Evidence for nutritional benefits in prolonging wellness[1–4]

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ABSTRACT

Healthy aging involves the interaction between genes, the environment, and lifestyle factors, particularly diet and physical activity. Worldwide, the increase in life span has led to an increase in morbidity and mortality as the result of chronic, lifestyle-influenced diseases such as type 2 diabetes, cardiovascular disease, and cancer. Nutrient deficiency diseases are giving way to energy imbalances, and links between diet and chronic disease are becoming clearer. The global demographic, epidemiologic, and nutrition transitions are dramatic and point to an urgent need to focus on preventive approaches in health care. Thus, nutrition research has shifted from focusing exclusively on alleviating nutrient deficiencies to also stressing chronic disease prevention. Ongoing initiatives to optimize long-term health and promote healthy aging are based on the concept of functional fitness, ie, the ability to lead an active and healthy life. The Dietary Reference Intakes provide a framework for assessing nutrient adequacy at the population and individual levels. In addition, the Healthy Eating Index provides a single summary measure of diet quality. To effect changes in lifestyles to optimize health as we age, health care providers need to consider all the lifestyle and environmental factors contributing to suboptimal eating and lifestyle patterns.   *Am J Clin Nutr* 2006;83(suppl):410S–4S.

KEY WORDS   Energy imbalance, diet, nutrition, Healthy Eating Index, Dietary Reference Intake, DRI, obesity, cancer, osteoporosis, chronic disease, nutrient deficiency, Recommended Dietary Allowance, RDA, adequate intake, AI, tolerable upper level, UL

INTRODUCTION

Life expectancy is increasing throughout the world. According to the World Health Organization, 605 million persons (20%) are currently aged ≥60 y. By 2025, it is estimated that this number will have grown to 1.2 billion (29%) (1). To live these additional years independently and relatively disease- and disability-free will demand attention to promoting healthy lifestyles early and maintaining these throughout life. Healthy aging involves the interaction between genes, the environment, and lifestyle choices. The most modifiable lifestyle factors are diet and physical activity. This article provides a broad overview of factors related to diet, nutrition, chronic diseases, and healthy aging. Each of the themes discussed is complex; the intent is not to provide a comprehensive summary of each issue but rather to illustrate examples of the links between nutrition, disease prevention, and the aging process.

Three important transitions that affect the aging process are occurring globally: demographic, epidemiologic, and nutritional. First, changes in demographics have occurred worldwide because scientific and social advances have decreased the incidence of infectious diseases and the associated mortality, which has resulted in longer life expectancy. Exceptions to this include large parts of sub-Saharan Africa where the prevalence of HIV/AIDS has resulted in a lower life expectancy over the past decade. Birthrates in developing countries have also fallen, and worldwide improvements have been made in hygiene, sanitation, diet, education, and income (1).

The epidemiologic transition has involved changing disease patterns. Infectious diseases of the early 1900s, such as pneumonia and tuberculosis, have been replaced by cardiovascular disease and cancers as the major causes of mortality. The nutrition transition occurring worldwide, even in some of the poorest countries of the world, involves a shift from traditional, grain-based diets to dietary patterns with more fats, sugars, and variety. Globally, chronic diseases such as obesity, type 2 diabetes, hypertension, coronary artery disease, and cancers are becoming more prominent. These transitions are dramatic and point to a need to increase the focus on preventive approaches to promoting healthy lifestyles.

HEALTHY PEOPLE 2010

Several initiatives are currently underway in the United States aimed at safeguarding and improving long-term health and promoting healthy aging. Healthy People 2010 is a comprehensive set of objectives designed to identify the most significant preventable threats to health and to establish national goals to reduce these threats (2). Healthy People 2010 was developed as a collaborative process among federal and state government health agencies; it is built on scientific knowledge and is designed to measure progress over time. Healthy People 2010 has 2 overarching goals: *1*) to increase the length and quality of healthy life and *2*) to eliminate health disparities. To achieve these goals, we must focus on some of the disparities that do occur.

Currently in the United States, clear income-to-health links exist. According to the US Department of Health and Human Services 2004 report (3), 20.4% of persons in the lowest income category perceived their health as poor or only fair, compared

with only 6.4% in the highest income category (3). Not only do lower-income persons perceive that they have poorer health, income inequality has also increased over the years. Recent gains in health in the United States are due disproportionately to achievements by upper-income groups, while lower-income groups lag behind in health status. Other disparities noted in the 2004 report include the longer life expectancy of women than of men, the lower life expectancy of ethnic minorities, the higher infant mortality rate in African Americans, and the two-fold higher rate of diabetes in Hispanics (3).

Although severe disabilities in persons aged ≥60 y are declining, the prevalence of chronic disease, particularly of those diseases linked to diet and lifestyle, is increasing (3). Obviously, the older one becomes, the higher the probability of having one or more chronic diseases and the inherent health, economic, and social consequences.

Research institutions worldwide are now looking closely at nutrition and nutritional requirements, not only from the perspective of alleviating nutrient deficiencies but also from the perspective of preventing them. How do we apply our growing understanding of the nutrient influence on disease processes to effectively modify dietary patterns population wide to reduce and prevent the incidence of chronic disease?

DIETARY REFERENCE INTAKES

The Recommended Dietary Allowances (RDAs) were first developed in the 1940s to establish nutrient requirements for the US population. Until the late 1980s, the RDAs set recommendations for a range of essential nutrients to cover the needs of 97–98% of the population. In the 1990s, the Institute of Medicine recognized the need to incorporate newer scientific knowledge, including that on diet and chronic disease links, into setting the nutrient recommendations for the US population (4). In 1994, an Institute of Medicine report concluded that the RDAs were not being applied appropriately and that the availability of only a single value for a specific nutrient requirement had led to inappropriate interpretations and applications (4).

The process that evolved over the next 10 y led to the development of a revised framework for calculating nutrient requirements in the United States. The Dietary Reference Intakes (DRIs) are a set of nutrient-based reference values that expand on and replace the former RDAs in the United States and the Recommended Nutrient Intakes (RNIs) in Canada (5); where data exist, the DRIs address the reduction of the risk of chronic diseases and not just the absence of deficiency diseases. Concepts of probability and risk underpin the development of the DRIs. Instead of nutrient recommendations expressed as a single, one-size-fits-all value, the DRI model is more comprehensive than the RDAs alone and represents a broader conceptual approach (**Figure 1**). The DRIs consist of 4 nutrient-based values: the estimated average requirement (EAR), the RDA, the adequate intake (AI), and the tolerable upper level (UL). For the first time, the concept of adverse effects of excess intake of specific nutrients is included in the form of the UL.

The RDA remains, as in the past, the amount of a nutrient sufficient to meet the needs of most individuals and should be the goal for daily intake of an individual. The EAR is the average daily nutrient intake level estimated to meet the requirements of one-half the healthy individuals in a particular age, life cycle, and sex group (5). The AI is used when an EAR, and, therefore, an
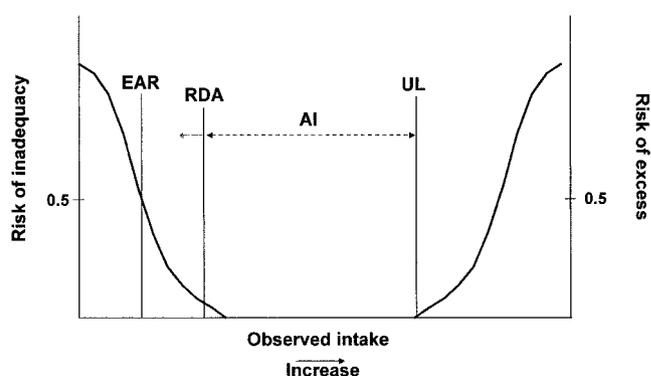

FIGURE 1. The Dietary Reference Intake model encompasses 4 nutrient-based values: the estimated average requirement (EAR), the recommended dietary allowance (RDA), the adequate intake (AI), and the upper level (UL). Increased risks are associated with both inadequate intake and excessive intake.

RDA, cannot be determined. The level of an AI is based on observed or experimentally determined estimates of nutrient intake by groups of healthy persons. Finally, the UL is the highest daily amount of a nutrient that is likely to pose no risk of adverse health effects to most persons in the population. The UL as developed is neither a recommended nor a desirable level. The spread between the EAR and the UL will vary for different nutrients. The intent of the DRIs is to address adequacy, and each EAR or AI is described in terms of a selected criterion or indicator of adequacy.

The DRI approach to setting iron requirements illustrates the difference from the traditional, single-value RDA approach used previously. The EAR for iron is derived through a factorial modeling process that considered the range of basal iron losses, needs for fetal growth, increased requirements during growth, and tissue and storage iron. The tolerable UL is set by using gastrointestinal distress as the adverse outcome associated with excessive iron intakes. The DRI provides a series of age-specific EARs in contrast with the single-reference RDA. For example, the RDA for iron for premenopausal women is 18 mg. The age-specific EARs are 8.1 mg for both 19–30-y-old and 31–50-y-old women and 5 mg for 51–70-y-old women. The tolerable UL for iron is 45 mg. The inclusion of the UL in the DRI can be especially useful in monitoring and controlling iron intake from nonprescription, over-the-counter nutritional supplements.

CHRONIC DISEASE AND NUTRITION

Worldwide morbidity and mortality from infectious diseases is being replaced by chronic diseases such as cancer, osteoporosis, and cardiovascular disease. In addition, evidence is mounting regarding a range of diet–chronic disease links. For example, a 2001 World Health Organization report summarized the links between intakes of total dietary fat and a range of cancers (colon, breast, esophageal, endometrial, and kidney) (6). The National Cancer Institute is also conducting research to further investigate the links between overweight, obesity, and cancers in the United States. Other dietary components associated with an increased cancer risk include consumption of alcohol; charred, smoked, and salted meats; nitrate-cured foods; and nitrous compounds (7). Increasingly, research is elucidating our understanding of the association between individual micronutrients and specific
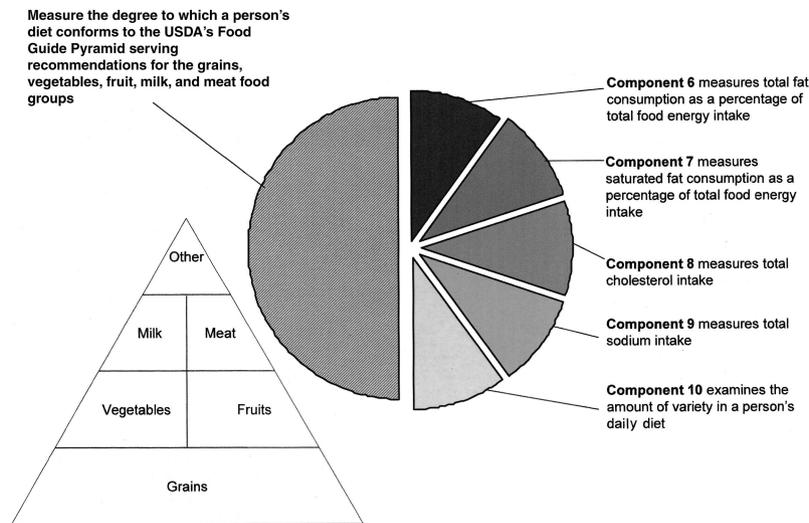
Measure the degree to which a person's diet conforms to the USDA's Food Guide Pyramid serving recommendations for the grains, vegetables, fruit, milk, and meat food groups

Component 6 measures total fat consumption as a percentage of total food energy intake

Component 7 measures saturated fat consumption as a percentage of total food energy intake

Component 8 measures total cholesterol intake

Component 9 measures total sodium intake

Component 10 examines the amount of variety in a person's daily diet

Other

Milk | Meat

Vegetables | Fruits

Grains

FIGURE 2. The Healthy Eating Index is a single summary measure of diet quality that comprises the US Department of Agriculture (USDA) Food Guide Pyramid (components 1–5) and intake of total and saturated fat, cholesterol, sodium, and food variety (components 6–10) (27).

forms of cancer. For example, diminished folate status has been associated with increased risk of colorectal cancer.

Similarly, much is known about osteoporosis and its links to dietary calcium, calcium reserves, and bone mass. Osteoporosis is characterized by an excessive decrease in bone mineral density with aging; in postmenopausal women, losses of skeletal calcium can reach ≥40% (8, 9). Prevention needs to start early, with attention to dietary calcium and vitamin D intake and interventions to build maximal bone density in childhood, as well as protect bone mass in adult women. In addition, at least one study reported that bone health is influenced by other nutrients, such as vitamin K (10); the results of that study indicated that low intakes of vitamin D and calcium correlated with low intakes of vitamin K. This type of association suggests that it may be healthy versus unhealthy dietary patterns and lifestyles, rather than a deficiency of a single nutrient, that contributes to osteoporosis.

AGING AND NUTRITION

The normal aging process involves changes that can influence nutritional status. Taste sensitivity normally declines with age and can affect energy regulation (11). If food doesn't taste good, we are less inclined to eat; this is a common problem in the elderly. Thirst mechanisms are also affected by aging. Dehydration is common in institutionalized populations and has also been found in free-living older adults (12).

Immune function is altered with aging, and dysregulation of immune function contributes to infection and neoplastic and inflammatory diseases (1). There are clear triggers for inflammatory disease, and research is underway with respect to nutrition, inflammatory disease, and prevention of the cascading events in the proinflammatory stages. For example, research has indicated that intake of foods rich in n−3 fatty acids is associated with an increase in antiinflammatory eicosanoids, whereas consumption of n−6 fatty acids is linked to the increased production of proinflammatory eicosanoids (13); n−3 polyunsaturated fatty acids also increase T cell–mediated function in healthy older persons (14), and vitamin B-6 supplements increase lymphocyte proliferation in response to T and B cell mitogens (15). These are just a few examples of the rapidly emerging research on how diet can influence immune function.

For many individuals, the cognitive changes that occur with aging are affected by micronutrient intake. Oxidative stress is one of the key factors that affect brain function in aging (16); antioxidants appear to be important in slowing this process (17), as are the B vitamins folate, vitamin B-6, and vitamin B-12 (18).

In the United States, the dual problem of overweight and obesity occurs side by side with problems of malnutrition in the elderly. Body fat tends to double during middle life; although, by 65–70 y of age, body fat generally decreases, even in healthy older persons who do not modify their diet or levels of physical activity (19). Despite the overweight and obesity crises in the United States, some undernutrition occurs as a result of unhealthy weight loss in older persons. Such unexplained, involuntary weight loss can lead to protein-energy malnutrition, which can precipitate sarcopenia, a loss of lean muscle mass. About 45% of older adults have some degree of sarcopenia (20), and adequate dietary protein is needed to conserve lean muscle mass.

AGING AND PHYSICAL ACTIVITY

Physical activity is key to healthy aging because of its positive effects on decreasing the risk of diabetes, hypertension, cardiovascular disease, osteoporosis, and sarcopenia (21). Skeletal muscle mass begins to decline as early as 45 y of age, and this is predictive of future disability (22). The World Health Organization recommends a minimum of 30 min of aerobic physical activity on most, preferably all, days of the week (1). Complementary resistance or strength training 2 to 3 times per week should also be included as part of a fitness regimen to prevent or reverse sarcopenia and increase muscle mass and strength (21).

ENERGY IMBALANCE: OVERCONSUMPTION

Energy requirements naturally decline with age; yet, today, overweight and obesity are common throughout the world. Much policy debate has been directed at identifying and implementing

TABLE 1
A comparison of Healthy Eating Index scores for adults aged ≥65 y between 1989–1990 and 1999–2000[1]

	1989–1990			1999–2000		
	Good diet	Diet needs improvement	Poor diet	Good diet	Diet needs improvement	Poor diet
		%			%	
65–74 y	18	74	8	20	66	14
≥75 y	26	66	8	19	68	13

[1] From reference 27. The results indicate that most of the elderly population would benefit from an improved diet.

approaches for the prevention and control of the health threats associated with overweight and obesity. This debate, to date, has focused almost exclusively on individual lifestyle choices related to diet and physical activity rather than on the intersection between individual choice and environmental barriers to achieving healthy lifestyles. A study of energy intakes since the 1950s showed that energy intakes of the US population in the 1950s and 1960s were generally higher than intakes in the 1990s, although Americans 50 y ago had lower levels of overweight and obesity (23). Clearly, the problem of overweight and obesity currently is related to energy imbalance and not simply the level of caloric consumption in the United States.

Steadily declining average levels of physical activity since World War II (eg, more mechanization, less physical labor, and less energy-intensive leisure-time activities) provide part of the explanation. However, the effect of the changing physical environment is an aspect that has not yet been satisfactorily addressed. The models stressing only personal choice in understanding the etiology of obesity have been unsuccessful in identifying effective approaches to prevention or treatment. Long-term solutions to the obesity epidemic will require an understanding of the intersection of diet, physical activity, and the environmental constraints to a healthy lifestyle (24).

MONITORING CONSUMPTION PATTERNS

The US Department of Agriculture developed the Healthy Eating Index (HEI) as a single summary measure of diet quality (25, 26). The HEI has been used in evaluating progress toward achieving the goals of Healthy People 2010. The HEI is a 10-component index (**Figure 2**) with scores ranging from 0 to 100. Components 1 to 5 are based on the 5 major food groups of the food guide pyramid: grains, fruit, vegetables, meat, and milk products. Components 6 to 10 measure various aspects of the dietary guidelines: total fat, saturated fat, cholesterol, sodium, and variety.

HEI data from the late 1980s and early 1990s correlated significantly with a range of nutrients, body mass index, and self-reported perceptions of diet quality. Individuals with an index ≥80 (good result) tended to have a body mass index within the normal range (26). Analysis of changes in dietary habits over 10 y has shown that total HEI scores have hardly changed for persons aged ≥65 y (27). Although 20–25% of elderly participants scored high on the HEI, most of the older population have diets that need improvement (**Table 1**).

CONCLUSION

Life expectancy worldwide is increasing; to achieve both a longer and a healthier life, increased attention must be placed on lifestyle choices, most importantly diet and physical activity. The need to focus on prevention is clear. Research has provided the scientific underpinnings for healthy aging. The challenge now is to use this scientific data to develop effective interventions for free-living individuals. More attention needs to be devoted to research elucidating the intersection between diet, physical activity, personal choice, and environmental constraints on influencing healthy aging. The current adult population in the United States is predicted to be the healthiest aging group yet seen in this country. It remains to be seen if we can apply what we already know of nutrition's role in healthy aging, as well as the results of future research, to ensure that this prediction holds true.

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