



Published in final edited form as:

*Maturitas*. 2013 August ; 75(4): 305–312. doi:10.1016/j.maturitas.2013.05.005.

## Fruit and vegetable intake among older adults: a scoping review

**Emily J. Nicklett [Assistant Professor]** and

University of Michigan School of Social Work 1080 South University Avenue Ann Arbor, MI, 48109 USA enicklet@umich.edu telephone: 001-734-763-6282 fax: 001-734-763-3372

**Andria R. Kadell [MSW student]**

University of Michigan School of Social Work 1080 South University Avenue Ann Arbor, MI, 48109 USA arkadell@umich.edu

### Abstract

Older adults are the fastest growing segment of the world population. Older adults are also at heightened risk of chronic conditions (such as diabetes, heart disease, and cancer) and specific geriatric conditions (such as cognitive impairment, frailty, and falls). Research studies have examined the relationship between fruit and vegetable intake and subsequent health outcomes and the correlates of fruit and vegetable intake in the U.S. population. However, relatively few studies have specifically examined health impacts and correlates of fruit and vegetable intake among older adults, who have unique biophysical and socioeconomic circumstances.

Evidence is reviewed to (1) describe findings related to consumption and chronic, geriatric, and other health outcomes among older adults and (2) describe patterns in fruit and vegetable consumption among older adults and how these patterns vary within and among populations. This review addresses specific barriers faced by older adults in obtaining and consuming fruits and vegetables in community settings. Recommendations for practice and policy are discussed.

### Keywords

Fruits and vegetables; Carotenoids; Risk factors; Food access; Elderly; Gender; Race/ethnicity; Socioeconomic status; Neighborhoods; Nutritional knowledge

---

“The doctor of the future will no longer treat the human frame with drugs, but rather will cure and prevent disease with nutrition.” - Thomas Edison

## 1. Introduction

There is a consensus among researchers and the general public that eating fruits and vegetables leads to life-long health benefits. Improved population nutrition is one of the key

---

© 2013 Elsevier Ireland Ltd. All rights reserved.

Correspondence to: Emily J. Nicklett.

**Publisher's Disclaimer:** This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

#### Contributors

Emily Nicklett and Andria Kadell contributed to the preparation and writing of the review article. Both authors revised the manuscript for its substantive content. Both authors provided final approval of the manuscript.

#### Conflict of interest

The authors declare no conflicts of interest.

factors underlying increased longevity in the past century [1]. Fruits and vegetables are often identified as the most important part of a diet in preventing age-related disease [2,3]. Throughout decades of nutritional guideline transitions from food groups to pyramids to plates, fruits and vegetables have maintained a prominent place in the daily nutritional guidelines set by departments and ministries of health worldwide [4,5]. Because of the recognized health benefits of eating fruits and vegetables, there are widespread policy and program initiatives to increase the availability and consumption of these foods, particularly among children. The older adult population, however, has unique nutritional needs and barriers [6].

This scoping review examines the outcomes associated fruit and vegetable intake in older adulthood and how these vary by individual and community-level characteristics. This review will discuss evidence of health-related benefits of fruit and vegetable intake in later life from epidemiologic and intervention studies. Studies were reviewed that examined fruit and vegetable intake among community-dwelling (non-institutionalized) older adults. Studies were excluded from the scoping analysis that addressed diet quality generally (without specific examination of fruit and vegetable intake or markers). Studies were also excluded from the analysis that examined the impact of early-life fruit and vegetable on health outcomes in late life. While such lifecourse studies do provide valuable information on the cumulative impact of diet, such studies are out of the scope of this review. The majority of studies reviewed were conducted in the United States, although a sizeable number of English-language studies are included that examine fruit and vegetable intake of older adults in other countries.

## 2. Health Outcomes Associated with Fruit and Vegetable Intake among Older Adults

Most research studies offer support that a positive relationship exists between fruit and vegetable intake and health outcomes across the lifespan, including the prevention and management of chronic illnesses, disease-specific mortality, and general mortality. However, the extent to which eating fruit and vegetables in old age is associated with these health benefits has received much less attention. The majority of studies on the health benefits of fruits and vegetables are cross-sectional or do not include older adults in the sample. As older adults have unique social and health circumstances, more research is needed in this area generally to provide necessary evidence for lifestyle-based interventions among older adults. This section reviews the findings from research studies that examine the health-related benefits of fruit and vegetable intake among older adults.

### 1.1 Mortality

Research has effectively linked fruit and vegetable consumption to reduced risk of mortality among older adults. Studies have found that fruit and vegetable intake promotes a longer life span and lowers the risk of disease-specific and all-cause mortality, whether intake is measured by self-report, food frequency questionnaires, or serum carotenoid levels in the blood [7-12]. One recent study found that the tertile of women with the highest serum carotenoid concentrations were 50% more likely to survive a five-year period compared with their counterparts in the lowest tertile [12]. Fruit and vegetable consumption is also predictive of disease-specific mortality, such as cancer- and cardiovascular-specific mortality [10]. Some of these health benefits are linked to specific foods; cruciferous (green and leafy) vegetables are particularly predictive of longevity [7].

## 1.2 Chronic Diseases

Nutrition is linked to the function and quality of life for older adults with chronic disease [1,13,14]. Fruit and vegetable consumption during older adulthood is associated with reduced likelihood of chronic disease [2]. A number of studies offer support to the linkage between fruit and vegetable intake during older adulthood and cardiovascular health. These dietary characteristics are protective against hypertension [8,15], coronary heart disease [2,15-17], atherosclerosis [18-20], and stroke [21] among older adults. Research also suggests fruit and vegetable intake in older adulthood is protective against the development or exacerbation of several kinds of cancer for men and women [10,23-27].

Evidence is also emerging regarding the relationship between diet and osteoporosis. Numerous studies have linked vitamin D and calcium consumption to improved bone mineral density. Additional research suggests that a diet rich in magnesium, potassium, vitamin C, and vitamin K (acquired from consuming a variety of fruits and vegetables) may also aid in the prevention of bone loss in both sexes [28,29].

## 1.3 Geriatric Conditions and Functional Impairments

Emerging research suggests that fruit and vegetable intake in older adulthood can prevent against the onset or exacerbation of cognitive impairment, falls/walking disability, and other geriatric-associated conditions.

Research has begun to examine the role of fruit and vegetable consumption in the aging brain. Emerging evidence indicates that fruit and vegetable intake is protective against cognitive decline and related conditions. Several prospective studies found that participants who consume greater levels of fruits and vegetables scored higher on cognitive and neuropsychological evaluations [30,31] and showed improvements in verbal fluency, memory, and rate of learning from such dietary changes [32]. In addition, a Mediterranean-style diet that is rich in nuts, oils, fruits, and vegetables has also been shown to be predictive of good heart health and of cognitive benefit for risk reduction of Alzheimer's disease and dementia [31-33].

Older adults who maintain physical function and avoid falls are less likely to be hospitalized or institutionalized and may have reduced risk of injury and mortality. While this field of research has only recently begun to emerge, studies have suggested that fruit and vegetable intake protects against physical decline and associated disability. Higher serum carotenoid levels predict improved muscle strength and bone density among older adults [29,34,35]. Fruit and vegetable consumption has also been found to improve physical function and walking speed while reducing walking disability and frailty among elders [34,36,37]. Older adults who maintain physical function and avoid falls are less likely to be hospitalized or to require assisted living.

There is evidence that fruit and vegetable consumption could protect against the onset or progression of other geriatric conditions. This is demonstrated by the discovery of a moderate association with a decrease in cataracts for older women [39]. Increased intake has also been connected to increased vaccination antibody response [40] and may be a risk reduction factor for inflammation with specific regard to fruit and vegetable intake variety, rather than quantity [34,41].

Associated health outcomes of a diet rich in fruits and vegetables appear to be largely positive, though further research might be conducted to determine the effects of different fruit and vegetables on elders of various social and cultural backgrounds as a foundation for appropriate intervention strategies.

### 3. Trends in Fruit and Vegetable Intake

Compared with younger adults, older adults tend to eat fewer high-energy sweets and fast food and eat more grains, fruit, and vegetables. On average, older adults eat more servings of fruits and vegetables, which might be nutritionally necessary given the change in metabolic processes that occurs in old age [6,13]. Although the majority of adults incorporate at least one serving of fruits and vegetables into their daily diet (85 and 95%, respectively), less than half of older adults eat the recommended five servings of fruit and vegetables per day [13]. Major studies have estimated that only 21 to 37% of men and 29 to 45% of women aged 65 and older achieve the recommended servings per day (depending on the study methodology) [14,42-45]. Older adults (aged 65 and older) tend to score well on the Healthy Eating Index in consumption of total fruit (and whole fruit in particular) and total vegetables, but have low scores in consumption of dark green and orange vegetables and legumes [46]. There are also noticeable differences by age among the older adult population as well; elders aged 75 and older are more likely to eat fruit, while elders aged 65-74 tend to eat more vegetables [46]. It is particularly important for older adults to be aware of fruit and vegetable consumption because they tend to eat smaller quantities of food overall, which can lead to deficiency of important vitamins and minerals [14].

### 4. Predictors of Fruit and Vegetable Intake among Older Adults

Although older adults tend to eat more fruits and vegetables than the general population, several trends warrant concern. First, as discussed above, the intake does not approach recommended levels. Second, the most nutritious and health-promoting foods are under-consumed. Starchy vegetables make up a large proportion of daily vegetable consumption per day, likely due to the ease of preparation and consumption (e.g., boiled and mashed potatoes). Dark green and orange vegetables, which tend to be more nutrient-rich, account for only 12 to 15% of total vegetable consumption among older adults [13]. Further, some research suggests that consumption has declined among older adults in the past decade [46].

Older adults' eating habits are also heterogeneous, and the determinants of fruit and vegetable intake among older adults are complex. With population aging, the number and intensity of barriers in accessing and consuming fruits and vegetables increase. The literature suggests that fruit and vegetable intake is influenced by numerous group- and individual-level predictors. Many of these are unique to situations and circumstances in older adulthood. The following predictors are discussed: (a) health status, (b) geographic/physical environment, (c) gender, marital status, and household composition, (d) social support, (e) race/ethnicity, (f) socioeconomic status, and (g) dietary knowledge. Although this is not an exhaustive discussion of predictors, these characteristics have been found to influence the access to—and consumption of—fruit and vegetables among older adults.

#### 4.1 Health Status

Older adults are at heightened risk of functional limitations, disability, and chronic disease onset and complications. While fruit and vegetable intake protects against the development and exacerbation of these conditions, ironically, being affected by these conditions makes accessibility, preparation, and consumption of these important nutrients problematic.

Old age is often accompanied by changes in appetite, and compromised oral health could reduce fruit and vegetable intake. Appetite loss is influenced by changes in perception of hunger [47], taste acuity, and sense of smell [48]; concern about digestive problems [49]; diminished pleasure associated with food [50]; and everyday emotions [51]. Older adults suffer from gum disease, tooth loss, decay, and mouth infections. Compromised oral and dental health is associated with decreased consumption of fruits and vegetables [52]. Older

adults typically eat fruit and vegetables in their whole form [13], and textures of these foods become difficult to bite, chew, swallow, and prepare, particularly among older adults who are missing posterior teeth and/or have dentures [45,53,54]. In sum, older adults are particularly affected by certain physiological changes related to appetite and oral health, which in turn influence nutrient intake.

Older adults who have functional limitations and disabilities confront unique barriers in acquiring, preparing, and consuming foods. Mobility-impaired older adults, in particular, confront challenges in accessing fresh fruits and vegetables [45,55], and home-bound older adults who must rely on home-delivered meals or other assistance are particularly vulnerable to under-nutrition [56].

Physical health decline is typically accompanied by a subsequent deterioration in dietary quality [45,57]. This association is explained by reduced access to fruits and vegetables as well as more difficulty in preparing and eating nutrient-rich foods. For example, older adults with severe arthritis are confronted by challenges in the physical requirements of cooking as well as the effort required to take part in food-related social activities [49]. One possible exception is that adults—young and old—tend to increase fruit and vegetable intake after diagnosis of cancer. Studies have found that fruit and vegetable intake increases after diagnosis of breast, prostate, and colorectal cancer [25-27]. Studies have found that these diet changes are often due to personal beliefs and preferences (such as having control over that aspect of their lives) rather than in response to a doctor or other provider's recommendation [58-61].

#### 4.2 Geographic and Environmental Characteristics

Health disparities in the United States are at least partially explained by differences in food access by geographic location. Stark disparities exist in urban environments where access to fresh fruits and vegetables varies by neighborhood, with greater access in more affluent and predominantly white neighborhoods [62-64]. Food stores in less affluent and in minority-segregated communities tend to have fewer fresh food options available [62,65,66]. In disadvantaged neighborhoods, food is not only more difficult to access, but prices are often higher for the same products [64,67].

However, it is important to note that these characteristics are not uniform across regions and countries [68]. Consumption of fruit and vegetables also varies greatly according to region and country [e.g. 69]. The physical environment and food culture influences consumption. For example, older adults eat more servings of fruit and vegetables in regions where the Mediterranean diet is predominant, particularly in Spain, Italy, and Greece [70]. In contrast, older adults living in rural areas of the United States face unique challenges in accessing fruits and vegetables. If unable to drive, rural elders have limited transportation options to food stores [71], and greater distance to such stores has been found to result in lower fruit and vegetable intake among rural elders [72]. Further, government programs that provide food to older adults (such as Meals on Wheels) have less reach in some rural areas due to lower tax bases and demanding transportation requirements for community volunteers [73]. Therefore, older adults living in urban and rural settings confront unique, and different, barriers to fruit and vegetable consumption.

#### 4.3 Gender, Marital Status, and Household Composition

A number of studies have found that older women eat more fruit and vegetables than older men, even though older men eat more food overall [74-77]. This disparity is heavily influenced by differences in nutrition-related knowledge and the degree of confidence in accessing and preparing nutrient-rich foods. While older men and women both recognize

that balanced meals benefit health, on average, men are less aware of dietary recommendations and the linkages between dietary intake, health, and disease [75,78,79]. Older adults gain knowledge about the nutritional benefits of fruit and vegetables from health care providers and in commercial settings such as grocery stores; across the lifespan, women are more likely to be at these settings than men [75]. This gendered difference in nutrition-related knowledge could explain up to half of the fruit-vegetable consumption disparity between men and women [75]. Older men with better cooking skills, who cook a greater variety of foods, and who have greater access to information, tend to consume more fruit and vegetables [76,79]. Access to meals containing fruit and vegetables that are the appropriate portion size and are easy to open, prepare, and cook are also predict higher intake among older men [76].

Marriage is positively associated with fruit and vegetable intake among older men and older women. A study of the relationship between marriage and fruit and vegetable intake in Canada found that older adults who were married were most likely to achieve recommended portions (48%), followed by seniors who were widowed, divorced, or separated (46%), and by seniors who were single or in a cohabiting common-law relationship (43%) [81]. Single men are at particularly high risk of low intake [76]. Marriage is particularly beneficial for older men's fruit and vegetable intake [80], and the presence of a woman in the household is associated with higher fruit and vegetable intake of male household members [76]. However, the benefits of marriage for fruit and vegetable intake are difficult to separate from the benefits related to companionship and eating meals together [81].

The experience of widowhood heightens risk of inadequate diet for both men and women. Older women are more likely to confront different barriers than are older men following the death of a spouse. Widowers are at risk because they often lack skills in the process of choosing and preparing nutrient-rich foods if this was previously their spouse's domain [76]. Following the death of a spouse, women are particularly socioeconomically vulnerable and at risk of social isolation. Older women, who might be more accustomed to cooking for others, are often less inclined to prepare food and cook complete meals for themselves—a process that might be reserved for shared special occasions [49,82].

#### 4.4 Social Support

Research that has examined the social correlates of fruit and vegetable intake among older adults generally agrees that social isolation is a strong risk factor for fruit and vegetable intake, and social interaction and support are associated with higher levels of fruit and vegetable intake, with some exceptions [77,83]. The benefits of social engagement on fruit and vegetable intake are multifactorial; socialization and companionship are key predictors [45,81,84], particularly since many social gatherings involve food [49]. Social interaction itself provides a motivation for older adults to go to congregate eating sites for meals [49]. Older adults with functional limitations experience restricted life-space, which is associated with nutritional risk [71]. As social support and social interaction are strong predictors of fruit and vegetable intake, further research should examine the specific kinds of support that protect against inadequate intake in older adulthood, and how this varies by race/ethnicity, functional status, and gender.

#### 4.5 Race/Ethnicity

There are differences in fruit and vegetable consumption across the lifespan by race/ethnicity, as defined by respondents and according to U.S. census categories. In the United States, African Americans are less likely to meet recommended intake of fruits and vegetables than non-Hispanic whites and Hispanics/Latinos. On average, African American adults consume nearly one serving of fruits or vegetables less than do non-Hispanic whites

or Hispanics/Latinos [85]. These disparities continue in old age; older African Americans are at heightened risk of low fruit and vegetable intake. Racial/ethnic differences are partly due to individual and neighborhood-level socioeconomic status [85-88]; however, research studies suggest that this relationship remains even after taking socioeconomic status into consideration [45,74,89]. Older African American men and women are at risk for social isolation and have limited social support and capital [71]. Fruit and vegetable consumption is particularly low among African Americans in minority-segregated neighborhoods [87,90,91]. Further, living in an economically deprived neighborhood is a particularly strong predictor of inadequate fruit and vegetable intake for African Americans compared to other racial/ethnic groups [63,85]. Fruit and vegetable access is limited in minority-segregated neighborhoods relative to availability in predominantly white and racially integrated neighborhoods, largely due to differences in the food retail environments [87,91,92]. However, the presence or magnitude of racial/ethnic disparities in intake varies by country and region [69].

#### 4.6 Socioeconomic Status

Among consumers who face economic constraints, older adults are likely to differ from their younger counterparts in the degree to which fruit and vegetables are considered priority purchases. The patterns and decisions behind food purchases differ between younger and older adults [93]. Fruit and vegetable purchases are influenced by cohort and age-related factors, such as food scarcity during childhood and transitions to retirement. However, the majority of research that examines the influence of socioeconomic status on fruit and vegetable consumption examines the general population or does not include older adults in the sample. Fruit and vegetables are generally considered priority purchases among older adults, even in food-insecure households [94]. However, research suggests that there are pervasive and strong socioeconomic determinants of fruit and vegetable intake among older adults. Elders with lower individual and household educational attainment are at heightened risk of not eating daily recommended values [45,69]. Individual and household income level also predicts intake [69,95,96]. In a recent study on income differences in eating patterns among older adults, individuals in the low and medium household income groups ate significantly fewer fruits and vegetables than those in the higher income group (0%-350% of poverty) to those in medium and higher income groups (above 350% of poverty) [96]. Fruit intake was progressively higher by income group as well [64]. Mechanisms operate for socioeconomic disparities in fruit and vegetable consumption at both community and individual levels. Individuals from low-income households spend a greater proportion of their income on food compared to higher-income households [64]. Fruits and vegetables (particularly in their preferred fresh form) are costly, and the retail prices have increased more rapidly than the prices of other food types over the past several decades [97].

Individuals with fewer resources are more likely to live in poorer neighborhoods, while people who live in poorer neighborhoods consume fewer fruits and vegetables [85-87]. Resource-deprived neighborhoods typically have fewer large grocery stores available and instead have smaller stores with fewer fruit and vegetable options [62,65-67,98,99]. In addition to being less available, fruits and vegetables in poorer neighborhoods usually cost more than they do in socially advantaged neighborhoods [64]. For older adults across the socioeconomic spectrum, the price and perceived worth of food are important considerations in food purchases [49].

#### 4.7 Knowledge

Although there is limited support for nutritional knowledge resulting in changed dietary behaviors in the general population [100], some research suggests that nutritional knowledge does predict fruit and vegetable intake among older adults [101,102] and particularly among

older men [75,79]. Many older adults do not think they are at risk for poor nutrition [103], and perceptions of what constitutes a healthy or balanced meal vary [49]. However, fruit and vegetable consumption remains challenging for older adults who are aware of its many benefits. As older adults confront unique barriers to acquiring, preparing, and eating fruits and vegetables, food intake is a balance of tradeoffs. In a qualitative research study, one participant describes such a tradeoff: “I’m very interested in nutrition and I read everything that I can get about it. And I try to do what I think is right, except when it conflicts with the difficulty of doing it. Or the cost of doing it. Those are the two things that I think influence the way I plan my meals” [49, pg. 262]. Interventions to increase diet-related knowledge should be tailored to the older adult population, given their unique experiences, barriers, and learning processes [1].

In sum, the literature suggests that older adults face unique challenges and barriers in obtaining, preparing, and consuming fruits and vegetables. These barriers exist at the individual- and group/environmental levels. Older adults with declining health, functional limitation, loss of appetite, and dentition problems tend to eat fewer fruit and vegetables. The communities in which older adults reside can provide opportunities for or impose barriers on fruit and vegetable consumption. Older men are at the highest risk for inadequate intake, but living alone and widowhood are risk factors for reduced fruit and vegetable consumption among all older adults. Social support is a protective factor, since company provides incentive to eat, and assistance breaks down barriers to acquiring and preparing food. Older African American adults and older adults with limited socioeconomic resources eat fewer fruits and vegetables than other groups, which is at least partially due to neighborhood environment and food availability. Increased knowledge about the benefits of fruit and vegetables—as well as what constitutes a healthful meal—is associated with higher levels of consumption; however, the barriers confronted by older adults can outweigh the perceived benefits.

## 5. Recommendations for Practice and Policy

Nutrition is one of the few modifiable predictors of health in old age [104]. This review discussed the current evidence regarding benefits of and barriers to fruit and vegetable access and consumption among older adults. In this review, we have discussed emerging literature that connects fruit and vegetable intake to improved health outcomes, including mortality, disability, chronic disease, and other geriatric conditions. While these studies provide compelling evidence, additional prospective epidemiologic studies on elder cohorts are needed; these should include detailed dietary information at baseline and at follow-up. Additional studies that identify the benefits of fruit and vegetable consumption in later-life health outcomes will be beneficial on several fronts. First, these data will provide older adults and their providers with evidence-based suggestions for preventing negative health outcomes and coping with chronic disease. Second, additional evidence is needed to promote policies for health-promotion interventions. In order to inform these interventions, it is particularly important that these studies examine late-life eating habits.

The literature review identified certain groups at heightened risk of inadequate fruit and vegetable consumption. In particular, older adults who are disabled or mobility impaired confront severe barriers in acquiring, preparing, and eating fruits and vegetables. The conditions are exacerbated by the intersection of health problems, social isolation, and inadequate transportation. Older men, African Americans, and adults living in homes and communities lacking socioeconomic resources also eat fewer fruits and vegetables. Interventions should continue to focus on knowledge-building, particularly among socially and economically vulnerable older adults.



Interventions to increase fruit and vegetable intake among older adult populations have generally been successful, whether they occur in community settings or in the home [105-108]. It is particularly important that interventions be planned and tailored specifically for older adults to address age-specific barriers in access or knowledge. Such interventions should aim to improve older adults' knowledge or access [46, 109]. More effective interventions also incorporate an individual's desire or readiness to change dietary behaviors [110]. Nutritional screening can help raise awareness, identify needs, and target limited resources for those in need. More systematic screening of the older adult population can help identify older adults in need of nutrition-related resources [1,111].

There are several federal resources available to older adults to improve access and intake of fruit and vegetables; however, studies suggest that the programs are limited in reach. The Supplemental Nutrition Assistance Program (SNAP) is the largest food assistance program in the United States, but participation is low among older adults. SNAP is an entitlement program that provides enrollees with electronic benefit transfer cards and, in many cases, nutrition education. Older adults have the lowest participation rates compared to all other demographic groups [112]. Eligible older adults would be more likely to enroll in SNAP benefits through simplification of the eligibility criteria, increased application assistance, and the provision of commodity alternatives [112,113]. The Elderly Nutrition Program (ENP), within the Older Americans Act, is the largest program to coordinate nutrition services to older adults. Its original intent was to provide nutritionally sound meals and promote physical and social well-being [114]. The food services provided to older adults (such as Meals on Wheels) rely on community members and local volunteers. However, there is inadequate funding for such programs, as less than 10% of older adults at nutritional risk participate in the Elderly Nutrition Program [115].

Private and community-based organizations have long recognized the benefit of providing locally available fruits and vegetables, particularly to socially disadvantaged populations [116]. Increasingly, community-based approaches have been promoted to link locally grown food to segments of the population at risk of under-nutrition. The integration of community-based approaches with federal funding mechanisms can improve fruit and vegetable access and intake among older adults. Successful approaches include promoting SNAP benefit use in farmers' markets and developing programs to promote Meals on Wheels delivery through drivers' education programs [105,117]. Unfortunately, relatively few programs that aim to enhance the availability of fruits and vegetables are prospectively evaluated [e.g., 118,119]. Even fewer community-driven programs that specifically target seniors have been adequately evaluated [105]. It is important for practitioners and researchers to engage in the evaluation process of promoting innovative strategies to meet the fruit and vegetable needs of seniors alongside community-initiated strategies. Such strategies will enhance the evidence base and will assist stakeholders in promoting policies that promote fruit and vegetable access and intake among older adults.

## Acknowledgments

This article was written in appreciation of all the mothers and fathers who told us to eat our vegetables when we were young. We would like to thank Kathy Sykes for her mentorship and the helpful suggestions on this manuscript. We are also grateful to Dr. Lynda Anderson and Dr. Richard Semba for providing ongoing guidance and support.

### Funding

The preparation of this article was supported by the Claude D. Pepper Older Americans Independence Centers (AG024824).

## References

1. Chernoff R. Nutrition and health promotion in older adults. *J Gerontol A Biol Sci Med Sci*. 2001; 56A:47–53. [PubMed: 11730237]
2. Hung HC, Joshipura KJ, Jiang R, Hu FB, Hunter D, Smith-Warner SA, et al. Fruit and vegetable intake and risk of major chronic disease. *J Natl Cancer Inst*. 2004; 96:1577–84. [PubMed: 15523086]
3. Anlasik T, Sies H, Griffiths HR, Mecocci P, Stahl W, Polidori MC. Dietary habits are major determinants of the plasma antioxidant status in healthy elderly subjects. *Br J Nutr*. 2005; 94:639–42. [PubMed: 16277763]
4. U.S. Department of Agriculture and U.S. Department of Health and Human Services. Dietary guidelines for Americans. 7 Edition. U.S. Government Printing Office; Washington, DC: 2010. December 2010. Available from
5. Food Standards Agency. FSA nutrient and food based guidelines for UK institutions. Oct. 2006 Available from: <http://www.food.gov.uk/multimedia/pdfs/nutguideuk.pdf>
6. Lichtenstein AH, Rasmussen H, Yu WW, Epstein SR, Russell RM. Modified MyPyramid for older adults. *J Nutr*. 2008; 138(1):5–11. [PubMed: 18156396]
7. Zhang X, Shu XO, Xiang YB, Yang G, Li H, Gao J, et al. Cruciferous vegetable consumption is associated with a reduced risk of total and cardiovascular disease mortality. *Am J Clin Nutr*. Jul; 2011 94(1):240–6. [PubMed: 21593509]
8. Strandhagen E, Hansson PO, Bosaeus I, Isaksson B, Eriksson H. High fruit intake may reduce mortality among middle aged and elderly men. The Study of Men Born in 1913. *Eur J Clin Nutr*. 2000; 54:337–41. [PubMed: 10745285]
9. Khaw K-T, Wareham N, Bingham S, Welch A, Luben R, et al. Combined impact of health behaviours and mortality in men and women: The EPIC-Norfolk Prospective Population Study. *PLoS Med*. 2008; 5(1):e12. doi:10.1371/journal.pmed.0050012. [PubMed: 18184033]
10. Genkinger JM, Platz EA, Hoffman SC, Comstock GW, Helzlsouer KJ. Fruit, vegetable, and antioxidant intake and all-cause, cancer, and cardiovascular disease mortality in a community-dwelling population in Washington County, Maryland. *Am J Epidemiol*. 2004; 160.12:1223–33. [PubMed: 15583375]
11. Ray AL, Semba RD, Walston J, Ferrucci L, Cappola AR, Ricks MO. Low serum selenium and total carotenoids predict mortality among older women living in the community: The Women's Health and Aging Studies. *J Nutr*. 2006; 135:172–6. [PubMed: 16365078]
12. Nicklett EJ, Semba RD, Xue QL, Tian J, Sun K, Cappola AR, et al. Fruit and vegetable intake, physical activity, and mortality in older community-dwelling women. *J Am Geriatr Soc*. 2012; 60:862–8. [PubMed: 22587851]
13. U.S. Department of Agriculture and Center for Nutrition Policy and Promotion. Fruit and vegetable consumption by older Americans.. Nutrition Insight 34. Mar. 2007 Available from: <http://www.cnpp.usda.gov/Publications/NutritionInsights/Insight34.pdf>
14. Drewnowski A, Schultz JM. Impact of aging on eating behaviors, food choices, nutrition, and health status. *J Nutr Health Aging*. 2001; 5(2):75–9. [PubMed: 11426286]
15. Wang L, Manson JE, Gaziano JM, Buring JE, Sesso HD. Fruit and vegetable intake and the risk of hypertension in middle-aged and older women. *Am J Hypertens*. 2012; 25(2):180–9. [PubMed: 21993367]
16. Bazzano LA, He J, Ogden LG, Loria CM, Vupputuri S, Myers L, et al. Fruit and vegetable intake and risk of cardiovascular disease in US adults: the first National Health and Nutrition Examination Survey Epidemiologic Follow-up Study. *Am J Clin Nutr*. 2002; 76.1:93–9. [PubMed: 12081821]
17. Liu S, Lee IM, Ajani U, Cole SR, Buring JE, Manson JE. Physicians' Health Study. Intake of vegetables rich in carotenoids and risk of coronary heart disease in men: The Physicians' Health Study. *Int J Epidemiol*. 2001; 30.1:130–5. [PubMed: 11171873]
18. Rissanen TH, Voutilainen S, Nyyssönen K, Salonen R, Kaplan GA, Salonen JT. Serum lycopene concentrations and carotid atherosclerosis: The Kuopio Ischaemic Heart Disease Risk Factor Study. *Am J Clin Nutr*. 2003; 77:133–8. [PubMed: 12499332]

19. Ellingsen I, Hjerkin EM, Seljeflot I, Arnesen H, Tonstad S. Consumption of fruit and berries is inversely associated with carotid atherosclerosis in elderly men. *Br J Nutr.* 2008; 99.03:674–81. [PubMed: 17894919]
20. Iribarren C, Folsom A, Jacobs DR Jr, Gross MD, Belcher JD, Eckfeldt JH, for the ARIC Study Investigators. Association of serum vitamin levels, LDL susceptibility to oxidation, and autoantibodies against MDA-LDL with carotid atherosclerosis. *Arterioscler Thromb Vasc Biol.* 1997; 17:1171–7. [PubMed: 9194770]
21. Joshipura KJ, Ascherio A, Manson JE, Stampfer MJ, Rimm EB, Speizer FE, et al. Fruit and vegetable intake in relation to risk of ischemic stroke. *JAMA.* 1999; 282(13):1233–9. doi:10.1001/jama.282.13.1233. [PubMed: 10517425]
22. Moore LE, Hung R, Karami S, Boffetta P, Berndt S, Hsu CC, et al. Folate metabolism genes, vegetable intake and renal cancer risk in central Europe. *Int J Cancer.* 2008; 122.8:1710–15. [PubMed: 18098291]
23. Holick CN, Michaud DS, Stolzenberg-Solomon R, Mayne ST, Pietinen P, Taylor PR, et al. Dietary carotenoids, serum  $\beta$ -carotene, and retinol and risk of lung cancer in the Alpha-Tocopherol, Beta-Carotene cohort study. *Am J Epidemiol.* 2002; 156.6:536–47. [PubMed: 12226001]
24. Zhang S, Hunter DJ, Forman MR, Rosner BA, Speizer FE, Colditz GA, et al. Dietary carotenoids and vitamins A, C, and E and risk of breast cancer. *J Natl Cancer Inst.* 1999; 91.6:547–56. [PubMed: 10088626]
25. Freudenheim JL, Marshall JR, Vena JE, Laughlin R, Brasure JR, Swanson MK. Premenopausal breast cancer risk and intake of vegetables, fruits, and related nutrients. *J Natl Cancer Inst.* 1996; 88.6:340–8. [PubMed: 8609642]
26. Fairfield KM, Hankinson SE, Rosner BA, Hunter DJ, Colditz GA, Willett WC. Risk of ovarian carcinoma and consumption of vitamins A, C, and E and specific carotenoids. *Cancer.* 2001; 92.9:2318–26. [PubMed: 11745286]
27. Lee JE, Giovannucci E, Smith-Warner SA, Spiegelman D, Willett WC, Curhan GC. Intakes of fruits, vegetables, vitamins A, C, and E, and carotenoids and risk of renal cell cancer. *Cancer Epidemiol Biomarkers.* 2006; 15.12:2445–52.
28. Tucker KL. Dietary intake and bone status with aging. *Curr Pharm Des.* 2003; 9.32:2687–2704. [PubMed: 14529541]
29. Tucker KL, Chen H, Hannan MT, Cupples LA, Wilson PW, Felson D. Bone mineral density and dietary patterns in older adults: The Framingham Osteoporosis Study. *Am J Clin Nutr.* 2002; 76.1:245–52. [PubMed: 12081842]
30. Polidori MC, Praticó D, Mangialasche F, Mariani E, Aust O, Anlasik T, et al. High fruit and vegetable intake is positively correlated with antioxidant status and cognitive performance in healthy subjects. *J Alzheimers Dis.* 2009; 17.4:921–7. [PubMed: 19542607]
31. Johnson EJ, McDonald K, Caldarella SM, Chung HY, Troen AM, Snodderly DM. Cognitive findings of an exploratory trial of docosahexaenoic acid and lutein supplementation in older women. *Nutr Neurosci.* 2008; 11(2):75–83. [PubMed: 18510807]
32. Middleton LE, Yaffe K. Promising strategies for the prevention of dementia. *Arch Neurol.* 2009; 66.10:1210. [PubMed: 19822776]
33. Scarmeas N, Stern Y, Tang MX, Mayeux R, Luchsinger JA. Mediterranean diet and risk for Alzheimer's disease. *Ann Neurol.* 2006; 59.6:912–21. [PubMed: 16622828]
34. Semba RD, Lauretani F, Ferrucci L. Carotenoids as protection against sarcopenia in older adults. *Arch Biochem Biophys.* 2007b; 458.2:141. [PubMed: 17196927]
35. Lauretani F, Semba RD, Bandinelli S, Dayhoff-Brannigan M, Giacomini V, Corsi AM, et al. Low plasma carotenoids and skeletal muscle strength decline over 6 years. *J Gerontol A Biol Sci Med Sci.* 2008; 63(4):376–83. [PubMed: 18426961]
36. Alipanah N, Varadhan R, Sun K, Ferrucci L, Fried LP, Semba RD. Low serum carotenoids are associated with a decline in walking speed in older women. *J Nutr Health Aging.* 2009; 13.3:170–5. [PubMed: 19262947]
37. Drewnowski A, Evans WJ. Nutrition, physical activity, and quality of life in older adults: summary. *J Gerontol A Biol Sci Med Sci.* 2001; 56(2):89–94. [PubMed: 11730242]

38. Semba RD, Bartali B, Zhou J, Blaum C, Ko CW, Fried LP. Low serum micronutrient concentrations predict frailty among older women living in the community. *J Gerontol A Biol Sci Med Sci*. 2006; 61.6:594–9. [PubMed: 16799142]
39. Moeller SM, Voland R, Tinker L, Blodi BA, Klein ML, Gehrs KM, et al. Associations between age-related nuclear cataract and lutein and zeaxanthin in the diet and serum in the Carotenoids in the Age-Related Eye Disease Study, an Ancillary Study of the Women's Health Initiative. *Arch Ophthalmol*. 2008; 126(3):354–64. [PubMed: 18332316]
40. Gibson A, Edgar JD, Neville CE, Gilchrist SE, McKinley MC, Patterson CC, et al. Effect of fruit and vegetable consumption on immune function in older people: a randomized controlled trial. *Am J Clin Nutr*. Dec; 2012 96(6):1429–36. doi: 10.3945/ajcn.112.039057. Epub 2012 Nov 7. [PubMed: 23134881]
41. Bhupathiraju SN, Tucker KL. Greater variety in fruit and vegetable intake is associated with lower inflammation in Puerto Rican adults. *Am J Clin Nutr*. 2011; 93.1:37–46. [PubMed: 21068354]
42. Serdula MK, Coates RJ, Byers T, Simoes E, Mokdad AH, Subar AF. Fruit and vegetable intake among adults in 16 states: Results of a brief telephone survey. *Am J Public Health*. 1995; 85(2): 236–9. [PubMed: 7856784]
43. Li R, Serdula M, Bland S, Mokdad A, Bowman B, Nelson D. Trends in fruit and vegetable consumption among adults in 16 US states: Behavioral Risk Factor Surveillance System, 1990-1996. *Am J Public Health*. 2000; 90(5):777–81. [PubMed: 10800429]
44. Krebs-Smith SM, Cook A, Subar AF, Cleveland L, Friday J. US adults' fruit and vegetables intakes, 1989 to 1991: a revised baseline for the Healthy People 2000 objective. *Am J Public Health*. 1995; 85(2):1623–9. [PubMed: 7503335]
45. Sahyoun NR, Zhang XL, Serdula MK. Barriers to the consumption of fruit and vegetables among older adults. *J Nutr Elder*. 2005; 24(4):5–21. [PubMed: 16597557]
46. Federal Interagency Forum on Aging Related Statistics. Older Americans 2012: key indicators of well-being. 2012. Available from: [http://www.agingstats.gov/agingstatsdotnet/Main\\_Site/Data/2012\\_Documents/Docs/EntireChartbook.pdf](http://www.agingstats.gov/agingstatsdotnet/Main_Site/Data/2012_Documents/Docs/EntireChartbook.pdf)
47. Hays NP, Roberts SB. The anorexia of aging in humans. *Physiol Behav*. 2006; 88(3):257–66. [PubMed: 16769094]
48. Schiffman SS. Taste and smell losses in normal aging and disease. *JAMA*. 1997; 278(16):1357–62. [PubMed: 9343468]
49. Falk LW, Bisogni CA, Sobal J. Food choice processes of older adults: a qualitative investigation. *J Nutr Educ*. 1996; 28:257–65.
50. Westenhoefer J. Age and gender dependent profile of food choice. *Forum Nutr*. 2005; 57:44–51. [PubMed: 15702587]
51. Paquet C, St-Arnaud-McKenzie D, Kergoat M, Ferland G, Dubé L. Direct and indirect effects of everyday emotions on food intake of elderly patients in institutions. *J Gerontol A Biol Sci Med Sci*. 2003; 58(2):153–8. [PubMed: 12586853]
52. Walls AW, Steele JG. The relationship between oral health and nutrition in older people. *Mech Ageing Dev*. 2004; 125(12):853–7. [PubMed: 15563930]
53. Roininen K, Fillion L, Kilcast D, Läteenmäki L. Exploring difficult textural properties of fruit and vegetables for the elderly in Finland and the United Kingdom. *Food Qual Prefer*. 2004; 15:517–30.
54. Sheiham A, Steele J. Does the condition of the mouth and teeth affect the ability to eat certain foods, nutrient and dietary intake and nutritional status amongst older people? *Public Health Nutr*. 2001; 4(3):797–803. [PubMed: 11415487]
55. Lee JS, Frongillo EA Jr. Factors associated with food insecurity among US elderly persons: importance of functional impairments. *J Gerontol B Psychol Sci Soc Sci*. 2001; 56B(2):S94–S99. [PubMed: 11245369]
56. Sharkey JR. The interrelationship of nutritional factors, indicators of nutritional risk, and severity of disability among home-delivered meal participants. *Gerontologist*. 2002; 42(3):373–80. [PubMed: 12040139]
57. Andersen LF, Jacobs DR Jr, Gross MD, Schreiner PJ, Williams OD, Lee DH. Longitudinal associations between body mass index and serum carotenoids: the CARDIA study. *Br J Nutr*. 2006; 95:358–65. [PubMed: 16469154]

58. Patterson RE, Neuhouser ML, Hedderson MM, Schwartz SM, Standish LJ, Bowen DJ. Changes in diet, physical activity, and supplement use among adults diagnosed with cancer. *J Am Diet Assoc.* 2003; 103(3):323–8. [PubMed: 12616253]
59. Skeie G, Hjartaker A, Lund E. Diet among breast cancer survivors and healthy women. The Norwegian Women and Cancer Study. *Eur J Clin Nutr.* 2006; 60(9):1046–54. [PubMed: 16482067]
60. Salminen E, Bishop M, Poussa T, Drummond R, Salminen S. Dietary attitudes and changes as use of supplements and complementary therapies by Australian and Finnish women following the diagnosis of breast cancer. *Eur J Clin Nutr.* 2004; 58(1):137–44. [PubMed: 14679379]
61. Maskarinec G, Murphy S, Shumay DM, Katai H. Dietary changes among cancer survivors. *Eur J Cancer Care.* 2001; 10(1):12–20.
62. Morland K, Wing S, Diez Roux A, Poole C. Neighborhood characteristics associated with the location of food stores and food services places. *Am J Prev Med.* 2002; 22:23–9. [PubMed: 11777675]
63. Larson NI, Story MT, Nelson MC. Neighborhood environments: disparities in access to healthy foods in the U.S. *Am J Prev Med.* 2009; 36:74–81. [PubMed: 18977112]
64. Jetter KM, Cassady DL. The availability and cost of healthier food alternatives. *Am J Prev Med.* 2006; 30:38–44. [PubMed: 16414422]
65. Moore LV, Diez Roux AV. Associations of neighborhood characteristics with the location and types of food stores. *Am J Public Health.* 2006; 96(2):325–31. [PubMed: 16380567]
66. Laska MN, Morradaile KE, Tester J, Foster GD, Gittelsohn J. Healthy food availability in small urban food stores: a comparison of four US cities. *Public Health Nutr.* 2010; 13:1031–5. [PubMed: 19968901]
67. Chung C, Myers J. Do the poor pay more for food? An analysis of grocery store availability and food price disparities. *J Consum Aff.* 1999; 22:276–96.
68. Pearce J, Hiscock R, Blakely T, Witten K. The contextual effects of neighbourhood access to supermarkets and convenience stores on individual fruit and vegetable consumption. *J Epidemiol Community Health.* 2008; 62:198–201.
69. Riediger ND, Moghadasian MH. Patterns of fruit and vegetable consumption and the influence of sex, age and sociodemographic factors among the Canadian elderly. *J Am Coll Nutr.* 2007; 27(2): 306–13. [PubMed: 18689563]
70. Bamia C, Orfanos P, Ferrari P, Overvad K, Hundborg HH, Tjønneland A, et al. Dietary patterns among older Europeans: The EPIC-Elderly study. *Br J Nutr.* 2005; 94:100–13. [PubMed: 16115339]
71. Locher JL, Ritchie CS, Roth DL, Baker PS, Bodner EV, Allman RM. Social isolation, support and capital and nutritional risk in an older sample: Ethnic and gender differences. *Soc Sci Med.* 2005; 60:747–61. [PubMed: 15571893]
72. Sharkey JR, Johnson CM, Dean WR. Food access and perceptions of the community and household food environment as correlates of fruit and vegetable intake among rural seniors. *BMC Geriatr.* 2010; 10:32. [PubMed: 20525208]
73. Krout, JA. An overview of older rural populations and community-based services.. In: Krout, JH., editor. *Providing community-based services to the rural elderly.* Sage; Thousand Oaks, CA: 1994. p. 3-18.
74. Thompson RL, Margetts BM, Speller VM, McVey D. The health education authority's health and lifestyle survey 1993: Who are the low fruit and vegetable consumers? *J Epidemiol Community Health.* 1999; 53(5):294–9. [PubMed: 10396536]
75. Baker AH, Wardle J. Sex differences in fruit and vegetable intake in older adults. *Appetite.* 2003; 40:269–75. [PubMed: 12798784]
76. Donkin AJ, Johnson AE, Morgan K, Neale RJ, Page RM, Silburn RL. Gender and living alone as determinants of fruit and vegetable consumption among the elderly living at home in Urban Nottingham. *Appetite.* 1998; 30:39–51. [PubMed: 9500802]
77. Johnson AE, Donkin A, Morgan K, Neale RJ, Page RM, Silburn RL. Fruit and vegetable consumption in later life. *Age Ageing.* 1998; 27:723–8. [PubMed: 10408667]

78. Paquette M. Perceptions of healthy eating: state of knowledge and research gaps. *Can J Public Health*. 2005; 96:S15–S19. [PubMed: 16042159]
79. Hughes G, Bennett KM, Hetherington MM. Old and alone: barriers to healthy eating in older men living on their own. *Appetite*. 2004; 43:269–76. [PubMed: 15527929]
80. Davis MA, Murphy SP, Neuhaus JM, Gee L, Quiroga SS. Living arrangements affect dietary quality for US adults aged 50 years and older: NHANES III 1988-1994. *J Nutr*. 2000; 130:2256–64. [PubMed: 10958821]
81. Payette H, Shatenstein B. Determinants of healthy eating in the community-dwelling elderly people. *Can J Public Health*. 2005; 96:S27–S31. S30. [PubMed: 16042161]
82. Quandt SA, McDonald J, Arcury TA, Bell RA, Vitolins MZ. Nutritional self-management of elderly widows in rural communities. *Gerontologist*. 2000; 40:86–96. [PubMed: 10750316]
83. Nicklett EJ, Semba RD, Simonsick EM, Szanton S, Bandeen-Roche K, Ferrucci L, et al. Diet quality and social support: factors associated with serum carotenoid concentrations among older disabled women (The Women's Health and Aging Study). *J Nutr Health Aging*. 2012; 16(6):511–8. [PubMed: 22659988]
84. Devine CM, Wolfe WS, Frongillo EA, Bisogni CA. Life-course events and experiences: association with fruit and vegetable consumption in 3 ethnic groups. *J Am Diet Assoc*. 2011; 99:309–16. [PubMed: 10076582]
85. Dubowitz T, Heron M, Bird CE, Lurie N, Finch BK, Basurto-Dávila R, et al. Neighborhood socioeconomic status and fruit and vegetable intake among whites, blacks, and Mexican Americans in the United States. *Am J Clin Nutr*. 2008; 87:1883–91. [PubMed: 18541581]
86. Nicklett EJ, Szanton S, Sun K, Ferrucci L, Fried LP, Guralnik JM, et al. Neighborhood socioeconomic status is associated with serum carotenoid concentrations in older, community-dwelling women. *J Nutr*. 2011; 141:284–9. [PubMed: 21178091]
87. Zenk SN, Schulz AJ, Israel BA, James SA, Bao S, Wilson ML. Fruit and vegetable access differs by community racial composition and socioeconomic position in Detroit, Michigan. *Ethn Dis*. 2006; 16:275–80. [PubMed: 16599383]
88. August KJ, Sorkin DH. Racial/ethnic disparities in exercise and dietary behaviors of middle-aged and older adults. *J Gen Intern Med*. 2010; 26(3):245–50. [PubMed: 20865342]
89. Trudeau E, Kristal AR, Li S, Patterson RE. Demographic and psychosocial predictors of fruit and vegetable intakes differ: implications for dietary interventions. *J Am Diet Assoc*. 1998; 98(12):1412–17. [PubMed: 9850109]
90. Morland K, Filomena S. Disparities in the availability of fruits and vegetables between racially segregated urban neighbourhoods. *Public Health Nutr*. 2007; 10:1481–9. [PubMed: 17582241]
91. Zenk SN, Lachance LL, Schulz AJ, Mentz G, Kannan S, Ridella W. Neighborhood retail food environment and fruit and vegetable intake in a multiethnic urban population. *Am J Health Promot*. 2009; 23:255–64. [PubMed: 19288847]
92. Gordon C, Puriel-Hill M, Ghai NR, Kaufman L, Graham R, Van Wye G. Measuring food deserts in New York City's low-income neighborhoods. *Health Place*. 2011; 17:696–700. [PubMed: 21256070]
93. Ricciuto L, Tarasuk V, Yatchew A. Socio-demographic influences on food purchasing among Canadian households. *Eur J Clin Nutr*. 2006; 60:778–90. [PubMed: 16418741]
94. Dixon LB, Winkleby MA, Radimer KL. Dietary intakes and serum nutrients differ between adults from food-insufficient and food-sufficient families: Third National Health and Nutrition Examination Survey, 1988-1994. *J Nutr*. 2001; 131:1232–46. [PubMed: 11285332]
95. Drewnowski A, Darmon N. Food choices and diet costs: an economic analysis. *J Nutr*. 2005; 135:900–4. [PubMed: 15795456]
96. Bowman S. Low economic status is associated with suboptimal intakes of nutritious foods by adults in the National Health and Nutrition Examination Survey 1999-2002. *Nutr Res*. 2007; 27:515–23.
97. Putnam, J.; Gerrior, S. Trends in the U.S. food supply, 1970-97.. In: Frazaeo, E., editor. *America's Eating Habits: Changes and Consequences*. U.S. Department of Agriculture, Economic Research Service; Washington, DC: 1999. p. 133-60.

98. Shaffer, A. The persistence of L.A.'s grocery gap: the need for a new food policy and approach to market development. Center for Food and Justice, Urban and Environmental Policy Institute, Occidental College; 2002. Available from: [http://scholar.oxy.edu/uep\\_faculty/16](http://scholar.oxy.edu/uep_faculty/16)
99. Franco M, Diez Roux AV, Glass TA, Caballero B, Brancati FL. Neighborhood characteristics and availability of healthy foods in Baltimore. *Am J Prev Med.* 2008; 35:561–5. [PubMed: 18842389]
100. Shepherd D, Towler G. Nutrition knowledge, attitudes and fat intake: application of the theory of reasoned action. *J Hum Nutr Diet.* 1992; 5:387–97.
101. Wardle J, Parmenter K, Waller J. Nutrition knowledge and food intake. *Appetite.* 2000; 34:269–75. [PubMed: 10888290]
102. Kearney JM, Gibney MJ, Livingstone BE, Robson PJ, Kiely M, Harrington K. Attitudes toward and beliefs about nutrition and health among a random sample of adults in the Republic of Ireland and Northern Ireland. *Public Health Nutr.* 2001; 1:1117–26. [PubMed: 11820925]
103. Martin CT, Kayser-Jones J, Stotts N, Porter C, Froelicher ES. Nutritional risk and low weight in community-living older adults: a review of the literature (1995-2005). *J Gerontol A Biol Sci Med Sci.* 2006; 61(9):927–34. [PubMed: 16960023]
104. Payette H, Coulombe C, Boutier V, Gray-Donald K. Nutrition risk factors for institutionalization in a free-living functionally dependent elderly population. *J. Clin. Epidemiol.* 2000; 53:579–87. [PubMed: 10880776]
105. Johnson DB, Beaudoin S, Smith LT, Beresford SA, LoGerfo JP. Increasing fruit and vegetable intake in homebound elders: the Seattle Senior Farmers' Market Nutrition Pilot Program. *Prev Chronic Dis.* 2004; 1(1):1–9.
106. Hendrix S, Fischer JG, Reddy RD, Lommel TS, Speer EM, et al. Fruit and vegetable intake and knowledge increased following a community-based intervention in older adults in Georgia Senior Centers. *J Nutr Elder.* 2008; 27(1-2):155–78. [PubMed: 18928195]
107. Bernstein MA, Nelson ME, Tucker KL, Layne J, Johnson E, et al. A home-based nutrition intervention to increase consumption of fruits, vegetables, and calcium-rich foods in community-dwelling elders. *J Am Diet Assoc.* 2002; 102:1421–2. [PubMed: 12396159]
108. Resnicow K, Jackson A, Blissett D, Wang T, McCarty F, et al. Results of the Healthy Body Healthy Spirit Trial. *Health Psychol.* 2005; 24(4):339–48. [PubMed: 16045368]
109. Berry TR, Spence JC, Plotnikoff RC, Bauman A, McCargar L, et al. A mixed methods evaluation of televised health promotion advertisements targeted at older adults. *Eval Program Plann.* 2009; 32:278–88. [PubMed: 19493572]
110. Clark PG, Rossi JS, Greaney ML, Riebe DA, Greene GW, et al. Intervening on exercise and nutrition in older adults: The Rhode Island SENIOR project. *J Aging Health.* 2005; 17(6):753–78. [PubMed: 16377771]
111. Keller HH. Promoting food intake in older adults living in the community: a review. *Appl. Physiol Nutr. Metab.* 2007; 32:991–1000. [PubMed: 18059571]
112. Kamp D. Position of the American Dietetic Association, American Society for Nutrition, and Society for Nutrition Education: food and nutrition programs for community-residing older adults. *J Am Diet Assoc.* 2010; 110:463–72. [PubMed: 20213956]
113. Cody, S.; Ohls, JC. Evaluation of the US Department of Agriculture Elderly Nutrition Demonstration: volume I, evaluation findings. US Department of Agriculture; Washington, DC: 2005. Publication No. CCR9-1
114. Wellman NS, Rosenzweig LY, Lloyd JL. Thirty years of the older Americans nutrition program. *J Am Diet Assoc.* 2002; 102:348–54. [PubMed: 11902366]
115. Wellman NS. Nutrition 2030. The Elderly Nutrition Program: contributing to the health and independence of older adults. A white paper on lessons from Federal Nutrition Assistance Programs; National Policy and Resource Center on Nutrition and Aging. 1999
116. Warner, SB.; Durlach, H. To dwell is to garden: a history of Boston's community gardens. Northeastern University Press; Boston: 1987.
117. Young C, Karpyn A, Uy N, Wich K, Glyn J. Farmers' markets in low income communities: impact of community environment, food programs and public policy. *Community Dev J.* 2011; 42:208–20.

118. Twiss J, Dickinson J, Duma S, Kleinman T, Paulsen H, Rilveria L. Community gardens: lessons learned from California healthy cities and communities. *Am J Public Health*. 2003; 93:1435–8. [PubMed: 12948958]
119. Yancey, AK.; Kumanyika, SK.; Ponce, NA.; McCarthy, WJ.; Fielding, JE.; Leslie, JP., et al. Population-based interventions engaging communities of color in healthy eating and active living: a review.. *Prev Chronic Dis*. 2004. Available from: [http://www.cdc.gov/pcd.issues.2004.jan.03\\_0012.htm](http://www.cdc.gov/pcd.issues.2004.jan.03_0012.htm)