The role of nutrition in the care of the elderly patient[1]

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Nutrition has a direct bearing on the health of the geriatric patient. For the rapidly growing elderly population, nutrient deficiencies are a reality, especially deficiencies in calcium, iron, vitamins A, C, and the water-soluble B vitamins. The risk of malnutrition increases with the progressive physiological and socioeconomic changes of aging. The quality of the diet can be further compromised by physical and mental disabilities, chronic alcoholism, overmedication, and diseases such as cardiovascular diseases, diabetes, cancer, reduced immunity, and osteoporosis. Geriatric patients may be undernourished on entering the hospital. Many questions remain concerning the nutritional status, nutritional requirements, cause of deficiencies, nutrient supplementation, drug treatment, and the role of nutrition in the overall care of the elderly patient.

Index terms: Aged • Nutrition

Cleve Clin Q 53:75–82 Spring 1986

With the number of persons over 65 years of age growing in our society, the challenges of their health care are receiving much more attention. The elderly constitute a special group with distinct individual needs arising from the progressive physiological and biochemical changes of aging and from socioeconomic conditions.[1,2] Aside from the difficulties that bring the elderly to a physician's care, the older patient is unique because the rate of aging differs from person to person. The care of each patient requires the physician to recognize the extent of aging with its physiological changes in body composition and in metabolic and immune reactions.

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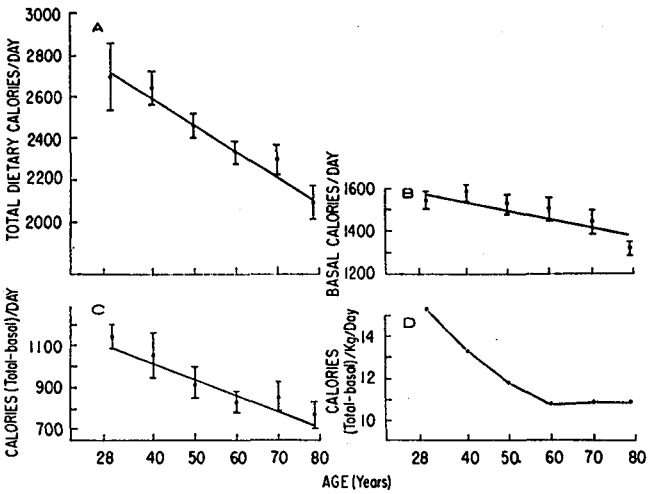

Figure. Mean total daily caloric intakes (**A**), basal metabolic rates (**B**), energy expenditures (**C**) and energy expenditures per unit of body weight (**D**) in men of different ages. Vertical bars represent standard errors of the means. Correlation coefficients for regressions on age of total calories, basal calories, and total-basal calories were −0.374, −0.374, and −0.231, respectively, and were all statistically significant ($P < 0.01$).

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Because aging increases the risk of malnutrition in the elderly person[3,4] and because undernutrition inevitably reduces the ability to resist and to recover from disease, nutrition must be integrated with the overall care of the geriatric patient. Although adult nutrient requirements are sufficiently well known to do this, more must be learned about the elderly's specific nutrient requirements, how they change with age, and the relationship of nutrient intake to nutrient status, overall health, and the risk of disease. This paper reviews the physical and physiological changes of aging as they affect the health of the elderly person and indicates some areas of research necessary for adequate nutritional care of the geriatric patient.

The aging process

Aging is a lifelong process beginning, for our purposes, with mature adults, 25 to 30 years old. Changes occur, imperceptibly at first; yet by age 45 to 55, alterations in appearance, body weight, and endocrine activity are apparent. Physiological aging is characterized by a gradual deterioration in the efficiency of metabolic processes,[1,2,5] which is related to the breakdown of integrated mechanisms rather than to changes in individual cells, tissues, and organs. Although the homeostatic mechanisms of specific organs and systems are still in place in the elderly, they readjust more slowly than in the young. There is no particular age at which any one function, such as glucose tolerance, renal function, or immune reaction, is diminished. Consequently, the elderly person is increasingly vulnerable to stress, injury, infection, and disease.

Body composition changes throughout adult life.[5,6] Both cross-sectional and longitudinal studies demonstrate a gradual decline in lean body mass (LBM) between the second and sixth decade, estimated[6] to be about 3 kg/10 yr; between age 70 and 76, 1 kg is lost.[7] Muscle tissue accounts for the majority of the weight loss. Calcium resorption from bone contributes to weight loss and also reduces height.[8] At the same time, the proportional amount of body fat increases, resulting in a heavier body weight despite the loss of LBM.[9,10] Body weights of Americans rise between age 30 and 60 and gradually decline thereafter.[11]

This change in body composition results in a reduction of the amount of food consumed and calories ingested. In a study of 500 men, aged 20 to 99 years, food intake decreased by 300 calories per day between ages 28 and 55 years and by 600 calories after age 75 years[12] (*Figure*). The reduced caloric requirement was accounted for by decrements in the basal metabolic rate and in energy expenditure resulting from the lowered LBM. This low calorie intake and food consumption has been found in all population surveys and in many smaller studies of the elderly.[3,4]

With a decline in food consumption and diminishing need for calories, the nutrient quality of food becomes more important for the elderly. Foods should be nutrient-dense and moderate in calories. The elderly cannot afford to indulge in any quantity of high-energy, nutrient-poor foods like fat- and sugar-rich desserts or alcoholic beverages. Protein, mineral, and vitamin requirements are independent of energy needs, so the risk of becoming undernourished and even malnourished increases as food intake decreases. The reduced calorie intake, however, need not jeopardize nutrient intake. The men in the study illustrated in the *Figure* were living independently, healthy, and consuming adequate amounts of nutrients as measured by the Recommended Dietary Allowances (RDA).[13] Be-

cause the RDA are designed to meet the needs of most individuals and to prevent deficiencies, they are neither minimal nor optimal amounts. Two thirds of the RDA is often used as the minimum amount of nutrients necessary to support good health. Those who regularly ingest less than two thirds are considered undernourished.

Undernutrition in the elderly

The quality of foods an older person selects depends on the eating habits and food preferences established over a lifetime. The person whose food choices were previously limited is already at high risk of nutrient insufficiency. The risk of undernutrition is further increased by the physical and socioeconomic changes that often occur with age.[3,14] General health, activity, and income affect the ability of an elderly person to shop and prepare meals. Physically handicapped persons in particular may have difficulty getting to the store. Inadequate cooking and refrigeration facilities also limit food preparation. The ability to eat and enjoy food is impaired by poor dentition, loss of taste and smell, and poor eyesight. Appetite and interest in food are lost with loneliness, physical isolation, and depression.

These social and psychological factors in the lives of the elderly can often lead to chronic alcoholism, a major contributor to undernutrition.[15] With alcoholism, multiple nutrient deficiencies are possible.[16] Protein-calorie malnutrition results from the lack of protein-rich foods. Alcohol also interferes with absorption of electrolytes (calcium, magnesium, potassium, zinc) and vitamins (folic acid, B_{12}, thiamine) and the storage of vitamin A. Alcoholism's effect on the individual depends on the extent of the deficiencies and the nutrients involved. Anemia, however, is a common development.

Undernutrition of the elderly in our population is a reality. Surveys of the eating habits of older Americans living independently[3,4] indicate that their average nutrient intake was less than the RDA; over one third were eating less than minimal amounts (<⅔ RDA). Other than calories, which were below the RDA in all studies, calcium, iron, vitamins A and C, and the water-soluble B vitamins were most likely to be deficient, especially thiamine, niacin, and riboflavin.

The Health and Nutrition Examination Survey (HANES) of a large, representative U.S. population[17] reported that 45% to 65% of those over 65 years of age were eating less than two thirds of the RDA of calories, calcium, and vitamin A. These deficiencies were present regardless of the income, sex, or ethnic origin. Income below the poverty level was only one of the conditions associated with low nutrient intake. All women, especially blacks and whites with low incomes, were likely to be deficient in iron. Niacin, thiamine, and vitamin C intakes were also reported to be substandard, especially in women, blacks, and low-income groups. In the Ten-State Survey,[18] protein intake was also found to be low for several of these population subgroups.

Clinical signs of nutritional deficiency were rarely identified in HANES, although some indications of inadequacy were evident.[19] Biochemical studies revealed subnormal hematological indices, especially in blacks with low incomes. Erythrocyte folacin levels were extremely low (<140 ng/mL in 60% of the black elderly persons with low incomes.[20] As determined by urinary levels or enzyme/coenzyme function tests, values for B vitamins, thiamine, riboflavin, and pyridoxine were marginal.[3]

The quality of meals served in nursing homes is as divergent as that of meals eaten by the independent-living population.[4,21,22] Food purchased by nursing homes varies in nutrient content from home to home.[23] Food eaten by residents of nursing homes may be below the minimum standard in several nutrients, such as calcium, iron, vitamin C, and protein,[4] whereas residents of other nursing homes may receive adequate nutrients.[22]

Hospitalized elderly patients may also be undernourished. In a Swedish study, up to one third of the geriatric patients had signs of malnutrition when they were first admitted to the hospital. These were psychogeriatric patients, medical emergency patients, and acute stroke patients.[24] Undernourishment was evaluated by easily available nutritional indicators. Elderly patients who are at risk of undernutrition during their hospital stays are those with infections, malignancy, severe cardiovascular disease, strokes associated with eating problems, presurgical patients, and those with poor mental performance and poor dental status. Hospitalized patients recovering from femoral neck fractures were found to be eating less than 50% of nutrient requirements of protein, calcium, and vitamins, especially vitamin D, in spite of adequate food being offered them.[25]

Attempts to provide adequate food with congregate meals for independent-living elderly

have improved their nutrition,[26] especially their intake of calcium, iron, zinc, and niacin.[4] Sufficient amounts of all nutrients (>⅔ RDA) were provided in a Cincinnati program.[27]

To correct or prevent deficiencies, many elderly take vitamin supplements that are either prescribed or self-administered,[28] but those using them most need them least.[29] Vitamin absorption is adequate unless a particular cause of vitamin depletion is present, such as gastrointestinal disease, alcoholism, or certain medications. The clinical and functional benefit of vitamin supplementation has yet to be established.[3]

Megadoses of vitamins are not necessary and are toxic when taken for extended periods.[28] Excess vitamin A causes liver damage and dermatological injury. Excess vitamin D causes gastrointestinal upset, renal damage, and calcification; excess vitamin E results in coagulation defects, vitamin C loss, and oxalate stones in the bladder. Megadoses also interfere with the effectiveness of drugs.

Drugs and the elderly

Foods and nutrients affect the efficacy of drug treatment beyond that induced by the aging process[30–33]: they modify the rates of drug absorption and uptake, compete with drugs for binding to plasma proteins, and alter rates of detoxification and renal and biliary clearance. No general statement can be made, however, about the effect of foods on the amount of drugs in circulation: plasma levels depend on the particular nature and chemical form of the drug itself, the volume of fluid taken with the drug, the time between dosage and meals, and the type of food eaten.[30] For example, the plasma levels of erythromycin were twice as high when doses were taken with meals as when they were taken after overnight fasting.[34] In contrast, the plasma levels of acetylsalicylate with fasting were twice those attained when it was taken at mealtime.[35] The form in which salicylate is administered is another determinant: food reduces plasma levels of acetylsalicylate taken in enteric-coated capsules but does not affect plasma levels of the drug taken in the form of enteric-coated granules.[36]

Drugs, in turn, affect nutrition. In the elderly, drug-induced malnutrition is also common. Certain drugs can modify appetite, impair digestion, and inhibit nutrient absorption, thus compromising nutrients' ability to maintain body function and changing metabolic excretion rates.[37] Mineral loss is caused by such drugs as antibiotics, corticosteroids, cardioglycosides, and digitalis, as well as nephrotoxic agents, oral hypoglycemics, and cancer therapeutic agents. With multiple drug use and prolonged treatment, mineral loss can be severe. Excessive amounts of salicylates and laxatives also deplete minerals. Oral diuretics not only deplete sodium and potassium but also calcium, magnesium, and zinc. Drugs that tend to damage intestinal mucosa interfere with calcium absorption, and intestinal bleeding results in iron loss and may also cause folate malabsorption. Excessive use of antacids causes overloads of sodium, magnesium, and aluminum, depending on the type of antacid. Some antacids can result in toxicity in persons with renal insufficiency. Folate deficiency also arises with misuse of antacids. Mineral oil interferes with the absorption of the fat-soluble vitamins, including vitamins A and D. Magnesium hydroxide causes hypophosphatemia, resulting in calcium loss.

Overmedication of the elderly is now common. The typical geriatric patient takes 5 to 10 or more different drugs a day.[24,36] Potential interactions among drugs producing clinical effects increase rapidly as the number of drugs taken rises. Only 2% of patients taking two drugs are likely to receive interacting drug combinations, whereas 33% of the patients taking 10 drugs are likely to be exposed to drug interactions, and 50% are so exposed with 12 drugs. Loss in the efficacy of a drug's action is hard to evaluate, though the situation may have serious implications. Potentially adverse drug combinations occur with drugs the elderly commonly take: Salicylates may interact with corticosteroids, sulfonylureas, ethanol, and spirolactone.[38] Salicylates also affect the action of anticoagulants, oral hypoglycemics, methotrexate, and probencid.[39] Thiazide diuretics react with the D vitamins and with sulfonylureas; the danger in using thiazides with digitalis preparations is probably widely recognized.

Physicians treating the elderly need to understand the nutritional consequences of drugs in addition to interactions and intolerances. An effective therapeutic regimen for a geriatric patient is one with a minimum number and dosage of appropriate drugs.

Disease in the elderly

Many diseases common in the elderly have a nutritional component, including heart disease,

hypertension, and diabetes. Treating these conditions calls for limiting dietary fat, refined sugar, and salt and emphasizing nutrient-dense foods (milk, bread and cereal, fruit and vegetables). One purpose of the diet for heart disease is to maintain a moderate plasma cholesterol level. Although hypercholesterolemia is not a strong risk factor for coronary heart disease beyond the sixth decade, the low-fat, nutrient-dense regimen meets the nutritional needs of the elderly. Salt restriction is necessary to control blood pressure. For elderly persons with taste insensitivity, omitting salt in cooking and at the table may increase the tendency to appetite loss and inadequate food intake.

The development of cancer is much more likely to be a result of the composition of the diet as it is ordinarily prepared and consumed rather than a result of natural toxic agents, contaminants, or additives contained in the food.[40] Dietary fat is directly associated with the development of cancer,[41] especially in the breast, prostate, and colon, as demonstrated by epidemiological and case-controlled studies. Cancer incidence and mortality correlate with the total dietary fat level. Changing from a low- to high-fat diet increases the incidence of these cancers, as demonstrated by Japanese emigrants to the United States.[42] The vegetarian-type diets followed by Seventh-Day Adventists and Mormons are associated with low incidence and mortality of breast and colon cancers.[43,44] Prostate cancer correlated with breast and colon cancers in several epidemiological studies but was found to be low in native Hawaiians, even though the incidence of breast cancer was high. A high incidence of prostate and low incidence of breast cancer were reported in the Mormons in Utah.[44]

Specific nutrients may protect against cancer development.[40] In epidemiological and experimental studies[41] the fiber in fruits, vegetables, grains, and cereals seems to be protective, but the specific components of the fiber need to be identified before these observations can be verified. The protective action of vitamin A and the retinoids reported in experimental animals and epidemiological studies may be particularly important in treating the elderly because of the extent of the vitamin A deficiency in this population. The cancers of epithelial cells are those most affected. Increased intake of vitamin A in animals has demonstrated its protective effect. Reviewers of the evidence, however, do not recommend use of vitamin A beyond standard amounts "because of its toxicity and the inability of epidemiological studies to distinguish the effects of carotenes from those of vitamin A."[41]

The immune system becomes less responsive as a person ages,[45] but undernutrition causes further deterioration.[46] An adequate diet can improve the immune system, as was demonstrated in a group of elderly patients[47] given a diet with sufficient calories, vitamins, and trace elements for eight weeks. Their plasma protein levels, i.e., albumin, prealbumin, transferrin, retinol-binding protein, increased as well as their zinc and iron levels. Similarly, the effectiveness of vaccines for pneumonia, influenza, and tetanus were enhanced when nutrient deficiencies in the diets of the elderly were corrected. Supplementation with zinc and vitamin C have also improved immune response. Megadoses of vitamins and minerals, however, have not been beneficial and may be harmful. Much more has to be learned to understand the relationship of nutritional elements, immune reactions, and the modifications imposed by age.[48]

Osteoporosis is a serious condition in the elderly in which calcium loss from bone so exceeds calcium deposit that bones fracture spontaneously.[49–52] After the late 20s or early 30s, when bones attain their maximum density, calcium depletion may occur, and after the fifth decade calcium loss is accelerated and becomes significant, particularly in women after menopause. Because calcium balance is controlled by the serum level of vitamin D (calcitrol) and the parathyroid hormone, a diet adequate in calcium and vitamin D is required.

The availability of calcium is strongly influenced by living and eating habits. Calcium absorption is increased by exercise and decreased by immobilization, causing bone resorption. Calcium loss is intensified by caffeine, nicotine, and alcohol. Certain food components, such as phytates, cellulose, and oxalic acid, may induce negative calcium balance.[53] Diets high in vegetable protein increase urinary calcium output; animal protein, containing phosphate, does not.[54] As has been noted, aluminum antacids deplete phosphates, resulting in calcium loss and bone resorption. Diuretics, glucocorticoids, and tetracycline also cause calcium loss.

Osteoporotic patients are in negative calcium balance, with increased resorption of bone, rapid rate of bone turnover, and a relative estrogen deficiency in women. In addition, these patients' intestinal absorption and renal conservation of

calcium are not as efficient as in those without the disease,[55] and their kidneys are less responsive to parathyroid hormone in stimulating the synthesis of 1,25 $(OH)_2$ vitamin D,[56] which is needed for calcium absorption. Altered living habits and inactivity are also important contributors to the negative calcium balance.

The therapeutic agents now available are sex steroids, dietary calcium, and vitamin D. Although these agents may reduce resorption up to six months, they do not usually increase bone formation. Sodium fluoride may become an important treatment for osteoporosis since it induces calcium absorption and increases bone formation and bone mass.[49] Its effect is not apparent for several months to a year. The effective sodium fluoride dose is between 50 mg and 75 mg, and treatment requires concomitant intake of 1200 mg to 1500 mg of calcium a day. Although epidemiological studies[57,58] and long-term treatment of osteoporotic patients[49,59] have indicated fluoride treatment is effective, it is still experimental.

The serious effects of osteoporosis in our aging society have led many nutritionists to conclude that the present RDA of 800 mg calcium is not sufficient. Increased requirements call for calcium supplementation, especially when calorie intake is limited, as in the elderly. Calcium gluconate, carbonate, and citrate are equally effective and should be taken along with calcium-rich dairy products[55,60] and adequate sources of vitamin D. Twelve to fifteen hundred milligrams of calcium a day are now found necessary to maintain a positive calcium balance in the older person. In one study, such supplementation increased bone density in half of the osteoporotic patients treated.[53]

Areas of investigation

Many questions need to be answered concerning the elderly's nutritional requirements and the contribution nutrition can make to their overall care. Do nutrient requirements of a healthy elderly person differ from those of a healthy middle-aged person? The present dietary standards (RDA) do not include the specific requirements of persons 60 years old and beyond. The standards should be extended by decades to 65, 75, and 85 years.[60] What disorders might an elderly person have that do not affect a healthy nutritional state?[61] Munro suggests that the range of allowances be expanded as appropriate to include the elderly with degenerative diseases along with the well elderly.[60]

Reasons for nutrient deficiencies common in the elderly need to be found.[62] For instance, absorption of iron and folate may be impaired by gastric atrophy. This common ailment in the elderly results in reduced production of hydrochloric acid leading to a more alkaline pH in the proximal duodenum. Because a higher intramural pH increases folate absorption, the higher pH due to reduced acid could result in folate deficiency. Folate deficiency could also result in anemia in this age group. Low dietary iron could account for low hemoglobin levels. Absorption of iron apparently is intact in the elderly, yet the transfer to the red blood cell is defective.[62]

Low plasma levels of one or more nutrients in the older person may or may not be significant.[62] For instance, 80 mg ascorbate per day above the amount in the diet is needed in the elderly person to attain white cell ascorbate levels equal to those in young people, yet no clinical benefits have been demonstrated for the vitamin C–supplemented elderly.[63] Low serum albumin levels are not increased by a high-protein diet in the elderly as they are in the young.[64] Assessing protein nutriture is complex.[62] Reduced muscle mass is partly responsible for the low rate of protein breakdown in the elderly. Research is needed to investigate how those proteins that turn over more rapidly than albumin (i.e., prealbumin, retinol-binding protein, transferrin) are affected by age. Is the supplementation of specific vitamins and minerals able to overcome their loss due to drug treatment?

More general questions remain[65–68]: Do nutrient deficiencies result from an inadequate diet or from impaired utilization? Are they the result of aging or of disease? Under what conditions is nutrient supplementation effective? What is the relationship of nutritional status to development of particular disorders? Does optimal nutrition deter disease development? Will it improve physiologic and metabolic functions? How does treatment with specific drugs affect nutritional status? Would nutritional support of the geriatric patient result in the use of fewer drugs and in lower dosage? The immunologic status of the older person is another important area of investigation.

Nutrition may have a significant influence on the aging process. How "old" is "old?" Can the extent of the aging process be measured in physiological or in metabolic terms? Are there im-

munological factors that can serve as a measure of the degree of aging?

Questions must also be asked concerning the care of our older citizens. What is the impact of the living situation and physical condition on their health and nutritional status? What kind of medical and social support systems, both in the family and in the community, are required to meet their needs?

The evidence is sufficient to conclude that nutrition has a direct bearing on the health of the elderly person. Changes with age, in themselves, make nutritional demands that increase the risk of malnutrition and become more acute with physical, mental, and physiological incapacities. The geriatric patient requires integration of nutritional and medical care along with measures for overall health maintenance.[70,71] Physicians need to know the nutritional status of their geriatric patients and of the particular conditions of their lives that may compromise their health. Nutritional care should be an integral part of the overall medical and social care of the elderly.

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