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EXECUTIVE SUMMARY

DIET, NUTRITION and the PREVENTION of CHRONIC DISEASES

WORLD HEALTH ORGANIZATION
GENEVA

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"Since appetite is governed by the need for energy, and since changes in energy intake are difficult to sustain, it becomes especially important to consider which foods are habitually chosen to satisfy energy needs."

"Knowledge about the causes of chronic diseases is now sufficiently strong to support the view that changes in dietary practices, rebalanced along the lines recommended in this report, can do much to prevent the premature death and disability caused by these diseases."

"Few governments realize that policies intended to guarantee an adequate food supply have introduced major threats to health."

Introduction

The possibility that what people like to eat may be hazardous to their health is a fairly recent worry in the course of human history. Throughout most of its existence, the human species survived hand-to-mouth on whatever it could manage to hunt, gather, harvest, or hoard. Anthropological studies show that the diet which fueled most of human evolution was low in fat, very low in sugar, and high in fibre and other complex carbohydrates.

It was only some 200 years ago, when the industrial revolution brought radical improvements in methods of food production, processing, storage, and distribution, that populations in developed countries could stop worrying so much about the threat of occasional hunger and start indulging in preferred foods. And it has only been over the past few decades that research, coming from an impressive number of studies, has raised the increasingly well-founded suspicion that dietary preferences may influence the development of several major chronic diseases.

Much of this research has taken its cue from comparisons between countries characterized by strikingly different dietary patterns and equally different rates of chronic diseases, including coronary heart disease, stroke, various cancers, diabetes mellitus, gastrointestinal disorders, and various bone and joint diseases. Although a large number of dietary factors have been investigated, those most frequently linked to such diseases are embodied in the so-called "affluent" diet, a pattern of eating typified by high consumption of energy-dense foods of animal origin and of foods processed or prepared with added fat, sugar, and salt.

One consequence of the very intensity of this research — and the publicity it often receives — has been a tendency to focus attention on individual food items or nutrients, with the result that consumers frequently lose sight of the need for balance in their diets. The problem is compounded by the fact that the concept of the balanced diet, though still extremely important, was introduced to protect populations from the diseases of nutrient deficiency, and may require adjustment in the light of growing evidence that nutrient excesses can also cause disease.

How strong is the evidence linking the "rich" diet to poor health? Will changes in food choices confer substantial protection against disease and, if so, which specific changes should be followed? Would the diet needed to prevent one disease conflict with the diet needed to protect against other chronic diseases? In short, if diet is to be regarded as preventive medicine, what does the scientific evidence, viewed as a body, have to say about the nutrient composition of a diet balanced to protect against all diet-related diseases?

These were some of the questions put before a panel of experts commissioned by the World Health Organization to assess the strength of evidence linking dietary factors to the development of chronic diseases and to issue advice on prevention. Although emphasis was placed on chronic diseases, the experts were also asked to consider the persistent problems of malnutrition and deficiency diseases, which remain a principal concern of the World Health Organization. Apart from the published literature, data from some 150 background papers were reviewed by the experts. Their conclusions, now published in a 200-page technical report[1], are summarized in this document.

Concerning the strength of the link between diet and disease, the experts concluded that repeated and consistent findings of an association between specific dietary factors and a disease suggest that such associations are real and indicative of a cause-and-effect relationship. The report also documents the alarming consequences of dietary changes in developing countries, which are now experiencing a universal and spontaneous shift towards the "affluent" diet. In these parts of the world, even modest increases in prosperity are accompanied by major changes in dietary patterns and a dramatic increase in the incidence of diet-related disease. If such trends continue, the end of this century will see cardiovascular disease and cancer established as major health problems in virtually every country in the world.

In one of its key achievements, the report issues a series of "population nutrient goals" put forward as a universal guide to the nutrient intakes needed to prevent all diet-related diseases and appropriate for application in all countries throughout the world. Lower and upper intakes are set for each of the main nutrient groups, including total fat, saturated fatty acids, polyunsaturated fatty acids, protein, total carbohydrates, complex carbohydrates, and free sugars. Expressed as a proportion of total energy, this recommended "safe" range of intakes specifies the minimum intake of a nutrient needed to prevent deficiency diseases and the maximum intake that should not be exceeded in the interest of preventing chronic diseases. Recommended daily intakes, expressed in grams, are issued for salt, dietary fibre, dietary cholesterol, and fruits and vegetables. The zero value given as the lower limit for saturated fatty acids, dietary cholesterol, and free sugars indicates that these dietary components meet no special nutritional need and are thus not required for the prevention of any deficiency disease.

The report is explicit in its insistence on the need for a population-wide, as opposed to individualized, approach to the prevention of diet-related chronic diseases, arguing that the entire population of most affluent countries shows a high risk profile and that intervention on a mass scale is needed to shift dietary patterns closer to the "safe" range of intakes specified in the report. In undertaking such mass interventions, governments are challenged to develop policies that will make healthy food choices the easy choices for consumers to make.

[1]Diet, Nutrition and the Prevention of Chronic Diseases, *WHO Technical Report Series*, No. 797

The concluding section, devoted to food policies, explains why current policies governing food production and supply are essentially agricultural policies driven by the economic and political issues of food availability, food security, and the security of food producers. A review of the evolution of these policies, most of which were formulated in the 1940s, reveals roots in nutritional concepts based on the need to prevent deficiency diseases and thus ill-equipped to protect populations from the many diseases now linked to nutrient excesses.

The report notes that the new nutritional objectives of preventing both the deficiency diseases and the chronic diseases will have immense implications for the economics of farming, for government, industrial and social policies, and for international trade, and can thus be expected to meet with considerable opposition.

CONCEPTS

Food as fuel

Appetite is primarily geared to the control of energy intake. Children and adults normally eat to meet their energy needs, the amount of food eaten being adjusted subconsciously over a period of days so that it approximates the individual's rate of energy expenditure. This adjustment in appetite and food intake is under powerful physiological control and occurs despite the different water and energy contents of foods.

Individual energy needs are finely tuned to changes in body size and physical activity and are also affected by age, sex and, probably, genetic factors. When energy intake is deliberately restricted, as in dieting, the body loses weight, adapts its metabolism to the smaller body mass, handles food differently, and may become less active.

At the same time, however, the metabolic flexibility of the body is limited, making it difficult to introduce major changes in energy intake for more than a few days before signals of hunger or fullness take control of the appetite and limit further changes in weight.

Energy needs in developing countries

For the most part, adults in developing countries tend to be shorter and thinner than their counterparts in affluent societies. Thus, though adult men and women in developing countries do more physical work, their energy requirements are lower than those of North Americans simply because their body weights are lower.

Evidence indicates that this smaller body size may be partly due to common inadequacies in the diet that have kept populations from reaching their genetic potential for height. Thus, as populations of developing countries gain access to unlimited food supplies, improved conditions of water and food hygiene, and a lower risk of infectious diseases, they can be expected to grow taller and possibly become more physically active. When this is the case, population average energy requirements will increase even if population growth is zero.

Energy-dense versus nutrient-dense foods

The first and foremost priority of any food policy is to make certain that the supply of food and its system of distribution are delivering enough energy to support childhood growth and adult work and leisure activities. Once this overriding need for food energy has been met, then the health effects of different sources of energy can be considered.

Certain types of foods are now known to play a more important role than others in the development of chronic diseases. Since appetite is governed by the need for energy, and since changes in energy intake are difficult to sustain, it becomes especially important to consider which foods are habitually chosen to satisfy energy needs.

Some foods are more likely to promote weight gain and obesity than others. An increase in the proportion of energy derived from energy-dense foods rich in fat and sugar and low in complex carbohydrates and fibre can produce progressive weight gain, with changes becoming apparent over a period of weeks or months.

Energy-dense foods are generally not rich in nutrients. Though foods processed with sucrose may carry a number of nutrients, sucrose does not, in itself, meet any special nutritional requirement. Fat carries its few nutrients in the form of fat-soluble vitamins. Alcohol, which is also energy-dense, is accompanied by few if any nutrients.

As the world's population of the elderly continues to grow, the issue of nutrient density in the diet takes on special importance. Whereas energy requirements fall progressively in the elderly, the need for protein, calcium, iron, and other nutrients either stays the same or increases. Thus, because the elderly consume less food yet need a high intake of nutrients, the nutrient density of their diets plays a critical role in health. When the habitual diet draws upon energy-dense, nutrient-poor foods, the elderly will face a need to change dietary patterns at a point in life when eating habits are firmly entrenched.

The problem of meeting the nutritional needs of the elderly argues strongly for a diet rich in nutrient-dense foods and low in energy-dense foods that begins in childhood and is maintained throughout life. A second argument for the importance of good dietary habits early in life comes from knowledge that the atherosclerotic process leading to coronary heart disease starts in childhood and, moreover, is strongly and directly linked to a diet rich in fat and low in foods providing complex carbohydrates and fibre.

The population approach

Within any one population, the medical care system can sometimes develop approaches to reduce the risk of disease in certain individuals, particularly those identified as being at high risk. Such persons are detected in screening programmes and then singled out for individually tailored interventions most often involving prescribed diets and drugs and regular medical monitoring.

The past two decades have seen considerable disagreement concerning the value of screening programmes and high-risk interventions as a strategy for preventing cardiovascular disease. When serum cholesterol concentrations were linked to the risk of developing coronary heart disease, investigators suddenly had a tool in hand for detecting individuals at risk. Though serum cholesterol concentration has proved to be a reliable predictor of individuals at very high risk, this screening tool is much less reliable in its ability to predict which individuals, among the much larger group at moderate to high risk, will eventually develop coronary heart disease. Since most deaths from heart disease will occur in the large group at moderate risk, screening programmes, though of unquestionable value for persons at very high risk, cannot be regarded as an adequate approach to the prevention of coronary heart disease on the largest possible scale.

If individual interventions are directed only to the high-risk group, a correspondingly small proportion of all deaths from cardiovascular disease will be delayed or averted. Conversely, if the screening criteria are lowered with the aim of detecting those at moderate to high risk, then a very large number of people will be selected for intervention, many of whom, in view of the weakness of serum cholesterol as a predictor in this group, will not be in need of special care. Health care systems, even in the most prosperous of countries, cannot afford such a broad base of individualized intervention.

A different picture and a different set of priorities emerge when populations of different countries are compared in terms of dietary patterns and death rates from chronic disease. When such an approach is applied, the entire population of most affluent countries shows a high-risk profile defined by a prevalence of obesity, blood pressure levels, and average serum cholesterol concentrations that are significantly higher than those seen in countries characterized by low rates of chronic disease and healthier eating patterns. In those countries where diet-related risks prevail, the whole population can be considered at moderate to high risk of disease. Such a situation begs for mass intervention designed to protect the entire population rather than to treat individuals at very high risk.

When the objective is to prevent disease in the entire population and bring down national mortality rates, then the focus shifts to the underlying causes of the disease and the need to eliminate or reduce these causes.

The population approach specifically argues against differentiation down to the level of the individual. It adopts the position that, when an entire population is perceived to be at risk, then the entire population must be treated through strategies aimed at reducing or eliminating the risk. In the case of diet-related chronic diseases, the population approach calls for modification and improvement of the environment in which individuals make their food choices, as well as an improvement in the ability of individuals to make wise choices. Because policies governing food production and supply can have a profound impact on consumer choices, the protection of populations from diet-related diseases requires action at the policy level.

All of the available evidence suggests that, for cardiovascular disease and for cancer, diet has an influence throughout the life cycle, even though the end-points are manifested in the adult. Thus, policies and programmes directed towards the control of nutritional inadequacies and nutritional excesses in populations need to influence food choices throughout the life cycle.

This report is concerned with the primary, population-wide, and worldwide prevention of chronic diseases and therefore aims to assist in the elimination or reduction of the diet-related risk factors for coronary heart disease, cancer, diabetes, and other chronic diseases. The nutrient intakes recommended in this report are intended to guide the detection of dangerous dietary patterns and aid the formulation of policies that can adjust national diets towards this "safe" range of intakes. Such a strategy promises to make the greatest contribution to prevention, not just for individuals at high risk, but for everyone, and not just for rich countries, but everywhere.

THE POPULATION NUTRIENT GOALS

	Limits for population average intakes	
	Lower limit	Upper limit
Total fat	15% of energy	30% of energy[a]
Saturated fatty acids	0% of energy	10% of energy
Polyunsaturated fatty acids	3% of energy	7% of energy
Dietary cholesterol	0 mg/day	300 mg/day
Total carbohydrate	55% of energy	75% of energy
Complex carbohydrates[b]	50% of energy	70% of energy
Dietary fibre[c] As non-starch polysaccharides (NSP)	16 g/day	24 g/day
As total dietary fibre	27 g/day	40 g/day
Free sugars[d]	0% of energy	10% of energy
Protein	10% of energy	15% of energy
Salt	—[e]	6 g/day

Total energy

Energy intake needs to be sufficient to allow for normal childhood growth, for the needs of pregnancy and lactation, and for work and desirable physical activities, and to maintain appropriate body reserves of energy in children and adults. Adult populations on average should have a body-mass index (BMI) of 20–22 (BMI = body mass in kg/[height in metres]^2).

[a] An interim goal for nations with high fat intakes; further benefits would be expected by reducing fat intake towards 15% of total energy.

[b] A daily minimum intake of 400 g vegetables and fruits, including at least 30 g of pulses, nuts, and seeds, should contribute to this component.

[c] Dietary fibre includes the non-starch polysaccharides (NSP), the goals for which are based on NSP obtained from mixed food sources. Since the definition and measurement of dietary fibre remain uncertain, the goals for total dietary fibre have been estimated from the NSP values.

[d] These sugars include monosaccharides, disaccharides, and other short-chain sugars extracted from carbohydrates by refining. These refined, or purified sugars do not include the natural sugars consumed when eating fruits and vegetables or drinking milk.

[e] Not defined

The population nutrient goals defined in the report.

The lower limit defines the minimum intake needed to prevent deficiency diseases, while the upper limit expresses the maximum intake compatible with the prevention of chronic diseases.

POPULATION NUTRIENT GOALS

Total fat

Lower limit: 15% energy
Upper limit: 30% energy

A restriction in the intake of total fat contributes to the prevention of obesity, coronary heart disease, and possibly several cancers.

The importance of a raised serum cholesterol level and hypertension in the development of coronary heart disease provides the key reason for limiting total fat intake. While total fat intake does not increase blood cholesterol concentration unless it contains appreciable amounts of saturated fatty acids, fat intake as such may promote obesity and thus contribute to the development of hypertension. In addition, because most affluent diets contain an excess of saturated fatty acids, any policy that leads to a fall in total fat intake is also likely to reduce the content of saturated fatty acids.

Evidence suggests a direct relationship between the risk of certain cancers and the level of total fat in the diet. At present, the range over which the relationship holds is not clear. As additional and more definite evidence accumulates for cancer, it may prove necessary to lower the upper limit for total fat from 30% of energy to 25% or perhaps even to 20%.

As the total fat content in a population's diet goes up, so does the number of persons developing obesity with all its complications. Studies have not yet found any differences between the capacity of saturated and unsaturated fatty acids to promote obesity. It is therefore the total amount of fat that needs to be restricted in the interest of preventing obesity.

Fat provides only a few nutrients in the form of fat-soluble vitamins. Nonetheless, a diet conducive to good health needs to derive at least some of its energy from fat. The lower limit fixed for total fat reflects the absolute need to meet nutritional requirements for the essential fatty acids and the need, at certain times in life, to consume at least some energy-dense foods. This need is especially important in young children who, because of their small stomachs, may simply not be able to eat enough to meet energy requirements when all foods are low in energy.

Saturated fatty acids

Lower limit: 0% energy
Upper limit: 10% energy

Knowledge about the causes of coronary heart disease provides the primary justification for restricting the intake of saturated fatty acids. Saturated fatty acid intake has a direct and major impact on blood cholesterol concentrations and thus on the development of coronary heart disease. Population data clearly associate a decrease in saturated fatty acid intake with a progressive fall in cardiovascular disease mortality. When intake has declined to the point that saturated fatty acids account for less than 10% of energy, there is little additional fall, though further benefits can be expected from lower intake. A value of 10% of energy has thus been fixed as the maximum upper limit for saturated fatty acids.

Saturated fatty acids have also been implicated in the promotion of certain cancers, most notably of the colon and breast, though the strength of this link does not compare with that established for coronary heart disease.

Saturated fatty acids are not essential nutrients and do not need to be included in the diet. The lower limit for saturated fatty acids is therefore zero.

Polyunsaturated fatty acids

Lower limit: 3% energy
Upper limit: 7% energy

Polyunsaturated fatty acids include the essential fatty acids required for the normal growth and function of tissues. There is an absolute requirement for their inclusion in the diet. Current evidence shows that diets deriving a minimum of 3% of their energy from polyunsaturated fats will meet this absolute need for the essential fatty acids.

With regard to an upper limit for safety, most concern centres around animal studies suggesting that diets containing excessively high levels of polyunsaturated fat might contribute to the risk of certain cancers. Levels used in these animal experiments are regarded as "exces-

sively high" because they go well beyond the intakes found in typical diets throughout the world.

In reality, existing national diets rarely derive more than 7% of their energy from polyunsaturated fatty acids, even in those cases where total fat intake in the national diet is high. Since human studies have not yet linked this 7% intake for polyunsaturated fatty acids to any major disease or illness, and since higher intakes bring no known health benefits, an energy value of 7% for polyunsaturated fatty acids has been established as the safe upper limit.

This report does not support the notion of a desirable ratio of polyunsaturated fat to saturated fat intake. For clear health reasons, people need to eat fewer foods containing saturated fatty acids. The belief, popular in some countries, that increased consumption of polyunsaturated fat might somehow cancel out the risks associated with a continuing high consumption of saturated fat may encourage excessive intake of polyunsaturated fat, keep saturated fat intake at a potentially dangerous level, increase the proportion of total fat in the diet, and thus raise the risk for the many diseases linked to high total fat intake.

Monounsaturated fatty acids

No limits defined

Some Mediterranean diets with a total fat intake accounting for more than 40% of energy are accompanied by low rates of coronary heart disease. The fact that most of this fat is supplied by oleic acid-containing olive oil has stimulated efforts to define a place for monounsaturated fatty acids in the prevention of coronary heart disease.

As yet, no physiological explanation has emerged. Moreover, Mediterranean diets are known to be high in complex carbohydrates and low in saturated fatty acids, suggesting that the explanation for the lowered rates of coronary heart disease may lie elsewhere.

This report offers no specific recommendations on upper or lower intakes for monounsaturated fatty acids. Diets should draw upon this class of fatty acids in order to make up the difference between the recommended total fat intakes and the sum of saturated and polyunsaturated fatty acids.

Total protein

Lower limit: 10% energy
Upper limit: 15% energy

Protein requirements are readily met in children and adults eating a varied diet based predominantly on cereals and pulses. These diets, which are consumed by the majority of the world's population, provide approximately 10-15% of their energy in the form of protein.

Protein also contributes 10-15% of total energy in the diets of affluent societies found around the world. Increasing the proportion of energy derived from protein brings no known advantages. Moreover, a high intake of protein may have harmful effects in promoting excessive losses of body calcium and perhaps also in accelerating an age-related decline in kidney function.

A diet drawing 10-15% of its energy from protein is neither inadequate nor excessive provided energy needs are being met, a reasonable range of protein sources, usually including both animal and plant foods, is part of the diet, and due attention is paid to the control of infectious diseases in children.

Total carbohydrates

Lower limit: 55% energy
Upper limit: 75% energy

The energy contribution of protein, ranging from 10-15%, is typical of existing diets throughout the world and does not need to change. The remaining 85-90% of dietary energy comes from fat, carbohydrates and alcohol. The use of alcohol is discouraged and the intake of fat should be kept to a minimum. Thus, if protein is to provide 10-15% of dietary energy, and fat 15-30%, it follows that total carbohydrates should account for 55-75% of energy. Most of this energy should be in the form of complex carbohydrates.

Food carbohydrates are classified, on the basis of chemical structure, into three groups: the monosaccharides, which include glucose, fructose, and galactose and are available in fruits, vegetables and honey; the disaccharides, which include sucrose (common table sugar), and lactose (milk sugar); and the polysaccha-

rides, of which the most important available carbohydrate is starch.

The structural distinction between monosaccharides and disaccharides becomes blurred in the body, where the digestive actions of saliva and pancreatic juice break sucrose down into glucose and fructose.

The monosaccharides, or "simple" sugars, and the disaccharides are together referred to as simple carbohydrates. The polysaccharides are the complex carbohydrates. Because their most important dietary component is starch, complex carbohydrates are also referred to as "starchy" carbohydrates. Major sources of complex carbohydrates are cereals, pulses, vegetables, potatoes, roots and other tubers.

In issuing separate recommendations for complex carbohydrates and for free sugars, the intention is to stress the many specific advantages brought by a high intake of complex carbohydrates while also guarding against the health risks linked to excessive intakes of sugars, most notably sucrose and other sugar-based sweeteners.

Complex carbohydrates (starch foods)

Lower limit: 50% energy
Upper limit: 70% energy

Unlike the population nutrient goals established for fats and protein, the upper and lower limits for complex carbohydrates have not been fixed on the basis of knowledge about the risks of deficient or excessive intakes of starch. Research into the nutritional qualities and benefits of starch intake as such is comparatively limited. Nonetheless, abundant evidence demonstrates that foods and diets rich in starch have many positive effects on health and, moreover, confer protection against several diseases.

Studies have consistently shown that diets rich in starchy carbohydrates favour a lower incidence of several cancers, limit the occurrrence of hyperlipidaemia, and assist in the management of diabetes and other metabolic diseases. These diets also help to limit excessive weight gain.

Foods rich in complex carbohydrates have beneficial effects on intestinal function, on the chemistry of the gut, and on the physiology of the gut wall. In addition, starch foods from plants are an especially rich source of many minerals and vitamins, including essential fatty acids, calcium, zinc, iron and a variety of water-soluble vitamins, all known to have a clear and positive effect on health.

Because starches affect colonic function and normal absorptive mechanisms in a variety of different and positive ways, it is likely that better understanding of the mechanisms by which starch exerts these various effects will lead to a clear definition of the role of starch per se in the nutritional prevention of disease.

For the time being, evidence from studies of foods and diets rich in starch is sufficient to justify the recommendation that, once the limits of fat and protein intake required to prevent diseases of deficiency or excess have been set for a national diet, the remaining energy needs will best be met, and at the greatest profit for health, by foods rich in complex carbohydrates.

Free sugars

Lower limit: 0% energy
Upper limit: 10% energy

Free sugars are short-chain sugars which are extracted from carbohydrates by refining. These refined, or purified sugars do not include the natural sugars consumed when eating fruits and vegetables or drinking milk.

The upper limit for free sugars is based primarily on what is known about the causal link between sucrose and dental caries. Because other free sugars are also implicated, though to a lesser extent, in the development of dental caries, the contribution of these substances to total energy has also been considered.

At the individual level, the risk of dental caries is influenced by a number of factors, including individual susceptibility, the form in which sugars are consumed, and the daily frequency of consumption. At the population level, studies show a direct relationship between both the quantity and frequency of sucrose consumption and the development of caries. An increased consumption of sucrose within a population therefore signals an increased risk of dental caries, regardless of whether the increase is due to greater frequency of consumption by individuals or more widespread consumption throughout the population. Since

energy-dense foods rich in fat and sugar may promote weight gain and obesity, a restriction in sugar intake may also contribute to weight control.

Sucrose and other free sugars are not known to have specific adverse effects on health beyond their clear link to dental caries and their possible contribution to the problem of excessive weight. The upper limit fixed for sugars is based on the sharp increase in dental caries seen when annual sugar consumption exceeds 15 kg per person. A yearly sugar consumption of 15-20 kg works out to around 40-55 grams of sugar per day, which is equivalent to approximately 6-10% of dietary energy. The limit on sugar intake, fixed at 10% of energy, should be sufficient to protect against high rates of dental caries, provided fluoridation is widely available.

While the pain and expense of dental caries and the difficulty of treating obesity certainly argue for prevention, a restriction in sugar intake can be advised on nutritional grounds alone.

Free sugars, which are not essential nutrients and therefore meet no specific nutritional requirements, make an empty contribution to total energy. Because appetite is primarily geared to the control of energy, consumption of foods rich in sucrose reduces the desire for other food sources of energy. Sucrose intake at the expense of starch is of particular concern, since starch, when obtained from cereals, pulses, and vegetables, is accompanied by a wide range of health-promoting micronutrients.

Given the established role of vitamins and minerals in the prevention of deficiency diseases and their potential protective role in chronic diseases, it is simply unwise for diets to draw a substantial proportion of energy from an inessential nutrient and thus displace other foods needed by the body to promote good health and protect against disease. Populations consuming small amounts of sucrose and other free sugars are therefore strongly advised to maintain this tradition.

Free sugars contribute no nutrients and are not essential for human health. The lower limit is therefore zero.

Dietary fibre (expressed as non-starch polysaccharides)

Lower limit: 16 grams per day
Upper limit: 24 grams per day

Dietary fibre refers to those complex carbohydrates that escape digestion in the mouth, stomach, and small intestine and thus pass on to the colon. Some may undergo bacterial digestion there with subsequent absorption of digestive products.

Most of the complex carbohydrates that escape digestion are in the form of non-available, or "non-starch", polysaccharides. Because these complex carbohydrates are readily specified and measured, this report expresses recommended intakes for dietary fibre as non-starch polysaccharides. Levels so expressed are appreciably lower than the "dietary fibre" levels often reported using the older enzyme methods of the 1970s. This difference should be considered when comparing the proposed lower and upper limits with reported population mean intakes.

Dietary fibre has important functions both in the intestine and in body metabolism. Through its effects on stool bulking, fibre helps to prevent constipation and haemorrhoids. By speeding up intestinal transit, fibre may reduce the duration of exposure of intestinal tissues to noxious agents in the diet or secreted in the small intestine. Fibre also affects the rate of release and absorption of glucose and therefore has a role in the treatment of diabetes. Because fibre prolongs the time for gastric emptying, and because fibre-rich foods tend to have a lower caloric density, diets rich in fibre may decrease the urge to eat and hence assist in appetite control.

Although diets rich in complex carbohydrates and fibre have been associated with a lower incidence of coronary heart disease, it is not certain that the fibre per se is responsible for the protective function. A more likely explanation is the spontaneous restriction in the intake of saturated fat that occurs when diets derive substantial energy from starch foods and fibre.

The recommended upper and lower daily intakes for dietary fibre are therefore based on the beneficial effects of fibre on gastrointestinal function and reflect the intakes needed to prevent constipation.

The range of 16 to 24 grams per day represents the range of intakes needed to prevent constipation in a population characterized by many children and adults of short stature. This particular population structure was chosen in order to protect against the selection of an artificially high goal for populations. For an adult of average stature, the recommended population intakes translate into a range of from 22 to 32 grams of non-starch polysaccharides per day. The lower limit is consistent with the amount of fibre recommended, in North American and Europe, for the management of diabetes or for individuals at high risk of coronary heart disease.

The upper limit was set in view of concern that, in high-fibre diets, the fibre itself, the phytates found in whole grains, nuts and beans, or the oxalates in certain leaves and sprouts, may impair the absorption of minerals, most notably calcium, zinc, and iron. A high intake of oxalate-rich foods, such as spinach, is known to limit mineral absorption. When fibre is obtained from full grain cereals, however, the added mineral content of the whole grain compensates for any reduction in the absorption of minerals caused by the fibre itself. Thus, in human studies, replacement of refined starches low in fibre with full grain cereals produced no reduction in the absorption of calcium, zinc, or iron.

These findings lead to the conclusion that high-fibre diets will not disturb mineral balance provided the intake of fibre comes from a mixed diet and does not exceed the proposed upper limit. This conclusion may not, however, be valid for foods made rich in fibre through the selective addition of bran, which contains extra phytates as well as fibre and can thus impair mineral absorption.

Salt (sodium chloride)

Upper limit: 6 grams per day
Lower limit: not defined

Salt intake is of principal concern because of the effects of sodium on blood pressure. At the population level, a salt intake higher than 6 grams per person per day is strongly linked to an increased incidence of hypertension. In populations with a salt intake of less than 3 grams per day, no rise of blood pressure with age is observed. High salt intake may also play a role in the etiology of stomach cancer.

The upper limit for salt of 6 grams per day is therefore fixed in the interest of preventing both hypertension and stomach cancer. This upper limit pertains to sodium from all sources, and not just to salt added to food during processing, preparation or at the table

Some intake of sodium is essential to human health. Nonetheless, because all known diets have a sodium content in excess of that needed to prevent deficiency, no lower limit needs to be defined.

Dietary cholesterol

Upper limit: 300 mg per day
Lower limit: 0 mg per day

Dietary cholesterol has a direct effect on total serum cholesterol and thus on the risk of developing coronary heart disease, though this effect is less than that produced by saturated fat. In addition, studies comparing populations have shown that diets with a high intake of dietary cholesterol are associated with more deaths from coronary heart disease even when the values for total serum cholesterol remained the same. This evidence suggests that dietary cholesterol intakes may convey a risk in their own right, over and above any effect on serum cholesterol levels.

Evidence links high dietary intake of cholesterol with increased incidence of coronary heart disease. However, the shape of this risk curve is not known. The suggested upper limit of 300 mg for the population mean intake reflects the consensus of views on currently available evidence.

Dietary cholesterol is not an essential nutrient, as the body is capable of synthesizing cholesterol. The lower limit is therefore zero.

Dietary cholesterol, which is found only in foods of animal origin, is particularly rich in the fatty portion of meat and milk products. A reduction in the consumption of animal fat will reduce the intake of both dietary cholesterol

and saturated fat, thus conferring additional protection against coronary heart disease. A moderate consumption of low-fat animal products is readily compatible with the upper limit specified for cholesterol.

Fruits and vegetables

Lower limit: 400 grams per day, of which at least 30 grams should be in the form of pulses, nuts, and seeds

Fruits and vegetables are low-energy, nutrient-dense foods having several beneficial effects on health. Apart from their protein and fibre content, fruits and vegetables are rich sources of several important vitamins. This vitamin content is especially important in view of the continuing problem of vitamin A deficiency and the improvement in the availability of dietary iron that occurs when ascorbic acid is part of the diet.

In addition, data consistently show that fruits and vegetables play a protective role in the prevention of certain cancers. It is not clear, however, whether this effect is nutritionally based, involving the free radical scavenging of vitamins E and C and beta-carotene, or whether other components of these foods are exerting powerful effects.

A daily average population intake of at least 400 grams of fruits and vegetables is recommended in view of the low intake of these foods characteristic of many diets and the considerable benefits to be gained from greater intakes. For many populations, this recommended lower limit implies a substantial increase in the consumption of fruits and vegetables. In other populations, the lower limit is already being met or even exceeded, indicating that such a goal is feasible in national dietaries.

Although potatoes, roots, and other tubers are important sources of nutrients in many national diets, particularly when they substitute for cereals, these foods are not included in this recommendation in view of the absence of evidence that they influence susceptibility to cancer.

The specific recommendation concerning pulses, nuts, and seeds is included because of the importance of these foods as a protein source in vegetarian diets. This recommendation therefore serves as a precaution against possible nutrient inadequacies in diets where animal source foods are not included.

The contribution that fruits and vegetables will make to total carbohydrate, fat, and protein intakes is to be included within, and not in addition to, the upper and lower limits fixed for these nutrients.

DIETARY PATTERNS

Viewed from a species perspective, *Homo sapiens* is a non-specialized, omnivorous eater capable of surviving on a diet consisting either mainly of meat or almost entirely of vegetables and fruit. Despite this versatility, which no doubt enhanced the ability to survive an erratic food supply, the human species is known to have subsisted for many thousands of years on a diet high in vegetable content and low in animal products.

Anthropological studies indicate that the diet of prehistoric man had a typical fat intake of about 20% of total calories, a high ratio of unsaturated to saturated fatty acids, a fibre intake amounting to approximately 45 grams per day, and a high intake of vitamin C, calcium, potassium, and other micronutrients. Though evolution involved progressive adjustment to a growing diversity of animal and vegetable foods, the proportional content of carbohydrates, fat, and protein in the diet remained fairly constant for some 30,000 to 40,000 years. Given the time needed for evolutionary change, it can be assumed that human biology is adapted to achieve optimum function on a diet low in fat, high in fibre and rich in micronutrients.

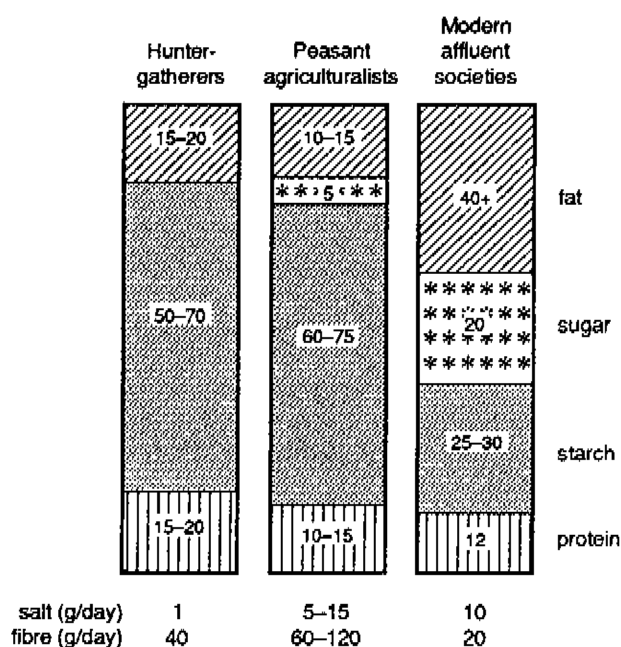
The cultivation of crops, introduced approximately 10,000 years ago, vastly improved food production and storage, providing a measure of protection against starvation. Even so, the change in the overall diet was small, with starch intake somewhat higher and fat intake even lower than in prehistoric times.

The most dramatic changes in diet followed the industrial revolution, which brought radical improvements in methods of food production, processing, storage and distribution. This new abundance of food and security in its supply, introduced just 200 years ago, brought immediate health benefits expressed in the elimination of starvation and the near elimination of many vitamin deficiency diseases in the more developed countries of the world. The resulting improvement in nutritional status meant an increase in childhood growth rates, which further worked to increase resistance to infectious diseases.

In addition, the sanitary revolution, which followed the industrial revolution in Europe, led to improved hygiene, housing, and food and water quality, with a corresponding drop in mortality from tuberculosis, typhoid and other filth-related fevers, diarrhoea, dysentery, cholera, smallpox, and scarlet fever. Life expectancy jumped upwards.

With the food supply assured and material well-being considerably improved, populations in the industrialized world were free, for the first time in human history, to exercise a dietary preference for foods rich in fat and sugar, a preference amplified by modern marketing techniques. As a result, populations in affluent countries now habitually consume a diet unknown to the human species a mere ten generations ago. Compared with the diet that fueled human evolution, today's affluent diet has twice the amount of fat, a much higher ratio of saturated to unsaturated fatty acids, a third of the daily fibre intake, much more sugar and sodium, fewer complex carbohydrates, and a reduced intake of micronutrients.

Throughout the world, the adoption of such a diet, foreign to human biology, has been accompanied by a major increase in the incidence of chronic diseases, including coronary heart disease, stroke,



Percentage of energy obtained from different dietary components during the course of human evolution. Human biology is adapted to function best on a diet low in fat, high in fibre and rich in micronutrients.

various cancers, diabetes mellitus, gallstones, dental caries, gastrointestinal disorders, and various bone and joint diseases. The causes of these diseases are complex, and dietary factors are only partly responsible. Nonetheless, data from a wide range of sources strongly support the view that a number of chronic diseases can be prevented to a substantial extent by lifestyle changes, among which diet plays a crucial role. Moreover, when compared with the difficulty of giving up smoking, changing drinking behaviour, or breaking free from a sedentary life, changes in food choices may very well be one of the easier preventive measures available.

Downward trends in disease

In many industrialized countries, increased public awareness of the links between diet and disease has already contributed to a substantial reduction in deaths from coronary heart disease. In Australia and New Zealand, where government health campaigns have been underway for several years, deaths from ischaemic heart disease went down by 40-50% from 1970 to 1985.

During the same period, the USA saw a reduction of 49% in deaths from ischaemic heart disease in men aged 30-69 years. Over half of this reduction has been attributed to dietary changes involving a shift towards lean meat, low-fat milk, and the use of vegetable oils low in saturated fatty acid. Other contributing factors include medical interventions, such as coronary by-pass operations, and a fall in cigarette smoking. Nonetheless, the fat content of the USA diet remains high, as does the prevalence of obesity and its associated complications.

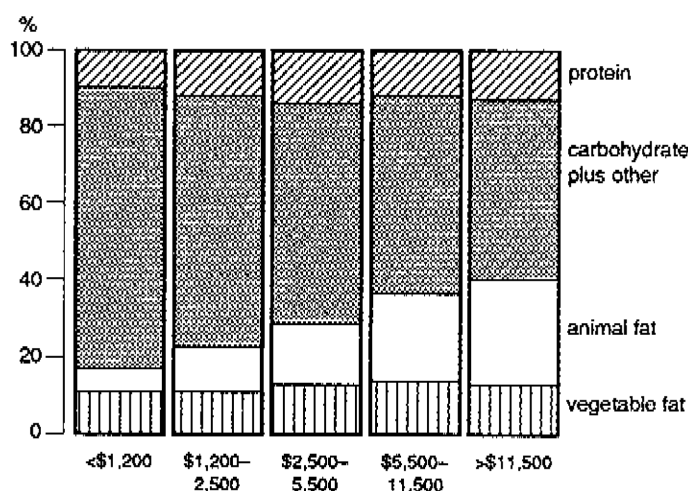
Not all industrialized countries have experienced downward trends in diet-related disease. During the same 15-year period, deaths from coronary heart disease went up an alarming 72% in Poland, where smoking rates are high and consumers have traditionally placed emphasis on a plentiful supply of cheap fatty meat and dairy products.

The United Kingdom, together with Finland and Ireland, continues to rank at the top of the world table for deaths from heart disease. Over the past two decades, death rates from coronary heart disease in the UK fell by only 10% in men and 2% in women. Dietary factors clearly play a role. Serum cholesterol levels are so elevated that at least two-thirds of the adult population should, on the basis of standards set by the European Atherosclerosis Society, be given immediate dietary advice. The UK also suffers from one of the world's highest rates of breast and large bowel cancer, diseases possibly linked to high intakes of fat.

Except for salt intake, the amounts of fat, saturated fat, cholesterol, sugar, dietary fibre, and protein in the typical Japanese diet are all within the nutrient goals recommended in this report. This national dietary pattern is believed to be one of the main reasons why life expectancy is extending year by year in Japan.

Modest prosperity, major risk

The situation in industrialized countries, however varied, contrasts starkly with changes now underway in the developing world. In some areas, populations, finally blessed with an assured food supply, are suddenly pressured to adapt to industrialization, urbanization, and an unprecedented opportunity to indulge in fat- and sugar-rich foods. These changes, which sometimes occur over the span of a single generation, mimick a transition that required 200 years elsewhere in the world.



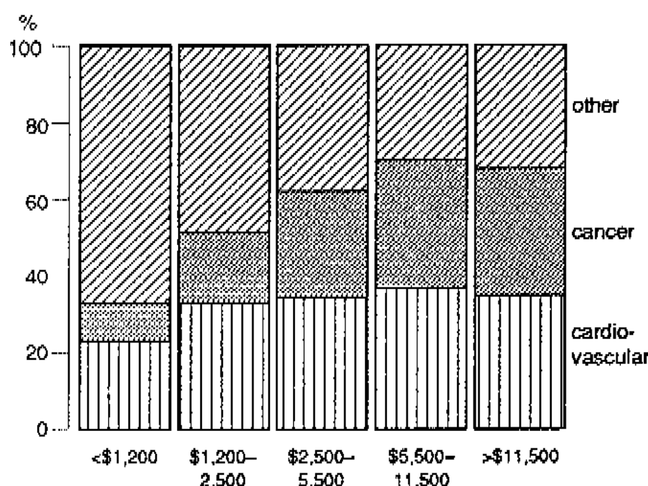
Percentage of energy obtained from different dietary components according to per caput gross national product (US $).

In virtually every developing country in the world, diet-related chronic diseases are becoming the new health problem as populations, typically first in the cities, abandon traditionally healthy diets in favour of "affluent" foods. In part, these changes respond to economic pressure to establish local food industries producing products high in fat, sugar, and salt. The tendency to abandon traditional diets is further aggravated by inappropriate public perceptions of what constitutes an appropriate diet and by a tendency to equate "good" food with "rich" food.

Regardless of the cause, the link between dietary change and chronic disease is close and consistent. In the typical pattern, diabetes occurs early, followed after several decades by coronary heart disease and gallstones, then cancer of the large bowel, and finally various chronic disorders of the gastrointestinal tract.

The Australian Aborigines traditionally derived most of their diet from roots and vegetables rich in fibre. During the first half of this century, the source of carbohydrate energy shifted to white flour and sugar. This dietary change, which coincided with adoption of a sedentary lifestyle, led to high rates of obesity and diabetes, followed by high rates of hypertension and coronary heart disease.

Pima Indians in the USA, who formerly consumed maize in large quantities, have experienced gross obesity and diabetes once they changed to a diet rich in white flour and sugar. Today, every second Pima Indian over the age of 35 suffers from diabetes.



Percentage of mortality (35 to 69 years, for both sexes) from cardiovascular diseases, cancer, and other diseases according to per caput gross national product (US $).

The almost universal increase in chronic diseases, which tend to occur in middle and later adult life, works in developing countries to counteract the gains in life expectancy attributable to an improved food supply and control of infectious diseases. Moreover, evidence suggests that even a modest increase in prosperity can bring on the considerable burden of chronic diseases.

■ Striking increases in deaths from cardiovascular disease and cancers are evident between very poor countries and those with an average gross national product of US $2,000. In countries with a gross national product of US $3,000- 4,000, the burden of cardiovascular disease and cancers is nearly as great as in the very affluent countries with an average income three times higher.

■ Hypertension and heart disease are already major health problems in many African cities, where processed foods high in fat, calories, sugar and salt have become popular. These diseases are also of rapidly increasing concern in Asia.

■ During the 1970s, age-specific mortality from chronic diseases underwent a relative increase of 105% in tropical South America and 56% in Central America, Mexico, and Panama. Hypertension is prevalent in over 30% of the population of Brazil. In the urban areas of Trinidad, every third woman over the age of 40 is obese.

The situation is all the more alarming in view of evidence that the speed at which chronic diseases become a problem is amplifed in populations undergoing rapid cultural transition.

■ In the South Sea Island people of Nauru, the rapid introduction of a cash income and a shift to a sedentary lifestyle have been followed by a dramatic deterioration in health. Today, 70% of the population over the age of fifty has diabetes.

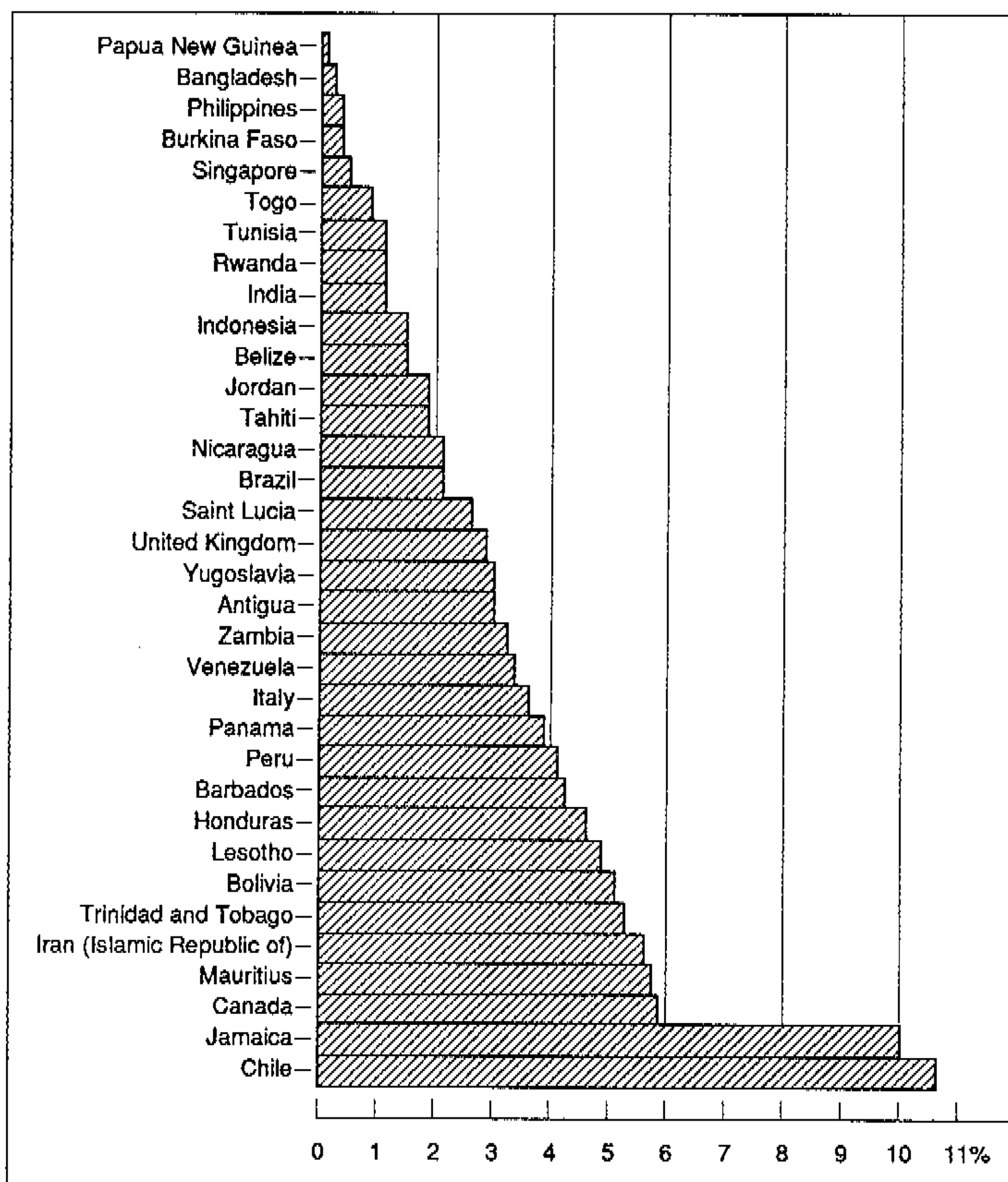
■ The prevalence of high blood pressure is at least four times greater in men and women living in urban, as opposed to rural, areas of Ghana.

■ For centuries, the Chinese diet drew most of its energy from rice, corn, or wheat. Now, eating patterns in urban areas are moving towards the affluent diet with predictable results. During 1960-62, cancer, cerebrovascular disease, and heart disease were the sixth, seventh, and eighth most common causes of mortality in Shanghai County. By 1980, they ranked as the top three causes of death.

■ In the early 1940s, cardiovascular disease accounted for only 2% of deaths on the island of Mauritius. By 1980, the figure had jumped to 45%. Since 1960, death rates have trebled for cancer of the breast.

Though such figures suggest bleak prospects for the health of development, chronic diseases are, to a large extent, manifestations of nutrient excesses and imbalances in the diet and are thus largely preventable. An epidemic of cancers, heart disease and other chronic ills need not be the inevitable price paid for the privilege of socioeconomic progress.

Percentage of obese pre-school children in selected countries. The problem of obesity, in children as well as adults, is no longer confined to the industrialized world.



Knowledge about the causes of chronic diseases is now sufficiently strong to support the view that changes in dietary practices, rebalanced along the lines recommended in this report, can do much to prevent the premature death and disability caused by these diseases.

In both affluent and developing countries, the dietary pattern associated with an increased risk of chronic diseases is characterized by high consumption of sugar-rich foods and of those meat and other animal products rich in saturated fat and dietary cholesterol. These foods now fill up the space in the diet previously – and historically – held by the starchy, complex carbohydrates.

The population nutrient intakes recommended in this report translate into a diet that is low in fat, and especially low in saturated fat, and high in complex starchy carbohydrates. Such a diet is characterized by frequent consumption of vegetables, fruits, cereals and legumes, and contrasts sharply with current diets drawing substantial amounts of energy from whole-milk dairy products, fatty meats, and refined sugars.

Adjusting the "balanced" diet

In industrialized countries, the challenge is to correct dietary excesses by shifting national diets closer to the "safe" range of intakes recommended in this report. Populations already aware of the link between diet and disease are advised to remember the principle of the balanced diet, with its emphasis on a diversity of foods, and then adapt this principle to current knowledge about the links between diet and disease.

In particular, it is important to remember that
- plant foods provide protein as well as numerous vitamins and minerals
- foods of animal origin are no longer viewed as dominant items in an optimum healthy diet
- consumption of saturated fat contributes far more to total blood cholesterol levels than does dietary cholesterol
- both saturated fat and dietary cholesterol are abundant in fatty products of animal origin
- fat intake, and especially saturated fat, is also linked to the risk of several cancers
- energy-dense "rich" foods are not the "best" foods in a healthy diet.

At the same time, a plate of food should not be viewed as a cluster of competing risk factors. Though some foods are clearly healthier than others, there is no single food item that will either cause or prevent heart attacks, cancer or any of the other diet-related ills. Excessive consumption of any single food is risky. Diets must continue to be balanced, though with less of a bias towards meat and dairy products.

The population nutrient intakes recommended in this report are also consistent with the dietary pattern needed to prevent obesity and reduce excessive weight.

Because many of the risks for chronic diseases, including the atherosclerotic process leading to heart disease, are now known to begin in childhood, the dietary advice embodied in this report needs to be put into practice early in life and maintained thereafter. The recommendations in this report are equally sensitive to the special nutritional needs of the elderly and to the difficulty of altering eating habits late in life.

Preserving traditional diets

Unlike the situation in industrialized countries, where the task is to alter entrenched eating habits and minimize well-established diseases, developing countries have a privileged opportunity to develop policies that can halt the spontaneous shift towards the affluent diet and thus hold chronic diseases to their traditionally low levels. The need is to avoid dangerous trends rather than reverse them. The challenge is how best to formulate national food policies that capitalize on the usual benefits of an improved food supply and nutritional status and yet minimize the future social and economic costs of diet-related chronic diseases.

Authorities in developing countries are cautioned not to imitate agricultural, farming, food production and promotion policies that were designed to emphasize the production of animal products and are based on nutritional knowledge long since outmoded. The difficulty of altering such policies, now apparent in many wealthy nations, serves as a further warning against their introduction.

Data available to FAO and WHO indicate that the problem of acute childhood malnutrition is finally beginning to recede in some areas of the developing world. Though continuing food shortages in the sub-Saharan region of Africa cause extreme concern, these difficulties should not obscure the dramatic improvements in health observed in many of the region's urban communities, and the major advances in agriculture and health care made in the rest of the world.

Some regions have seen a rise in per caput food production that has kept ahead of the population explosion. In these areas, indices of general nutritional status, as well as of health care, have shown substantial improvements, with progressive declines in the proportion of low-birth-weight babies and of wasted children, and in infant and child mortality.

Despite these gains, chronic undernutrition remains a widespread problem and a cause for deep concern. Diseases linked to nutrient deficiencies continue to affect some segments of the population in wealthy as well as developing countries throughout the world. For this reason, the population nutrient goals set out in this report take into account both the minimum intake of a nutrient needed to prevent deficiency diseases and the maximum intake that should not be exceeded in the interest of preventing several chronic diseases.

WHO has identified the following deficiency diseases as having particular importance in world food policies. In reviewing these diseases, the objective is to make certain that adoption of the recommended population nutrient goals will consistently ameliorate, and in no case exacerbate, the severe health problems linked to deficient diets.

Protein-energy malnutrition

The term "protein-energy malnutrition" describes a range of pathological conditions that result when sufficient quantities of protein or energy fail to reach the body's cells and thus compromise growth and development. Marasmus and kwashiorkor, singly or together, are the most severe diseases in this group. Wasting and stunting are the less severe, yet far more common, forms.

The two most important causes, which usually occur together, are insufficient food intake, whether due to improper feeding practices or to a shortage of food, and infectious diseases. Infants and young children are the most frequently and severely affected.

Growth failure (stunting) remains widespread in most of the developing world. Although the overall trends indicate an improvement in growth, the average rates of growth in childhood may be decreasing in some African countries. The decrease in the proportion of wasted and stunted children has unfortunately been outweighted by large increases in the total populations of South-East Asia and Africa, so that the net result has been an increase in the total number of wasted and stunted children in Africa, and no change in Asia.

Many epidemiological studies have linked a low intake of animal protein to high childhood mortality, morbidity, and growth failure. For many years, this evidence was interpreted as meaning that the amino acids present in animal protein were necessary to complement the amino acids in plant foods. Most animal sources contain the complete range of essential amino acids, while many plant sources are low in one or more.

As recently as the 1970s, protein deficiency was widely thought to be the fundamental cause of global malnutrition. Acting on this assumption, considerable efforts were made to increase people's intakes of "quality" protein from animal sources.

Progressively it was recognized that, even in totally vegetarian diets containing a diversity of foods, plant sources tended to complement one another in amino acid supply. Although the total amount of protein in the diet may need to be higher in vegetarian diets to provide an adequate intake of all the amino acids, the usual concentrations of proteins in these diets are sufficient. If the energy needs of the child or adult are met by these diets, then so are the amino acid needs.

With this evolution of understanding, a reconsideration of the epidemiological data suggested that the apparent "animal protein effect" on childhood growth and health was not necessarily a biological effect related to protein supply as such. Animal protein consumption might instead be serving as an index of more affluent household conditions that affected both buying power and living conditions. Alternatively, animal food sources may be

improving health by counteracting micronutrient deficiencies.

Evidence shows a strong link between the removal of income constraints and the development of a spontaneous demand for increased intakes of animal products. Studies continue to show a positive association between intake of such foods and a range of improved physical and psychological functions among the deprived segments of many populations. It has not, however, been shown scientifically that increasing the consumption of such food will, in itself, improve these human functions.

There are nevertheless a number of nutritional advantages to consuming at least modest amounts of foods of animal origin, particularly in view of their contribution to meeting micronutrient requirements. Diversity in the diet is an extremely important part of the concept of healthy eating. A policy to limit the consumption of saturated fatty acids should not be taken to mean a blanket restriction on all foods of animal origin, regardless of their fat content.

Iodine deficiency disorders

Food and water fail to provide adequate amounts of iodine for more than 1000 million people worldwide who live in environments that are deficient in this essential trace element. The result is that over 200 million people suffer from endemic goitre, which is a swelling in the neck caused by enlargement of the thyroid gland as it struggles to produce enough thyroid hormone in the absence of sufficient iodine.

The tragic effects of iodine deficiency during pregnancy, infancy, and childhood go far beyond enlargement of the thyroid gland to include spontaneous abortion, stillbirth, infant death, retarded fetal brain development, mental retardation, delayed motor development, hearing defects, and lethargy. All of these disorders are preventable. Once they have developed, however, most are irreversible. Worldwide there are currently some 20 million people who are brain damaged to one degree or another because of iodine deficiency, while another 6 million are afflicted by the severest form of this deficiency, frank cretinism.

The Andes, Alps, Great Lakes basin of North America, and the Himalayas are particularly iodine-deficient mountainous areas, but coastal areas and plains may also be deficient. Excessive intakes of goitrogens, as from consumption of cassava in central Africa or of waterborne goitrogens in Latin America, interfere with the normal uptake and metabolism of iodine and can thus amplify the effects of iodine deficiency.

Iodine deficiency disorders have been virtually eliminated in North America, most of Northern Europe, Australia and New Zealand, mainly through salt iodization and the increased dietary intake of iodine that is associated with social and economic development. In other parts of the world, oral and injected iodized oil are being successfully used to provide immediate protection for severely iodine-deficient populations.

Salt iodization to prevent iodine deficiency may also provide a useful opportunity to fortify salt with iron in order to combat nutritional anaemia. Nutritional policies using salt as a vehicle for iodine or iron need to be coordinated with policies seeking to reduce salt intake as a measure for controlling hypertension. In several European countries, voluntary reductions in salt intake, motivated by concern over hypertension, have contributed to the persistence of significant iodine deficiency disorders.

Vitamin A deficiency

Dietary vitamin A deficiency is the world's most common cause of preventable childhood blindness. An estimated 13 million children below six years of age already have some degree of eye damage, or xerophthalmia, due to vitamin A deficiency. Every year at least half a million children go partially or totally blind as a result. An estimated two-thirds of these die within a few months of becoming blind.

In addition to its impact on vision, vitamin A plays a crucial role in the healthy functioning of epithelial tissues, the immune system, and the processes of cell differentiation and bone growth. Recent studies show that vitamin A supplements in deficient populations can reduce mortality as well as blindness.

Although there is a slow but steady improvement in the availability of foods rich in vitamin A in most countries, deficiency remains a serious problem in some 37 countries. Worldwide, an estimated 40 million preschool children suffer from vitamin A deficiency.

The absorption of vitamin A and provitamin A, which are fat soluble vitamins, is impaired by very low fat intakes. The level of fat advocated

in the population nutrient goals is sufficient to protect against the impaired absorption of these vitamins.

Iron deficiency

The main health problem caused by iron deficiency is anaemia. Iron deficiency anaemia is the most prevalent nutritional problem in the world today, affecting more than 750 million persons. The regions with the highest overall prevalence of anaemia are Africa and southern Asia, where over 50% of children and more than 60% of pregnant women are anaemic. The severity of this public health problem is underscored by the consequences of iron deficiency anaemia. In children, these include impaired motor and language development, psychological and behavioural effects and decreased physical activity. In adults, iron deficiency anaemia results in decreased work and earning capacity and lowered resistance to fatigue. In pregnant women, the consequences include increased morbidity and mortality and an increased risk of giving birth to infants of low weight.

Iron deficiency anaemia usually occurs because the amount of iron absorbed in the body is insufficient to meet functional needs. This can be due to low total iron intake, a reduction in the absorbability of dietary iron, increased need for iron, as during pregnancy, or chronic blood loss, as in the case of infection with intestinal parasites. Of these potential causes, one of the most important is low absorption of dietary iron.

The availability of dietary iron for absorption is affected by both the form of iron and the nature of the foods concurrently ingested. Two major forms of iron exist in diets: haem iron and "inorganic" iron. While haem iron, which is found only in animal products, is readily available and unaffected by other constituents of the diet, the absorption of inorganic iron is strongly influenced by factors present in foods ingested at the same time. Phytates found in wheat and other cereals, tannins present in tea, and other polyphenols found in nuts and legumes, all markedly reduce the absorption of inorganic iron.

Two widely recognized promotors of absorption are animal foods and ascorbic acid (vitamin C). Even though diets based primarily on cereals and legumes may contain abundant iron, the actual availability of this iron will be low unless animal foods or foods rich in vitamin C are are also part of the diet.

The immense global problem of iron deficiency anaemia, and the dietary difficulties inherent in meeting iron requirements, provide strong nutritional arguments for recommending the consumption of either at least some meat, or fruits and vegetables rich in ascorbic acid.

Vitamin B_{12} deficiency

Vitamin B_{12} deficiency causes anaemia. Severe or long-standing deficiency can disturb neurological functions and, in young children, can cause mental regression, convulsions, coma, and eventually death.

Vitamin B_{12} is a product of bacterial fermentation, such as occurs in the intestines of cattle, sheep, goats, and other ruminant animals. Because meat and milk are major sources, the need for vitamin B_{12} has been a part of the rationale for recommending the consumption of animal foods.

The vast majority of diets of meat-eating populations provide amounts of vitamin B_{12} well in excess of requirements. People who eat little or no food of animal origin generally ingest less than the recommended amounts of vitamin B_{12}. Although some overt vitamin B_{12} deficiency does occur in these groups, it appears to affect only a small proportion of the population, possibly because human vitamin B_{12} needs are also partially met by the vitamin B_{12} produced by small-bowel bacteria. An intake of animal foods consistent with the recommendations in this report would be ample to supply the dietary needs for this vitamin.

Pernicious anaemia is a severe form of vitamin B_{12} deficiency secondary to a defect in the absorption of vitamin B_{12}. This form of anaemia, which occurs with low incidence in all societies, is unaffected by either the dietary level of vitamin B_{12} or the nature of the diet.

CARDIOVASCULAR DISEASE

The risk of developing coronary heart disease is increased by three major factors: high serum total cholesterol, high blood pressure, and cigarette smoking. Diet is known to have a direct impact on both cholesterol levels and blood pressure.

Cholesterol

Cholesterol is transported in the bloodstream and supplied to different body tissues by five major classes of lipoprotein: chylomicrons, very-low-density lipoproteins, intermediate-density lipoproteins, low-density lipoproteins, and high-density lipoproteins. Of these, low-density lipoprotein plays a significant role in the metabolic processes leading to atherosclerosis; low-density lipoprotein has been identified as the major source of cholesterol in atherosclerotic plaques.

Several studies have shown that cholesterol transported by a second class of lipoprotein, high-density lipoprotein, is associated with a reduced incidence of coronary heart disease. Further studies indicate that other factors such as excessive weight, lack of exercise, and smoking may reduce levels of high-density lipoprotein cholesterol and thus impair this potential protective effect. Despite these suggestive findings, high-density lipoprotein cholesterol has not been shown to play an important role in explaining the striking differences in deaths due to coronary heart disease observed between populations.

Cholesterol transported by low-density lipoprotein accounts for most of the total cholesterol in the blood. An elevated level of total serum cholesterol is therefore regarded as a reliable indicator of an elevated level of low-density lipoprotein and thus of the risk for developing atherosclerosis and coronary heart disease. Total blood cholesterol also reflects the dynamic equilibrium between cholesterol absorption, synthesis and metabolism, transfer to tissues, and clearance into the bile.

The first and foremost dietary determinant of total serum cholesterol is the intake of saturated fat, which regulates the receptors of low-density lipoproteins. Cholesterol levels may also be increased by the consumption of foods innately rich in cholesterol, though the role of this "dietary cholesterol" is far less important than that of saturated fat. The evidence linking both saturated fat and dietary cholesterol to atherosclerotic cardiovascular diseases is strong, consistent, and convincing.

Dietary fibre is also known to influence total serum cholesterol, though different forms of dietary fibre have different effects on cholesterol levels.

Early work suggested that whereas saturated fatty acids clearly elevate serum cholesterol, polyunsaturated fatty acids might reduce the level, while monounsaturated fatty acids showed little direct effect. More recent studies have confirmed the beneficial effect of polyunsaturated fat while also suggesting that monounsaturated fat may likewise lower blood cholesterol. This relationship does not, however, hold true for all individual fatty acids nor necessarily for all isomers of the fatty acids, such as the *trans* fatty acids.

Nonetheless, many of the dietary factors known or presumed to influence cholesterol levels tend to cluster together in certain typical diets. Thus, when an "affluent" diet rich in foods of animal origin and refined cereals is compared with the more vegetarian diet found in many developing countries, the affluent diet contains more total fat, saturated fat, and cholesterol; the intake of polyunsaturated fatty acids, as a proportion of total fat, is less; and the content of dietary fibre is less. Since all these factors can influence serum cholesterol, it is likely their combined effects which are operating to accelerate the progression of atherosclerosis.

Blood pressure

The risk of both coronary heart disease and stroke increases progressively throughout the observed range of blood pressure. A range of 40 mmHg diastolic blood pressure represents a five-fold difference in coronary heart disease and a ten-fold difference in the risk of stroke. Studies also show that a sustained difference of only 7.5 mmHg in the diastolic blood pressure confers up to a 28% difference in the risk of coronary heart disease and a 44% difference in the risk of stroke.

Excessive weight and heavy alcohol intake have strong independent effects on blood pressure. Sodium intake has a weaker, but probably significant, relationship to the gradual increase of blood pressure that accompanies aging. Other minerals, such as potassium and magnesium, may play a role in limiting the rise of blood pressure; these minerals are readily found in diets rich in complex carbohydrates.

Vegetarians have been consistently shown to have lower blood pressure than non-vegetarians, regardless of age, weight, and pulse rate. This observation suggests that some component of animal products, possibly protein or fat, may have an adverse effect on blood pressure in well nourished populations.

Increased dynamic physical exercise may reduce blood pressure independent of its effect on weight change.

CANCER

Dietary factors have a significant overall impact on global cancer rates. In developed countries, where cancer rates are highest and account for approximately one-quarter of all deaths, some estimates attribute 30-40% of cancer in men and up to 60% of cancer in women to dietary factors.

Cancers that have been linked repeatedly to dietary factors in different populations are cancer of the oral cavity, pharynx, larynx, oesophagus, stomach, large bowel, liver, pancreas, lung, breast, endometrium, and prostate.

Cancers of the oral cavity, pharynx, larynx and oesophagus

Drinking alcoholic beverages is causally related to cancer of the mouth, pharynx, oesophagus and upper part of the larynx. There is no indication that the effect is dependent on the type of alcoholic beverage.

Studies have also found positive associations between oesophageal cancer and several dietary factors, including low intakes of lentils, green vegetables, fresh fruits, animal protein, vitamins A and C, riboflavin, nicotinic acid, magnesium, calcium, zinc, and molybdenum. Cancer of the oesophagus is also linked to high intakes of pickles, salt-pickled vegetables, and moldy foods containing *N*-nitroso compounds as well as to the consumption of foods and beverages very hot in temperature.

Studies of oral and larynx cancers have also shown an increased risk associated with infrequent ingestion of fruit and vegetables.

Stomach cancer

A high incidence of stomach cancer is found in South America, Japan and other parts of Asia, but not in North America or Western Europe where rates are low and contine to decrease.

Stomach cancer is associated with diets comprising large amounts of smoked and salt-preserved foods (which may contain precursors of nitrosamines) and low levels of fresh fruits and vegetables (acting as possible inhibitors of nitrosamine formation). Improvements in food conservation methods and the widespread availability of refrigeration could explain the declines in stomach cancer mortality in industrialized countries over the past 50 years, though the evidence is not conclusive.

Colo-rectal cancer

International comparisons indicate that diets low in fibre-containing foods and high in fat increase the risk of colon cancer. It is not clear whether dietary fibre per se is protective or whether the apparent effect is due to other food constituents. Several studies also demonstrate positive associations between the risk for colorectal (primarily colon) cancer and dietary fat. In general, the data implicate saturated, as opposed to unsaturated, fatty acids. Other studies have associated meat consumption with colon cancer. In addition, several studies provide suggestive but inconclusive data for a causal role of alcoholic beverages, most often beer, in rectal cancer.

Liver cancer

Primary liver cancer remains common in sub-Saharan Africa and Southeast Asia, where incidence is associated primarily with exposure to hepatitis B virus infection. Evidence in developed countries shows that consumption of alcoholic beverages is causally related to liver cancer.

Lung cancer

The most important causal factor of lung cancer is cigarette smoking.

Studies in several populations have shown an interactive effect between smoking and a low frequency of intake of green and yellow vegetables rich in beta-carotene. These findings are consistent with experimental data showing tumour inhibition by vitamin A and synthetic analogues. In other studies, the frequency of consumption of beta-carotene-containing foods and the concentration of beta-carotene in serum have been inversely associated with the risk of lung cancer. Early reports of a similar inverse association for vitamin A have not been confirmed.

Female breast cancer

Several lines of evidence support the importance of dietary factors in the aetiology of breast cancer. Data from animal studies show that the incidence of mammary tumours in rats increases substantially with diets high in total and saturated fat, provided that the diet contains a small amount of polyunsaturated fat. Epidemiologic studies also define a role for fat and other dietary factors.

Some evidence points to a direct association between breast cancer mortality and the intake of calories, fats, and specific sources of dietary fats, such as milk and beef.

Evidence relating alcohol consumption to the risk of female breast cancer is not fully consistent.

Endometrial cancer

A strong association between endometrial cancer risk and excess weight has been reported in several studies, and a hormonal mechanism has been postulated for this association. Beyond this association with obesity, no specific dietary factors have been identified as a risk for this disease.

Prostate cancer

Inter- and intra-country analyses suggest positive correlations between mortality from prostate cancer and the per capita intake of total fat. These findings have been supported in analytical studies showing an association of prostate cancer with the intake of high-fat foods.

Associations between selected dietary components and cancer.

Site of cancer	Fat	Body weight	Fibre	Fruits and vegetables	Alcohol	Smoked, salted, and pickled foods
Lung				–		
Breast	+	+			+/–	
Colon	++		–	–		
Prostate	++					
Bladder				–		
Rectum	+			–	+	
Endometrium		++				
Oral cavity				–	+[a]	
Stomach				–		++
Cervix				–		
Oesophagus				–	++[a]	+

+ = Positive association; increased intake associated with increased cancer.
– = Negative association; increased intake associated with decreased cancer.
[a] Synergistic with smoking.

Major diet and cancer associations

A review of available data indicates that **a high intake of total fat** — and, in some cases, of saturated fat in particular — is associated with increased risk of cancers of the colon, prostate, and breast. The evidence is strongest for cancer of the colon, and weakest for breast cancer. Though the epidemiologic evidence is not totally consistent, it is generally supported by laboratory data from studies in animals. Experimental data pointing to an adverse effect of polyunsaturated fats refer to very high levels that are considerably above current intakes in human populations.

Diets high in plant foods, especially green and yellow vegetables and citrus fruits, are associated with a lower occurrence of cancers of the lung, colon, oesophagus, and stomach. Although the mechanisms underlying these effects are not fully understood, such diets are usually low in saturated fat and high in starches and fibre as well as in several vitamins and minerals, including beta-carotene and vitamin A.

Sustained heavy alcohol consumption causes cancer of the upper alimentary tract and liver.

Excessive body weight is clearly a risk factor for endometrial and post-menopausal breast cancers. The association of these cancers with excessive energy intake per se is less well established.

Although several lines of evidence indicate that dietary factors are important in the etiology of many cancer sites and that dietary modifications may reduce cancer risk, the contribution of diet to total cancer incidence and mortality cannot be quantified on the basis of present knowledge.

Nevertheless, evidence indicates that a diet that is low in total and saturated fat, high in plant foods, especially green and yellow vegetables and citrus fruits, and low in alcohol, salt-pickled, smoked and salt-preserved foods is consistent with a low risk of many of the major cancers in the world today, including cancer of the colon, prostate, breast, stomach, lung and oesophagus.

OBESITY

The major diseases linked to obesity include hypertension, coronary heart disease, diabetes, osteoarthritis, gallstones, and other gastrointestinal disorders. In addition, obese women face an increased risk of cancers of the gallbladder, breast (after the menopause), and uterus; in men, obesity may increase the risk of cancers of the prostate and kidney.

The importance of these health risks increases according to the severity of obesity. A growing body of evidence indicates that fat deposited abdominally is of particular concern, so that a waist-to-hip circumference ratio of more than 0.85 signals a significant health hazard.

Changes in body fat are governed by the balance between energy intake and energy expenditure. Though many factors, including family history, can contribute to obesity, the varying prevalence of obesity observed in different populations is largely the result of differences in diet and physical activity.

Factors that either increase energy intake or reduce physical activity can disturb the normal mechanisms of appetite control and metabolic regulation. Changes in the regulation of appetite and of metabolic functions become highly complex as weight gain progresses to obesity, making the treatment of this condition notoriously difficult.

Findings from several sources single out fat consumption as the dietary factor most likely to promote weight gain. The body stores excess dietary fat more readily than dietary carbohydrates. Moreover, fibre-rich complex carbohydrates are much bulkier than fat, tend to be more filling, and thus work to limit energy intake. National and international analyses strongly support the concept that, as the proportion of energy derived from fat increases, so does the problem of obesity, particularly in people coming from overweight families.

In view of the great difficulty of treating obesity, a preventive policy seems the only long-term solution.

DIABETES

Non-insulin-dependent diabetes mellitus is a chronic metabolic disorder involving an impairment in the body's capacity to utilize glucose derived from carbohydrate foods, from body stores of glycogen, or from body and dietary protein. The disease, which usually starts in middle adulthood, is strongly associated with an increased risk of coronary heart disease as well as a range of renal, neurological, and ocular disorders. In pregnant diabetics, the disease may have an adverse effect on the fetus.

A major risk factor is obesity, with the risk increasing according to both the duration and degree of obesity. Approximately 80% of non-insulin dependent diabetics are obese. The incidence rate is close to double in the moderately overweight and can be increased more than three-fold in the presence of frank obesity.

The occurrence of diabetes within a community appears to be triggered by a number of environmental factors such as sedentary lifestyle, stress, urbanization, and socioeconomic status as well as by dietary factors. The prevalence of this form of diabetes varies from zero in the highland population of Papua New Guinea, which has retained its tradition lifestyle, to 50% or more in the Pima Indian and Nauruan populations.

The prevention of obesity through both exercise and diet is the most rational and promising approach to the prevention of this disease. Glucose tolerance improves as weight is reduced. Exercise, apart from helping to reduce weight, has its own benefical effect on insulin metabolism.

GALLSTONES

Gallstones, which are chiefly composed of cholesterol crystals, are formed when bile becomes saturated with cholesterol. The condition is far more common in affluent societies and, moreover, in people consuming meat-containing, as opposed to vegetarian, diets. In women, the prevalence increases steadily from around 5% in young adulthood to around 30% in old age. Prevalence rates in men are about half those of women. Approximately one quarter of cases will require either surgical removal of the gallbladder or physical or chemical dissolution of the stones.

The composition of bile is especially responsive to dietary factors. Overweight adults have high bile concentrations of cholesterol and are thus at particular risk of gallstones. Fibre intake is effective in reducing cholesterol saturation of the bile, since fibre can block the recycling of

bile acids from the intestine and increase the amounts of bile and metabolites excreted in the faeces. A starchy diet rich in fibre may therefore be protective, especially if it helps reduce the problem of excessive weight.

DENTAL CARIES

Diet affects teeth in two ways. First, dietary factors, most notably the intake of certain minerals, can influence the tooth while it is forming. The second effect of diet, which is far more important, occurs after the teeth have erupted and involves the direct actions, sometimes destructive and sometimes protective, of certain foods on the teeth themselves.

Sugar

Sugars, and sucrose in particular, are the most important dietary factor linked to dental caries. Data from many sources support a causal relationship between frequent sucrose intake and tooth decay, though several other factors, including individual susceptibility, modify the way teeth respond to sucrose. In general, very little caries occurs in children when the national consumption of sugar averages less than 10 kg per person per year (approximately 30 grams of sugar per day). A yearly sugar consumption of 15 kg or more is linked to a steep increase in caries.

Glucose alone or mixed with sucrose and fructose may also cause caries. Increased emphasis is therefore being given to the cariogenic potential of simple sugars, including sucrose, rather than to sucrose alone.

The properties of different foods, including their stickiness, their nutrient content, and their scrubbing and detergent effects, may enhance or diminish caries rates.

Fresh fruit, despite its intrinsic sugar content, has a low cariogenic potential. Likewise, cooked staple starch foods, such as rice, potatoes, and bread, have low cariogenic potential, provided no sugar has been added during preparation. Moreover, the less refined starchy foods may actually help protect teeth from dental caries. Thus, when children are given carbohydrates as wholemeal bread, beans, oats, rice, potatoes and fruit, even with added molasses, they will develop fewer and smaller cavities than children fed a diet containing the level of sucrose and refined flour typical of affluent societies.

As populations in developing countries move away from traditional diets and begin to eat sugar-containing foods, the problem of caries increases quickly and dramatically. The problem is often exacerbated by inadequate fluoride intake.

Fluoride

Fluoride intake significantly reduces the incidence of dental caries. Fluoride acts principally by remineralizing the early carious lesion and by an effect on the bacteria in dental plaque.

At the same time, however, fluoride has toxic effects on teeth and bone when ingested in excess. Unfortunately, the margin of safety between the level needed to protect teeth and the level that can produce toxicity is narrow. Though experts agree that a sufficient daily ingestion of fluoride is needed to prevent dental caries, opinion differs on the exact amount of fluoride needed, with recommended amounts ranging from 0.7 to 1.5 mg per day from all sources.

In most countries, drinking water provides around 75% of the daily fluoride intake. Many communities, particularly in temperate climates, have water supplies fluoridated to a level of around 1 part per million (ppm). A concentration of 0.6 ppm in drinking water has been proposed for tropical countries, with this lower level reflecting both the known toxic effects of fluoride and the comparatively high daily intake of water in the tropics.

OSTEOPOROSIS

Osteoporosis is mainly an age-related condition characterized by decreasing bone density and increasingly fragile bones. Osteoporosis is a major cause of bone fractures, though other age-related factors, such as instability of gait, deteriorating eyesight, and poor coordination also contribute to the risk.

In developed countries, many elderly persons die following fracture of the hip. These deaths most often occur in older women after a relatively minor fall. For reasons that remain poorly understood, the number of hip fractures in the elderly is rapidly increasing, reaching epidemic levels in many affluent countries. By age 90, one-third of the women and one-sixth of the men in the United States will have suffered hip fractures.

Bone density increases in all parts of the skeleton during childhood and adolescence, reaching its peak value at around the age of 20. Healthy young adults show a wide range of bone densities. Values below the normal lower limits found in healthy young adults are defined as osteoporotic.

The normal rise in bone density during childhood and adolescence is governed by genetic, hormonal and nutritional factors. Exercise also promotes bone growth. These factors may prove very important in determining whether an individual will eventually develop osteoporosis.

Bone density begins to decrease after the menopause in women and from around age 55 in men. Individuals who reach middle life at the lower end of the normal density range rapidly become osteoporotic with advancing age, whereas those whose mid-life bone density is high may never develop osteoporosis.

Known determinants of bone density have been classified under five headings, of which four are known to enhance the risk of osteoporosis: insufficient oestrogen, immobility, smoking, alcohol intake and drug therapy. The fifth determinant, which has a positive influence, is calcium intake. The traditional emphasis given to calcium intake reflects the important contribution of calcium to bone density during growth and the corresponding significance of a high peak bone density at age 20 in predicting the risk of later osteoporosis.

High calcium supplements in postmenopausal women may be helpful in reducing the rate of bone loss. The intakes required are, however, of pharmacological rather than nutritional relevance. At the same time, it is by no means certain that calcium intakes are the key determinant of bone density and bone loss in adult life. Both protein and salt are known to increase obligatory calcium loss from the body, meaning that diets high in protein and salt will also have an impact on bone loss.

Though populations in developing countries generally have lower body weights and consume less calcium, they face a lower risk of fractures, possibly because they smoke less, drink less alcohol, do more physical work, and consume less protein and salt.

While the problem of bone fractures in the elderly tends to be of less concern in developing countries, osteoporosis remains important for other reasons. Recent studies from India clearly show that osteoporosis occurs in population groups subsisting on low-calcium vegetarian diets and living in areas where drinking water contains high concentrations of natural fluorides. Similar observations have been made in China and Tanzania. Unlike the osteoporosis seen in affluent societies, this type of osteoporosis involves cortical bones throughout the body and affects a younger age group. Calcium intake is of particular importance. A dietary pattern combining low calcium intake with a high fluoride intake causes metabolic bone disease characterized by osteoporosis. Where dietary calcium is high, no osteoporosis is found despite a high intake of fluoride.

CIRRHOSIS OF THE LIVER

Liver cirrhosis is the major chronic disease caused by alcohol consumption. The disease occurs when the amount of alcohol consumed consistently surpasses the liver's capacity to detoxify it. The resultant poisoning destroys liver cells, which are replaced with scar tissue.

In affluent countries, at least 40% of fatal liver damage is caused by alcohol. Evidence indicates that women who drink are more likely to suffer liver damage than men.

Long-term excessive alcohol consumption has a variety of other adverse effects on the gastrointestinal tract and pancreas, as well as on the risk of coronary heart disease, hypertension, certain cancers, and permanent brain damage.

In affluent countries, most of the policies that govern food production and supply are essentially agricultural policies driven by the economic and political issues of food availability, food security, and the security of food producers. The majority of these policies were formulated in the 1940s, are geared to the prevention of deficiency diseases, and are thus ill-equipped to protect populations from diseases linked to dietary excess.

Concern about the adequacy of national diets emerged as a public health issue following the remarkable advances in nutrition research that began with the discovery of vitamins in the 1920s. Subsequent research defined a clear role for vitamins, protein, minerals, and other micronutrients in the maintenance of human health. Research likewise demonstrated that adequate intakes of micronutrients relieved beriberi, pellagra, scurvy, xerophthalmia, goitre, and many other conditions. Thus, for the first time, specific components in the diet could be precisely linked to physiological functions and to the prevention of deficiency diseases. The definition of an optimum national diet came to mean an adequate supply of nutrients as well as an adequate supply of food.

Meat and milk

Because most foods were found to contain only a portion of the essential nutrients, the concept of the "balanced" diet, emphasizing the need to eat a variety of foods, was put forward as a strategy for assuring adequate nutrient intake and thus protecting populations from deficiency diseases. Animal products carried special weight in the diet balanced to prevent deficiencies. Analyses of different foods revealed that meat and dairy products were a major source of protein and provided substantial amounts of calcium, iron, zinc, and the B vitamins. Feeding trials showed that children, particularly if small for age, grew faster when fed extra milk.

This knowledge convinced public policy-makers that optimum national diets could be achieved through policies that assured a good supply of nutrients and a plentiful intake of animal products. Efforts were made to step up the production of meat and milk. Economic policies that included large subsidies, support for marketing initiatives, controls on animal-feed prices, standards for meat-carcass quality, and minimum milk-fat content all developed hand in hand with major educational programmes through the schools, medical services, and the media. The public was also led to believe that the quality of milk and meat is related to its fat content, especially "good" sources of food being butter and cream.

As a result, a large part of the agricultural industry in many affluent countries is geared to providing cereals, pasture or other feed for animal production, and to producing meat and milk. Furthermore, most governments still see this sector of the industry as in need of promotion, even if animal feeds have to be imported. Thus over decades, affluent countries have striven to produce more meat and milk, and this policy continues to dominate much of agricultural planning, particularly in Europe.

The developing world has also been influenced by this thinking. Protein-energy deficiency, first described in Africa and the Caribbean in the 1940s, was soon shown to occur widely throughout the world. Recurrent famines, endemic vitamin deficiencies, and the nutritional emphasis on protein deficiency as a cause of kwashiorkor led to intense efforts by governments and international agencies to improve the diet of rural communities and to encourage animal production where possible.

Entrenched interests

Given such a background, it is not surprising that policy-makers often equate the task of meeting a population's nutrition needs with an expansion of animal production. Efforts to change agricultural and food priorities are further impeded by the fact that today's food supplies are governed by economic, marketing, and farming practices that grew up in line with food needs defined 50 years ago.

There are entrenched farming and industrial interests that will not welcome a policy encouraging populations to consume only modest amounts of meat and milk low in fat content. Many farming policies have also been developed to encourage the cultivation of sugar beet and sugar cane as a method of supporting farm incomes. Since sugar has the advantages of being a non-perishable and readily transported commodity, it is understandable that large industrial interests in affluent societies are involved in maintaining or promoting sugar consumption.

Because the activities of many governments are dominated by economic issues, agriculture has developed over several decades not only to provide enough food for the population, but also to ensure that the farming community's viability and welfare are maintained at a reasonable level. Many

industrialized countries, including Japan and countries in North America and Europe, provide substantial financial subsidies for farmers. Agricultural policy is therefore a very important issue in any discussions on trade, and these economic issues understandably have high priority in government planning.

The public health dilemma

The dilemma for those in the field of public health is that, although the nutritional thinking of 50 years ago called for the urgent improvement of agriculture, the priorities set then have been incorporated into routine government policy-making without considering whether food supplies match a population's nutrient needs or contribute to good health. The fact that nutrient excess can be a major threat to health is only now beginning to emerge as an issue in agricultural policy in affluent nations, and has not been considered before by agricultural economists and planners in the developing world.

Since the new nutritional objectives of preventing both the deficiency diseases and the chronic diseases may have immense implications for the economics of farming, for government, industrial and social policies, and for international trade, it will inevitably take time for coherent policies and programmes to emerge, and for entrenched attitudes to change. Change is further impeded by the fact that government actions, responding to the call for agricultural improvements, have developed in so coordinated and comprehensive a manner. Policies initiated at a time when an adequate food supply meant an adequate supply of nutrients may be hard-pressed to adapt to the fact that nutrient excesses are now linked to the leading causes of death in virtually every country blessed with an abundant food supply.

- In the United Kingdom, substantial government grants helped to develop the dairy industry. Milk marketing boards were established to facilitate the production, distribution, and sale of milk, with guaranteed prices for milk and butter production. Prices were linked to the level of fat in the milk, and high-quality milk was identified by its particularly high fat content. Daily delivery of milk and other dairy products to individual households was instituted on a national scale and became part of the social fabric of society. Government controls on carcass-grading ensured that fattened sheep and cattle received special subsidies.

- In the United States of America, agricultural subsidies continue to promote the production of sugar, milk, and beef. Such support has hindered government involvement in campaigns aimed at persuading consumers to adopt healthier eating habits. Though the government has provided information on the links between diet and disease, most campaigns for prevention have been initiated by physicians, consumer organizations, and voluntary organizations, such as the American Heart Association.

- The food industry in Europe and North America has grown remarkably since the Second World War. The desire for convenience foods, amplified by the growing number of working women, has created a large market for food items processed and packaged for a long shelf-life and for simple preparation in the home. In some countries, over three quarters of all purchased food items are now processed or packaged in one way or another.

- Over the past decade, a growing consumer demand for leaner meat has created a major discrepancy between the amount of animal fat produced by European farmers and the consumers' purchasing preferences. Unwanted surplus animal fat, often produced with the help of government subsidies, has then been used by food manufacturers to produce a wide variety of cheap food products rich in fat. In northern Europe, this practice has altered the pattern of fat intake, with a conscious reduction in "visible" fat consumption accompanied by an increase in the consumption of "invisible" fat hidden in processed foods.

- A similar shift in sugar consumption is apparent in many countries, with consumers seeking to reduce their sugar consumption for health reasons only to find that this cheaply produced commodity is being widely used to provide an inexpensive and attractive component for a wide range of food products.

- In many countries, populations continue to regard the ready availability of meat and milk, in large quantities and at a reasonable price, as a symbol of the affluent good life. This public perception of a high-quality diet as abundant in animal products and rich in fat has been sustained by decades of public education, as well as by the cultural status accorded to foods that were once luxury items in the poor man's diet. Governmental controls on farming, or attempts

to persuade the population of the virtues of a low-fat diet, can be unpopular if advice is seen to be given for economic rather than for health reasons. In some East European countries, the popular demand for more meat is a major political issue.

- While most developing countries have a set of government policies controlling the home production or sale of food, it is very rare for any of these policies to have a nutrition or health component that goes beyond the need to supply an adequate quantity of food. Practically all governmental action is geared to economic or political priorities such as maintaining the economic viability of rural communities, providing cheap food for urban populations, or controlling import-export trade to ensure an appropriate balance of payments. More complex policies have also developed to improve food security and ensure a country's ability to feed its people despite unfavourable harvesting or weather conditions. Mechanisms for relating the nutrient content of food supplies to a population's nutrient needs are virtually non-existent.

Food choices

The ability to feed a population has long been accepted as a primary responsibility of governments. In fulfilling this responsibility, few governments realize that policies intended to guarantee an adequate food supply have introduced major threats to health.

The traditions for tackling public health problems related to nutrition range from an almost exclusive concentration on public education to a perception that the availability, price and nutrient compositional standards of foods are a major responsibility of national governments and will have a profound effect on food and nutrient consumption. This last view was held by most governments during the Second World War and remains an accepted principle in many countries.

When food policies are acknowledged to have an impact on the consumer's choice of food, it becomes extremely important to consider whether these policies are encouraging consumers to choose foods conducive to good health. With diet now linked to the major chronic diseases, such considerations take on special urgency. As the health component of most food policies remains rigidly aligned with the dietary requirements set out 50 years ago to prevent deficiency diseases, adaptation to protect populations from dietary excesses will not be easy.

Efforts to prevent chronic diseases through dietary intervention have not been given high priority by any government. Most governments have yet to realize that policies aligned with current medical views on diet and health can bring economic advantages. A very large proportion of international trade in cereals is for animal feed. If policies viewed high fat content in meat carcasses as a hazard rather than a standard for defining high quality and price, farmers would no longer have to follow the intensive feeding practices needed to produce fatty meat carcasses. Farming policies that do not require intensive animal production systems would reduce the world demand for cereals. Use of land could be reappraised, since cereal production for direct consumption by the population is much more efficient and cheaper than dedicating large areas to growing feed for meat production and dairying.

The economic value of preventive policies can be argued on other grounds as well. Nutrition programmes directed towards the control of diet-related chronic diseases will reduce premature mortality and morbidity and thus represent an investment in human capital. By reducing chronic morbidity, such programmes will considerably relieve the financial strain on health care systems, as care of the chronically ill is generally characterized by sophisticated, expensive, and long-term medical interventions.

Medical and scientific research has established clear links between dietary factors and the risk of developing coronary heart disease, hypertension, stroke, several cancers, osteoporosis, diabetes, and other chronic diseases. This knowledge is now sufficiently strong to enable governments to assess national eating patterns, identify risks, and then protect their populations through policies that make healthy food choices the easy choices. The population nutrient goals developed in this report are put forward to assist in this task.

A checklist for government action

Governments are recommended to establish a national board for nutrition and food policy involving, in addition to the ministry of health, the many government ministries whose policies affect the production, distribution, and consumption of food. Governments should also ensure that adequate nutritional competence exists within the ministry of agriculture to allow full participation in a national board for nutrition and food policy.

Governments should ensure that experts are available to the ministry of health to monitor the nutritional and health status of the population, as assessed by a national surveillance system.

Ministries of health should initiate or strengthen professional training programmes, at both undergraduate and postgraduate levels, to ensure that the role of diet in the prevention of chronic diseases is understood by the medical profession and other health care workers.

Governments in all countries are advised to consider their investment and subsidy policies in both agriculture and the food industry to ensure that these are consistent with the nutritional concepts contained in this report. Policies should be geared to promoting the growing of plant foods, including vegetabes and fruits, and to limiting the promotion of fat-containing products.

Governments in developing countries should identify the indigenous plant foods that are of high nutritional value, and should encourage their production and consumption. Local food industries should be encouraged to develop processing techniques that do not add fat, sugar, and salt to food products.

Each government should examine its animal production policies and incentives to ensure that they do not promote the production of excessive quantities of saturated fat. Authorities also need to consider trading practices that might lead to adverse effects on health. The export of subsidized saturated fat, unwanted by health-conscious domestic consumers, is one clear example.

Each government should consider all new legislation bearing on agriculture and food to ensure that it is compatible with the prevention of chronic diseases.

Discussions should be encouraged between the government, the food industry, and the consumers to ensure the development of food products that are low in fat, free sugars, and salt.

Because chronic diseases can start in childhood, ministries of education need to ensure that the health and nutrition education of children and teachers gives due attention to the prevention of diet-related chronic diseases.

Governments are recommended to establish, where possible, compulsory labelling of food products based on the Codex Standards and Guidelines for Labelling of Food and Food Additives. Labelling should be clear and consistent and, to be understandable as well as scientifically correct, should be simple and expressed both graphically and numerically. Moreover, in view of the recommendations in this report, consideration needs to be given to changes in labelling policies that specify only "carbohydrates" or only "fat" and do not indicate type of fat or distinguish between sugars and complex carbohydrates.

WHO Study Group on Diet, Nutrition and Prevention of Noncommunicable Diseases

Geneva, 6–13 March 1989

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EXECUTIVE SUMMARY

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