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A NUTRITION OVERVIEW

Photo: WHO/P. Virot

"Food comes first, then morals."

Bertolt Brecht, The Threepenny Opera *(1928)*

Key issues

Energy

- Nutritionists have established the energy expenditure for men and women for a variety of activities. Sedentary office work requires 1.8 kcal per minute; sitting requires 1.39 kcal per minute; farming, mining, forestry and construction can require 5 to 10 kcal per minute worked.
- Poorer nations are more likely to rely on manual labour; and workers in poorer nations are more likely to consume inadequate calories for these labour-intensive tasks.
- Consuming more calories than expended will result in weight gain. Consuming fewer calories than expended will lead to weight loss, fatigue, low productivity and accidents.

Macronutrients

- Macronutrients are broadly defined as those food components present in the diet in quantities of one gram or more. They include proteins, carbohydrates and fats.
- Recommended daily intake of protein for adults is 0.8–0.9 grams per kilogram of body weight; 8–15 per cent of the total energy consumption should come from protein. In regions where diarrhoea is prevalent, health experts recommend increasing the protein intake by 10 per cent.

- Protein deficiencies may lead to mental retardation or stunted growth among children, or a loss of muscle mass among adults. Deficiencies are rare in developed countries but still of great concern in developing countries.
- Fats contain more than twice the number of calories compared with equal measures of carbohydrates or proteins – on average, 9 kcal per gram.
- Active, non-obese adults may derive up to 35 per cent of their energy from fat and sedentary adults may consume up to 30 per cent as long as no more than 10 per cent of the energy intake is from saturated fats.
- Recommended intake of carbohydrates is 50–70 per cent of total calories.
- Healthy fats and complex carbohydrates are associated with lower rates of circulatory disease and certain cancers. Unhealthy (saturated) fats and simple carbohydrates are associated with circulatory disease and diabetes, respectively.

Micronutrients

- Micronutrients, often present in minute quantities, are vitamins and minerals that are essential for proper growth and metabolism.
- More than one billion people are ill or disabled as a result of a micronutrient deficiency and billions more are at risk.
- Illnesses and conditions brought about by a micronutrient deficiency include mental retardation, depression, dementia, low work capacity, chronic fatigue, blindness and loss of bone and muscle strength.
- Iron deficiency anaemia alone affects hundreds of millions of workers. Anaemia, and more mild levels of iron deficiency, decrease physical work capacity and work productivity in repetitive tasks, yet can be inexpensively remedied.

Humans are indeed a diverse species with vastly different body types suited to vastly different environments. We have populated nearly every region of the globe, from lush rainforests and fertile river deltas to rugged mountainous terrain and cold, treeless tundra. We have adopted the foods of these regions, be it protein from the sea or from land, carbohydrates from rice or from millet, vitamin C from berries or citrus fruits. And we have also created for ourselves a world of diverse cultures, which provide structure to what and when and even how much we should eat. Yet despite these differences we remain one species, one human race requiring a uniform set of nutrients. Thus, it is possible to characterize proper nutrition at its chemical level – proteins, lipids, vitamins, minerals – and provide universal guidelines on how best to attain good health through nutrition.

Certain vulnerabilities to diseases do exist from region to region. For example, wheat and other food products grown in selenium-poor soil in places as distinct as China, Finland and New Zealand can leave local populations susceptible to Keshan disease, a heart condition. In landlocked Afghanistan, the lack of iodine in the diet has led to an epidemic of goitre in recent years. These vulnerabilities are a result of the land, however, not the people's genetic make-up. We all require the same kind of nourishment, the same basic building blocks of nutrition. The main nutritional diseases, in terms of public health, are protein energy malnutrition, micronutrient deficiencies (especially iron, vitamin A and iodine), and obesity; and these are largely a result of inadequate food security and education.

This chapter describes in general terms the current state of scientific knowledge about diet and nutrition with the focus on adults, both female and male. This is an overview independent of the social, legal, economic and logistic issues of providing workers with access to food. Some readers may wish to skip this chapter and move on to the framework and case study chapters. We have provided a more extensive review of nutrition in appendices A and B to augment this chapter because, while the topic is important, we did not want to interrupt the flow of the publication with detailed nutrition information. The appendices expand on the notion of nutrient absorption, how certain diseases limit absorption, and how certain nutrients complement or conflict with each other. Also, subsequent chapters address food security. As defined by the WHO, food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life.

To reach as broad an audience as possible, a variety of foods are listed here and in the appendices as sources for specific nutrients. For example, beef, pork, lamb, goat, fowl and fish are all legitimate sources of high-quality protein; and vegetables, including soya beans, in the right combination can supply protein needs. These foods may seem exotic, unappetizing and taboo to some. No judgement has been cast, however, regarding the "right" food to eat. Fortunately, in most situations, we do not have to compromise. Our planet provides a sizeable menu from which we can choose; and most traditional diets – barring restrictions due to war, famine or religious obligations – satisfy and often exceed the nutritional requirements of most individuals.

2.1 Energy

The first law of thermodynamics concerns the conservation of energy. What is true for a machine is true for the human body. Humans need fuel to work. Energy that is consumed as food and not used by the body will be stored and

result in weight gain. Inadequate intake of food to meet energy requirements will result in weight loss and often the breakdown of body tissue. In both scenarios – obesity or undernourishment – the result is a decreased ability to work and to resist disease.

Undernourishment, or insufficient dietary intake, plagues developing nations and stunts productivity. This is a result of either low iron (Haas and Brownlie, 2001), low amounts of other nutrients, or too few calories. Poorer nations are most likely to rely on manual labour, and workers there are mostly likely to be underfed. One study has shown that some cutters and stackers in South African sugar-cane fields lose 3 per cent of their body mass as a result of high energy expenditure and inadequate calorie intake (Lambert, Cheevers and Coopoo, 1994). Protein energy malnutrition is the main nutritional disorder associated with a diet poor in quality and quantity. Obesity is an emerging pandemic. In the United States, the total cost attributable to obesity amounted to US$99.2 billion in 1995, including approximately US$51 billion in direct medical costs (Wolf and Colditz, 1998). Ten years on, the obesity problem in the United States is worse. Obesity is a growing concern in most developed countries and in many developing countries, as energy-dense foods, coupled with automation, serve to promote weight gain. Proper utilization of energy in terms of calories consumed and spent must be the foundation of any nutrition programme.

Energy requirements and energy content in food are measured in calories or joules. One calorie equals 4.187 joules, although scientifically these units are not truly comparable. The public health community prefers using the term joule or kilojoule. However, this publication will use the term kilocalorie or kcal (referred to as a calories in the United States), which is more familiar to many readers. Energy requirements vary among individuals based on body size, age and level of physical and mental activity. On average, adult males of working age require 2,500 kcal and non-nursing or pregnant adult females require 2,000 kcal.

Nutritionists have long established the energy expenditure for men and women for a variety of activities. (See *The feeding of workers in developing countries*, Food and Nutrition Paper No. 6, FAO, 1976.) For example, among males, sedentary office work requires 1.8 kcal per minute; sitting requires 1.39 kcal per minute; and sleeping requires 1.08 kcal per minute. Over the course of a day, eight hours of each activity amounts to a 2,050-kcal expenditure. In this scenario, consuming more than 2,050 kcal will lead to weight gain. Farming, mining, forestry and construction can require 5 to 10 kcal per minute energy. Substituting this for office work in the above scenario, the energy requirement for the day rises to over 3,500 kcal. Consuming fewer calories than this will result not only in weight loss over time but also an inability to perform the work.

Merely providing enough calories to workers to perform their tasks will not guarantee good health. Some workers in poorer nations are fed meals comprising mostly carbohydrates – such as corn porridge or bread – and little protein, fat or micronutrients. Workers cannot sustain their health on this kind of diet for long. Similarly, in wealthier nations, office workers could consume most of the daily requirement of 2,050 kcal in one meal of a cheeseburger, fried potatoes and a milkshake, yet receive few micronutrients, such as vitamins A and C. Energy is generic. Food choice is clearly crucial for maintaining good health.

2.2 Macronutrients

Macronutrients are broadly defined as food components present in the diet in quantities of one gram or more. This includes proteins, carbohydrates, fats and oils and also water (WHO, 1998, p. 55). Macronutrients are sometimes referred to as energy-giving foods.

2.2.1 Proteins

Proteins are needed for the growth and maintenance of muscle, bone, skin and organs, and for the synthesis of key enzymes, hormones and antibodies. Proteins are made from combinations of 20 amino acids. Of these, eight are considered "essential" and must be present in the diet because they cannot be synthesized by the body from precursors. Proteins from animal sources are mostly "complete" or "high-quality" proteins, meaning they contain all of the essential amino acids. Vegetable proteins lack one or more essential amino acids and are referred to as "incomplete" or "low-quality" proteins. A vegetarian diet can supply all the essential amino acids provided one combines complementary vegetable proteins, such as those from rice and beans. But in general, protein quality is far better in animal protein than in cereal and legume proteins.

No upper limit of protein intake has been set, but data suggest that excessive protein consumption can adversely affect the kidneys. Health experts in many countries recommend a daily intake for adults of 0.8 grams of protein per kilogram of body weight (WHO, 1998, p. 59). Diets largely composed of cereals and legumes with some animal products (meat, eggs or milk) are sufficient to supply this amount. Diets chiefly composed of low-quality proteins, however, need to provide 0.9 grams of protein per kilogram of body weight for proper nutrition (WHO, 1998, p. 59). The risk of protein energy malnutrition is high in regions where diarrhoea is prevalent. Once diarrhoea has been treated, workers should be given extra energy, proteins

and also vitamins to regain the weight and nutrients lost during the diarrhoea episode. In this case, experts recommend increasing the protein intake by 10 per cent. Protein needs during convalescence increase by 20–40 per cent (WHO, 1998, p. 59). A deficiency of just one essential amino acid will result in a decrease in protein synthesis and may lead to mental retardation or stunted growth among children or a loss of muscle mass among adults. Protein deficiencies are rare in developed countries but still of great concern in developing countries.

The World Health Organization suggests that 8–15 per cent of the total energy consumption should come from protein, with the range depending on whether one is eating high- or low-quality protein or in convalescence (WHO, 1998, p. 59). Of this, 10–25 per cent of dietary protein should be of animal origin (WHO, 1998, p. 58). Virtually all unprocessed foods contain protein, even foods thought of as carbohydrates, such as rice and wheat. Animal products are considered to provide the highest-quality protein. This includes beef, pork, lamb, game, fowl, fish, some insects, dairy products and eggs. Legumes – particularly soya and other beans, chickpeas, split peas and lentils – are considered very good sources of vegetable protein, as are nuts and some seeds. Potatoes are high in protein quality but low in quantity; cereals and leafy vegetables are low in protein quality but complement legumes. Whey protein (commercially available in powder form) is a high-quality, relatively inexpensive protein source with a long shelf life suitable for warm climates and remote work locations, where meat products may be hard to secure or store.

2.2.2 Fats

Fats, although often maligned, are vital for proper nutrition. Fats provide essential fatty acids, which are not made by the body and must be obtained from food. These fatty acids are the raw materials that help regulate blood pressure, blood clotting, inflammation and other body functions. Fats are also necessary for healthy skin and hair and for the transport of the fat-soluble vitamins A, D, E and K. Fats serve as energy reserves, stored in the adipose tissue (fat cells) that helps cushion and insulate the body. The body first burns carbohydrates during physical exertion. After about 20 minutes of intense exertion, the body depends on fat for calories.

Dietary fats consist of a chain of carbon atoms with hydrogen and oxygen attachments at various positions and degrees of saturation along the chain. The metabolic fate of a particular type of fat depends on the number and arrangement of these atoms. There are three categories of fats: saturated (solid at room temperature), unsaturated (liquid at room temperature) and

hydrogenated or trans fats. A saturated fat has a maximum number of hydrogen atoms along its carbon chain. This type of fat is more readily stored in adipose tissue as a long-term fuel reserve because it provides a higher energy yield compared with an unsaturated fat. Monounsaturated fat is preferentially used for energy more quickly than saturated fat.

Whether from plant or animal sources, fats contain more than twice the number of calories compared with equal measures of carbohydrates or proteins. On average, fats contain 9 kcal per gram. Experts recommend that adults derive at least 15 per cent of their energy from fats and oils and that women of child-bearing age consume at least 20 per cent (WHO, 1998, p. 59). Certain fats are healthier than others, however, and the key to proper nutrition is the proper balance of unsaturated fatty acids. Active, non-obese adults may derive up to 35 per cent of their energy from fat and sedentary adults may consume up to 30 per cent as long as no more than 10 per cent of the energy intake is from saturated fats (WHO, 1998, p. 60). In general, the need for fat increases during times of protein malnutrition. A minimum requirement for dietary (unsaturated) fat is 10 per cent of the energy intake (WHO, 1998, p. 60).

Saturated fats are largely considered unhealthy and their consumption should be kept to a minimum. Sources of saturated fat include most animal products, particularly butter, cheese, whole milk, ice cream, organ meats, fatty cuts of beef and pork and some shellfish. Coconut, palm and palm-kernel oils are also high in saturated fats. Health experts recommend avoiding or sharply limiting food products with more than 20 per cent saturated fat (NIH NHLBI, 2001). However, saturated fats in small amounts can be healthy if the sources provide other beneficial nutrients. Red palm oil, specifically, is an excellent source of vitamins A and E and serves as a nutritious, low-priced oil for populations chronically deficient in these vitamins.

Unsaturated fats help regulate a healthy balance of "good" and "bad" cholesterol – low-density lipoprotein (LDL) and high-density lipoprotein (HDL), respectively. Polyunsaturated fats lower LDL levels while mono-unsaturated fats increase HDL levels. Polyunsaturated fats, depending on their level of saturation, contain the essential fatty acids omega-3 and omega-6. The recommended ratio of omega-6 to omega-3 acid ranges from 10:1 to 5:1, with the narrowing ratio indicative of growing knowledge about how omega-3 may improve cardiovascular health (WHO, 1998, p. 60). Western diets often have an undesirable ratio of 40:1. Sources of omega-6 include the oils of sunflower, safflower, corn and soya bean. Sources of omega-3 include flaxseed and flaxseed oil, walnuts and walnut oil, and oily fish such as salmon, mackerel, herring, sild, pilchard, sardine and anchovy, cod liver oil, and whale and seal blubber. Monounsaturated food sources include nuts and nut oils (such as

Box 2.1 Dietary sources of fats

Healthier fats

Polyunsaturated, omega-3 – flaxseed and flaxseed oil, walnuts, oily fish such as salmon, mackerel, herring, sild, pilchard, sardine and anchovy, cod liver oil and whale and seal blubber.

Polyunsaturated, omega-6 – most liquid vegetable oils such as sunflower, safflower, corn and soya bean, sesame oil and most nuts.

Monounsaturated – olives and olive oil, canola (rapeseed) oil, avocado, peanuts, almonds, cashews.

Fats to use in moderation

Saturated fats – found in most animal products, such as butter, cheese, whole milk, ice cream, organ meats and fatty cuts of beef and pork, ghee (clarified butter), lard and beef tallow; also in tropical oils such as coconut, palm and palm kernel oils.

Fats to avoid

Trans fats – found in fried foods, most margarines, processed foods and commercial baked goods such as crackers, biscuits and doughnuts.

peanut oil), olives and olive oil, avocados, canola (rapeseed) oil and, to some extent, meat and butter. Although considered healthy, unsaturated fats do have their limit. Like saturated fats, they are high-caloric, energy-dense foods. High intake of any kind of fat can contribute to an increased risk of obesity, cardiovascular disease, cancer, diabetes, arthritis and gall bladder disease (A.D.A.M., 2004).

Hydrogenated or trans fats form when vegetable oil hardens. Trans fatty acids are commonly found in fried foods, most margarines, processed foods, and commercial baked goods such as crackers, biscuits and doughnuts. Trans fats have been shown to not only raise blood levels of LDL, the bad cholesterol, but also lower levels of HDL, the good cholesterol (Mensink et al., 2003). Thus, reducing, if not eliminating, trans fatty acids from the diet lowers the risk of coronary heart disease (Expert Panel, 1995).

With regard to obesity, fats can quickly add up in the daily calorie count. Fifty-five grams of fat contribute about 500 kcal (55 grams x 9 kcal/gram), which is 20 per cent of a 2,500-kcal diet. A 125-gram hamburger patty contains

about 22 grams of fat, most of which is saturated fat. Reduction of fat in the diet by 10 per cent translates to a reduction of about 3 kilogram in body weight over 2 months (Mokdad et al., 2001). The increased consumption of fast-foods, high in animal fats and simple carbohydrates, combined with a decreased level of exercise and changes in lifestyles, is the main cause of obesity.

2.2.3 Carbohydrates

Carbohydrates are the main source of energy in most diets. Their primary function is to provide energy for the body, especially the brain and the nervous system. This varied macronutrient takes the form of sugars (monosaccharides), oligosaccharides and starches and fibre (polysaccharides), all related by their simple molecular structure consisting of carbon tied to water molecules. The body breaks down carbohydrates into glucose, which acts like a pellet of fuel that cells can use to perform their many functions.

There appears to be no absolute daily carbohydrate requirement, for the human body can derive energy from fat and protein if necessary. The WHO recommends that at least 10 per cent of the energy intake should come from carbohydrates (about 50 grams) to prevent severe ketosis, a condition in which the blood becomes abnormally acidic from ketones, the by-product of burning fat for fuel instead of glucose (WHO, 1998, p. 63). A diet consisting primarily of carbohydrates, on the other hand, may cheat the body of valuable nutrients found in proteins and fats. Health experts recommend that 50–70 per cent of an individual's energy intake should be derived from carbohydrates (WHO, 1998). As with fats, however, a proper balance of certain types of carbohydrates can prevent chronic diseases such as obesity, cancer and cardiovascular disease.

Sugars are simple carbohydrates, which are most easily digested and quickly converted to glucose for fuel. Common sugars are sucrose, also called saccharose, primarily derived from sugar cane and sugar beets; fructose, from fruits and honey; and lactose, from milk. The consumption of simple sugars throughout the day – particularly sucrose and high-fructose corn syrup, as found in soft drinks – adds calories to the diet but few nutrients, and is a major cause of dental caries. Moderate intake of sugars, however, can make food more palatable. And the slight relationship between sugar consumption and obesity is offset by an inverse relationship between sugar and fat intake (Gibney et al., 1995). It should be noted that spices could be substituted for both sugar and fat to make food tastier.

Complex carbohydrates, such as starches and fibres, are large chains of sugars often containing hundreds of monosaccharides molecules. Complex carbohydrates take longer to digest and are preferred over simple carbohydrates

for weight maintenance and the control of diabetes, an emerging pandemic. Slower digestion also provides a feeling of fullness, curbing hunger in between meals. This limits the need for snacking, a major cause of weight gain. Most recommendations for adults specify an intake of at least 20 grams of fibre daily, which translates to around 10 grams per 1,000 kcal, although twice this amount can be easily tolerated (WHO, 1998, p. 64). Water-soluble fibre, found in oats, barley, legumes and the flesh of fruit, seems to reduce the risk of colon cancer (Le Marchand et al., 1997) and cardiovascular disease (Bazzano et al., 2003). One drawback is that fibre interferes with the absorption of nutrients, particularly minerals. Requirements for protein and minerals need to be adjusted accordingly in the presence of a high-fibre diet.

In summary, with regard to macronutrients and the prevention of chronic diseases, experts recommend that healthy adults choose a diet with a caloric intake of 50–70 per cent carbohydrates (predominantly complex carbohydrates), 15–30 per cent fat (predominantly unsaturated fats) and 8–15 per cent protein (with some animal protein) (WHO, 1998). Saturated fats increase the risk of some cancers, cardiovascular disease and obesity and obesity-related diseases, while a proper balance of unsaturated fats reduces these risks. Excessive amounts of simple carbohydrates increase the risk of weight gain and may be associated with diabetes, while complex carbohydrates and fibre reduce these risks and may prevent certain cancers. Exercise or physical labour is also key to preventing weight gain.

2.3 Micronutrients

Micronutrients are vitamins and minerals that are essential for proper growth and metabolism. Often only minute quantities are required. Their discovery and the subsequent in-depth study of their role and importance in the diet has led to mass food-fortification efforts – an important public health achievement of the twentieth century. Micronutrient deficiencies are cited as causing or exacerbating a host of mental and physical diseases, including infectious diseases. A diversified diet will help prevent micronutrient malnutrition. Food fortification and supplementation are also useful approaches.

Despite steady gains through the twentieth century in the field of nutrition, more than one billion people are ill or disabled as a result of a micronutrient deficiency, and over two billion more people are at risk (WHO, 1998, p. 66). These figures add up to half the world's population. As with diseases associated with macronutrients, for example, cardiovascular disease, diabetes, cancer and obesity, micronutrient-related diseases cut across class, age and gender in both developing and developed countries. Examples of illnesses and conditions brought about by a micronutrient deficiency include

mental retardation, depression, dementia, low-work capacity, chronic fatigue, blindness and the loss of bone and muscle strength. These conditions, many of which are reversible, directly affect the near-term health of employees and their work performance and quality. Thus, an adequate supply of micronutrients for the workforce is paramount. Iron deficiency anaemia alone affects hundreds of millions of workers (Haas and Brownlie, 2001). Anaemia and milder levels of iron deficiency decrease physical work capacity and productivity in repetitive tasks, yet can be inexpensively remedied. The main micronutrient deficiencies are vitamin A (largely affecting children), iron and iodine deficiency. Other deficiencies, such as folic acid, zinc and B-complex deficiencies, are a problem in certain populations.

2.3.1 Vitamins

Vitamins are organic chemicals found in plants and animals that are essential for human growth and health maintenance. There are more than a dozen known vitamins. A varied diet can supply these vitamins naturally, but supplementation is recommended for those individuals lacking vitamins as a result of famine, war, harsh climate or poor eating habits. (See Appendix B for a description of vitamins A, B-complex, C, D, E and K.) Of particular concern for adult workers are: vitamin C, because of its role in helping iron absorption; vitamin E, because of its role in preventing heart disease and cancers; and vitamin B_{12}, important in maintaining a healthy nervous system, which is lacking in vegetarian diets.

2.3.2 Minerals

Minerals and trace elements in the diet are inorganic chemicals essential for growth and fitness. Of particular public health importance are calcium, fluoride, iodine, iron, sodium and zinc. A varied diet can supply most minerals and trace elements naturally, but supplementation may be needed for fluoride and, depending on the location, certain chemicals not abundant in the soil, such as selenium, and thus not present in the local food supply. See Appendix B for a description of key minerals. Of particular concern for adult workers are zinc, often lacking from vegetarian diets, and iron.

Indeed, iron deserves discussion here, for iron deficiency cripples workers' productivity. Iron, as a constituent of haemoglobin, is needed to carry oxygen in red blood cells. Iron is also a key element in many enzymatic reactions. Even a slight reduction of blood iron (haemoglobin concentration of below 110 grams/litre) is associated with delayed learning and behaviour changes in children (Grantham-McGregor and Ani, 2001). Anaemia, a

condition marked by low concentrations of haemoglobin, often results in adults in sluggishness, low endurance and decreased physical work capacity and work productivity for repetitive tasks (Haas and Brownlie, 2001). Modest falls in iron levels also increase absorption of toxic metals, such as cadmium and lead. An estimated two billion people worldwide have clinical anaemia as a result of iron deficiency, constituting a public health emergency (WHO, 1998, p. 76). Women are at greater risk of iron deficiency due to blood loss during menstruation.

Usually, anaemia can be remedied through the provision of iron-rich or iron-fortified foods. The daily recommended iron intake varies, however, because the bioavailability of iron from foods varies from 1 to 45 per cent. Vitamin C and animal foods enhance iron absorption. Fibre, tannins (found in tea), phytates (found in grains) and polyphenols (found in coffee and red wine) reduce it. The recommended daily intake of iron depends on its bioavailability from foods, defined as very low (<5 per cent), low (5–10 per cent), intermediate (11–18 per cent) and high (>19 per cent) bioavailability. Corresponding intake levels are 20, 11, 5.5 and 3.5 milligrams of iron per 1,000 kcal (WHO, 1998, p. 77). The type of iron most easily absorbed is called haem-iron. Sources include clams, oysters, organ meats, beef, pork, poultry, fish and fortified grains. Fortification of wheat or maize flour, salt and soy sauce has been shown to be successful in regions where the natural diet is low in bioavailable iron.

2.4 Other nutrients

Simple fortification or dietary supplementation in pill form, although exceedingly beneficial in some circumstances, cannot be viewed as a panacea. Food is more than a container of macronutrients, vitamins and minerals that can be isolated in a laboratory and injected directly into the bloodstream. Attaining nutrients through food instead of supplementation is largely seen as a superior means of meeting nutritional requirements. This may be due to the fact that little is known about other components in the foods we eat, particularly carotenoids, bioflavonoids, salicytates and phytoestrogens. Also, a class of chemicals called antioxidants appears to reduce the risk of age-related diseases by helping repair cellular and DNA damage caused by free radicals. Appendix B contains a description of these other nutrients.

A well-balanced diet will supply adequate amounts of most of the nutrients discussed in this chapter. According to the WHO and the Food and Agriculture Organization (FAO), the right balance is 50–70 per cent carbohydrates (predominantly complex carbohydrates, with plenty of vegetables), 15–30 per cent fat (predominantly unsaturated fats) and 8–15 per cent protein

Table 2.1 Ranges of population nutrient intake goals

Dietary factor	Goal
Total fat	15–30 per cent (of total energy)
Saturated fatty acids	10 per cent
Polyunsaturated fatty acids	6–10 per cent
ω-6 Polyunsaturated fatty acids	5–8 per cent
ω-3 Polyunsaturated fatty acids	1–2 per cent
Trans fatty acids	<1 per cent
Monounsaturated fatty acids	By difference[1]
Total carbohydrate	55–75 per cent[2] (of total energy)
Free sugars[3]	<10 per cent (of total energy)
Protein	10–15 per cent[4] (of total energy)
Cholesterol	<300 mg per day
Salt (sodium)	<5 g per day (<2 g per day)
Fruits and vegetables	≥ 400 g per day
Total dietary fibre	>25 g per day
Non-starch polysaccharides	>20 g per day

Notes: [1] Calculated as: total fat (saturated fatty acids + polyunsaturated fatty acids + trans fatty acids). [2] The percentage of total energy available after taking into account that consumed as protein and fat – hence the wide range. [3] The term "free sugars" refers to all monosaccharides and disaccharides added to foods by the manufacturer, cook or consumer, plus sugars naturally present in honey, syrups and fruit juices. [4] The suggested range should be seen in the light of the Joint WHO/FAO/UN Expert Consultation on Protein and Amino Acid Requirements in Human Nutrition, held in Geneva from 9 to 16 April 2002.

Source: Adapted from: WHO/FAO, 2002.

(with some animal protein) (WHO, 1998). Table 2.1 gives ranges of population nutrient intake goals. Chapter 11 lists several key documents and programmes available to help employers and health workers choose appropriate nutrition and food safety plans for workers.