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**Tufts University School of Medicine**  
**Nutrition and the Elderly:**  
Learning Objectives

**Margo N. Woods, D.Sc.**

1. List at least **nine** physiological changes associated with aging. Identify those that can be improved by diet or exercise.
2. Name the nutrients most likely to be inadequate in the diets of the elderly.
3. List the nutrients and their function related to the following diseases or conditions that are prevalent among the elderly:
  - Osteoporosis
  - Cancer
  - Cardiovascular Disease
  - Atrophic Gastritis
  - Constipation
  - Susceptibility to infection
  - Dementia
4. Identify at least three nutrient-drug interactions common in the elderly population.
5. Explain how vitamin B<sub>12</sub> and folate status may be important to the health of the elderly.
6. Identify factors in the elderly that may predispose them to inadequate intake and subsequent nutritional inadequacy.

## **Nutrition and the Elderly**

### Answers to Learning Objectives:

**1. List at least nine physiological changes associated with aging. Identify those that can be improved by diet or exercise.**

**a.) Body composition changes( decreased muscle mass, increased body fat)**

The decline in lean body mass that occurs with age is progressive, leading to a condition called *sarcopenia*, literally, a deficiency of flesh or muscle. The etiology of sarcopenia is multifactorial and includes biological changes of aging – loss of motor neurons, decrease in the effectiveness of anabolic hormones, declining physical activity, protein or energy undernutrition or catabolic disease processes such as congestive heart failure (CHF), chronic obstructive pulmonary disease (COPD), rheumatoid arthritis, hyperthyroidism, Parkinson’s disease, or chronic infection or inflammation. This loss of muscle tissue strongly influences muscle strength, gait, and balance, and contributes to the risk of falls and frailty in the elderly.

**Nutritional implications:** There are many nutritional implications related to the loss of lean body mass. First, because basal metabolic rate is dependent upon lean body mass, energy requirements diminish by about 100 kilocalories per decade. Energy intake usually parallels energy needs, so caloric intake usually declines with declining muscle mass. With lower energy intakes and constant or even lower nutrient density of the diet, it becomes increasingly difficult to ingest a diet that meets all the micronutrient requirements of the older person. Among the micronutrients, vitamin D, magnesium, calcium, and zinc intakes are most substantially below the DRI among sarcopenic individuals. In addition, sarcopenia may be associated with decreased insulin sensitivity as skeletal muscle is the largest repository for glucose disposal. Exercise has been shown to be crucial for reversing these deleterious effects of sarcopenia. Specifically, resistance training targets specific muscle groups and can rebuild loss muscle. For the most benefit, the exercise prescription should be targeted specifically at reversal of muscle atrophy, not simply at increasing general activity. There is now evidence that it is never too late to start such exercise, even in frail, institutionalized men and women up to 100 years of age.

**b.) Loss of calcium and decrease in bone density**

Women have lower total bone mass or total body calcium than men at all ages. Over the course of a lifetime, women lose about 40 percent of their skeletal calcium. Approximately one-half of this loss occurs in the first 5 years after menopause. An inadequate intake of either calcium or vitamin D (necessary for calcium absorption from the gut) influences calcium-regulating hormone levels and thus, bone mass.

**Nutritional implications:** The current DRI for calcium is 1000 mg during the ages of 31-50, and 1200 mg for adults over the age of 50. Yet, intakes of calcium are often low among the elderly. Furthermore, lactose intolerance may inhibit the

intake of calcium-rich milk products. Besides low calcium and vitamin D intakes, other lifestyle choices contribute to the development of osteoporosis: smoking, alcohol consumption, lack of physical activity, and a loss of estrogen at menopause. In addition, high intakes of sodium and protein may increase urinary calcium excretion. A diet rich in calcium and vitamin D, and regular weight bearing and/or resistance exercise, will help to prevent further bone loss and may actually help rebuild bone. Calcium and vitamin D supplements may be necessary if intake from the diet is consistently low.

**c.) Decrease in synthesis of vitamin D, both in skin and liver**

Inadequate vitamin D intake or decreased synthesis of vitamin D in the skin can lead to bone loss and increased risk of osteoporosis. Serum levels of 25-hydroxyvitamin D are the best clinical indicator of vitamin D status. Levels of 25-hydroxyvitamin D fall in the winter with decreasing skin exposure to the sun, and also decline with age. Reduced levels of 25-hydroxyvitamin D in the elderly result from declining intake, decrease sun exposure, and most importantly, less efficient skin synthesis of vitamin D.

**Nutritional implications:** Research indicates that treatment of elderly persons with low serum levels of vitamin D with a 400 IU vitamin D supplement prevents significant seasonal variation in serum 25-hydroxyvitamin D and reduced wintertime bone loss from the spine. (Dawson-Hughes et al.)

**d.) Decreased immune function, with increased susceptibility to infections**

Throughout life there is a continuing decline in the mass of immune tissue, which is associated with some decline in immune function (particularly T-lymphocyte function).

**Nutritional implications:** Adequate protein, vitamin, and mineral intakes are essential for the maintenance of immune function. Additionally, the quality of immune function may be influenced by the type of lipids in the diet that act as precursors for eicosanoids, prostaglandins, and leukotrienes. Prostaglandins and leukotrienes are highly active substances that play an important role in the regulation of immune and inflammatory responses. Eicosanoid synthesis can also be modified by dietary antioxidant nutrients such as vitamin E, selenium, vitamin C, and copper. This can influence cytokine production as well as other aspects of the immune and inflammatory response. The age-associated decline in T-cell-mediated function has been attributed to defective interleukin II (a cytokine) production and responsiveness. Healthy elderly humans supplemented with 800 IU of vitamin E for 30 days had a significantly greater increase in production of interleukin II than those given a placebo. Other studies have shown that vitamin B<sub>6</sub> and zinc deficiencies impaired T-cell-mediated function. Nutritional supplementation with a multivitamin-mineral preparation improved in vitro tests of lymphocyte function but also decreased incidence of infections. Protein malnutrition, zinc deficiency, vitamin B<sub>6</sub> deficiency, and inadequate antioxidant intake, all conditions for which the elderly are at greater risk, may negatively influence the function of the immune system and thereby risk of infection.

**e.) Elevated serum homocysteine**

There appears to be an age-related increase in the level of homocysteine in the blood. High circulating levels of homocysteine are associated with cardiovascular disease, possibly by effects on both thrombogenesis and on the vascular wall itself. The lower risk of vascular disease among premenopausal versus postmenopausal women is reflected in an age-related rise in homocysteine levels. The lower homocysteine levels among premenopausal women may be due to estrogens or to better nutritional status.

**Nutritional implications:** Homocysteine metabolism is regulated by vitamins folate, B<sub>6</sub>, and B<sub>12</sub>. A response of homocysteine levels to folate therapy in elderly men and postmenopausal women suggests that the higher homocysteine levels may be due to subclinical vitamin deficiency. Changes in neurocognitive function in the elderly may be related to moderate elevations in homocysteine as well. There is evidence that vitamin B<sub>12</sub> therapy that reduces homocysteine levels also improves neurologic function in impaired individuals, often in the absence of hematologic signs of vitamin deficiency.

**f.) Development of cataracts**

The National Eye Institute's Age-Related Eye Disease Study (Sperduto RD, Ferris III FL, Kurinij N: *Do we have a nutritional treatment for age-related cataract or macular degeneration?* Arch Ophthalmol.108:1403-1405,1990) is looking at nutrients with antioxidative capabilities – primarily the carotenoids, vitamin C, and vitamin E – and their relationship to the development and treatment of cataracts.

**Nutritional implications:** Specifically, carotenoids, such as beta-carotene, have the capacity to perform as free-radical traps in lens tissues, and higher serum levels have been shown to correlate with a delay in cataract formation. Vitamin E, a highly lipid soluble antioxidant, may also have a role in maintaining the integrity of lens cell membranes. In addition, vitamin C occurs in the lens in concentrations up to 30 times those found in plasma. Limited studies have shown that persons with plasma ascorbate levels of 90 µmol/l have less chance of developing cataracts than those with 40 µmol/l. Findings from the Physicians' Health Study, a 1982 study of 17,744 male physicians age 40-84 years, showed a modest decrease in risk of cataracts in physicians who took multivitamins compared with those who did not.

**g.) Atrophic gastritis**

With aging, the secretion of acids in the stomach declines. Specifically, atrophic gastritis results in a low acid-pepsin secretion by the gastric mucosa that is required for the cleavage of B<sub>12</sub> from its dietary protein sources. Therefore, the absorption of B<sub>12</sub> via intrinsic factor binding is decreased. In addition, hypochlorhydria in atrophic gastritis results in bacterial overgrowth of the stomach and small intestine, and these bacteria may bind B<sub>12</sub> for their own use.

**Nutritional implications:** Atrophic gastritis contributes to B<sub>12</sub> deficiency in the elderly population. The ability to absorb crystalline vitamin B<sub>12</sub> remains intact in older people with atrophic gastritis. The current recommendation for B<sub>12</sub> (2001

DRI) is 2.4  $\mu\text{g}$ , and elderly people should try to obtain their vitamin B<sub>12</sub> from either supplements or fortified foods to ensure adequate absorption from the gastrointestinal tract.

**h.) Decreased GI motility**

Constipation may be a result of altered gastrointestinal motility and slackened muscle tone, inadequate fluid intake, and inactivity. In the elderly it may also be related to energy intake rather than fiber consumption alone, and to psychological distress factors. Low energy intake, fewer meals per day, low fluid intake and depression have been shown to be the most relevant factors.

**Nutritional implications:** Constipation can be corrected by increasing fiber-containing foods, fluid and energy intake, and activity. A 1994 study found that 8.8% of elderly persons living in the community used laxatives on a regular basis, while 74.6% use them in nursing homes. Laxative use increases with increasing age and is independently associated with hypoalbuminemia and electrolyte imbalances.

**i.) Increased likelihood of presence of chronic disease (i.e., CVD, cancer, etc.)**

See below.

**j.) Declining cognitive function (dementia)**

No other organ system in the body depends more minutely on its nutrient supply than the CNS. Likewise, the CNS has profound effects on dietary intake in both health and disease. The number and function of brain receptors for neurotransmitters that control hunger and satiety decline with age. This may contribute to the decline in appetite often associated with aging. In addition, there are well-documented declines in olfactory and taste function with age that may influence eating behavior, food choices, and the pleasure of eating.

**Nutritional implications:** Healthy elderly subjects with low blood levels of certain vitamins score less well on tests of memory and nonverbal abstract thinking. Declining vitamin status for B<sub>12</sub>, B<sub>6</sub>, and folate is associated with lower scores on tests of memory and nonverbal abstract thinking. B<sub>12</sub> supplementation has been associated with reversal of both cognitive and peripheral nervous system deficits. As noted previously, folate, B<sub>6</sub>, and B<sub>12</sub> are involved in the modulation of homocysteine metabolism and circulating levels in the blood. There is now compelling evidence that high levels of homocysteine are an independent risk factor for cerebrovascular disease. Thus, in addition to the direct CNS and/or behavioral effects of certain nutrients, there is evidence that these B vitamins limit the risk of cerebrovascular disease as it contributes to changing cognitive function with age. There is also evidence that antioxidants may play a role in neurodegenerative diseases affecting cognition in the elderly. For example, patients with moderately advanced Alzheimer's disease have been shown to benefit from treatment with high levels of alpha-tocopherol (2000 IU/d for 2 years), in terms of delayed time to institutionalization, loss of activities of daily living, or death.

**k.) Underweight**

Loss of appetite due to sarcopenia, declining basal metabolic rate, CNS changes, depression, and inadequate income often lead to decreased caloric intake and weight loss.

**Nutritional implications:** According to the Nutrition Screening Initiative, developed by the American Academy of Family Physicians, The American Dietetic Association and the National Council on Aging, a weight loss of  $\geq 5\%$  usual body weight over 1 month, or 10% over 6 months indicates a high risk of malnutrition. Regular exercise to increase BMR and appetite, along with medical nutrition therapy (a high calorie/high protein diet, nutritional supplements like Ensure, Carnation Instant Breakfast, etc.) is recommended to promote weight gain.

**2. Name the nutrients most likely to be inadequate in the diets of the elderly.**

- Calcium
- Vitamin D
- Folate, and Vitamins B<sub>6</sub> and B<sub>12</sub>
- Vitamin E
- Zinc
- Antioxidants

**3. For the following diseases and conditions common among the elderly, list the nutrients (and their function) that are required for treatment.**

- **Osteoporosis** - Calcium and vitamin K as related to protection of bone mass and vitamin D for facilitating increased calcium absorption.
- **Cancer** - Fiber, folate and antioxidants (see Cancer lecture)
- **Cardiovascular Disease** - Intake of saturated fat, total fat, dietary cholesterol, and trans fatty acids increases risk of CVD; intake of PUFA, especially omega 3 fatty acids, MUFA, vitamin E, folate (and B<sub>6</sub> and B<sub>12</sub>), and fiber decreases risk of CVD. (See CVD lecture.)
- **Atrophic Gastritis** - Will cause decrease in the absorption of vitamin B<sub>12</sub>, especially from animal products. Supplements of vitamin B<sub>12</sub> may be necessary.
- **Constipation** - Fiber will increase bulk, increase water-holding capacity of the stool, decrease intraluminal pressure, and thereby aid in normal defecation and the prevention of diverticulosis, polyps, and cancer. Adequate fluid intake is necessary as well.
- **Susceptibility to infection** - Inadequate protein and deficiencies of zinc, B<sub>6</sub> and antioxidants (vitamin E) impact the immune system (see above).
- **Dementia** - Vitamin B<sub>12</sub> (see above)

**4. Identify at least three nutrient-drug interactions common in the elderly population.**

- **Antacid** - can cause deficiency of folate, phosphate, calcium and copper
- **Antibiotics** - Tetracycline decreases calcium absorption
- **Anti-inflammatory agents** - Sulfasalazine can cause deficiency of folate, NSAIDs can cause deficiency of iron, Glucocorticoids interfere with vitamin D and calcium absorption
- **Anticancer drugs** - Methotrexate decreases folate and calcium, Cisplatin decreases magnesium
- **Diuretics** - Thiazides decrease potassium and magnesium, Furosemide decreases potassium, calcium and magnesium, Triamterene decreases folate.
- **Hypocholesterolemic agents** - Cholestyramine decreases absorption of calcium, fat and fat soluble vitamins (A,D,E,K), folate, MCT (medium chain triglycerides), and glucose; Colestipol decreases absorption of A, D, E, K.
- **Laxatives** - Mineral oil interferes with the absorption of carotene, retinol, Vitamins D and K (fat soluble vitamins); Phenolphthalein decreases serum potassium, sodium, and calcium; Bisacodyl decreases serum potassium and calcium.

**5. Explain how vitamin B<sub>12</sub> and folate status may be important to the health of the elderly.**

- Homocysteine metabolism is regulated by folate, vitamins B<sub>6</sub> and B<sub>12</sub>
- Irritability and dementia – folate, B<sub>12</sub> deficiency
- Peripheral neuropathy, sub-acute combined system degeneration, dementia – Vitamin B<sub>12</sub> deficiency

**6. Identify factors in the elderly that may predispose them to inadequate intake and subsequent nutritional inadequacy.**

- Decreased appetite
- Decreased socialization and decreased interest in meals
- Decreased ability to prepare meals, shop, etc.
- Depression
- Decreased finances
- Decreased absorption
- Decreased synthesis of vitamin D
- Increased requirements of some nutrients
- Poorly fitting dentures

**Reference:**

Information in this chapter was excerpted from:

Fiatarone Singh M, and Rosenberg IH. Nutrition and Aging. In: Hazzard WR, Blass JP, Ettinger WH, et al., editors. Principles of Geriatric Medicine and Gerontology. Fourth edition. McGraw-Hill Professional. 1998, Chapter 6.

**Useful Website:**

Osteoporosis and Related Bone Disease National Resource Center (ORBO-NRC):

<http://www.niams.nih.gov/bone>