REVIEW

Healthy Aging—Nutrition Matters: Start Early and Screen Often

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ABSTRACT

The amount of time spent in poor health at the end of life is increasing. This narrative review summarizes consistent evidence indicating that healthy dietary patterns and maintenance of a healthy weight in the years leading to old age are associated with broad prevention of all the archetypal diseases and impairments associated with aging including: noncommunicable diseases, sarcopenia, cognitive decline and dementia, osteoporosis, age-related macular degeneration, diabetic retinopathy, hearing loss, obstructive sleep apnea, urinary incontinence, and constipation. In addition, randomized clinical trials show that disease-specific nutrition interventions can attenuate progression—and in some cases effectively treat—many established aging-associated conditions. However, middle-aged and older adults are vulnerable to unhealthy dietary patterns, and typically consume diets with inadequate servings of healthy food groups and essential nutrients, along with an abundance of energy-dense but nutrient-weak foods that contribute to obesity. However, based on menu examples, diets that are nutrient-dense, plant-based, and with a moderately low glycemic load are better equipped to meet the nutritional needs of many older adults than current recommendations in US Dietary Guidelines. These summary findings indicate that healthy nutrition is more important for healthy aging than generally recognized. Improved public health messaging about nutrition and aging, combined with routine screening and medical referrals for age-related conditions that can be treated with a nutrition prescription, should form core components of a national nutrition roadmap to reduce the epidemic of unhealthy aging. *Adv Nutr* 2021;12:1438–1448.

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Background: Living Longer Compared with Living Healthier

Leading a long and healthy life is a goal that is embraced worldwide (1), and fear of death has long been proposed to be a defining characteristic of humans (2, 3). From these perspectives, the 30-y increase in life expectancy during the 20th century is a transformational advance. Furthermore, life expectancy continues to increase for adults aged >65 y (4), and adults >85 y are the fastest growing demographic (5). However, a little-recognized corollary of the recent trends is that older adults are now living in an ill and disabled state for longer: the mean duration of disability at the end of life was just 5.3 y in the 1960s (6), whereas more recent calculations indicate that the duration of poor health and functional impairments has increased from 8.9 to 10.2 y between 1990 and 2017 (7). This extension of unhealthy life is unprecedented in human history, and presents major personal and public health burdens. This is particularly evident during the current coronavirus disease-19 (COVID-19) pandemic, because the association of COVID-19 severity and age is substantially weakened when comorbidities are taken into account (8), and highlights the need to identify ways to support healthy aging (9). This review summarizes current knowledge of the underrecognized role of diet in prevention and treatment of diseases and functional losses that become increasingly prevalent during aging, with a focus on data available from research conducted in North America and Europe.

There is no single definition of “healthy aging” or the related term “healthspan” (1, 10, 11), but it is generally taken to mean the absence of the archetypal diseases and functional impairments associated with old age. The specific diseases and functional losses associated with aging have been defined as those conditions where there is a quadratic relation between disease prevalence and chronological age (12). These include: sarcopenia [loss of skeletal muscle (13)],

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wasting, and osteoporosis (14, 15), which are linked to frailty and falls (16); impaired cognitive function and increased risk of dementia (17, 18); impaired vision via age-related macular degeneration, cataracts, and diabetic retinopathy (19); hearing loss (20); noncommunicable diseases (NCDs) such as type 2 diabetes, cardiovascular disease, and cancer (12); obstructive sleep apnea (21, 22) and poor sleep quality (22, 23); and urinary incontinence (24) and chronic constipation (25, 26). The prevalence of these problems is often >50% in adults aged >85 y, especially in racial and ethnic minorities (26–28). The proposed underlying mechanisms of the aging-associated pathologies include inflammation, oxidative stress, and limited capacity for removal of damaged proteins and DNA repair (29–34). Because these changes affect all organ systems, aging with multiple comorbidities is the norm (35, 36).

Current Status of Knowledge

Unhealthy nutrition throughout life, but especially in old age

American adults of all ages typically eat a broadly unhealthy diet relative to national recommendations (37). **Figure 1**A illustrates the percentage of adults in different age groups who consume less than the estimated average requirements (EARs) of micronutrients (38). Mean intakes of choline, vitamin B-6, zinc, magnesium, and calcium are increasingly inadequate as adults age. In addition, 21% of women and 13% of men aged >70 y consume less than the RDA for protein (39), which is an important concern because emerging evidence suggests that protein levels higher than the RDA (1.0–1.2 g/kg) can be optimal for older adults to prevent muscle wasting (40) due to factors such as decreased muscle uptake of dietary amino acids and reduced anabolic signaling for protein synthesis (41). These findings of broadly low intakes of essential nutrients throughout adult life and especially in older adults are based on self-reported diet, but are consistent with nationally representative biochemical data showing that 30–36% of older adults have ≥1 micronutrients in the deficient range (42). Low micronutrient intakes have also been documented in older adults living in other countries

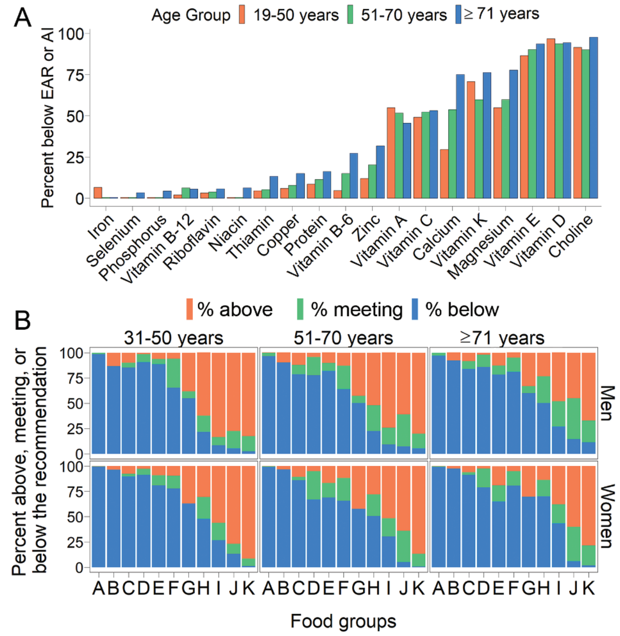

FIGURE 1 Dietary adequacy in different age-groups. (A) Percentage of adults consuming below the estimated average requirement (EAR), or at or below the adequate intake (AI) when EAR values are not available, based on reported usual intakes in the NHANES 2009–2012. Includes nonconsumers of supplements examined in NHANES 2009–2012. Figure adapted from published information (39, 43). (B) Percentage of adults consuming above, below, or at the recommended intakes for food groups in the 2020–2025 Dietary Guidelines (44) by sex and age group, based on dietary data obtained from the 2007–2010 NHANES. A: Whole grains, B: Dairy, C: Seafood, D: Vegetables, E: Fruit, F: Oils, G: Nuts, seeds, soy, H: Protein, I: Meat, poultry, eggs, J: Refined grains, K: SoFAS. Note: Total vegetables includes beans and peas. Protein excludes beans and peas (45). SoFAS, solid fats and added sugars.

(46), indicating this is likely a global, rather than a specifically US, phenomenon.

The dietary patterns of older adults are also broadly inadequate compared with food-based recommendations. Figure 1B shows that adults of all ages typically consume less than the 2020–2025 Dietary Guidelines recommended portions of most healthy food groups including whole grains, dairy, seafood, vegetables, fruits, nuts, seeds, and legumes (44). The figure also shows consumption of excess amounts of meats, saturated fats, and added sugars compared with the recommendations. Using currently available nutritional benchmarks, the majority of adults aged >50 y consume diets that fall far short of recommendations (37, 39, 43). Some groups are especially vulnerable, including low-income and minority populations (37), those participating in the national supplemental nutrition assistance program (47), and older adults with obesity (41% of adults >60 y) (48, 49).

In relation to these observations, it should be noted that current dietary recommendations for older adults are largely based on requirements measured in young adults. Thus,

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Supplemental Tables 1 and 2 and Supplemental Information on Menu Calculations are available from the "Supplementary data" link in the online posting of the article and from the same link in the online table of contents at https://academic.oup.com/advances/.
Address correspondence to SBR (e-mail: susan.roberts@tufts.edu).
Abbreviations used: COVID-19, coronavirus disease-19; DASH, Dietary Approaches to Stop Hypertension Trial; EAR, Estimated Average Requirement; NCD, noncommunicable disease.

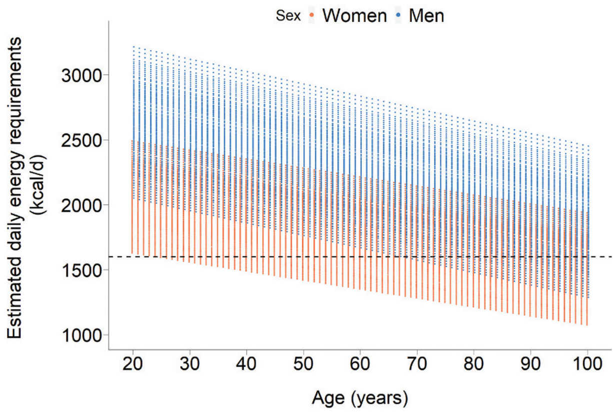

FIGURE 2 Energy requirements for individuals in the healthy weight range at different ages. Data are based on the Institute of Medicine's equations for predicting energy requirements of individuals with typical heights (for men: 1.58–1.9 m; for women: 1.45–1.78 m), a BMI in the healthy range of 18.5–25 kg/m^2, and sedentary or light activity levels (38). The dotted line represents the lowest energy menu examples in the US Dietary Guidelines.

further research is needed to refine essential nutrient and food group recommendations for healthy aging (50). Nevertheless, empirical considerations suggest that mean requirements for protein and several micronutrients can increase during aging, with only a few energy-related vitamins (such as thiamin) decreasing (51–53).

Low energy requirements contribute to unhealthy nutrition in older adults

An important yet underrecognized factor in unhealthy dietary patterns in old age is that there is a large decrease in typical energy requirements as individuals age (54). **Figure 2** shows the Institute of Medicine's estimated energy requirements of men and women of different ages and heights for the healthy weight range (BMI = 18.5–25.0 kg/m^2), which were based on measurements of energy expenditure using the gold-standard doubly labeled water method (38). The equations used to generate the figure are given in **Supplemental Table 1**. As shown, the decrease in energy requirements to maintain healthy weight during adult life is substantial, with a typical reduction of ≥500–700 kcal/d between early adulthood and late life in healthy women and men. This creates the challenge that to meet the same or increased absolute intakes of protein and micronutrients in a diet containing a diminishing level of energy, the proportion of nutrient-dense foods in the diet has to keep increasing over time, with a parallel decrease of greater magnitude in the quantity of low-nutrient foods. In other words, a healthier diet is needed in older age to counterbalance decreasing energy requirements. **Supplemental Table 2** shows EARs for protein and micronutrients as a percentage of 1000 kcal of typical energy requirements, illustrating that the density of most micronutrients needs to increase in older adults by 50%, and by nearly 100% for nutrients that are required in greater absolute amounts.

US Dietary Guidelines for 2020–2025 (44) give examples of healthy dietary patterns designed for all Americans, and include portion guidelines for adults with requirements of ≥1600 kcal/d (lower-calorie menus are illustrated for children, who have different nutritional needs). However, as illustrated in Figure 2, many older individuals, particularly women, require <1600 kcal/d to maintain a healthy weight, and some frail older adults will need as little as 1000 kcal/d to maintain a healthy weight depending on their age, weight, and height and health status. Thus, current Dietary Guidelines do not provide adequate guidance on healthful dietary patterns for the increasing population of older adults.

Functional losses are contributors to unhealthy nutrition in older adults

There is a negative cycle between functional losses and inadequate nutrition in older adults that accelerates unhealthy aging. Sarcopenia, the age-associated loss in skeletal muscle mass and function, is a key underlying cause of decreases in movement, physiological capacity, and functional performance, and increased disability and mortality observed with advancing age (55, 56). The causes of sarcopenia are multifactorial but include inadequate nutrition, low physical activity, inflammation, and multiple NCDs and other comorbidities (57, 58). Sarcopenia also has a profoundly negative impact on nutritional status in older adults, because decreased muscle mass contributes to reduced energy requirements, and can also limit the ability to shop for food and prepare meals (58).

As summarized below, poor vision in old age also limits the capability to purchase, prepare, and consume healthy food. For example, many older adults cannot see clearly the food on their plate. Similarly, reduced dental health, taste, smell, and hunger are associated with aging and also reduce the drive to eat (54, 59–62). Older adults are also more likely to take medications that impact food intake (63) and have digestive problems including gastric atrophy, chronic constipation, and/or malabsorption (64, 65) that negatively impact appetite and nutrient absorption. Older adults additionally have changes in homeostatic mechanisms regulating thirst sensation and renal water absorption, resulting in a higher risk of dehydration, (66, 67), which can be exacerbated by the use of common diuretics and fear of incontinence due to limited mobility (68).

Socioeconomic factors are contributors to unhealthy nutrition in older adults

In addition to physiological and genetic factors influencing nutritional status during aging, there are widely recognized demographic and social factors that increase the risk of consuming an unhealthy diet as adults grow older. These include poverty and food insecurity, which make it harder to purchase the nutrient-rich foods that are both more necessary and more expensive (69, 70). Older adults are also more likely to live alone and be socially isolated, factors that limit food preparation and predict unhealthy dietary intake (61, 62).

TABLE 1 Consistent evidence for nutrition parameters and prevention and treatment of common aging-associated diseases and functional losses[1]

	Prevention(derived from expert consensus reports, or umbrella/systematic reviews, or meta analyses)	Reduced disease progression and or remission(derived from expert consensus reports, or powered randomized trials)
Musculoskeletal		
Frailty/sarcopenia, risk falls	• Healthy BMI (18.5–25 kg/m^2) (71) • Dietary patterns: "Prudent" (72), Mediterranean (73) • Specific nutrients: Recommended protein (77), high total antioxidants (40, 78)	• Specific nutrients: High protein: 1.3–1.5 g/kg protein alone or combined with exercise (74–76) • For sarcopenic obesity: high-protein and weight loss with or without exercise (79)
Osteoarthritis	• Healthy BMI (80)	• Weight loss (81)
Osteoporosis	• Specific nutrients: Adequate intakes of calcium (82), protein (83), vitamin D (84)	• Specific nutrients: 1200 mg Ca + 800 IU vitamin D + weight-bearing exercise (85, 86)
Cognition		
Cognitive decline	• Healthy BMI (87) • Dietary patterns: Mediterranean diet (89, 90), HEI, WHO's Healthy Diet Indicator (91)	• Weight loss (88)
Dementia/Alzheimer disease	• Healthy BMI (87) • Dietary patterns: Mediterranean diet (90, 92) • Specific nutrients: Low saturated fat (92, 93)	
Sense-organ diseases		
Age-related macular degeneration	• Healthy BMI (7, 94) • Dietary patterns: Mediterranean diet, oriental diet, low-glycemic-index diet (95)	• Nutrients: High vitamins C + E, lutein, zeaxanthin, zinc, copper (96)
Cataracts	• Healthy BMI (97), healthy glycemic control in type 2 diabetes (98) • Specific nutrients: Multivitamin-mineral supplement (99, 100)	
Hearing loss	• Healthy BMI (101) • Dietary patterns: HEI, low-glycemic-index carbohydrates (102, 103)	• Nutrients: Folic acid in individuals with high homocysteine (104)
Noncommunicable diseases		
Type 2 diabetes	• Healthy BMI (105, 106) • Dietary patterns: Mediterranean (107, 108), DASH, and HEI (109), plant-based (110), low glycemic index, and low glycemic load (111)	• Lifestyle intervention with weight loss, healthy diet, and exercise (105, 112, 113) • Dietary patterns: Mediterranean, plant based (114, 115), low-carbohydrate (116, 117)
Cardiovascular disease	• Healthy BMI, weight loss if obesity (105, 106) • Dietary patterns: Mediterranean (107, 119, 120), DASH, and HEI (121, 119, 109), plant-based (119) [not low-carbohydrate (122)]	• Weight loss with healthy diet, exercise (105, 118) • Dietary patterns: Mediterranean (123), DASH (124)
Cancers	• Healthy BMI (125, 126) • Dietary patterns: Mediterranean (107, 127–129, 120), DASH/HEI (109), plant-based diet (130, 131)	
Sleep		
Obstructive sleep apnea	• Healthy BMI (21)	• Weight loss (132)
Gastrointestinal		
Chronic constipation	• Specific nutrients: Recommended fiber intake, including coarse wheat bran fiber (133–135)	• Specific nutrients: Coarse wheat bran fiber, adequate fluid (133)
Urinary incontinence	• Healthy BMI (136)	• Weight loss (24)

[1] DASH, Dietary Approaches to Stop Hypertension Trial; HEI, Healthy Eating Index.

Dietary patterns, nutrients, and weight management for prevention and treatment of aging-associated diseases and conditions

Dietary patterns and nutrients.

Table 1 summarizes the evidence from recent consensus reports, umbrella and systematic reviews, and meta-analyses for the associations of specific dietary patterns, nutrients, and BMI with prevention of age-related diseases and functional impairments. Table 1 also summarizes data from randomized controlled trials of nutritional treatments for specific conditions.

A variety of dietary patterns and indices have been evaluated for their association with age-associated diseases and conditions, including Mediterranean-style diets (137), US Dietary Guidelines and the related Healthy Eating Index (138, 139), the WHO's Healthy Diet Indicator (140), Dietary Inflammatory Index (29), the MIND diet (141), and low glycemic index carbohydrate and high-fiber diets (142). These dietary profiles are associated with prevention of a broad range of age-associated diseases and conditions including: frailty and risk of falls, osteoporosis, cognitive decline, dementia, age-related macular degeneration, cataracts, hearing loss, NCDs (including type 2 diabetes, cardiovascular disease, and many cancers), and chronic constipation (72, 73, 89–92, 95, 102, 103, 107, 108, 121, 119, 109, 127–129, 120, 130, 131). In some cases, these associations are confirmed with randomized trials (143, 123). In addition Table 1 highlights specific nutrients associated with preventing unhealthy aging including: dietary protein at least equal to current RDAs for preventing sarcopenia, frailty, and falls in combination with exercise (77); adequate calcium and vitamin D intake with recommended protein for preventing osteoporosis (82–84); and whole grains and dietary fiber (in particular, coarse wheat bran fiber) for preventing type 2 diabetes and chronic constipation (133, 134).

There is also evidence that healthy aging is fostered by the cumulative effects of healthy nutrition earlier in life. For example, for prevention of osteoporosis late in life, attaining a high peak bone mineral density by age 30 is required (after which bone mineral density falls) and this requires consuming recommended levels of calcium throughout childhood and young adulthood (144). Similarly, high dietary flavanol intakes over 2 decades are associated with a reduced risk of Alzheimer disease and related dementias (145), and greater adherence to a Mediterranean diet for >5 y is associated with a 1–3-fold reduction in risk of frailty (146, 147), a 30% reduction in risk of a major cardiovascular event (123), and a 41% reduced risk of incident advanced age-related macular degeneration (148).

In addition there are a number of age-related diseases and conditions that randomized trials indicate can be treated to attenuate progression (and in some cases support remission) with a nutrition regimen (Table 1). These include sarcopenia, osteoporosis and fractures, age-related macular degeneration, type 2 diabetes, and chronic constipation (133, 74–76, 85, 86, 96). However, not all age-related diseases and conditions that are apparently prevented by healthy nutrition can also be treated after their diagnosis. For example, randomized trials have indicated no significant effect of omega-3 fatty acids, B vitamins, vitamin D, or soy protein on recurrence of various cancers (149, 150).

Although food-based nutrition is the focus of this report, a strong case can be made for targeted supplementation with specific nutrients that are hard to achieve in old age through a healthy diet. In particular, the mean intake of vitamin D in US women aged 51–70 is only about one-fourth of the RDA, and lower intakes are reported for ages ≥71 y (151). Similarly, mean calcium intake is less than one-third of the RDA in older adults (151). Some older adults can also benefit from supplemental vitamin B-12 because they are at increased risk of deficiency due to chronic atrophic gastritis [present in 30–50% of older adults (152)] and the widespread use of gastric acid–blocking drugs that inhibit digestion of food-based vitamin B-12 to an absorbable form (153).

Weight management.
BMI values above the healthy range (>25.0) are strongly associated with increased risk of a wide range of age-associated diseases (Table 1). Older adults with obesity [41% of adults >60 y (154)] are at higher risk of frailty and osteoarthritis, and consequently have more functional limitations than those who are not obese (155). Obesity also increases the risk of all the major NCDs, cognitive decline and dementia, obstructive sleep apnea, sensory impairments (age-related macular degeneration, cataracts, diabetic retinopathy, and hearing loss), and urinary incontinence (7, 21, 156, 105, 106, 136, 71, 80, 87, 94). It should also be noted that unhealthy dietary patterns with high intakes of sugar-sweetened beverages, processed snack foods, and red meat, and low intakes of vegetables, whole grains, fruits, and nuts are associated with weight gain (157), which emphasizes the key link between diet, BMI, and health. As observed with dietary patterns, the risks of obesity for unhealthy aging increase over time, and there is a progressive increase in the risks of type 2 diabetes (158), cardiovascular disease (159), and cancer (160) with every year that obesity is maintained. Conversely, reduced energy intake promotes healthy aging, with data from studies of nonhuman primates (161) and a 2-y trial of calorie restriction in nonobese humans (162, 163) indicating that low energy intake promotes favorable changes in a broad range of age-related biomarkers of healthspan (162, 164).

Weight loss is also an effective first-line therapy for treatment of several age-related diseases and conditions in individuals with obesity, including urinary incontinence and sleep apnea (24, 132). Furthermore, a mean weight loss of 10% has been reported to achieve remission of type 2 diabetes in 50% of cases when implemented within 7 y of onset, providing a remarkable example of the potential for nutrition to impact age-related disease more effectively than current medication regimens (112).

It is also important to note that recommendations for maintaining physical activity into old age can play a valuable role in supporting nutritional health in old age, not only by preserving musculoskeletal health (165, 166) but also by attenuating the decline in energy requirements with aging. These findings are consistent with a recent federal report noting the lack of specificity in nutrition assistance programs to support healthy aging in current government programs (50).

Are All Generally Healthy Dietary Patterns Equivalent for Achieving Nutritional Health in Old Age?

There is currently insufficient information to categorically differentiate the effects of consuming the different broadly healthy dietary patterns discussed above. This is because they

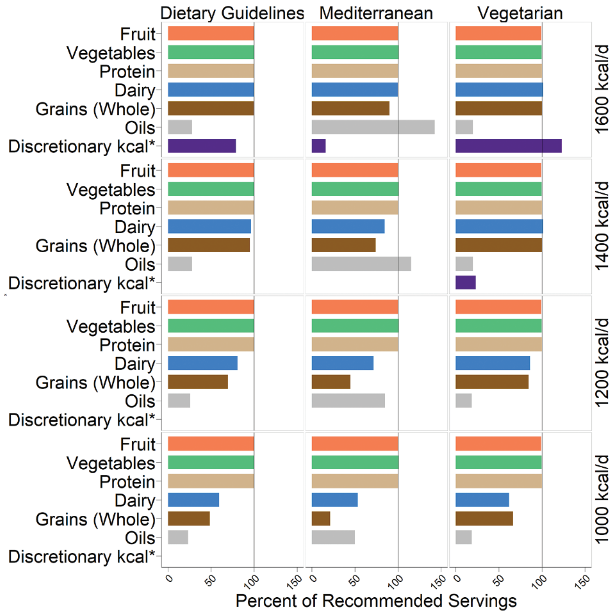

FIGURE 3 Illustration of the adequacy of healthy food group servings that can be achieved with different dietary patterns at lower levels of energy requirements in older adults. Typical menu examples were used to calculate the number of servings per day of foods in key healthy food groups (fruit, vegetables, proteins, dairy, grains, and oils) for 3 healthy dietary patterns (US Dietary Guidelines, Mediterranean, and Vegetarian) implemented at 4 energy levels (1600, 1400, 1200, and 1000 kcal/d). Suggested servings reflect a mean of 3 different menus that adhere to the respective dietary pattern and are shown relative to the serving size recommendations outlined in the Dietary Guidelines for Americans for each dietary pattern at 1600 kcal/d intakes. The vertical black line represents 100% of the recommended servings for the specified dietary patterns, and for discretionary calories * (all calories not included in healthy food group servings) represents 200 kcal/d. Note: Legumes are included in the protein category not vegetables, and oils do not reflect oils included in food items (e.g., avocado, nuts). Discretionary calories reflect calories that remain for other uses after meeting recommended servings of fruit, vegetables, protein, dairy, and grains.

share multiple common features including an emphasis on regular consumption of vegetables and fruits, whole grains, legumes, nuts and seeds, seafood, and liquid oils such as olive and canola, and with low intakes of saturated fat and nutrient-weak foods such as sugar-sweetened beverages. However, different dietary patterns can differ in the extent to which adequate portion sizes of healthy foods can be achieved despite the decreased energy requirements associated with aging. We therefore created typical example menus for 3 healthy dietary patterns (Dietary Guidelines MyPlate, a Mediterranean-style diet, and a Vegetarian diet) and analyzed them for their ability to support nutritional sufficiency for older adults at different levels of energy requirements.

A summary of the results is provided in **Figure 3**, with descriptions of the menu items given in the **Supplemental Information on Menu Calculations**. As shown, for dietary energy ≥1600 kcal/d, all of the healthy dietary patterns could provide recommended portions of different recommended food groups, and also provide a calorie allowance for other "discretionary" foods of 32 (Mediterranean-style) to 246 (Vegetarian) kcal/d. However, for the lower dietary energy requirements observed in many older adults, the menus increasingly did not provide recommended portions of all healthy foods without exceeding total energy requirements, even when discretionary calories were reduced to zero (which is unrealistic). The Vegetarian menu was the one that best met portion recommendations for all food groups and protein at lower energy levels (including possibly higher protein needs than current US RDAs), and is consistent with the United Nations' calls for greater reliance on plant-based foods (167). Among MyPlate and Mediterranean menus, reducing dairy and grain servings (selectively removing refined grains to preserve whole grain intake) resulted in moderately low carbohydrate options that did allow proteins, fruits, and vegetable servings to be as recommended at the lower calorie levels. These calculations suggest that lower-carbohydrate Dietary Guidelines menus provide another practical approach to meeting healthy nutrition guidelines for older adults at lower levels of energy intake.

Opportunities for a National Nutrition Strategy to Reduce Unhealthy Aging

The United States currently ranks only #55 in a global assessment of years of age-related disease burden at the end of life (#1 being best-ranked) (12) despite health care expenditures that are approximately twice those of other affluent nations (168). This striking public health failure has occurred despite acknowledgement of the general importance of nutrition across the lifespan (11, 169–171). The breadth of healthy aging benefits achievable with healthy nutrition described herein clarifies the broad and important role that nutrition can play to keep older adults healthy, and supports the development of a national nutrition strategy with clinical involvement for healthy aging.

One important element of a successful nutrition strategy for healthy aging would be increasing investment in federal nutrition research directed to this goal (172), with coordination among stakeholders to maximize research efficiency. This would recognize a strong role for nutrition in supporting healthy aging (as summarized here), the relative shortage of data from conventional randomized trials of specific interventions, and the need for fresh approaches to conduct rapid, rigorous testing of different dietary interventions in diverse populations. Stakeholders in a national nutrition strategy for healthy aging would include consumers, government agencies, food producers, the food industry, health professionals, and community organizations. Health professionals would play a pivotal role by leading the development of consensus recommendations (e.g., within societies for nutrition, geriatric medicine, primary care, nursing, physician assistant, occupational therapy) that would aid diagnosis and evidence-based treatments based on existing knowledge and identify priorities for next-generation research. This work could also be a springboard for developing training modules and continuing education for health care professionals.

Another important key to healthy aging would be the development of routine nutrition screening, implemented years before age-related diseases become prevalent, combined with research initiatives to develop and refine lifestyle interventions supporting aging-focused healthy behavior changes in different population groups. Direct nutrition screening is currently not performed in primary care and current indirect measures, such as BMI and lipid panels, do not provide adequate information to understand the specific nutritional vulnerabilities of individuals. Ideally, the development and use of broad nutrition screening panels to support healthy aging would allow for identification of at-risk individuals within primary care and either treatment within primary care or referral to specialized services (11, 70, 169, 173). In addition, artificial intelligence could be used to add nutrition screening data in real time, for rapid identification of time-sensitive nutritional risks, and such information could also be used as the basis for artificial intelligence–enabled personalized interventions. As well as evaluating dietary intake, screening assessments could include BMI and weight change. This inclusion would recognize both that obesity is a major risk factor for unhealthy aging (105), and that weight loss and protein-energy malnutrition with a low BMI are increasingly prevalent as adults age (174) and are similarly linked to reduced independence and greater risk of poor health. The apparent paradox that both obesity and weight loss with low BMI are risk factors emphasizes the importance of screening to allow for personalized nutrition support for healthy aging. There is currently no validated screening tool for the range of dietary intakes, BMI, and weight change seen in community-dwelling adults beginning in midlife on, but scales used in hospitalized patients (175) have potential for adaptation to standardized instruments for primary care.

Conclusions

Maintenance of functional independence and quality of life are of primary importance to older adults. Although aging is clearly programmed and progressive, a cohesive body of research finds that a healthy diet and weight management are able to not only reliably delay the onset of most typical diseases and functional losses in aging, but also arrest progression and severity, and even support remission for some conditions. Public health measures to facilitate healthy aging are currently lacking, but can be developed based on existing research to reduce the growing burden of poor health in old age.

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