

# Nutrition, Physical Activity, and Quality of Life in Older Adults: Summary

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**W**E live in an aging society. Not only is 1 in every 8 Americans older than 65 years, but a person aged 65 can expect to live an average of 18 more years (1). People aged 85 years and over are the fastest-growing group, and the proportion of these "oldest old" is expected to triple between now and year 2030 (2). Continued good health of the elderly population is a major challenge to public health (3).

Increased longevity is associated with an increase in multiple chronic conditions that sometimes translate into functional disability and need for assistance (2). The extra years can be marked by declining health, reduced mobility, depression, isolation, and loneliness (4). Health and functioning of older adults are influenced by many factors other than biological senescence. Demographic, social, and environmental factors, including physical activity and dietary habits, play a major role. Fortunately, many of these societal factors are amenable to public health interventions and programs (5). More than any other age group, older adults are seeking health information and are willing to make behavioral changes to maintain their health and independence into advanced old age (1). Among the most important self-care behaviors are those that involve physical activity and diet. Their contribution to health and quality of life is the principal topic of this review.

In many past studies the success of the efforts at health promotion has been measured in terms of lower mortality rates or reduced disease risk. There is increasing concern that these classic medical endpoints (mortality and morbidity) may not adequately represent functional impairments and disabilities during the later years of life. Increasingly, health is viewed as not only the absence of infirmity and disease but also as a state of physical, mental, and social well-being (6,7). Much progress has been made in establishing a broader conceptual framework of health status for older adults (8). Indexes of health-related quality of life (HRQL), a relatively new concept, expand the morbidity- and mortality-based definition of health to include a personal sense of physical and mental health, social functioning, and emotional well-being. Other and more global measures of quality of life are even more inclusive, taking overall life satisfaction and happiness into account (9,10). Quality-of-life measures permit researchers to compare the status of different groups over time and assess the effectiveness of public health interventions and programs (2,7).

However, the effectiveness of diet and exercise programs continues to be measured in terms of biomedical endpoints. Many of the existing quality-of-life indexes do not directly address the contribution of either physical activity or diet. Very few studies have explored the interrelationships among dietary measures, physical activity variables, and quality-of-life indexes in older adults or the nature of the intervening variables. As documented below, such factors as perceived mastery and control, enjoyment of the diet, or satisfaction with exercise programs may be as important to quality of life as is reduced plasma cholesterol or increased grip strength. This monograph summarizes what we know about age-associated changes in activity levels and eating habits and suggests how these factors may be related to quality of life.

## WHAT HAPPENS AS WE AGE

Healthy life means a full range of functional capacity at each life stage, from infancy to old age (1). Some age-related changes involve a gradual decline in function that is due to biological senescence (11). For example, aging is generally associated with more body fat and reduced muscle mass (12,13). Reduced muscle mass has been directly linked with lowered muscle strength, lowered maximal aerobic capacity, and decreased bone density in elderly adults (12). However, not all age-associated changes are caused by age alone. Some scientists believe that the age-associated decline in function is caused by cumulative exposure to risk factors rather than only by aging (2,14). For example, lower insulin sensitivity and increased risk of type 2 diabetes are also influenced by genetics, body composition, and sedentary lifestyles (15). Very little, if any, of the age-associated change in glucose tolerance is caused by age alone (15).

Age-associated changes in metabolism or physiological function may be partly responsible for the observed decline in energy intakes as well as for shifts in dietary choices and eating habits (16). Reduced muscle mass results in lower energy requirements. As noted by Morley (16), aging has been associated with altered sensations of thirst, hunger, and satiety and with incomplete adjustments for day-to-day variations in food intake. The observed deficits in taste and smell may lead to a reduced sensory enjoyment of foods by elderly adults (4). The lack of sensory-specific satiety (a variety-seeking mechanism) may explain why some elderly

people restrict food choices and adopt a monotonous diet (4). Some of these phenomena may be mediated by an age-associated increase in the levels of the satiety hormone (cholecystokinin). A decline in testosterone levels is reported to lead to increased levels of leptin and therefore reduced food intakes by older men. Studies of aging rodents further point to reduced activity of dynorphin (kappa opioid) and neuropeptide Y systems, both of which influence food intake. Mild inflammatory disorders that result in the release of cytokines may also lead to age-associated anorexia. Loss of appetite and anorexia are the key predictors of malnutrition in clinical settings (16). Among independently living elderly adults, low nutrient density of the diet and inadequate intakes of protein, vitamins, and minerals are the chief areas of nutritional concern (17).

The aging process can also be viewed as the cumulative effect of chronic diseases—namely, hypertension, diabetes, hyperlipidemia, and atherosclerosis—on individual functioning. Poor health, medications, and medically prescribed diets affect dietary choices, eating habits, and nutrient intakes (4,18). Impaired mobility, inability to feed oneself, or poor oral health may alter eating habits and further contribute to dietary inadequacies (16). Other studies suggest that the observed drop in energy requirements is only partly due to physiological factors such as reduced muscle mass and lower metabolic rate. Recent studies based on the doubly labeled water methodology and reported by Westerterp and Meijer in this volume (13) suggest that the primary reason for reduced energy needs is the sharp drop in physical activity that also occurs with advancing age.

#### AGING, NUTRITION, AND DIETS

Our knowledge of how dietary patterns change with age is limited. Most dietary data are cross-sectional—people in one age group are compared with different people in another age group. Such studies do not permit the effects of age to be distinguished from those of a given cohort. Studies of the same cohort followed over time would provide better data on how food preferences and eating habits change with age. Unfortunately, as noted by Wakimoto and Block (19), few large-scale longitudinal studies collected comprehensive dietary data over several decades and even fewer have been published. Furthermore, the emphasis has generally been on health outcomes rather than on age-associated changes in eating habits.

For the most part, data from cohort studies, such as the Baltimore Longitudinal Study of Aging, are consistent with data from cross-sectional studies, such as the National Health and Nutrition Examination Survey (NHANES), leaving no doubt that there is a substantial decline in food intake with advancing age (19,20). As shown by NHANES III data, energy intakes between ages 25 and 70 years can decline by as much as 1000 to 1200 kcal/day for men and 600 to 800 kcal/day for women. By age 80, 1 in 10 men consumed less than 890 kcal/day whereas 1 in 10 women consumed less than 750 kcal/day.

Reduced energy intakes can lead to inadequate intakes of protein, vitamins, and minerals. NHANES III data show potentially important decreases with age in median protein and zinc intakes (down by about one third in men) as well as in-

takes of calcium, vitamin E, and other nutrients (19). Risk for inadequate nutrient intakes was especially acute for older men. As many as 10% of older men obtained only one fifth to one third of the recommendations for protein, zinc, calcium, vitamin E, thiamin, riboflavin, vitamin B<sub>6</sub>, and vitamin B<sub>12</sub>. In contrast to the general decline in micronutrient intakes, estimated intakes of carotene, vitamin A, and vitamin C tended to increase with age, especially for women.

Wakimoto and Block (19) also examined the nutrient density of diet (i.e., consumption of a given nutrient expressed per 1000 kcal). Although the absolute intake of a nutrient may decrease with age, the absolute intake of energy decreases even more, such that the observed proportion of the nutrient in the diet is higher than that for younger groups. One question was whether dietary guidelines for older adults should be formulated in terms of absolute intake or in terms of nutrient density. There is no consensus at this point as to how dietary requirements change as a function of age. However, some evidence suggests that because of declining metabolic efficiency and bioavailability, requirements for some micronutrients might actually be higher for older adults than for younger people.

Although clinical studies revealed few overt nutrient deficiencies among elderly adults (17), subclinical deficiencies can adversely affect health and physical functioning. Diet and exercise modulate the rate of functional decline with age and can be used to delay or postpone the onset of disability or dysfunction. For example, the prevalence of osteoporosis goes up with age, roughly doubling with each decade. In women 50 years and older, 37% to 50% had osteopenia whereas 13% to 18% had osteoporosis. The risk of osteoporosis—a major cause of fractures in postmenopausal women and elderly adults—is reduced by a combination of diet and exercise. Similarly, optimal diets have been associated with lower risk of chronic diseases, notably coronary heart disease, obesity, diabetes, and some forms of cancer.

#### AGING AND PHYSICAL ACTIVITY

Sedentary lifestyles are becoming increasingly common at any age. Aging leads to lower activity levels and a further narrowing of physical activity options. Data from the Behavioral Risk Factor Survey showed that more than 40% of U.S. women aged 65 and older reported no leisure time activity in 1992 (21). Recent cross-sectional data from the Aerobics Center Longitudinal Study showed that older adults expended significantly less energy on exercise than did younger adults (22). In the Zutphen Elderly Study of elderly men, mean time spent on physical activity other than walking decreased by 28 minutes/day during 10 years of follow-up (23).

Walking was the most common physical activity reported by adults (21). Older adults in the United States were more likely to report lower-intensity activities such as walking, gardening, or golf, rather than running, aerobics, or team sports (21). Although the time spent on bicycling and gardening showed a significant drop with age in the Zutphen cohort, the time spent on walking was not affected (23). Significant disparities in activity levels by sex and ethnicity were also noted. Reported levels of leisure-time physical activity were lowest for minority respondents and for older

women. Data from the Coronary Artery Risk Development in Young Adults study showed that important ethnic differences in physical activity patterns remained even after adjustments were made for important demographic factors such as education or income (21). Significantly, unfavorable perceptions of one's own health were associated with lower participation in a cardiac rehabilitation program (21). In contrast, perceived enjoyment and satisfaction were positive predictors of physical activity in men and women of all ages (24). These data suggest that psychosocial rather than biomedical variables may influence continued participation in exercise programs.

The recommendation that every American accumulate at least 30 minutes of exercise on most—and preferably all—days (25,26) is based on evidence that even moderate physical activity is associated with a substantial drop in all-cause mortality (27). Although there is evidence that current activity is more protective than past activity, cumulative lifetime activity pattern may be the most influential factor of all (21).

The question remains as to whether a sustained active lifestyle can delay the age-associated changes in body composition and decline in lean body mass. Studies of physical activity and aging, including some outlined in this volume, suggest that fat-free mass and body composition of active elderly subjects are not very different from those of inactive elderly subjects (13). In contrast to younger subjects, the effect of exercise programs on total activity of elderly subjects was minimal because elderly subjects compensated for exercise training by reducing their spontaneous physical activity. However, exercise training did have a positive effect on muscle function and may have contributed to the activities of daily living.

Continuing to function without assistance may be the most salient outcome variable. Some 7 million Americans over age 65 depend on others for help with some basic task of daily living (2). According to NHANES III data, 23% of people 80 years and older were unable to prepare their own meals and 17% were unable to walk. The Activities of Daily Living score includes capacity for daily self-care as well as other functions related to cooking, eating, and access to food. Such activities are essential for ensuring independent living and contribute importantly to overall quality of life.

Physical activities that improve muscular strength, endurance, and flexibility also improve ability to perform the tasks of daily living. For example, strength training can result in substantial improvements in muscle size and strength in elderly men and women (28) and can also increase resting metabolic rate, resulting in increased energy requirements (29). In addition, strength training improves balance and gait speed in very old and frail nursing home residents, improves bone health, and decreases many of the risk factors for an osteoporotic fracture (28). Exercise programs for elderly adults can delay the age-induced impairment in personal mobility necessary for the performance of routine activities.

#### QUALITY-OF-LIFE MEASURES

The definition of health used to be based on life expectancy, mortality, and morbidity statistics. Quality of life pro-

vides a validated approach for expanding the definition of health to include other domains of physical, mental, and social well-being (30). HRQL measures reflect a personal sense of physical and mental health and the capacity to react to diverse factors in the environment. Among measurement tools are years and days of healthy life and a self-rated index of overall health. HRQL indexes address broad aspects of physical, mental, and social functioning and their determinants at both individual and community levels (9,31). One important domain of quality of life is physical functioning, as assessed with the Activities of Daily Living score.

Some researchers have argued that quality-of-life measures should go beyond biomedical and health outcomes and that global concepts such as life satisfaction and happiness also ought to be included (9). In this view, quality of life is a multidimensional construct that addresses physical state, social functioning, and emotional well-being. Recent studies suggest that the key perceived dimensions of quality of life may be comparable across cultures and can be broadly grouped into health, psychological, social, and environmental domains (9).

The 100-item quality-of-life instrument developed by the World Health Organization lists physical health, psychological health, social relationships, and environmental issues as its four domains (9). As shown in Table 1, neither the domains nor facets incorporated within domains directly assess food, eating habits, or physical activity issues.

Much current research on quality of life has come from clinical studies. The usual focus has been on quality-of-life indexes after surgery or some major health trauma. Studies of quality of life of cancer patients have focused on physical

Table 1. Facets and Domains of the 100-Item Quality-of-Life Instrument Developed by the World Health Organization

Domain	Facets Incorporated Within Domain
Physical health	Activities of daily living Dependence on medicines and medical aids Energy and fatigue Mobility Pain and discomfort Sleep and rest Work capacity
Psychological	Body image and appearance Negative feelings Positive feelings Self-esteem Spirituality, religion, personal beliefs Thinking, learning, memory and concentration
Social relationships	Personal relationships Social support Sexual activity
Environment	Financial resources Freedom, physical safety, and security Health and social care: accessibility and quality Home environment Opportunities to acquire new information and skills Participation in and opportunities for recreation/leisure activities Physical environment (pollution, noise, traffic, climate) Transport

functioning, psychological distress, pain and pain relief, fatigue and malaise, nausea and vomiting, symptoms, and toxic effects. Social support, economic disruption, and global quality of life were also measured. A number of disease-specific tools were outlined by Amarantos and colleagues (32). One such instrument assessed HRQL specific to obesity and included general health, distress, depression, and self-esteem among its key domains (33).

The benefits of diverse medical treatments and interventions are often measured with regard to quality-of-life outcomes (9). Additional studies on quality of life come from the broader arena of research on social indicators. In studies of developing nations, quality of life is being increasingly used to determine stages of social development in preference to strictly economic indicators such as income or the gross national product. Quality-of-life indexes are a compelling dependent variable, one that is broadly based and well-suited for studies of diet, activity, and health in elderly adults.

### PHYSICAL ACTIVITY AND QUALITY-OF-LIFE MEASURES

Increasing physical activity is a viable strategy for improving both health and quality of life of older adults (34). However, the two sets of outcome measures may not be exactly the same. Stewart and King (35) proposed two outcome categories—functioning and well-being—to measure the effect of physical activity on the overall quality of life. Functioning included physical ability and dexterity, cognition, and activities of daily living; well-being included not only symptoms and bodily states but also emotional well-being, self-concept, and global perceptions related to health and overall life satisfaction (34). The basic question was whether outcome measures would best be served by symptom-driven HRQL measures or whether quality of life was more of a psychological construct that included conscious cognitive judgment of satisfaction with one's life.

Physical activity improved HRQL measures regardless of age, activity status, or health of participants (36). However, the relationship between physical activity and quality of life largely depended on what outcome was of greatest concern to the elderly individual. The effect of fitness on HRQL was less dramatic when the person was already functioning above the norm. Furthermore, there was a much closer link between performance dysfunction and HRQL than between fitness and HRQL. In other words, disability and dysfunction were far more salient and far more detrimental to quality-of-life measures than were reductions in the general level of fitness.

How does physical activity improve health and quality of life? Rejeski and Mihalko (34) suggested that perceived control and mastery and overall satisfaction and enjoyment may be key variables. Self-esteem and positive feelings may mediate the effect that physical activity has on life satisfaction. However, as Rejeski and Mihalko (34) noted, the current guidelines for exercise prescription offer little advice for outcomes other than improved physical health (26). When quality of life becomes the primary outcome, the focus shifts to areas that are most relevant and most valued. Continued independent physical functioning is one such area. Furthermore, physical activity programs involve more

than performance of a simple act. The input that participants may have in the design or running of a program may be more important to quality-of-life outcomes than meeting specific criteria for frequency intensity and duration.

### DIET AND QUALITY OF LIFE

Virtually no research has been done on how nutrition and dietary variables can best be integrated in the quality-of-life concept. The focus has been mostly on biomedical measures and health outcomes. For example, clinical assessment of nutritional status in elderly adults is commonly based on dietary intake assessments, anthropometric measures, and plasma chemistry values (37). Such measures have been used to document the prevalence of malnutrition in elderly adults, assess the degree of nutritional risk, and compare dietary intakes with recommended dietary allowances.

Epidemiological studies of diet and chronic disease risk have focused on the relationship between a single nutrient and the relevant health outcome. The traditional approach has been to examine the consumption of fats, saturated fats, or cholesterol in relation to morbidity and mortality data for coronary heart disease or cancer. Other studies have explored the consumption of specific foods or food groups, such as legumes or vegetables and fruits, always relating estimated consumption to plasma biomarkers, disease risks, or some other biomedical endpoint.

Assessing the quality of the total diet is a promising new approach to nutritional epidemiology. Earliest measures of diet quality were mostly concerned with malnutrition and nutrient deficiency diseases. Current measures of diet quality, such as the Diet Quality Index and the Healthy Eating Index, are more concerned with issues of overnutrition and focus on dietary moderation, variety, and balance (38,39). Studies conducted with the Healthy Eating Index suggested that elderly women had the highest scores, reflecting high consumption of grains, vegetables, and fruits. Healthy Eating Index scores increased with age, education, and income, again showing that the quality of the diet is largely determined by social and environmental variables (39).

The success of dietary strategies for health promotion is commonly measured in terms of compliance with Dietary Guidelines for Americans or with the U.S. Department of Agriculture Food Guide Pyramid (38,39). Few attempts have been made to relate diet quality indexes to quality-of-life measures. In the sense that quality of life reflects a general sense of happiness and satisfaction with our lives and environment, it has not been a part of mainstream research on nutrition and diet of elderly adults.

Physical health and psychological well-being are among the key domains of quality of life. Perceived control, satisfaction, and enjoyment have been mentioned as potential variables mediating the link between physical performance and HRQL measures. Assessments of diet quality have not taken control or satisfaction variables into account. Some suggestions for potential domains of a diet-related quality-of-life index are summarized in Table 2.

### STRATEGIES FOR COMMUNITY HEALTH PROMOTION

Health promotion strategies, policies, and educational approaches now target the aging population. Among these are



Table 2. Potential Domains and Content Areas for Nutrition- and Fitness-Related Quality-of-Life Measures

Domain	Potential Facets	Content Areas
Physical health	Dietary choices	Low-calorie diet
		Low-fat diet
		Low-cholesterol diet
		Low-sodium diet
		High-fiber diet
	Eating habits	Medically prescribed diets
		Meal replacements
	Dietary supplements	Vitamins
		Minerals
		Herbals
Alternative medicine		
Medications	Diuretics	
	Steroids	
	Polypharmacy	
Physical activity	Assistance with eating	
	Access to food and shopping	
	Walking	
	Exercise program	
	Body image	
Psychological well-being	Sense of control	Satisfaction with diet quality
		Satisfaction with fitness level
		Perceived health benefits
		Company at meals
Social relationships	Social support	Social interactions
	Marital status	
Environment	Financial resources	Food security
	Education	
Life satisfaction		Satisfaction measures

Source: Drewnowski, unpublished, 2000.

activities conducted in senior centers, congregate housing, life care facilities, and retirement villages. Older adults also participate in employer-sponsored and community health promotion activities that often emphasize physical activity and diet (40,41).

Although the scientific consensus is that both aerobic and resistance exercise training can provide substantial benefits to elderly adults, the strategies to increase their levels of physical activity are less clear. Exercise programs for elderly adults have been shown to be both effective and safe (12,41). The question is how physical activity (both increased and decreased levels) affects the quality of life. To those who have engaged in regular physical activity for many years, the answer may be obvious. However, despite a tremendous amount of information in both the scientific and lay press about the positive effects of exercise in preventing disease and increasing life expectancy, an astonishing number of Americans remain sedentary, particularly older Americans. An understanding of why people choose to begin an exercise program rather than remain sedentary is critical in attempting to implement a community-based exercise program, particularly one that targets elderly people.

Economic constraints may be one barrier to change. In addition to health-related issues and concerns, aging is often associated with more restricted social and economic resources (1). These may result from retirement, living on fixed income, failing health, or death of spouse. Studies in

social nutrition consistently show that marital status, living arrangements, and even socialization at meals have a measurable effect on energy intakes and eating habits. NHANES III data show that two factors—education and marital status—had a positive effect on physical functioning for adults 80 years and older. Marriage had a protective effect against disability in both men and women. In addition, such measures of HRQL as self-rated health, healthy days, and activity days all varied with age, ethnicity, education, and income.

Social and behavioral interventions can successfully improve eating habits and nutritional status as well as physical fitness levels. However, not all elderly adults have equal access to such programs. The second goal of *Healthy People 2010* is to eliminate health disparities among different segments of the population, in particular, to increase quality, availability, and effectiveness of educational and community-based programs designed to prevent disease and improve health and quality of life. The stated aim is to increase to at least 90% the proportion of people aged 65 and older who participated in at least one organized health promotion program during the preceding year.

### Summary

If health-related quality of life—and not longevity—is the key goal for health promotion, then it is captured only partly by the existing mortality and morbidity indexes (1). Researchers now urge that government agencies and health care providers begin collecting quality-of-life data on the populations they serve (1).

Adding life to years, not years to life, is the current agenda for productive and successful aging (42). Policies and programs on aging are increasingly focused on identifying ways to improve quality of life and health status rather than just extending life span (1). In the *Healthy People 2000* report, the chief goal of health promotion was to increase the span of healthy life (43). The focus was on mortality and morbidity data and symptom checklists as the principal measures of ill health (43). In contrast, the new emphasis in the *Healthy People 2010* report is on quality of life and overall well-being (1). Helping people to increase life expectancy and improve their quality of life is the primary goal of the *Healthy People 2010* report.

The authors of this special issue of the *Journals of Gerontology: Biological Sciences and Medical Sciences* are united in the belief that optimal nutrition and physical activity make a significant contribution to the overall quality of life at any age and especially for older adults. The key research challenge lies in deciding which aspects of improved fitness, nutrition, and diet contribute the most to quality-of-life measures. We have attempted to provide a comprehensive review of research on exercise, nutrition, diet, and health in elderly adults. Past studies on diet, nutrition, and fitness have largely addressed biomedical outcomes, pointing to substantial benefits in physical functioning, remission of disease symptoms, and improved health. This special issue goes a step further in assessing the effect of improved nutrition and physical activity on the global quality of life and its four principal domains.

Although links between diet and exercise and chronic

disease risks have been well documented, more needs to be known about motivations for behavioral change and perceived benefits as assessed using quality-of-life measures. No single segment of our society can benefit more from regularly performed exercise and improved diet than elderly adults (44). These important articles provide a link between diet and exercise and quality-of-life issues, as outlined in the *Healthy People 2010* report.

## ACKNOWLEDGMENTS

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