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Nutrition for older adults: Perspectives on dietary guidance for healthy aging

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Abbreviations:

AD Alzheimer’s disease

BHB Betahydroxybutyrate

BPRHS Boston Puerto Rican Health Study

CVD Cardiovascular disease

DASH Dietary Approaches to Stop Hypertension

DGAC Dietary Guidelines for Americans Advisory Committee

DGAs Dietary Guidelines for Americans

DHA Docosahexaenoic acid

DRIs Dietary Reference Intakes

EPA Eicosapentaenoic acid

FFQ Food frequency questionnaire

GAO Government Accountability Office

Health ABC Health, Aging, and Body Composition Study

HEI Healthy Eating Index

HHS Department of Health and Human Services

MIND Mediterranean-DASH Intervention for Neurodegenerative Delay

MPS Muscle protein synthesis

MTOR Mammalian / mechanistic target of rapamycin

NHANES National Health and Nutrition Examination Survey

PICO Population, intervention, comparison, and outcomes

PREDIMED Prevención con Dieta Mediterránea

PUFA Polyunsaturated fatty acid

RCT Randomized controlled trial

RDA Recommended Dietary Allowance

T2D Type 2 diabetes

TNI Total nutrient index

WHO World Health Organization

Key words: older adults, aging, nutrition, diet, dietary patterns, dietary guidelines, healthy aging

Statement of Significance: Although substantial scientific progress has been made in understanding the role of diet and nutrition in promoting healthy aging, important knowledge gaps remain. This is due, in part, to the inter-individual variability in the aging process. This article summarizes the scientific presentations and discussions from a nutrition and healthy aging workshop and provides recommendations for future research aimed at addressing unanswered questions so that dietary guidance for older adults can be improved and refined.

Teaser Text: This article summarizes proceedings from a workshop focused on the role of diet and nutrition in promoting healthy aging and provides recommendations for future research to fill critical knowledge gaps.

Abstract

The world is rapidly aging. It is projected that “young old” (i.e., 60+ y) will double by 2050 and “older old” (i.e., 80+y) will nearly triple. Greater life expectancy has been accompanied by more chronic health conditions and disabilities, especially those that are related to diet and lifestyle. Although people are living longer, their healthy life expectancy has not kept pace, meaning that more years are spent in poorer health - thus, the need to identify targets to increase “health span”. Nutrition plays a critical role in aging healthfully. However, the aging process is accompanied by unique physiological, social, contextual factors that impact the nutritional needs of the aging population – requiring more specific and tailored dietary recommendations. To examine the complexity of diet within the aging population, the *Nutrition and Wellness Science Forum: Exploring the Journey to Healthy Aging* was held in Washington, D.C to focus on scientific evidence and research gaps surrounding dietary intakes and nutrient adequacy among older adults, as well as the role of nutrition in musculoskeletal, cardiometabolic, and cognitive health. Discussions also addressed the need for culturally appropriate dietary assessment methods and interventions that reflect the heterogeneity and diversity of older adults, as well as the importance of the food system. This review summarizes the forum’s key themes, discussions, and identified research gaps.

The Consequences of Increased Life Expectancy

Population aging, the demographic shift toward an older population, is rapidly occurring worldwide. By 2050, it is estimated the global population of people ages 60 y or older will double to 2.1 billion, and the number of persons aged 80 y or older will triple to 426 million (1). While this global shift toward an older population started in high-income countries, low- and middle-income countries are now experiencing accelerated transitions toward an older demographic. An estimated two-thirds of the global population over 60 y will be living in low- and middle-income countries by 2050 (1). As people age, they are more likely to develop coexisting chronic health conditions and utilize multiple medications. Globally, over the last 30 years, the total burden of disability increased by 52%, driven primarily by non-communicable diseases, which accounted for 80% of disability in 2017 (2). In this time frame, disability from metabolic diseases, such as type 2 diabetes (T2D) and fatty liver disease, increased globally and across all levels of economic development. In 2019, global life expectancy at birth was 73 y, yet healthy life expectancy was only 63 y (3), indicating that people spend nearly a decade living with illness and/or disability. which poses significant challenges to health care systems (4).

A gap remains in nutrition guidance for older adults especially those living with chronic conditions, despite the U.S. Government Accountability Office (GAO) recommendation that the Department of Health and Human Services (HHS) develop a plan to focus on older adults' nutritional needs in 2019 (5). Understanding how nutrition can influence the unique physiological and health challenges of older adults is important, given their increased risk for chronic disease and disability. In response to this need, the *Nutrition and Wellness Science Forum: Exploring the Journey to Healthy Aging* convened experts across industry, academia, and federal agencies (all of whom are co-authors on this review) to examine the core elements of dietary patterns to support healthy aging, with a focus on musculoskeletal, cardiometabolic, and cognitive health. The purpose of this narrative review is to describe the forum's central themes and scientific discussions and to highlight research gaps that need to be addressed to foster the development of effective dietary strategies, guidance, and interventions that support healthy aging across diverse populations.

What is *Healthy Aging*?

"If in old age I can walk on the beach and discuss poetry with my friends, I will be happy." - Luigi Ferrucci, MD, PhD, Scientific Director, National Institute on Aging, National Institutes of Health poignantly began the discussion with this quote.

"Healthy aging" is a multi-dimensional concept that combines scientific perspectives and lived experiences of older adults themselves (6). It is commonly described through three domains. Medical health refers to the presence or absence of disease and is documented clinically. Functional health refers to the ability to perform daily activities independently. Self-rated health is how individuals describe their own physical and mental health (7). Self-rated health predicts morbidity and mortality and has been recommended by international organizations, including the World Health Organization (WHO), for international comparisons of health status. The WHO defines healthy aging as, "the process of developing and maintaining the functional ability that enables wellbeing in older age" (8). This definition accounts for physiological and environmental influences that impact biological aging that are shaped by the social determinants of health. With this current definition, research efforts can shift from a focus on lifespan to health span, to help ensure that older adults maintain independence as they age.

Dietary Intakes of Older Adults in the U.S.

While aging has historically been associated with frailty and underweight, older adults are now more likely to be obese than underweight. The most recently published data from NHANES indicate that 39% of adults over age 60 are obese, while <2% of adults 60 y and older are underweight (9, 10). As we age, energy (i.e., kilocalorie) needs tend to decrease while nutrient requirements are unchanged or, in some instances, increase (11, 12). Thus, it is important to focus on guidance towards consuming more nutrient-dense foods to meet nutrient requirements without additional energy intake. However, adherence to the Dietary Guidelines for Americans (DGAs) among adults 60 y and older is suboptimal (as measured by a Healthy Eating Index (HEI)). Those with low socio-economic status and those who reported limited access to healthy foods were more likely to have a suboptimal diet, as measured by the HEI (13). Older adults with obesity are at higher risk for micronutrient inadequacies compared to those who are normal weight (14). This is due, in part, to lower overall diet quality, combined with obesity-related physiological changes that alter nutrient metabolism that can result in higher nutrient requirements (15).

Although older adults in the U.S. fall short on micronutrient intakes from foods and beverages, dietary supplement use is high among this segment of the population.

Nearly 70% of adults over 60 y report taking one or more dietary supplements daily (16). Given the high prevalence of dietary supplement use, methods to assess nutrient intakes from both diet and supplements are important. Similar to the HEI, the total nutrient index (TNI) is a score that reflects overall nutrient adequacy. Unlike the HEI, which focuses on adherence to the DGAs and overall diet quality based on foods and beverages, the TNI evaluates micronutrient intakes from foods, beverages, and dietary supplements relative to the Dietary Reference Intakes (DRIs) (16). Both the HEI and TNI are used for research purposes, and the HEI is also used for monitoring diet quality at the population level. The inclusion of nutrient exposures from dietary supplements improved the correlation with nutritional biomarkers, indicating that older adults may have higher actual micronutrient status than what is captured by the HEI (17, 18). It is important to note that most dietary supplements used among older adults are not at the recommendation of a health care provider, but rather out of personal motivations to improve or maintain overall health (16). Supplements can represent a key source of certain nutrients given lower energy demands throughout the aging process, including loss of skeletal mass. While the DGAs and registered dietitians consistently recommend obtaining nutrients primarily from foods and beverages to the extent possible (19) it may not be possible for all Americans. For this reason, the National Institute of Health's Office of Dietary Supplements all supplement users to consult and alert their health care providers and report all products taken (20).

Special Dietary Considerations for Older Adults

As appetite and energy needs decline with age, nutrient density - the ratio of nutrient intake to energy intake – becomes particularly important. Higher nutrient dense foods and dietary patterns are necessary to meet recommendations for nutrients that tend to be under consumed. Conversely, for nutrients like sodium, which are typically consumed in excess, consumption should be reduced in proportion to energy intake. For example, when 2,400 mg of sodium is consumed as part of a 1,500 kcal per day diet, the sodium density is 1.6 mg/kcal. When 2,400 mg of sodium consumed as part of a 2,000 kcal the sodium density is 1.2 mg per kcal. This concept of sodium density has practical implications for tailoring dietary recommendations as energy needs change. The Dietary Approaches to Stop Hypertension (DASH) study was seminal in finding that a diet rich in fruits, vegetables, and low-fat dairy foods and with low saturated and total fat can substantially lower blood pressure (21). During the original DASH trial, sodium and energy intakes were maintained constant. The subsequent DASH-sodium trial tested the effect of the DASH diet with different sodium intakes (1150, 2300, or 3450 mg / d) on blood pressure (22) and found that reduced sodium intake and the DASH diet lowered blood pressure independently, with even greater reductions when combined (22). A secondary analysis of the trial data found the dose-response relationship between sodium and blood pressure was not linear (23) and importantly, blood pressure increased more steeply with higher sodium intake at lower energy intakes than at higher ones. This reinforces that sodium density (sodium relative to energy intake) is a critical factor in understanding blood pressure responses. There was also evidence that the diastolic blood pressure response varied with energy intake only among the African American participants (23). These findings are one example of the importance of considering nutrient density in making dietary recommendations and individualizing dietary recommendations for certain populations.

Chemosensory changes in older age are important to consider because they affect food choice and reduce diet quality (24, 25). These changes are only partly attributable to the aging process itself. Environmental insults, chronic disease, and the use of prescription medications and supplements are key contributors to chemosensory decline in older age (26). Among the chemosensory changes, taste perception generally declines in older age, although the impact on eating habits is variable. For example, some studies suggest older adults may need a markedly higher salt concentration to achieve the same taste intensity as younger adults (27). This shift could increase sodium density in the diet and potentially elevate blood pressure and contribute to poorer metabolic health in older adults. However, the literature on age-related differences in salt taste perception is mixed (28, 29). Additional research is needed to clarify how diminished chemosensory function affects eating behavior, nutritional and overall health status of older adults (30, 31).

Nutritional Needs of Older Adults for Musculoskeletal, Cardiometabolic, and Cognitive Health.

Musculoskeletal Health:

After age 60 y, muscle mass is lost at an average rate of approximately 1% per year, while strength decreases, on average, by 3% per year (32). Identifying strategies that mitigate loss of muscle, strength, and function are vital for maintaining independence and quality of life in older adulthood. Protein adequacy is emerging as a key player. In the Health, Aging and Body Composition Study (Health ABC), participants in the highest quintile of protein intake (1.1 g/kg/d) lost approximately 40% less lean mass and appendicular lean mass that those in the lowest quintile (0.7 g/kg/d) over three years of follow-up (33). Among those that lost weight over the three-year study period, lower protein intake was associated with greater loss of lean mass (33). These findings suggest that consumption of adequate dietary protein could mitigate loss of muscle mass in older adulthood. Moreover, a separate analysis of Health ABC, found that the association of protein intake with physical function and mobility disability differed by race and sex (34), highlighting the importance of considering race and sex in studies of protein requirements in older age.

Current dietary protein recommendations in the U.S. are based predominantly on short-term nitrogen balance studies that were conducted in young adults (35). Some studies have suggested that the current RDA for protein, 0.8 g/kg/d, is suboptimal for maintaining muscle mass and function in older adults (36-39). Both the PROT-AGE Study Group, an international group that reviews dietary protein needs with aging, and the European Society for Clinical Nutrition and Metabolism Expert Group recommend protein intakes of 1.0 – 1.2 g/kg/d to maintain muscle mass and function in older adults (38, 39). However, meeting an increased dietary need for protein in older age can be challenging due to reduced energy needs and loss of appetite that accompany aging. Protein supplementation has been suggested as one way that older adults can consume sufficient protein to mitigate age-related loss of muscle mass and function (40). However, the available evidence regarding the efficacy of protein supplementation on muscle function in older adults remains mixed. A systematic review and meta-analysis of randomized controlled trials (RCTs) found that protein supplementation did not benefit lean mass, muscle strength or physical performance either alone or in combination with resistance exercise (41). The populations included in the analysis were mostly non-frail older adults who were already consuming protein above the RDA, which may explain why there was no additional effect of protein supplementation on muscle mass or function. Another systematic review and meta-analysis focused on the effect of protein supplementation on body composition and muscle function with respect to timing of protein intake and observed a positive effect of protein supplementation on lean mass, but not strength, regardless of timing (42). A third meta-analysis evaluated how increasing daily protein intake combined with resistance exercise training contributed to lean body mass, muscle strength, and physical function in healthy adults and found that protein intake of 1.6 g/kg/d combined with resistance exercise training resulted in small, but significant, gains in lean body mass, muscle strength, and physical function (43).

The mammalian / mechanistic target of rapamycin (mTOR) pathway has emerged as a central player (44, 45). Clinical trials conducted in healthy adults demonstrated that muscle protein synthesis (MPS) via mTOR-dependent mechanisms was stimulated by resistance exercise training (46) and ingestion of essential amino acids, particularly the branched chain amino acid leucine (47-49). This observation fostered the design of several RCTs of leucine supplementation as a potential therapy to counteract anabolic resistance – the findings of which are inconsistent. Approximately 1.7 g of leucine (from 15 g of protein) was adequate to stimulate MPS in young adults while older adults needed 2.8 g of leucine (from 30 g of protein) (48). However, in a

RCT of men and women aged 65 y or older with low muscle mass and/or strength at baseline, supplementation with 3 g leucine with 10 g protein twice daily for 6 months did not affect appendicular lean mass, knee extensor strength, grip strength, physical performance, or MPS (50). A trial specifically designed to determine the leucine requirements of healthy adults 60 y and older utilizing the indicator amino acid oxidation method found that the RDAs for dietary leucine for males and females were 81.0 and 82.0 mg/kg/day, which are more than double current dietary recommendations (51). However, because of methodological differences between this study and earlier studies used to establish leucine recommendations, it may be misleading to make direct quantitative comparisons (52).

Contractile muscle proteins serve as the primary storage reservoir for essential amino acids during the fed state (53). During fasting and in times of stress, skeletal muscle is broken down to supply endogenous aminos acids to support energy needs, thus playing a critical role in overall protein homeostasis. Amino acid availability is a central regulator of whole-body protein turnover, not only supporting MPS, but also contributing to the maintenance of the bone matrix through collagen formation (54). A reduction in MPS is one factor that contributes to age-related muscle loss, known as sarcopenia. This age-related reduction in MPS, known as anabolic resistance, is complex, involving both resistance to protein ingestion as well as resistance to the anabolic effects of insulin (54). Anabolic resistance with aging is associated with sarcopenia and bone loss (54), so understanding its underlying biological mechanisms is important to develop practical interventions to mitigate muscle loss in older age.

Concurrent with population aging, the prevalence of older adults living with obesity is also increasing (55). When excess adiposity is accompanied by age related loss of skeletal muscle it is referred to as sarcopenic obesity (56). However, recommending weight loss for individuals with sarcopenic obesity is controversial. While weight loss helps mitigate metabolic dysfunction associated with obesity, it can also accelerate loss of muscle mass and function (56). A meta-analysis of RCTs of adults aged ≥ 50 y with overweight or obesity undergoing dietary energy restriction found those who consumed more than 25% of energy from protein per day (1.0 g/kg/d) retained more lean mass and lost more fat mass during weight loss than those who consumed less (57). These findings support the recommendation to increase protein intake during weight loss to help preserve lean mass. However, results of studies completed since the publication of this meta-analysis in 2016 (57) are inconsistent. In older adults (79% female) with obesity and poor physical function who underwent a 6-month weight loss intervention, those who consumed a higher protein diet (1.2 g/kg/d) lost a similar amount of weight and lean mass as those who consumed the RDA for protein (8.1% versus 7.5%). However, those randomized to the higher protein diet group had greater improvements in physical performance (58). In postmenopausal women with obesity undergoing dietary energy restriction, body composition, including lean mass, did not differ between those who received 1.5 g/kg/d protein and those who received 0.8 g/kg/d (59). In older men and women undergoing energy restriction, lean mass loss and strength also did not differ between those who consumed 1.7 g/kg/d protein and those who consumed 0.9 g/kg/d (60). Although higher protein intake appears to have favorable effects on muscle mass and function in older age, its effect on preserving lean mass during hypocaloric weigh loss is equivocal. The optimal protein dose and meal distribution needed to minimize lean mass loss while promoting clinically meaningful weight loss in older adults with obesity merits further research.

Cardiometabolic Health:

The typical American dietary pattern is characterized by lower than recommended intakes of fruits, vegetables, dairy foods, and dietary fiber and excessive consumption of total energy, sodium, saturated fat, refined grains, and added sugars. This contributes to widespread under consumption of essential nutrients, such as vitamin D, calcium, potassium, magnesium, and iron (61). Dietary patterns that are rich in fruits, vegetables, whole grains, dairy, seafood, legumes, and nuts; lower in red and processed meats; and low in sugar-sweetened foods and drinks are associated with reduced risk of all-cause mortality, CVD, T2D, overweight, and obesity (61). The 2015 – 2020 DGA Committee reported that the evidence of inverse association between healthy dietary patterns and risk of CVD and T2D in adults was strong and moderate, respectively (19). However, their recommendations did not explicitly consider older adults in the patient / population, intervention, comparison, and outcomes (PICO) framework. As approximately 60% of Americans over the age of 65 y were living with at least one diet-related chronic disease in 2018, it is important to consider older age in diet and disease associations (62).

Therefore, the 2025 Dietary Guidelines Advisory Committee (DGAC) expanded its analysis to consider older adults specifically (63). Their systematic review of dietary patterns and cardiovascular disease included 9 randomized controlled trials and 101 prospective cohort studies published since 2014. The Committee concluded that dietary patterns consumed by adults and older adults higher in vegetables, fruits, legumes, nuts, whole grains, unsaturated relative to saturated fats and lower sodium, with lower intakes of red and processed meat, refined grains, and sugar-sweetened foods and beverages are associated with lower risk of CVD, including clinically meaningful improvements in blood lipids and blood pressure. Some of these patterns also included low-fat dairy and seafood. Consistent findings across diverse racial, ethnic, and socioeconomic groups supported their conclusion that the evidence linking healthy dietary patterns to lower risk for CVD is strong (64). Similarly, the Committee's systematic review of dietary patterns and T2D, which included 14 RCTs and 104 prospective cohort studies published since 2014, concluded that dietary patterns higher in vegetables, fruits, whole grains, legumes, nuts, and fish/seafood, and lower in red and processed meats, high-fat dairy products, refined grains, and sugar-sweetened foods and beverages, were associated with a reduced risk of T2D. This conclusion was likewise supported by strong evidence (65).

Despite this strong evidence linking healthy dietary patterns to lower risk for CVD and T2D (64, 65), there are outstanding research questions regarding the role diet in cardiometabolic health for older adults. The cardiometabolic response to dietary intake is variable across individuals (66), highlighting a need to develop precision nutrition approaches (67, 68). Further research should elucidate the determinants and mechanisms driving this inter-individual variability (69). Moreover, despite strong evidence that following a healthy diet lowers risk for cardiovascular and metabolic diseases (64, 65), many older adults do not consume a healthy diet (70), highlighting a need a need to address the behavioral and environmental factors that influence dietary choices.

Cognitive Health:

Diet has emerged as an important modifiable factor for maintaining cognitive health in older age (71). Rather than being driven by any single nutrient or food group, the relationship between diet and brain health is likely multifaceted (72). There are several pathways thought to mediate the influence of diet on brain health, with oxidative stress and inflammation being key mechanisms. Oxidative stress occurs when reactive oxygen species accumulate more rapidly than they can be neutralized by the cell's antioxidant defense systems, leading to cellular damage and inflammation. Both processes are implicated in normal aging and neurodegenerative diseases. Nutrition plays a central role in oxidative pathways because many nutrients function as direct antioxidants or as regulators of endogenous antioxidant systems. Among the most studied are the omega-3 fatty acids eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), which are primarily found in fish oil and in smaller amounts in certain plant oils. A meta-analysis of RCTs that included older adults without dementia found that omega-3 supplementation was associated with modest cognitive benefits (73), whereas a meta-analysis of omega 3 supplementation trials conducted in patients with Alzheimer's disease did not find any overall benefit (74). These findings suggest that the potential cognitive benefits of omega-3s may depend on the stage of neurodegeneration. These benefits may be attributable, in part, to the role of omega-3 fatty acids in maintaining the structural integrity of neuron cell membranes, as PUFAs have been demonstrated to support white matter myelination (75), a process essential for information transmission and synaptic response (76).

A second pathway through which dietary factors may contribute to cognitive health involves brain energetics. The brain predominately utilizes glucose for energy. When glucose availability is diminished, such as during carbohydrate restriction or prolonged fasting, ketone bodies – mainly beta-hydroxybutyrate (BHB) - are utilized as alternate brain energy. Impaired cerebral glucose metabolism is implicated in Alzheimer's disease (AD) pathogenesis (77). As a result, ketogenic diets and other nutritional approaches that elevate ketone production have been proposed to support brain energetics and delay dementia onset (78, 79). There is evidence that increased BHB, produced in response to ketogenic diets, medium-chain triglyceride supplementation, or direct BHB supplementation, may improve cognitive health not only by providing an alternate brain energy source, but also by influencing key cell-signaling pathways involved in neuronal cell function. However, the evidence base to date is equivocal due, in part, to the difficulty of adhering to ketogenic diets over the long term, as well as variability in study design (80-83). While ketogenic diets and ketone supplementation represent potential strategies to improve brain energetics and cognitive health in older age, well-designed RCTs are needed to clarify the optimal interventional approaches, as well as long-term efficacy and safety.

Brain networks refer to the integration of modules within the cerebral cortex, which enable information to be processed more efficiently. These modules consist of cortical regions that are more strongly connected to facilitate communication across different parts of the brain. Brain networks are vital for coordinating cognitive function but are also susceptible to the effects of neurodegenerative diseases, which can then lead to cognitive decline. Emerging evidence suggests that nutrition is involved brain network organization and integration in older age (84). Omega-6 PUFAs, omega-3 PUFAs, and carotene nutrient biomarker patterns were associated with enhanced functional brain network efficiency, while omega-3 PUFAs and lycopene moderated the dorsal attention network and executive function (84). The use of fMRI in this study provided insight into how nutrient status is associated with the brain's network organization. However, the cross-sectional design is a notable limitation. Future research is needed to clarify how nutritional interventions may preserve brain network integrity and cognitive function in older age.

Despite the plausible mechanisms linking dietary factors to brain health and generally favorable evidence from observational studies that adherence to healthier dietary patterns is associated with reduced risk of cognitive decline and dementia (72, 85), RCTs on this topic are few and findings equivocal (71). Two sub-studies of the PREDIMED intervention in Spain found that the Mediterranean diet supplemented with either olive oil or mixed nuts improved cognitive function, compared to those in the control group (who were advised to follow a low-fat diet) (86, 87). The PREDIMED was designed to test the effect of the Mediterranean diet on the primary prevention of cardiovascular diseases (88), and cognitive outcomes were secondary. More recently, a 3-year RCT was designed to test the effect of adherence to the MIND diet, a hybrid of the Mediterranean and DASH diets, in older adults from the U.S. with BMI ≥ 25 kg/m2 and a family history of dementia (89). Participants were randomly assigned to a MIND diet intervention with energy restriction or a control group with energy restriction and followed for 3 years. The MIND diet intervention group received dietary guidance and incentives to incorporate relevant foods into their diets, and those randomized to the control group received guidance on portion control, energy tracking, and behavioral modifications for weight loss. Both groups included 3-5% caloric restriction. Global and domain specific cognitive function improved in both groups, but the improvements did not differ between them. Energy restriction has been reported to improve cognitive function in some studies (90, 91), which may have confounded the diet intervention. Future randomized controlled dietary intervention trials need to be designed to address these methodological limitations and incorporate frameworks that support both personalized nutrition and broader population-level dietary guidance (71, 92).

The Importance of Cultural Diversity in Nutrition and Aging Research

Over the next two decades, it is projected that racial and ethnic minority populations of older adults in the U.S. will grow by 105%, on average (93). To ensure that research focused on the role of diet and nutrition in healthy aging reflects the diversity of the U.S population, it is essential to include participants from racially, ethnically, culturally and socioeconomically diverse backgrounds. This necessitates the development and/or adaptation of culturally appropriate dietary assessment tools that query the intake of culturally specific foods (94). The Boston Puerto Rican Health Study (BPRHS) is one example of a study that sought to address this issue for a large and understudied segment of the US population. The BPRHS developed and validated a culturally tailored FFQ for this population and enrolled 1,500 older Puerto Rican adults living in the Greater Boston area beginning in 2004 (95). Adjustments for culturally relevant foods and portion sizes were important to improve the accuracy of dietary intake data and micronutrient status among Puerto Ricans and non-Hispanic white adults (96). Lack of culturally adapted dietary assessment tools has been shown to result in misclassification of dietary intakes in subgroups (97-99) and therefore bias results of diet-disease associations.

Using data driven methods, in this case principal components analysis, the BPRHS identified a Puerto Rican dietary pattern, high in rice and oil, that was associated with higher likelihood of developing metabolic syndrome (100). Additional findings showed that food insecurity significantly affects dietary quality, with lower intake of fruits and vegetables associated with poorer glycemic control, particularly among those with diabetes (101). Dietary patterns differ significantly by population sub-group of Hispanic Americans (102, 103) and therefore cannot be generalized to all. These findings emphasize the need for culturally tailored interventions and diet assessment tools to improve diet quality and health outcomes across diverse racial and ethnic populations in the U.S.

The Importance of the Food System

Older adults food choices and intake are influenced by age-related changes in physiology, socioeconomic status, family dynamics, such as eating alone or in an assisted living setting, and one's relationship with food (104). To support evolving dietary needs throughout life, the food system must adopt a holistic approach to food and dietary recommendations. This approach considers not only human health, but also the composition of foods, the bioavailability and accessibility of nutrients within those foods, as well as the effects that those foods and eating patterns have on communities (105). The food system is complex and dynamic – evolving over time due to changes in agricultural practices and pressure to produce large amounts of food that are affordable, accessible, and safe to consume (105). Therefore, research investment in diet and human health must address the realities of the current food system and will require transdisciplinary approaches, innovative methodologies and tools, and complex data systems developed through collaboration between public and private sectors to ensure nutritional security for an aging population.

Conclusion

Within 20 years, the number of adults 65 y and older is expected to reach ~80 million in the United States (55) and to exceed 2 billion worldwide (3). While this increased life expectancy represents a public health achievement, it brings notable challenges. The number of adults living with multiple comorbid diseases and disabilities will concomitantly increase, underscoring the importance of shifting the research priorities towards extending health span, not just lifespan. Nutrition has a central role in this regard. Obesity is now more common among older adults than being underweight. Age-related declines in chemosensory function, which are often exacerbated by co-morbidities, can negatively affect diet quality. As appetite and energy needs decline, it becomes increasingly important to consume nutrient dense dietary patterns, yet many older adults face barriers in doing so. Dietary factors contribute to musculoskeletal, cardiometabolic, and cognitive health, yet significant research gaps persist, partly because older adults are typically considered as a homogeneous group. Precision nutrition approaches are needed to address this limitation. The dietary needs of older adults vary widely based on race, ethnicity, culture and socioeconomic status –

highlighting a need for tailored interventions and diet assessment tools to improve diet quality and health outcomes for diverse populations in the United States. Meeting these challenges will require a multidisciplinary approach involving food systems, health care, and public health to support healthy aging for all older adults.

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References

1. World Health Organization. Aging and Health October 1, 2025. Internet: https://www.who.int/news-room/fact-sheets/detail/ageing-and-health (accessed November 25 2025).
2. Global Burden of Disease and Injury Prevention Collaborators. Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. Lancet 2018;392(10159):1789-858. doi: 10.1016/S0140-6736(18)32279-7.
3. World Health Organization. Global Health Estimates. https://www.who.int/data/global-health-estimates (accessed November 25 2025).
4. 2021 Global Nutrition Report: The State of Global Nutrition. Bristol UK, 2021. https://globalnutritionreport.org/reports/2021-global-nutrition-report/
5. Nutrition Assistance Programs Agencies Could Do More to Help Address the Nutritional Needs of Older Adults. Washington DC: United States Government Accountability Office, 2019. https://www.gao.gov/assets/gao-20-18.pdf
6. Michel JP, Sadana R. "Healthy Aging" Concepts and Measures. J Am Med Dir Assoc 2017;18(6):460-4. doi: 10.1016/j.jamda.2017.03.008.
7. Park S, Kang SW. Factors Related to Self-Rated Health Among Community-Dwelling Older Adults. Healthcare (Basel) 2025;13(3). doi: 10.3390/healthcare13030314.
8. World Health Organization Internet. Health Aging and Functional Ability: https://www.who.int/news-room/questions-and-answers/item/healthy-ageing-and-functional-ability (accessed November 25 2025).
9. Emmerich SD, Fryar CD, Stierman B, Ogden CL. Obesity and Severe Obesity Prevalence in Adults: United States, August 2021-August 2023. NCHS Data Brief 2024(508). doi: 10.15620/cdc/159281.
10. Fryar CD, Carroll MD, Afful J. Prevalence of underweight among adults aged 20 and over: United States, 1960–1962 through 2017–2018. NCHS Health E-Stats 2020. doi: https://www.cdc.gov/nchs/data/hestat/underweight-adult-17-18/underweight-adult.htm.
11. Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B(6), Folate, Vitamin B(12), Pantothenic Acid, Biotin, and Choline. Washington (DC), 1998.
12. Ross AC, Taylor CL, Yaktine AL, Del Valle HB, eds. Dietary Reference Intakes for Calcium and Vitamin D. Washington (DC), 2011.Edtion ed. In: Ross AC, Taylor CL, Yaktine AL, Del Valle HB, eds. Dietary Reference Intakes for Calcium and Vitamin D. Washington (DC), 2011.
13. Choi YJ, Crimmins EM, Kim JK, Ailshire JA. Food and nutrient intake and diet quality among older Americans. Public Health Nutr 2021;24(7):1638-47. doi: 10.1017/S1368980021000586.
14. Jun S, Cowan AE, Bhadra A, Dodd KW, Dwyer JT, Eicher-Miller HA, Gahche JJ, Guenther PM, Potischman N, Tooze JA, et al. Older adults with obesity have higher risks of some micronutrient inadequacies and lower overall dietary quality compared to peers with a healthy weight, National Health and Nutrition

Examination Surveys (NHANES), 2011-2014. Public Health Nutr 2020;23(13):2268-79. doi: 10.1017/S1368980020000257.
15. Astrup A, Bugel S. Overfed but undernourished: recognizing nutritional inadequacies/deficiencies in patients with overweight or obesity. Int J Obes (Lond) 2019;43(2):219-32. doi: 10.1038/s41366-018-0143-9.
16. Gahche JJ, Bailey RL, Potischman N, Dwyer JT. Dietary Supplement Use Was Very High among Older Adults in the United States in 2011-2014. J Nutr 2017;147(10):1968-76. doi: 10.3945/jn.117.255984.
17. Cowan AE, Bailey RL, Jun S, Dodd KW, Gahche JJ, Eicher-Miller HA, Guenther PM, Dwyer JT, Potischman N, Bhadra A, et al. The Total Nutrient Index is a Useful Measure for Assessing Total Micronutrient Exposures Among US Adults. J Nutr 2022;152(3):863-71. doi: 10.1093/jn/nxab428.
18. Cowan AE, Jun S, Tooze JA, Dodd KW, Gahche JJ, Eicher-Miller HA, Guenther PM, Dwyer JT, Potischman N, Bhadra A, et al. A narrative review of nutrient based indexes to assess diet quality and the proposed total nutrient index that reflects total dietary exposures. Crit Rev Food Sci Nutr 2023;63(12):1722-32. doi: 10.1080/10408398.2021.1967872.
19. Dietary Guidelines for Americans 2020-2025. https://www.dietaryguidelines.gov/resources/2020-2025-dietary-guidelines-online-materials
20. Office of Dietary Supplements. Dietary Supplements and Older Adults. https://www.nia.nih.gov/health/vitamins-and-supplements/dietary-supplements-older-adults (accessed November 25 2025).
21. Appel LJ, Moore TJ, Obarzanek E, Vollmer WM, Svetkey LP, Sacks FM, Bray GA, Vogt TM, Cutler JA, Windhauser MM, et al. A clinical trial of the effects of dietary patterns on blood pressure. DASH Collaborative Research Group. N Engl J Med 1997;336(16):1117-24. doi: 10.1056/NEJM199704173361601.
22. Sacks FM, Svetkey LP, Vollmer WM, Appel LJ, Bray GA, Harsha D, Obarzanek E, Conlin PR, Miller ER, 3rd, Simons-Morton DG, et al. Effects on blood pressure of reduced dietary sodium and the Dietary Approaches to Stop Hypertension (DASH) diet. DASH-Sodium Collaborative Research Group. N Engl J Med 2001;344(1):3-10. doi: 10.1056/NEJM200101043440101.
23. Murtaugh MA, Beasley JM, Appel LJ, Guenther PM, McFadden M, Greene T, Tooze JA. Relationship of Sodium Intake and Blood Pressure Varies With Energy Intake: Secondary Analysis of the DASH (Dietary Approaches to Stop Hypertension)-Sodium Trial. Hypertension 2018;71(5):858-65. doi: 10.1161/HYPERTENSIONAHA.117.10602.
24. Mattes RD. The chemical senses and nutrition in aging: challenging old assumptions. J Am Diet Assoc 2002;102(2):192-6. doi: 10.1016/s0002-8223(02)90047-7.
25. Spence C, Youssef J. Aging and the (Chemical) Senses: Implications for Food Behaviour Amongst Elderly Consumers. Foods 2021;10(1). doi: 10.3390/foods10010168.
26. Duffy V. Causes of Smell, Taste, and Oral Somatosensory Disorders Affecting Eating and Drinking. Edtion ed., 2020:1-40.

27. Mathieu ME, Reid RER, King NA. Sensory Profile of Adults with Reduced Food Intake and the Potential Roles of Nutrition and Physical Activity Interventions. Adv Nutr 2019;10(6):1120-5. doi: 10.1093/advances/nmz044.
28. Drewnowski A, Henderson SA, Driscoll A, Rolls BJ. Salt taste perceptions and preferences are unrelated to sodium consumption in healthy older adults. J Am Diet Assoc 1996;96(5):471-4. doi: 10.1016/S0002-8223(96)00131-9.
29. Hendi K, Leshem M. Salt appetite in the elderly. Br J Nutr 2014;112(10):1621-7. doi: 10.1017/S0007114514002803.
30. Reed DR, Alhadeff AL, Beauchamp GK, Chaudhari N, Duffy VB, Dus M, Fontanini A, Glendinning JI, Green BG, Joseph PV, et al. NIH Workshop Report: sensory nutrition and disease. Am J Clin Nutr 2021;113(1):232-45. doi: 10.1093/ajcn/nqaa302.
31. Mattes RD. Sensory nutrition: lessons learned and opportunities. Obesity (Silver Spring) 2024;32(8):1421-4. doi: 10.1002/oby.24089.
32. Volpi E, Nazemi R, Fujita S. Muscle tissue changes with aging. Curr Opin Clin Nutr Metab Care 2004;7(4):405-10. doi: 10.1097/01.mco.0000134362.76653.b2.
33. Houston DK, Nicklas BJ, Ding J, Harris TB, Tylavsky FA, Newman AB, Lee JS, Sahyoun NR, Visser M, Kritchevsky SB, et al. Dietary protein intake is associated with lean mass change in older, community-dwelling adults: the Health, Aging, and Body Composition (Health ABC) Study. Am J Clin Nutr 2008;87(1):150-5. doi: 10.1093/ajcn/87.1.150.
34. Elstgeest LEM, Schaap LA, Heymans MW, Hengeveld LM, Naumann E, Houston DK, Kritchevsky SB, Simonsick EM, Newman AB, Farsijani S, et al. Sex-and race-specific associations of protein intake with change in muscle mass and physical function in older adults: the Health, Aging, and Body Composition (Health ABC) Study. Am J Clin Nutr 2020;112(1):84-95. doi: 10.1093/ajcn/nqaa099.
35. Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids. Washington, DC: The National Academies Press, 2005.
36. Gaffney-Stomberg E, Insogna KL, Rodriguez NR, Kerstetter JE. Increasing dietary protein requirements in elderly people for optimal muscle and bone health. J Am Geriatr Soc 2009;57(6):1073-9. doi: 10.1111/j.1532-5415.2009.02285.x.
37. Traylor DA, Gorissen SHM, Phillips SM. Perspective: Protein Requirements and Optimal Intakes in Aging: Are We Ready to Recommend More Than the Recommended Daily Allowance? Adv Nutr 2018;9(3):171-82. doi: 10.1093/advances/nmy003.
38. Bauer J, Biolo G, Cederholm T, Cesari M, Cruz-Jentoft AJ, Morley JE, Phillips S, Sieber C, Stehle P, Teta D, et al. Evidence-based recommendations for optimal dietary protein intake in older people: a position paper from the PROT-AGE Study Group. J Am Med Dir Assoc 2013;14(8):542-59. doi: 10.1016/j.jamda.2013.05.021.
39. Deutz NE, Bauer JM, Barazzoni R, Biolo G, Boirie Y, Bosy-Westphal A, Cederholm T, Cruz-Jentoft A, Krznaric Z, Nair KS, et al. Protein intake and exercise for optimal muscle function with aging: recommendations from the

ESPEN Expert Group. Clin Nutr 2014;33(6):929-36. doi: 10.1016/j.clnu.2014.04.007.
40. Campbell WW, Deutz NEP, Volpi E, Apovian CM. Nutritional Interventions: Dietary Protein Needs and Influences on Skeletal Muscle of Older Adults. J Gerontol A Biol Sci Med Sci 2023;78(Suppl 1):67-72. doi: 10.1093/gerona/glad038.
41. Ten Haaf DSM, Nuijten MAH, Maessen MFH, Horstman AMH, Eijsvogels TMH, Hopman MTE. Effects of protein supplementation on lean body mass, muscle strength, and physical performance in nonfrail community-dwelling older adults: a systematic review and meta-analysis. Am J Clin Nutr 2018;108(5):1043-59. doi: 10.1093/ajcn/nqy192.
42. Wirth J, Hillesheim E, Brennan L. The Role of Protein Intake and its Timing on Body Composition and Muscle Function in Healthy Adults: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. J Nutr 2020;150(6):1443-60. doi: 10.1093/jn/nxaa049.
43. Nunes EA, Colenso-Semple L, McKellar SR, Yau T, Ali MU, Fitzpatrick-Lewis D, Sherifali D, Gaudichon C, Tome D, Atherton PJ, et al. Systematic review and meta-analysis of protein intake to support muscle mass and function in healthy adults. J Cachexia Sarcopenia Muscle 2022;13(2):795-810. doi: 10.1002/jcsm.12922.
44. Han X, Goh KY, Lee WX, Choy SM, Tang HW. The Importance of mTORC1-Autophagy Axis for Skeletal Muscle Diseases. Int J Mol Sci 2022;24(1). doi: 10.3390/ijms24010297.
45. Tang H, Inoki K, Brooks SV, Okazawa H, Lee M, Wang J, Kim M, Kennedy CL, Macpherson PCD, Ji X, et al. mTORC1 underlies age-related muscle fiber damage and loss by inducing oxidative stress and catabolism. Aging Cell 2019;18(3):e12943. doi: 10.1111/acel.12943.
46. Moro T, Brightwell CR, Deer RR, Graber TG, Galvan E, Fry CS, Volpi E, Rasmussen BB. Muscle Protein Anabolic Resistance to Essential Amino Acids Does Not Occur in Healthy Older Adults Before or After Resistance Exercise Training. J Nutr 2018;148(6):900-9. doi: 10.1093/jn/nxy064.
47. Dickinson JM, Fry CS, Drummond MJ, Gundermann DM, Walker DK, Glynn EL, Timmerman KL, Dhanani S, Volpi E, Rasmussen BB. Mammalian target of rapamycin complex 1 activation is required for the stimulation of human skeletal muscle protein synthesis by essential amino acids. J Nutr 2011;141(5):856-62. doi: 10.3945/jn.111.139485.
48. Katsanos CS, Kobayashi H, Sheffield-Moore M, Aarsland A, Wolfe RR. A high proportion of leucine is required for optimal stimulation of the rate of muscle protein synthesis by essential amino acids in the elderly. Am J Physiol Endocrinol Metab 2006;291(2):E381-7. doi: 10.1152/ajpendo.00488.2005.
49. Volpi E, Kobayashi H, Sheffield-Moore M, Mittendorfer B, Wolfe RR. Essential amino acids are primarily responsible for the amino acid stimulation of muscle protein anabolism in healthy elderly adults. Am J Clin Nutr 2003;78(2):250-8. doi: 10.1093/ajcn/78.2.250.
50. Murphy CH, Flanagan EM, De Vito G, Susta D, Mitchelson KAJ, de Marco Castro E, Senden JMG, Goessens JPB, Miklosz A, Chabowski A, et al. Does

supplementation with leucine-enriched protein alone and in combination with fish-oil-derived n-3 PUFA affect muscle mass, strength, physical performance, and muscle protein synthesis in well-nourished older adults? A randomized, double-blind, placebo-controlled trial. Am J Clin Nutr 2021;113(6):1411-27. doi: 10.1093/ajcn/nqaa449.
51. Szwiega S, Pencharz PB, Rafii M, Lebarron M, Chang J, Ball RO, Kong D, Xu L, Elango R, Courtney-Martin G. Dietary leucine requirement of older men and women is higher than current recommendations. Am J Clin Nutr 2021;113(2):410-9. doi: 10.1093/ajcn/nqaa323.
52. Millward DJ. Leucine requirements for the elderly. Am J Clin Nutr 2021;113(4):1056-7. doi: 10.1093/ajcn/nqab030.
53. Moro T, Ebert SM, Adams CM, Rasmussen BB. Amino Acid Sensing in Skeletal Muscle. Trends Endocrinol Metab 2016;27(11):796-806. doi: 10.1016/j.tem.2016.06.010.
54. Aragon AA, Tipton KD, Schoenfeld BJ. Age-related muscle anabolic resistance: inevitable or preventable? Nutr Rev 2023;81(4):441-54. doi: 10.1093/nutrit/nuac062.
55. Mather M, Scommegna P. Rising Obesity in an Aging America: Policy and Program Implications. Washington D.C.: Population Reference Bureau, 2022.
56. Coker RH, Wolfe RR. Weight Loss Strategies in the Elderly: A Clinical Conundrum. Obesity (Silver Spring) 2018;26(1):22-8. doi: 10.1002/oby.21961.
57. Kim JE, O'Connor LE, Sands LP, Slebodnik MB, Campbell WW. Effects of dietary protein intake on body composition changes after weight loss in older adults: a systematic review and meta-analysis. Nutr Rev 2016;74(3):210-24. doi: 10.1093/nutrit/nuv065.
58. Porter Starr KN, Pieper CF, Orenduff MC, McDonald SR, McClure LB, Zhou R, Payne ME, Bales CW. Improved Function With Enhanced Protein Intake per Meal: A Pilot Study of Weight Reduction in Frail, Obese Older Adults. J Gerontol A Biol Sci Med Sci 2016;71(10):1369-75. doi: 10.1093/gerona/glv210.
59. Englert I, Bosy-Westphal A, Bischoff SC, Kohlenberg-Muller K. Impact of Protein Intake during Weight Loss on Preservation of Fat-Free Mass, Resting Energy Expenditure, and Physical Function in Overweight Postmenopausal Women: A Randomized Controlled Trial. Obes Facts 2021;14(3):259-70. doi: 10.1159/000514427.
60. Backx EM, Tieland M, Borgonjen-van den Berg KJ, Claessen PR, van Loon LJ, de Groot LC. Protein intake and lean body mass preservation during energy intake restriction in overweight older adults. Int J Obes (Lond) 2016;40(2):299-304. doi: 10.1038/ijo.2015.182.
61. McGuire S. Scientific Report of the 2015 Dietary Guidelines Advisory Committee. Washington, DC: US Departments of Agriculture and Health and Human Services, 2015. Adv Nutr 2016;7(1):202-4. doi: 10.3945/an.115.011684.
62. Boersma P, Black LI, Ward BW. Prevalence of Multiple Chronic Conditions Among US Adults, 2018. Prev Chronic Dis 2020;17:E106. doi: 10.5888/pcd17.200130.
63. Scientific Report of the 2025 Dietary Guidelines Advisory Committee: Advisory Report to the Secretary of Health and Human Services and Secretary of

Agriculture. Washington D.C.: United States Department of Health and Human Services, 2024. https://doi.org/10.52570/DGAC2025

64. Anderson CAM, Gardner C, Talegawkar S, Hoelscher DM, Stanford FC, Tobias D, Booth S, Fung T, Deierlein A, Giovannucci E, et al. Edtion ed. Dietary Patterns and Risk of Cardiovascular Disease: A Systematic Review. Alexandria (VA), 2024.
65. Talegawkar S, Tobias D, Fung T, Giovannucci E, Hoelscher DM, Anderson CAM, Booth S, Deierlein A, Gardner C, Raynor H, et al. Edtion ed. Dietary Patterns and Risk of Type 2 Diabetes: A Systematic Review. Alexandria (VA), 2024.
66. Berry SE, Valdes AM, Drew DA, Asnicar F, Mazidi M, Wolf J, Capdevila J, Hadjigeorgiou G, Davies R, Al Khatib H, et al. Human postprandial responses to food and potential for precision nutrition. Nat Med 2020;26(6):964-73. doi: 10.1038/s41591-020-0934-0.
67. Bermingham KM, Linenberg I, Polidori L, Asnicar F, Arre A, Wolf J, Badri F, Bernard H, Capdevila J, Bulsiewicz WJ, et al. Effects of a personalized nutrition program on cardiometabolic health: a randomized controlled trial. Nat Med 2024;30(7):1888-97. doi: 10.1038/s41591-024-02951-6.
68. Jinnette R, Narita A, Manning B, McNaughton SA, Mathers JC, Livingstone KM. Does Personalized Nutrition Advice Improve Dietary Intake in Healthy Adults? A Systematic Review of Randomized Controlled Trials. Adv Nutr 2021;12(3):657-69. doi: 10.1093/advances/nmaa144.
69. Valles-Colomer M, Menni C, Berry SE, Valdes AM, Spector TD, Segata N. Cardiometabolic health, diet and the gut microbiome: a meta-omics perspective. Nat Med 2023;29(3):551-61. doi: 10.1038/s41591-023-02260-4.
70. Shea MK, Barger K, Rogers GT, Talegawkar SA, Eicher-Miller HA, Booth SL. Dietary Intakes of Community-Dwelling Adults in the United States across Older Adulthood: National Health and Nutrition Examination Survey 2015-March 2020. J Nutr 2024;154(2):691-6. doi: 10.1016/j.tjnut.2023.12.014.
71. Charisis S, Yannakoulia M, Scarmeas N. Diets to promote healthy brain ageing. Nat Rev Neurol 2025;21(1):5-16. doi: 10.1038/s41582-024-01036-9.
72. Booth SL, English LK, Reigh NA, Jacques PF, Forester BP, Shea MK. Dietary Patterns and Brain Aging: Enthusiasm Before Evidence? Annu Rev Nutr 2025;45(1):251-68. doi: 10.1146/annurev-nutr-013125-030429.
73. Barros MI, Brandao T, Irving SC, Alves P, Gomes F, Correia M. Omega-3 Polyunsaturated Fatty Acids and Cognitive Decline in Adults with Non-Dementia or Mild Cognitive Impairment: An Overview of Systematic Reviews. Nutrients 2025;17(18). doi: 10.3390/nu17183002.
74. Kalamara TV, Dodos K, Georgakopoulou VE, Fotakopoulos G, Spandidos DA, Kapoukranidou D. Cognitive efficacy of omega-3 fatty acids in Alzheimer's disease: A systematic review and meta-analysis. Biomed Rep 2025;22(4):62. doi: 10.3892/br.2025.1940.
75. Yehuda S, Rabinovitz S, Mostofsky DI. Essential fatty acids and the brain: from infancy to aging. Neurobiol Aging 2005;26 Suppl 1:98-102. doi: 10.1016/j.neurobiolaging.2005.09.013.

76. Bonetto G, Belin D, Karadottir RT. Myelin: A gatekeeper of activity-dependent circuit plasticity? Science 2021;374(6569):eaba6905. doi: 10.1126/science.aba6905.
77. Butterfield DA, Halliwell B. Oxidative stress, dysfunctional glucose metabolism and Alzheimer disease. Nat Rev Neurosci 2019;20(3):148-60. doi: 10.1038/s41583-019-0132-6.
78. Hersant H, Grossberg G. The Ketogenic Diet and Alzheimer's Disease. J Nutr Health Aging 2022;26(6):606-14. doi: 10.1007/s12603-022-1807-7.
79. Davis JJ, Fournakis N, Ellison J. Ketogenic Diet for the Treatment and Prevention of Dementia: A Review. J Geriatr Psychiatry Neurol 2021;34(1):3-10. doi: 10.1177/0891988720901785.
80. Myette-Cote E, Soto-Mota A, Cunnane SC. Ketones: potential to achieve brain energy rescue and sustain cognitive health during ageing. Br J Nutr 2022;128(3):407-23. doi: 10.1017/S0007114521003883.
81. Gabuzyan R, Lee C, Nygaard HB. Ketogenic Approaches for the Treatment of Alzheimer's Disease. J Alzheimers Dis 2024;101(s1):S443-S53. doi: 10.3233/JAD-240186.
82. Fortier M, Castellano CA, St-Pierre V, Myette-Cote E, Langlois F, Roy M, Morin MC, Bocti C, Fulop T, Godin JP, et al. A ketogenic drink improves cognition in mild cognitive impairment: Results of a 6-month RCT. Alzheimers Dement 2021;17(3):543-52. doi: 10.1002/alz.12206.
83. Brandt J, Buchholz A, Henry-Barron B, Vizthum D, Avramopoulos D, Cervenka MC. Preliminary Report on the Feasibility and Efficacy of the Modified Atkins Diet for Treatment of Mild Cognitive Impairment and Early Alzheimer's Disease. J Alzheimers Dis 2019;68(3):969-81. doi: 10.3233/JAD-180995.
84. Zwilling CE, Talukdar T, Zamroziewicz MK, Barbey AK. Nutrient biomarker patterns, cognitive function, and fMRI measures of network efficiency in the aging brain. Neuroimage 2019;188:239-51. doi: 10.1016/j.neuroimage.2018.12.007.
85. Booth S, Talegawkar S, Fung T, Hoelscher DM, Anderson CAM, Deierlein A, Gardner C, Giovannucci E, Raynor H, Stanford FC, et al. Edtion ed. Dietary Patterns and Risk of Cognitive Decline, Dementia, Alzheimer's Disease, and Mild Cognitive Impairment: A Systematic Review. Alexandria (VA), 2024.
86. Valls-Pedret C, Sala-Vila A, Serra-Mir M, Corella D, de la Torre R, Martinez-Gonzalez MA, Martinez-Lapiscina EH, Fito M, Perez-Heras A, Salas-Salvado J, et al. Mediterranean Diet and Age-Related Cognitive Decline: A Randomized Clinical Trial. JAMA Intern Med 2015;175(7):1094-103. doi: 10.1001/jamainternmed.2015.1668.
87. Martinez-Lapiscina EH, Clavero P, Toledo E, Estruch R, Salas-Salvado J, San Julian B, Sanchez-Tainta A, Ros E, Valls-Pedret C, Martinez-Gonzalez MA. Mediterranean diet improves cognition: the PREDIMED-NAVARRA randomised trial. J Neurol Neurosurg Psychiatry 2013;84(12):1318-25. doi: 10.1136/jnnp-2012-304792.
88. Estruch R, Ros E, Salas-Salvado J, Covas MI, Corella D, Aros F, Gomez-Gracia E, Ruiz-Gutierrez V, Fiol M, Lapetra J, et al. Primary Prevention of Cardiovascular Disease with a Mediterranean Diet Supplemented with Extra-

Virgin Olive Oil or Nuts. N Engl J Med 2018;378(25):e34. doi: 10.1056/NEJMoa1800389.
89. Barnes LL, Dhana K, Liu X, Carey VJ, Ventrelle J, Johnson K, Hollings CS, Bishop L, Laranjo N, Stubbs BJ, et al. Trial of the MIND Diet for Prevention of Cognitive Decline in Older Persons. N Engl J Med 2023;389(7):602-11. doi: 10.1056/NEJMoa2302368.
90. Leclerc E, Trevizol AP, Grigolon RB, Subramaniapillai M, McIntyre RS, Brietzke E, Mansur RB. The effect of caloric restriction on working memory in healthy non-obese adults. CNS Spectr 2020;25(1):2-8. doi: 10.1017/S1092852918001566.
91. Witte AV, Fobker M, Gellner R, Knecht S, Floel A. Caloric restriction improves memory in elderly humans. Proc Natl Acad Sci U S A 2009;106(4):1255-60. doi: 10.1073/pnas.0808587106.
92. Yassine HN, Samieri C, Livingston G, Glass K, Wagner M, Tangney C, Plassman BL, Ikram MA, Voigt RM, Gu Y, et al. Nutrition state of science and dementia prevention: recommendations of the Nutrition for Dementia Prevention Working Group. Lancet Healthy Longev 2022;3(7):e501-e12. doi: 10.1016/s2666-7568(22)00120-9.
93. Administration for Community Living. Profile of Older Americans. Washington D.C.: U.S. Department of Health and Human Services, 2024. https://acl.gov/aging-and-disability-in-america/data-and-research/profile-older-americans
94. Ojo AS, Nnyanzi LA, Giles EL, Ells LJ, Awolaran O, Okeke SR, Afaya A, Bolarinwa OA. Perceptions of dietary intake amongst Black, Asian and other minority ethnic groups in high-income countries: a systematic review of qualitative literature. BMC Nutr 2023;9(1):85. doi: 10.1186/s40795-023-00743-8.
95. Tucker KL, Mattei J, Noel SE, Collado BM, Mendez J, Nelson J, Griffith J, Ordovas JM, Falcon LM. The Boston Puerto Rican Health Study, a longitudinal cohort study on health disparities in Puerto Rican adults: challenges and opportunities. BMC Public Health 2010;10:107. doi: 10.1186/1471-2458-10-107.
96. Tucker KL, Bianchi LA, Maras J, Bermudez OI. Adaptation of a food frequency questionnaire to assess diets of Puerto Rican and non-Hispanic adults. Am J Epidemiol 1998;148(5):507-18. doi: 10.1093/oxfordjournals.aje.a009676.
97. Olendzki B, Procter-Gray E, Magee MF, Youssef G, Kane K, Churchill L, Ockene J, Li W. Racial Differences in Misclassification of Healthy Eating Based on Food Frequency Questionnaire and 24-Hour Dietary Recalls. J Nutr Health Aging 2017;21(7):787-98. doi: 10.1007/s12603-016-0839-2.
98. Block G, Mandel R, Gold E. On food frequency questionnaires: the contribution of open-ended questions and questions on ethnic foods. Epidemiology 2004;15(2):216-21. doi: 10.1097/01.ede.0000112144.77106.bf.
99. Jaceldo-Siegl K, Fan J, Sabate J, Knutsen SF, Haddad E, Beeson WL, Herring RP, Butler TL, Bennett H, Fraser GE. Race-specific validation of food intake obtained from a comprehensive FFQ: the Adventist Health Study-2. Public Health Nutr 2011;14(11):1988-97. doi: 10.1017/S1368980011000735.
100. Noel SE, Newby PK, Ordovas JM, Tucker KL. A traditional rice and beans pattern is associated with metabolic syndrome in Puerto Rican older adults. J Nutr 2009;139(7):1360-7. doi: 10.3945/jn.109.105874.

101. Berkowitz SA, Gao X, Tucker KL. Food-insecure dietary patterns are associated with poor longitudinal glycemic control in diabetes: results from the Boston Puerto Rican Health study. Diabetes Care 2014;37(9):2587-92. doi: 10.2337/dc14-0753.
102. van Rompay MI, McKeown NM, Castaneda-Sceppa C, Falcon LM, Ordovas JM, Tucker KL. Acculturation and sociocultural influences on dietary intake and health status among Puerto Rican adults in Massachusetts. J Acad Nutr Diet 2012;112(1):64-74. doi: 10.1016/j.jada.2011.08.049.
103. Mattei J, McClain AC, Falcon LM, Noel SE, Tucker KL. Dietary Acculturation among Puerto Rican Adults Varies by Acculturation Construct and Dietary Measure. J Nutr 2018;148(11):1804-13. doi: 10.1093/jn/nxy174.
104. Whitelock E, Ensaff H. On Your Own: Older Adults' Food Choice and Dietary Habits. Nutrients 2018;10(4). doi: 10.3390/nu10040413.
105. Nesheim MC, Oria M, Yih PT, editors. A Framework for Assessing Effects of the Food System. Washington (DC), 2015.