reviewer: Sarah L. Booth, USA.

Dietary Antioxidants expert: Samar Basu, France. Peer reviewer: Lars Ove Dragsted, Denmark.

Vitamin A: Håkan Melhus, Sweden. Evaluation of need for revision. Chapter revised by the NNR5 working group.

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Introduction

For several decades, the Nordic countries have collaborated in setting guidelines for dietary composition and recommended intakes of nutrients. Similarities in dietary habits and in the prevalence of diet-related diseases, such as cardiovascular diseases, osteoporosis, obesity and diabetes, has warranted a focus on the overall composition of the diet, i.e. the intake of fat, carbohydrate, and protein as contributors to the total energy intake. In 1968, medical societies in Denmark, Finland, Norway, and Sweden published a joint official statement on "Medical aspects of the diet in the Nordic countries" (Medicinska synpunkter på folkkosten i de nordiska länderna). The statement dealt with the development of dietary habits and the consequences of an unbalanced diet for the development of chronic diseases. Recommendations were given both for the proportion of fat in the diet and the fat quality, i.e. a reduced intake of total fat and saturated fatty acids and an increase in unsaturated fatty acids.

The Nordic Nutrition Recommendations (NNR) are an important basis for the development of food, nutrition, and health policies; for formulation of food-based dietary guidelines; and for diet and health-related activities and programmes. Previous editions mainly focused on setting dietary reference values (DRVs) for the intake of, and balance between, individual nutrients for use in planning diets for various population groups. The current 5th edition puts the whole diet in focus and more emphasis is placed on the role that dietary patterns and food groups play in the prevention of diet-related chronic diseases.

The NNR are intended for the general population and not for groups or individuals with diseases or other conditions that affect their nutrient requirements. The recommendations generally cover temporarily increased requirements, for example, during short-term mild infections or certain medical treatments. The recommended amounts are usually not suited for long-term infections, malabsorption, or various metabolic disturbances or for the treatment of persons with a non-optimal nutritional status. They are meant to be used for prevention purposes and are not specifically meant for treatment of diseases or significant weight reduction. The NNR do, however, cover dietary approaches for sustainable weight maintenance

after significant and intentional weight reduction. For specific groups of individuals with diseases and for other groups with special needs or diets, dietary composition might have to be adjusted accordingly.

After a thorough revision in which experts have reviewed a vast amount of scientific publications, most of the recommendations from the 4th edition (2004) remain unchanged. However, the RIs for vitamin D in children older than 2, adults, and the elderly ≥75 years of age and for selenium in adults have been increased. An emphasis has been put on the quality of fat and carbohydrates and their dietary sources. The recommendation for protein has been increased for the elderly ≥65 years of age. No recommended intakes have been set for biotin, pantothenic acid, chromium, fluoride, manganese, or molybdenum due to insufficient data, and this represents no change from the 4th edition.

The primary aim of the NNR 2012 is to present the scientific background of the recommendations and their application. A secondary aim is for the NNR 2012 to function as a basis for the national recommendations that are adopted by the individual Nordic countries.

The NNR 2012 are to be used as guidelines for the nutritional composition of a diet that provides a basis for good health. The basis for setting recommendations is defined for each individual nutrient using the available scientific evidence. In many cases, the values for infants and children are derived from adult data using either body weight or energy requirement as a basis for the estimations. As new scientific knowledge emerges with time, the NNR have to be reassessed when appropriate and should, therefore, not be regarded as definitive.

The NNR are based on the current nutritional conditions in the Nordic countries and are to be used as a basis for planning a diet that:

- satisfies the nutritional needs, i.e. covers the physiological requirements for normal metabolic functions and growth, and
- supports overall good health and contributes to a reduced risk of diet-associated diseases.

The NNR are valid for the average intake over a longer period of time of at least a week because the dietary composition varies from meal to meal and from day to day. The recommended intakes refer to the amounts of nutrients ingested, and losses during food preparation, cooking, etc. have to be taken into account when the values are used for planning diets.

The NNR can be used for a variety of purposes:

- as guidelines for dietary planning
- as a tool for assessment of dietary intake
- as a basis for food and nutrition policies
- as a basis for nutrition information and education
- as guiding values when developing food products

1 Nordic Nutrition Recommendations 2012 A summary

Background

The current 5th edition of the Nordic Nutrition Recommendations (NNR 2012) puts the whole diet in focus. The recommendations emphasize food patterns and nutrient intakes that, in combination with sufficient and varied physical activity, are optimal for development and function of the body and that contribute to a reduced risk of certain diet-associated diseases. The development of the NNR is based on current scientific knowledge and an overall assessment of the available evidence.

Previous editions of the NNR mainly focused on setting DRVs for the intake of, and balance between, individual nutrients for use in planning diets for various population groups. In the current 5th edition, however, more emphasis is put on the role of dietary patterns and food groups in contributing to the prevention of the major diet-related chronic diseases. Nutrition research has traditionally strived to identify the specific mechanisms and health impacts of single nutrients, but most foods contain many nutrients as well as a multitude of other potential bioactive constituents that can affect bioavailability, uptake, and metabolic responses. Nutrients and other constituents interact with each other and the surrounding food matrix in complex ways. Thus, associations between single factors and chronic disease can be difficult to identify and difficult to interpret. In contrast, studies of dietary patterns or whole diets examine the association of combinations of many foods and nutrients with health.

The NNR 2012 has established the scientific evidence for an optimal intake and combination of nutrients for various groups in the general population. The evidence underlying the DRVs for nutrients includes the scientific evidence regarding food and nutrient intakes and dietary patterns and thus also accounts for factors other than nutrients.

Long-term energy balance and adequate physical activity are other important characteristics of healthy nutrition and lifestyle. NNR 2012 puts emphasis on the importance of adequate physical activity that, in combination with an appropriate food pattern, supports the long-term maintenance of a healthy body weight.

The scientific documentation is found in the individual chapters.

What characterises a healthy diet?

In recent years, much new data from both observational and experimental studies have been published on the health impact of foods, food patterns, and whole diets. These studies do not search for the specific mechanism or influence of a single nutrient but strive to capture the combined effects of all nutrients and food components consumed. As a result, there is currently a large body of evidence directly supporting the importance of specific food patterns or dietary patterns in maintaining good health. This evidence might facilitate the formulation of food-based dietary guidelines and recommendations for nutrient intakes. In addition, the evidence for the importance of early nutrition in terms of both short- and long-term health is growing. Promoting and supporting exclusive breastfeeding for the first 6 months of an infant's life followed by partial breastfeeding until the age of one year is one strategy to promote adequate growth and prevent obesity later in life.

By also considering factors like food production characteristics, seasonal food supply, and food origin when selecting food items, a diet that supports health can also be sustainable from an environmental and ecological perspective.

Dietary patterns and health – scientific evidence

SRs of prospective population studies as well as RCTs regarding associations between dietary patterns and the risk for chronic diseases such as coronary heart disease, myocardial infarction, postmenopausal breast cancer, and obesity reach similar conclusions. Dietary patterns rich in vegetables, including dark green leaves, fresh peas and beans, cabbage, onion, root vegetables, fruiting vegetables (e.g., tomatoes, peppers, avocados, and olives), pulses, fruits and berries, nuts and seeds, whole grains, fish and seafood, vegetable oils and vegetable oil-based fat spreads (derived from, for example, rapeseed, flaxseed, or olives), and low-fat dairy products are,

compared to Western-type dietary patterns (see below), associated with lower risk of most chronic diseases. These observations are similar to SRs of the health impact of diets such as the Mediterranean-like diets. Such plant food-dominated dietary patterns provide high amounts of micronutrients (essential minerals and vitamins), and the types of fats (including essential fatty acids) and carbohydrates in these diets are generally favourable to good health. This type of plant food-based diet also provides a number of potential bioactive components such as antioxidants, phenolic compounds, and phytoestrogens that have been associated with protection against many chronic diseases. In addition, randomised controlled intervention trials of whole diets have repeatedly and convincingly demonstrated that diets in line with current dietary recommendations are associated with important health benefits. Several such trials have been conducted in the US, Europe, and the Nordic countries.

In contrast, Western-type dietary patterns that are characterized by high consumption of processed meats and red meats (i.e., beef, pork, and lamb) and of food products low in essential nutrients but high in added sugar and fat (i.e., foods with high energy density) and high in salt are associated with adverse health effects and chronic diseases. Evidence also exists that suggests that food preparation and manufacturing methods that involve prolonged treatment at very high temperatures might contribute to adverse health effects.

The findings mentioned above underscore the fact that single food items or nutrients cannot alone ensure overall health and that diet as a whole needs to be considered.

Foods and health – scientific evidence

Plant foods such as vegetables, fruits and berries, nuts and seeds, and whole-grain cereals are rich in dietary fibre, micronutrients, and potential bioactive constituents. There is strong scientific evidence that natural fibre-rich plant foods contribute to decreased risk of diseases such as hypertension, cardiovascular diseases, type-2 diabetes, and some forms of cancer. The low energy density and the physico-chemical properties of most plant foods can contribute to weight maintenance. Because obesity and excessive body fat are established risk factors for most chronic diseases, including many types of cancer, low energy-density diets might also contribute to protection against a majority of chronic diseases. Fatty fish, nuts, seeds, and vegetable oils provide different kinds of unsaturated fatty acids. Seed

oils such as rapeseed and flaxseed oils are rich in both n-3 and n-6 fatty acids. The very long-chain n-3 fatty acids found in fish are of special health importance. There is strong scientific evidence supporting unsaturated fats as the major part of the total fat intake.

Animal foods such as meat, dairy, and eggs are important protein and mineral sources in the diet. Because meat and dairy are also major contributors of saturated fatty acids, high-fat products should be exchanged for low-fat dairy and low-fat meat alternatives. There is strong epidemiological evidence that high consumption of processed meat increases the risk of colorectal cancer, type-2 diabetes, obesity, and coronary heart disease. Similar, but weaker, associations have been observed for red meat. Replacing processed and red meat with vegetarian alternatives (such as pulses), fish, or poultry reduces the risk. High consumption of low-fat milk products has been associated with reduced risk of hypertension, stroke, and type-2 diabetes.

High consumption of beverages with added sugars is linked to increased risk of type-2 diabetes in both epidemiological and randomized controlled trials. Diets with plenty of meat, refined grains (i.e., white bread and products made with sifted flour), sweets, sugar-rich drinks, and desserts predict more weight gain and larger waist circumference. There is also strong scientific evidence that high salt (NaCl) intakes lead to increased risk of hypertension.

Implications of documented diet-related disease risks

Based on the scientific evidence documented in the 5th edition of the NNR, an overall micronutrient-dense dietary pattern and a set of food selection changes have been identified to promote health and wellbeing in the Nordic populations. These are summarized in Table 1.1.

– *Decrease energy density, increase micronutrient density, and improve carbohydrate quality*

Diets dominated by naturally fibre-rich plant foods will generally be lower in energy density compared to diets dominated by animal foods. Energy density is generally high in food products high in fat and added sugar (e.g., desserts, sweets, candy bars, cakes and biscuits, savoury snacks, some breakfast cereals, ice-cream, and some milk products). Whole grains and whole-grain flour are rich in dietary fibre and have lower energy density compared to refined grains and sifted flour. Limited consumption of sugar-

sweetened beverages will contribute to increased micronutrient density and reduced intake of added sugars.

– *Improve dietary fat quality by balancing the fatty acid proportions*
Fatty fish, nuts and seeds, vegetable oils, and vegetable oil-based fat spreads that provide essential and unsaturated fatty acids should be prioritized. Animal products high in fat contribute saturated fatty acids. A switch from high-fat to low-fat dairy will contribute to an improved fat quality while sustaining micronutrient density.

– *Limit processed and red meat*
Limited processed and red meat consumption, and a switch from high-fat to low-fat meat, will contribute to both an improvement of dietary fat quality and to lower energy density in the diet.

– *Limit the use of salt in food products and food preparation*
Manufactured foods provide a large proportion of the total salt intake. A reduction of the salt intake can be achieved by choosing low-salt varieties and limiting the amount of salt added during food preparation.

Table 1.1. Dietary changes that potentially promote energy balance and health in Nordic populations.

Increase	Exchange		Limit
Vegetables Pulses	Refined cereals	➞ Wholegrain cereals	Processed meat Red meat
Fruits and berries	Butter Butter based spreads	➞ Vegetable oils vegetable oil based fat spreads	Beverages and foods with added sugar
Fish and seafood	High-fat dairy	➞ Low-fat dairy	Salt
Nuts and seeds			Alcohol

Nutrients and health – scientific evidence

Macronutrients

NNR 2012 establishes Recommended Intake Ranges for macronutrients. The current scientific evidence used to set recommended intake ranges is strong for certain sub-categories of macronutrients but less so for the

intake of total carbohydrates and fat. The scientific evidence for the fatty acid composition in the diet is stronger than for the total fat intake with respect to development of chronic diseases such as coronary heart disease, type-2 diabetes, and certain cancers. Also, the dietary sources of major fatty acid categories play an important role in the associations with health. The same applies to carbohydrates where the content and profile of the various dietary constituents determine the physiological and health effects. Frequent consumption of plant foods that are rich in dietary fibre, such as whole-grain cereals, is generally associated with health benefits, and frequent consumption of foods rich in refined grains and sifted flour and added sugars is associated with increased risk of chronic diseases. Scientific evidence also indicates that the health effects of fat intake can be modified by the amount and food sources of carbohydrates and fibre.

Vitamins and minerals

NNR 2012 sets Recommended Intakes (RI) for most essential micronutrients. These RIs are based on different types of scientific evidence, and should, when consumed as part of a varied, well-balanced diet, assure optimal function and development and contribute to a reduced risk of major chronic diseases. RIs have traditionally been based on criteria for optimal development and maintenance of body functions. In recent decades, however, more emphasis has been put on criteria such as the influences on the risk factors for chronic disease and on the risk of chronic diseases. Thus recent national nutrition surveys and dietary patterns in the Nordic countries indicate that emphasis needs to be put partly on certain micronutrients (e.g., vitamin D, selenium, iodine, sodium, iron, and folate) and partly on the quality of carbohydrates and fats.

Dietary Reference Values for nutrient intakes intended for dietary planning

NNR 2012 includes recommended intake ranges for macronutrients, upper or lower threshold levels for certain subcategories, and RIs of essential micronutrients. The macronutrient sub-categories are polyunsaturated, monounsaturated, saturated, and trans-fatty acids; protein; dietary fibre; and added, refined sugars. Recommendations are also given for alcohol consumption for adults.

Recommended intakes of macronutrients (excluding energy from alcohol)

Adults and children from 2 years of age

Fatty acids (expressed as triglycerides)

Intake of cis-monounsaturated fatty acids should be 10-20 % of the energy intake (E%).

Intake of cis-polyunsaturated fatty acids should be 5-10 E%, of which n-3 fatty acids should provide at least 1 E%.

Cis-monounsaturated and cis-polyunsaturated fatty acids should constitute at least two thirds of the total fatty acids in the diet.

Intake of saturated fatty acids should be limited to less than 10 E%.

Intake of trans-fatty acids should be kept as low as possible.

The total fat recommendation is 25-40 E% and is based on the recommended ranges for different fatty acid categories.

Linoleic (n-6) and alpha linolenic (n-3) acids are essential fatty acids and should contribute at least 3 E%, including at least 0.5 E% as alpha linolenic acid. For pregnant and lactating women, the essential fatty acids should contribute at least 5 E%, including 1 E% from n-3 fatty acids of which 200 mg/d should be docosahexaenoic acid, DHA (22:6 n-3).

Partly replacing saturated fatty acids with cis-polyunsaturated fatty acids and cis-monounsaturated fatty acids (oleic acid) from vegetable dietary sources (e.g., olive or rapeseed oils) is an effective way of lowering the serum LDL-cholesterol concentration. Replacement of saturated or trans-fatty acids with cis-polyunsaturated or cis-monounsaturated fatty acids decreases the LDL/HDL-cholesterol ratio. Replacing saturated and trans-fatty acids with cis-polyunsaturated fatty acids reduces the risk, for example, of coronary heart disease, and replacement of saturated and trans-fatty acids with cis-monounsaturated fatty acids from vegetable dietary sources (e.g., olive or rapeseed oils) has similar effects.

Even though total fat intake varies widely, population and intervention studies indicate that the risk of atherosclerosis can remain quite low as long as the balance between unsaturated and saturated fatty acids is favourable. In addition to the quality of fat, it is important to pay attention to the quality of carbohydrates and the amount of dietary fibre, that is, the

recommendations for dietary fibre and carbohydrates (with low intakes of added sugar) should be achieved through an ample supply of plant-based foods. The recommended range for the total amount of fat is 25-40 E% based on the sum of the ranges of the recommendations for individual fatty acid categories.

For the intake of total fat, a suitable target for dietary planning is 32-33 E%.

At total fat intakes below 20 E%, it is difficult to ensure sufficient intake of fat-soluble vitamins and essential fatty acids. A reduction of total fat intake below 25 E% is not generally recommended because very low-fat diets tend to reduce HDL-cholesterol and increase triglyceride concentrations in serum and to impair glucose tolerance, particularly in susceptible individuals.

Carbohydrates and dietary fibre

Health effects of dietary carbohydrates are related to the type of carbohydrate and the food source. Carbohydrates found in whole-grain cereals, whole fruit, vegetables, pulses, and nuts and seeds are recommended as the major sources of carbohydrates. Total carbohydrate intakes in studies on dietary patterns associated with reduced risk of chronic diseases are in the range of 45-60 E%. A reasonable range of total carbohydrate intake is, however, dependent on several factors such as the quality of the dietary sources of carbohydrates and the amount and quality of fatty acids in the diet.

Dietary fibre

Adults: Intake of dietary fibre should be at least 25-35 g/d, or approximately 3 g/MJ.

Children: An intake corresponding to 2-3 g/MJ is appropriate for children from 2 years of age. From school age, the intake should gradually increase to reach the recommended adult level during adolescence.

An adequate intake of dietary fibre reduces the risk of constipation and contributes to a reduced risk of colorectal cancer and several other chronic diseases such as cardiovascular disease and type-2 diabetes. Moreover, fibre-rich foods help in maintaining a healthy body weight. Intake of appropriate amounts of dietary fibre from a variety of foods is also important for children.

For dietary planning purposes, a suitable target is >3 g/MJ from natural fibre-rich foods such as vegetables, whole grains, fruits and berries, pulses, and nuts and seeds.

Added sugars

Intake of added sugars should be kept below 10 E%.

A restriction in the intake of added refined sugars[1] is important to ensure adequate intakes of micronutrients and dietary fibre (nutrient density) as well as to support a healthy dietary pattern. This is especially important for children and persons with a low energy intake. Consumption of sugar-sweetened beverages has been associated with an increased risk of type-2 diabetes and excess weight gain and should, therefore, be limited. Frequent consumption of sugar-containing foods should be avoided to reduce the risk of dental caries. The recommended upper threshold for added sugar is also compatible with the food-based recommendation to limit the intake of sugar-rich beverages and foods.

The recommended range for the total amount of carbohydrate is 45-60 E%. For dietary planning purposes, a suitable target for the amount of dietary carbohydrate is 52-53 E%.

Protein

Adults and children from 2 years of age: Protein should provide 10-20% of the total energy intake (E%).

Elderly (≥65 years): Protein should provide 15-20 E%, and with decreasing energy intake (below 8 MJ/d) the protein E% should be increased accordingly.

In order to achieve an optimal intake in a varied diet according to Nordic dietary habits, a reasonable range for protein intake is 10-20 E%. This intake of protein should adequately meet the requirements for essential amino acids.

1 Added sugars include sucrose, fructose, glucose, starch hydrolysates (glucose syrup and high-fructose syrup), and other isolated sugar preparations used as such or added during food preparation and manufacturing.

For food planning purposes, a suitable target for the amount of protein intake should be 15 E%. This corresponds to about 1.1 g protein per kg body weight and day.

For food planning purposes in the elderly, a suitable target for the amount of protein intake should be 18 E%. This corresponds to about 1.2 g protein per kg body weight and day.

Alcohol

The consumption of alcohol should be limited and should not exceed approximately 10 g alcohol per day for women or 20 g per day for men. The energy contribution from alcohol should not exceed 5 E% in adults. Pregnant women, children, and adolescents are recommended to abstain from alcohol.

Recommended intakes of macronutrients for children up to 2 years of age

n-6 fatty acids should contribute at least 4% of the total energy intake (E%) for children 6-11 months and 3 E% for children 12-23 months of age.

n-3 fatty acids should contribute at least 1 E% for children 6-11 months and 0.5 E% for children 12-23 months.

During the first year, the intake of trans fatty acids should be kept as low as possible.

From 12 months, the recommendation on saturated and trans-fatty acids for older children and adults should be used.

Exclusive breastfeeding is recommended for infants during the first 6 months. Recommendations for the intake of energy-yielding nutrients for children 6-23 months are given in Table 1.2. There is convincing evidence that the risk of obesity in childhood and adolescence increases with increased protein intake during infancy and early childhood. Protein intake should increase from about 5 E% (the level in breast milk) to the intake range of 10-20 E% for older children and adults.

Table 1.2. Recommended intake of fat, carbohydrates, and protein
Expressed as per cent of total energy intake (E%) for children 6-23 months[a].

Age	E%
6-11 months	
Protein	7-15
Fat	30-45
Carbohydrates [b]	45-60
12-23 months	
Protein	10-15
Fat	30-40
Carbohydrates [b]	45-60

[a] Because exclusive breastfeeding is the preferable source of nutrition for infants <6 months, no recommendations for fat, protein, or carbohydrate intakes are given for this age group. For non-breastfed infants, it is recommended that the values for infant formula given in the EC legislation (REGULATION (EC) No 1243/2008 and Directive 2006/141/EC) be used. If complementary feeding has started at 4-5 months, the intakes recommended for 6-11 month olds should be used.

[b] Intake of added sugars should be kept below 10 E%.

Recommended intake of vitamins and minerals

The RIs of certain vitamins and minerals, expressed as average daily intakes over time, are given in Table 1.3. The values for RIs are intended mainly for planning diets for groups of individuals of the specified age intervals and sex. The values include a safety margin accounting for variations in the requirement of the group of individuals and are set to cover the requirements of 97% of the group. An alternative way to plan a diet is to use the requirements in combination with the distribution of reported or usual intakes for the specific nutrients (see Chapter 3 Use of Nordic Nutrition Recommendations).

The NNR 2012 do not cover all known essential nutrients because the scientific basis for establishing recommendations was considered incomplete for some nutrients.

Table 1.3. Recommended intake of certain nutrients
Expressed as the average daily intake over time for use in planning diets for groups [a]. The requirements are lower for almost all individuals.

Age mo/ years	Vit. A RE [c]	Vit. D [d] µg	Vit. E a-TE [e]	Thiamin mg	Riboflavin mg	Niacin NE [f]	Vit. B_6 mg	Folate µg	Vit. B_{12} µg	Vit. C mg
<6 mo [b]	-	-	-	-	-	-	-	-	-	-
6-11 mo	300	10	3	0.4	0.5	5	0.4	50	0.5	20
12-23 mo	300	10	4	0.5	0.6	7	0.5	60	0.6	25
2-5 y	350	10	5	0.6	0.7	9	0.7	80	0.8	30
6-9 y	400	10	6	0.9	1.1	12	1.0	130	1.3	40
Females										
10-13	600	10	7	1.0	1.2	14	1.1	200	2.0	50
14-17	700	10	8	1.2	1.4	16	1.3	300	2.0	75
18-30	700	10	8	1.1	1.3	15	1.3	400	2.0	75
31-60	700	10	8	1.1	1.2	14	1.2	300 g	2.0	75
61-74	700	10	8	1.0	1.2	13	1.2	300	2.0	75
≥75	700	20	8	1.0	1.2	13	1.2	300	2.0	75
Pregnant	800	10	10	1.5	1.6	17	1.5	500	2.0	85
Lactating	1100	10	11	1.6	1.7	20	1.6	500	2.6	100
Males										
10-13	600	10	8	1.1	1.3	15	1.3	200	2.0	50
14-17	900	10	10	1.4	1.7	19	1.6	300	2.0	75
18-30	900	10	10	1.4	1.6	19	1.6	300	2.0	75
31-60	900	10	10	1.3	1.5	18	1.6	300	2.0	75
61-74	900	10	10	1.2	1.4	16	1.6	300	2.0	75
≥75	900	20	10	1.2	1.3	15	1.6	300	2.0	75

[a] Refers to the consumed amount, and losses during preparation, cooking, etc. must be accounted for.
[b] Exclusive breastfeeding is the preferable source of nutrition for infants during the first six months of life. Therefore, recommendations for single nutrients are not given for infants <6 months. If breastfeeding is not possible, infant formula formulated to serve as the only food for infants should be given (see Chapter on breastfeeding). If complementary feeding has started at 4-5 months, the recommended intakes for 6-11 month old infants should be used.
[c] Retinol equivalents; 1 retinol equivalent (RE) = 1 µg retinol = 12 µg β-carotene.
[d] From 1-2 weeks of age, infants should receive 10 µg vitamin D_3 per day as a supplement. For people with little or no sun exposure, the recommended intake is 20 µg per day. This can be achieved by taking a daily supplement of 10 µg vitamin D_3 in addition to the dietary intake or by choosing foods rich in vitamin D. For the elderly ≥75 years of age, the recommended intake can be achieved by selecting foods naturally high in vitamin D and vitamin D-enriched foods in combination with a supplement if necessary.
[e] a-tocopherol equivalents; 1 a-tocopherol equivalent (a-TE) = 1 mg RRR a-tocopherol.
[f] Niacin equivalent; 1 niacin equivalent (NE) = 1 mg niacin = 60 mg tryptophan.
[g] Women of reproductive age are recommended to have an intake of 400 µg/d.

Table 1.3, continued. Recommended intake of certain nutrients
Expressed as average daily intake over time for use in planning diets for groups. The requirement is lower for almost all individuals.

Age mo/ years	Calcium mg	Phosphorus mg	Potassium g	Magnesium mg	Iron [h] mg	Zinc [i] mg	Copper mg	Iodine µg	Selenium µg
<6 mo [b]	-	-	-	-	-	-	-	-	-
6-11 mo	540	420	1.1	80	8	5	0.3	50	15
12-23 mo	600	470	1.4	85	8	5	0.3	70	20
2-5 y	600	470	1.8	120	8	6	0.4	90	25
6-9 y	700	540	2.0	200	9	7	0.5	120	30
Females									
10-13	900	700	2.9	280	11	8	0.7	150	40
14-17	900	700	3.1	280	15 l	9	0.9	150	50
18-30	800 j	600 [j]	3.1	280	15 l	7	0.9	150	50
31-60	800	600	3.1	280	15/9 [k]	7	0.9	150	50
61-74	800	600	3.1	280	9	7	0.9	150	50
≥75	800	600	3.1	280	9	7	0.9	150	50
Pregnant	900	700	3.1	280	-- [m]	9	1.0	175	60
Lactating	900	900	3.1	280	15	11	1.3	200	60
Males									
10-13	900	700	3.3	280	11	11	0.7	150	40
14-17	900	700	3.5	350	11	12	0.9	150	60
18-30	800 [j]	600 [j]	3.5	350	9	9	0.9	150	60
31-60	800	600	3.5	350	9	9	0.9	150	60
61-74	800	600	3.5	350	9	9	0.9	150	60
≥75	800	600	3.5	350	9	9	0.9	150	60

[h] The composition of the meal influences the utilization of dietary iron. The availability increases if the diet contains abundant amounts of vitamin C and meat or fish daily, and it is decreased with simultaneous intake of polyphenols or phytic acid.

[i] The utilization of zinc is negatively influenced by phytic acid and positively influenced by animal protein. The recommended intakes are valid for a mixed animal/vegetable diet. For vegetarian cereal-based diets, a 25%–30% higher intake is recommended.

[j] 18-20 year olds are recommended to consume 900 mg calcium and 700 mg phosphorus per day.

[k] Menstrual flow and its associated iron losses can vary considerably among women. This means that some women require a larger iron supply than others. At an availability of 15%, 15 mg/d will cover the requirement of 90% of women of reproductive age. Some women require more iron than the habitual diet can supply.

[l] Recommended intake for post-menopausal women is 9 mg per day.

[m] Iron balance during pregnancy requires iron stores of approximately 500 mg at the start of pregnancy. The physiological need of some women for iron cannot be satisfied during the last two thirds of pregnancy with food only, and supplemental iron is needed.

Sodium as salt

A gradual reduction in the intake of sodium expressed in the form of sodium chloride is desirable. The population target is 6 g/d salt for adults. This corresponds to 2.3 g/d of sodium. The salt intake of children should also be limited, and for children below 2 years of age the sodium density, expressed as salt, should not exceed 0.5 g/MJ. This is to prevent children becoming accustomed to a diet with a high salt content. From 2 years up to 10 years of age, salt intake should be limited to about 3-4 g/d.

Dietary supplements

In general, the nutrient requirements can be met with a varied and balanced diet. However, dietary supplements might be needed by certain population groups or during certain life-stages, for example, infants or the elderly in nursing homes.

Prolonged intakes of nutrients from supplements have generally not been associated with decreased risk of chronic diseases or other health benefits in healthy individuals eating a varied diet that covers their energy requirements. In contrast, there is a large body of evidence suggesting that elevated intakes of certain supplements, mainly vitamins with antioxidative properties, might even increase the risk of certain adverse health effects, including mortality. Thus, there is no scientific justification for using supplements as a tool for adjusting an unbalanced diet.

Recommendations for planning diets for heterogeneous groups

In planning diets for groups with a heterogeneous age and sex distribution, the amounts of nutrients per MJ given in Table 1.4 can be applied. For each nutrient, the values are based on the age and sex category of individuals 6-65 years old for which the highest nutrient density is necessary to meet the RIs. These recommendations are not intended for pregnant and lactating women or for adult diets with an energy intake of less than 8 MJ per day. They are also not suitable for planning diets with an energy intake above 12 MJ per day in which a lower density of many nutrients might be sufficient.

An energy intake of 6.5-8 MJ is considered a low-energy intake with an increased risk of an insufficient intake of micronutrients. A very low energy intake is defined as an energy intake below 6.5 MJ/d and is associated with a considerable risk of an insufficient intake of micronutrients.

A very low energy intake is related to either a very low physical activity level or to a low body weight. Low body weight is related to small muscle mass and, therefore, to low energy expenditure. Very low energy intake is found among persons on slimming diets and among persons with eating disorders, food intolerances, etc. A suitable way to prevent low and very low energy intake is to increase the physical activity level.

With low energy intakes it might be difficult to meet the needs for all the nutrients using the values in Table 1.3. In such cases, the recommended nutrient density per MJ from Table 1.4 should be followed and supplementation with a multivitamin/mineral tablet should be considered. For groups with a very low energy intake (<6.5 MJ), the diet should always be supplemented with a multivitamin/mineral tablet.

Table 1.4. Recommended nutrient density (per MJ) to be used for planning diets for groups of individuals 6-65 years of age with a heterogeneous age and sex distribution. The values are adapted to the reference person requiring the highest dietary nutrient density.

		Content per MJ
Vitamin A	RE*	80
Vitamin D	µg	1.4
Vitamin E	a-TE*	0.9
Thiamin	mg	0.12
Riboflavin	mg	0.14
Niacin	NE*	1.6
Vitamin B_6	mg	0.13
Folate	µg	45
Vitamin B_{12}	µg	0.2
Vitamin C	mg	8
Calcium	mg	100
Phosphorus	mg	80
Potassium	g	0.35
Magnesium	mg	32
Iron	mg	1.6
Zinc	mg	1.2
Copper	mg	0.1
Iodine	µg	17
Selenium	µg	5.7

*See Table 1.3 for definitions

Reference values for energy intake

Both excessive and insufficient energy intake in relation to energy requirements can lead to negative health consequences in the long term. In adults, therefore, an individual's long-term energy intake and energy expenditure should be equal.

In Table 1.5, reference values are given for energy intake for groups of adults with two different physical activity levels. An active lifestyle, corresponding to PAL 1.8, is considered desirable for maintaining good health. An activity level of PAL 1.6 is close to the population median and corresponds to a common lifestyle with sedentary work and some increased physical activity level during leisure time. The reference body weights used for the calculations are based on Nordic populations. The original weights have been adjusted so that all individuals would have a body mass index (BMI) of 23. Therefore, the reference values indicate an energy intake that would maintain normal body weight in adults.

Specific recommendations for energy intake cannot be given due to the large variation between individuals with respect to metabolic rate, body composition, and degree of physical activity.

Tables 1.6 and 1.7 contain reference values for energy intakes in groups of children. It must again be mentioned that individual energy requirements might be very different from these group-based average values.

Table 1.5. Reference values for energy intakes in groups of adults with sedentary and active lifestyles. [a]

Age, years	Reference weight[b] kg	REE[c] MJ/d	Average PAL[d] 1.6 MJ/d	Active PAL 1.8 MJ/d
Females				
18-30	64.4	5.8	9.4	10.5
31-60	63.7	5.5	8.8	9.9
61-74[e]	61.8	5.0	8.1	9.1
Males				
18-30	75.4	7.3	11.7	13.2
31-60	74.4	6.9	11.0	12.4
61-74[e]	72.1	6.1	9.7	10.9

[a] It should be noted that these estimations have a large standard error due to inaccuracy in estimation of both REE and PAL. Therefore, the results should be used only for estimation on the group level. See chapter on Energy for more details.

[b] Reference weight corresponds to a body mass index (BMI) of 23 kg/m^2; data based on actual heights of populations in all Nordic countries

[c] REE = Resting Energy Expenditure

[d] PAL = Physical Activity Level

[e] The REE for 61-74 year olds was calculated by using the equation for 61-70 year olds.

Table 1.6. Reference values for estimated average daily energy requirements (per kg body weight) for children 6-12 months assuming partial breastfeeding

Age months	Average daily energy requirements kJ/kg body weight	
	Boys	Girls
6	339	342
12	337	333

Table 1.7. Reference values for estimated daily energy requirements (MJ/d) for children and adolescents (from 2 to 17 years)

Age	Reference weight, kg	REE MJ/d	Estimated energy requirement MJ/d
2-5 y	16.1	3.6	5.3
6-9 y	25.2	4.4	6.9
Girls			
10-13 y	38.3	5.0	8.6
14-17 y	53.5	5.7	9.8
Boys			
10-13 y	37.5	5.4	9.3
14-17 y	57.0	6.8	11.8

[1] PALs (average) for age groups: 1-3 years = 1.39; 4-9 years = 1.57; 10-17 years = 1.73.

Recommendations on physical activity

Adequate physical activity contributes to the prevention of lifestyle-related diseases such as cardiovascular disease, osteoporosis, and certain types of cancer. Daily physical activity is, therefore, recommended as part of a healthy lifestyle together with a balanced diet. There is also emerging evidence that extended daily periods of sedentary behaviour (several hours of sitting or lying during the daytime) increase the risk for chronic diseases. Therefore, it is recommended to reduce sedentary behaviour.

Adults

The following are the recommendations on physical activity for adults including elderly:

1. Adults should engage in least 150 minutes of moderate-intensity physical activity throughout the week, or engage in at least 75 minutes

of vigorous-intensity physical activity throughout the week, or engage in an equivalent combination of moderate- and vigorous-intensity activity.
2. Aerobic activity should be performed in bouts of at least 10 minutes duration.
3. For additional health benefits, adults should increase their moderate-intensity physical activity to 300 minutes per week, or engage in 150 minutes of vigorous-intensity aerobic physical activity per week, or engage in an equivalent combination of moderate- and vigorous-intensity activity.
4. Reduce sedentary behaviour.

Even though there is a lack of conclusive data, it seems that the amount of daily activity needed to avoid weight gain is about 60 minutes of moderate-intensity activity or a somewhat shorter duration of vigorous-intensity activity.

Children and adolescents

The following are the recommendations on physical activity for children and adolescents:

1. Children and adolescents should accumulate at least 60 minutes of moderate to vigorous-intensity physical activity daily.
2. Physical activity of amounts greater than 60 minutes daily will provide additional health benefits.
3. Activities should be as diverse as possible in order to provide optimal opportunities for developing all aspects of physical fitness, including cardio-respiratory fitness, muscle strength, flexibility, speed, mobility, reaction time, and coordination. Vigorous-intensity activities should be incorporated, including those that strengthen muscle and bone, at least 3 times per week.
4. Reduce sedentary behaviour.

Overweight and obesity

Obesity is one of the main health problems in the Nordic countries, and reducing the prevalence of obesity requires both effective treatment of obesity and prevention of weight gain. The focus of the NNR is on the prevention of obesity and excessive weight gain.

Long-term weight change is one of the main outcomes when defining

the recommended intake ranges of macronutrients and food groups. In prospective studies on macronutrients and weight change, the evidence linking a higher dietary fibre intake to reduced weight gain is clear. No other evident associations between macronutrients and weight change in adults were observed in the NNR SR on diet and long-term weight change. However, combined results from intervention studies not designed for intentional weight loss show that reduced total fat intake was associated with a modest weight reduction. Also, reduced intake of sugar and sugar-sweetened beverages has been associated with modest weight loss. The evidence linking proportions of macronutrients (fats, carbohydrates, and proteins) to weight change in adults is partly conflicting, and this indicates that gross macronutrient composition per se does not seem to be a major predictor of long-term weight change or maintenance. The observed effects on body weight changes among adults might, therefore, be partly mediated by food-related factors that affect long-term energy intake. In contrast, high protein intake in early childhood might induce obesity later in life.

There is clear evidence to conclude that fibre-rich foods (e.g., whole grains, vegetables, fruits, berries, legumes, nuts, and seeds), and perhaps also dairy products, are associated with reduced weight gain. In contrast, refined cereals, sugar-rich foods and drinks, red meat, and processed meat are associated with increased weight gain in long-term studies. Diets based on natural plant foods generally have lower energy density compared to diets rich in animal foods and to food products high in fat and sugar.

In addition, adequate physical activity will contribute to maintaining a healthy body weight in the long-term.

Reference values for assessing nutrient intakes

Vitamins and minerals

Assessing nutrient adequacy

Table 1.8 gives values for the estimated average requirement (AR) and lower intake level (LI) for certain vitamins and minerals. The values are intended only for use in assessing results from dietary surveys. Before comparing intake data with these reference values, it is crucial to check whether the intake data derived from a particular survey are suitable for assessing adequacy. More guidance on this topic and on how to use NNR in this context is given in Chapter 3 (Use of Nordic Nutrition Recommendations).

The AR is the value to be primarily used to assess the risk for inadequate intake of micronutrients in a certain group of individuals. The percent-

age that has an intake below the AR indicates the proportion having an increased risk of inadequate intake.

Long-term intakes below the LI are associated with an increased risk of developing deficiency symptoms. There is substantial uncertainty in several of these values so they should be applied with caution and, if possible, related to clinical and biochemical data. Furthermore, intake of nutrients above these values is no guarantee that deficiency symptoms could not occur in certain individuals.

It should be noted that a comparison with AR and LI values can never determine whether intake is adequate or not, it can only indicate the probability that it is. This is because nutrient intake data are not absolute values but are calculated using food composition tables and reported food consumption, both of which have a considerable error margin. Therefore, in order to find out whether an intake of a particular nutrient is adequate, biochemical measurements and thorough dietary assessments are necessary.

Assessing high intakes

For some nutrients, high intakes can cause adverse or even toxic symptoms. Upper intake levels (UL) have thus been established for some nutrients (Table 1.9). For certain nutrients, especially preformed vitamin A (retinol), vitamin D, iron, and iodine, prolonged intakes above these levels can lead to an increased risk of toxic effects. For other nutrients the adverse effects might be different and milder, e.g. gastrointestinal problems or interference with the utilization of other nutrients. The ULs are not recommended levels of intake but are maximum levels of daily chronic intakes judged to be unlikely to pose a risk of adverse health effects in humans. The ULs are derived for the normal healthy population, and values are given for adults. For other life stages, such as infants and children, specific data might exist for deriving specific values or such values could be extrapolated. To establish whether a population is at risk for adverse effects, the fraction of the population exceeding the UL and the magnitude and duration of the excessive intake should be determined. There is a substantial uncertainty in several of the ULs, and they must be used with caution for single individuals. UL values do not necessarily apply in cases of prescribed supplementation under medical supervision.

Energy-providing nutrients

The assessment of macronutrient intake mainly concerns the energy distribution (as energy per cent, E%) from protein, fat, fatty acids, added

sugars, and total carbohydrates. For protein intake, i.e. gram per kg body weight and day, is also used and for dietary fibre the intake amount is given per day or per MJ.

In the assessment of the usual energy contribution from protein, fat, and carbohydrates, the proportion of the group that has energy contributions from these macronutrients within (or outside) the recommended intake range is estimated. In the assessment of the energy contribution from macronutrients with a recommended upper threshold (i.e., saturated fat and added sugars) the proportion of the group that exceeds this threshold is estimated. Likewise, when energy contribution from macronutrients with a recommended lower threshold (e.g., dietary fibre) is assessed, the proportion of the group that goes below this level is estimated.

Table 1.8. Estimated average requirement (AR) and lower intake level (LI) for certain vitamins and minerals for adults. The values are intended for use only in assessing results from dietary surveys. Long-term intakes below the LI are associated with an increased risk of developing deficiency symptoms. An intake of nutrients above these values is no guarantee that deficiency symptoms could not occur in certain individuals.

Nutrient		Women		Men	
		LI	AR	LI	AR
Vitamin A	RE	400	500	500	600
Vitamin D	µg	2.5 [a]	7.5	2.5 [a]	7.5
Vitamin E	a-TE	3	5	4	6
Thiamin	mg	0.5	0.9	0.6	1.2
Riboflavin	mg	0.8	1.1	0.8	1.4
Niacin	NE	9	12	12	15
Vitamin B6	mg	0.8	1.1	1.0	1.3
Folate	µg	100	200	100	200
Vitamin B12	µg	1	1.4	1	1.4
Vitamin C	mg	10	50	10	60
Calcium	mg	400	500	400	500
Phosphorus	mg	300	450	300	450
Potassium	g	1.6	-	1.6	-
Iron	mg	(5) [b, c]	10 (6) [b]	7	7
Zinc	mg	4	5	5	6
Copper	mg	0.4	0.7	0.4	0.7
Iodine	µg	70	100	70	100
Selenium	µg	20	30	20	35

[a] Primarily for individuals >60 years of age.
[b] () Refers to post-menopausal women.
[c] A lower limit cannot be given for women of fertile age without considering the woman's iron status as determined by clinical and biochemical methods.

Table 1.9. Estimated upper intake levels (UL) for average daily intake of certain nutrients for adults.
The ULs are maximum levels of daily chronic intakes judged to be unlikely to pose a risk of adverse health effects in humans. The ULs are derived for the normal healthy population. There is a substantial uncertainty in several of the UL values, and they must be used with caution for single individuals. UL values do not necessarily apply in cases of prescribed supplementation under medical supervision.

Nutrient		UL per day
Preformed vitamin A [a]	µg	3,000 [b]
Vitamin D	µg	100
Vitamin E [c]	a-TE	300
Niacin [c]		
nicotinic acid	mg	10 [d]
nicotinamide	mg	900
Vitamin B_6 [c]	mg	25
Folic acid [c]	µg	1,000
Vitamin C	mg	1,000
Potassium [c]	g	3.7
Calcium	mg	2,500
Phosphorus	mg	5,000
Iron	mg	25 [e]
Zinc	mg	25
Copper	mg	5
Iodine	µg	600
Selenium	µg	300

[a] As retinol and/or retinylpalmitate.
[b] Intake of retinol above 3,000 µg/d in pregnant women has been associated with an increased risk of foetal malformations. The upper tolerable level might not adequately address the possible risk of bone fracture in vulnerable groups. Postmenopausal women who are at greater risk for osteoporosis and bone fractures should, therefore, restrict their intake to 1,500 µg/d.
[c] In the form of supplements and fortification only.
[d] Not applicable for pregnant and lactating women.
[e] 10 mg in addition to habitual dietary iron intake.

2 Principles and background of the Nordic Nutrition Recommendations

Background

The Nordic Nutrition Recommendations (NNR) constitute the scientific basis for the planning of diets for population groups and for the development of food-based dietary guidelines in the Nordic countries. The recommendations serve as a basis for assessing nutrient intakes by groups of healthy individuals and for developing national and regional nutrition policies, nutritional educational programs, food regulations, and action programmes. The NNR are primarily valid for groups of healthy individuals with various levels of physical activity (excluding competitive athletes). For individuals with diseases and other groups with special needs, the dietary composition and energy content might have to be adjusted accordingly. Based on current scientific knowledge, the NNR give values for the intake of, and balance between, individual nutrients that are adequate for development and optimal function and that reduce the risk of developing certain diet-related diseases. If a diet provides enough food to cover the energy requirements, complies with the ranges for distribution of energy from macronutrients, and includes foods from all food groups, the requirements for practically all nutrients will be met. Exceptions might be vitamin D, iron, iodine, and folate in certain subgroups of the population or during certain life-stages.

The NNR are primarily valid for groups of healthy individuals with various levels of physical activity (excluding competitive athletes).

Historically, the main objective of nutrition recommendations was to determine the level of nutrient intake that would prevent deficiency disorders. Certain vitamin and mineral deficiency diseases, such as iodine and vitamin D deficiency, were common before these essential nutrients were recognised as vital components of the diet.

The concept of setting recommended dietary intakes dates back to the 1920s and 1930s. The first international table of energy and protein requirements by age and sex was published in 1936 by the League of Nations (1) and was followed by reference values for fat and some micronutrients. Recommended dietary allowances (RDA) for macronutrients and several micronutrients were published in 1941 by the National Academy of Sciences in the United States to serve as a guide for planning adequate nutrition for the general population (2). Since then, the concept has evolved to take into account not only the avoidance of clinical or subclinical deficiencies but also a reduction in the risk of development of overweight and obesity and major lifestyle diseases such as cardiovascular diseases, type-2 diabetes, cancer, and osteoporosis. More recently, the concern for health promotion through the diet has led to the concept of an optimal level of nutrient intake that is defined as an intake level that maximises physiological and mental functions and minimises the risk of development of chronic diseases (**Fig 2.1**). Because new scientific data on the relationships between nutrient intakes, food patterns, physical activity, and health are being published regularly, our knowledge about the relationship between nutrient intake, nutrient status, and health is gradually increasing. Nutrition recommendations, therefore, need to be updated regularly.

For most nutrients, a hierarchy of criteria for nutrient adequacy can be established ranging from prevention of clinical deficiency to optimal levels of body stores and functionality. A higher intake of a nutrient is, however, not necessarily better for health. Beyond a certain intake level a higher intake might even lead to adverse health effects.

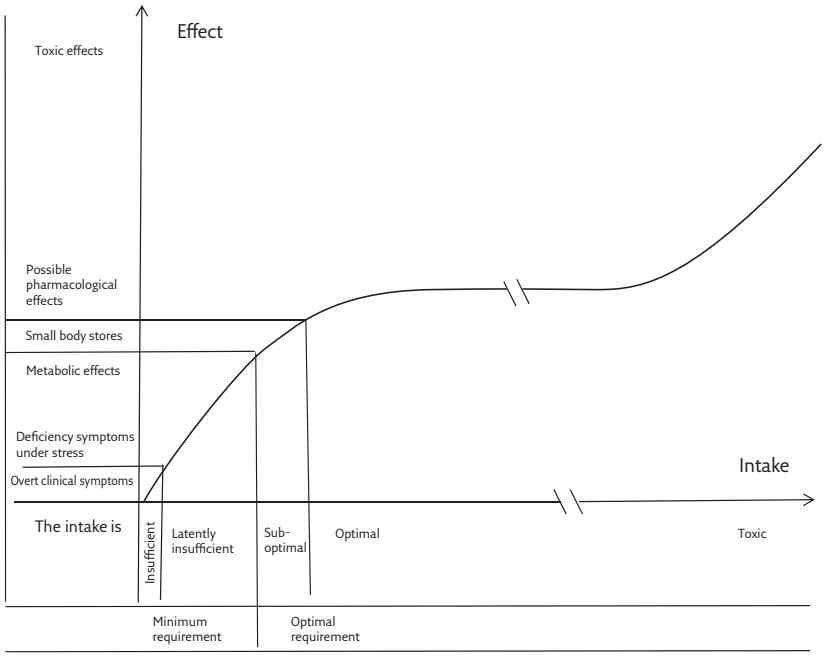

Figure 2.1. The theoretical relationship between intake of a nutrient and the effect on the organism.

It should be noted that normally there is a transitional phase from deficiency diseases and/or symptoms to optimal conditions and even to toxicological effects of a certain intake level of a nutrient. There is also a transitional phase between overt toxic effects at very high intakes and milder adverse effects at lower intakes.

General approach

The main objective of the nutrition recommendations is to use the best available scientific evidence to ensure a diet that provides energy and nutrients for optimal growth, development, function, and health throughout life. It should be noted that a certain recommendation for a given nutrient is only applicable if the supply of other nutrients and energy is adequate.

The recommendations are intended for healthy individuals. Generally, the recommendations cover increased requirements such as during short-term mild infections or certain medical treatments. The recommended amounts are usually not suited for long-term infections, mal-absorption, and various metabolic disturbances or for treatment of persons with a

non-optimal nutritional status. They are meant to be used for prevention purposes and are not specifically meant for treatment of diseases or for significant weight reduction. The NNR, however, do cover dietary approaches for sustainable weight maintenance after significant, intentional weight reduction. For individuals with disease and for other groups with special needs, the dietary composition might have to be adjusted accordingly.

The 5th edition of the NNR is an update of the 4th edition from 2004 and focuses on the existing scientific evidence for updating the Nordic dietary reference values for nutrients in the context of a balanced diet. In the present NNR, an evidence-based approach has been adapted for deriving NNR reference values. For selected nutrients and topics, a systematic review (SR) has been used that includes a quality assessment of all pertinent studies and a final grading of the overall evidence. This approach has also been used as a basis for the food-based dietary guidelines. For the other nutrients and topics, an updated review has been undertaken using the documentation published in NNR 2004 as a starting point. In all reviews, data from observational and intervention studies have been used as the basis to estimate nutrient requirements for micronutrients and for establishing recommendations for optimal ranges of macronutrient intakes. Randomized clinical trials (RCTs) have been used where possible. Animal and in vitro studies have been included when needed to explain mechanisms of action. Thus, the NNR values are based on the totality of the available evidence (3, 4).

Terminology and definitions

The term 'NNR' refers to a set of dietary reference values (DRVs) for essential nutrients that includes the average requirement (AR), recommended intake (RI), upper intake level (UL), lower intake level (LI), and reference values for energy. All of the values are expressed as daily intakes and recommended intake ranges of macronutrient intakes.

Average requirement (AR)

The *average requirement (AR)* is defined as the lowest long-term intake level of a nutrient that will maintain a defined level of nutritional status in an individual. In the NNR, the *AR* value is used to define the level of a nutrient intake that is sufficient to cover the requirement for half of a defined group of individuals provided that there is a normal distribution of the requirement (**Fig 2.2**).

In general, the selected criteria for establishing the *AR* apply to micronutrients and are usually based on data on biochemical markers of adequate nutritional status. However, the *AR* can also be derived for some macronutrients such as protein and essential fatty acids.

Deficiency of a nutrient would imply that the supply is so small that specific symptoms of disturbances in body functions emerge. During serious, manifest deficiency, overt clinical symptoms or signs such as bleeding of the gums during scurvy or neurological symptoms due to vitamin B_{12} deficiency would arise. Data on biochemical markers can include the activity of certain enzymatic systems in which nutrients have a role as co-factors or concentrations of a nutrient in cells or fluids as a measure of tissue stores. Low activities or concentrations might be associated with deficiency symptoms or impaired function. Moreover, it is possible to define an interval between manifest deficiency and optimal intake level in which clinical symptoms are more diffuse or do not exist at all. This level is sometimes called latently insufficient (**Fig 2.1**). Such indicators are available only for a limited number of nutrients, e.g. vitamin D, iron, folate, and vitamin B_{12}.

The definition of *AR* corresponds to the term 'Estimated Average Requirement' (EAR) used in the UK and US recommendations (2, 5). The European Food Safety Authority (EFSA) uses the term 'Average Requirement' (6).

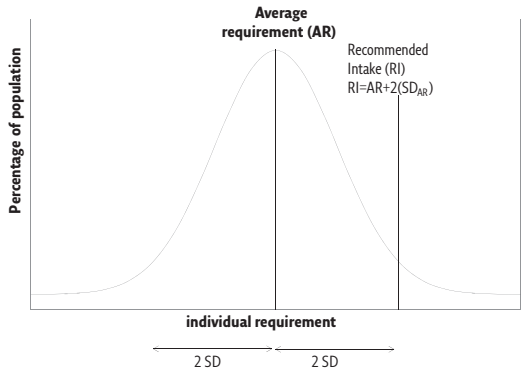

Figure 2.2. Frequency distribution of an individual nutrient requirement. SD = Standard deviation.

It is important to distinguish between the average requirement for a nutrient and the recommended intake of a nutrient. The recommended intake represents more than the requirement for the average person and also covers the individual variations in the requirement for the vast majority of the population group (**Fig 2.2**). Depending on the criteria used for setting the average requirement, the safety margin between the average requirement and recommended intake can vary.

Recommended intake (RI)

The term *recommended intake (RI)* refers to the amount of a nutrient that meets the known requirement and maintains good nutritional status among practically all healthy individuals in a particular life stage or gender group. When the distribution of a requirement among individuals in a group can be assumed to be approximately normally distributed (or symmetrical) and a standard deviation (SD) can be determined, the *RI* can be set as follows (**Fig. 2.2**):

$$RI = AR + 2(SD_{AR})$$

For other nutrients where data about the variability in requirements are insufficient to calculate an SD_{AR}, an approximate coefficient of variation (CV) of 10%–15% can be used (see **Fig 2.2**).

The *RI* corresponds to the amount of a nutrient that is consumed, and this means that losses during handling, preparation, processing, etc. have to be taken into consideration in dietary planning. The *RI* is appropriate for an average intake of a group expressed per day over a longer period of one week or more. The body can adapt and retain some nutrients when the intake is lower than the immediate requirement. The storage capacity for nutrients varies and is highest for the fat-soluble vitamins (several months) while the stores of water-soluble vitamins (with the exception of vitamin B_{12}) are usually lower.

Where sufficient scientific evidence is available on interactions with other dietary factors, these are accounted for. Examples are the enhancing effect of ascorbic acid on non-haem iron absorption and the effect of folate on homocysteine levels in the blood. When establishing the *RI* values, these aspects have been taken into consideration.

High doses of certain vitamins and minerals can have pharmacological effects different from their primary nutritional effects. Generally, this concerns amounts that the target group could not normally obtain from the diet. The effect of high doses of nicotinic acid as a lipid-lowering agent and the effect of fluoride on dental caries can be considered pharmacological rather than nutritional effects. Such effects have not been taken into consideration in the establishment of the *RI*.

The *RI* is intended for healthy individuals and is not necessarily appropriate for those with different needs due to diseases such as infections. In general, the *RI*s are only applicable when the supply of other nutrients and energy is adequate.

The definition of *RI* corresponds to the term 'Recommended Intake' used in the UK and 'Recommended Dietary Allowance' (RDA) used in the US (2). The EFSA uses the term 'Population Reference Intake' (PRI) to denote "the level of nutrient intake that is enough for virtually all healthy people in a group" (6).

Setting RI for micronutrients

In setting recommendations for micronutrients, the NNR use the classical approach with the following steps:

The first step includes an evaluation of the average physiological and dietary requirement for the population group in question as judged by criteria that have to be set specifically for every individual nutrient. The establishment of these criteria includes considerations of clinical and biochemical deficiency symptoms, body stores, body pool turnover, and tissue levels. The nutritional requirements are influenced mainly by different biological factors such as age, sex, growth, height, weight, pregnancy, and lactation.

The second step includes an estimation of a safety margin to ensure that all individual variations are considered and added to the requirement to obtain a level of recommended intake. The size of this safety margin depends on several factors, among others the variation in the requirements between individuals and potential adverse effects of high intakes. Furthermore, the precision of the estimation of the requirement should be taken into consideration (**Fig 2.2**).

Upper intake level (UL)

For most nutrients, high intakes might cause adverse effects or even toxic symptoms. The *upper intake level (UL)* is defined as the maximum level of long-term (months or years) daily nutrient intake that is unlikely to pose a risk of adverse health effects in humans. The threshold for any given

adverse effect varies depending on life-stage, sex, and other individual characteristics just as it does for any nutrient requirement. However, there are insufficient human data to establish distributions of thresholds for each adverse effect. The different steps in setting the *UL* include the identification of the critical endpoint, which is the lowest dose at which an adverse effect occurs, and using a surrogate measure for the threshold (**Fig 2.3**). The thresholds are the following:

No observed adverse effect level (NOAEL), which is the highest intake of a nutrient with no observed adverse effects;

Lowest adverse effect level (LOAEL), the lowest intake level with an observed adverse effect.

Based on these evaluations, a *UL* is derived by taking into account the scientific uncertainties in the data by dividing the *NOAEL* by an uncertainty factor (UF) (**Fig 2.3**). This factor should account for uncertainties in human inter-variability or, in the case of insufficient human data, an extrapolation from animals to humans as well as other uncertainties or deficiencies in the data. The definition of *UL* corresponds to the term 'Tolerable upper intake level' used in the US (2) and by the EFSA (6).

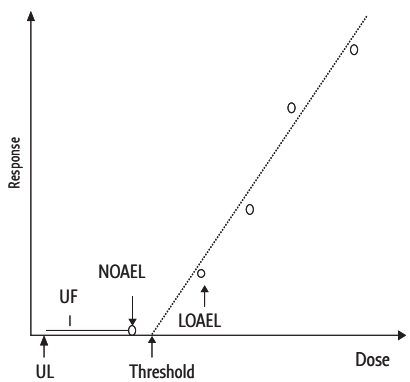

Figure 2.3. Derivation of Upper Intake Level (UL). For explanation see text.

Lower intake level (LI)

The *lower intake level (LI)* is defined as a cut-off intake value below which an intake could lead to clinical deficiency symptoms in most individuals. Establishment of an *LI* is thus based on observations of individuals and is in many cases based on criteria other than the average requirement.

The definition of *LI* differs from the term 'Lower reference nutrient intake' (LRNI) used in the UK (5), which is defined as EAR minus 2 SD (5).

The EFSA uses the term 'Lower threshold intake' (LTI) to define the level of intake below which almost all individuals will be unlikely to maintain 'metabolic integrity' according to the criterion chosen for each nutrient (6).

Reference values for energy intake

The term *reference value for energy intake* is used in the NNR and refers to the calculated estimated energy requirement for groups of healthy individuals with normal body size and various levels of physical activity. Setting the *reference value for energy intake* requires a different approach compared to the reference values for vitamins and minerals. For some vitamins and minerals, *RI*s can be given with large margins because the absorption can be limited or the excess broken down or secreted. The *RI*s might, therefore, exceed the defined requirements of the individual on a long-term basis. For energy intake, the situation is different because an energy intake consistently above or below the energy requirement will result in weight gain or weight loss that can adversely affect health. As a consequence and to prevent under- or overconsumption, energy intake should equal energy expenditure. The *reference value for energy intake* is expressed as the average energy requirement for a defined population group with various levels of physical activity (excluding competitive athletes). Thus, the *reference value for energy intake* should be considered as a theoretical value intended to be used as a reference for the entire population group.

Recommended intake range of macronutrients

The term *recommended intake range of macronutrients* is used to emphasise the importance of the distribution of energy between energy-providing nutrients (macronutrients). The current major lifestyle diseases mainly result from over-nutrition and nutritional imbalances rather than from under-nutrition and deficiency symptoms. The intention of setting the recommended intake range of macronutrients is, therefore, to derive a dietary macronutrient composition that will provide an adequate intake of essential nutrients for optimal health and a reduced risk of major lifestyle diseases (**Fig 2.1**).

The *recommended intake range of macronutrients* is based on an overall assessment of current knowledge about the impact of macronutrient intake on health and/or risk of disease. This requires various types of scientific data primarily from RCTs, prospective cohort studies, and other epidemiological studies. Where possible, studies providing evidence of a causal relationship and dose-response effects are used. A direct causal relation-

ship between intake of a single nutritional factor and a specific function or selected criterion, such as reduction of risk of diseases, is not always evident from the scientific data due, for example, to interactions between several energy-providing nutrients. In such cases, effects due to substituting different energy-providing nutrients are taken into consideration under energy-balance conditions (e.g. replacing saturated fat with unsaturated fat or complex carbohydrates). In these cases, the *recommended intake range of macronutrients* is based on an overall assessment of the scientific evidence and includes specific considerations about known patterns of intake of nutrients and foods and the actual composition of available foods in the Nordic countries. On this basis, the *recommended intake range of macronutrients* should be considered as 'optimal' in Nordic conditions.

The recommended intake range of macronutrients refers to appropriate ranges of usual intake in the majority of individuals in the population (7). For planning purposes, a value approximately in the middle of this range can be used as the target.

An upper threshold is used to specify a maximum level of intake for certain macronutrients (i.e. saturated fat and added, refined sugar) below which the intake of all individuals in a group is recommended. Likewise, a lower threshold denotes a certain minimum level of intake (i.e. dietary fibre) above which the intake of all individuals in a group is recommended.

Food-based dietary guidelines

Food-based dietary guidelines are based on an overall assessment of the present knowledge about the impact of food and food groups on health and/or risk of disease. Setting food-based dietary guidelines requires various types of scientific data, especially RCTs, prospective cohort studies, and other epidemiological studies. These guidelines are considered as a translation of nutrient recommendations into foods. They also take into consideration the habitual dietary patterns and scientific evidence of the effects of foods on different health outcomes. A causal relationship between food intake and risk of diseases is not always available from the scientific data. The food-based dietary guidelines are, therefore, based on an overall assessment of the scientific evidence and include specific considerations about known patterns of intake of foods and food groups and the actual composition of available foods in the Nordic countries. On this basis, the food-based dietary guidelines should be considered as 'optimal' in Nordic countries.

Physical activity

Guidelines for physical activity are an integral part of the NNR. Physical activity (and inactivity) influence growth, development, and long-term health and interact with food intake and dietary patterns. The physical activity guidelines generally apply to a physical activity level corresponding to an 'active lifestyle' as further defined in the physical activity chapter.

Methodological considerations

Types of data used and extrapolation

A variety of different types of studies have been used for setting the dietary reference values. For some nutrients (especially micronutrients) the basic *AR*s and *RI*s are derived from data on maintenance of body stores and/or function along with a safety factor. For other nutrients, evidence from experimental and/or observational human studies on the relationship between dietary intake and risk of chronic diseases (8) forms the basis for setting *RI*s (see above and **Fig 2.4**). A similar approach is also used for deriving guidelines on breastfeeding and physical activity.

Original data for various life-stage groups have been preferred in deriving values for the NNR (9). Where original data are lacking or due to a lack of sufficient data for some nutrients and some subgroups, extrapolation from one group to another is often necessary. The most common method is to extrapolate values from adults to children using a weight or metabolic factor and adjusting for growth. This approach has also been applied in the current NNR.

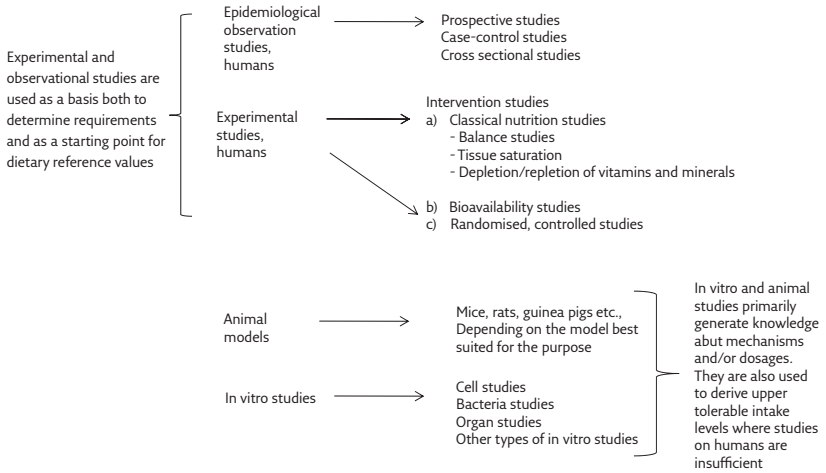

Figure 2.4 Types of studies used as a basis for dietary reference values

Interpretation of nutrition epidemiology studies

In the NNR, evidence from observational studies, mainly prospective cohort studies, is used extensively to assess the relationship between diet and nutrient intake and health. A number of issues influence the quality and interpretation of the results and are related to the complexity of foods and diets, subject characteristics, dietary assessment methods, and the statistical approaches used in analysing the data.

In addition to energy and essential nutrients, foods also contain a large number of other bioactive components that have potentially important effects on metabolic processes and health. The diet, therefore, is an extremely complex matrix of exposures. Some important issues to consider include:

- The co-variation between nutrients could be considerable because single foods might contain many nutrients and other bioactive substances. It can be difficult to isolate the biological effect of a specific nutrient or to examine the independent effect during statistical analysis.
- Socio-economic factors and lifestyle often show co-variation with food habits and it can be difficult to isolate dietary influences from these other factors.
- Characteristics of the individual can influence the examined associations. For instance, genetic factors can modify the effects of nutrients.

In dietary assessments, food records and dietary recalls collect detailed and quantitative, but episodic, information from specific days ("current diet") while diet history interviews and questionnaires collect semi-quantitative information about the overall diet ("usual diet"). Some other important issues to consider include:

- Food choices might vary greatly from one day to the next. Many repeated records (or recalls) or records covering a longer time period might, therefore, be needed when using "current diet" assessment methods to capture the "usual" (habitual, average) nutrient intake of an individual. This varies between nutrients and depends on how often foods rich in the nutrient are eaten and if the nutrient is present in many food items.
- Self-reported dietary data often have skewed distributions in contrast to physiological data, and zero-consumption might be common. As a consequence, it might be impossible in epidemiological studies to examine the health benefit of certain foods or nutrients at certain intake levels because very few individuals are regular consumers.

Obtaining a full picture of dietary habits is a methodological challenge. Different biases or mis-classifications of exposures arising from the methodology itself or from the individual's self-reporting are common in dietary data collection. Some important issues to consider include:

- Personal characteristics such as a desire to please others (social desirability) or dietary concerns might lead the individual to describe their food habits in a way that does not mirror their actual diet.
- Nutrition epidemiological studies usually examine the relative ranking of individuals. So although dietary intake variables are often continuous (e.g. gram, mg), nutrition epidemiological studies do not examine the influence of nutrients at specific intake levels. Instead, studies often use categorical variables (e.g. quintiles) of exposure and simultaneously reduce the influence of extreme or uncertain values.

In summary, the interpretation of results in nutrition epidemiology is often a challenge. The researcher must take several confounders into account including a lack of data about the composition of foods and food practices in the examined populations as well as issues concerning measurement errors in dietary assessment and the statistical handling of dietary data.

Approaches used in evaluating the scientific evidence

This 5th edition of the NNR consists of two approaches:

1. An SR is used for nutrients for which new data of specific importance for setting the NNR are available since the previous 4th edition of the NNR. The SR approach is also applied to nutrition for specific groups (e.g. children, the elderly, pregnant and lactating women), weight maintenance and for food-based dietary guidelines.
2. A less stringent updating of current reference values is applied for the other nutrients and topics not subject to SR.

Systematic review

An SR approach is used to study the available scientific evidence to allow firm conclusions to be drawn and to minimise potential reporting bias through comprehensive and reproducible literature searches. In SRs, clearly defined search strategies are used together with clearly defined and described selections and reporting protocols to provide a comprehensive and distilled evidence document for the decision makers/working group and to enhance the transparency of the decision-making process (10).

The key characteristics of the SR include:

- a clearly stated set of objectives and research questions with predefined eligibility criteria for the studies (including the outcomes of interest)
- an explicit, reproducible methodology
- a systematic search that attempts to identify all studies that would meet the eligibility criteria
- an assessment of the validity of the findings of the included studies through an assessment of the quality of the studies (to minimize risk of bias)
- a systematic presentation and synthesis of the characteristics and findings of the included studies
- a grading of the overall evidence

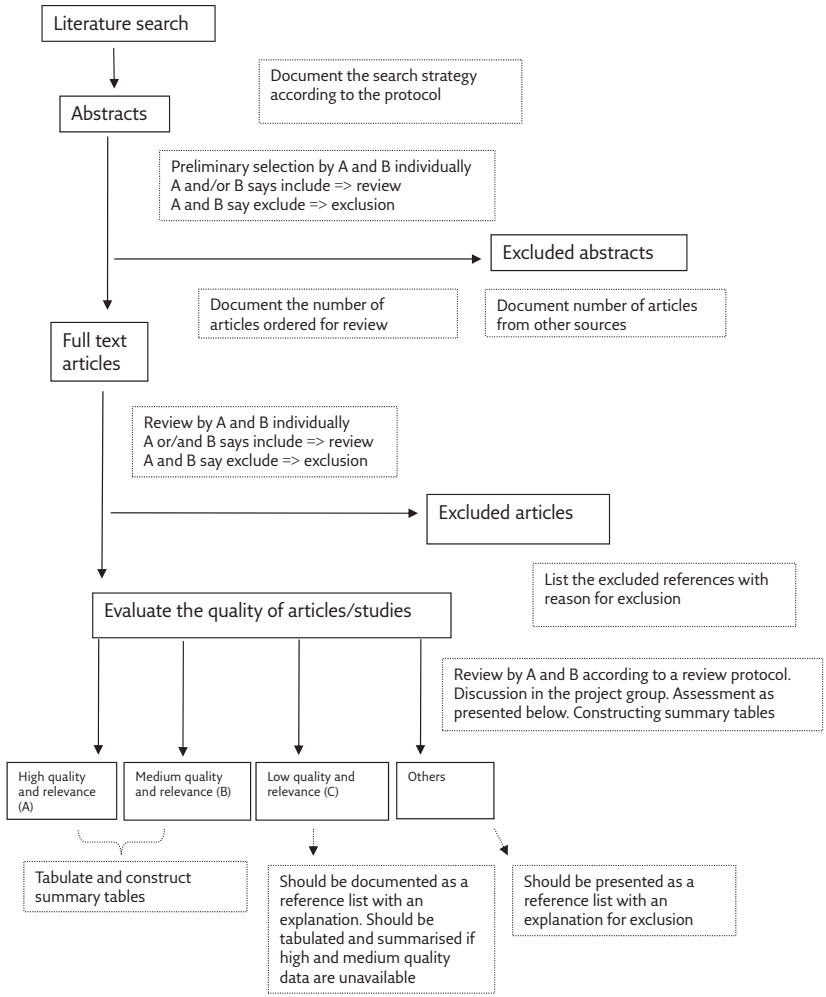

Figure 2.5. Flow chart of the reviewing process in the Systematic Review (SR)

The first step in the SR is identifying and defining the research questions. This is done using a PICO/PECO approach (Population/Participants, Intervention/Exposure, Control, and Outcome). Examples of research questions are shown in **Box 2.1**. In the next step, the protocol and search strategy is performed, and appointed experts for each nutrient or topic collaborate closely with a methodologist (librarian) who specialises in performing database searches (**Fig 2.5**). After the literature search, the first selection is carried out. Abstracts of articles identified in the database searches are screened for potentially relevant articles in a consistent, comprehensive

manner by a minimum of two independent experts according to the eligibility criteria. The abstracts not fulfilling the predefined inclusion criteria are excluded. For the remaining articles, full-text papers are collected and reviewed and the articles excluded from the SR are listed with reasons for exclusion according to predefined eligibility criteria. The methodological quality of the remaining articles is assessed using a three-category grading system (**Box 2.2**). Tools for the assessment of the different study categories – clinical trials, prospective cohort studies, retrospective case-control studies, nested case-control studies, cross-sectional studies, and an AMSTAR quality assessment for systematic reviews used by the experts – are included in the SR guide (NNR guide).

After the quality assessment of the individual studies, the studies not fulfilling the quality criteria, such as those that have such a serious bias that the results are not useful for the purpose of deriving NNR, are excluded. A list of the excluded articles, together with reasons for exclusion, is included in the SR. The results from the remaining articles/studies are then tabulated and summarised. In summarising their findings, the experts describe the methods used for their review, including details of data sources, databases searched, and search strategies. Preference is given to data published in peer-reviewed journals, but other sources such as official or expert reports and government-funded research can also be used to obtain valuable information so long as there is a clear indication of the source. Basic statistical information is included in order to indicate the strength of the findings. This information consists of at least the number of cases included in the analysis and the 95% confidence interval. After summarizing the results, the grading of the evidence is conducted according to criteria defined by the World Cancer Research Fund (11) with minor modifications (**Box 2.3**). The grading of evidence is based on the analysis of the scientific basis (the study quality, consistency, generalizability, effect size, risk for publication bias, imprecise data, or other aspects such as correlation of dose-response) by the expert group. The strengths and the weaknesses that the summarised evidence for each outcome measure is based on are specified. The grading of the evidence results in one of the following grading categories: 'convincing', 'probable', 'limited –suggestive', and 'limited – no conclusion' (**Box 2.3; Fig 2.5**).

The conclusions of the SR provide an overall summary of the reviewed evidence. Where appropriate, the conclusions also point out principal areas of uncertainty and areas where further research is required.

Box 2.1 Example of two research questions

1. What is the influence of sugar intake on type 2 diabetes, cardiovascular disease and related metabolic risk factors, and all-cause mortality?

2. What is the effect of different *dietary macronutrient compositions* on long-term (≥ 1 y) changes in weight, waist circumference, and body fat in the general adult population?

Box 2.2. Assessing methodological quality of the studies: The three-category quality grading system*

A. The results from studies that have an acceptably low level of bias are considered valid. These studies adhere mostly to the commonly held concepts of high quality including the following: a comprehensive study design; clear description of the participants, setting, interventions, and control group(s); appropriate measurement of outcomes; appropriate statistical and analytical methods and reporting; less than 30% percent dropout (depending on the length of the study, see the QAT for clinical studies) or over 50% participation rate for prospective cohort studies; clear reporting of dropouts; and no obvious bias. Where appropriate, studies must provide a valid estimation of nutrient exposure from dietary assessments and/or biomarkers within a reasonable range of measurement error and justification for approaches to control for confounding in the design and analyses.
B. Studies may have some bias, but not sufficient to invalidate the results. They do not meet all the criteria in category "A" and they have some deficiencies, but these are not likely to cause major bias. The study might be missing information making it difficult to assess limitations and potential problems.
C. Studies have significant bias that might invalidate the results. These studies have serious errors in design, analysis, or reporting and there are large amounts of missing information or discrepancies in reporting.

* Tufts Evidence-based Practice Center. Vitamin D and Calcium: A Systematic Review of Health Outcomes. Boston: Agency for Healthcare Research and Quality US Department of Health and Human Services, 2009.

Box 2.3. Criteria for assigning grade of evidence (modified from WCRF) connected to the three category quality grading system (AHQR)

This box lists the criteria modified from the WCRF cancer report that have been connected to the three-category quality grading system developed by the AHQR. The grades used in the NNR are 'convincing', 'probable', 'limited – suggestive', and 'limited – no conclusion'.

Convincing (High)

These criteria are for evidence strong enough to support a judgement that there is a convincing causal relationship or absence of relationship. A convincing relationship, or absence of relationship, should be robust enough to be highly unlikely to be modified in the foreseeable future even as new evidence accumulates. All of the following criteria are generally required:

- Evidence from more than one study type (RCT, prospective cohort, or nested case-control studies). For some outcomes (e.g. some risk factors) evidence from several RCTs might be sufficient.
- Evidence from at least two independent cohort studies (see above).
- No substantial unexplained heterogeneity within or between study types or in different populations in relation to the presence or absence of an association or the direction of effect.
- Several good quality studies (quality grading category A) with consistent findings to confidently exclude the possibility that the observed association, or absence of association, results from random or systematic error, including confounding, measurement error, or selection bias.
- Presence of a biological gradient ('dose response') in the association. Such a gradient need not be linear or even in the same direction across the different levels of exposure so long as this can be explained plausibly.
- Strong and plausible experimental evidence, either from human studies or relevant animal models, that typical exposures in humans can lead to relevant outcomes.

Probable (Moderate)

These criteria are for evidence strong enough to support a judgement of a probable causal relationship. All of the following criteria are generally required:

- Evidence from at least two independent cohort studies or at least five case-control studies. For some outcomes (e.g. some risk factors) evidence from a few RCTs might be sufficient.
- No substantial unexplained heterogeneity between or within study types in the presence or absence of an association or the direction of effect.
- Several good quality studies (quality grading category A and B) with consistent findings to confidently exclude the possibility that the observed association, or absence of association, results from random or systematic error, including confounding, measurement error, or selection bias.
- Evidence for biological plausibility in the case of an observed association.

Limited – suggestive (Low)
These criteria are for evidence that is too limited to permit a probable or convincing causal, or absence of causal, relationship but where there is evidence suggestive of a direction of effect. The evidence might have methodological flaws or be limited in quantity but show a generally consistent direction of effect. All of the following criteria are generally required:

- Evidence from at least two independent cohort studies or at least five case-control studies.
- The direction of effect is generally consistent though some unexplained heterogeneity might be present.
- Several studies of at least moderate quality (quality grading category B).
- Evidence for biological plausibility.

Limited – no conclusion (Insufficient)
Evidence is so limited that no firm conclusion can be made. A body of evidence for a particular exposure might be graded 'limited – no conclusion' for a number of reasons. The evidence might be limited by the amount of evidence in terms of the number of studies available, by inconsistency in direction of effect, by poor quality of the studies (for example, lack of adjustment for known confounders), or by any combination of these factors. Most of the studies are in the quality grading category C, or there are two or more high (A) or moderate (B) quality studies with contradicting results.

Other nutrients/topics

Some nutrients or topics have not been subject to an SR. The reason for this is that comprehensive scientific reports were already available; that few major new scientific data were available; or that the nutrient is of little public health concern. The reference values and topics have been updated with a similar approach as was used in the previous NNR and build on the evidence included in the 4th edition from 2004. The review of the literature was concentrated on papers and other reports published after 2000 primarily using PubMed and SweMed+ as a database sources. Studies on Nordic population groups have been included where available. Other important data sources included scientific reports and recommendations published by national and international institutions and expert groups. Additional papers and reports were identified during the work through reference lists. The reference lists in the individual chapters not subject to an SR include major key references used for the establishment of the reference values but do not intend to cover all of the literature that might be relevant to the basic issues of each nutrient or topic.

Derivation of the Nordic Nutrition Recommendations

The framework that has evolved during recent years for the development of dietary reference values is increasingly recognized as being similar to that developed in other fields and is referred to as risk analysis (12). However, when setting DRVs the focus lies more on the assessment of health benefits associated with intakes of nutrients and foods than on the assessment of avoiding risks, although the term 'health benefit' also covers reduced risk of developing chronic disease (13). Thus it is appropriate to use the term 'risk-benefit analysis'. In the development of the NNR, the risk assessment in a risk analysis can be compared to the process of conducting an SR. The next step of the risk analysis, risk management, also plays a role in the development of the NNR. The process of deriving the NNR includes consideration of the evidence for each nutrient or topic as well as possible inter-relations and consequences for the diet as a whole. In addition, classical risk analysis includes consideration of risk communication.

In general, an assessment of the evidence as 'convincing' or 'probable' (**Box 2.3**) justifies the use of that evidence as a basis for a recommendation, but evidence judged as 'limited – suggestive' or 'limited – no conclusion' cannot be used. However, rating the quality of the evidence and the strength of the conclusions is, as mentioned above, not the last stage in the evaluation process. The SR and rating of the evidence are used as the basis for deriving the dietary reference values in the NNR. The process of deriving the NNR includes considerations of whole-diet approaches and current dietary practices. This evaluation was performed by the NNR5 working group and was not a part of the SR conducted by the expert groups. The SRs were used as primary and independent components – but not the only components – for the decision-making processes performed by the NNR5 working group that is responsible for developing the recommendations.

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3 Use of Nordic Nutrition Recommendations

The Nordic Nutrition Recommendations (NNR) were established in the 1980s for planning purposes only. Today the NNR comprise a set of Nordic dietary reference values based on the scientifically grounded relationships between nutrient intakes and indications of adequacy, the promotion and maintenance of good health, and the prevention of diet-related lifestyle diseases in the general population. These values have been adapted to the Nordic region.

The NNR were developed in recognition of the growing need for quantitative values for a range of purposes:

- as a tool for assessment of dietary intake
- as guidelines for dietary planning
- as a basis for food and nutrition policies
- as a basis for nutrition information and education
- as guiding values when developing food products

The NNR define the following dietary reference values (DRVs): Average requirement (AR), Recommended Intake (RI), Lower Intake Level (LI), and Upper Intake Level (UL) for micronutrients and Recommended Intake Ranges for macronutrients. An overview of the conceptual framework originally proposed by Beaton (1) is shown in **Figure 3.1**, and the different approaches available for dietary assessment and planning purposes are described below.

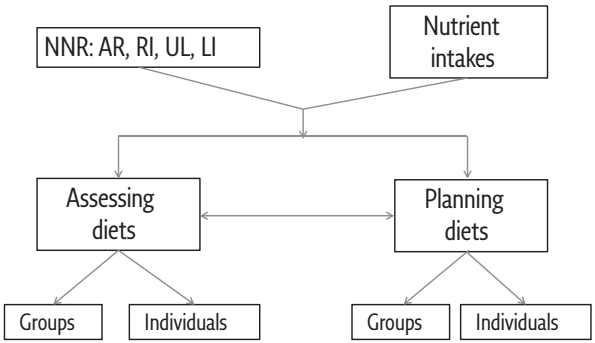

Figure 3.1 Conceptual framework of the use of the Nordic Nutrition Recommendations (NNR) *Adapted from Beaton (1)*

Application of the NNR for assessment and planning purposes

The applications of the NNR for assessment and planning purposes are based on the statistical concept of a distribution curve with an adjacent probability of adequacy or inadequacy as well as excessive intakes. For micronutrients, the application of the NNR makes use of the distribution of nutrient requirement and the distribution of nutrient intake (**Figure 3.2**) (2).

The distribution of nutrient requirement reflects the variability in requirements between individuals in a group where a group can be defined in terms of sex, age, and body size. For micronutrients for which requirements are normally distributed, the mean nutrient requirement of the group corresponds to the AR, which means that 50% of the individuals are estimated to have a higher requirement and 50% to have a lower requirement. In such cases, the RI is generally set to the AR + 2 SD and is thus estimated to cover the requirements of 97-98% of the individuals in the group (see Chapter 2 Principles and background).

The AR is a key reference value. When assessing nutrient intakes, nutrient intakes below the AR value are associated with a considerable probability of not meeting the requirement according to the selected criterion. Intakes between AR and RI do not exclude the probability of inadequate intakes.

Figure 3.2 illustrates how the probability approach can be applied to estimate the prevalence of inadequacy when usual intake is compared with the AR. Based on a continuous probability-of-inadequacy scale, the

distribution of the usual intake is used to estimate the probability of inadequacy. Based on such data the following questions can be answered:

1) What proportion of the group has a minimal probability of inadequacy? If minimal probability of inadequacy is defined as a risk of less than 2%, this means that the proportion of the group with a usual intake above the RI has a minimal probability of inadequacy (in Figure 3.2, example A illustrates a situation in which the distribution of intake of 100% of the population is above the RI).

2) What proportion of the group has a relatively high probability of inadequate intake? If a relatively high probability of inadequate intake is defined as a probability above 50%, this means that the proportion of the group with a usual intake below the AR has a relatively high probability of inadequacy (in Figure 3.2, examples B and C illustrate the situation in which 0% or 10%, respectively, of the population is below the AR).

3) What proportion of a group has a very high probability of inadequate intake? If very high probability of inadequate intake is defined as an intake below the LI, this means that the proportion of a group with a very high probability of inadequate intake is the proportion of the group with a usual intake below the LI.

This approach gives a rough estimate of the overall situation. This estimate can be elaborated upon by also looking at the remaining part of the group with intakes between the reference points applied above, for example those between AR and RI. For a detailed description of this approach and its assumptions, see (2).

When the AR is not established and the RI is based on the average observed daily intake level in a defined population group, the RI value is used for both planning and assessment purposes.

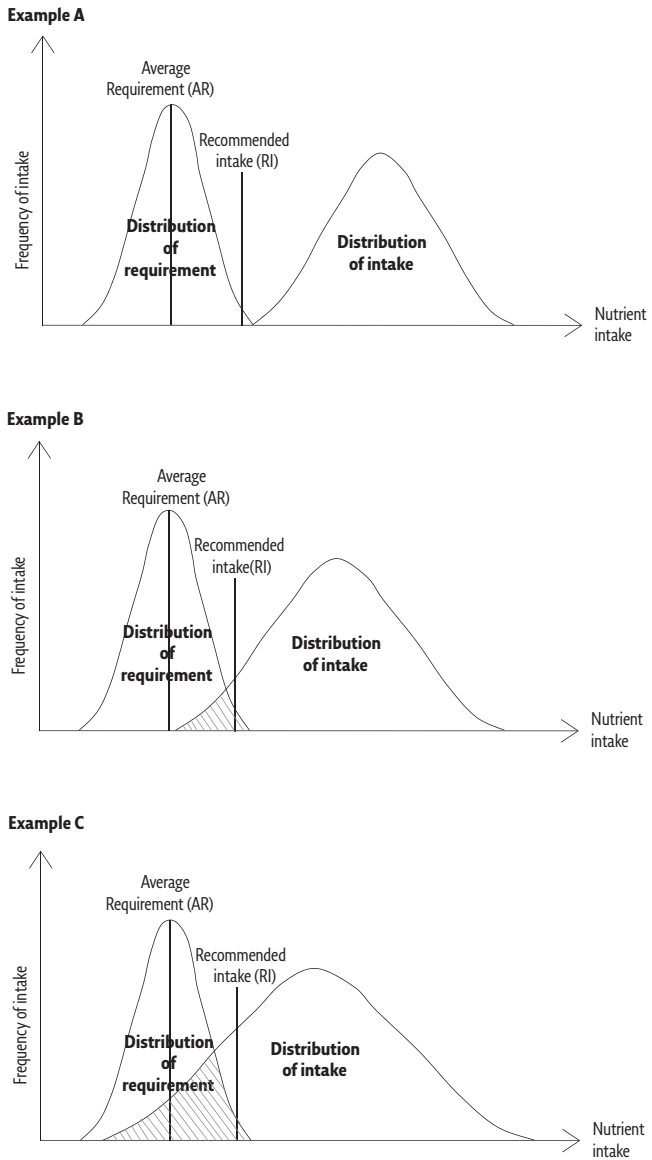

Figure 3.2. Examples of distributions of average requirements (AR) and average usual intakes of micronutrients illustrating different scenarios in assessment and planning of nutrient intakes.

The distribution of nutrient intakes reflects the day-to-day variability in the intake of an individual and the variability between individuals within a group. For application purposes, the usual intake of nutrients is an im-

portant concept, and usual intake is defined as the average intake over a longer period of time.

The distribution curve for nutrient intakes depend on the actual intake, dietary assessment methodology, and sample size (3). The dietary assessment methodology chosen depends on the purpose of the survey. Dietary intake data obtained from only a single day (a one-day food record or a single 24-hour recall) will have a relatively wide distribution curve compared with intake obtained over a longer period (Fig. 3.3). Intake data obtained from a single one-day assessment can, therefore, lead to a gross overestimation of the probability of inadequate or excessive intakes. These measurements are not considered suitable for assessment of dietary (in) adequacy unless the intake distribution is adjusted based on the intake of a subgroup of the sample over several days. Several statistical methods are available to obtain "usual intake" distributions from dietary assessment methods looking at one or several days (4, 5). Sample size is another important factor that will influence the reliability of the probability of inadequate or excessive intakes (3). Several other issues should also be addressed before making an assessment of nutrient intakes (Table 3.1).

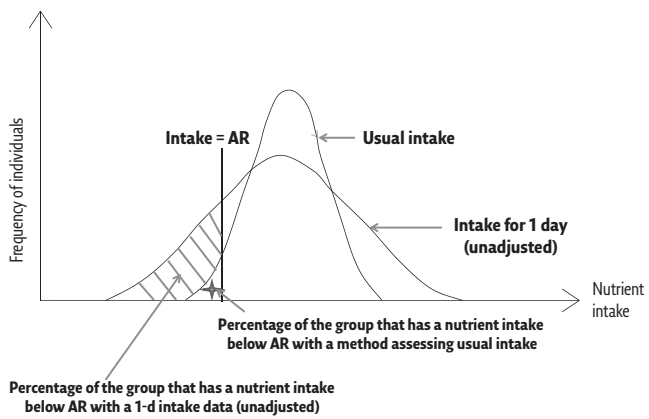

Figure 3.3 The frequency distribution of a nutrient intake by a group assessed with a one-day dietary method and by a method assessing usual intake (including a longer period of time). AR (average requirement).

Table 3.1 Checklist for issues to be addressed before assessment of nutrient intake data.

a)	How many days per individual are the nutrient intake data based on? Is the number of days sufficient to reflect "usual intake"? Is the number of days sufficient to estimate the proportion of individuals considered at risk? Is the number of days sufficient for assessment of a specific individual's intake?
b)	Do the intake data include total intake from the diet? Is the dietary record/interview covering all 24 hours of the day? Water, tea, coffee, and other non-energy beverages are often excluded from the calculated intake, but they might be important sources of certain minerals and trace elements.
c)	Is the reported energy intake acceptable? Underreporting of energy intake is common in dietary assessments and implies underreporting of most nutrients (including vitamins and minerals). Check for underreporting in the group as a whole, and in subgroups, before assessment of nutrient intake. This can be done by using published cut-off values for physiologically plausible EI/BMR ratio). If a subgroup shows low intake of a micronutrient, check for underreporting of energy intake in that group. Over reporting of energy intake is less common than underreporting.
d)	Do the data include nutrient supplements? Can information on nutrient supplements be analysed separately? Is the information on nutrient content and dose in supplements specific enough for calculating intake from these sources?
e)	Do the data include fortified foods? Can information on fortified foods be analysed separately? Is the information on nutrient content in foods specific enough for calculating intake from these sources?
f)	Have losses of nutrients during cooking been taken into account in calculation of nutrient intakes? This is particularly important for nutrients such as ascorbic acid and folate, for which substantial losses can occur during cooking/processing.
g)	Is the quality of the food composition database acceptable for all the nutrients calculated? Certain trace elements in particular databases can have missing values even for commonly consumed foods, and this can result in substantial underestimation of calculated intake. Database values for a specific nutrient can also be based on out-dated analytical methods that might provide systematically higher or lower values than the method currently in use.

Dietary assessment

How to assess the nutrient intake of a group

Micronutrients

The goal of assessing nutrient intake of groups is to determine the prevalence of inadequate or excessive nutrient intakes within a pre-defined group of individuals. Assessing nutrient intake of groups is an integral part of dietary monitoring, for example, in national dietary surveys or dietary intervention studies. Before comparing intake data with the DRVs, it is crucial to check whether the intake data reflect the usual nutrient intake and are suitable for an assessment (Table 3.1).

It is a common misunderstanding that the intake of a group *by definition* is adequate if the average intake of the group is equal to or above the RI. The key to an appropriate assessment of inadequacy at the group level is to think in terms of a continuous probability-of-inadequacy scale where the prevalence of inadequacy increases as intake decreases (illustrated in **Fig 3.2**).

The AR is the primary reference value for evaluation of nutrient intakes, and the RI, LI, and UL can be used as complementary values. Assessment of inadequate or excessive nutrient intakes is based on the distribution intakes of individuals in the group with the underlying assumption that nutrient intakes and requirements are not directly correlated (this is true for most nutrients – with the exceptions of a few, such as iron) (**Figure 3.2**).

For nutrients with an AR, assessment of nutrient intakes within a group starts with the division of the distribution of the usual intakes into percentiles. Based on these data, the following questions can be answered:

1. What proportion of the group has a minimal probability of inadequacy? – *defined as the proportion of the group that has an intake above the RI.*
2. What proportion of the group has a relatively high probability of inadequate intake? – *defined as the proportion below the AR.*
3. What proportion of the group has a very high probability of inadequate intake? – *defined as the proportion of the group that has an intake below the LI.*
4. What proportion of the group has a high probability of excessive intake? *defined as the proportion of the group that has an intake above the UL.*

For a detailed description of this approach and its assumptions, see IoM (6) and example 1.

Table 3.2. The intake distribution of vitamin C (mg/d) for a group of Danish women 18-75 years old (n = 1785)*.

Percentile	1st	5th	10th	25th	50th	75th	90th	95th	99th
Vitamin C intake (mg/d)	24	39	50	69	100	144	190	227	321

*[7]

Example 1: Example of assessing the usual intake of vitamin C.

Table 3.2 shows that about 10% of the group has an intake below 50 mg/d (AR) and about 70% has an intake above 75 mg/d (RI). This means that almost 10% of the group has a relatively high probability of acquiring inadequate amounts of vitamin C from the usual diet (intake below AR, probability of inadequacy >50%). About 70% of the group has a minimal probability of inadequacy (intake above RI). None of the women in the group have an intake above UL (1,000 mg/d). In conclusion, the intake distribution data indicate that approximately 10% of the group has a relatively high probability of inadequacy and that none of the women have an intake below the lower intake level (LI).

If the assessment results in a high prevalence and thus a high probability of inadequate nutrient intake that can only be explained by an implausibly low reported energy intake, the results might indicate that the risk is real. Biochemical measurements of nutritional status, however, are necessary to substantiate whether there is an actual lack of intake of the nutrient in question. The probability approach has recently been successfully applied to a nutrient status biomarker (7), and this can be used as a complementary tool for assessing adequacy or excess.

For nutrients with no AR, the assessment of the group intakes of nutrients is relatively simple and is based on just the mean intake of the group (8). If the mean intake of the group is at or above the RI, there is probably a low prevalence of inadequacy. If the mean intake is below the RI, no firm conclusions can be drawn regarding the prevalence of inadequacy at the group level.

The UL values can be used to estimate the proportion of a group with intakes above the UL and, therefore, at potential risk of adverse health effects from excess nutrient intake.

Energy

In the assessment of energy intake at the group level, the estimated average energy intake is compared with the reference value for energy intake for the specific group in which body size, age, sex, and appropriate levels of physical activity are taken into account. The proportion of the group with intakes above or below the reference value can be assessed. A prerequisite for an appropriate assessment of energy intake at the group level is to ensure that energy intake is accurately assessed, and the approach suggested by Black (9) is useful in this regard.

Assessment of energy intakes over a longer period of time should be supported by measurements of body weight at several points in time because changes in body weight reflect an imbalance in energy intake.

Macronutrients

The main focus in the assessment of macronutrient intake is to determine the energy distribution from protein, fat, fatty acids, sugars and total carbohydrates, and, in the case of dietary fibre, the amount of dietary fibre per day or per MJ. In the assessment of the usual energy contribution from protein, fat, and carbohydrates, the proportion of the group that has a usual energy contribution from these macronutrients within or outside the recommended intake range is estimated. In the assessment of the usual energy contribution from macronutrients with a recommended upper threshold (e.g. saturated fat and added, refined sugar) the proportion of the group that exceeds this threshold is estimated. Likewise, when the energy contribution from macronutrients with a recommended lower threshold (e.g. dietary fibre) is assessed, the proportion of the group that exceeds this level is estimated.

How to assess nutrient intake by individuals

Micronutrients

The goal of dietary assessment of an individual's usual nutrient intake is to assess the probability of inadequacy for an individual. Using the probability approach is conceptually simple; one compares the individual's usual intake of a nutrient to his or her requirement (10).

The probability approach for individuals can be used for nutrients with an AR as illustrated in Figure 3.4, which shows a theoretical example of the usual nutrient intake (I) of 3 individuals and their individual requirement (R). In this example, the nutrient intake of two of the individuals (I1 and I2) is above their individual requirements (R1 and R2) and, therefore, both individuals have a minimal probability of inadequate intake of the particular nutrient. The situation for individual 3, who has a usual nutrient intake (I3) below his/her requirement (R3), is different and no conclusion can be drawn on the probability of inadequate nutrient intake. Taking into consideration that it is extremely difficult to obtain the usual nutrient intake and virtually impossible to know the requirement of an individual, biochemical and other clinical measurements of nutritional status will, therefore, be necessary in the situation of individual 3 to clarify whether there is an actual situation with inadequate intake of the nutrient in question.

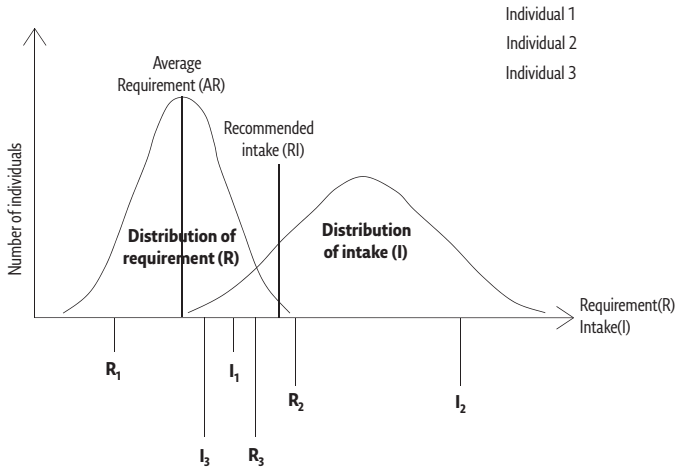

Figure 3.4 The distribution of the nutrient requirement and nutrient intake in a group and highlighting the individual requirement (R) and usual intake (I) of three theoretical individuals 1, 2, and 3. The larger the overlap between the two distributions curves, the higher the risk of inadequacy.

Energy

In the assessment of energy intake of an individual, the estimated average usual energy intake is compared with the reference value for energy intake for the individual in which body size, age, sex, and appropriate levels of physical activity are taken into account. A prerequisite for an appropriate assessment of energy intake at the individual level is that energy intake is accurately assessed. Here the approach suggested by Black (9) can be useful. Assessment of energy intakes over a longer period of time should be supported by measurements of body weight at several points of time because changes in body weight will reflect an energy imbalance over a period of time.

Macronutrients

As in the assessment of macronutrient intake at the group level, the main focus in the assessment of macronutrient intake of an individual is the energy distribution from protein, fat, fatty acids, sugars and total carbohydrates, and, in the case of dietary fibre, the amount of dietary fibre per day or per MJ. In the assessment, it is estimated whether the usual intake is within the recommended range for protein, fat and carbohydrates. In the case of macronutrients with a recommended upper threshold (i.e. saturated fat and added, refined sugar) or lower threshold (i.e. dietary

fibre) it can be estimated if the usual intake of the nutrient is above or below the threshold.

Dietary planning

How to plan a diet for a group

Micronutrients

The goal of dietary planning for groups is to compose a varied diet that meets the requirements of most individuals in the group and to obtain an acceptably low prevalence of intakes below the AR (**Figure 3.2**) while not exceeding the UL for the particular nutrient. Planning diets for groups includes food planning in the public meal sector, food fortification, and assuring food safety. Dietary planning is not intended for use on a daily basis but as an average over a longer period of preferably at least a week. The nutrient intakes are considered as "net-intake" of nutrients and losses of vitamins and minerals during peeling, cooking, and other handling procedures are subtracted. This is usually the case if the nutrient calculation is based on prepared foods.

For heterogeneous groups, the *nutrient density approach* is another approach to planning a diet. Here the goal is to plan a diet with a nutrient intake – expressed per unit of energy (MJ) – that is above the RI for the whole group as illustrated in example A of **Figure 3.2**. This approach is especially useful for planning a diet for a week or longer for heterogeneous groups with subgroups such as children, women, men, and the elderly because it ensures that the requirement of the "most demanding subject" is met. The recommended nutrient density to be used for planning diets for heterogeneous groups is shown in Chapter 1 (Table 1.4).

For homogeneous groups, it is appropriate in the planning of a whole diet over a longer period of time to use the recommended intake for the relevant age and gender group (Chapter 1, Table 1.3). The *nutrient density approach* can also be useful for the homogenous groups in question, e.g. men or women in a specific age group. In practice, the planning is done by calculating the planned recommended nutrient intake and expressing it per MJ of energy. For example, for sedentary men between 31 and 60 years old, the RI of vitamin C is 75 mg/d and the reference energy intake 11.0 MJ/d. The recommended density of vitamin C in the diet, therefore, is 6.8 mg/MJ for this group.

The probability approach is another approach to plan a diet. Here the goal is to plan a diet taking into consideration the entire distribution of

usual nutrient intakes within a group (**Figure 3.2**). Such planning seeks to achieve a usual intake that meets the requirements of most individuals but at the same time is not excessive. This approach was introduced by the Institute of Medicine as summarized (11). The prerequisite of this method is that the distribution of reported or observed usual intakes of the target group is known. The planning includes a decision on an acceptable prevalence of inadequacy (i.e. prevalence below the AR)(**Figure 3.2**) and a decision on a target usual intake distribution positioned within the distribution of usual intakes relative to the AR (12). In other words, how far the distribution of the intake curve is shifted to the right of the distribution of the requirement (**Figure 3.2C**). One example is provided in Table 3.3.

Table 3.3 An example of using the probability approach for diet planning for vitamin B_6. Current and target vitamin B_6 intake distribution (mg/d) for Danish women 18-24 years old (n = 150) and the required change (mg/d) to achieve a target intake with a prevalence of inadequacy in the group of 5%.

	Current intake* mg/d	Target intake mg/d	Change mg/d
Average	1.3	1.6	+0.3
Percentiles			
1st	0.5	0.8	+0.3
5th	0.7	1.0	+0.3
10th	0.8	1.1	+0.3
25th	1.0	1.3	+0.3
50th	1.2	1.5	-
75th	1.5	1.8	-
90th	1.7	2.0	-
95th	1.9	2.2	-
99th	2.4	2.7	-
Per cent below the AR	25%	5%	-20%
Per cent below the LI	10%	1%	-9%

**(13)*

Example 2: Table 3.3 shows the distribution of the current usual intake of vitamin B_6 in a representative sample of Danish women aged 18-24 years (n = 150) as assessed by a seven-day food record (13). The AR of vitamin B_6 in this age group is 1.0 mg/d and the RI is 1.3 mg/d. A Comparison of the average intake with the RI would leave the impression that the current intake level would be adequate at the group level. However, using the probability approach, the distribution of the current intake shows that up to 25% of the women in this group might have a relatively high probability of inadequate intake of vitamin B_6, i.e. their intake is below the AR. If the target (or desirable) intake is set to a level where only up to 5% of the group has a relatively high probability of inadequate intake (below the AR), it is necessary to plan for an increase of the usual intake by 0.3 mg/d. Thus, an increase at this level is added to percentiles with lower usual intake and the shape of the lower part of the distribution curve is moved to the right (Figure 3.2). The next step in the planning is to identify food sources rich in vitamin B_6 and currently consumed by the target group. Finally, the nutritional effects of this change in vitamin B_6 intake should be assessed by appropriate methods.

NB! This example illustrates that RI values should be used with caution in the planning of diets for groups. The challenge is that reliable usual intake data are needed but are not always available.

Energy

For planning of energy intake at group level, the average energy requirement at group level can be used as the reference value after taking into account normal body size, age, sex, and appropriate level of physical activity.

Macronutrients

The recommended intake range of macronutrients refers to appropriate ranges of usual intake in the majority of individuals in the population. For macronutrients with a recommended intake range, a value approximately in the middle of this range can be used as the population target (see Chapter 2). For macronutrients with an upper threshold (e.g. saturated fat and added, refined sugar) the diet should be planned not to exceed this threshold. For the macronutrients with a lower threshold (e.g. dietary fibre), the diet should be planned to exceed this threshold.

How to plan diets for individuals

The goal of dietary planning for individuals is to compose a varied diet that meets the requirements of the individual and to obtain an acceptably low risk of inadequate intake while not exceeding the UL for the nutrient.

National food-based dietary guidelines (FBDGs) can be used as practical guidelines for achieving a diet that meets the requirements of the individuals. Because the NNR apply to the apparently healthy population, special guidance should be provided by qualified personnel for those with other nutritional needs.

For energy, the reference values (the average energy requirements) relevant to the individual (see Chapter 1, Tables 1.5 and 1.7) can be used. If the characteristics of the individual in question differ from those in the tables, more specific energy values can be calculated based on sex, age, body weight, height, and usual physical activity level.

Food and nutrition policy

The NNR constitute an important basis for food and nutrition policy formulation and actions. In particular, the recommended composition of diets with regard to the proportions of fat and fatty acids, carbohydrates, dietary fibre and intake of sodium (NaCl), sugars, protein have been a key element in the setting of added national goals for dietary intake in Western countries, including the Nordic countries, for several decades. Development of the Nordic Action Plan in 2006 and subsequent monitoring and assessment of the action plan has made substantial use of the NNR (14, 15).

Health promotion through improved dietary habits and increased physical activity is now an integral part of nutrition and public health policies, and the NNR serve as an important yardstick in the substantiation of need for changes and actions. The NNR also provide reference values for monitoring dietary intakes, the evaluation of programs, and other food and nutrition policy initiatives.

Food and nutrition policies also include the FBDGs. For example, many countries have guidelines on fruit and vegetable intake (as portions/amounts per day) that are estimated to have potential health benefits in relation to diet-related diseases (16). Developing FBDGs based on scientific data on the relationships between the consumption of food groups and health ensures a varied diet that meets most nutrient requirements of the general population and a balanced intake of the whole spectrum of nutrients, including trace elements and other bioactive compounds. Both nutrient recommendations and FBDGs are relevant in the context discussed above. The FBDGs are particularly useful for planning of the food supply at a national level and for evaluating long-term trends in dietary intake based on national food supply statistics. Data on food supply have been

used extensively for several decades, including in the Nordic countries, in spite of the shortcomings of this type of data.

Two aspects of food and nutrition policy deal specifically with vitamins and minerals, namely the addition of nutrients to foods and use of dietary supplements.

Addition of nutrients to foods

Addition of a nutrient to selected foods can be used in nutrition policy as a means to increase the average intake of a specific nutrient in the general population and, in particular, to increase the intake in the portion of the population with usual intake below the AR without increasing the usual intake above the UL. Iodine is added to salt as a means to increase iodine intake in many parts of the world and is one of the classic examples of nutrient fortification. In the Nordic countries, fortification of selected foods began as early as the 1930s with the most common being fortification of household salt, flour, and margarine.

Before the food and/or health authorities decide to introduce fortification with a given nutrient, the following questions need to be answered:

1. Is there a documented need for increasing the intake of this nutrient in this population group?
2. Is fortification an effective way to increase the intake of the target group?
3. Are there other possibilities for increasing the intake of the target group?
4. Are there any risks of potential adverse effects of the fortification in the target group?
5. How can the effect of the fortification be evaluated?

The NNR DRVs serve several purposes in this context, both in the identification of a situation with inadequate intake and in the planning, implementation, and evaluation of a program. First, when assessing the usual nutrient intake of a group or groups in the general population, DRVs are used for evaluating the adequacy of current usual intake. If the dietary intake data suggest that the intake is inadequate, nutritional status information must also be considered. Second, when planning the amount of nutrients to be added to obtain a relevant increase in the usual nutrient intake in the target group, the DRVs should be used. Data on the distribution of the usual current intake are particularly useful.

Examples of on-going fortification programs introduced during the

2000s in the Nordic countries include the iodine fortification program (17, 18) and the vitamin D fortification program in Finland (19, 20).

Dietary supplements

Dietary supplements are defined as concentrated sources of vitamins and minerals that can supplement a normal diet and can have a nutritional or physiological effect either alone or in combination. In nutrition and public health policy, dietary supplements might be recommended for a specific target group that has a requirement that is too high to be met through a varied diet alone.

There are certain life stages and circumstances in which individuals might be especially vulnerable due to relatively high demands for micronutrients for growth. Thus dietary supplements might be relevant for groups such as infants and young children, pregnant and lactating women, the elderly, or others with *very low* energy intakes.

In the Nordic countries, a varied diet that meets the recommendations on macronutrient content and composition and meets the energy needs will usually contain adequate amounts of most vitamins and minerals. For specific groups, and under certain circumstances, attention should be paid to the possible need for dietary supplementation in connection e.g. food allergies and vegan diets. In general, individuals with a very low energy intake (<6.5 MJ/d) often have problems achieving adequate intakes of all micronutrients from the diet alone and a multivitamin/mineral supplement might be relevant in these cases. Due to food and cultural habits, some immigrant groups are particularly vulnerable to specific deficiencies, such as vitamin D deficiency, and supplements might also be considered in these cases. A number of dietary supplements are used in the treatment of certain diseases, but these aspects are mostly outside the scope of the NNR. In addition, attention should be paid to the fact that numerous common drugs can interfere with the absorption and metabolism of vitamins and minerals.

Nutrition information and education

Dietary information and advice

The NNR are a basis for FBDGs and for information regarding practical advice on diet, meal composition, and food selection. The FBDGs are useful tools for use by professionals (nutritionists, dieticians, nutrition educators, and health care providers) to inform and educate groups and

individuals. They are also useful for individual consumers in their planning of an overall healthy diet.

The formulation and focus of FBDGs vary somewhat between the Nordic countries due to cultural and culinary habits. Common features, however, are an emphasis on ample intake of fruits and vegetables, whole grain cereals, frequent consumption of fish, and choice of soft fats.

The introduction of the Keyhole labelling in Sweden in the late 1980s and in Norway and Denmark during the 2000s and the Finnish Heart Symbol are examples of tools for guiding consumers in making healthy food choices. These were introduced by national food agencies and widely adapted by food producers. The Keyhole concept covers a large number of food product categories using category-specific criteria for certain nutrients and is based primarily on the NNR. A similar labelling tool, the Heart Symbol, is used in Finland.

Education

The NNR is an important basis for the teaching of nutrition and food science. The NNR publication can be used directly as teaching material because it contributes to a basic understanding of how the DRVs for different nutrients and energy are derived and how they should be used in an appropriate way for various purposes. Food composition tables and databases, nutrient calculations programs, and data on dietary habits are relevant as supplementary material in this context.

There are some aspects of the NNR that could be stressed more in all levels of teaching and education. First, a primary emphasis could be placed on dietary composition and dietary sources with a focus on the quality of macronutrients and their possible interactions. Second, it should be stressed that the recommended levels do not have to be met every single day even though they are expressed as amounts per day (e.g. g/d or mg/d). Instead, they refer to an average intake over several days or approximately one week. Some days an individual might obtain more of a certain nutrient, and other days less, depending upon the foods consumed. In teaching, as in nutrition information, the nutrient recommendations should be linked to foods and FBDGs as well as to "real life" eating.

Development of new food products

The recommended intake values and other reference values can be used as guidelines when defining the desirable nutrient content of a food product. Obviously, no single food or meal is expected to contain the recommended intake of all nutrients unless it is a special product such as infant formula or a dietetic product used in clinical nutrition. The nutritional content of a food product can be compared with a dietary reference value and it can also be compared with the recommended energy distribution of macronutrients. Complete meals can be evaluated by comparison with the recommended macronutrient composition of the diet. In the European Union, the regulation specifying nutritional labelling includes a set of specific labelling values for certain vitamins, minerals, and macronutrients that must be used in labelling. These values refer to an adult reference person and are compiled from several sources. They might, therefore, differ somewhat from national recommended intakes such as those given in the NNR.

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Intake of vitamins and minerals in the Nordic countries

If a diet provides enough food to cover the energy requirements, complies with the ranges for distribution of energy from macronutrients, is varied and includes food from all food groups, the requirements for practically all nutrients will be covered. Exceptions might be vitamin D, iron, iodine and folate in subgroups of the population. The nutrient density of average diets in the Nordic countries is presented in Table 1. Data are calculated from recent national dietary surveys. Some of the pronounced differences may be explained by different dietary patterns (i.e. consumption of fish), levels of micronutrients added to foods (vitamin D, thiamin, riboflavin, vitamin B_6, iron and iodine) or differences in soil and composition of fertilizers (selenium). There may also be significant differences caused by the various survey methods and calculation procedures, e.g. recipes and correction for losses in cooking. Contributions to intakes of vitamins and minerals from supplements are not included.

For comparison the NNR 2012 recommended nutrient density for planning of diets (Chapter 1, Table 1.4) is included in Table 1. These values are intended for groups of individuals with a heterogeneous age and sex distribution and they form a rather strict reference based on the principle of the 'most demanding subject' (explained in Chapter 3, use of Nordic Nutrition Recommendations). It is obvious that the average diets do not meet the reference nutrient density for all micronutrients. However, this does not mean that food supply is inadequate, but rather it should be seen as a reminder to the diet planner of where to focus.

Table 1. Nutrient density (per 10 MJ) of selected vitamins and minerals in the average diet in the Nordic countries

		Denmark	Finland	Iceland	Norway	Sweden	Reference values for heterogeneous groups
Vitamin A	RE	1,241	1,085	1,319	961	1,117	800
Vitamin D	µg	3.5	12.8	9.8	6.2	8.8	14
Vitamin E	α-TE	7.9	13.0	12.0	12.1	15.8 [1]	9
Thiamin	mg	1.4	1.62	1.5	1.7	1.5	1.2
Riboflavin	mg	1.8	2.4	2.0	2.0	1.9	1.4
Niacin	NE	33	42	42	–	43	16
Vitamin B_6	mg	1.6	2.4	1.9	1.9	2.5	1.3
Folate	µg	350	322	329	280	349	450
Vitamin B_{12}	µg	5.7	7.6	8.0	8.0	6.9	2
Vitamin C	mg	124	152	125	123	132	80
Calcium	mg	1.207	1,417	1,087	995	1,114	1000
Phosphorus	mg	1,563	1,941	1,820	1,871	1,697	800
Potassium	g	3.7	4.8	3.6	4.2	4.0	3.5
Magnesium	mg	382	479	354	428	419	320
Iron	mg	11.0	14.3	13.0	12.2	13.1	16
Zinc	mg	11.7	14.4	12	12.5	13.1	12
Iodine	µg	217	263	204	–	–	170
Selenium	µg	47	86	85	63	58	57
Corrected for cooking losses		Yes	Yes	Yes	No	Yes [3]	
Age group	years	4-75	25-74	15-80	18-70	18-80	
Survey method		7-d food record	48-h recall	24-h recall	24-h recall	4-d food record	
Reference		3	2	4	5	1	

1 Calculated from α-tocopherol
2 Refers to vitamin A and E, thiamine, riboflavin, vitamin C and folate
3 Refers to thiamin, riboflavin, preformed niacin, vitamin B_6 and vitamin C
4 Contribution from b-carotene is calculated as 1/12

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Nordic Nutrition Recommendations

2012 · Part 1

Summary, principles and use

The Nordic countries have collaborated in setting guidelines for dietary composition and recommended intakes of nutrients for several decades through the joint publication of the Nordic Nutrition Recommendations (NNR).

The 5th edition, the NNR 2012, gives Dietary Reference Values (DRVs) for nutrient intakes, but more emphasis than in earlier editions has been put on evaluating scientific evidence for the role played by dietary patterns and food groups that could contribute to the prevention of the major diet-related chronic diseases. A Nordic perspective has been accounted for in setting the recommendations.

The NNR 2012 has used an evidence-based and transparent approach in assessing associations between dietary patterns, foods and nutrients and specific health outcomes. Systematic reviews (SRs) form the basis for the recommendations of several nutrients and topics, while a less stringent update has been done for others. SRs and individual chapters have been peer reviewed. The draft chapters were also subject to an open public consultation.

The present publication contains three parts: a summary of the recommendations, background and principles for the derivation of DRVs and use of the NNR. The documentation of the scientific basis for individual nutrients and topics will be included in a subsequent publication.

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