Micronutrient requirements in older women

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ABSTRACT
The nutritional requirements of older women is an area of great interest because the extended life expectancy leads to an increase in women living into their 80s, 90s, and longer. The recommended dietary allowances (RDAs) and dietary reference intakes (DRIs) are not specific for women living to advanced ages, and little research has been conducted specifically on the micronutrient needs of elderly women. Older adults are at greater risk for nutritional deficiencies than are younger adults due to physiologic changes associated with aging, acute and chronic illnesses, prescription and over-the-counter medications, financial and social status, and functional decline. Among the significant age-associated changes in nutrient requirements, the need for energy decreases and the requirements for protein increase with age. Among the micronutrients, the significant ones that may be associated with deficiencies in elderly women include vitamin B-12, vitamin A, vitamin C, vitamin D, calcium, iron, zinc, and other trace minerals. In old and very old women, these are micronutrients of interest but there is a great need for research to determine appropriate recommendations. The importance of these selected nutrients and the reasons for the likelihood of deficiency are discussed briefly. However, there is little specific information regarding micronutrient requirements for elderly women. One reason for this is the difficulty in conducting reliable and valid studies due to the heterogeneity of older adults and their unique rate of aging associated with their health status, limited income, disability, and living situation. Am J Clin Nutr 2005;81(suppl):1240S–5S.

KEY WORDS Micronutrient requirements, older women, energy, protein, vitamins, trace minerals

INTRODUCTION
The nutritional requirements of older women is an area of great interest, particularly because their life expectancy continues to increase due to better health care and earlier awareness of health promotion activities. Interestingly, though interest in the area of nutritional requirements is increasing, there is a lack of research targeted to exploring the needs of the very elderly. The nutrition recommendations provided by the RDAs and the DRIs levels are not helpful when it comes to providing advice to old and very old women, although in the most recent publications there are separate recommendations for individuals over age 70 (1–3); little research has been conducted specifically on the needs of elderly women.

Older adults are generally at greater risk for nutritional deficiencies than are younger adults. They experience the normal changes associated with aging (decrease in lean body mass, decrease in total body water, decrease in bone density, and an increase in the proportion of total body fat), as well as physiologic challenges associated with chronic and acute medical conditions. Compounding these changes, there may be environmental, social, financial, and functional barriers faced by older women that may interfere with adequate dietary intake.

One of the most significant changes that is seen in old and very old adults is a decrease in basal energy requirements; this can generally be attributed to the decrease in lean body mass. A reduction in energy expenditure is also associated with sedentary behavior and a loss of mobility related to systemic (eg, cardiovascular, pulmonary) or bone and joint disease. To avoid weight gain, which may compound already existing functional deficits (4, 5), dietary intake may be decreased. A reduction in nutrient consumption will add to a decrease in overall dietary quality because favorite foods are consumed and foods that are less well-liked (vegetables) are often the first foods eliminated. Nutrient-dense foods often fall into that category; favorite and “comfort” foods are frequently those that are high in fat and carbohydrate. Obtaining sufficient amounts of micronutrients becomes a challenge within the complex nature of the human aging process (6).

Risk for poor nutritional status is also related to a decreased efficiency of the gastrointestinal tract that occurs in some elderly people. Chewing, swallowing, digesting, and absorbing nutrients may be impaired for a variety of reasons (7). Oral health status, edentulousness, dentures that may not fit properly, or lesions in the oral cavity will interfere with consumption of a well-balanced diet and sufficient intake to meet nutrient needs (8). Nutrients may not be as efficiently digested and absorbed due to atrophic gastritis, a decrease in hormone and enzyme production, senescent changes in the cells of the bowel surface, and the interactions among drugs and nutrients (7). Constipation is a chronic problem in many older adults; this may be associated with a decrease in peristaltic strength or in adequate dietary fluids and fiber to provide bulk.

Compounding these changes is the effect of both chronic and acute illness (6). Dietary modifications are frequently introduced...
to accommodate loss of functional capacity to feed oneself, effectively lower sodium intake, manage lipid profiles, control blood glucose levels, lose weight, or manage other metabolic conditions associated with disease. Demands for specific nutrients may be increased because of increased needs associated with healing, recovery, or rehabilitation (9). Dietary intake in elderly women may decrease due to alterations in their health, functional or cognitive status, disease-related anorexia, or changes in taste sensitivity often associated with medication use.

Many very old women face challenges associated with their environment, social and financial status, and their level of functional ability. Many older women have been widowed, have had their children move to other geographical areas, are living on a fixed income, and experience disability. Cooking for one may not be an activity that motivates an elderly woman after years of shopping and preparing food and meals for a family and spouse. There may be financial challenges associated with limited income, living on pensions, or social security. Health care costs can be burdensome, even for someone in relatively good health; costs for someone who has multiple chronic conditions or acute illness may be financially disastrous. Because older women have a greater life expectancy than elderly men, there is a greater likelihood that they will experience more disability in their later years simply because they live longer. Disability may lead to elderly women becoming homebound or more dependent on social services that will help them meet their basic needs. Obesity is a risk factor for disability, and sedentary lifestyle is a risk factor for obesity; this is a difficult cycle to avoid but one that adds burden to nutritional intake and status (4–6).

NUTRIENT NEEDS OF VERY OLD WOMEN

Although there is little research conducted on micronutrient requirements in elderly women, there are key nutrients that demand attention. Though not a micronutrient, protein is an important nutrient for old and very old individuals. Protein needs actually increase with age (10,11). Because lean body mass decreases with age, it would seem that protein requirements would decline, but they increase to maintain nitrogen equilibrium; when demands increase to heal wounds, fight infection, repair fractures, or restore muscle mass lost from immobility, dietary protein must be increased above maintenance requirements but frequently protein is overlooked as a target nutrient in elderly women. Among the micronutrients, the significant ones that may be associated with deficiencies in elderly women include vitamin B-12, vitamin A, vitamin C, vitamin D, calcium, iron, zinc, and other trace minerals. In old and very old women, these are the micronutrients of interest and there is a need for a great deal more research.

Vitamin B-12

Vitamin B-12 is a nutrient of interest in the old and very old woman primarily because the consumption of foods rich in this nutrient decreases with age (12). (Figure 1) The bioavailability of protein-bound vitamin B-12 decreases as people age. The mechanism that is most affected by age is the ability to cleave the vitamin from its protein carrier; the prevalence of atrophic gastritis, reported to be 40%–50% of individuals over age 80, is a severe impediment to the transport and release of vitamin B-12 (13). The production of gastric acid is necessary for the digestion of food rich in vitamin B-12. Animal protein, the primary source of vitamin B-12, is expensive, difficult to chew, and has been associated with elevated blood lipids. Bacterial overgrowth in the gut may also be a factor in the reduction in the bioavailability of vitamin B-12; bacteria may bind the B-12, rendering it unavailable for absorption (14). This condition is easily treated with antibiotics.

Vitamin B-12 requirements that are not met through diet can be met with supplements that contain crystalline vitamin B-12; however, there is still a limited bioavailability (15). For elderly adults, the recommendation to meet vitamin B-12 needs is through foods fortified with B-12 or B-12-containing supplements.

Vitamin A

Vitamin A has many roles in the maintenance of health; it is important to maintain normal vision, for cell differentiation, efficient immune function, and genetic expression (6, 16). Vitamin A recommendations for older adults have been lowered from previous editions of the RDAs (2). Present suggested levels are 700 μg retinol activity equivalents (RAEs) for women and 900 μg RAE for men. Some researchers have recommended that these recommendations be set at even lower levels because although the vitamin A intake for many older adults is below current recommendations, their vitamin A levels remain normal (17). (Figure 2) It has been suggested that dietary vitamin A be obtained from an increased intake of carotenoids, including β-carotene, lycopene, zeaxanthine, and lutein, among others (18).

It is not common to find vitamin A deficiency in elderly individuals in the United States, as vitamin A is easily obtained from food as well as dietary supplements. However, absorption in...
elderly adults increases, therefore making the possibility of toxicity greater if supplements with high levels of vitamin A are included in the diet daily. Compromised hepatic function may contribute to an increased risk of toxicity, particularly in those who are using supplements or eating fortified foods. In old adults who may have asymptomatic hepatic dysfunction, the risk for vitamin A toxicity increases. Levels of retinyl esters rise when liver damage or vitamin A toxicity occurs (19).

One consequence of high vitamin A intake is its association with a higher risk for fractures. Vitamin A is a vitamin D and calcium antagonist and a high intake of vitamin A over long periods of time may create serious bone health problems (20). Obtaining supplemental vitamin A in its precursor form, β-carotene, appears to be considerably safer, more effective, and has not been associated with adverse or unanticipated side effects. Consuming a diet rich in fruits and vegetables is a reasonable way to meet vitamin A needs in older adults as well as providing a good source of dietary fiber.

Vitamin C

Vitamin C status is generally related to dietary intake; presently, requirements for older adults are higher than the 1989 RDAs. Newer data set the recommendations for vitamin C at 90 mg/d for males and 75 mg/d for females over age 50 (21). Reductions in vitamin C intake are associated with illness, hospitalization, and institutionalization. Lowered intake often is associated with chronic disease including atherosclerosis, cancer, senile cataracts, lung diseases, cognitive decline, and organ degenerative diseases (21).

Vitamin C is relatively easy to replenish by consuming fruits, fruit juice, and vegetables, or through vitamin supplementation. Elderly individuals who smoke may require double the recommended intake just to maintain tissue levels. As a key nutrient, it is important to consume adequate amounts, particularly in old adults. The role of vitamin C is that of an antioxidant; as a metabolic reducing agent; as a catalyst needed for hydroxylation for proline and lysine, needed for collagen production essential to make new tissue and heal wounds; and, for the maintenance of vascular integrity.

Tissue saturation of vitamin C is achieved easily (22); excess dietary vitamin C will be excreted in the urine. Chronic large doses may contribute to diarrhea or renal calculi formation and should be discouraged among elderly persons.

Vitamin D

It is well recognized that older women are at risk for inadequate vitamin D consumption. Vitamin D has significant roles in bone health by regulating bone mass, but it also is an essential nutrient in immune function (9, 23). There are 2 primary sources of vitamin D: diet and skin. Dietary sources of vitamin D are fatty fishes and fortified dairy products. Consumption of fortified dairy products is very variable among older women, especially because lactose intolerance is more prevalent in older adults. There has been some speculation that even in people who are including fortified foods in their diet, the foods are underfortified (6).

Skin as a source for vitamin D precursor may be helpful for those who live in warmer areas, fear of skin cancer from too much sun exposure is also an impediment to the activation of vitamin D precursors. Additionally, the vitamin D precursor found in skin decreases with age. The ability of the kidney and liver to hydroxylate vitamin D precursors is affected by age, thereby suggesting that the vitamin D requirements might be higher than have been recommended (24).

Calcium

Calcium is an essential nutrient that many older women consume in inadequate amounts. (Figure 3) Despite this, the endocrine system serves to maintain serum calcium within a fairly narrow range by managing absorption, bone mineral balance, and calcium excretion in urine (25). For older women, the dynamics of calcium requirements change. Presently the DRI for calcium for adult women is 1200 mg calcium/d but there have been suggestions that a daily intake of 1500 mg/d for postmenopausal or over 65-year-old women would be appropriate (26). The challenge is that when the RDA was 1000 mg/d there were a significant number of women who consumed diets with inadequate levels of calcium; changing the requirement does not necessarily alter eating patterns and it is apparent that supplemental calcium is needed from nondietary sources.

Calcium has been linked to the prevention or lowered risk for many chronic conditions such as osteoporosis (27, 28), colon cancer (29), and hypertension (30).

Iron

Requirements for iron for women change after menopause; the need for iron to replace menstrual losses ceases, and tissue stores are generally adequate if dietary intake is at acceptable levels. Needs for iron in older women revert to the same levels as those for adult males: 10 mg/d. Dietary iron bioavailability may be affected by the consumption of heme iron, supplemental iron, dietary ascorbic acid, and alcohol (31, 32).

If there is an inadequate consumption of dietary iron, iron deficiency anemia may occur. In older adults, this would indicate a significant deficiency over a long time. However, there is little evidence that iron deficiency is prevalent in either an American or European population of older adults (33). Iron deficiency anemia is most often encountered in older adults who have comorbidities, particularly chronic inflammatory diseases. Iron deficiency anemia can be diagnosed using serum ferritin measures, plasma transferrin receptors, and erythrocyte sedimentation rates. There is an inverse relation between tissue iron stores and serum ferritin levels.

**FIGURE 3.** Mean intake of calcium (mg) in adults age 20–80+, NHANES III, Ref 12.
Although iron deficiency may not be the most common type of anemia seen in older adults, it is seen among hospitalized, institutionalized, or chronically ill older adults. Usually, anemia associated with age is due to chronic bleeding in the gastrointestinal tract. Iron deficiency anemia may be manifested as “restless legs syndrome” (34); this condition is easily treated by providing iron supplementation. To enhance absorption, iron should be taken in divided doses and with meals, which will decrease the gastrointestinal side effects. If oral supplementation is not tolerated, parenteral iron may be given as a short-term intervention.

Zinc

Zinc has been recognized as an essential trace nutrient since the 1930s. It is a metal that has a role in many enzymes, in gene expression, and in immune function, among other physiologic functions (35). Marginal intake of dietary zinc will lead to a lower physiologic zinc levels, but the real challenge may be factors that inhibit or interfere with zinc absorption. Divalent positively charged ions, such as iron, can interfere with zinc bioavailability. Phytates, from grains, cereals, rice and legumes, may interfere with the absorption of zinc; the zinc found in vegetable foods may be less bioavailable than zinc from animal sources (35).

Malabsorption, physiologic stress, trauma, and muscle wasting will all contribute to inadequate zinc status, as will both prescription and over-the-counter medications. For older women, these circumstances may occur too frequently. Consequences of poor zinc status may include reduced immune function, dermatitis, loss of taste acuity, and impaired wound healing (35).

In zinc deficient elderly individuals, T lymphocyte impairment and cellular immunity are compromised (36, 37). Zinc replacement will improve immune status. Inadequate zinc status will affect the efficiency of wound healing, and zinc supplementation will contribute to more efficient healing; however, zinc supplementation in individuals with adequate zinc nutriture will not produce any benefit.

Dermatitis is a commonly seen manifestation of zinc deficiency, as is a decreased sense of taste. Zinc supplementation may contribute to a reversal of symptoms in individuals who are zinc deficient. In individuals who have adequate zinc status, supplementation will not improve their conditions. In fact, too much zinc may lead to suboptimal absorption of other trace minerals (38).

Copper

Copper is a positively charged divalent ion that is an essential nutrient. Large doses of zinc will interfere with the absorption of copper. Copper deficiency is difficult to diagnose and is not often thought about. Symptoms are vague and can easily be associated with other nutritional or medical problems. In humans, copper deficiency may manifest as hypochromic anemia, osteoporosis, arterial disease, myocardial symptoms, and decreased metabolic activity of copper-containing enzymes. Copper deficiency has been linked with hypercholesterolemia, glucose intolerance, and hypertension, all of which are not unusual to see in elderly adults (2, 39).

Copper is widely distributed in a variety of foods and is relatively accessible if a diet with variety is consumed in adequate amounts. Estimated average requirements (EAR) for copper for adults to age 70 have been established at 700 mg/d (2). The RDA is 900 mg/d.

OTHER TRACE NUTRIENTS

Chromium

Chromium status in adults is most usually related to dietary intake. Impaired chromium absorption is generally associated with high intake of nutrients that impact on bioavailability or that increase excretion; these food components include high levels of fiber or simple sugars that increase urinary excretion. In individuals who have low levels of chromium, symptoms of hyperglycemia or abnormal lipid levels may be corrected by providing supplementation designed to normalize chromium status (39, 40).

Selenium

Selenium has been identified as an essential nutrient; however, it is rare to see selenium deficiency in the United States (21). However, selenium deficiencies have been reported among institutionalized elderly, particularly those who have multiple pathologies (41), but, once identified, this is easily corrected with supplementation. Selenium does function as an antioxidant and individuals may take supplements to enhance immune function or increase antioxidant activity. There is an upper limit of 400 μg of selenium/d, which, if exceeded, may lead to toxicity. Symptoms of toxicity may include nausea, vomiting, hair loss, irritability, peripheral neuropathy, and fatigue.

Aluminum

Although aluminum has not been identified as an essential nutrient, it is worthy of mention due to its past association with the development of Alzheimer’s disease (42, 43). Elderly women may have exposure to aluminum through excessive use of antacids, buffered analgesics, some antiulcer compounds, and other medications (37). Although absorption of exogenous aluminum may increase with genetic predisposition, advancing age or mucosal damage, aluminum is absorbed in relatively small amounts. Since Alzheimer’s disease was first described in 1907, the association between dietary aluminum, use of over-the-counter medications, use of aluminum cookware, or dialysis fluids that contain high amounts of aluminum is extremely unlikely.

Magnesium

Recommendations for intake of magnesium is 350 mg/d for men and 280 mg/d for women, and there is no indication that elderly adults have needs different from younger adults (25). Intakes of magnesium in elderly people may be marginal but, even in individuals with atrophic gastritis, there does not appear to be any interference with magnesium absorption. However, hypomagnesemia should be considered as a possible factor in depressed immune function, muscle atrophy, osteoporosis, hyperglycemia, hyperlipidemia, and other neuromuscular, cardiovascular, or renal dysfunction (25).
Boron
Boron is a trace mineral that may have some importance for elderly women due to its association with calcium metabolism and bone mineralization (44). Whether boron will be assigned a recommendation or requirement is not presently clear, but high levels of boron in association with magnesium may lead to increased excretion of calcium (45).

Lead
Lead may not be an essential nutrient and is most closely linked with problems in growth and development in children in poverty, particularly in housing built and painted with lead-based paint years ago. However, lead poisoning from consuming lead-based paint has been reported in elderly, institutionalized individuals (46).

SUMMARY
There is little specific information regarding micronutrient requirements for elderly women. As the population grows older, the need for more information on nutrient needs in very old people will become more important. One of the challenges in defining nutritional needs is the heterogeneity of elderly adults, compounded by the likelihood of multiple chronic conditions, use of many prescription and over-the-counter medications, and the variable quality of nutritional intake associated with limited income, disability, and institutionalization. It seems that the metabolic changes that occur with aging would have some impact on vitamin, mineral, and trace element needs, but there is a clear need for future research to elucidate these nutrient needs.

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REFERENCES