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REVIEW

Nutrition and Healthy Aging: A Review

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Abstract

Purpose of Review The review attempts to highlight various dietary approaches for healthy aging; it examines the current evidence regarding the impact of various dietary components on physiological, cognitive, and functional outcomes in older adults. The aim is to promote nutritional awareness to add to what is currently reported in this field that helps for the needful revisions in the policy and in the current national nutrition strategy to incorporate effective public health communication on nutrition and aging.

Recent Findings The relationship between diet and healthy aging is becoming increasingly clear with recent studies. Consuming a balanced diet that includes nutrient-rich foods, such as fruits, vegetables, whole grains, lean proteins, and healthy fats, has been linked to a lower risk of chronic diseases and better overall health in older adults. Specific dietary factors that have been found to be beneficial for healthy aging include adherence to a Mediterranean-style diet, Okinawa diet, Dietary Approaches to Stop Hypertension (DASH) diet, and caloric restriction as well as the healthy eating index. Therefore, making dietary changes that promote healthy aging can be an important strategy for maintaining physical and cognitive function and preventing age-related diseases.

Summary Adopting a healthy diet in older age can be an effective strategy for maintaining optimal health and function with adequate intake of protein, fiber, vitamin D, and omega-3 fatty acids for better physical function, bone health, muscle strength, cognitive function, and lower risk of chronic diseases and disability.

Keywords Aging · Nutrition · Public health · Dietary patterns · Polyphenols · Age-related disorders

Introduction

Biologically, the aging process results from gradual accumulation of various types of damage at the cellular and molecular levels, which brings about a decrease in mental and physical abilities and eventually leads to death [1]. The World Health Organization [2] defines healthy aging as the process of acquiring and maintaining functional capacity that promotes well-being in older age. Healthy aging has been linked to a longer lifespan, but other factors, such as regular exercise, good sleep patterns, lifestyle changes, and chronic disease management, can also work in conjunction with a healthy diet to improve longevity.

Although longevity does not always equate to good health, the present group of elderly individuals has a longer lifespan than their predecessors, likely due to notable progress and advancement in technology, science, medicine, and public health [3]. Nutritional education is emphasized in current research on nutrition science [4] as a means of preventing premature chronic diseases and promoting healthy aging. An effective team consisting of epidemiologists, dieticians, and allied health professionals can achieve nutritional adequacy in a diverse population of older adults.

The modification of one's diet is a controllable aspect of lifestyle that can help prevent the onset of age-related illnesses and promote overall health as one ages [5••]. This viewpoint aligns with the World Health Organization's model of healthy aging, which prioritizes the maximization of individual potential in terms of cognition, locomotion, sensory function, psychological status, and vitality.

Existing research has demonstrated that consuming various fruits and vegetables as part of a dietary regimen can be beneficial in delaying the occurrence of age-related conditions and improving cognitive function among older adults. Additionally, such diets can enhance overall brain health,

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with examples including, among others, the Mediterranean diet [6], Okinawan diet [7], Dietary Approaches to Stop Hypertension (DASH) [8], and Healthy Eating Index [9]. Therefore, this review provides a comprehensive overview of previous research linking diet and healthy aging worldwide, with a particular emphasis on the association between healthy diets and prolonged lifespan. Most of the reviews and existing literature is from the West and the current review throws light on the vital role of nutrition in aging and cognition. Through this review, we also aim to identify the limited studies in Indian perspective as India is a country with multicultures and drastic demographic and social transitions impacting the status and quality of life of aging adults.

Search Strategy

Literature review search for systematic reviews, research articles, and randomized controlled trials that studied the effectiveness of different dietary patterns in promoting healthy at different age groups were sourced from MEDLINE, Embase, PubMed, Cochrane Library, and Google Scholar databases. The search was done with the keywords and MeSH terms that can be used to identify articles in the Nutrition & Healthy Aging field on PubMed: "Nutrition"[MeSH Terms] OR "Diet"[MeSH Terms] OR "Dietary Patterns"[MeSH Terms]) AND ("Aging"[MeSH Terms] OR "Aged"[MeSH Terms] OR "Elderly" [MeSH Terms].

Inclusion and Exclusion Criteria

Only published studies performed between 1980 till 2022 were eligible for inclusion and we excluded those in languages other than English. Short communication letters, conference abstracts, book chapters, and short surveys as well as studies based on the perspective of authors were also excluded.

The selected ($n = 56$) studies (Fig. 1) included in this review focused on various interactions of positive benefits of nutrition in promoting healthy aging. The dietary plans that have demonstrated success in warding off age-related illnesses are primarily centered around fruits and vegetables and offer various advantages such as antiinflammatory, antidiabetic, antioxidant, and anticancer properties. These benefits can lead to a healthier aging process and lessen the impact of chronic illnesses. As a result, healthy eating patterns are often recommended to ensure proper hydration and nutrient intake, support the body's physiological functions, and provide essential macronutrients for energy needs.

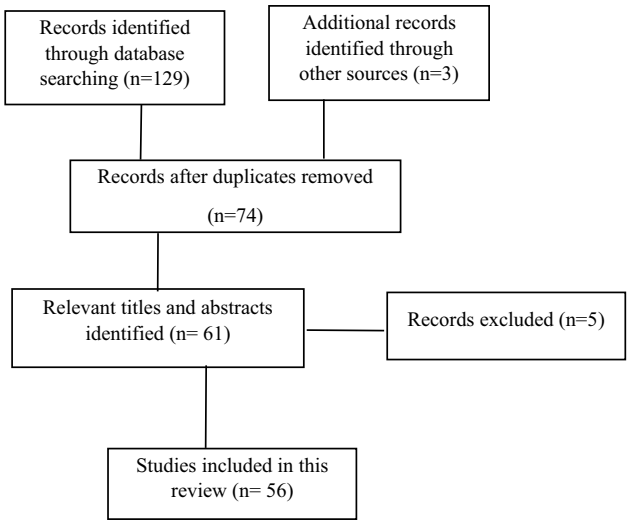

Fig. 1 Flow diagram for study selection process

Ultimately, this can enhance an individual's nutritional status and promote optimal body balance.

Dietary Patterns for Healthy Aging

Adherence to a healthy dietary pattern may aid in diminishing the degenerative alterations in the body. Incorporating fruits and vegetables into the diet can also provide essential nutrients to the brain [10]. Additionally, it is recommended to consume sources of low-fat protein such as beans, fish, and skinless poultry to help curb the gradual loss of tissues in the body.

Due to advancing age and a higher risk of health issues, the elderly has specific nutritional demands. In addition to fiber, fruits, vegetables, and good fats, older adults also need sufficient protein to maintain muscle mass and strength, which can decline with age. Good sources of protein include lean meats, fish, poultry, eggs, beans, and nuts. Calcium and vitamin D are also important for bone health and can help prevent osteoporosis. Good sources of calcium include dairy products, leafy greens, and fortified foods, while vitamin D can be obtained from sunlight exposure or supplements. Fluid intake is another crucial aspect of nutrition for older adults, as dehydration can lead to a range of health problems. Older adults should aim to drink plenty of water and consume fluids from other sources such as soups, broths, and herbal teas. Due to reduced appetite, digestive problems, dental issues, and reduced palatability, many elderly individuals tend to consume inadequate amounts of food. Thus, it is important to prioritize nutrient-dense foods such as spinach and healthy fats. A variety of diets either priori or posteriori (Table 1) have been demonstrated to have a significant impact on one's health in older age [11].

Table 1 Epidemiological study reviews on the impact of diet on different health outcomes

Study title	Study design	Population studied	Dietary pattern	Health outcome	Findings
"Mediterranean diet and health status: an updated meta-analysis and a proposal for a literature-based adherence score" [49]	Meta-analysis	General population	Mediterranean diet	All-cause mortality, cardiovascular disease, cancer, neurodegenerative diseases, diabetes	Higher adherence to the Mediterranean diet was associated with lower risk of all-cause mortality, cardiovascular disease, cancer, neurodegenerative diseases, and diabetes
"Dietary patterns and risk of colorectal cancer: a systematic review of cohort studies " [50]	Systematic studies	Cohort studies	Western dietary pattern, prudent/healthy dietary pattern	Colorectal cancer	Higher adherence to the prudent/healthy dietary pattern was associated with lower risk of colorectal cancer
"The Mediterranean and Dietary Approaches to Stop Hypertension (DASH) diets and colorectal cancer" [51]	Prospective cohort studies	Nurses' Health Study and Health Professionals Follow-up Study	Mediterranean diet, DASH diet	Mediterranean diet, DASH diet	Higher adherence to the Mediterranean and DASH diets was associated with lower risk of colorectal cancer
"Dietary patterns and the risk of type 2 diabetes in overweight and obese individuals" [52]	Prospective cohort study	Overweight and obese individuals	Healthy eating index, Mediterranean diet	Type 2 diabetes	Higher adherence to the healthy eating index and Mediterranean diet was associated with lower risk of type 2 diabetes
"Dietary patterns and cardiovascular disease mortality in Japan: a prospective cohort study" [53]	Prospective cohort study	Japanese population	Dietary patterns based on intake of rice, miso soup, fish, meat, and vegetables	Cardiovascular disease mortality	Higher intake of rice, miso soup, and vegetables and lower intake of meat were associated with lower risk of cardiovascular disease mortality
"Dietary patterns and cognitive function in older adults" [54]	Systematic review	Older adults	Mediterranean diet, DASH diet, Japanese diet, plant-based diet	Cognitive health	Higher adherence to the Mediterranean diet, DASH diet, Japanese diet, and plant-based diet was associated with better cognitive function in older adults
"Mediterranean diet and incidence of and mortality from coronary heart disease and stroke in women" [55]	Prospective cohort study	Older women	Mediterranean diet	Coronary heart diseases and stroke	Adherence to a Mediterranean dietary pattern (rich in vegetables, fruits, whole grains, nuts, legumes, fish, and olive oil) was associated with a lower risk of coronary heart disease and stroke incidence and mortality
Dietary Patterns in Association With Hypertension: A Community-Based Study in Eastern China [56]	Cross-sectional study	Male and female adults in Suzhou, Eastern China	Rice-vegetable pattern, fast food pattern, fruit-dairy pattern, and wheat-meat pattern	Hypertension	The fruit-dairy pattern was inversely associated with the risk of hypertension among Chinese adults

Mediterranean Diet (MedDiet)

Ancel Keys first discovered the MedDiet in 1960, and it is widely recognized as the most extensively researched and popular dietary pattern [12]. The Mediterranean diet, known for its emphasis on daily consumption of fruits, vegetables, legumes, and whole grains, and reduced intake of meat, fish, and dairy, is the dietary pattern most commonly linked with delayed onset of age-related chronic diseases [13•].

The Mediterranean diet, which mainly consists of plant-based foods and employs olive oil as the primary fat source, has certain differences that vary throughout the Mediterranean region [14]. In North Africa, for instance, legumes, couscous, and vegetables are consumed as part of the MedDiet, whereas in Southern Europe, vegetables and legumes are emphasized along with pasta, polenta, rice, or potatoes. This indicates that there is variability in the MedDiet across different countries [15].

The MedDiet has proven to work towards lowering the incidence of various diseases like cardiovascular diseases [16], cancer [17, 18], diabetes [19, 20], and mostly on cognitive function and neurodegenerative disorders [21–24].

Okinawa Diet

Eating habits focused mainly on plant-based diets may be crucial for extending lifespan and promoting a healthy quality of life [25]. In regions with high rates of longevity, such as the "Blue Zones," populations tend to follow similar healthy plant-based diets [26]. In Okinawa, Japan's Blue Zone, more than half of the daily caloric intake is derived from sweet potatoes, which are rich in phytochemicals and antioxidants. The Okinawan diet also includes soy products and leafy greens with low or no fat, resulting in a longer life expectancy compared to other countries. Factors such as mild calorie restriction, genetics, high-quality cuisine, and physical exercise contribute to this extended lifespan. The Okinawan diet comprises 9% protein, 85% carbohydrates, and small amounts of healthy fats [27].

Dietary Approaches to Stop Hypertension (DASH) DIET

The National Heart, Lung, and Blood Institute in the USA recommends the Dietary Approaches to Stop Hypertension (DASH) diet as a way to prevent and manage hypertension. This dietary pattern is characterized by a high consumption of fruits, vegetables, whole grains, poultry, nuts, and low-fat dairy products. The DASH diet emphasizes the intake of foods rich in potassium, calcium, and magnesium while limiting sodium intake [28]. Besides blood pressure control, this diet also offers benefits for weight loss and overall health improvement.

Mediterranean Dietary Approach to Systolic Hypertension Diet Intervention for Neurodegenerative Delay (MIND DIET)

The MIND diet is a hybrid of the Mediterranean and DASH diets which incorporates foods and nutrients that promote brain health and protect against neurodegenerative disorders [29]. This diet emphasizes the consumption of vegetables, especially green leafy vegetables, beans, berries, whole grains, almonds, seafood, chicken, olive oil, and wine, while limiting the intake of animal-based and high-saturated fat meals as well as unhealthy foods such as red meat, margarine, cheese, pastries, sugary snacks, and junk foods because they contain high levels of cholesterol and trans fatty acids that can impair brain function and increase the risk of cognitive impairment. Alzheimer's disease and frontotemporal disorders can accelerate the development of dementia and affect memory, language, visual perception, problem-solving, and self-management. Therefore, the MIND diet plays an essential role in improving brain health and delaying the onset of neurodegenerative diseases [30].

In one of the published systematic reviews [31], they assessed the relationship between the MIND diet and cognition in the elderly, where most of the cross-sectional and interventional studies validated that conforming to the MIND diet may be linked to the improvement in cognitive function among older adults and regarded as advantageous compared to other plant-rich dietary patterns for improving cognition and neuropsychological status of older adults.

Caloric Restriction

Caloric restriction (CR) involves consuming less food than one's energy needs while maintaining adequate nutrition and optimal intake, focusing on high-fiber and micronutrient-rich foods that provide enough energy to maintain metabolic homeostasis despite restricting calorie intake [32]. Short-term food restriction has been shown in Drosophila studies to reduce mortality rates in as little as 1–3 days compared to lifelong restriction [33]. The CALERIE (Comprehensive Assessment of Long-Term Effects of Reducing Intake of Energy) Consortium conducted a randomized controlled trial of 25% caloric restriction for 2 years in over 220 healthy, non-obese individuals, with the goal of reducing calorie intake without enforcing a predetermined food composition and simply requiring that the chosen personal meals fulfill daily micronutrient needs. During the first 27 days of the trial, all meals were provided to the participants, who followed three 9-day diets: low fat, low glycemic load, and Mediterranean. All diets had a fiber ratio of 14 g/1000 kcal and ranged between 20 and 35% fat, 15 and 30% protein, and 40 and 60% carbohydrates. The findings demonstrated

significant improvements in glucose metabolism with CR, decreased muscle mass, and an $11.7 \pm 0.7\%$ reduction in energy levels over 2 years, resulting in a weight loss of $10.4 \pm 0.6\%$—less than half the set point of a 25% reduction in energy intake [34]. Although this nutritional pattern is associated with improved cardiometabolic status, research linking its benefits to longevity or its precise impact on general health status is limited.

Polyphenol Supplementation and Health

Polyphenols, found in foods such as vegetables, fruits, legumes, olive oil, and nuts, are secondary metabolites of plants [35]. These compounds have been found to be beneficial for human health and are often referred to as "antioxidant compounds" because they can react with reactive oxygen species (ROS) produced during metabolic processes, which can contribute to healthy aging. Fruits and vegetables that contain polyphenols are known to have properties such as antioxidants, antibacterial, anticancer, antidiabetic, and anti-inflammatory effects.

Research shows inflammation as one of the key factors in the etiology of Alzheimer's disease. The immune system can be adjusted through dietary choices, with certain nutrients and bioactive components being influential in the regulation of neuroinflammation [36]. Examples of these bioactive components include polyphenols, unsaturated fats, and antioxidant vitamins, which are known to mitigate oxidative stress and reduce neuroinflammation [37, 38].

Various types of phenols found in different fruits have been shown to have beneficial effects on disease prevention. For instance, grape polyphenols have been found to offer numerous health benefits, such as increasing insulin sensitivity, reducing the risk of type 2 diabetes, exhibiting antiinflammatory properties, and improving cardiovascular health and neuroprotection [39]. For instance, increased motor and memory functions have been demonstrated in healthy aged rats after consumption of grape-derived products [40], furthermore, rodents' age-related cognitive degradation was found to be decreased by consumption of polyphenol-rich berries, and more precisely, berry extracts [41].

Diet and Cognition

Research in neuroscience, neuropsychology, and neuroimaging has established a correlation between cognitive decline and changes in the structure and function of the brain. Specifically, a decrease in brain volume has been associated with a decline in cognitive domains such as memory, attention, and executive functioning, particularly in patients with dementia. The World Health Organization (WHO) has recognized dementia as one of the primary causes of disability in the elderly [42].

As we get older, our physical function, which refers to the body's capability to process physiological stimuli into muscle movements, tends to decline. This is one of the changes associated with aging. Additionally, cognitive function, which pertains to the interaction of the mind with the external environment through brain activity, also deteriorates with age [43].

Cognitive impairment is an increasingly pressing public health issue that is mainly associated with aging. With the global elderly population growing at a fast pace, it is expected that the socioeconomic and financial costs of cognitive decline will rise significantly [44]. Previous research has suggested that adherence to the Mediterranean diet and the DASH diet can lead to improvements in visuospatial function, while the consumption of legumes and nuts has been linked to enhanced performance in global cognition and various cognitive domains [45•].

Furthermore, the incorporation of polyunsaturated fatty acids (PUFA) into one's diet is beneficial for improved cognition. Fish is a particularly abundant source of n-3 long-chain polyunsaturated fatty acids, such as eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), which are essential for optimal brain development and cognitive functioning from childhood to old age [46–48].

Limitations

There is currently insufficient clinical trial evidence on the effects of whole diets or specific dietary components on conditions such as cardiovascular disease, diabetes, and cognitive outcomes in healthy older individuals. Most of the clinical trials linking various dietary exposures to diseases (outcome) are mostly reported from the West and the literature from the European continent may provide a limited understanding of the cultural practices in the countries from Asia and Africa; hence, we have drawn the conclusion that more clinical trials are required especially on the healthy older individuals so as to be able to draw interventions in the prevention/delay of age-related functional and cognitive declines. This represents a gap in research, as preventing age-related diseases from the onset is critical for promoting healthy aging. To address this gap, further studies should concentrate on the maintenance and sustenance of health in later life, as well as personalized nutritional interventions that are tailored to each individual's disease specificity, with greater emphasis on clinical trials.

Furthermore, having a clear understanding of the specific areas where the community lacks knowledge can assist in customizing nutrition education initiatives to cater to

particular subsets or geographical regions. This approach can be a successful strategy to enhance nutrition comprehension and promote healthy eating behaviors and lifestyle in Indian perspective and across the globe. That is, the more nutritional awareness across continents the more we achieve healthy aging and promotion of quality of life in older population.

Conclusion

Adopting healthy eating habits is an essential aspect of maintaining a healthy lifestyle and reducing the risk of age-related diseases and impairments, such as cognitive decline and dementia, cardiovascular diseases, sarcopenia, non-communicable diseases, age-related macular degeneration, osteoporosis, hearing loss, diabetic retinopathy, and obesity. A balanced diet that includes fruits, vegetables, whole grains, lean proteins, and healthy fats can provide the necessary nutrients to support healthy aging. Additionally, it is essential to limit the intake of processed and high-calorie foods, which can lead to obesity and other health problems. By incorporating strong public health measures, physical exercise, good mental health practices, and disease-specific nutritional interventions, it is possible to attenuate the progression of many age-associated conditions.

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Declarations

Ethics Approval Authors declare that the article is original and not submitted anywhere else and the table and figure included in the article are original.

Conflict of Interest The authors declare no conflict of interest.

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•• Of major importance

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