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Importance of Nutrition Security to CVD Prevention Efforts in the USA

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Abstract

Purpose of Review The importance of addressing nutrition security for the primary and secondary prevention of cardiovascular disease (CVD) in the USA is reviewed by describing the relationships between food security, diet quality, and CVD risk along with the ability of governmental, community, and healthcare policies and interventions to address nutrition security.

Recent Findings Existing safety net programs have shown to be effective at improving food security and diet quality and reducing risk for CVD, but continued efforts to increase reach and improve standards are needed. Adoption of policies, healthcare initiatives, and community- and individual-level interventions addressing the nutritional intake of socioeconomically disadvantaged populations may also lessen CVD burden, but scaling interventions remains a key challenge.

Summary Research suggests simultaneously addressing food security and diet quality is feasible and could help reduce socioeconomic disparities in CVD morbidity and mortality. Intervening at multiple levels among high-risk groups should be a priority.

Keywords Cardiovascular risk · Cardiovascular disease · Nutrition security · Diet · Prevention · Health promotion

Introduction

Modifying lifestyle factors including diet is key to the prevention of cardiovascular disease (CVD) [1, 2]. Diet has been linked to CVD through traditional risk factors, including total cholesterol, hypertension, type 2 diabetes, and body weight, and newly recognized risk factors, including oxidative stress and inflammation [3]. Poor diet quality and diet-related chronic diseases are associated with food insecurity [4], which is defined as an "economic and social condition of limited or uncertain access to adequate food" [5]. Effective policies and interventions can help address barriers to achieving both food security and nutritionally adequate dietary intake, or nutrition security [6••], and help promote equitable reductions in CVD. The purpose of this review is to describe the importance of addressing nutrition security in CVD prevention efforts in the United States of America.

In 2021, 12.5% US households with children and 9.4% without children were classified as food insecure (i.e., low or very low food security) [7], but it is unknown how many households are nutrition insecure because no standard measure of nutrition security exists. An American Heart Association (AHA) policy statement recently defined nutrition security [6••] as having stable and equitable access, availability, affordability, and utilization of nutritionally adequate foods and beverages that can promote health and prevent and treat disease [6••, 8]. Thus, individuals who possess the financial means to access a sufficient amount of food are not nutrition secure if they are unable to afford or utilize nutritionally adequate food. Indeed, the health status of marginally food insecure individuals falls between that of those who are food secure and those who are food insecure [4, 9]. In addition to households with food insecurity, 9.3% of US households with children and 6.4% without children are marginally food insecure [7].

Diet quality is a holistic measure of the overall eating pattern and is an important target for CVD prevention efforts

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[10]. Improvements in diet quality have the potential to reduce diabetes, heart disease, and stroke prevalence, reduce deaths, and lower health care costs [11–13] with recent analyses reaffirming the beneficial cardiovascular effect of achieving dietary goals [14•]. Encouragingly, those with the worst initial diet quality may benefit most from dietary interventions [15].

While various measures of diet quality exist, the 2020–2025 Dietary Guidelines for Americans [16] and the 2021 AHA Dietary Guidance [17••] recommend a dietary pattern rich in fruits and vegetables, limited in added sugars, saturated fat, and sodium, and preferencing whole grains, fat-free and low-fat dairy products, and lean protein foods. Americans generally fail to meet nutritional recommendations and have poor overall diet quality [16]. Compared to individuals with higher socioeconomic status, those with food insecurity and those who participate in the Supplemental Nutrition Assistance Program (SNAP) [18–21] or use food pantries [22] are more likely to have poor diet quality, micronutrient inadequacy [23], and biomarker-detected micronutrient deficiencies [24•].

These nutritional disparities by food security status are reflected in greater atherosclerotic CVD risk among adults [25••, 26]. Food security status is more likely than income level to be associated with self-reported chronic conditions [4]. Disparities by food security status also exist in the total number of comorbid conditions [27], diabetes development, and CVD mortality [28]. Food insecurity is more prevalent among those with CVD compared to those without [29] , and the rates of food insecurity among people with CVD increased to nearly 40% in 2018 [30•]. While the relationship between food security and CVD risk factors is less clear among children and adolescents due in part to the lower prevalence in younger age groups [31–33], good nutritional habits starting from childhood are likely to be important for CVD prevention in adulthood.

US food assistance programs and policies have largely focused on providing sufficient calories with less emphasis on diet quality [8]. However, in September 2022, the White House announced the National Strategy on Hunger, Nutrition, and Health that focuses on improving food access and affordability, integrating nutrition and health, empowering consumers to make healthy choices, and enhancing research related to food and nutrition security [34]. With an eye to the future, this paper reviews several important cross-sector interventions and policies in the USA that simultaneously target food security and diet quality (Table 1) to provide evidence that addressing nutrition security is feasible and effective for both primary and secondary prevention of CVD outcomes. The paper provides an overview of interventions and policies that not only target individual behaviors but also the socio-environmental context in which food choices are made.

Federal, State, and Local Policies and Programs

Supplemental Nutrition Assistance Program (SNAP)

SNAP is the largest federal nutrition assistance program, serving over 35 million individuals through provision of funds to be used towards grocery purchases [35]. Research shows the annual cost of a healthy diet is greater than the cost of a less healthy diet [36], and low-income individuals with food insecurity spend less on food and purchase fewer fruits than those without food insecurity [37]. As spending more on food is associated with better diet quality, increasing the spending power of low-income individuals has the largest potential benefit to diet quality [38]. Indeed, previous expansions of SNAP benefits have been associated with better weight outcomes among children and youth [39] and in hemoglobin A1c (HbA1c) and total cholesterol among young and middle-aged adults [40]. Therefore, recent increases in SNAP benefit amounts through the October 2021 updates to the Thrifty Food Plan and through pandemic relief (e.g., increasing benefits to the maximum amount) could be expected to improve nutrition security.

Beyond the provision of funds, SNAP also provides education interventions (SNAP-ed) to further address commonly reported nutrition security barriers, such as lack of time to prepare meals and cooking skills [41]. However, these programs are underutilized [41], and the provision of nutrition education alone may be insufficient for changing dietary intake [42]. However, when SNAP-ed programs are combined with financial incentives for purchasing healthy foods, modest dietary improvements may be achieved [42].

Growing evidence suggests instituting SNAP policy adaptations in food production and distribution (e.g., restricting sugar-sweetened beverage [SSB] purchases) could improve food security and diet quality [43•]. For example, simulations of adding both fruit and vegetable incentives and SSB disincentives to SNAP estimated up to 940,000 CVD events prevented over a lifetime while being cost-saving [44]. Changes in SNAP eligibility and enrollment procedures have also been recommended in order to improve both food security and diet quality [43]. For example, changes such as streamlining the recertification process may reduce the amount of time with lapsed benefits, which disproportionately affects minority households [45]. Additionally, encouraging participation in related programs such as school meals would also improve nutrition security.

Special Supplemental Nutrition Program for Women, Infants, and Children (WIC)

The reach of WIC is wide, with over 6 million women and children served in an average month [46]. In contrast to

Table 1 Description of policies and programs addressing nutrition security relevant to the review of the importance of nutrition security to CVD prevention efforts in the USA

Policy/program	Description
Federal, state, and local programs and policies	
Child and Adult Care Food Program	State-administered program providing reimbursements for nutritious meals and snacks to enrolled child care centers, afterschool care programs, day care homes, and adult day care centers serving eligible children and adults (fns.usda.gov/cacfp).
Dietary Guidelines for Americans	Jointly published by the USDA and HHS every 5 years, the guidelines outline "the components of a healthy and nutritionally adequate diet to help promote health and prevent chronic disease" and are required to be based on the most current scientific and medical knowledge (dietaryguidelines.gov).
Families First Coronavirus Response Act	Legislation adopted in 2020 that augmented SNAP by suspending work requirements, allowing distribution of maximum benefits, and initiating the pandemic electronic benefits transfer program (congress.gov/116/plaws/publ127/PLAW-116publ127.htm).
Fruit and vegetable subsidies	Lower the cost of produce by providing the consumer with a voucher, coupon, or debit card to pay for produce.
Healthy, Hunger-Free Kids Act of 2010	Legislation in 2010 that required USDA school meals to include whole-grain-rich foods, more fruits and legumes, and a broader mix of vegetables (fns.usda.gov/cn/healthy-hunger-free-kids-act).
National Salt and Sugar Reduction Initiative	Established voluntary targets for sugar and salt reduction through a partnership of organizations and health authorities (nyc.gov/site/doh/health/health-topics/national-salt-sugar-reduction-initiative.page).
NSLP	Operated in public and nonprofit private schools and residential child care institutions, NSLP provides nutritionally balanced, low-cost or free lunches to children who qualify individually based on household income or who attend schools that qualify under the Community Eligibility Provision (fns.usda.gov/nslp, frac.org/community-eligibility).
Reformulation	Changing the nutrient profile of foods by targeting products high in the target nutrient (e.g., trans-fat, sodium) and setting product-specific reformulation goals [66].
SBP	Administered by the USDA and state education agencies, local school food authorities are reimbursed for providing nonprofit breakfast programs in schools and residential childcare institutions for free or at reduced price to eligible children (fns.usda.gov/sbp/school-breakfast-program).
WIC	Determined by Congress annually federal grants are provided to states which determine the type of benefit provided. This may include supplemental foods, health care referrals, and nutrition education for low-income pregnant, breastfeeding, and non-breastfeeding postpartum women, and children up to age 5 who have a qualifying dietary or medical condition putting them at nutritional risk (fns.usda.gov/wic).
Sugar-sweetened beverage taxation	Taxes on beverages (e.g., soda, juice, sweetened tea or coffee drinks, sports drinks, and energy drinks) may be applied directly to the consumer or to the distributor/wholesaler and passed on to the consumer.
SNAP	The largest federal food assistance program, SNAP provides monthly nutrition benefits to eligible low-income individuals and families via an electronic benefits card that can be used to purchase food at authorized retailers (fns.usda.gov/snap).
SNAP-Ed	Through federal grant funding, implementing agencies (e.g., state departments, universities) contract with state agencies to implement evidence-based programs that help participants lead healthy, active lives. (snaped.fns.usda.gov/)
Thrifty food plan	Updated annually and used to adjust the maximum monthly SNAP benefit that can be allotted, The thrifty food plan identifies the cost of groceries needed to provide a healthy, budget-conscious diet for a family of four (fns.usda.gov/snap/thriftyfoodplan).
Community-based programs	
Food environment	Various aspects of the food system that interact with the physical and social environment (e.g., farms, retail locations, availability, marketing, store hours) [83].
Charitable food system	Food banks, food pantries, meal programs, and other community organizations that distribute food to those experiencing food insecurity at no cost [77].
Community garden	Spaces where community members can grow plants, fruits, and vegetables. Typically, a membership or plot fee apply (communitygarden.org/).

Table 1 (continued)

Policy/program	Description
Community kitchen	Kitchen spaces owned by schools, churches, businesses, or other organizations that are opened for shared use for community-initiated cooking programs in which members can learn cooking skills and prepare meals (legalfoodhub.org/wp-content/uploads/2018/07/Community-Kitchens-Massachusetts-July-2018.pdf).
Community supported agriculture	Enables consumers to purchase a share of the goods, typically produce, produced from a farm, by becoming "members" [91].
Healthcare interventions	
Food prescription programs	Typically vouchers for free or discounted healthy food are provided to patients through their health care provider for use at participating locations like retail stores or farmers' markets [101•].
Medically tailored meals	Referred through their health care provider or health plan, patients with chronic illnesses (e.g., diabetes) typically receive meals delivered to patients' homes that are designed by nutrition professionals to meet their dietary needs (fimcoalition.org/our-model).
Section 1115 demonstration waivers	Allow Centers for Medicare and Medicaid Services to waive certain provisions of the Medicaid Statute and provide federal funds to pay for services and services to populations that would not otherwise be covered. For example, some states have used these to fund produce prescriptions (medicaid.gov/medicaid/section-1115-demonstrations/about-section-1115-demonstrations/index.html).
Teaching kitchens	Typically located in hospitals or community organizations, classes are offered for participants to learn how to prepare healthy meals, and funding is usually sourced from the government, sponsorships, philanthropy, or patient insurance or payment (teachingkitchens.org).

HHS, Health and Human Services; *NSLP*, National School Lunch Program; *SBP*, School Breakfast Program; *SNAP*, Supplemental Nutrition Assistance Program; *SNAP-Ed*, Supplemental Nutrition Assistance Program-Education; *USDA*, United States Department of Agriculture; *WIC*, The Special Supplemental Nutrition Program for Women, Infants, and Children

SNAP, the funds provided by WIC are restricted to allowable purchases based on healthfulness, and therefore can more directly address nutrition security. Changes to allowable purchases instituted in 2009 were associated with improved diet quality among toddlers [47]. The changes were also associated with a reversal of the previously observed increasing obesity trends among 2- to 4-year-olds [48]. These improvements may be attributable to increased purchasing of WIC-allowed foods, such as whole grain bread, brown rice [49], and fruit [50], as well as reduced purchasing of whole milk and cheese [51] and juice [52] and improvements in greens and beans consumption [47].

School Breakfast Program (SBP) and National School Lunch Program (NSLP)

The US Department of Agriculture (USDA) SBP and NSLP programs provide food free or at reduced cost. These programs are associated with improvements in food security, marginal food security, and diet quality [53] and are more healthful than meals eaten at home [54]. After the Healthy, Hunger-Free Kids Act of 2010 strengthened nutritional standards for foods and beverages served in school, the percent of fruits and vegetables distributed to schools rose, and cheese, poultry, and red meat distribution dropped [55]; improvements in selection, intake, and sales of healthy food were observed [56]; and obesity rates among children living in poverty decreased by 47 percent within eight years [57]. Community eligibility allows schools in select low-income areas to serve breakfast and lunch to all students at no cost. These universal school meals can address nutrition security by removing barriers to SBP and NSLP enrollment among eligible children (e.g., reducing paperwork burden and stigma) and by providing meals to other low-income children who do not meet eligibility requirements. Indeed, universal school meals are associated with improvements in diet quality and food security with some studies showing additional benefits to household incomes, school finances, and academic performance [58].

Taxes, Marketing, Labeling, and Reformulation

Sugar-sweetened beverage consumption has been linked to CVD mortality [59], and disadvantaged groups have higher SSB intake [60]. SSB taxation has been shown to discourage SSB consumption through higher prices and lower sales [61•]. One suggested strategy for making taxation more acceptable is to combine taxation with fruit and vegetable subsidies such that there is a net financial gain among low-income households [62]. Such strategies could prevent CVD events and deaths across the population but would especially benefit SNAP [63], Medicaid, and Medicare beneficiaries [64]. However, important caveats need to be considered. When enacted only at the local level,

the health benefits of SSB taxation may be undercut by purchases outside the tax zone [61]. Furthermore, more evidence would be needed before considering taxes and subsidies for other food groups and products.

Other tax strategies that increase households' ability to spend more on food, such as expansion of the child tax credit, could be viable for reducing nutrition insecurity. Evaluations of the tax expansion during the COVID-19 pandemic showed food purchases were the most common use of funds, and one study's findings suggested improvements in food security and dietary intake [65].

Other policy, systems, and environmental changes to improve nutrition have been proposed, including reformulation, marketing restrictions, and labeling [66]. For example, the US National Salt and Sugar Reduction Initiative [67] is meant to encourage food companies to reformulate products voluntarily in line with set standards and could address nutrition security directly by altering the quality of accessible foods. A microsimulation study has suggested that achieving such reformulation goals could lead to reductions in CVD events and mortality and increases in quality-adjusted life-years, even with imperfect compliance [68].

Targeted marketing of nutritionally inadequate food, such as SSBs, disproportionately affects racial minorities and individuals with low socioeconomic status [69]. One study demonstrated that SSBs were marketed in retail stores more on the days SNAP benefits were issued compared to non-issuance days [70]. Restricting marketing, particularly to children, may reduce disparities in health and dietary intake [71].

Finally, both SNAP and non-SNAP recipients who utilize nutrition information are more likely to make healthful food purchases [72]. Therefore, various labeling strategies (e.g., menu and front-of-pack labeling) have been considered to aid selection of healthy and low-calorie foods [73, 74]. While the effect on CVD outcomes of labeling and marketing policies are unknown, they are an important component of a food systems approach to improving nutrition security [75•].

Community-Based Programs

Charitable Food Assistance

The charitable food system, comprised of food banks, food pantries, and meal programs, is an important resource for providing nutrition to food insecure individuals. In 2021, approximately 1 in 6 people received charitable food assistance [76]. However, the ability of food banks and food pantries to adequately address nutrition security may be limited by operational resources (e.g., limited hours) and ability to store perishable foods (e.g., lack of space) [77]. Furthermore, culturally acceptable foods and foods meeting health needs are often unavailable in pantries with limited inventory [78].

Several studies have demonstrated that behavioral economics strategies to make healthier food choices more appealing and easier are effective in food banks and pantries. There is evidence that the Supporting Wellness at Pantries (SWAP) traffic-light labeling system [79] can help food pantry staff procure healthier food options [80] and that placing healthier foods in more prominent locations (e.g., eye-level) results in healthier consumption [81•].

Other behavioral interventions to promote more nutritious food choices have been tested in food pantries, many of which include educational components but may also provide recipes, cooking classes, medically tailored meals, or referrals to other social services [82]. While multi-component interventions often succeed in reducing food insecurity, their effect on diet quality is not as consistent, strong, or long-lasting [82]. Similarly, while positive effects on glycemic control, weight, and waist circumference have been observed, the strength of the evidence is limited by lack of methodological rigor such as small samples, lack of control groups, short follow-up time, and poor measurement of diet [82].

The Food Environment

The food environment both positively and negatively relates to dietary behavior [83•]. Despite significant focus on what have been previously referred to as "food deserts" (i.e., geographic areas where residents do not live in close proximity to a grocery store), research suggests that living in low-income communities [84] and "food swamps" (i.e., geographic areas with a high density of food outlets serving high-calorie, non-nutritious foods) [85] may be more influential in determining dietary choices and health. "Healthy Food Priority Areas" or "low-income, low access areas" have been proposed as alternate terms with more focus on broader barriers and facilities than distance alone (ers.usda.gov/data-products/food-access-research-atlas/documentation/). The relationship between the food environment and health, and the effectiveness of changing aspects of the food environment, can vary depending on whether the environmental measure is objective (e.g., sales data) or subjective (e.g., consumer perception of healthfulness) and the type of environment (e.g., home or restaurant) [83].

Results from studies evaluating the impact of policy interventions in the food environment are complex. In one natural experiment, the addition of a supermarket to an urban "food desert" was related to improved dietary intake and reduced food insecurity, but findings were not explained by shopping at the new supermarket or healthy food availability in the larger food environment [86]. Healthy corner store [87, 88] and healthy checkout line [89] initiatives have attempted to make healthy foods more prominent (e.g. better displays),

more available (e.g., installation of refrigerators to keep produce fresh), and more appealing (e.g., taste tests) at existing locations and have shown some promising impacts on purchases. These strategies represent feasible point of purchase changes to the food environment in low-income neighborhoods which may help improve health equity [90].

Community-Supported Agriculture

Some local farms offer community-supported agriculture (CSA) memberships that entitle community members to receive a share of the products produced. In a randomized study of community health center patients with obesity, those receiving a subsidized CSA membership had better diet quality and less food insecurity compared to control patients receiving only education and similar monetary compensation [91]. Extrapolating these results to all low-income adults, such a subsidy would reduce disability-adjusted life years due to diabetes and CVD while being cost-saving [92•]. While governmental nutrition assistance program funds can be used to purchase memberships, a limitation of this strategy is that CSA may appeal only to select low-income families. Flexibility in choice, payments, and pick-up times and locations may be needed to improve reach and engagement, and addressing meal planning and recipes might increase acceptability [93, 94].

Healthcare Interventions

Health care visits are underutilized opportunities to identify food insecurity and inadequate dietary intake and to implement dietary counseling and referrals to governmental- and community-based food assistance programs [95•, 96]. Health care providers are uniquely positioned to assess how services provided to their patients address their CVD risk over time.

The strongest evidence for interventions addressing nutrition security in health care is for medically tailored meals (MTMs) [97•]. Typically, dietitians or nutritionists design healthful prepared meals meeting dietary specifications for patients with particular chronic conditions. In a small randomized trial, patients with food insecurity and diabetes receiving MTMs for 12 weeks reported less food insecurity, better diet quality, and improved mental health compared to control participants [98]. In a simulation study, national coverage of MTMs for those with at least one diet-related medical condition and a limitation in daily living was estimated to result in a net cost savings of $13.6 billion dollars annually by preventing 1.6 million hospitalizations [99•]. In sensitivity analyses which added food insecurity as a criterion, MTMs remained cost-saving [99•].

There has also been growing interest in produce prescriptions, teaching kitchens, and hospital-based food pantries [100]. Although more research is needed, emerging evidence suggests produce prescription programs can increase fruit and vegetable consumption and reduce household food insecurity; however, the mixed evidence for effects on diet-related health outcomes (i.e., weight, blood pressure, HbA1c) is in part due to suboptimal redemption rates, short intervention durations, and barriers such as limited employee training at voucher-redemption locations [101•, 102]. Similarly, while teaching kitchens are seemingly feasible, participation rates can be low [103], and few studies have actually assessed hospital-based food pantries [101•]. More evaluations are needed to understand the acceptability, uptake, and potential impact of these interventions among nutrition insecure groups specifically.

Discussion

Diet is the cornerstone of CVD prevention, but achieving optimal diet quality and equity in nutrition security remains elusive. To reach CVD prevention goals in the USA, researchers, policy makers, and practitioners cannot ignore the significant proportion of the population who are at higher risk for diet-related diseases due to food insecurity and poor diet quality. Equitable prevention and treatment of CVD can only be achieved with policies and programs that simultaneously address both food security and diet quality.

Federal safety net programs have evolved over the years with recognized benefits to food security, diet quality, and CVD outcomes [39, 48]. The USDA has recently committed to improving nutrition security through multiple strategies, such as increasing the reach of their programs [104], which may be particularly helpful as only about half of food insecure households participate in at least one of the three largest federal nutrition assistance programs [7]. Another USDA strategy is continued updating of the nutritional standards of school meals [104]. While likely to improve children's diet, as have been seen with previous initiatives [56], evaluation will still be needed. Other changes such as allowing SNAP and WIC recipients to use benefits for online shopping [104] may address nutrition security indirectly by reducing the time burden associated with shopping and by potentially reducing stigma associated with using food assistance. Future research could test behavioral economic strategies, such as incentives and default strategies, to promote healthier choices while using online shopping platforms.

The USDA has also committed to strengthening nutrition security for Native American/Tribal school food programs, the Fresh Fruit and Vegetable Program, the Emergency Food Assistance Program, and the Commodity Supplemental Food Program [104]. To date, most program evaluations

have focused on SNAP, WIC, and NSLP, but assessment of other programs will be necessary to gauge their reach and effectiveness. For example, The Child and Adult Care Food Program (CACFP) can improve the dietary intake of participating low-income children [105], but many centers are not aware they are eligible to participate in the program [106]. Without assistance from CACFP staff and sponsoring organizations to clarify eligibility and help with implementation, the reach of the program will remain limited [106]. Higher dietary standards for CACFP may also be needed to address lack of effectiveness in improving dietary intake [107].

Despite the effectiveness of federal food assistance programs in promoting nutrition security, many individuals are not eligible to participate in these programs due to age, income, or citizenship eligibility requirements. Therefore, it is important to consider how other types of assistance programs could be strengthened to help improve nutrition security. As the reach of the charitable food system is broad, improvements in food banks and pantries can have far-reaching effects on nutrition security. Recent efforts have been made to create a toolkit for food banks that describes how to work with donors to increase nutritious food availability, how to implement behavioral economics approaches for food environment change, and how to develop intercultural competency plans [108]. Overarching food policy and environmental changes are also important for addressing the nutrition security of the entire population. For example, in September 2022, the FDA proposed updating the nutritional requirements for manufacturers to claim a product is "healthy" and creation of a symbol to aid consumer identification of healthier food at the point-of-purchase [109].

While there is relatively good evidence of the effectiveness of multicomponent behavioral interventions (e.g., nutrition education, motivational interviewing) for improving food security, there is less evidence linking food security interventions to improvements in diet quality and health outcomes [42, 82]. Research evaluations are needed with larger sample sizes and control groups. More reliable measurement of diet (including measurement of dietary components beyond fruit and vegetable intake) and CVD risk (including surrogate endpoints beyond weight) would strengthen the evidence base. Utilizing Multiphase Optimization Strategy (MOST) [110] and Sequential Multiple Assignment Randomized Trial (SMART) [111] designs could help determine the optimal combination, dosing, and sequence of interventional components.

Similarly, future research is needed to determine optimal multilevel strategies in the food retail environment to improve equity in nutritious food purchases. Research should assess both objective and subjective measures of the environment and consider interactions between the environment and social, psychological, and economic factors [83•]. Examining the effects of the environment and environmental change requires carefully designed and interpreted studies [112]. Causal inference methods, such as instrumental variable regression, may be particularly useful [113]. Other analytical approaches, such as agent-based modeling, may help to compare the effectiveness of various proposals for altering the food environment [114•].

Healthcare is an important and underutilized avenue to addressing nutrition security's effect on CVD. As of late 2022, the US Preventive Services Task Force is in the process of reviewing the evidence for screening for food insecurity in primary care [115]. However, screening for food insecurity alone does not adequately assess nutrition security. Brief dietary screening paired with food insecurity screening would provide a more complete assessment of nutrition security [95•]. The AHA has identified an urgent need for developing validated brief dietary screeners with clinical decision support that could assist non-registered dietitian (RD) clinicians with assessing diet and providing brief counseling or RD referral [95•]. Medical nutrition therapy provided by RDs is covered for only select conditions, such as diabetes and chronic kidney disease, but expansion for other diet-related conditions has been proposed [34].

There are major barriers to addressing nutrition security within healthcare. Resources to pay for and deliver MTMs and food prescription programs are limited. Potential pathways to scale access have been proposed through Special Supplementary Benefits for the Chronically Ill (SSBCI) [116], Medicaid section 1115 demonstration waivers [117•], and Community Benefit activities [118]. Upcoming evaluations of pilot programs through Medicaid in several states (e.g., MA, NC) will add to the evidence base. While effectiveness will be important to evaluate, implementation research will be key to delivering high-quality programs [119••].

Although promising, there are gaps in knowledge about several community-based interventions for promoting nutrition security. Few studies have assessed the effectiveness and acceptability of community kitchens and gardens among low-income populations in the USA [120, 121]. Although mobile food markets may eliminate transportation barriers and increase the availability of fresh produce, more research is needed to determine their effectiveness in improving diet and health [122]. Workplace and faith-based nutrition initiatives also require more investigation [123••]. Overall, there is a need to include more racial and ethnic minorities and older adults in nutritional intervention research [123••].

The main pathway that has been described to explain food insecurity's effect on CVD risk has been through diet quality and its effect on physiological measures (e.g., weight) [25••]. However, individuals with food insecurity may experience increased stress (e.g., allostatic load), engage in unhealthy coping behaviors (e.g., alcohol use), experience poor mental health (e.g., depression), and have poor disease management (e.g., unable to afford medications) through

which their CVD risk may be increased [25••, 124, 125]. It is worth investigating whether policies and programs affect these other pathways through which food insecurity influences CVD risk.

In conclusion, socioeconomic disadvantage is a major barrier to eating a heart healthy diet [17••]. To address equity in nutrition security and associated CVD, innovations for creating and sustaining a healthy food system are needed [75•]. Future research should explore policy, community, and individual-level interventions that simultaneously address food security and diet quality and can inform the national agenda for improving equity in nutrition security.

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Declarations

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•• Of major importance

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