

Food and Nutrition Communication

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Nutrient Density

How do you decide which foods you want to eat? Flavour? Convenience? Comfort? Many people choose the foods they eat based on immediate gratification. This often results in total dietary habits of that are not the best for health and longevity.

The Dietary Guidelines for Americans 2005 recommend the consumption of a variety of “nutrient-dense” foods and beverages within and among the basic food groups. So what is nutrient density? According to definitions, nutrient density is a measure of nutrients provided per calorie of food, or the “ratio of the amount of a nutrient in foods to the energy provided by these same foods.”

Nutrient-dense food choices, therefore, provide a high proportion of vitamins, minerals and antioxidants relative to calories, helping to cover all nutritional requirements without encouraging weight gain. These foods are the opposite of so-called “empty-calorie” or “junk” foods.

In this issue we look at how to make our own best balanced diet from among the many food choices available, without sacrificing the pleasure of taste and variety.



Nutrient density

The term nutrient density means different things to different people. To epidemiologists, the term nutrient density of the diet means crude nutrient intakes (in μg or IU) divided by the total energy intakes. In epidemiological studies, nutrient density often means diet composition, as indexed by the percentage of energy from carbohydrate, protein, and fat. In terms of nutrition in emergency situations, such as famine, a nutrient-dense food is one that delivers a complete nutritional package and can be used to sustain life. For example, researchers described a nutrient-dense infant feed as one composed of milk protein, peanut butter, oil and sugar, and fortified with vitamins and minerals. By contrast, in the cancer prevention literature, vegetables and fruit are classified as being nutrient-dense, whereas a substantial level of oil and sugar would be enough to classify a food as being nutrient-poor.

Nutrient density can be defined as a ratio of nutrient content (in grams) to the total energy content (in kilocalories k/cal or joules). In general, nutrient-dense foods are not energy-dense. For example, fruit and vegetables are considered nutrient-dense food, while highly refined products containing added sugars, saturated fats and alcohol are considered nutrient-poor food.

A Concept of Nutritious Food

To help improve the nutrient-to-energy ratio, the 2005 Dietary Guidelines for Americans advise consumers to replace some foods in their diets with more nutrient-dense options. The problem with this is that there has so far been no universal nutrient density standard or criterion to use as a guideline, for use for example in food labelling. In many cases “healthy foods” are defined as those that do **not** contain popularly stigmatized ingredients such as fat, sugar, and sodium—rather than by high levels of the positive presence of any beneficial nutrients they might contain.

Adam Drewnowski, writing in the *American Journal of Clinical Nutrition*, and on whose articles much of this edition is based, has made a comprehensive study of nutrient density and proposed a classification or “score” according to certain criteria [see page 4].

Background of the concept

Concerns that the American diet has become energy-rich but nutrient-poor have been expressed for over thirty years. Energy-dense sweets and fats have long been contrasted unfavorably to foods that contained substantial amounts of key nutrients, and terms such as “junk foods” or “empty calories” are commonly used in antithesis to such descriptors as “healthy”, “packed with nutrients” etc. But these have just been words, not measurable criteria. A 1977 review of the literature showed that there were only limited efforts to define the concept of a nutritious food. General statements that such and such a food should provide “significant amounts of essential nutrients” were not backed by any agreed standards. Three decades later, in 2004, there was still no total agreement as to the definition of a nutrient dense food or a healthy drink.

Recommendations based on the absence of fat, cholesterol, sodium

The US National Heart Lung and Blood Institute defined healthy foods by low amounts of fat, e.g. less than 12 g of fat, 4g of saturated fat, 100mg of cholesterol and 480 mg of sodium per “serving”. The definition of healthy foods adopted by the **American Heart Association** was also based on the virtual absence of fat (less than 3g), saturated fat less than 1 g, and cholesterol less than 20 mg, and sodium less than 480 mg) per serving. The 2003 **Food Guide Pyramid** made few distinctions among foods within food groups that were not based on their fat and sugar contents. The main message was that consumers should not ingest too many calories or too much



fat, saturated fat, cholesterol, sugar, sodium, or alcohol. In dealing with problematic nutrients, the **FDA** has taken the position that health claims can be used only if a serving of food contains ≥ 13 g fat, ≥ 4 g saturated fat, ≥ 60 mg cholesterol, and ≥ 960 mg Na. Whereas all of the “absence” criteria had to be met, the criteria for the **presence of beneficial nutrients** were more permissive. Per FDA rules, healthy foods should contain $\geq 10\%$ of daily values per serving for at least one of the following: protein, calcium, iron, vitamins A and C, and fibre. Using comparable criteria, the **USDA** had defined foods of minimum nutritional value as those that failed to provide 5% of the reference daily intakes per serving for 8 key nutrients: protein, calcium, iron, vitamin A, vitamin C, riboflavin, thiamine, and niacin. Attempts to translate dietary guidelines into practice, as formulated by professional associations and expert panels, have also tended to focus on the negative. Typically, the emphasis was on avoiding too much fat, saturated fat, cholesterol, sugar, and sodium. **The American Diabetes Association** explained that “sugary foods do not have the nutrients, vitamins, and minerals that your body needs to be healthy. That is why they call these calories “empty” and list these foods at the top of the Food Guide Pyramid.”

Complicated calculations

For years many American consumers struggled with fastidious calculations of every portion of what they ate, prompting the Food and Drug Administration Commissioner to observe that “people shouldn’t need a calculator or an advanced degree in mathematics or nutrition to calculate what makes a healthy diet”.

Over the past two decades, consumer advocacy groups such as *Center for Science in the Public Interest* flourished in the US, publishing long lists of food brands they denounced as bad foods.

In view of the general confusion that reigned in consumers’ (and some experts’) minds over what





to eat, people were then advised that there were “no bad foods, only bad diets”, and that any food could fit into an overall (albeit calorie controlled) diet. Although there is a lot of truth in that statement, as long as the consumer was advised that “all foods could fit in” there was no reason to emphasize the nutritional quality of individual foods.

In keeping with the new concept that there were no good or bad foods, only good or bad diets, most measures of nutritional quality subsequently focused on total diets only, to the exclusion of single foods. Yet some of the early attempts to define the nutrient quality of individual foods, as opposed to diets, should not be overlooked. They may assist certain consumers in substituting the foods in their diets with healthier balanced choices.

14 key nutrients and Recommended Daily Values based on the dietary reference intakes that were used to calculate the naturally nutrient rich sources

Nutrient	Value
Protein	65 g
Vitamin A	5000 IU
Vitamin C	75 mg
Calcium	1300 mg
Iron	18 mg
Zinc	11 mg
Folate	400 µg
Thiamine	1.2 mg
Riboflavin	1.3 mg
Vitamin B ₁₂	2.4 µg
Vitamin D	10 µg
Vitamin E	15 mg
MUFA	20 g
Potassium	3500 mg

Source: Drewnowski A

The Naturally Nutrient Rich (NNR) Score

Past attempts to quantify the nutrient density of foods have been based on a variety of calories-to-nutrient scores, nutrients-per-calorie indices, and nutrient-to-nutrient ratios. The naturally nutrient rich (NNR) score, which is based on average percentage Daily Values for **14 nutrients** in 2000 kcal food, can be used to assign nutrient density values to foods within and across food groups. Use of the NNR score may allow consumers to identify and select nutrient-dense foods while permitting some flexibility where the discretionary calories are concerned. This approach has implications for food labelling, nutritional policy making, and consumer education.

The Food and Drug Administration has considered approving nutrient claims based on the ratio of a beneficial nutrient to the food’s energy content, as opposed to a specified minimum amount of a nutrient per serving size. Given the current dietary trends, the nutrient density approach can be a valuable tool for nutrition education and dietary guidance.

The 14 nutrients forming the (NNR) score were selected based on past efforts to define healthy diets. For example, 5 key nutrients (protein, calcium, iron, vitamin A, and vitamin C) were based on those most likely to be lacking in the diets of low income women, plus folate, vitamin B₆, and zinc. Among the additional nutrients of public health significance, as listed by the National Cancer Institute are fibre, carotene, magnesium, and vitamin E. A broader list is provided by the FAO. The NNR score is a nutrients-to-calories ratio. The initial version of the NNR Index was based on 14 nutrients: protein, calcium, iron, vitamin A, vitamin C, thiamine, riboflavin, vitamin B₁₂, folate, vitamin D, vitamin E, monounsaturated fat, potassium, and zinc. A more recent version of the NNR score added fibre and vitamin B₅ (pantothenic acid), for a total of 16 nutrients. Daily value percentages were calculated based on 2000 kcal food. The reference amounts were the upper limits of the recommended intakes for individuals as provided by the Food and Nutrition Board.



Classification still an on-going process

As shown in the table below, the definition of nutrient-dense foods seems to encompass whole grains, meats and dairy products, vegetables, and fruit. In the absence of agreed standards, there are continuing differences of opinion as to which foods are truly nutrient-rich. For example, in 1979, one expert wrote that *“with the exception of thiamin, the nutrients provided by breads and cereals were not particularly notable”*. In his view, the main importance of cereals was that they provided calories, protein, thiamine, calcium, and iron at a very low cost. In contrast, other researchers have described breads and cereals as being nutrient-rich, and the current literature refers to nutrient-dense carbohydrates and nutrient-packed whole grains. There are also differences of opinion regarding fruit juices because of the relatively high fruit sugar and energy content. In an extreme case, even the nutritional value of milk was challenged, as described in a recent review.

Water changes the density

The advice to limit the consumption of energy-rich foods is grounded in the assumption that energy density and nutrient density are inversely linked. In reality, the energy density of foods is not always determined by their sugar and fat contents. Often, energy-dense foods are simply those foods that are dry. Water, which provides weight or volume but no calories, influences the energy density of foods more than does any macro-nutrient, including fat. Examples of dry energy-dense foods are confectionery and potato chips, but also healthy whole grains and cereals! In contrast, soft drinks, fruit, vegetables, and low-fat milk have “diluted” energy. Although the overall inverse relation between energy density and nutrient density may hold, not all energy-dense foods are necessarily nutrient-poor or vice versa. The automatic assignment of all energy-dense foods into the “bad” category seems arbitrary and is not based on any particular metric or scale.

Common examples of foods described as healthy, healthful, nutrient-dense, or nutrient-rich in research

Term	What is meant
Nutrient-dense foods	Milk, vegetables, protein foods, fruit, grains
Nutrient-dense food groups	Dairy, fruit, grain, meat, vegetable groups
High-nutrient-density-foods	Fruit, vegetables, milk, whole-grain products
Nutrient-dense beverages	100% juice, milk
Nutrient-dense foods	Fruit, cheese, yoghurt, cereals
“Good” foods	Fruit, vegetables, cucumbers, spinach, tomatoes, beans, low-fat milk, whole-grain bread, oats, salmon, fish
Healthy foods	Fresh fruit, cooked vegetables, raw vegetables and salad, olive oil
Healthy foods	Fish, fruit, vegetables, nuts, whole-grain cereals
Healthful foods	Fruit and vegetables, meats, grains, dairy products
Healthy foods (diabetes)	Diet soda, 1% or skim milk, high-fibre bread, low-carbohydrate bread, fresh fruit, fresh tomatoes, fresh green vegetables
Healthful snacks	Vegetables, fruit, yoghurt
Healthful vended snacks	Peanuts, almonds



Underweight

People who are underweight or suffering from anorexia need not only nutrient dense but also energy-dense foods to help them to gain some weight. Healthy energy dense foods include peanut butter, dried fruits, starchy vegetables and cheese.

Obesity

Rising rates of obesity and type 2 diabetes continue to be linked to a growing consumption of refined grains, added sugars, and added fats. Refined grains, fats, and sweets are inexpensive, palatable, and convenient. However, they can also be energy-dense. The World Health Organization and other scientists have found sufficient evidence to link high consumption of energy-dense foods to the global obesity epidemic. Whereas counting calories has been the main strategy for weight control, application of the nutrient density standard will make each calorie count more. Focusing attention on the nutrient-to-calorie ratio, the NNR score allows consumers to identify the more nutrient-dense foods within each food group and make

Foods generally considered as low nutrient-dense and high energy-dense. Tip of the food pyramid - for discretionary calories only!

Sugars, sweetened beverages, snacks, sugar confectionery, sodas, baked goods, high fat ice cream, cakes, cookies, doughnuts; syrups, jams; fried potato chips and corn chips; baked and dairy desserts, savory and sweet pies, pastries, puddings, cheesecake, salted snacks, hamburgers, lasagne, biscuits, visible meat fat, margarine, white bread, pancakes.

their food selections accordingly. A naturally nutrient-rich diet is one that includes a balanced intake of fruit and vegetables, whole grains, lean meats, fish, eggs, beans and nuts, low-fat and nonfat dairy products.

All the calories we take in come from the three macronutrients (protein, fat and carbohydrate), plus alcohol, which contributes 7kcal/g. Consuming more than necessary of any of the three macronutrients and alcohol can have detrimental effects on long term health. Inhabitants of modern western societies generally consume more macronutrients than they need hence the trend towards obesity and diabetes.

Calories – Why fewer are more

For over sixty years, it has been known and repeatedly demonstrated in animal studies that if you reduce caloric intake below a certain set point while maintaining adequate nutrition you can extend lifespan. This experiment has been performed on numerous species, including the primates, (a category we human beings share with the apes). In each case, the average animal lifespan was increased 25 – 50 percent. Reducing calories not only extends life, it delays the processes of ageing. It is quite appealing to think you can live younger for longer. In clinical studies published to date, animals fed reduced calorie diets were also more disease resistant. Evidence for increased lifespan by caloric restriction is no longer challenged. Indeed overweight and obesity are increased risk factors for cancers. Animals on a calorie-restricted diet are not only more cancer resistant, but oxidative stress is inhibited and youthful features of young tissue are retained with ageing.

What is clear is that health and longevity are inversely proportional to caloric intake (within reasonable limits). Some writers claim calorie reduction is the closest thing that science has to a fountain of youth. Animal studies suggest that you would have to reduce calories by about 30%

to achieve significant life-extending benefits. This means that someone who would normally require 2200 Calories would need to reduce intake to 1800 calories in order to achieve the longevity benefits. However it is not enough just to reduce calories without ensuring optimal nutrient density. The effect would lead to the symptoms of malnutrition and deficiency diseases.

Teenagers and Dieting

In growing children and adolescents, even a marginal reduction in energy intake can be associated with slowed growth and a risk of essential nutrient deficiencies. Teenagers' reasons for dieting are many and varied, but low self-esteem, dissatisfaction with body-image and a desire to be thinner are the motivating factors behind the majority, whether they are overweight or not. The choices made by a teenager on a diet may be consistent with recommendations, such as increasing vegetable and whole grain intake, (indeed many young girls tend to be drawn to vegetarianism) but the changes are often temporary, due to habit and hunger, resulting in a return to previous behaviours and thus a feeling of failure and frustration. A significant percentage of girls, according to a study reported by the Canadian Paediatric Society, resorted to unhealthy practices such as fasting, skipping meals, crash diets, laxative and diuretic use, self-induced emesis, diet pills and smoking. Besides the obvious psychological and physical consequences of such practices and dysfunctional eating patterns, there is mounting concern that self-directed dieting in pre-adolescents and adolescents may have the paradoxical effect of resulting in excess weight gain over time, as well as a range of other dangers to health. Nutrition education based on the concept of balance, and nutrient density, may be the best advice for young girls concerned about their self-image.





Nutrient Density of Green Vegetables

It is not merely the overconsumption of fat, empty-calorie foods, animal foods, such as milk, cheese, butter, meat, and poultry that causes disease and premature deaths in much of the developed world. It is also what we are *missing* in our diets by not eating enough plant foods. Why are plant foods so protective and essential for human health?

Potassium requirements have been largely overlooked because severe deficiencies are uncommon due to the fact that this element is present in very many foods. However, a transition toward modern

“Westernized” diets has led to a substantial decline of potassium intake compared with traditional food habits, and a large sector of the population might now have sub-optimal potassium intake. A high potassium intake was demonstrated to have protective effects against several pathologic states affecting the cardiovascular system, kidneys, and bones. Additionally, fruits and vegetables contain potassium/organic anion salts (malate, citrate), which exert alkalinizing effects, through KHCO_3 generation, which serves to neutralize acidity in urine. Low-grade metabolic acidosis, when not properly controlled, may exacerbate various destructive processes (loss of bone calcium, proteolysis), especially in the elderly.

Estimated Calorie Requirements (in Kilocalories) for Gender and Age Group at Three Levels of Physical Activity

Estimated amounts of calories needed to maintain energy balance for various gender and age groups at three different levels of physical activity. The estimates were determined using the Institute of Medicine equation.

Gender	Age (years)	Activity Level		
		Sedentary	Moderately Active	Active
Child	2 – 3	1,000	1,000 – 1,400	1,000 – 1,400
Female	4 – 8	1,200	1,400 – 1,600	1,400 – 1,800
	9 – 13	1,600	1,600 – 2,000	1,800 – 2,200
	14 – 18	1,800	2,000	2,400
	19 – 30	2,000	2,000 – 2,200	2,400
	31 – 50	1,800	2,000	2,200
	51+	1,600	1,800	2,000 – 2,200
Male	4 – 8	1,400	1,400 – 1,600	1,600 – 2,000
	9 – 13	1,800	1,800 – 2,200	2,000 – 2,600
	14 – 18	2,200	2,400 – 2,800	2,800 – 3,200
	19 – 30	2,400	2,600 – 2,800	3,000
	31 – 50	2,200	2,400 – 2,600	2,800 – 3,000
	51+	2,000	2,200 – 2,400	2,400 – 2,800

These levels are based on Estimated Energy Requirements (EER) from the Institute of Medicine Dietary Reference Intakes macronutrients report, 2002, calculated by gender, age, and activity level for reference-sized individuals. “Reference size,” as determined by IOM, is based on median height and weight for ages up to age 18 years of age and median height and weight for that height to give a BMI of 21.5 for adult females and 22.5 for adult males.

Fruits and vegetables are therefore receiving great attention in a strategy to increase the nutritional value of meals while reducing energy density and intake. The need to ensure a 2.5 – to 3.5-g daily potassium supply from fruits and vegetables represents a strong rationale for the **“5–10 servings per day”** recommendations for a balanced diet.

Are micronutrients in our diet really that important?

The question many will ask is *“Could we not just take a vitamin pill and eat a diet with low nutritional quality and be just as healthy?”* Indeed pills can meet our requirements for the vitamins and minerals which are now well defined. However we would miss out on the goodness of all the more recently discovered natural substances (phytonutrients) and the fibre from plant foods. These phytonutrients often give plant foods their characteristic colours and flavours. Large epidemiological studies have shown that consumption of fruit and vegetables (5 or more portions daily) is associated with decreased risk of several diet-related diseases such as cancers and heart disease, and it is thought that this protective effect is at least partly due to the phytonutrients. Most vitamin pill formulations do not contain these natural plant substances. Evidence suggests that it is the synergistic effect of several of these phytonutrients that produces protective effects against disease, and that isolating one or another of them is less useful for human nutrition than consuming the whole food in which it is found. The phytonutrients make up large group of chemical substances - there may be as many as 80,000 of them - as not all have yet been identified and classified. Large sub-groups include the carotenoids, phytosterols, saponines, glucosinolates, and polyphenols. These substances appear to produce very interesting anti-cancer, anti-microbial, anti-oxidant, anti-thrombotic and anti-inflammatory effects. Non-starchy vegetables naturally contain more micronutrients per calorie than any other food. Other plant foods such as pulses, nuts, berries and seeds also provide a range of these phytonutrients; coffee and tea





contain polyphenols. Nutrient-dense plant foods, especially non-starchy vegetables, help to promote health and satisfy appetite while reducing calorie intake, and are thought to increase the chances of living a long, healthy life. (see also *Food and Nutrition Communication "Vitamin Intakes – how much is too much and how much is not enough ?"*)

A colour guide to phyto-nutrients:

- Orange and deep yellow indicate beta-carotene. The darker the colour, the more beta-carotene. Carrots, sweet potatoes, apricots, winter squash, mangoes, papayas, cantaloupe melons all contain Beta-carotene, which helps the body neutralize free radicals, and may reduce the risk of cancer.
- Red is for lycopene. Lycopene is a carotenoid, just like beta-carotene. Present in tomatoes, tomato puree and paste, pink grapefruit, watermelons. Lycopene may reduce prostate cancer risk.
- Dark green indicates that vegetables contain lutein and zeaxanthin. Spinach, collard or turnip greens, dark green lettuces, kale all contain these in large quantities. Zeaxanthin is also found in maize. These compounds help the eye and vision by cutting the risk for age-related damage to the retina, called macular degeneration.
- Purple, dark red and blue colours indicate the presence another kind of phytochemical – the flavonoids. Examples of foods with flavonoids include all types of berries, purple grapes, cherries, red cabbage and red-skinned potatoes. flavonoids can help keep our heart and blood vessels healthy, and may provide some protection from cancer. Flavonoids in cranberries seem to help prevent urinary tract infections.
- Green, white and purple cruciferous vegetables are a family of strong-flavoured winter vegetables, such as broccoli, cabbage, Brussels sprouts, leeks, onions, garlic and cauliflower. Their colours vary, but they all have one thing in common: they contain sulfurous phytochemicals. These compounds are protective against cancers, cardiovascular problems and cholesterol levels.

In November 2007, the World Cancer Research Fund and the American Institute of Cancer Research published a global perspective on food, nutrition, physical activity and the prevention of cancer, which will be the subject of our next edition of Food and Nutrition Communication. The report emphasizes the necessity of not putting on weight (in fact being at the lower end of the “normal” MBI range), limiting the consumption of energy-dense foods, salt, and alcohol, and eating mostly plant foods. The recommendations for minimizing the risk of cancer are therefore in line with the principle of choosing nutrient-dense foods for general health and wellness.

Bioavailability

Processes such as cooking can affect the bio-availability of certain phytonutrients, sometimes favourably, as in the case of lycopene from tomatoes. Tomato purée has more assimilable lycopene than fresh tomato, cooked carrots more beta-carotene than raw, for example.

Animal proteins, the constituent amino-acids of which form a complete set, are efficiently taken up by the body to form proteins of the human body. Vegetable proteins are structurally incomplete for human protein formation and need to be consumed with other foods containing the missing elements to form assimilable proteins. Examples of traditional diets using this type of food combination as a staple are the rice and beans, or rice and lentils diets of certain regions of South America and the Indian subcontinent. Other examples include maize(corn) with milk.

Subjective advice

The concept of nutritional density, just as many other ideas that have preceded it, has provided a bandwagon for activists to jump on eagerly. In contrast to the objective, systematic approach adopted by the health agencies, many other attempts to grade the nutrient density of individual foods appear in the words of Adam Drewnowsky, “*arbitrary, tautological, and imprecise*”.

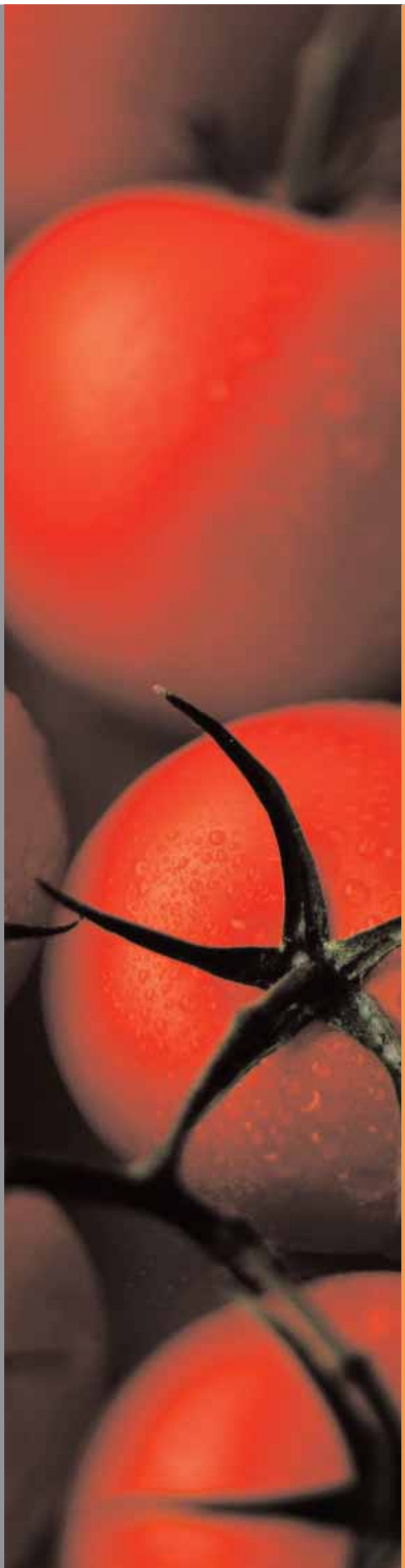
This author gives as examples, the Traffic Light Diet, in which individual foods are categorized as green, amber, or red on the basis of their (unspecified) nutrient density.*

Working with a list of 60 Swedish foods, two researchers stated that they “simply” categorized foods as good or bad on the basis of their (unspecified) nutrient content and on data from statistical surveys. All meat was deemed bad and therefore not recommended; white bread (high glycemic index), cheese (too much saturated fat), and margarine (*trans* fatty acids) were also not recommended. Poultry did not make the list of recommended foods because the researchers did not consider chicken to be a health-promoting food; juices (too much sugar) and boiled potatoes (high glycemic index) also did not make the list. Whole milk and 3%-fat yogurt were judged to be about as desirable as alcohol and did not count toward either food score. Escaping censure were crispy rye bread, lettuce, cucumber, tomatoes, salmon, herring, and other fish (except shellfish) — in other words, the classic ingredients of a Swedish open sandwich.

When it comes to deciding which foods have nutritional value, Adam Drewnowsky points out that some researchers seem to share the viewpoint of the Supreme Court Justice Potter Stewart: *“I know it when I see it”*.

The only problem with this subjective view of what constitutes nutritious food, is that when such groups are successful in lobbying authorities and consumer organisations, simplistic interpretation of scientific information can be more widely diffused and enter legislative areas. At their recent congress in Sydney, the consumer federation *Consumers International* endorsed the Traffic Light system of food labelling put forward in the UK on the grounds of “simplicity” despite the serious defects of the system.

**It has been remarked that a labelling system that “looks like a Homeland Security terrorist alert is hardly conducive to developing a balanced and sensible attitude to food.*





Nutrient density for older people

Dr. Y. N. Berner, F. Stern, Z. Polyak and Y. Dror of the Institute of Biochemistry, Food Science and Nutrition, Faculty of Agricultural, Food and Environmental Quality Sciences, Rehovot, Israel, studied the deterioration of physiological states resulting from sub-optimal nutrient intakes in old aged patients. Dietary intake was assessed in 50 institutionalized elderly people (18 men, 32 women, average age 84.6 years) according to data collected by using food frequency questionnaires based on the institutional kitchen recipes, weekly menus and portion size.

The results of this trial showed daily energy derived from protein and fat was 15.1% and 35.4% respectively. Dietary fibre consumption was very low. Calcium intake of all of the subjects, and magnesium, zinc and copper intakes of most of them were low. Iron intake of almost all of the subjects was sufficient or above RDA. Intake of vitamins D, E, B₆, thiamine (vitamin B₁) and folic acid in all or most of the subjects was low.

In almost all of the 39 similar studies and reviews including the one above, densities of at least two nutrients did not meet the calculated RDA density. Consistently low were the nutrient densities of vitamins C and E, thiamine, vitamin B₆, folic acid and vitamin D, as well as of calcium, magnesium, zinc and copper.

Supplementation with half of the RDA of micronutrients (except for vitamin A and iron) may result in micronutrient intakes that are higher than two thirds of the RDA. This is a clear indication that old aged patients should be able to benefit from an improvement in their diets either in the form of supplements or substitution of certain food items for others, or both solutions.

Prepare yourself a nutrient-dense meal

Clear vegetable soups are nutrient-dense and help to calm the appetite and provide the body with liquid. The meal should include one small (100g) serving of a healthy protein source such as eggs, fish, poultry, pulses or lean meat. Several vegetables, some brown rice or whole grain pasta or a slice of wholegrain bread, a mixed green salad, a low-fat dairy product such as quark or yoghurt, and some fresh fruit can complete the meal. Tea or coffee for the pleasure and the additional antioxidants.



Affordability

The use of the RDAs in determining diet quality was based, in part, on the assumption that a wide variety of food choices will ensure that all the nutrient requirements are met. However, dietary variety is usually a function of socio-economic status. Even in 1979, families in the middle- and upper-income brackets consumed more meat, poultry, fish, milk and milk products, and fruit and vegetables, whereas poor people ate more breads and cereals. The revisions in the United States WIC food aid package in the late 1970s and 1980s helped low-income groups to obtain foods rich in key nutrients: protein, calcium, iron, and vitamins A and C.

In a report based on the French national food consumption survey, the diet costs were estimated using retail food prices in France. Adult participants were stratified by quartiles of dietary energy cost (in €/10 MJ). Dietary energy density, energy and nutrient intakes were then compared across groups.

As expected, participants in the lowest quartile of energy cost had the highest energy intakes, the most energy-dense diets and the lowest daily intakes of key vitamins and micronutrients.

Participants in the highest quartile of energy cost had lower energy intakes, and diets that were higher in nutrients and lower in energy density. However, their daily diet costs were **165%** higher.

The ongoing challenge is to provide foods that maximize the nutrient-to-calorie ratio at an affordable cost.

From the USA: Nutrient-Dense Ethnic and Regional Foods

	Chinese	Mediterranean	Mexican	Deep South (West African Influence)
Bread, Cereal, Rice, and Pasta	millet, rice, rice noodles, steamed buns	Greek breads, flat bread, noodles	cereal, corn or flour tortillas, macaroni, rice	grits, macaroni, rice
Vegetables	baby corn, bamboo shoots, bean sprouts, bok choy, cabbages, scallions, seaweed, snow peas, water chestnuts	cucumbers, eggplant, lentils and beans, onions, peppers, tomatoes	cabbage, cactus, legumes, squash, tomatoes	beans, black-eyed peas, collards (other leafy greens), green beans, okra, tomatoes
Fruits	oranges, pears, plums, and other fresh fruit	all citrus fruits, grapes, dates, figs, peaches, melons, pomegranates	bananas, guava, mango, oranges, papaya, pineapple	apples, bananas, berries, melons, peaches, pears
Milk, Yogurt, and Cheese	not traditionally consumed	yogurt	evaporated low-fat milk, powdered fat-free milk	low-fat buttermilk, low-fat cheeses, low-fat milk
Meat, Poultry, Fish, Dry Beans, Eggs, and Nuts	broiled or stir-fried fish and seafood, egg whites	egg whites, fish and seafood, lentils and beans	fish, lean beef, poultry, lamb, and pork, and many bean varieties	beans and peas, grilled or smoked poultry and fish
Fats, Oils, and Sweets	none	olive	none	none
Seasonings and Sauces	bean sauce, garlic, ginger root, hoisin sauce, oyster sauce, plum sauce, rice wine, scallions, soy sauce	garlic, herbs, lemons, saffron, pimentón (paprika)	herbs, hot peppers, garlic, pico de gallo (finely chopped tomatoes, peppers, and onions with seasonings), salsas, spices	none

Source: adapted fromSizer, Frances and Eleanor Whitney. *Nutrition Concepts and Controversies, Ninth Edition, 2003.*



Nutrient dense food for humanitarian aid

Some populations are in need both of nutrient-dense and energy-dense food. According to the humanitarian organisation Médecins sans Frontières (MSF), on the African continent where thousands of young children suffer from acute malnutrition, the use of nutrient-dense ready to use foods needs urgent expansion.

Unlike other food aid, ready to use foods do not leave children vulnerable to diseases they should be able to fight off easily. The organisation says that current food aid, which focuses on fighting hunger but does not yet treat malnutrition, is not doing enough to address the needs of young children most at risk. It was not only about how much food children get, but what kind of food is distributed, as many children are forced to live without healthy essentials like milk. MSF estimates that of the 20 million young children worldwide suffering from acute malnutrition, only about three percent will receive ready to use foods in 2007. Five million children's deaths each year are related to malnutrition. It is in conflict zones where the packages of food — containing milk powder, sugars and vegetable fats — are particularly applicable. In insecure environments, like Somalia and Darfur, where people are often forced to run for their lives with nothing but the clothes on their backs, they can not carry with them the means to prepare food, there is often no access to clean water for cooking, or charcoal for fires, or cooking utensils in general. But ready to eat foods can be eaten straight from the packet and do not spoil in the African heat, according to the NGO. They are also lighter to carry. Some analysts, however, say more evidence from the field is needed on ready to use foods, and that food distribution is essentially an economic question. Some restrictions on ready to use foods are in place, but research is ongoing, with World Food Programme as well as in universities. The cost of ready to use foods' base ingredients are all increasing, with the price of milk powder doubling since January 2007.

The United States Agency for International Development Bureau for Humanitarian Response has sought to create specifications for an Emergency Ration Bar. The prototype soy-based bar could be used for refugees and displaced persons. The primary source of protein is likely to be in the form of soy flour, concentrates, isolates or textured vegetable protein, with partially hydrogenated soybean oil and flaxseed oil, a cereal base, vitamin/mineral premix, sugars and baking and leavening agents could be constituents of the bar.

A report on the project is published in the Journal of Food Science Vol 69,N°9.2004.

Food and water safety

We have stressed the excellent nutritional value of plant foods such as legumes and pulses. However a safety risk associated with the production of such crops is the possible development of toxic moulds. Moulds can infect all pulse crops, especially chick-pea and lentil in the field, where spores can survive long periods. Many moulds are killed by cooking, but their toxins can remain, gradually lowering immune-system response over the long term. Mycotoxins, of which perhaps Aflatoxins are the best known, may develop on many crops post-harvest, including cereals, nuts and seeds, especially in damp, humid storage conditions. Good agricultural practices, inspection and screening of the crops are essential measures to ensure a safe supply.

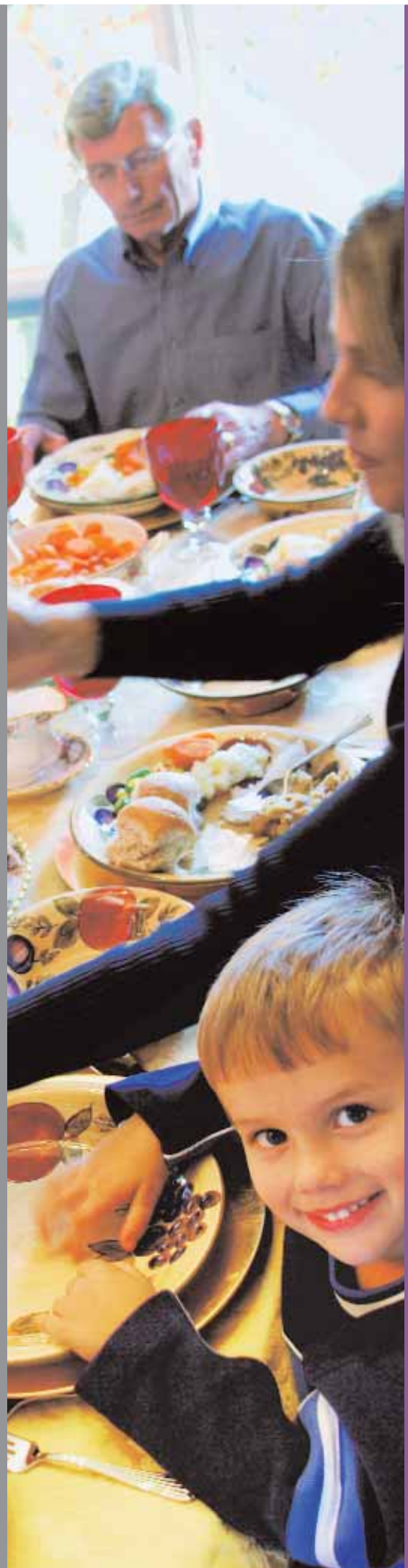
Another health risk is the problem of contaminated water supplies. High concentrations of arsenic in drinking water have been found in China, India and Bangladesh and localized areas of Argentina, Australia, Chile, Mexico, Taiwan, Mexico, Vietnam and the USA. Arsenic is defined as a carcinogen by the IARC. The importance of pure drinking water can not be over-stressed. Contamination of water supplies may result from the release of industrial effluents into rivers, and also through natural geological formations of the ground water table. More on cancer risks in our next edition.

Conclusion: Adequate nutrients within calorie needs

The ability to make healthier balanced choices within or across food groups depends on being able to identify the more nutrient dense foods.

To act on dietary advice, consumers need clear guidelines. The 2005 Dietary Guidelines for Americans recommended nutrient-dense foods, limiting, but not excluding energy-dense foods. By selecting the nutrient-dense foods first, consumers will meet the recommended nutrient intakes without exceeding their energy allowance. Any “left-over” or “discretionary” calories in proportion to energy needs can then include indulgence items such as chocolate and ice cream, so that the diet is not too austere and is in touch with real-world situations such as celebrations, rewards, and the pleasure of taste.

As long as nutrient density remains undefined, the concept of a nutritious food is all too often a matter of personal opinion. These issues need to be resolved if authorities are to adopt the nutrient density approach to balanced dietary guidance and Public Health.





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