

# ***Evidence Synthesis***

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# **Preventive Services for Food Insecurity: A Systematic Review for the U.S. Preventive Services Task Force**

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Agency for Healthcare Research and Quality  
U.S. Department of Health and Human Services  
5600 Fishers Lane  
Rockville, MD 20857  
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### **Prepared by:**

Kaiser Permanente Evidence-based Practice Center  
Kaiser Permanente Center for Health Research  
Portland, OR

### **Investigators:**

Elizabeth A. O'Connor, PhD  
Elizabeth M. Webber, MS  
Allea Martin, MPH  
Michelle L. Henninger, PhD  
Michelle Eder, PhD  
Jennifer S. Lin, MD, MCR

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## Structured Abstract

**Objective:** To examine the evidence on benefits and harms of screening for and interventions to ameliorate food insecurity, and the accuracy of screening tools.

**Data Sources:** Previous reviews on this topic and MEDLINE via Ovid, CINAHL via EBSCO, and the Cochrane Central Registry of Controlled Trials beginning January 1, 2017 (for screening studies) and June 1, 2018 (for intervention studies) and ending on October 11, 2022.

**Study Selection:** Randomized clinical trials (RCTs), nonrandomized studies of interventions, and pre-post studies conducted in U.S. healthcare settings that examine the impact of screening or interventions for food insecurity; instrument accuracy studies of brief screening tools.

**Data Analysis:** Data were presented in separate summary tables and figures for each key question for narrative synthesis.

**Results:** Thirty-nine studies (n=198,762) were included in the review. One RCT (n=789) examined the impact of screening for food insecurity and resource information for identified risk factors. This study found no difference between groups in the percent reporting food insecurity after 6 months (29.6% in the intervention group vs. 29.8% with usual care). Ten accuracy studies (n=123,886) compared 1-, 2-, or 6-item subsets of the U.S. Department of Agriculture Household Food Security Survey (HFSS) with the full HFSS. Sensitivity (defined by agreement with the full HFSS) was typically above 95 percent and specificity above 82 percent for all 2-item screeners, although for most studies the screener was fully embedded in the reference standard. The 1-item screener had the lowest accuracy, with sensitivity of 0.59 and specificity of 0.87 (95% confidence intervals [CIs], not reported), but was also the only screener administered independent of the reference standard. Twenty-nine studies (n=74,292) were included that examined interventions to address food insecurity, but 27 were rated as poor quality for the specific outcomes of interest for this review. Of the two fair-quality studies, one was a randomized crossover study comparing 12 weeks of medically tailored meals (“on-meal”) with 12 weeks of not having meals delivered (“off-meal”). This study found that home delivery of medically tailored meals was associated with reduced food insecurity (41.9% while “on-meals” vs. 61.5% while “off-meals”;  $p=0.05$ ) as well as improvements in diet quality and mental health quality of life, but no significant impact on other quality-of-life measures, blood pressure, lipid levels, glucose levels, or cost-related medication underuse. The other fair-quality study found a smaller increase in body mass index among children whose families participated in a mobile food bank than among those who did not after 6 months (mean difference in change,  $-0.68 \text{ kg/m}^2$  [95% CI,  $-1.2$  to  $-0.2$ ];  $p=0.01$ ). The remaining studies examining effects of interventions found wide-ranging effect sizes for change in food security status, but the findings trended in the direction of benefit for all but one study. Interventions involving free or subsidized food and vouchers typically showed increased consumption of fruits and vegetables. There was minimal impact on physiologic outcomes (blood pressure, lipid levels, glucose levels) or acute healthcare utilization, although these outcomes were not reported by more than three studies.

**Limitations:** All but two studies of the impact of food security interventions had high risk of bias for the outcomes included in this review; many were pre-post studies, and several were

designed for other purposes (e.g., primary interest in other outcomes, comparative effectiveness). Only one study examined the impact of screening for food insecurity, and only one reported the accuracy of a brief screener administered separately from the reference standard.

**Conclusions:** Brief screening tools likely have sufficient sensitivity to identify people with food insecurity in healthcare settings and interventions to improve food insecurity show promise, especially those that directly provide food or vouchers/subsidies; however, most studies suffered from high risk of bias, limiting firm conclusions.

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# Chapter 1. Introduction

## Purpose

This report will be used by the U.S. Preventive Services Task Force (USPSTF) to make a recommendation on *Preventive Services for Food Insecurity*.

## Condition Background

### Condition Definition

*Food insecurity* is generally defined as a household-level economic and social condition of limited or uncertain access to sufficient amounts of safe, nutritious food needed for an active and healthy life.<sup>1,2</sup> Food insecurity, reflecting economic instability, may be long term or temporary. For some, it may occur following a specific event (e.g., loss of employment), while for others it may occur regularly (e.g., running out of money at the end of each month due to other competing expenses).<sup>3</sup> Additionally, food insecurity can differ even among members of a household; for instance, adults are more likely to go without food to maintain the dietary patterns of the children in the household. Food insecurity differs from *hunger*, which is an individual-level physiological state that may result from food insecurity and is defined as insufficient caloric intake.<sup>4</sup> The U.S. Department of Agriculture (USDA) divides food insecurity into two categories: “*very low food security*,” in which some household members reduce their food intake because of an inability to afford enough food, and “*low food security*,” indicating that at some point during the year households reduced the quality, variety, and desirability of their diets while maintaining normal eating patterns.<sup>5</sup> Food security also is classified according to two categories: “*marginal food security*,” in which households had problems or anxiety at times, but did not substantially alter the quality, variety, or quantity of their intake, and “*high food security*,” in which households had no problems or anxiety about consistently accessing adequate food.<sup>5</sup> Thus, food insecurity can be thought of as a continuum in which individuals may alter the amount of food they consume, their preferred variety of foods, or their food sources (e.g., food pantries), and, in extreme cases, go without.<sup>3,6</sup>

Food insecurity may lead to disrupted meal patterns and/or skipped meals, which can contribute to inadequate dietary intake, malnutrition, nutritional deficiency, or poor dietary quality.<sup>3,7</sup> Recently, there has been an increased focus on *nutrition insecurity*, which goes beyond simply meeting caloric sufficiency to include access to nutritious foods. Nutrition insecurity can occur with or without food insecurity; for instance, one can consume sufficient calories without meeting nutritional recommendations for vegetables or protein. However, the concepts are often linked, as food insecurity can imply some degree of nutrition insecurity. A definition of food security that incorporates nutrition security includes consistent, equitable, and reliable access, availability, and affordability of foods that promote well-being.<sup>8,9</sup> Another related term is *food insufficiency*, which refers to lack of adequate quantity of food in past week.<sup>10</sup>

Food insecurity is considered a key *social risk factor*—a measurable, intervenable, individual-level social and economic condition shaped by broader social and structural determinants of health such as house costs, wages, and the cost of higher education.<sup>11-14</sup> *Social needs* are social risk factors that individuals prioritize as something they believe is important to address and would like assistance with.<sup>12</sup> The Centers for Medicare & Medicaid Services (CMS) has identified five core social risk factors that community services can help with: food insecurity, housing instability, transportation needs, utility help needs, and interpersonal safety.<sup>15</sup> These social risk factors are interconnected. For instance, a low income and unemployment are often directly connected to other risk factors, such as food insecurity, housing instability, and transportation issues.

## Historical Context

The concept of food insecurity has evolved over time. Fifty years ago, hunger was a prominent cause of disease in children in the United States.<sup>8</sup> Since then, federal policies and programs, such as the Supplemental Nutrition Assistance Program (SNAP) (previously Food Stamps), National School Lunch and Breakfast Programs, Special Supplementation Nutrition Program for Women, Infants, and Children (WIC), and local hunger relief agencies have greatly reduced the issue of hunger, although food insecurity is still a concern for many families in the United States, and disparities in access to healthy and affordable food remain.

## Prevalence and Burden

### Prevalence of Food Insecurity

According to the USDA Economic Research Service's Current Population Survey (CPS), 12.8 percent (17.0 million) of households were food insecure in 2022, with 7.7 percent of households experiencing low food security and 5.1 percent of households experiencing very low food security.<sup>16,17</sup> The 2022 prevalence of food insecurity (12.8%) is significantly higher than the prevalence measured from 2017 through 2020.<sup>16</sup> The economic changes and fluctuations of government aid programs during and after the COVID-19 pandemic have also significantly impacted rates of food insecurity: in April 2020, the prevalence of food insecurity was reported to be as high as 20.4 percent,<sup>18</sup> and while the USDA implemented a number of economic support programs in 2020, including some specific to food and nutrition assistance, many of those programs have since come to an end.<sup>16</sup>

The prevalence of food insecurity varies significantly by household type and is higher in households with children (17.3%), households with children younger than age 6 years (16.7%), households headed by a single woman (33.1%) or a single man (21.2%), and households with incomes below 185 percent of the poverty threshold (32.0%).<sup>16,17</sup> While children are sometimes protected from substantial reductions in food intake even in households with very low food security, about 1.0 percent of all households with children in the United States (381,000 households) experienced very low food security: these households reported that children were hungry, skipped a meal, or didn't eat for an entire day due to lack of money for food.<sup>15-17</sup> People



who identify as lesbian, gay, bisexual, or trans (LGBT) are also more than twice as likely to experience food insecurity as the general population, especially adults younger than age 35 years.<sup>19,20</sup>

Older adults are also at increased risk for food insecurity. Over the past two decades in the United States, food insecurity has increased by 45 percent in older adults.<sup>21</sup> Adults with disabilities are also at high risk for food insecurity, primarily due to limited financial resources for food (i.e., limited income and employability along with high healthcare expenditures).<sup>22</sup> Thirty-three percent of U.S. households with adults who are not in the labor force due to disability experience food insecurity, including 16.6 percent with very low food security, compared with 8.1 percent of households without an adult with disabilities.<sup>23</sup>

Working-age veterans have a 7.4 percent greater risk for food insecurity than nonveterans. From 2015 to 2019, 11.1 percent of working-age veterans lived in food insecure households, and 5.3 percent lived in households with very low food security.<sup>24</sup> Food insecurity was substantially higher among disabled (33.6%), unemployed (20.0%), and female (13.5%) working-age veterans.

There are also significant differences by race and ethnicity. In 2022, 22.4 percent of Black non-Hispanic households and 20.8 percent of Hispanic households experienced food insecurity, compared with 9.3 percent of White households.<sup>16</sup> While USDA data on other racial and ethnic groups are not available, data from other studies indicate that American Indian/Alaska Native groups are more than twice as likely as White populations to experience food insecurity.<sup>25-32</sup> The factors contributing to these differences are complex and related to other social needs such as income, employment, housing, and access to transportation, which are ultimately shaped by broader social and structural determinants. However, there is an increasing acknowledgment in the literature that racial discrimination and structural racism play an important role in health inequities, including food insecurity,<sup>26,33</sup> and people of color have a higher risk of food insecurity even when other social risk factors are removed.<sup>26-31</sup> In addition to structural racism, one study has shown that the frequency of lifetime racial discrimination is significantly associated with increased odds of experiencing very low food security.<sup>32</sup>

### **Burden of Food Insecurity**

Links between living in a household experiencing food insecurity and health outcomes are well documented, especially in children, among whom food insecurity is associated with birth defects, anemia, cognitive problems, aggression, anxiety, asthma, behavioral problems, depression, suicide ideation, obesity, and worse oral health.<sup>34,35</sup> In young children (e.g., ages 4 to 36 months), food insecurity is associated with developmental problems,<sup>36</sup> and persistent food insecurity in early childhood has been associated with lower health status later in childhood.<sup>37</sup> Experiences of hunger during childhood have also been associated with poor health into late adolescence.<sup>38</sup> The causal pathways of food insecurity and adverse health outcomes in children are not well understood.<sup>39-42</sup>

In adults, living in a household with food insecurity is associated with an increased risk of obesity and a number of health conditions, including diabetes, hypertension, cardiovascular disease, asthma, chronic obstructive pulmonary disease, arthritis, and kidney disease.<sup>5,34,43-45</sup> The relative probability of chronic disease and hospitalization increases significantly when adults experience more severe levels of household food insecurity.<sup>5,46</sup> Those experiencing food insecurity are also more likely to experience poor mental health, including psychological distress, depression, and anxiety.<sup>39-41,47-49</sup>

Food insecurity among adults may impact health outcomes directly or indirectly; however, in children, the mechanisms are not fully understood. Some theoretical pathways include: 1) food insecurity can contribute to stress, depression, drug and alcohol use, and poor overall mental health status, which increases risk of cardiovascular disease and other adverse health outcomes;<sup>50</sup> 2) individuals experiencing food insecurity are more likely to have cost-related medical nonadherence;<sup>51,52</sup> 3) food insecurity may lead to peripheral insulin resistance and stress-related increases in cortisol and other physiologic impacts of stress, which can increase the risk for diabetes;<sup>34,52,53</sup> 4) food insecurity may lead individuals to alter their diets in ways that increase the risk of or impair management of conditions affected by diet, and subsequently increase obesity, which may in turn increase the risk of chronic disease;<sup>34</sup> and 5) food insecurity may alter gut microbiota and/or white blood cell count, causing inflammation that has been associated with health conditions such as diabetes and cardiovascular disease.<sup>54,55</sup> Regarding mental health outcomes, food insecurity can be both a cause and effect: the transition to food insecurity is associated with a decline in mental health, but food insecurity can also precede depression outcomes.<sup>3</sup>

## **Risk Factors**

### **Related Risk Factors**

At its core, food insecurity is an economic issue; therefore, poverty, underemployment or unemployment, lack of affordable housing, and related economic factors are all likely to be risk factors for food insecurity. In 2022, 36.7 percent of households with annual incomes below 185 percent of the poverty threshold were food insecure, compared with 6.8 percent of those at or above the threshold.<sup>16</sup> Unemployment can contribute to challenges in meeting basic household food needs,<sup>56</sup> and children with unemployed parents have higher rates of food insecurity than those with employed parents.<sup>57</sup> However, the high cost of housing in the United States contributes to food insecurity as well; data from the 2021 U.S. census indicate that 25.4 percent of renter-occupied households spend more than 50 percent of their incomes on housing,<sup>58</sup> leaving fewer resources to pay for food.

The presence of chronic conditions is also considered a risk factor for food insecurity. In a sample of 41,854 adults experiencing poverty, food insecurity was associated with higher probability of 10 chronic conditions—hypertension, coronary heart disease, hepatitis, stroke, cancer, asthma, diabetes, arthritis, chronic obstructive pulmonary disease, and kidney disease—and was associated with the total number of chronic conditions reported.<sup>5</sup> In a national sample of older adults, approximately 54 percent of food insecure people had two or more chronic

conditions.<sup>21</sup> Functional limitations is also a risk factor for food insecurity among older adults; an analysis of National Health and Nutrition Examination Survey data found that older adults with four or more physical limitations were more than twice as likely to report very low food security than older adults without limitations (adjusted odds ratio, 2.62 [95% confidence interval {CI}, 1.43 to 4.81]).<sup>59</sup> Data from the Medical Expenditure Panel Survey indicate that the prevalence of food insecurity is much higher among adults with diabetes compared with those without diabetes (16% vs. 9%).<sup>60</sup> Among Medicaid enrollees with insulin-dependent diabetes and diabetes-related eye or kidney complications, over 40 percent were food insecure.<sup>60</sup> The pressure of limited income combined with increased healthcare expenditures, reduced employment opportunities, and increased stress related to chronic disease can all work together to increase the risk of food insecurity.<sup>61</sup> Furthermore, for individuals with diet-related chronic disease such as diabetes, food insecurity can in turn exacerbate their health.

Neighborhood conditions can affect physical access to healthy foods, which may contribute to disparities. Low-income neighborhoods have fewer full-service supermarkets and more convenience stores.<sup>62,63</sup> Residents are at higher risk for food insecurity in these neighborhoods, especially if public transportation options are limited.<sup>64</sup> People with chronic diseases or disabilities and those residing in rural areas are less likely to have access to personal or public transportation, further limiting their access to food.<sup>43,64,65</sup>

## Rationale for Screening and Screening Strategies

Historically, the assessment of patients' social needs has not been a routine part of preventive or primary care, but because food and nutrition security are so intertwined with health and health outcomes, some have argued that screening for food insecurity is an ethical imperative for clinicians and in healthcare.<sup>66</sup> As a result, screening for unmet social needs is increasingly being linked with screening for health behaviors (e.g., smoking).

### Commonly Used Tools to Identify Food Insecurity

The USDA's Household Food Security Survey Module (HFSS) is the primary tool for the assessment of food insecurity in the United States.<sup>67</sup> The HFSS includes a series of 10 questions for households with no children and 18 questions for households with children that elicit information on the household's difficulty in meeting basic food needs due to lack of resources. These questions have been included as part of the Community Population Survey (distributed by the U.S. Census Bureau) since 1995. The 18-item scale has been further developed to incorporate subscales, including a 6-item set that measures food insecurity and hunger in states' surveillance systems.<sup>67</sup> Brief (1- or 2-item) screening tools to identify household food insecurity used in healthcare delivery settings are all derived from and validated against the HFSS (**Table 1**).<sup>68</sup> The most frequently used and studied single-domain screening tool for food insecurity is the 2-item Hunger Vital Sign tool,<sup>69-71</sup> which is available in one of the most widely used electronic health records systems (i.e., EPIC). Multiple social risk factors are often assessed via multidomain tools, rather than screening for food insecurity in isolation, and food or nutrition security are typically included in these tools (**Appendix D Table 1**). Evaluation of CMS's Accountable Health Communities (AHC) Model found that tailoring social risk screening practices (e.g.,

timing, location, staff responsibility, mode of administration) to each clinical site's workflows, staffing, and intake processes was important.<sup>72</sup> Patients appear to prefer self-administered formats, and sparse evidence does not suggest a difference between formats specifically for the identification of food insecurity.<sup>68,73 74-76</sup> For more information see **Appendix F, Contextual Questions, Contextual Question 1.**

Limited information is available to inform the appropriate reassessment interval for food insecurity. Food and nutrition insecurity may change over time, and research to date has not addressed the appropriate frequency of screening for food and nutrition insecurity.<sup>68,73</sup> One study looking at food insecurity over the course of the first years of the COVID-19 pandemic found that children of caregivers who received social needs screenings and relevant referrals every 6 months had greater improvements in social needs than those who received routine annual well-child screenings and referrals,<sup>77</sup> although the applicability to non-pandemic times is unclear. Furthermore, while the recall period for different screening tools varies from 30 days to 12 months, most screening tools do not assess the duration of food insecurity, and therefore cannot assess whether it is temporary or chronic.<sup>78</sup> For more information see **Appendix F, Contextual Questions, Contextual Question 2.**

## **Intervention Approaches**

Interventions to address food and nutrition insecurity (**Table 2**) can include policies at the governmental or institutional level (e.g., WIC, SNAP, siting new grocery stores in underserved areas, fruit and vegetable gleaning initiatives), programs at the community level (e.g., community gardens, community kitchens for nutrition education) and at schools (e.g., school breakfast or lunch programs, farm-to-school programs, use of school-based health centers to connect families to community resources), and interventions directly embedded in healthcare (e.g., medically tailored meals or food prescriptions, food boxes or pantries linked to clinics). Other types of government programs provide monetary assistance that may not be specifically for food but can nonetheless address food and nutrition insecurity by offsetting other expenses (e.g., Medicaid expansion, child tax credit, federal safety net public assistance programs).

Commonly evaluated interventions tied to healthcare include referrals to community-based food banks and food pantries or enrollment in a formal program that a healthcare system runs in partnership with a food bank, a food pantry located in the healthcare setting, programs to increase access to fresh produce not in partnership with a food bank (e.g., food voucher and prescription programs for fruit and vegetables or other healthy foods, partnerships with local grocery stores or markets), subsidized community supported agriculture (CSA) shares, and SNAP enrollment (e.g., onsite benefits coordinator to assist with enrollment and application, referral to local food bank to assist with enrollment process).<sup>68,79</sup> Other types of interventions in healthcare include meal delivery programs and medically tailored meals or groceries, often targeted to patients with diabetes (e.g., meals distributed, referral to food bank or pantry for medically appropriate foods with a "prescription," medically tailored food box).<sup>79,80</sup> These types of interventions aim to improve nutrition security as well as food insecurity, which may have important health benefits aside from adequate caloric intake. Many of these interventions also

include targeted components specifically addressing nutrition insecurity, such as health education coaching, nutrition education, and/or cooking classes.

Some models of care directly link food insecurity assessments to staff-led interventions or an electronic screening platform that provides resources, referrals, and other assistance.<sup>73</sup> In other models, designated staff (e.g., navigators, case managers, community health workers, social workers) respond to identified social needs. In published studies, referrals were typically provided by medical staff, while resources were typically provided by other staff (e.g., medical assistant, volunteers).

Because food insecurity assessments are often conducted as part of a broader screening for multiple social risk factors and social needs, interventions that follow may address social needs in addition to food security (e.g., financial security, housing, transportation). Thus, evaluations of interventions aimed at multiple social needs or delivered alongside medical co-interventions may not be able to isolate the benefit from intervening on food insecurity.

## Recent Recommendations and Current Clinical Practice in the United States

Several professional societies recommend that healthcare systems incorporate food insecurity screening and referral to food sources into their care programs (**Appendix E Table 2**). The American Academy of Family Physicians' EveryONE Project™ initiative recommends that family physicians use a social risk screening instrument that includes food insecurity.<sup>81</sup> Similarly, AARP developed a resource guide and toolkit for implementing food insecurity screening and referral for older patients in primary care.<sup>82</sup> The American Academy of Nutrition and Dietetics,<sup>83</sup> the American Academy of Pediatrics<sup>84</sup> and the American Diabetes Association<sup>85</sup> suggest using the 2-item Hunger Vital Sign screener to assess the possibility of food insecurity. The American College of Cardiology/American Heart Association,<sup>86</sup> American College of Physicians,<sup>87</sup> and American College of Obstetricians and Gynecologists<sup>88</sup> do not endorse a particular screening tool. Regarding interventions, the Community Preventive Services Task Force (CPSTF) recommends fruit and vegetable incentive programs for households with lower incomes, which the CPSTF found to be effective in reducing household food insecurity and increasing fruit and vegetable consumption.<sup>89</sup>

Screening and interventions for food insecurity and other social needs are rapidly changing in current clinical practice. Estimates of screening for food insecurity range from 25 to 100 percent; a more precise estimate is challenging due to data limitations (e.g., heterogeneity in survey instruments, low response rates, reliance on self-report).<sup>90</sup> Standards of practice for assessment have not been identified, and the likelihood of getting screened and screening positive for food insecurity varies for a host of reasons (e.g., screening tool, setting, type of visit, format/mode of delivery, timing of screening).<sup>91</sup> Some healthcare systems use assessments as a means to measure prevalence and better understand the needs of their population, while others follow with referrals, clinical care, and additional services.<sup>79</sup> For example, the Veterans Health Administration began screening for food insecurity in 2017, and to ensure regular screening instituted a 3-month reminder in the health record of every veteran who screened positive for

food insecurity. Veterans with food insecurity are provided resource referrals such as food pantries, federal food assistance programs, and meal delivery programs.<sup>92,93</sup>

There are also important quality measures related to food insecurity, in the context of broader screening for social risk factors. The National Committee for Quality Assurance has a quality measure on social needs screening and intervention, which is the percentage of members screening for unmet food, housing, and transportation needs, and receiving a corresponding intervention for those who screening positive.<sup>94</sup> CMS has similarly published a quality metric on screening for social drivers of health, which includes screening for food insecurity, housing instability, transportation needs, utility difficulties, and interpersonal safety.<sup>95</sup>

The Affordable Care Act (ACA) of 2010 requires nonprofit hospital systems to conduct community health needs assessments every 3 years and identify how community health funds could address identified needs.<sup>79</sup> Healthcare organizations are also exploring new payment structures that could reimburse healthcare providers or social service organizations for programs that address social needs.<sup>79</sup> In 2014, the National Academy of Medicine recommended a set of 11 core social and behavioral domains and measures for inclusion in patients' health records.<sup>96</sup> In 2017, CMS's Innovation Center launched the AHC Model to ascertain whether connecting Medicare and Medicaid beneficiaries to community resources could improve health outcomes and reduce costs by addressing health-related social needs, of which food security was the most commonly identified.<sup>72</sup> Some states have been approved for Section 1115 Medicaid waivers to test new approaches to address social determinants of health.<sup>97</sup> For example, in Arkansas, Medicaid enrollees meeting certain requirements can receive nutrition counseling and education, including information on healthy meal preparation.<sup>98</sup>

# Chapter 2. Methods

## Scope and Purpose

This review was commissioned to support the USPSTF in considering a recommendation on preventive services for food insecurity in primary care settings.

## Key Questions and Analytic Framework

We followed USPSTF procedures and methods to define study inclusion and exclusion criteria (**Appendix A Table 1**) and developed an Analytic Framework (**Figure 1**) and five key questions (KQs) to guide the literature search, data abstraction, and data synthesis.

1. Does identifying food insecurity in healthcare improve health outcomes?
2. What is the performance of risk assessment or screening tools to identify food insecurity?
3. What are the harms or unintended consequences of assessment for food insecurity?
4. What is the effect of healthcare-related interventions to address food insecurity on food security, intermediate outcomes, or health outcomes?
  - a. What are the effects of improvements in food security outcomes on intermediate and health outcomes?
  - b. What are the effects of improvements in intermediate outcomes on health outcomes?
5. What are the harms or unintended consequences of healthcare-related interventions to address food insecurity?

## Data Sources and Searches

This review builds upon the work of a 2021 technical brief conducted for the USPSTF<sup>11</sup> on screening and interventions for social risk factors and a 2019 scoping review by De Marchis and colleagues addressing screening for food insecurity in healthcare settings.<sup>99</sup> We evaluated the studies included in these reports, comparing them with this review's inclusion and exclusion criteria, and conducted bridge searches to capture any new studies relevant to screening or interventions for social risk factors that include food insecurity. We bridged from the existing searches by searching MEDLINE via Ovid, CINAHL via EBSCO, and the Cochrane Central Registry of Controlled Trials for relevant studies published beginning January 1, 2017 (for screening studies, bridging from the De Marchis review) and June 1, 2018 (for intervention studies, bridging from the technical brief) and ending on August 21, 2023. A research librarian developed and executed the search, which was peer reviewed by a second research librarian (**Appendix A**). We limited all searches to articles published in English.

In addition to database searches, we examined the reference lists of other previously published reviews, meta-analyses, and primary studies to identify potential studies for inclusion. We also

reviewed the literature in the Patient-Centered Outcomes Research Institute Evidence Map on Social Needs Interventions to Improve Health Outcomes.<sup>100</sup> We supplemented our searches with news and table-of-content alerts such as those produced by the USPSTF Scientific Resource Center LitWatch activity.<sup>101</sup> We conducted ongoing surveillance for relevant literature through April 3, 2024. One new study showing high sensitivity and specificity of the Abbreviated Child and Adult Food Security Scale was identified; however, it did not substantively change the review’s interpretation of findings or conclusions and is not addressed further.<sup>102</sup> We managed literature search results using version X9 of Endnote® (Thomson Reuters, New York, NY), a bibliographic management software database.

## Study Selection

Two reviewers independently reviewed the title and abstract of each identified article using DistillerSR (DistillerSR, Inc, Ottawa, Canada) to determine whether the study might meet our a priori inclusion criteria for aim, population, intervention, comparator, outcomes, setting, and study design. Two reviewers then independently evaluated full-text articles of all potentially relevant studies against the complete inclusion criteria. We resolved disagreements about the abstract and/or full-text review disposition by discussion. A list of included studies is available in **Appendix B** and excluded studies can be found in **Appendix C**.

The review was limited to U.S.-based studies because other economically developed nations have very different social benefits and social welfare structures, as well as different structures and resourcing of food accessibility for lower-income households. For all KQs other than KQ2 (performance of screening tools), some part of each study had to have occurred in a healthcare setting (e.g., case-finding, recruitment, referral, intervention) and included screening conducted in a clinical setting or identified through a healthcare delivery or payment system (e.g., health plan data) and interventions or programs integrated into, associated with, or referred from healthcare. For KQ2 (performance of screening tools), we included studies that did not have a healthcare connection but did have large, nationally representative U.S. samples after finding two such studies based on U.S. census data. We applied no age restrictions for any KQ. We excluded studies *limited to* participants who were undergoing cancer treatment, had other acute medical or psychiatric conditions, or had severe malnutrition or known nutritional deficiencies. In addition, we excluded studies if one of these groups comprised more than 50 percent of the study sample. However, we included studies that were limited to participants with chronic medical conditions such as diabetes and hypertension.

For KQ1 (benefits of screening) and KQ3 (harms of screening), we included both randomized clinical trials (RCTs) and nonrandomized studies of interventions (NRSIs) comparing a group that was systematically screened for food insecurity with a group that was not systematically or universally screened for food insecurity. We allowed naturalistic screening in individual cases as part of usual care in the control groups. KQ1 and KQ3 studies may include interventions to address food insecurity for those screening positive. For studies that screened for multiple social needs (e.g., housing, transportation, financial need), we included only food security–related outcomes because improvements in other outcomes could be due to changes in other social needs



entirely independent of screening for food insecurity. For studies that screened for multiple social needs, we required reporting of baseline and followup measures of food insecurity. We required at least 12 weeks of followup after the baseline assessment for KQ1 but applied no restrictions for KQ3, on the assumption that short-term harms could be clinically meaningful. For KQ1, outcomes included food and nutrition security, access to food, behavioral outcomes (e.g., dietary intake, substance use), physiologic outcomes (e.g., blood pressure, lipid levels, glucose or insulin-related measures), healthcare-related decision-making outcomes, health-related patient participation outcomes (e.g., medication compliance, attendance at medical appointments), healthcare utilization outcomes (e.g., emergency department visits, hospitalizations), and health outcomes (i.e., outcomes directly felt by patients, such as quality of life, mental health, cardiovascular events, and developmental outcomes in children). We included any harms to study participants identified by the studies for KQ3.

For KQ2 (performance of screening tools), we included studies that compared either a brief screener or risk assessment tool with a longer, more detailed assessment of food insecurity, such as the USDA food security surveys.<sup>103</sup> The screener could involve a brief (e.g., 1- to 2-minute) set of questions asked directly of the study participant or use medical records to identify patients at higher risk. For inclusion, we required that studies report one or more measures of test accuracy (sensitivity, specificity) or test discrimination (for risk assessment tools), or sufficient data to calculate them.

For KQ4 (benefits of interventions) and KQ5 (harms of interventions), we included randomized trials, NRSIs with a control comparison group, and pre-post studies without contemporaneous comparison groups.

Included interventions had to have elements specifically designed to reduce food insecurity, such as directly providing food or food vouchers, referrals to local food resources, or assistance signing up for government or other food assistance programs. We limited KQ4a and 4b to studies included in KQ4.

For KQ4 (benefits of interventions) studies with interventions that primarily or exclusively addressed food insecurity, we required that samples either 1) include 50 percent or more with food insecurity at baseline or 2) reported results separately for participants with food insecurity at baseline. For interventions that addressed other social and health needs in addition to food insecurity, the percent with food insecurity had to be reported at baseline and followup.

We extracted only outcomes related to food security for studies with components that addressed risk factors other than food insecurity. Other components, such as housing, transportation, nutrition education, and healthcare, could directly impact intermediate and health outcomes such as blood pressure or quality of life. Thus, we felt it could be misleading to ascribe improvements in these outcomes to the food-related components of the intervention. The full list of relevant outcomes was abstracted for KQ4 interventions that only addressed food insecurity. We included any harms reported by the KQ4 studies for KQ5 (harms of interventions). We required at least 12 weeks of followup after the baseline assessment for KQ4 but applied no restrictions for KQ5, on the assumption that short-term harms could be clinically meaningful.

## Quality Assessment and Data Abstraction

Two reviewers independently assessed the methodological quality of each study by applying predefined study-design specific criteria (**Appendix A Table 2**).<sup>101</sup> For screening accuracy evidence (KQ2) we used the Quality Assessment of Diagnostic Accuracy Studies (QUADAS)-2.<sup>104</sup> For RCT and NRSI evidence, we applied signaling questions from the Cochrane Risk of Bias (RoB 2) tool<sup>105</sup> and the Risk of Bias In Non-randomized Studies of Interventions (ROBINS-I) tool<sup>106</sup>, respectively, along with the USPSTF-design specific criteria.<sup>101</sup> We used criteria developed by the National Heart, Lung, and Blood Institute to rate pre-post studies and multi-arm comparative effectiveness studies—which we treated as pre-post studies (see Study Selection).<sup>107</sup> For pre-post studies, we used item 11 as a signaling question (“Were outcome measures of interest taken multiple times before the intervention and multiple times after the intervention?”). We rated studies as poor quality that did not use this design and conducted no further assessment of risk of bias. Disagreements about quality ratings were resolved by discussion. Each study was given a final quality rating of good (low risk of bias), fair (moderate risk of bias), or poor (high risk of bias). We rated studies based on the main outcome of interest to our review, and the quality rating reflected our confidence that the food security screening or intervention caused the changes in the relevant outcomes. As mentioned above, a study’s primary aim might have differed from the result extracted for this review, so a poor-quality rating does not necessarily reflect a high risk of bias for the study’s primary aim.

Good-quality studies were those that met nearly all the specified quality criteria for the outcome of interest to this review (e.g., comparable groups were assembled initially and maintained throughout the study, followup was approximately  $\geq 85\%$ , conservative data substitution methods were used in cases of missing data, no evidence of selective outcome or analysis reporting). Fair-quality studies did not meet all these criteria but did not have serious threats to their internal validity related to the design or execution of the study. Studies we rated as poor quality had several important limitations, including at least one of the following risks of bias: no control group to determine whether change differed from naturalistic rates or lack of repeated measures before and after the intervention to establish clear baseline and followup rates; very high attrition (generally  $>40\%$ ) or unknown attrition, differential attrition between intervention arms (generally  $>20\%$ ); lack of baseline comparability between groups without adjustment; unclear methods or differing methods between groups for ascertainment of outcomes; or issues in trial conduct, analysis, or reporting of results (e.g., possible selective reporting, inappropriate exclusion of participants from analyses, and questionable validity of randomization and allocation concealment procedures). Due to the lack of literature and the pilot nature of this review in addressing unmet social needs, we departed from usual USPSTF methods and included poor-quality studies in the evidence base for KQ4 and KQ5.

For all included studies, one reviewer extracted key elements into standardized abstraction forms in DistillerSR (Evidence Partners, Ottawa, Canada). A second reviewer checked the data for accuracy. For each study, we abstracted general characteristics (e.g., author, year, study design, setting), sample characteristics (e.g., age, race and ethnicity, socioeconomic characteristics), screening approach, intervention duration and components, and results. For intervention characteristics, we abstracted information on both food-related and non-food-related

components. Food security–related components included provision of food (not medically tailored), medically tailored food, medically tailored prepared meals, food vouchers, community referrals, and support in completing applications for food assistance. Examples of non-food security components included those addressing housing, transportation, employment, education, utilities, language barriers, social isolation, interpersonal violence, childcare, and legal concerns. We considered nutrition or meal preparation education to be separate from food security unless we characterized it as minimal (e.g., electronic newsletters or print materials included in food boxes; optional food tastings, demonstrations, and information at food box pick-up sites).

## Data Synthesis and Analysis

We developed separate tables for each of the three broad bodies of evidence covered by this review: studies of food security screening (KQs 1 and 3), studies on the accuracy of the screening tools (KQ2), and studies on interventions to improve food security (KQs 4 and 5). The tables included study, population, intervention characteristics, and outcomes. We examined population characteristics to ascertain whether the evidence included traditionally marginalized or underrepresented groups that have a higher prevalence of food insecurity, such as Black, Hispanic, and American Indian/Alaska Native populations.

To synthesize findings on screening tool accuracy, we calculated sensitivity and specificity based on the 2-by-2 contingency table of true positives, false positives, true negatives, and false negatives if they were not reported. Most studies examined agreement between the full HFSS 18-item assessment tool and a subset of the items embedded in this tool, without separate administration of the screener and reference standard. We used the terms “sensitivity” and “specificity” but acknowledge the departure from the preferred method of independent administration.

For KQ4, we grouped interventions into three broad categories:

- *Food security only*: intervention focused only on food security (e.g., providing food or vouchers for food, referrals to local organizations that provide food, assistance with food-related benefits such as SNAP and WIC) and did not address other social needs.
- *Food security + nutrition education*: combined food security components with nutrition and food preparation education (beyond minimal approaches such as inserts in food boxes or demonstrations at food box pick-ups).
- *Multidomain*: multidomain interventions that assessed and addressed other social needs in addition to food insecurity, as needed.

Because intervention components addressing nutrition, medical needs or disease management, or other social needs could affect health and intermediate outcomes, only food security–related outcomes were reported for studies with the latter two intervention categories (food security + nutrition education, multidomain). The highest-level food security components were identified and categorized as: 1) food (e.g., food boxes, delivery of prepared meals), 2) vouchers (exchanged for food, or subsidies to increase purchasing power), 3) application support (e.g.,

patient navigation or help with identifying relevant resources and completing applications), and 4) referral only (information about local and federal food resources with no further support).

We conducted narrative synthesis of the evidence based on the created tables, since evidence was too sparse and heterogeneous for meta-analysis. For the outcome of percent with food insecurity, however, we calculated risk ratios (RRs) and 95 percent CIs comparing the intervention and control groups for traditional RCTs and NRSIs, “on-meal” and “off-meal” for a randomized crossover trial of meal provision, and post-intervention versus pre-intervention values for pre-post studies, consistent with another review on this topic.<sup>80</sup> RRs are shown in a forest plot but not pooled, due to the heterogeneity in study design and other important features. All significance testing was 2-sided, and results were considered statistically significant if the p-value was 0.05 or less.

## Grading the Strength of the Body of Evidence

We graded the strength of the overall body of evidence for each KQ. We adapted the Evidence-based Practice Center approach,<sup>108</sup> which is based on a system developed by the Grading of Recommendations Assessment, Development and Evaluation (GRADE) Working Group.<sup>109</sup> Our method explicitly addresses four of the five Evidence-based Practice Center-required domains: consistency (similarity of effect direction and size), precision (degree of certainty around an estimate), reporting bias (potential for bias related to publication, selective outcome reporting, or selective analysis reporting), and study quality (i.e., study limitations). We did not address the fifth domain—directness—as it is implied in the structure of the KQs (i.e., pertains to whether the evidence links the interventions directly to a health outcome).

We rated the domain of consistency as reasonably consistent, inconsistent, or not applicable (e.g., single study) and the domain of precision as reasonably precise, imprecise, or not applicable (e.g., no evidence). Study quality reflects the quality ratings of the individual trials and indicates the degree to which the included studies for a given outcome have a high likelihood of adequate protection against bias. The body-of-evidence limitations field highlights important restrictions in answering the overall KQ (e.g., evidence of reporting bias, lack of replication of interventions, nonreporting of outcomes important to patients).

At least two independent reviewers rated the overall strength of evidence for each intervention type. We resolved discrepancies through consensus discussion with the full review team, consulting with outside reviewers as needed. We graded the overall strength of evidence as high, moderate, low, or insufficient. “High” indicated high confidence that the evidence reflected the true effect, and that further research is very unlikely to change our confidence in the estimate of effects. “Moderate” indicated moderate confidence that the evidence reflected the true effect, and that further research may change our confidence in the estimate of effect as well as the estimate. “Low” indicated low confidence that the evidence reflected the true effect, and that further research is likely to change our confidence in the estimate of effect as well as the estimate. A grade of “insufficient” indicated that evidence was either unavailable or did not permit an estimate of an effect.

## Contextual Questions

In addition to the systematically reviewed questions, we addressed contextual questions (CQs) to aid with the broader interpretation of the evidence. CQs are important considerations that may not be readily answerable from the KQ evidence. Seven CQs were prespecified in our Research Plan:

1. What risk assessment or screening tools are commonly used in clinical practice to identify food insecurity? What are the benefits and limitations of these tools (e.g., ease of administration)?
2. What factors inform the appropriate reassessment interval for food insecurity?
3. What are important moderators that affect the effectiveness or harms of food insecurity assessment and healthcare-related interventions?
4. What is the acceptability (e.g., satisfaction) of food insecurity assessment and healthcare-related interventions to patients and providers?
5. What is the uptake of services (e.g., rate of adoption, receipt of benefits) after food insecurity is identified?
6. What are the patient, provider, and health system facilitators and barriers to implementing assessment for food insecurity?
7. What are the patient, provider, health system, and community facilitators and barriers to implementing interventions to address food insecurity?

CQs were not systematically reviewed. Evidence for CQs was identified based on literature retrieved for the systematic search for KQs as well as targeted searches and scanning bibliographies of relevant articles. A best-evidence approach was used to identify the most recent, applicable, and robust evidence. CQs are addressed in the Introduction and Discussion section of this report.

## Expert Review and Public Comment

A draft Research Plan including the Analytic Framework, KQs, and inclusion and exclusion criteria was posted on the USPSTF website for public comment from February 22 to March 21, 2022. In response to public comment, the USPSTF added several outcomes to KQs 1 and 4, including food access, clinical decision making, and patient adherence. The USPSTF also made minor clarifying changes to the KQs, CQs, and inclusion criteria. A final Research Plan was posted to the USPSTF website on July 28, 2022.

The draft version of this report was reviewed by invited experts and individuals at USPSTF federal partner agencies. Experts were selected based on their expertise with both methodologic and content aspects of the review and were selected to obtain diverse informed perspectives. The revised draft of the report was posted for public comment on the USPSTF website from June 25, 2024, to July 22, 2024. The draft received several public comments, leading to minor editorial changes but no updates to the included evidence or report conclusions.

## **USPSTF and AHRQ Involvement**

We worked with USPSTF members at key points throughout this review, particularly when determining the scope and methods and developing the Analytic Framework and KQs. The USPSTF members approved the final Analytic Framework, KQs, and inclusion and exclusion criteria after revisions reflecting the public comment period. AHRQ staff provided oversight for the project, coordinated the review, reviewed the draft report, and assisted in an external review of the draft evidence synthesis.

# Chapter 3. Results

## Description of Included Studies

We identified 39 studies (n=198,762) meeting inclusion criteria for this review, including one examining the benefits of screening for food insecurity (KQ1),<sup>110</sup> 10 examining the accuracy of screening tools (KQ2),<sup>69-71,110-116</sup> 29 examining the impact of interventions to reduce food insecurity (KQ4),<sup>117-127 128-145</sup> and one reported on harms of interventions (KQ5), which was also included for KQ4.<sup>117</sup> One study was included for both KQs 1 and 2.<sup>110</sup>

### KQ1. Does Identifying Food Insecurity in Healthcare Improve Health Outcomes?

#### Summary of Results

One fair-quality RCT (n=789) examined the impact of screening for food insecurity, along with other factors related to child maltreatment, among parents with a child younger than age 6 years (**Table 3, Table 4**).<sup>110</sup> Families screening positive for food insecurity were given information on how to access federal and local food-related assistance. This RCT found no difference in the percent reporting food insecurity after 6 months between the intervention group (29.6% with food insecurity) and usual care (29.8%; **Table 5**).

#### Detailed Results

We identified one study (n=789) that examined the benefits of screening for food insecurity compared with usual care at an urban clinic serving children from low-income families.<sup>110</sup> This RCT trained pediatric residents assigned to the intervention group to screen parents of children younger than age 6 years for child maltreatment risk factors, including food insecurity, intimate partner violence, parent depression, substance abuse, and use of corporal punishment. Parents who screened positive for food insecurity were given information on how to apply for SNAP benefits and other federal food assistance programs and information about local food resources such as food pantries. Ninety-three percent of study participants were African American, 93 percent were women, and 76 percent had a high school education or less. This study was rated as fair quality (**Appendix A Figure 2**, Lane, 2014 study). The main methodologic concerns were the relatively high overall attrition rate (32%) and the difference between groups in completing the baseline assessment (81% in the intervention group vs. 67% in the control group), leading to concerns about baseline comparability between groups.

The only reported outcome that met our inclusion criteria was food insecurity, as measured by the 18-item HFSS-18. At the 6-month followup, there was no difference in food insecurity between groups (29.6% in the intervention group [from 32.7% at baseline] vs. 29.8% in the usual care group [from 31.1% at baseline]; p=0.9). This is despite the fact that a larger proportion of the intervention participants had maintained SNAP enrollment at the 6-month followup (97% of

intervention participants were still enrolled after 6 months vs. 81% of control participants; p=0.05)

## KQ2. What Is the Performance of Risk Assessment or Screening Tools to Identify Food Insecurity?

### Summary of Results

Ten studies (n=123,886) examined the accuracy of a brief screening instrument to identify individuals or families with food insecurity (**Table 6**).<sup>69-71,110-116</sup> These studies examined 1-item, 2-item, or 6-item screeners (**Table 7**), all derived from the USDA's HFSS-18.<sup>17</sup> Sensitivity was typically above 95 percent and specificity above 82 percent for all 2-item screeners when the screener was fully embedded in the reference standard, as was the case for most studies, or administered within the same larger questionnaire (**Table 8, Figure 2**). The lack of independent administration of the screener is likely to overestimate the performance of the screener under usual clinical use. The 1-item screener had the lowest accuracy, with sensitivity of 0.59 and specificity of 0.87 (95% CIs, not reported), but was also the only instance of the screener being administered independently from the reference standard.<sup>110</sup>

### Detailed Results

#### *Study Characteristics*

We included 10 fair-quality studies (n=123,886) that examined the accuracy of a brief screening instrument to identify individuals or families with food insecurity (**Table 6**).<sup>69-71,110-116</sup> These studies examined 1-item, 2-item, or 6-item screeners (**Table 7**), all derived from the HFSS-18.<sup>1</sup> Most used a standard 2-item screener with the following items referencing the previous 12 months:

- “We worried whether our food would run out before we got money to buy more.”
- “The food we bought just didn't last and we didn't have money to get more.”

An affirmative response to either item was considered a positive screen, and studies used either 2- or 3-level response options (2-level: yes or no, as originally recommended by the American Academy of Pediatrics<sup>84</sup>; 3-level: often true, sometimes true, or never true, which we will refer to as the Hunger Vital Sign scoring). One study examined all 2-item combinations of three items: the two items listed above along with a third item “[I/We] couldn't afford to eat balanced meals.”<sup>113</sup> The study examining the single-item screener used a variant of the first item above: “In the last year, did you worry that your food would run out before you got money or food stamps to buy more?”<sup>110</sup>

Six of the studies compared the screening tools with the HFSS-18.<sup>69,70,110,112-114</sup> Of the remaining studies, three used the 6-item version of the Household Food Security Survey (HFSS-6) as the reference standard,<sup>71,115,116</sup> and another used the relevant USDA food security survey (USDA-



FSS) based on the age and parental status of the respondent (HFSS-18 for adults self-identifying as parents, 10-item Adult Food Security Survey Module for patients age 18 years or older who were not parents, 9-item Self-Administered Food Security Survey Module for Youths for participants ages 15 to 17 years).<sup>111</sup>

In all studies, the reference standard and screening tool were administered on the same day, either via interview<sup>69,70,112-114</sup> or self-administration<sup>71,110,111,115</sup> (one study did not report the administration format).<sup>116</sup>

Study settings included primary care,<sup>69,70,110,111,114,116</sup> emergency department [ED],<sup>69-71</sup> and dental<sup>115</sup> settings. We also included two studies that did not have direct ties to healthcare settings but were highly representative of the general U.S. population, being collected as part of the census in 1995<sup>112</sup> and 2013.<sup>113</sup>

Some studies were limited to families with children,<sup>69,70,110,115</sup> and another included caregivers from pediatric as well as adult settings to ensure substantial representation of families with children.<sup>71</sup> One study was limited to adolescents and young adults ages 15 to 25 years,<sup>111</sup> and the remaining studies recruited adults.<sup>71,112-114,116</sup> In six<sup>69-71,110,111,114</sup> of the eight studies that reported on race and ethnicity, more than half of the study samples comprised Black adults. Hispanic participation ranged from 6.8 to 30.4 percent,<sup>70,71,111,114-116</sup> and White adults comprised 6.4 to 63.1 percent<sup>69-71,111,114-116</sup> of the samples. Two studies reported the percent of participants who were Asian or Pacific Islander (1.4%<sup>70</sup> and 11.3%<sup>115</sup>); only one study reported on the percent of participants who were American Indian or Alaska Native (0.3%).<sup>70</sup>

### *Risk of Bias*

The main quality-related concern for these studies was that only one study reported separate administration of the screening tool and the reference standard.<sup>110</sup> For eight of the nine other studies, one<sup>71</sup> or both<sup>69,70,111-115</sup> screening items were part of the reference standard. For these eight studies (which we refer to as having the screener “embedded” in the reference standard), only the reference standard was administered to participants, and subsequent analyses examined how well the subset of the items corresponded to the full instrument.<sup>69,70,111-115</sup> The final study administered a single larger questionnaire that included the 2-item screener and the 6-item reference standard in different sections of the questionnaire.<sup>116</sup> Other concerns were that many samples were described as convenience samples, rather than as random or consecutive samples of a known population; some studies provided limited information on how the samples were selected; and some studies provided limited information on how representative their samples were of the target populations.

### *Results*

Sensitivity was typically 95 percent or higher and specificity above 82 percent for all 2-item screeners when the screener was fully embedded in the reference standard and when the screener and reference standard were each administered within the same larger questionnaire (**Table 8, Figure 2**). The lack of independent administration of the screener is likely to overestimate the

performance of the screener under usual clinical use. In these studies, sensitivity and specificity were similarly very high in subgroup analyses among participants who were Black or Hispanic; were immigrants; had disabilities; had incomes below 100 percent or 200 percent of the federal poverty limit; had or did not have children in the household; and had adults older than age 60 years in the household (**Appendix D Table 1**). For one study in which one of the two screening items was embedded in the reference standard and the other was not (but were still administered in a single sitting), sensitivity was lower and specificity was higher when the original American Academy of Pediatrics yes/no response categories was used than when the standard 3-level response was used.<sup>71</sup> In this study, sensitivity was 0.76 (95% CI, 0.65 to 0.85) and specificity was 0.95 (95% CI, 0.85 to 0.97) with the yes/no scoring method, compared with sensitivity of 0.94 (95% CI, 0.86 to 0.98) and specificity 0.82 (95% CI, 0.72 to 0.9) with the standard 3-level scoring. The 1-item screener had the lowest accuracy, with sensitivity of 0.59 and specificity of 0.87 (95% CIs, not reported).<sup>110</sup> This study was the only one that administered the screener separately from the reference standard. We detected no pattern of results related to whether the screener was self-administered or administered by an interviewer.

### **KQ3. What Are the Harms or Unintended Consequences of Assessment for Food Insecurity?**

No studies reported harms or unintended consequences of assessment for food insecurity.

### **KQ4. What Is the Effect of Healthcare-Related Interventions to Address Food Insecurity on Food Security, Intermediate Outcomes, or Health Outcomes?**

#### **Summary of Results**

Twenty-nine studies (n=74,292) examined interventions to address food insecurity,<sup>117-145</sup> and all but two<sup>117,142</sup> were rated as poor quality (**Table 10**). Six of the studies targeted families with children,<sup>126,128,129,131,133,142</sup> and the remaining focused on adult populations. Of the two studies rated as fair quality, one was a randomized crossover trial (n=44) that included home delivery of medically tailored meals to patients with diabetes for 12 weeks.<sup>117</sup> At the end of the 24-week study period, the intervention was associated with reduced food insecurity (41.9% while on-meals vs. 61.5% while off-meals; p=0.05) (**Figure 3**), improved mental health quality of life (4.7-point change from baseline while on-meals vs. 0.8-point change while off-meals), and improved diet quality (e.g., the 100-point total Healthy Eating Index score improved by 14.1 points while on-meals compared with baseline but declined by 17.3 points while off-meals). However, there was no apparent impact on other quality-of-life measures; physiologic measures of blood pressure, lipid levels, or glucose levels; or cost-related medication underuse. The other study rated as fair quality was an NRSI that compared children in families who participated in a mobile food pantry with a propensity-score matched cohort of pediatric patients from the same neighborhood as the mobile pantry participants, or from nearby neighborhoods not offering a mobile pantry program after 6 months.<sup>142</sup> This study found a smaller increase in body mass index

(BMI) among children of families who participated in the mobile food pantry. This study did not report between-group differences in food insecurity but reported a reduction from 4.3 to 3.3 on a 6-point food insecurity scale among participants in the intervention group.

Nineteen additional studies (n=70,537) reported a food security outcome but were rated as poor quality for the specific outcomes of interest for this review; improvements in food security were rarely reported to be statistically significant.<sup>118,120-123,125,126,128-132,136-138,140,143-145</sup> Effect sizes were wide ranging, typically reported after 6 months or less, and trended in the direction of benefit in all studies but one.<sup>118</sup> Eight studies (n=3,535) did not report a food security outcome; all of these included the provision of food or food vouchers but had other study aims, such as healthier diets or physiologic outcomes specific to the study population.<sup>119,124,127,132-134,139,141</sup> The consumption of fruits and vegetables generally increased after participation in interventions that included either food boxes or vouchers. For other outcomes, one pre-post study reported improvements in depression and self-rated health (e.g., 69% rated their health as excellent or very good after receiving 23 weekly food boxes, compared with 52% at baseline [p=0.039]).<sup>130</sup> There was minimal impact on physiologic outcomes (blood pressure, lipid levels, glucose levels) or acute healthcare utilization, although these outcomes were never reported by more than three studies.

## Detailed Results

### *Overview of Studies*

We included 29 studies (n=74,292) that examined interventions to address food insecurity, including one randomized crossover trial (n=44),<sup>117</sup> one cluster RCT (n=4,917),<sup>118</sup> three NRSIs that included control groups (n=513),<sup>119,120,142</sup> and 24 pre-post single cohort studies without a control group (n=68,818).<sup>121-127,128-141,143-145</sup> Only two studies were rated as fair quality,<sup>117,142</sup> and the remaining were rated as poor quality for the outcomes of interest to this review. The studies were grouped into three intervention categories: those addressing food security only,<sup>117,119,121,124,127,130,132-134,138-142</sup> food security + nutrition education,<sup>123,125,126,131,144,145</sup> and those addressing multiple domains (“multidomain”)<sup>118,120,122,128,129,135-137,143</sup> (**Table 10**).

### *Study Design and Population*

Interventions in 14 studies focused only on ameliorating food insecurity, without extensive nutrition education or addressing other social determinants of health or medical needs (**Table 11**, **Table 12**).<sup>117,119,121,124,127,130,132-134,138-142</sup> This group included both of the fair-quality studies. One was a randomized crossover trial (n=44) among adult primary care patients with diabetes.<sup>117</sup> Potential participants were screened via the Hunger Vital Sign in a primary care setting, and those who screened positive for food insecurity were enrolled, then compared on a wide range of outcomes between the end of the intervention (on-meal) period and the end of participants’ off-meal phase. The other fair-quality study was an NRSI that compared children in families who participated in a mobile food pantry with a propensity-score matched cohort of pediatric patients from the same neighborhood as the mobile pantry participants, or from nearby neighborhoods not offering a mobile pantry program.<sup>142</sup>

Of the remaining food security-only studies, 11 were pre-post studies in a single cohort,<sup>121,124,127,130,132-134,138-141</sup> and one was a nonrandomized study that employed a propensity-matched control group of people referred versus not referred to Food for Families,<sup>119</sup> an intervention for pregnant women that provided referrals and application support to community-based food resources and government assistance programs. One of the pre-post studies was an RCT comparing two active treatment conditions, but because this review did not include comparative effectiveness studies, we treated this study as having two separate pre-post studies (i.e., one study for each intervention group).<sup>140</sup> Collectively, these 14 studies covered a range of populations, including broad-based or low-income adult populations,<sup>117,121,124,130,132,134</sup> pregnant women,<sup>119</sup> adults with diabetes,<sup>127,139,140</sup> adults with any of a number of chronic conditions or cardiovascular risk factors,<sup>138,141,145</sup> Medicare and Medicaid beneficiaries with two or more ED visits in the past year, and families with children.<sup>133,142</sup> Nine of these studies identified participants with food insecurity via screening in medical settings.<sup>117,119,121,124,132,134,139,140,142</sup> The remaining studies used a variety of recruitment methods (e.g., clinician referral, participant self-referral in response to flyers, or recruitment of all clients at a specific clinic, food pantry, or community program).

Six studies focused on both ameliorating food insecurity and providing nutrition education to improve diet quality; all were pre-post studies (**Tables 13 and 14**).<sup>123,125,126,131,144,145</sup> We looked only at the food insecurity outcomes of these studies as dietary counseling may have had an effect on health independent of food security. Five of the studies were limited to people with chronic conditions or deemed at risk for chronic conditions (e.g., meeting criteria for obesity, prediabetes, diabetes, hypertension, or dyslipidemia),<sup>123,125,126,144,145</sup> and one of these five was also limited to families with young children.<sup>123</sup> The remaining study was conducted among Navajo families with young children.<sup>131</sup> Three of these studies recruited participants via screening for food insecurity.<sup>125,126,131</sup>

Nine studies offered multidomain interventions designed to assess and address (as needed) a wide range of social needs, including food insecurity (**Tables 15 and 16**).<sup>118,120,122,128,129,135-137,143</sup> Three of these studies were RCTs comparing two active treatment conditions, but because this review did not include comparative effectiveness studies, we treated these studies as separate pre-post studies (i.e., one study for each intervention group).<sup>128,129,143</sup> Four other multidomain intervention studies were pre-post studies,<sup>122,135-137</sup> one was a nonrandomized study in which intervention and control participants were recruited from different study sites,<sup>120</sup> and one was a cluster RCT.<sup>118</sup> Some of these studies included broad populations (primary care patients,<sup>122</sup> parents or caregivers of children,<sup>128,129</sup> Medicaid patients at a federally qualified health center [FQHC]<sup>137</sup>), while recruitment for others was based on health conditions (adults with diabetes<sup>135</sup> or diet-related conditions,<sup>120</sup> high levels of ED utilization,<sup>136,143</sup> or chronic illnesses and high risk for future hospitalization<sup>118</sup>). Eligible participants for seven of the studies were identified via screening for social needs.<sup>120,122,128,129,136,137,143</sup>

Across all KQ4 studies that reported race and ethnicity, 30 percent of the included participants were Black, 18 percent were Hispanic, and 41 percent were White. One study was limited to people of the Navajo Nation. Overall, there appeared to be minimal representation of other races or ethnicities such as Native Americans or of people of Asian descent.

## *Interventions*

Detailed descriptions of the interventions for all studies are available in **Appendix D Table 3**. Of the 14 interventions addressing only food insecurity, the fair-quality randomized crossover trial provided home delivery of medically tailored meals for 12 weeks,<sup>117,140</sup> and eight others included weekly, biweekly, or monthly food boxes for 6 to 12 months.<sup>121,130,132,134,138,141,142</sup> One of these, among patients attending a chronic disease clinic, was specifically tailored to the Dietary Approaches to Stop Hypertension (DASH) diet, and the box was delivered directly to patient homes rather than requiring pickup.<sup>138</sup> Four interventions supplied vouchers or subsidies for food, ranging in amount from \$15 per clinic visit to \$40 per month, which could be redeemed at local stores or farmers markets.<sup>124,127,133,139</sup> The remaining study that narrowly addressed food security relied on referrals to community and government assistance programs and helped participants with the application process.<sup>119</sup>

Among the six studies that addressed food insecurity supplemented by nutrition counseling, one provided delivery of medically tailored meals for 16 weeks,<sup>144</sup> two included the provision of biweekly food boxes,<sup>123,126</sup> and the other three included vouchers for \$1/day/family member, a median of \$63 per month, and up to \$5 per day.<sup>125,131,145</sup> Nutrition counseling typically involved monthly to biweekly sessions with information on healthy diet and food preparation, and often included food tastings, cooking demonstrations, and counseling techniques such as goal-setting for improved dietary intake. One intervention was delivered online and offered approximately 24 hours of virtual nutrition education with content that was culturally tailored for the African American community.<sup>126</sup>

The multidomain interventions involved a social needs assessment and interventions targeted to participants' social needs. Most of the interventions involved helping participants identify and enroll in appropriate local and federal resources related to a wide range of social needs, such as housing, transportation, childcare, and legal services.<sup>118,120,122,128,129,135-137,143</sup> One of these was a large (n=57,471) demonstration project by CMS that assigned patients who had screened positive for at least one social risk factor and had two or more ED visits in the previous year into three groups: 1) referral and information only, 2) referral plus the option for navigation, and 3) referral, navigation, and an organizational advisory board composed of beneficiaries, healthcare partners, and community service organizations that was charged with identifying and addressing gaps in community services relative to community needs.<sup>143</sup> Patient navigators, care coordinators, and community health advocates are examples of interventionists who implemented the navigation and application support activities. Two interventions focused primarily on food security, along with some other complementary components.<sup>120,135</sup> One of these two included the provision of diabetes-appropriate food boxes to patients with diabetes and food insecurity along with diabetes self-management support, blood sugar monitoring, and medical referrals.<sup>135</sup> The other intervention that had a relatively large emphasis on food and food security centered on the provision of vouchers to purchase produce, along with nutrition classes and financial literacy education.<sup>120</sup>

## *Risk of Bias*

**Appendix A Figure 2** shows the risk of bias ratings for the major risk of bias domains. The fair-quality randomized crossover trial was downgraded from good for the small study size (n=44), lack of allocation concealment, and differential followup between the on-meals and off-meals phases (70% completed assessments after on-meals vs. 89% after off-meals).<sup>117</sup> The fair-quality NRSI was downgraded from good primarily because unmeasured confounders could be the causal factor for differences between groups, due to the lack of randomization.

Two studies were nonrandomized studies that included control groups, but both were rated as poor quality.<sup>119,120</sup> For the study of a food security-only intervention with a propensity-matched control group, the main threat to validity was a lack of information about whether co-interventions were balanced across intervention groups (e.g., whether the groups received comparable prenatal medical care and whether use of medications for blood pressure was comparable across groups).<sup>119</sup> It was particularly concerning that there was no information on the comparability of blood pressure medication use across groups when the primary outcome was blood pressure. Blood pressure is monitored closely during pregnancy, and treatment is undertaken when blood pressure becomes elevated, so we had limited confidence that changes in blood pressure were related to food program referrals rather than medication use. In addition, it would be very difficult to control for all confounding factors that led some patients to be referred to a food security program versus not referred.

The other nonrandomized study of a multidomain intervention recruited intervention and control participants from separate locations.<sup>120</sup> The main concerns with this study were high attrition (38% to 42%) and an imbalance of population characteristics that suggest the study groups may not have been comparable (e.g., 55% of intervention participants were Hispanic vs. 0% in the control group). Intervention participants were recruited from both FQHCs and other community-based organizations, while control participants were recruited from a single FQHC, which lowered our confidence that the assembled groups were comparable. This study also had a very small sample (n=18 participants analyzed), further limiting our confidence that the results were broadly applicable.

We also rated as poor quality a cluster RCT that examined a multidomain intervention.<sup>118</sup> For the purposes of this review, this study was rated only for the food security outcome, which was not its primary outcome, and ascertainment of food insecurity was not described. Furthermore, participants were randomized based on the assignment of the community-based organization that was closest to where they lived, but we were concerned that participants might have chosen to access an organization based on previous experience with it or because of its specific focus or offerings, rather than on location only, potentially compromising the comparability of the intervention groups at baseline.

None of the pre-post studies reported more than one time point prior to and after the intervention, so all were rated as poor quality, akin to high risk of bias. The lack of multiple timepoints to establish a robust baseline estimate of food insecurity led to low confidence that the intervention elicited the changes observed in these studies, rather than confounding factors such as families'

independent efforts to obtain food and food resources. Included among the pre-post studies are four randomized comparative effectiveness trials, treated as pre-post studies with multiple arms for the purposes of this review.<sup>128,129 140,143</sup> In addition, three nonrandomized studies assembled comparison groups that we felt were not comparable with the intervention group to the point of having a high probability of resulting in misleading effects for the purposes of this review—for example, those that matched individuals screening positive for food insecurity with a historic control matched via medical records data, but without food insecurity screening information, or those that compared outcomes of patients who opted into a program with those who did not opt in.<sup>134,137,141</sup> In these cases, we retained the intervention group data and treated it as a pre-post study.

In addition to the above concerns, an issue across almost all studies was uncertainty about the assessment windows for the outcome of percent with food insecurity. The HFSS tools have 12-month and 30-day versions, but the included studies rarely reported which of these versions were used at either timepoint. If a 12-month version was used at both timepoints (which is the most widely used version) and the followup occurred after less than 12 months, then the assessment windows overlap and add uncertainty to the effect estimates. If they changed the followup measure to only report on food security status since the baseline questionnaire, or on the past 30 days, then the asymmetric time windows introduce bias that could make the intervention appear to have a larger effect, at least for pre-post studies without a comparison group.

### *Findings by Outcome*

**Food security outcomes.** Twenty-one of the 29 studies included for KQ4 reported a food security outcome (**Table 17** for the primary food insecurity finding of interest to this review for each study, **Appendix D Table 3** for all available food security outcomes at all timepoints, **Figure 3** for a forest plot showing study effect sizes).<sup>117,118,120-123,125,126,128-132,136-138,140,142-145</sup> In the fair-quality randomized crossover trial (n=44), participants were less likely to be food insecure at the end of their 12-week on-meal phase compared with those in the 12-week off-meal phase (41.9% on-meal vs. 61.5% off-meal; p=0.05).<sup>117</sup>

Among the remaining studies, neither of the two studies that included control groups—one with food vouchers (n=47)<sup>120</sup> and one with referrals to food resources (n=4,917)<sup>118</sup>—found statistically significant group differences in food insecurity after 6 to 12 months.

The pre-post studies all trended in the direction of improved food security at followup but had wide-ranging results, with absolute reductions from baseline ranging from 2 to 94 percentage points with food insecurity (median, 23 percentage point reduction). For example, among the studies centered on providing food directly to participants, results ranged from the percent of participants with food insecurity going from 100 percent at baseline to 6 percent at 6-month followup (p-value not reported) in one study, to going from 92 percent at baseline to 84 percent at 3.5-month followup (p-value not reported) in another study. Among all pre-post studies and those reporting only pre-post results, the statistical significance of changes was often either not reported<sup>121,123,125,128,132,136,140,142-144</sup> or was reported to be not statistically significant.<sup>122,126,130,138</sup>

Three of the pre-post studies reported statistically significant reductions in food insecurity at 6-month followup, however.<sup>129,131,145</sup>

One study did not report the absolute percent with food insecurity, but that food insecurity was reduced by 9 percent and 23 percent among those receiving referrals and application support, respectively, in a study of families with children screened in acute care settings.<sup>128</sup> Among studies that reported continuous outcomes, reduction from baseline to followup were 0.4<sup>126</sup> and 1.0<sup>142</sup> on a 6-point scale, and another study reported a 6-point reduction on the HFSS-18 used as a continuous measure, but the range was not described.<sup>144</sup>

As described above under Risk of Bias, these food insecurity findings are limited by uncertainty in the time windows for the assessment of food insecurity at baseline and followup, which may have the effect of exaggerating the apparent effect size for pre-post studies. There was no apparent pattern of larger or smaller effects according to intervention type (food security only, food security + nutrition education, multidomain) or the type of food support provided (food, vouchers, application support, referrals only).

**Food consumption and nutrition outcomes (limited to food security-only interventions).** The fair-quality randomized crossover trial reported a number of Healthy Eating Index (HEI) scores, which all indicated healthier eating during the 12-week on-meal phase (**Appendix D Table 4**).<sup>117</sup> The HEI total score has a range of 0 to 100, with higher scores indicating healthier eating, and 5-point changes are considered clinically significant, according to the study authors. The HEI total score had a mean (standard deviation [SD]) of 71.3 (7.5) on-meal and 39.9 (7.8) off-meal ( $p<0.001$ ). HEI scores were also better for intake of vegetables, fruits, greens and beans, whole grains, and empty calories (all had  $p<0.001$ ).

Eight additional studies with food security-only interventions reported a dietary outcome; all were pre-post studies.<sup>124,127,130,132,133,138,140,142</sup> Five of these studies included free food and three provided vouchers, and one study included a second study group that received only referrals. All eight studies reported some measure of fruit, vegetable, or fruit and vegetable consumption. Three of these found a statistically significant increase in consumption of fruits, vegetables, or both.<sup>124,130,132,138</sup> The remaining studies either did not report statistical significance<sup>133,140,142</sup> or found no significant differences between baseline and followup.<sup>127,138</sup> One study also reported increased consumption of fiber (3.1 additional g/day) among those who had received at least four of the seven food boxes.<sup>138</sup> Data were too sparse to draw conclusions about the association between improvements in food security and improved diet, however (the focus of KQ4a).

**Health outcomes (limited to food security-only interventions).** The fair-quality randomized crossover trial reported less mental health distress on a health-related quality of life measure when on-meal (mean [SD], 5.7 [not reported]) than off-meal (mean [SD], 9.6 [not reported];  $I^2=0.03$ ; **Table 18**).<sup>117</sup> No differences between on-meal and off-meal were found for other measures of health-related quality of life (health interference, physical health impacts), self-reported health status, diabetes distress, or depression.



Two other pre-post studies reported health outcomes (n=80).<sup>130,140</sup> One study (n=80) found that, after participating in a 23-week CSA program involving receipt of approximately \$100 worth of food for the cost of \$22 (payable with SNAP benefits), 67 percent of participants reported that their health status was very good or excellent, up from 52 percent at baseline (p=0.039).<sup>130</sup> In addition, 42 percent of participants reported feeling down, depressed, or blue at the end of the intervention, compared with 60 percent at baseline (p=0.035). In the other study (n=280) of a 24-week biweekly home delivery of ethnically tailored food boxes, there was minimal impact on depression symptoms or diabetes distress, but the percent reporting their health status to be good, very good, or excellent increased from 32 percent at baseline to 41 percent in the intervention group.<sup>140</sup> There was a decline in the percent rating their health status as good, very good, or excellent in the group that received only referral for food resources in this study, from 36 percent at baseline to 32 percent at followup.

**Physiologic outcomes (limited to food security-only interventions).** The fair-quality randomized crossover study found reductions in episodes of hypoglycemia (47% in the intervention group vs. 64% in the control group;  $I^2=0.03$ ), but no differences in other laboratory measures related to cardiovascular risk (hemoglobin A1c, high-density lipoprotein cholesterol, low-density lipoprotein cholesterol, triglycerides, total cholesterol, systolic and diastolic blood pressure) or BMI (**Table 19**).<sup>117</sup> The other fair-quality study found a smaller increase in BMI among children whose families participated in a mobile food bank than those who did not after 6 months (mean difference in change,  $-0.68 \text{ kg/m}^2$  [95% CI,  $-1.2$  to  $-0.2$ ]; p=0.01).<sup>142</sup>

Five other studies also reported one or more physiologic outcomes (**Table 19**).<sup>119,138-141</sup> One of these, a nonrandomized controlled study that provided referrals and application support to community and federal food resources during pregnancy (n=290), found no group differences in blood pressure or glucose levels at the end of pregnancy.<sup>119</sup> One pre-post study (n=80) found a statistically significant improvement in diastolic blood pressure of 7 mm Hg between baseline and up to 7 months later among participants who initially had high blood pressure and had received at least four of the seven monthly food boxes.<sup>138</sup> Other physiologic outcomes were not shown, nor was diastolic blood pressure reported for the full sample. Another pre-post study that provided produce vouchers to people with diabetes (n=353) found no change in hemoglobin A1c, systolic blood pressure, or BMI.<sup>139</sup> The remaining pre-post studies found minimal absolute change in blood pressure, low-density lipoprotein cholesterol, or BMI and did not report on the statistical significance of the changes.<sup>140,141</sup>

**Acute healthcare utilization (limited to food security-only interventions).** One pre-post study (n=340) reported on change in the proportion of patients with ED visits and hospital stays 1 year after implementing an intervention that provided biweekly food boxes for 1 year to primary care patients with food insecurity.<sup>134</sup> After 1 year, the percent of patients enrolled in the intervention with an ED visit or hospital stay did not differ from baseline, although findings trended in the direction of benefit (ED visits: 48% at baseline, 28% at followup; hospital stays: 11.7% at baseline, 10.2% at followup; **Table 20**).

**Patient decision making (limited to food security only interventions).** The fair-quality randomized crossover study found no differences in cost-related medication underuse or food-

medication tradeoffs during the on-meal and off-meal phases of the study (**Table 21**).<sup>117</sup> One other pre-post study reported on the likelihood that individuals had to choose between purchasing food and medication associated with their intervention that included diabetes-appropriate food boxes, diabetes self-management support, glucose monitoring, and healthcare referrals. This study found statistically significant reductions from baseline in the likelihood of needing to make a tradeoff between food or medication, both overall and among people with an hemoglobin A1c of 7.5 percent or greater.<sup>135</sup> One additional pre-post study found minimal absolute change in a continuous measure of cost-related medication underuse and did not report the statistical significance of the change.<sup>140</sup>

### **KQ4a. What Are the Effects of Improvements in Food Security Outcomes on Intermediate and Health Outcomes?**

None of the included studies reported on impact of improved food security on intermediate or health outcomes.

### **KQ4b. What Are the Effects of Improvements in Intermediate Outcomes on Health Outcomes?**

None of the included studies reported the impact of improved intermediate outcomes on health outcomes.

### **KQ5. What Are the Harms or Unintended Consequences of Healthcare-Related Interventions to Address Food Insecurity?**

One fair-quality study included for KQ4 reported that one person experienced gastrointestinal symptoms during the on-meals phase, but there were no other adverse events.<sup>117</sup> None of the other included studies reported on harms or potential harms of their interventions. We identified no pattern of results showing paradoxical worsening of any outcome associated with the included interventions.

## Chapter 4. Discussion

Optimal health is difficult to achieve when there are significant social needs such as food insecurity, and health challenges are further exacerbated by inequities in structural and social determinants of health. A substantial proportion of people who are eligible for federal food-related benefits are not enrolled.<sup>146</sup> Screening presents an opportunity to identify people who could benefit from programs to improve food security, as noted by the recent Biden-Harris Administration National Strategy on Hunger, Nutrition, and Health, which calls for universal food security screening in healthcare settings and connecting people to the services they need.<sup>147</sup> Unfortunately, there are important limitations to the literature on the benefits of screening for food insecurity.

### Summary of Evidence

We found insufficient evidence on the impact of screening for food insecurity in healthcare settings (**Table 22**). One fair-quality study among households with children did not show improved food security 6 months after screening and the provision of information to those who screened positive on how to access federal and local food-related assistance. Given the limited evidence base that screening plus referrals improves food insecurity, the indirect chain of evidence becomes important to examine (i.e., whether there are adequate screening tools and whether interventions can improve food security and other outcomes).

We found moderate strength of evidence that 2- and 6-item subsets of a longer 18-item food security assessment instrument had good agreement with the full 18-item questionnaire. This evidence may overestimate the accuracy of brief screeners, however, since all but two of these studies examined agreement based on a single administration of the full questionnaire. We found only one study that administered the screener independently from the reference standard; in this study a single-item screener had sensitivity of 0.59 and specificity of 0.87 (95% CIs, not reported), the lowest accuracy of all included studies.<sup>110</sup>

Because of the methodologic limitations of the studies in this review, it was difficult to ascertain the effectiveness of interventions to improve food security and other important outcomes, leading to low strength of evidence. Most were pre-post studies with only a single measurement at baseline and followup. As a result, we have little confidence that changes in food security were due to the intervention (as opposed to individuals' independent efforts to obtain food resources, for example, or changes in resources over the course of the month or with seasonal work). Setting aside these limitations, the evidence was generally favorable. One very small, fair-quality randomized crossover study did report lower levels of food insecurity when on-meal versus off-meal (42% vs. 62%),<sup>117</sup> and most of the poor-quality studies that focused on the provision of food or food vouchers generally found improved food security at followup, although many results were not statistically significant. The evidence was more mixed among studies that provided only application support or referrals, although some findings were favorable. Due to the

limitations of the data, we could conclude with only low certainty that interventions can improve food security in the short term (1 year or less), particularly those that provide food or vouchers.

Other outcomes were more sparsely reported. The only outcome with consistent evidence of benefit was fruit and vegetable consumption, which improved in many cases when food or vouchers were provided. This finding is consistent with the CPSTF recommendation for fruit and vegetable incentive programs for households with lower incomes.<sup>89</sup> There was no clear impact on physiologic outcomes or acute healthcare utilization (e.g., ED visits or inpatient stays), although these outcomes were rarely reported. Given the literature indicating that food insecurity is associated with poorer health, as cited in the Introduction section of this review, it is highly plausible that improved food security could help ease the impact of food insecurity on health, although the specifics of what kind of support is needed for whom and for how long cannot be clearly determined from the existing literature.

We found almost no reporting of harms in the included studies, but there may be a risk of some harms nevertheless.<sup>148,149</sup> For example, patients may have privacy concerns about sharing sensitive financial information, or feel shamed or stigmatized if screening is not handled in a sensitive manner. Lack of trust or hopelessness may develop if, after screening positive for food insecurity, individuals are not informed about resources. Also, the presence of food insecurity does not necessarily indicate a social *need*, and patients' understanding of whether they need assistance must be respected; to ignore a patient's self-assessment and attempt to persuade them to accept help may be viewed as paternalistic or offensive. Finally, parents and caregivers may have fears about Child Protective Services removing children from a home facing difficulties with basic needs such as food or housing security; other patients may fear that participating in interventions could reveal non-citizen status. Other studies have also indicated trust concerns. One study found that those with greater social needs may be uncomfortable with this information being added to their medical record,<sup>150</sup> and, at least among adults living in Appalachia, those with higher levels of food insecurity had higher levels of medical mistrust than those with lower levels of food insecurity.<sup>151</sup> In addition, from a societal perspective, there may be some potential downsides of social needs screening, including medicalization of social needs and deemphasis on upstream societal causes, such as criminal justice, housing, tax, and labor policies. There may also be unintended consequences to patients with social risk interventions. As an example, small or moderate increases in income can lead to SNAP or other benefits being reduced or cut off, resulting in financial strain that affects patients' ability to pay for housing, utilities, healthcare, or food.<sup>152</sup> Finally, it is worth noting that even interventions that improve food insecurity may not improve nutrition security.

Our findings are consistent with those of other recently published systematic reviews of screening and intervention for food security.<sup>68,80</sup> In general, much of the evidence is limited to study designs at higher risk of bias and focused on process outcomes (e.g., receipt of referral) or food insecurity status rather than patient health outcomes. For example, in a 2019 systemic review by De Marchis and colleagues evaluating interventions addressing food insecurity in healthcare settings, 17 of the 23 included studies were rated low or very low quality.<sup>68</sup> And while studies of referral-based interventions reported moderate increases in food program referrals and resource use, studies of interventions providing food or vouchers reported mixed results for

actual change in fruit/vegetable intake, with no impact when results were pooled. Another systematic review by Oronce and colleagues in 2021, which was not limited to interventions conducted in healthcare settings, found that the provision of food and monetary assistance was associated with improved food insecurity measures; however, it was unclear whether these changes translated into better health outcomes.<sup>80</sup> This review rated the strength of evidence for providing food and monetary assistance as high and moderate, respectively, despite concluding that the study limitations were serious and findings were inconsistent. The strength of evidence was based on the clear logic that providing food and monetary assistance improves food security.

## Implementation and Acceptability

Assessment for food insecurity relies on the identification of individuals or households who lack consistent access to nutritious and culturally appropriate food. Multiple factors at the patient, provider, and healthcare system levels may impact the implementation of food insecurity assessment in healthcare settings (summarized in **Table 23**).<sup>11</sup>

Several studies have reported high levels of patient satisfaction with the assessment of food insecurity in healthcare, with or without a broader social needs assessment.<sup>99</sup> Patient-level factors that may facilitate assessment of food insecurity include increased patient awareness, trusting relationships with their healthcare providers, and assurances of confidentiality.<sup>153,154</sup> On the other hand, food insecurity assessment programs may evoke feelings of stigma or shame or fear of consequences, eliciting hesitation about disclosing this information.<sup>11,153</sup> Further, one study found that those with food insecurity had higher levels of mistrust in medical professionals, suggesting the need for sensitive handling to discussions related to social needs.<sup>151</sup> Also, patients with limited health literacy or language barriers may struggle to understand the purpose or importance of food insecurity assessments, impeding their participation.<sup>153</sup> These concerns highlight the importance of involving community members in developing screening programs.

The acceptability of healthcare-related interventions for food insecurity is also well supported.<sup>122,126,136,155-157</sup> In the studies included in this review, use of food and vouchers was very high, suggesting high engagement with those components. On the other hand, enrollment in federal food assistance programs and use of local services was highly variable (7.5% to 97%). Participation levels were higher when navigators or other staff assisted, as compared with the provision of information only. The broader literature identifies factors that support patient engagement, which include understanding the benefits of interventions for food insecurity,<sup>158</sup> motivation to improve their food security,<sup>153</sup> and a supportive network of family, friends, or community members. Work conflicts, physical limitations, transportation challenges, and lack of access to grocery stores and fresh produce can hinder patients' ability to engage in interventions, however.<sup>158-161</sup> See **Appendix F, Contextual Questions 4** (acceptability), **5** (uptake of services), **6** (screening implementation), and **7** (intervention implementation) for more details.

Several studies have reported that providers believe that social needs, including food insecurity, should be addressed in healthcare,<sup>162-164</sup> and they have low levels of discomfort doing so.<sup>162,165-167</sup> Provider-level facilitators for food insecurity screening include adequate training and

education, access to screening tools and protocols, and a supportive work environment.<sup>66</sup> The integration of food security assessments with existing organizational practices, such as use of electronic health records or social work referrals, can enhance implementation.<sup>168-170</sup> One qualitative study reported that nurses implementing a clinic-integrated food prescription program desired additional training in cultural humility (e.g., better understanding of culturally specific beliefs, values, and customs) and behavioral change theory.<sup>171</sup> See **Appendix F, Contextual Questions 4** (acceptability), **6** (screening implementation), and **7** (intervention implementation) for more details.

At the healthcare system level, policies that recognize the importance of addressing food insecurity and allocate resources for interventions are important to facilitate implementation.<sup>172,173</sup> Simply implementing a risk screening tool in an electronic health record system is unlikely to lead to widespread adoption.<sup>174</sup> Sufficient resources, including appropriate staffing (e.g., community health workers, translation services), training, and funding can enable healthcare systems to implement food insecurity assessment more effectively.<sup>172,175,176</sup> Specifically, some authors have suggested the need to ensure that staff who administer social risk screening display empathy and are sensitive to patient's lived experience and social needs.<sup>148</sup> These authors suggest involving community members and social service agencies in co-designing social support programs and supporting partnerships with existing community organizations. Additionally, gathering data on implementation is important to monitor the program, understand gaps in the process, identify unintended consequences, and help ensure equitable delivery of screening and interventions.<sup>177</sup> Indeed, a study among four community health centers found differences in screening for social risk factors by patient race or ethnicity and preferred language, despite widespread support for the screening voiced in provider surveys.<sup>178</sup>

Mandates for social needs screening related to healthcare quality metrics do not provide resources for their implementation, and funding for screening and intervention programs can be an important barrier for healthcare organizations. In addition to limited organizational resources, health-system-level barriers to optimal implementation commonly include fragmented care, resistance to change, and data management difficulties.<sup>168</sup> Lack of coordination and communication between healthcare systems and community organizations can impede effective implementation, and resistance to the adoption of new practices or screening tools may arise from entrenched systems and routines within a given healthcare system.<sup>179</sup> Cultural and linguistic diversity within communities can present healthcare systems with challenges in delivering culturally appropriate interventions and engaging diverse populations.<sup>168</sup> See **Appendix F, Contextual Questions 6** (screening implementation) and **7** (intervention implementation) for more details.

Community-level factors may also have an important impact on the implementation of screening and interventions to address food insecurity. Common community-level barriers may include limited resources, cultural or language barriers, and geographic differences between communities. Communities with limited infrastructure, funding, and resources may struggle to develop and sustain interventions to address food insecurity.<sup>172</sup> Finally, rural communities may face unique challenges, such as limited access to healthcare, transportation, and food retail

options, making it difficult to implement interventions effectively. Healthcare systems could help by advocating for robust local and federal social safety net policies.

## Limitations of Our Approach

To provide the evidence most directly relevant to the mission of the USPSTF, we examined only studies of interventions that were conducted in or recruited from U.S. healthcare settings. Although community-based interventions may help improve food insecurity or other outcomes, issues surrounding privacy, trust, and expected scope of services may differ between communities and healthcare settings. Schools and other settings may provide important points of entry for addressing social needs for families with children but were not explored because they are outside the scope of healthcare systems. In addition, differences in the structure of healthcare and social services in other developed countries limits the applicability of studies conducted outside of the United States. While this approach improved the applicability of the research findings to U.S. primary care settings, there may still be differences in the accuracy of the screening instruments in everyday practice, where visits include a wide range of medical acuity and practical implementation barriers.

Although we specified in the a priori Research Plan that we would consider only studies that were conducted in U.S. healthcare settings for all KQs, we included two studies examining the accuracy of screening tools (KQ2) that were not conducted in U.S. healthcare settings. These were studies using data from the U.S. Census Bureau, including very large samples that are representative of the U.S. population. We felt that instrument accuracy might be less vulnerable to variation across settings than studies in individual healthcare settings and therefore that these studies would add potentially valuable information, given their large size and carefully constructed samples to be broadly representative of the U.S. population.

We did not examine the evidence on the effectiveness of federal programs such as WIC and SNAP, since these are not under the control of healthcare systems. We did include studies of interventions to help facilitate enrollment in these federal programs, however.

Another limitation of our review was that the scope only addressed screening and interventions to ameliorate food insecurity, yet people often experience more than one social risk factor. For interventions addressing food security along with other intervention components (e.g., nutrition counseling, medical management, addressing other social needs), we only included food security outcomes. We could not assume that improvements in outcomes other than food security would be due to the food security component rather than other components, so these outcomes were not included in this review. It is possible that other components affected the food security outcomes, limiting our confidence that the intervention's food security elements would have the same impact without the co-interventions. On the other hand, we focused on food-related interventions, yet there is evidence that improvement in other social domains improves food insecurity (e.g., rental assistance, Medicaid expansion). However, this was outside the scope of the current review.

Due to the focus of the USPSTF on preventive services rather than disease management, we did not include studies limited to people with significant health conditions, such as cancer, congestive heart failure, or renal failure. However, access to healthy meals may have an important impact on their health and quality of life.

We focused on the benefits and harms to the enrolled participants in the studies, although there may have been other parties affected by the interventions, such as family members, healthcare clinicians and staff, social services agencies, and community partners. While we did include information found on acceptability of the interventions to clinicians under Contextual Question 4, benefits and harms to these groups were not included in our review. In addition, looking at social needs more broadly, evidence suggests widespread dissemination of community resources may have benefits even in the absence of screening. For example, participants in a CMS innovation project who received information about community resources near their home were both more confident that they could find resources if needed and were likely to share the information with others in their community, thus spreading the benefits of the intervention into the community.<sup>180</sup>

## Limitations of the Literature and Future Research Needs

The included studies yielded little information on whether interventions to improve food security led to improvements in health, and none of the studies conducted analyses showing whether those who showed greater improvement in food security also showed greater improvements in health. Uncertainty about the assessment windows for food insecurity at baseline and followup further limit the strength of the conclusions from the pre-post studies, which constituted the vast majority of the evidence for interventions.

Despite this, there is strong logic to support screening for and assistance ameliorating food insecurity, both because food is a basic need (and lack of food can be presumed to compromise health), and because knowing that a patient is food insecure has important implications for the delivery of healthcare. Given the high plausibility that insufficient access to healthy food has negative impacts on health, the primary questions may be about the optimal form (food, vouchers, or incentives; application support), intensity (how much food, value of the vouchers or incentives, the number and type of locations that accept the vouchers), and duration of an intervention for a particular family to improve health. While these questions were not the focus of our review, we found a growing but still very limited evidence base aimed at addressing these questions. We found several ongoing RCTs in [clinicaltrials.gov](https://clinicaltrials.gov), most of which were explicitly comparative effectiveness of active interventions, that may help address these questions in coming years (**Appendix G Table 1**).

Many people with food insecurity have other social needs as well, and it is impossible to isolate the impact of food-related interventions in the larger context of multiple risk factors. Improving food security may be necessary but insufficient to improve health outcomes in the face of other social risk factors. Unless root social causes such as education, employment, and the availability



of affordable housing are addressed, the impact of interventions for food insecurity are by nature limited to the duration of the intervention (i.e., the effect ends when support ends).

As noted in the Introduction, there is a difference between social risk factors (e.g., food insecurity) and social needs (risk factors that patients prioritize as something they would like assistance with). Some have pointed out that a focus on social risk factors rather than social needs may foster paternalistic treatment of those with social risk factors, where clinicians may exert pressure upon patients to address their risk factors rather than respecting the patients' own understanding of their situation and needs.<sup>148</sup> These authors note that social needs screening is preferable to social risk screening, and they recommend a shared decision-making approach to addressing social needs once risk factors are identified. They note that this requires “authentic bidirectional conversations, cultural humility, and creation of novel partnerships and sharing of data between health care and social service organizations.” The included studies assessed for social risk factors rarely described how or whether social needs were determined after risk factors were identified. Future studies should carefully develop and describe the shared decision-making process once social risk factors have been identified.

Many of the included studies were reports of pragmatic programs where the primary aim was to deliver the intervention rather than to provide robust research findings. Most studies were rated as poor quality for the outcomes of interest to this review; however, due to the limited evidence base and the fact that this is the first USPSTF review on a social risk factor, we included poor-quality evidence on interventions for food insecurity that would typically not be included in systematic reviews for the USPSTF. Given the strong logic that the provision of food, vouchers, and help accessing relevant resources can mitigate food insecurity (at least for the duration of the intervention), RCT evidence may not be necessary to recommend helping those with food insecurity obtain food. In addition, studies with true control groups, without at least some information about accessing resources, may be difficult to justify among populations with food insecurity.

However, a pre-post design with only a single measurement before and after the intervention is too limited to provide information about the impact of the intervention on patients. At the least, multiple measurements before and after the intervention along with measurement of physiologic and health outcomes would provide much stronger evidence that change was related to the intervention rather than other factors, such as policy changes or the efforts of the individual to obtain needed resources. The pre-post studies do suggest that providing patients facing food insecurity with food and vouchers improves food security, but multiple measurements and longer followup after the intervention has ended would elicit much more valuable information. Even more definitive would be carefully conducted implementation studies in large health systems, perhaps with staged roll-out of food insecurity screening across clinics or practice groups and assessment of physiologic and health outcomes with outcomes assessed multiple times, up to 2 years or longer. Studies such as this may become impossible to complete, however, if screening for food insecurity become the standard of care, as is likely with the introduction of National Committee for Quality Assurance and CMS quality metrics on social risk screening that include food insecurity screening. As healthcare systems implement programs to address food insecurity,

it is crucial to publish lessons learned, best practices for implementation, how to address contextual factors, and barriers and facilitators to widespread uptake.

## **Conclusions**

Brief screening tools likely have sufficient sensitivity to identify people with food insecurity in healthcare settings and interventions to improve food insecurity show promise, especially those that directly provide food or vouchers/subsidies; however, most studies suffered from high risk of bias, limiting firm conclusions.

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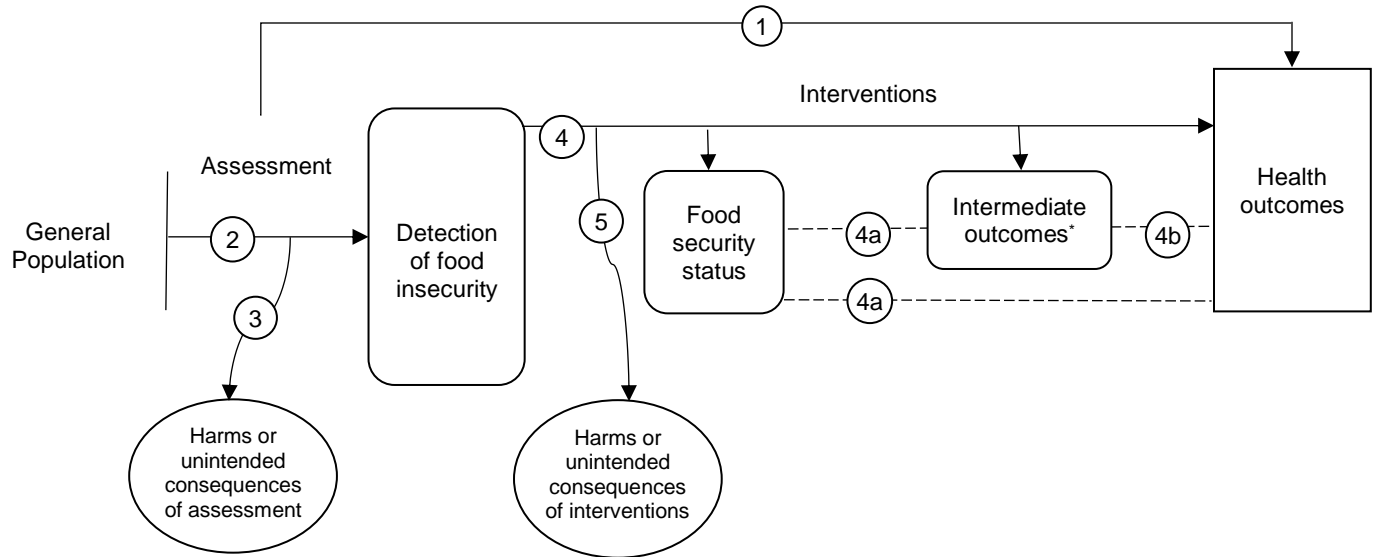
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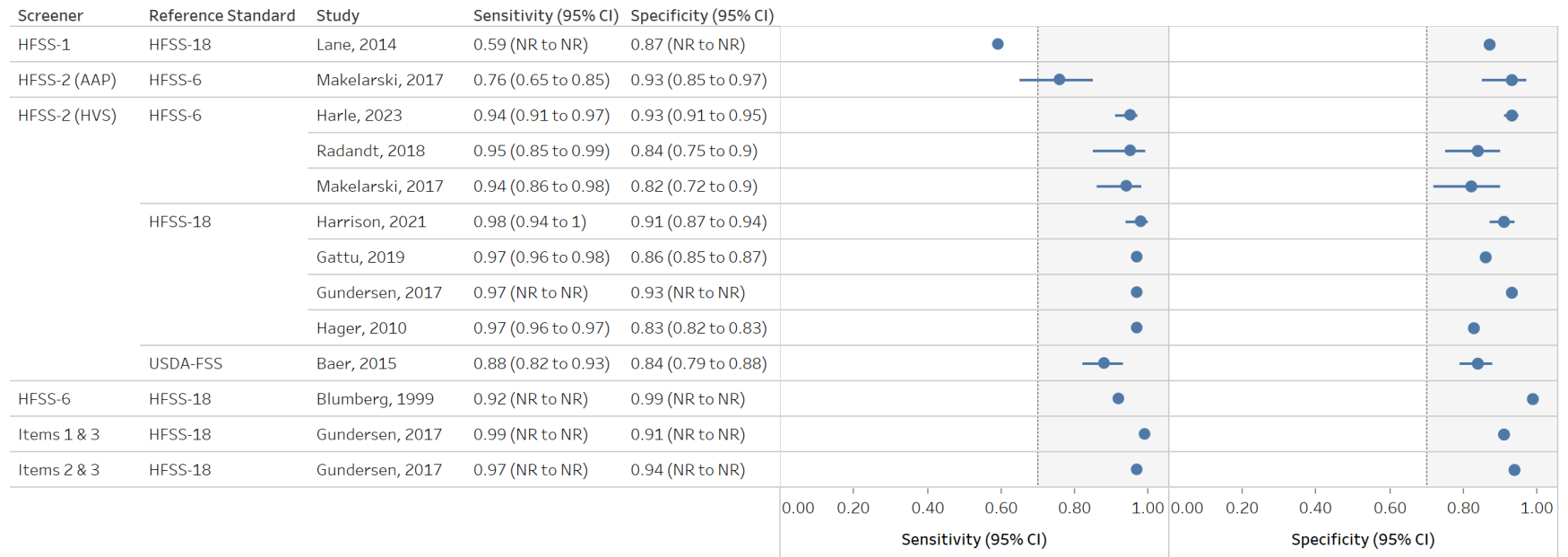
# Figures

Figure 1. Analytic Framework

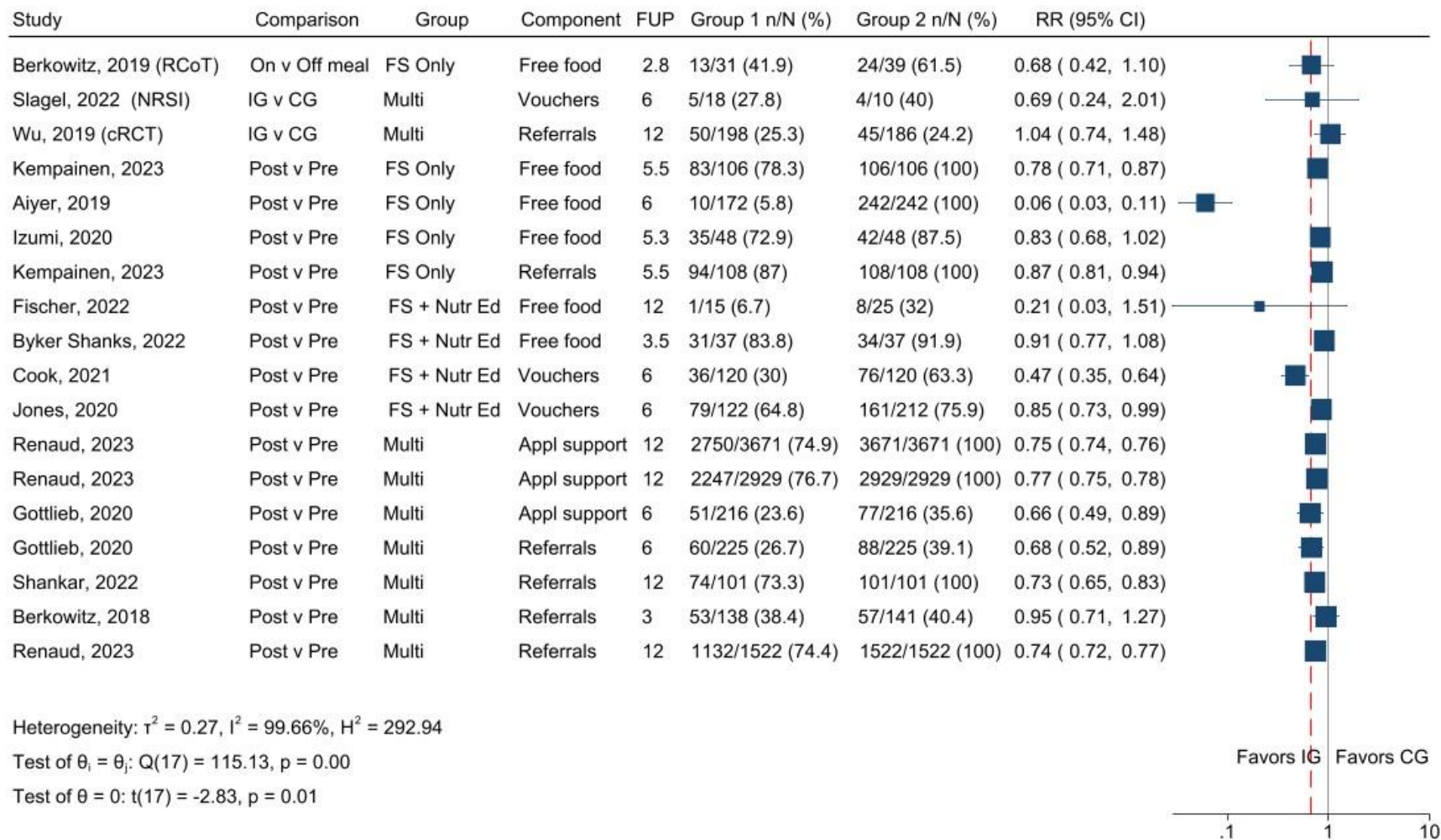


\* Intermediate outcomes include behavioral, physiologic, decision-making, patient participation, and healthcare utilization outcomes.

**Figure 2. Sensitivity and Specificity of Brief Screeners for Food Insecurity, Key Question 2**



**Figure 3. Percent Reporting Food Insecurity at Longest Followup, Key Question 4**



**Abbreviations:** CG=control group; CI=confidence interval; cRCT=crossover randomized controlled trial; IG=intervention group; FS=food security; FUP=followup (months); NRSI=nonrandomized studies of interventions; RcoT=randomized crossover trial; RR=risk ratio.

**Note:** Six additional studies not shown in this table reported outcomes related to food security, but either did not report detailed results sufficient for calculating the percent with food insecurity for all relevant groups or timepoints,<sup>145</sup> reported percent change in those reporting food insecurity,<sup>128</sup> reported a continuous measure of food barriers,<sup>137,142,144</sup> or reported only food-medication tradeoffs.<sup>135</sup>

# Tables

**Table 1. Food +/- Nutrition Insecurity-Specific Assessment Tools**

Name of Tool	Target population	Total # of questions
Hunger Vital Sign <sup>70</sup>	Pediatrics	2
U.S. Household Food Security Survey <sup>67,103,181</sup>	Adults and children	18
Short Form of the U.S. Household Food Security Survey <sup>103</sup>	Adults	6
U.S. Adult Food Security Survey <sup>103</sup>	Adults	10
U.S. Household Food Security Survey for Youth <sup>103,182</sup>	Pediatrics (Ages 12 & older)	9

**Table 2. Interventions to Address Food and Nutrition Insecurity<sup>183</sup>**

Intervention target	Intervention	Description
HOUSEHOLD/ INDIVIDUAL	Food or nutrition prescriptions	Provide prescriptions with healthy eating goals for patients and families, often accompanied by food subsidies or food supplies; most commonly prescribed foods are fruits and vegetables (i.e., produce prescriptions); can include partnerships with local farmers' markets via FVRx programs or co-interventions like nutrition education
	Food referrals	Passive (i.e., provide list of local resources) or active (i.e., provide navigation or directly links patients)
	Medically tailored meals	Meals, usually delivered, tailored to severely ill individuals to meet specific medical and nutritional needs
	Meal delivery programs	Deliver meals directly to participants' residences; often targeted to those with limited mobility and/or transportation issues
COMMUNITY	Mobile produce markets	Support fresh food carts or vehicles that travel to neighborhoods on a set schedule to sell fresh fruits and vegetables
	Farmers' markets	Support multiple vendor markets where producers sell goods such as fresh fruit and vegetables, meat, dairy items, and prepared foods directly to consumers
	Healthy food initiatives in food pantries	Combine hunger relief efforts with nutrition information and healthy eating opportunities, often with on-site cooking demonstrations, recipe tastings, produce display stands, etc.
	Healthy food in convenience stores	Encourage convenience stores, corner stores, or gas station markets to carry fresh produce and other healthier food options
	New grocery stores in underserved areas	Attract new grocery stores that sell a variety of fresh foods, baked goods, packaged, and frozen items to underserved areas via financing initiatives, tax incentives, or zoning regulation
	Fruit & vegetable incentive programs	Offer participants with low incomes matching funds to purchase healthy foods, especially fresh fruits and vegetables; often called bonus dollars, market bucks, produce coupons, or nutrition incentives; may be tied to SNAP benefits
	Community kitchens for nutrition education	Use existing kitchen spaces for community members to share knowledge, resources, and labor to prepare, cook, and consume food, often with nutrition education provided for participants experiencing food insecurity
	Community kitchens for food processing	Establish shared kitchen spaces that support licensed, commercial food processing and connect specialty food processors, farmers, and others who produce value-added goods
	Urban agriculture	Support food-producing and income-earning activities in urban environments (e.g., edible landscapes, front yard or rooftop gardens, window farming, hydroponics, livestock, etc.)
Food buying clubs & co-ops	Offer opportunities for group purchase and distribution of selected grocery items, generally at a reduced price	

Intervention target	Intervention	Description
	Food hubs	Support businesses or organizations that aggregate, distribute, and market local and regional food products (e.g., fresh fruits and vegetables, meat, dairy, grains, and prepared items)
	Community supported agriculture (CSA)	Establish partnerships between farmers and consumers in which consumers purchase a share of a farm's products in advance
	Fruit & vegetable gleaning initiatives	Gather food left in fields after a primary harvest, food in fields where harvesting is not profitable, or excess produce from orchards, packing houses, urban agriculture sites, etc.
	Food banks or pantries	Although the two terms are sometimes used interchangeably, "food banks" are organizations that distribute food to food pantries and other organizations that distribute food directly to households or individuals, while "food pantries" are local emergency food organizations that provide aid to food insecure households through the distribution of unprepared food for offsite consumption; food pantries typically rely on funding from local donors and labor from volunteers
GOVERNMENT	Supplemental Nutrition Assistance Program (SNAP)	SNAP provides benefits to eligible low-income individuals and families via an Electronic Benefits Transfer card, which can be used like a debit card to purchase eligible food in authorized retail food stores
	Special Supplemental Nutrition Program for Women, Infants, and Children (WIC)	Provides supplemental foods, healthcare referrals, and nutrition education for low-income pregnant, breastfeeding, and non-breastfeeding postpartum women, and to infants and children up to age 5 years who are found to be at nutritional risk
	WIC & Senior Farmers' Market Nutrition Programs	Support Farmers' Market Nutrition Programs, which provide WIC and Senior Nutrition Program participants with coupons for fresh, unprepared, locally grown fruits and vegetables
	Farm to school programs	Incorporate locally grown foods into school meals and snacks, often with visits from food producers, cooking classes, nutrition and waste reduction efforts, and school gardens
	School breakfast programs	Support programs to provide students with a nutritious breakfast in the cafeteria, from grab and go carts in hallways, or in classrooms
	Healthy school lunch initiatives	Modify the school lunch food environment by prominently displaying, marketing, and increasing the convenience of healthy foods and providing healthy options
	Electronic Benefit Transfer payment at farmers' markets	Enable farmers' markets to accept EBT, the electronic payment system of debit cards used to issue and redeem Supplemental Nutrition Assistance Program (SNAP) benefits

**Abbreviations:** CSA=community supported agriculture; EBT=electronic benefits transfer; FVRx=fruit and vegetable prescription; SNAP=Supplemental Nutrition Assistance Program; WIC=Supplemental Nutrition Program for Women, Infants, and Children

**Table 3. Study Characteristics, Key Question 1**

Study (Quality rating)	N	Study design	Population	Setting	Screening	Intervention	Food-related components	Non-food areas addressed	Control
Lane, 2014 <sup>110</sup> (Fair)	789	cRCT	Parents of children younger than age 6 years	Primary care	Multiple SDOH	Clinician training on screening for child maltreatment risk factors including food insecurity	Food referrals, Community resource referrals, Application support/coordination	Intimate partner violence, parent depression, substance abuse, stress, and corporal punishment	Usual well-child care

**Abbreviations:** cRCT=cluster randomized clinical trial; SDOH=social determinants of health

**Table 4. Population Characteristics, Key Question 1**

Study	Age, Mean (Range)	% Women	% Race/Ethnicity	% Food Insecurity and Assistance	% Other Assistance	Other SES
Lane, 2014 <sup>110</sup>	25.3 (NR)	92.8	Asian: NR Black: NR Hispanic/Latino: NR Native Amer: NR White: NR Multiracial: NR	Food Insecurity: 32.0 SNAP: NR WIC: NR	NR	Education: < HS: 39%, HS or GED: 37%, Some college: 24% Employed: 32% Household size, mean (SD): 2.2 (1.2) adults, 2.3 (1.4) children

**Abbreviations:** GED=general equivalency diploma; HS=high school; NR= not reported; SD=standard deviation; SES=socioeconomic status; SNAP=Supplemental Nutrition Assistance Program; WIC=Supplemental Nutrition Program for Women, Infants, and Children

**Table 5. Results, Key Question 1**

Study	Outcome	Measure	Group analyzed	Timepoint (months)	IG n/N (%)	CG n/N (%)	Effect (95% CI)
Lane, 2014 <sup>110</sup>	Food insecurity	HFSS-18	All	6	66/223 (29.6) BL: 32.7%	48/161 (29.8) BL: 31.1%	RR*: 0.99 (0.73 to 1.36)

\* Calculated unadjusted RR

**Abbreviations:** BL=baseline; CG=control group; CI=confidence interval; HFSS=Household Food Security Survey; IG=intervention group; RR=relative risk



**Table 6. Study Characteristics, Key Question 2**

Study (Quality rating)	N	Screener	Ref Standard	Setting (Participant selection)	Population	Mean Age (Range)	Race and ethnicity	Food Insecurity (%)	Assistance (%)	Other SES
Baer, 2015 <sup>111</sup> (Fair)	400	HFSS-2 (HVS)	USDA-FSS	Primary care (Convenience)	Adults, Teenagers	Adult: 18 (15-25) Child: NA (NA)	AI or AN: NR Asian or PI: NR Black: 55 Hispanic: 29 White: 9	32.5	SNAP: NR WIC: NR Public insurance: 59	Education: In HS: 48%, Did not complete HS: 10%, HS grad or GED: 10%, >HS grad: 32% Employment status: Student only: 57%, Employed: 25%, Unemployed: 14%, Unable to work: 4%
Blumberg, 1999 <sup>112</sup> (Fair)	44647	HFSS-6	HFSS-18	Other: 1995 Current Population Survey (US Census Bureau) (NR)	Adults	Adult: NR (NR) Child: NA (NA)	AI or AN: NR Asian or PI: NR Black: NR Hispanic: NR White: NR	NR	SNAP: NR WIC: NR	NR
Gattu, 2019 <sup>69</sup> (Fair)	5039	HFSS-2 (HVS)	HFSS-18	Primary care, ED (All eligible)	Families with children	Adult: NR (NR) Child: NR (NR)	AI or AN: NR Asian or PI: NR Black: 88.8 Hispanic: NR White: 6.4	21.5	SNAP: NR WIC: NR	Maternal education: Some HS or less: 22.5%, HS grad: 77.5% Maternal employment: 43.0% Housing insecure: 28.1%
Gundersen, 2017 <sup>113</sup> (Fair)	42081	HFSS-2 (HVS) Items 1 & 3 Items 2 & 3	HFSS-18	Other: 2013 Current Population Survey (US Census Bureau) (NR)	Adults	Adult: NR (NR) Child: NA (NA)	AI or AN: NR Asian or PI: NR Black: NR Hispanic: NR White: NR	14.2	SNAP: NR WIC: NR	NR
Hager, 2010 <sup>70</sup> (Fair)	30098	HFSS-2 (HVS)	HFSS-18	Primary care, ED (All eligible)	Families with children	Adult: NR (NR) Child: NR (0-3)	AI or AN: 0.3 Asian or PI: 1.4 Black: 53.6 Hispanic: 30.4 White: 13.6	23	SNAP: NR WIC: NR	Uninsured or receiving public insurance: 100%
Harle, 2023 <sup>116</sup> (Fair)	826	HFSS-2 (HVS)	HFSS-6	Primary care (NR)	Adults	Adult: 49.7 (NR) Child: NR (NA)	AI or AN: NR Asian or PI: NR Black: 39.2 Hispanic: 6.8 White: 44.8	36.0	SNAP: NR WIC: NR	Education: Less than high school: 6.5%; High school graduate or equivalent: 24.3%; Some postsecondary ed or higher: 66.8%

Study (Quality rating)	N	Screener	Ref Standard	Setting (Participant selection)	Population	Mean Age (Range)	Race and ethnicity	Food Insecurity (%)	Assistance (%)	Other SES
Harrison, 2021 <sup>114</sup> (Fair)	295	HFSS-2 (HVS)	HFSS-18	Primary care (Convenience)	Adults	Adult: 53 (18-93) Child: NA (NA)	AI or AN: NR Asian or PI: NR Black: 50.7 Hispanic: NR White: 41.8	17.6	SNAP: NR WIC: NR Medicaid: 24.8 Medicare: 31.5	Commercial insurance: 40.2%
Lane, 2014 <sup>110</sup> (Fair)	205	HFSS-1	HFSS-18	Primary care (Random)	Families with children	Adult: 25.3 (NR) Child: NR (0-6)	AI or AN: NR Asian or PI: NR Black: 93.0 Hispanic: NR White: NR	32.0	SNAP: 98.4 WIC: NR	Education: <HS: 38.7%, HS or GED: 37.1%, Some college: 24.2% Employed: 32.4%
Makelarski, 2017 <sup>71</sup> (Fair)	154	HFSS-2 (AAP) HFSS-2 (HVS)	HFSS-6	ED, Pediatric ED (Convenience)	Adults	Adult: NR (18-73) Child: NA (NA)	AI or AN: NR Asian or PI: NR Black: 77 Hispanic: 7 White: 8	46	SNAP: NR WIC: NR	Maternal education: HS grad: 32% Maternal employment: 43.0% Housing insecure: 28.1%
Radandt, 2018 <sup>115</sup> (Fair)	141	HFSS-2 (HVS)	HFSS-6	Dental (Convenience)	Families with children	Adult: NR (NR) Child: NR (NR)	AI or AN: NR Asian or PI: 11.3 Black: NR Hispanic: 14.9 White: 63.1	31.2	SNAP: NR WIC: NR Medicaid: 66	Single adult household: 31.9%

**Abbreviations:** AAP=American Academy of Pediatrics; AI=American Indian; AN=Alaskan Native; ED=emergency department; GED=general equivalency diploma; HFSS=Household Food Security Survey; HS=high school; HVS=Hunger Vital Sign; NA=not applicable; NR= not reported; PI=Pacific Islander; SES=socioeconomic status; SNAP=Supplemental Nutrition Assistance Program; USDA-FSS=US Dept of Agriculture-Food Security Survey; WIC=Supplemental Nutrition Program for Women, Infants, and Children

**Table 7. Screening Tools, Key Question 2**

Screener	Items	Scoring
HFSS-1	In the last year, did you worry that your food would run out before you got money or food stamps to buy more?	Response categories: Yes, No "Yes" was considered a positive screen
HFSS-2 (HVS) HFSS-2 (AAP)	<ol style="list-style-type: none"> <li>1. We worried whether our food would run out before we got money to buy more.</li> <li>2. The food we bought just didn't last and we didn't have money to get more.</li> </ol>	Response categories: Hunger Vital Sign (HVS): Often true, Sometimes true, Never true American Academy of Pediatrics (AAP): Yes, No  Affirmative response to either item was considered a positive screen.
3 items examined in Gunderson 2017 <sup>113</sup>	<ol style="list-style-type: none"> <li>1. We worried whether our food would run out before we got money to buy more.</li> <li>2. The food we bought just didn't last and we didn't have money to get more.</li> <li>3. [I/We] couldn't afford to eat balanced meals.</li> </ol>	Response categories: Often true, Sometimes true, Never true.  Examined all pair combinations of these three items; affirmative response to either item was considered a positive screen.
6-item	<ol style="list-style-type: none"> <li>1. In the last 12 months, since (date 12 months ago), did you (or other adults in your household) ever cut the size of your meals or skip meals because there wasn't enough money for food?</li> <li>2. IF YES: How often did this happen-almost every month, some months but not every month, or in only 1 or 2 months?</li> <li>3. In the last 12 months, did you ever eat less than you felt you should because there wasn't enough money to buy food?</li> <li>4. In the last 12 months, since (date 12 months ago), were you ever hungry but didn't eat because you couldn't afford enough food?</li> <li>5. The food that [I/we] bought just didn't last, and [I/we] didn't have money to get more. Was that often, sometimes, or never true for you in the last 12 months?</li> <li>6. [I/We] couldn't afford to eat balanced meals. Was that often, sometimes, or never true for you in the last 12 months?</li> </ol>	Affirmative response to 2 or more items was considered a positive screen.

**Abbreviations:** AAP=American Academy of Pediatrics; HFSS=Household Food Security Survey; HVS=Hunger Vital Sign

**Table 8. Sensitivity and Specificity of Food Security Screeners, Results From Full Study Samples**

Study	Screener	Reference Standard	Independence of screener	Format	Sensitivity (95% CI)	Specificity (95% CI)
Lane, 2014 <sup>110</sup>	HFSS-1	HFSS-18	Administered independently	Self-administered (paper-and-pencil)	0.59 (NR to NR)	0.87 (NR to NR)
Makelarski, 2017 <sup>71</sup>	HFSS-2 (AAP)	HFSS-6	Partially embedded	Self-administered (paper-and-pencil)	0.76 (0.65 to 0.85)	0.93 (0.85 to 0.97)
Gattu, 2019 <sup>69</sup>	HFSS-2 (HVS)	HFSS-18	Fully embedded	Interviewer administered	0.97 (0.96 to 0.98)	0.86 (0.85 to 0.87)
Gundersen, 2017 <sup>113</sup>	HFSS-2 (HVS)	HFSS-18	Fully embedded	Interviewer administered	0.97 (NR to NR)	0.93 (NR to NR)
Hager, 2010 <sup>70</sup>	HFSS-2 (HVS)	HFSS-18	Fully embedded	Interviewer administered	0.97 (0.96 to 0.97)	0.83 (0.82 to 0.83)
Harrison, 2021 <sup>114</sup>	HFSS-2 (HVS)	HFSS-18	Fully embedded	Interviewer administered	0.98 (0.94 to 1)	0.91 (0.87 to 0.94)
Harle, 2023 <sup>116</sup>	HFSS-2 (HVS)	HFSS-6	Same larger questionnaire	NR	0.95 (0.91 to 0.97)	0.93 (0.91 to 0.95)
Makelarski, 2017 <sup>71</sup>	HFSS-2 (HVS)	HFSS-6	Partially embedded	Self-administered (paper-and-pencil)	0.94 (0.86 to 0.98)	0.82 (0.72 to 0.9)
Radandt, 2018 <sup>115</sup>	HFSS-2 (HVS)	HFSS-6	Fully embedded	Self-administered (paper-and-pencil)	0.95 (0.85 to 0.99)	0.84 (0.75 to 0.9)
Baer, 2015 <sup>111</sup>	HFSS-2 (HVS)	USDA-FSS	Fully embedded	Self-administered (computer-based)	0.88 (0.82 to 0.93)	0.84 (0.79 to 0.88)
Blumberg, 1999 <sup>112</sup>	HFSS-6	HFSS-18	Fully embedded	Interviewer administered	0.92 (NR to NR)	0.99 (NR to NR)
Gundersen, 2017 <sup>113</sup>	Items 1 & 3	HFSS-18	Fully embedded	Interviewer administered	0.99 (NR to NR)	0.91 (NR to NR)
Gundersen, 2017 <sup>113</sup>	Items 2 & 3	HFSS-18	Fully embedded	Interviewer administered	0.97 (NR to NR)	0.94 (NR to NR)

\* Fully embedded: all items in the screener were administered as part of the reference standard, the sensitivity and specificity reflect agreement of the subset of items with the full scale; Partially embedded: one or more items (but not all) were administered as part of the reference standard

**Abbreviations:** AAP=American Academy of Pediatrics; CI=confidence interval; HFSS=Household Food Security Survey; HVS=Hunger Vital Sign; NR=not reported; USDA-FSS=US Dept of Agriculture-Food Security Survey

**Table 10. Overview of Studies, All Interventions, Key Question 4**

Intervention type; Study	Quality rating*	N	Study design	Population	Identified via screening†	Provides free food	Provides vouchers	Provides application support	Provides referrals
<b>Food security only intervention (FS Only)</b>									
Berkowitz, 2019 <sup>117</sup>	Fair	44	Randomized crossover trial	Patients with diabetes	Yes	X			
Woo Baidal, 2023 <sup>142</sup>	Fair	176	NRSI	Families with children age <6 years	Yes	X			X
Aiyer, 2019 <sup>121</sup>	Poor	242	Pre-post	Adult patients and parents of pediatric patients	Yes	X			
Cohen, 2017 <sup>124</sup>	Poor	177	Pre-post	SNAP enrolled adults	Yes		X		X
Freedman, 2013 <sup>127</sup>	Poor	45	Pre-post	FQHC patients with diabetes	No		X		
Izumi, 2020 <sup>130</sup>	Poor	80	Pre-post	FQHC patients	No	X			
Kempainen, 2023 <sup>140</sup>	Poor	281	Pre-post	Adults with type 2 diabetes and food insecurity	Yes	IG1			IG1, IG2
Morales, 2016 <sup>119</sup>	Poor	290	NRSI	Pregnant women	Yes			X	X
Orsega-Smith, 2020 <sup>132</sup>	Poor	41	Pre-post	Adults who are Medicaid enrollees, overweight, or have 2+ children	Yes	X			
Ranjit, 2023 <sup>141</sup>	Poor	2028	Pre-post	Adults who are food insecure and diagnosed with prediabetes/diabetes, hypertension, or obesity	No	X			
Saxe-Custack, 2019 <sup>133</sup>	Poor	261	Pre-post	Parents of children ages 7 to 18 years (regardless of food insecurity status)	No		X		
Scher, 2022 <sup>134</sup>	Poor	340	Pre-post	Adults	Yes	X			
Wetherill, 2018 <sup>138</sup>	Poor	80	Pre-post	Uninsured patients attending a chronic disease clinic	No	X			
Xie, 2021 <sup>139</sup>	Poor	353	Pre-post	Adults with diabetes (subgroup)‡	Yes		X		
<b>Food security intervention with nutrition education (FS + Nutr ed)</b>									
Byker Shanks, 2022 <sup>123</sup>	Poor	43	Pre-post	Adults at risk for chronic disease	No	X			

Intervention type; Study	Quality rating*	N	Study design	Population	Identified via screening†	Provides free food	Provides vouchers	Provides application support	Provides referrals
Cook, 2021 <sup>125</sup>	Poor	185	Pre-post	Adults with risk factor for diet-related chronic condition	Yes		X		
Fischer, 2022 <sup>126</sup>	Poor	25	Pre-post	Families with young children and diet-related chronic disease risk factor	Yes	X			
Hager, 2023 <sup>145</sup>	Poor	3881	Pre-post	Adults with, or at risk for, poor cardiometabolic health	No		X		
Jones, 2020 <sup>131</sup>	Poor	212	Pre-post	Navajo families with young children	Yes		X		
Rivera, 2023 <sup>144</sup>	Poor	13	Pre-post	Adults ages 35-75 years with hypertension	No	X			
<b>Intervention assessed and addressed multiple social risk factors (Multidomain)</b>									
Berkowitz, 2018 <sup>122</sup>	Poor	141	Pre-post	Primary care patients	Yes				X
Gottlieb, 2018 <sup>128</sup>	Poor	1237	Pre-post	Parents/caregivers of children	Yes			IG1	IG2
Gottlieb, 2020 <sup>129</sup>	Poor	639	Pre-post	Parents/caregivers of children	Yes			IG1	IG1, IG2
Renaud, 2023 <sup>143</sup>	Poor	54,471	Pre-post	Medicare and Medicaid beneficiaries with 2 or more ED visits in the past year	Yes			IG1, IG2	IG1, IG2, IG3
Seligman, 2015 <sup>135</sup>	Poor	687	Pre-post	Adults with diabetes	No	X			
Shankar, 2022 <sup>136</sup>	Poor	140	Pre-post	High ED utilizers	Yes				X
Singer, 2022 <sup>137</sup>	Poor	216	Pre-post	Medicaid patients at a FQHC	Yes				X
Slagel, 2022 <sup>120</sup>	Poor	47	NRSI	Adults with diet-related condition(s)	Yes		X		
Wu, 2019 <sup>118</sup>	Poor	4917	Cluster RCT	Chronically ill adults at high risk for future hospitalization	No				X

\* Quality rating was applied only to the outcomes and related analyses relevant to this review, which may differ from the primary aim of the study. Thus, studies could have Fair or Good quality methods for their primary aim, which would not be reflected in our rating

† Participants were screened for food insecurity as part of the study enrollment process (and may have also been screened for other social needs)

‡ Relevant outcomes only available on the subgroups of participants with diabetes

**Abbreviations:** FQHC= Federally Qualified Health Center; IG= intervention group; NRSI= nonrandomized studies of interventions; RCT= randomized controlled trial

**Table 11. Study Characteristics, Food Security Only Interventions, Key Question 4**

Study (Quality rating)	N	Study design	Population	Setting	Screening	FI screener	Intervention	Duration (weeks)	% Food Insecurity and assistance
Berkowitz, 2019 <sup>117</sup> (Fair)	44	Randomized crossover trial	Patients with diabetes	Primary care	FI only	Hunger Vital Sign	IG1: Home delivery of medically tailored meals	12	Food Insecurity: 100 SNAP: 66.7 WIC: NR
Woo Baidal, 2023 <sup>142</sup> (Fair)	176	NRSI	Families with children	Primary care	Multiple risk factors	Hunger Vital Sign	IG1: Twice-monthly food selection at mobile pantry to provide ~12 meals per household member with SNAP/WIC enrollment assistance	26	Food Insecurity: 100
Aiyer, 2019 <sup>121</sup> (Poor)	242	Pre-post	Adult patients and parents of pediatric patients	Primary care, Pediatric primary care	FI only	Hunger Vital Sign	IG1: "Food Rx" card for 30+ lbs produce + 4 non-perishable healthy items, for redemption at food pantry every 2 weeks for 12 redemptions, plus educational materials	26	Food Insecurity: 100 SNAP: 9.5 WIC: 3.3
Cohen, 2017 <sup>124</sup> (Poor)	177	Pre-post	SNAP enrolled adults	Primary care, Pediatric primary care	FI only	Current SNAP enrollment	IG1: Educational materials about Double Up Food Bucks (DUFb) + one-time \$10 voucher for farmers market	0.14	Food Insecurity: 79.6 SNAP: 100 WIC: 29.4
Freedman, 2013 <sup>127</sup> (Poor)	45	Pre-post	FQHC patients with diabetes	Primary care	NA (no screening)	NA	IG1: Vouchers for up to \$50 for on-site farmers' market	22	Food Insecurity: 51.2 SNAP: NR WIC: NR
Izumi, 2020 <sup>130</sup> (Poor)	80	Pre-post	FQHC patients	Primary care	NA (no screening)	NA	IG1: Weekly food box	23	Food Insecurity: 87 SNAP: WIC:
Kempainen, 2023 <sup>140</sup> (Poor)	281	Pre-post	Adults with type 2 diabetes and food insecurity	Primary care	FI only	Hunger Vital Sign	IG1: Home-delivered ethnically tailored food boxes biweekly for 24 weeks, plus information and assistance	24	Food Insecurity: 100

Study (Quality rating)	N	Study design	Population	Setting	Screening	FI screener	Intervention	Duration (weeks)	% Food Insecurity and assistance
							with food resources (including SNAP) IG2: Information and assistance with food resources (including SNAP)		
Morales, 2016 <sup>119</sup> (Poor)	290	NRSI	Pregnant women	Obstetrics	FI only	NR	IG1: Referrals & support with community food resources or government assistance programs (e.g., SNAP, WIC)	NR	Food Insecurity: 100 SNAP: NR WIC: 87
Orsega-Smith, 2020 <sup>132</sup> (Poor)	41	Pre-post	Adults who are Medicaid enrollees, overweight, or have 2+ children	Pediatric primary care	FI only	Current federal food assistance enrollment or Yes to "In the past 12 months, did you or others in your home ever cut the size of meals, skip meals, and/or buy fewer healthy foods such as fruit and vegetables because there was not enough money for food?"	IG1: 24 Biweekly produce boxes, ~15-25 lbs/month with nutrition education (format, intensity NR)	52	Food Insecurity: 100 SNAP: NR WIC: NR
Ranjit, 2023 <sup>141</sup> (Poor)	2028	Pre-post	Adults who are food insecure and diagnosed with prediabetes/diabetes, hypertension, or obesity	Other medical	NA (no screening)	NA	IG1: Twice monthly redemption of produce and other foods at food pantry	NR	Food Insecurity: 82.9 SNAP: 22.5 WIC: NR
Saxe-Custack, 2019 <sup>133</sup> (Poor)	261	Pre-post	Parents of children aged 7 to 18 (regardless of food insecurity status)	Pediatric primary care	NA (no screening)	NA	IG1: Fruit and vegetable voucher for \$15 by pediatricians at every clinic visit	26	Food Insecurity: 48.7 SNAP: 56.3 WIC: NR
Scher, 2022 <sup>134</sup> (Poor)	340	Pre-post	Adults	Primary care	FI only	Hunger Vital Sign	IG1: Twice monthly food box delivery for 12 months	52	Food Insecurity: 100



Study (Quality rating)	N	Study design	Population	Setting	Screening	FI screener	Intervention	Duration (weeks)	% Food Insecurity and assistance
									SNAP: NR WIC: NR
Wetherill, 2018 <sup>138</sup> (Poor)	80	Pre-post	Uninsured patients attending a chronic disease clinic	Primary care, Other medical	NA (no screening)	NA	IG1: Up to 7 monthly food prescription boxes (DASH diet)	NR	Food Insecurity: 87 SNAP: 55 WIC: NR
Xie, 2021 <sup>139</sup> (Poor)	353	Pre-post	Adults with diabetes (subgroup)	Primary care, Social service agencies, Academic site	FI only	Hunger Vital Sign or clinicians' informal understanding of patients' SES situation	IG1: Vouchers for \$40/month for fruits and vegetables at local grocery store	52	Food Insecurity: 100 SNAP: 100 WIC: NR

**Abbreviations:** DASH=Dietary Approaches to Stop Hypertension; DUFB=Double Up Food Bucks; FI=food insecurity; Food Rx=food prescription; FQHC=Federally Qualified Health Center; IG=intervention group; NA=not applicable; NR=not reported; NRSI=nonrandomized studies of interventions; SES=socioeconomic status; SNAP=Supplemental Nutrition Assistance Program; WIC=Supplemental Nutrition Program for Women, Infants, and Children

**Table 12. Population Characteristics, Food Security Only Interventions, Key Question 4**

Study (design)	Age, Mean (Range)	% Women	% Race/Ethnicity	% Other Assistance	Other SES
Berkowitz, 2019 <sup>117</sup> (RcoT)	58.5 (NR)	69	Asian: NR Black: 26.2 Hispanic/Latino: 16.7 Native Amer: NR White: 54.8 Multiracial: NR	Medicaid: 28.6 Medicare: 4.8	Median income: 140% of federal poverty level Born outside USA: 31% Education: < HS: 7%, HS: 24%, > HS: 69% Other insurance: Private: 14%, Dual: 52%
Woo Baidal, 2023 <sup>142</sup> (NRSI)	1.7 (<72)	51.1	Asian: NR Black: NR Hispanic/Latino: 85.8 Native Amer: NR White: NR Multiracial: NR	NR	NR
Aiyer, 2019 <sup>121</sup> (Pre-post)	47.3 (NR)	79.1	Asian: NR Black: 3.5 Hispanic/Latino: 79.7 Native Amer: NR White: NR Multiracial: NR	Medicare/Medicaid: 7.0	Household size, mean (SD) 2.7 (1.4) adult, 1.9 (1.5) children
Cohen, 2017 <sup>124</sup> (Pre-post)	NR (29-46)	85.3	Asian: NR Black: 59.9 Hispanic/Latino: 9.0 Native Amer: NR White: 29.4 Multiracial: NR	Other food assistance: 2.3	English speaking: 95% Education: College/tech school: 37%, College grad or higher: 11% Household size, mean (SD): 3.2 (1.7); ≥1 child
Freedman, 2013 <sup>127</sup> (Pre-post)	63.6 (34 -88)	82.9	Asian: 0 Black: 92.7 Hispanic/Latino: NR Native Amer: 0 White: 7.3 Multiracial: NR	SNAP, WIC, and/or free or reduced lunch: 53.7 Financial assistance (TANF, Medicaid, Disability, SSI): 36.6	Education: < HS: 29%, HS or GED: 44%, Some college or tech school: 15%, ≥College graduate: 12% Annual household income=1 year: 10%, Not employed for wages: 7%
Izumi, 2020 <sup>130</sup> (Pre-post)	46 (NR)	91.7	Asian: NR Black: 4.2 Hispanic/Latino: 52.1 Native Amer: NR White: 37.5 Multiracial: NR	SNAP or WIC: 68.8	Education: bachelor's degree: 8% Income: <10K: 25%, 10K-19,999: 40%, 20K-29,999: 25%, <30K: 6% Household size, mean (SD): 3.8 (2.0)

Study (design)	Age, Mean (Range)	% Women	% Race/Ethnicity	% Other Assistance	Other SES
Kempainen, 2023 <sup>140</sup> (Pre-post)	55.6 (21-70)	NR	Asian: NR Black: 67 Hispanic/Latino: 3 Native Amer: 9 White: 21 Multiracial: NR	NR	Education: No HS degree: 27%, HS degree or GED: 30%, Some college or tech school: 29%, College graduate: 14% Employment: Disabled: 50%, Part-time: 13%, Full-time: 7%, Unemployed: 13%, Retired: 11%, Homemaker/other: 6%
Morales, 2016 <sup>119</sup> (NRSI)	30.1 (NR)	100	Asian: NR Black: 6.9 Hispanic/Latino: 84.8 Native Amer: NR White: 4.8 Multiracial: NR	NR	Other insurance: Private: 48%, Uninsured: 3%
Orsega-Smith, 2020 <sup>132</sup> (Pre-post)	NR (NR)	NR	Asian: NR Black: NR Hispanic/Latino: 14 Native Amer: NR White: 90 Multiracial: NR	NR	Household size, mean (SD): 2.2 (0.8) adults, 2.5 (1.3) children
Ranjit, 2023 <sup>141</sup> (Pre-post)	57.1 (NR)	69.0	Asian: NR Black: 31.9 Hispanic/Latino: 55.8 Native Amer: NR White: NR Multiracial: NR	NR	Education: HS diploma: 22.5% Employment: Full time: 17.9%, Part time: 13.2%, Homemaker/ unemployed/ retired/ other: 68.9%
Saxe-Custack, 2019 <sup>133</sup> (Pre-post)	40.0 (NR)	89.3	Asian: NR Black: 77.4 Hispanic/Latino: NR Native Amer: NR White: 15.3 Multiracial: NR	Free and reduced-price lunch: 58.2	Education: ≤HS: 33%, Some college/technical school/associates: 40%, bachelor's degree: 15%, Graduate degree: 8%, Other/NR: 4%
Scher, 2022 <sup>134</sup> (Pre-post)	60.3 (NR)	65.6	Asian: NR Black: 86.3 Hispanic/Latino: NR Native Amer: NR White: NR Multiracial: NR	NR	NR
Wetherill, 2018 <sup>138</sup> (Pre-post)	51.7 (NR)	66	Asian: NR Black: NR Hispanic/Latino: NR	NR	Income <\$15,000: 74%

Study (design)	Age, Mean (Range)	% Women	% Race/Ethnicity	% Other Assistance	Other SES
			Native Amer: NR White: NR Multiracial: NR		
Xie, 2021 <sup>139</sup> (Pre-post)	61.2 (NR)	72.0	Asian: NR Black: 81.9 Hispanic/Latino: 4.8 Native Amer: NR White: 11.9 Multiracial: NR	Medicare: 28 Medicare advantage: 2 Medicaid: 23	Other insurance: Private: 12%, Other (uninsured, VA, or unlisted): 15%

**Abbreviations:** GED=general equivalency diploma; HS=high school; NR=not reported; RcoT=randomized crossover trial; SD=standard deviation; SES=socioeconomic status; SNAP=Supplemental Nutrition Assistance Program; SSI=Supplemental Security Income; TANF=Temporary Assistance for Needy Families; VA=Veterans Affairs; WIC=Supplemental Nutrition Program for Women, Infants, and Children

**Table 13. Study Characteristics, Food Security + Nutrition Education Interventions, Key Question 4**

Study (Quality rating)	N	Study design	Population	Setting	Screening	FI screener	Intervention	Duration (weeks)	% Food Insecurity and assistance
Byker Shanks, 2022 <sup>123</sup> (Poor)	43	Pre-post	Adults at risk for chronic disease	Community-based	NA (no screening)	NA	IG1: Weekly provision of unprocessed food from local food bank, plus 8 biweekly 20- to 30-minute nutrition education sessions	16	Food Insecurity: 93.0 SNAP: NR WIC: NR
Cook, 2021 <sup>125</sup> (Poor)	185	Pre-post	Adults with risk factor for diet-related chronic condition	Community-based, Primary care	NA (no screening)	NA	IG1: Group-based nutrition and cooking education plus subsidies for fresh produce (\$1/day/family member)	26	Food Insecurity: 63.3 SNAP: 57.0 WIC: 4.7
Fischer, 2022 <sup>126</sup> (Poor)	25	Pre-post	Families with young children and diet-related chronic disease risk factor	Pediatric primary care	FI only	Hunger Vital Sign	IG1: 24 biweekly fruit and vegetable delivery plus ~24 hours of virtual nutrition education	52	Food Insecurity: 100 SNAP: 64 WIC: 56
Hager, 2023 <sup>145</sup> (Poor)	3881	Pre-post	Adults with, or at risk for, poor cardiometabolic health	Primary care	NA (no screening)	NA	IG1: 22 produce prescription programs across the U.S. with nutrition education (median subsidies, \$63/month)	17 to 43	Food Insecurity: 52.6 SNAP: 62.7 WIC: 82.6
Jones, 2020 <sup>131</sup> (Poor)	212	Pre-post	Navajo families with young children	Community-based, Primary care, Other medical, Social service agencies	FI only	Varied by site. Indian Health Service Food Insecurity Screening Questionnaire at some sites; others NR	IG1: Fruit and vegetable prescriptions valued at up to \$5/day plus monthly health information sessions	26	Food Insecurity: 80 SNAP: 68 WIC: 66
Rivera, 2023 <sup>144</sup> (Poor)	13	Pre-post	Adults ages 35-75 years with hypertension	Other medical	FI only	NA	IG1: 16-week dietitian-led lifestyle and cooking intervention with medically tailored meal delivery	16	Food Insecurity: 100 SNAP: 69.2 WIC: NR

**Abbreviations:** FI=food insecurity; IG=intervention group; NA=not applicable; NR=not reported; SNAP=Supplemental Nutrition Assistance Program; WIC=Supplemental Nutrition Program for Women, Infants, and Children

**Table 14. Population Characteristics, Food Security + Nutrition Education Interventions, Key Question 4**

Study (design)	Age, Mean (Range)	% Women	% Race/Ethnicity	% Other Assistance	Other SES
Byker Shanks, 2022 <sup>123</sup> (Pre-post)	46.9 (NR)	78.4	Asian: NR Black: NR Hispanic/Latino: NR Native Amer: NR White: NR Multiracial: NR	NR	Education: ≤HS: 41%, Some college: 35%, 2- or 4-year degree: 22%; Income: 50K: 3% Employment: 1-10 hr/wk: 3%, 11-29 hr/wk: 5%, ≥30 hr/wk: 38%, Temp/seasonal job: 3%, Looking for work: 19%, Not employed, not looking for work: 8%, Retired, disabled, homemaker, or full-time student: 19%, Other: 5% Healthcare coverage: 92%
Cook, 2021 <sup>125</sup> (Pre-post)	NR (NR)	72.0	Asian: NR Black: 78.7 Hispanic/Latino: 9.3 Native Amer: NR White: 9.3 Multiracial: 1.9	Public health insurance: 47 Any public assistance: 62 Reduced price or free lunch: 2	Household income: <25k: 77%, 25k–34,999: 11%, 35k–49,999: 6%, ≥50k: 6% Employment: Full time: 14%, Part-time: 10%, Retired: 14%, Student: 3%, Not employed/homemaker: 24%, On disability: 33%, Other: 3% Other insurance: Private insurance: 9%, Through employer: 4%, Uninsured: 33%, Other: 6.5%
Fischer, 2022 <sup>126</sup> (Pre-post)	29.9 (NR)	100	Asian: 0 Black: 100 Hispanic/Latino: NR Native Amer: 0 White: 0 Multiracial: 0	Free/reduced price school lunch: 32 Supplemental security income: 28 Temporary Assistance for Needy Families (TANF): 56	Employment: Full-time: 16%, Part-time: 24%, Student or apprentice: 8%, Unemployed: 40%, Self-employed: 4%, Prefer not to say: 8% Education: <HS: 12%, HS or GED: 48%, Some college: 28%, College grad: 4%, Prefer not to say: 8% Income: <10K: 40%, 10,001-25k: 12%, 25,001-50k: 16%, Prefer not to say: 32% Household size, median: 1 adult, 3 children ages 0-17
Hager, 2023 <sup>145</sup> (Pre-post)	54.4 (adult); 9.2 (child) (NR)	61.5	Asian: NR Black: 29.8 Hispanic/Latino: 45.1 Native Amer: NR White: 19.9 Multiracial: NR	Medicaid/CHIP: 79	Insurance status: Medicaid/CHIP: 79%, Private: 3.9%, Uninsured: 11.4%, Other: 5.5% Parent/caregiver employment: Full time: 18.5%, Part time: 24.3%, Unemployed: 38.0%, Other: 19.2%
Jones, 2020 <sup>131</sup> (Pre-post)	3.96 (of children) (0-6 [of children])	50	Asian: 0 Black: 0 Hispanic/Latino: NR Native Amer: 100 White: 0 Multiracial: NR	Food Distribution Program on Indian Reservations & WIC: 1	Median household size: 5
Rivera, 2023 <sup>144</sup> (Pre-post)	58.9 (35-75)	76.9	Asian: 0 Black: 92.3 Hispanic/Latino: NR	NR	Employment status: Full/part-time: 15.4%, Unemployed due to health status: 46.2%, Retired: 23.1%, Student: 15.4% Total income/month: <1500: 23.1%, 1500-2000: 76.9%

Study (design)	Age, Mean (Range)	% Women	% Race/Ethnicity	% Other Assistance	Other SES
			Native Amer: 0 White: 7.7 Multiracial: NR		Education: < HS diploma: 30.8%, HS grad or GED: 38.5%, >HS grad: 30.8%

**Abbreviations:** CHIP=Child Health Insurance Program; GED=general equivalency diploma; HS=high school; NR=not reported; SES=socioeconomic status; TANF=Temporary Assistance for Needy Families; WIC=Supplemental Nutrition Program for Women, Infants, and Children

**Table 15. Study Characteristics, Multidomain Interventions, Key Question 4**

Study (Quality rating)	N	Study design	Population	Setting	Screening	FI screener	Intervention	Non-food components*	Duration (weeks)	% Food Insecurity and assistance
Berkowitz, 2018 <sup>122</sup> (Poor)	141	Pre-post	Primary care patients	Primary care	Multiple risk factors	HFSS-6	IG1: Patient navigation	Housing, Transportation, Other: Cost-related medication underuse	8.7	Food Insecurity: 40.4 SNAP: NR WIC: NR
Gottlieb, 2018 <sup>128</sup> (Poor)	1237	Pre-post	Parents/ caregivers of children	Pediatric urgent care	Multiple risk factors	2 items: How stressful do you find concerns that: (1) food will run out before you get money or food stamps to get more? And (2) not having enough healthy food (fruits, vegetables, and whole grains) to eat every day?	IG1: Met with patient navigators every 2 weeks for up to 3 months to address a wide range of social needs	Housing, Transportation, Utilities, Childcare, Legal services, Other: Medical or tax preparation	13	Food Insecurity: 39.6 SNAP: NR WIC: NR
							IG2: Preprinted handouts listing local community-based social service resources		0.14	
Gottlieb, 2020 <sup>129</sup> (Poor)	639	Pre-post	Parents/ caregivers of children	Pediatric urgent care	Multiple risk factors	FI item: Running out of food before having enough money or food stamps to buy more	IG1: In-person navigation every 2 weeks up for up to 3 months to address a wide range of social needs	Housing, Transportation, Employment, Utilities, Childcare, Legal services, Other: Disability interfering with work, health insurance, primary care clinician, medical or pharmacy bills, afterschool activities, bullying, adult mental or behavioral health	13	Food Insecurity: 37.5 SNAP: NR WIC: NR
							IG2: Written resources		0.14	
Renaud, 2023 <sup>143</sup> (Poor)	5747 1	Pre-post	Medicare and Medicaid beneficiaries with 2 or more	Other medical	Multiple risk factors	Hunger Vital Sign	IG1: Referrals + navigation + advisory board IG2: Referrals + navigation	Housing, Transportation, Utilities, Intimate partner violence	52	Food Insecurity: 66.4 SNAP: NR WIC: NR



Study (Quality rating)	N	Study design	Population	Setting	Screening	FI screener	Intervention	Non-food components*	Duration (weeks)	% Food Insecurity and assistance
			ED visits in the past year				IG3: Community resource referrals			
Seligman, 2015 <sup>135</sup> (Poor)	687	Pre-post	Adults with diabetes	Community-based, Primary care	NA (no screening)	NA	IG1: Diabetes-appropriate food boxes, diabetes self-management support, and primary care referrals as needed	Other: Blood sugar monitoring, primary care referral, self-management support	26	Food Insecurity: 83 SNAP: NR WIC: NR
Shankar, 2022 <sup>136</sup> (Poor)	140	Pre-post	High ED utilizers	ED	Multiple risk factors	FI items NR	IG1: Community health advocate and legal support	Housing, Transportation, Employment, Utilities, Social isolation, Legal services, Other: Caregiving help	26	Food Insecurity: 79.5 SNAP: NR WIC: NR
Singer, 2022 <sup>137</sup> (Poor)	216	Pre-post	Medicaid patients at a FQHC	Primary care	Multiple risk factors	FI item: In the past year, have you or any family members you live with been unable to get food when really needed?	IG1: Care coordination	Housing, Transportation, Employment, Education, Utilities, Language, Social isolation, Intimate partner violence, Childcare, Legal services	26	Food Insecurity: 21.3 SNAP: NR WIC: NR
Wu, 2019 <sup>118</sup> (Poor)	4917	Cluster RCT	Chronically ill adults at high risk for future hospitalization	Community-based	NA (no screening)	NA	IG1: Support for community-based organizations to make referrals to community resources and social services	Housing, Transportation, Employment, Utilities	52	Food Insecurity: NR SNAP: NR WIC: NR
Slagel, 2022 <sup>120</sup> (Poor)	47	NRSI	Adults with diet-related condition(s)	Community-based, Primary care	FI only	HFSS-6	IG1: Fruit & vegetable vouchers (1\$/day/household member) plus 10 60- to 90-minute	Other: Food and nutrition classes, Financial literacy	26	Food Insecurity: 60.7 SNAP: NR WIC: NR

Study (Quality rating)	N	Study design	Population	Setting	Screening	FI screener	Intervention	Non-food components*	Duration (weeks)	% Food Insecurity and assistance
							food/nutrition classes, 4 financial literacy classes			

\* Non-food insecurity components are domains listed by authors as being addressed; some studies did not provide an exhaustive list of all domains assessed or addressed, and domains were typically addressed only as needed by the study participant

**Abbreviations:** ED=emergency department; FI=food insecurity; FQHC=Federally Qualified Health Center; HFSS=Household Food Security Survey; IG=intervention group; NA=not applicable; NR=not reported; NRSI=nonrandomized studies of interventions; RCT=randomized controlled trial; SNAP=Supplemental Nutrition Assistance Program; WIC=Supplemental Nutrition Program for Women, Infants, and Children

**Table 16. Population Characteristics, Multidomain Interventions, Key Question 4**

Study (design)	Age, Mean (Range)	% Women	% Race/Ethnicity	% Other Assistance	Other SES
Berkowitz, 2018 <sup>122</sup> (Pre-post)	59.7 (NR)	64.9	Asian: NR Black: 28.4 Hispanic/Latino: 6.3 Native Amer: NR White: 50.4 Multiracial: NR	Medicare: 11.5 Medicaid: 50.4	Education: < HS: 13%, HS or GED: 49%, >HS: 38% Other insurance: Commercial: 30%, Self-pay: 8%
Gottlieb, 2018 <sup>128</sup> (Pre-post)	NR (NR)	NR	Asian: NR Black: NR Hispanic/Latino: 53.8 Native Amer: NR White: NR Multiracial: NR	NR	Household income < \$30,000/year: 80%
Gottlieb, 2020 <sup>129</sup> (Pre-post)	NR (18-74)	88.4	Asian: NR Black: 9.0 Hispanic/Latino: 82.0 Native Amer: NR White: 2.9 Multiracial:	NR	Household income <\$30,000/year: 88% Caregiver education level: <HS: 51%, HS grad or GED: 28, Some college or college grad: 21%
Renaud, 2023 <sup>143</sup> (Pre-post)	NR (NR)	65.6	Asian: NR Black: 27.1 Hispanic/Latino: 13.5 Native Amer: NR White: 43.6 Multiracial: NR	100% enrolled in Medicaid and/or Medicare	NR
Seligman, 2015 <sup>135</sup> (Pre-post)	56.6 (NR)	74	Asian: NR Black: 12 Hispanic/Latino: 53 Native Amer: NR White: 25 Multiracial: NR	NR	Education: > HS or GED: 41%, HS or GED: 21%, < HS or GED: 37%
Shankar, 2022 <sup>136</sup> (Pre-post)	47.7 (22-75)	57.9	Asian: NR Black: 60.7 Hispanic/Latino: 5.7 Native Amer: NR White: 30.0 Multiracial: NR	Medicaid: 65 Medicare: 21	Other insurance: Commercial: 14%

Study (design)	Age, Mean (Range)	% Women	% Race/Ethnicity	% Other Assistance	Other SES
Singer, 2022 <sup>137</sup> (Pre-post)	NR (NR)	75.1	Asian: 29.1 Black: 22.7 Hispanic/Latino: 30.6 Native Amer: 1.4 White: 14.8 Multiracial: NR	Medicaid: 100	Primary language: English: 56%, Spanish: 22%, Hmong: 20%, Other: 2% Unemployed: 54% Unstable housing: 24% Lack transportation: 26%
Slagel, 2022 <sup>120</sup> (NRSI)	49.86 (NR)	89.3	Asian: NR Black: NR Hispanic/Latino: 35.7 Native Amer: NR White: NR Multiracial: NR	Receiving federal assistance: 53.6	Uninsured: 85.7% Household size, mean (SD): 2.3 (2.1)
Wu, 2019 <sup>118</sup> (Cluster RCT)	62 (NR)	64	Asian: 1 Black: 55 Hispanic/Latino: 1 Native Amer: 0 White: 39 Multiracial: NR	Medicare: 65	NR

**Abbreviations:** GED=general equivalency diploma; HS=high school; NR=not reported; NRSI=nonrandomized studies of interventions; RCT=randomized controlled trial; SD=standard deviation; SES=socioeconomic status

**Table 17. Percent With Food Insecurity at Longest Followup, Key Question 4**

Study (design) Intervention Category	Quality Rating	Most intensive food component	Group	Analyzed	Follow-up (mos)	Group 1 n/N (%)	Group 2 n/N (%)	Between-group RR (95% CI)*	p-value
<b>FS only</b>									
Berkowitz, 2019 <sup>117</sup> (RcoT)†	Fair	Free food	IG1	All	2.8	On meal: 13/31 (41.9)	Off meal: 24/39 (61.5)	0.68 (0.42 to 1.1)	0.047
Aiyer, 2019 <sup>121</sup> (Pre-post)	Poor	Free food	IG1	All	6	Pre: 242/242 (100)	Post: 10/172 (5.9)	NA	NR
Izumi, 2020 <sup>130</sup> (Pre-post)	Poor	Free food	IG1	All	5.3	Pre: 42/48 (87.5)	Post: 35/48 (72.9)	NA	0.48
Kempainen, 2023 <sup>140</sup> (Pre-post)	Poor	Free food	IG1	All	5.5	Pre: 106/106 (100)	Post: 83/106 (78.0)	NA	NR
Kempainen, 2023 <sup>140</sup> (Pre-post)	Poor	Referrals	IG2	All	5.5	Pre: 108/108 (100)	Post: 94/108 (87.0)	NA	NR
Wetherill, 2018 <sup>138</sup> (Pre-post)	Poor	Free food	IG1	Received 4+ boxes	≤7	Pre: NR	Post: NR	NA	NSD
<b>FS + Nutr Ed</b>									
Byker Shanks, 2022 <sup>123</sup> (Pre-post)	Poor	Free food	IG1	All	3.5	Pre: 34/37 (91.9)	Post: 31/37 (83.8)	NA	NR
Fischer, 2022 <sup>126</sup> (Pre-post)	Poor	Free food	IG1	All	12	Pre: 8/25 (32)	Post: 1/15 (7.0)	NA	0.10
Cook, 2021 <sup>125</sup> (Pre-post)	Poor	Vouchers	IG1	All	6	Pre: 76/120 (63.3)	Post: 36/120 (30.0)	NA	NR
Hager, 2023 <sup>145</sup> (Pre-post)	Poor	Vouchers	IG1	All	4 to 10 (varied)	Pre: 2042/3881 (52.6)	Post: NR/3428 (NR)	NA	<0.001
Jones, 2020 <sup>131</sup> (Pre-post)	Poor	Vouchers	IG1	All	6	Pre: 161/212 (80)	Post: 79/122 (65.0)	NA	0.001
<b>Multidomain</b>									
Slagel, 2022 <sup>120</sup> (NRSI)	Poor	Vouchers	IG1	All	6	IG: 5/18 (27.8)	CG: 4/10 (40.0)	0.69 (0.24 to 2.01)	NSD

Study (design) Intervention Category	Quality Rating	Most intensive food component	Group	Analyzed	Follow-up (mos)	Group 1 n/N (%)	Group 2 n/N (%)	Between-group RR (95% CI)*	p-value
Gottlieb, 2018 <sup>128</sup> (Pre-post)	Poor	Appl support	IG1	All	4	Pre: 39.6%†‡	Post: -23% change in participants endorsing§	NA	NR
		Referrals	IG2					Post: -9% change in participants endorsing§	NA
Gottlieb, 2020 <sup>129</sup> (Pre-post)	Poor	Appl support	IG1	All	6	Pre: 77/216 (35.8)	Post: 51/216 (23.6)	NA	<.001
		Referrals	IG2	All	6	Pre: 88/225 (39.1)	Post: 60/225 (26.6)	NA	<.001
Renaud, 2023 <sup>143</sup> (Pre-post)	Poor	Appl support (+ advisory board)	IG1	Food insecurity at BL	12	Pre: NR (100)	Post: 2247/2929 (76.7)	NA	NR
		Appl support	IG2			Pre: NR (100)	Post: 2750/3671 (74.9)	NA	NR
		Referrals	IG3			Pre: NR (100)	Post: 1132/1522 (74.4)	NA	NR
Wu, 2019 <sup>118</sup> (Cluster RCT)	Poor	Referrals	IG1	All	12	IG: 50/198 (25.5)	CG: 45/186 (24.2)	1.04 (0.74 to 1.48)	.59
Berkowitz, 2018 <sup>122</sup> (Pre-post)	Poor	Referrals	IG1	All	3	Pre: 57/141 (40.4)	Post: 53/138 (38.2)	NA	0.73
Shankar, 2022 <sup>136</sup> (Pre-post)	Poor	Referrals	IG1	Food insecurity at BL	12	Pre: 101/101 (100)	Post: 74/101 (73.3)	NA	NR

\* Calculated unadjusted RR

† Study rated moderate (vs. high) risk of bias

‡ Baseline value is for both groups combined

§ We could not determine whether this was a relative or absolute percent change

**Abbreviations:** Appl=application; BL=baseline; CG=control group; CI=confidence interval; IG=intervention group; NA=not applicable; NR=not reported; NRSI=non-randomized studies of interventions; NSD=no significant difference; RcoT=randomized crossover trial; RCT=randomized controlled trial; RR=relative risk

Note: Four additional studies reported an outcome related to food security, but not the percent or percent change with food insecurity so are not shown in this table: a continuous measure of food barriers<sup>137,142,144</sup> and food-medication tradeoffs.<sup>135</sup> See Appendix D Table 3 for these studies' results.

**Table 18. Health Outcome Results (Food Security Only Interventions), Key Question 4**

Study (design) Quality rating Intervention Component	Outcome	Group	Analyzed	Follow-up (mos)	Group 1 n/N (%) or Mean change* (SD), N	Group 2 n/N (%) or Mean change* (SD), N	Between-group RR† (95% CI)	p-value
<b>Free Food Provided</b>								
Berkowitz, 2019 <sup>117</sup> (RcoT)‡ Fair	Health status Excellent or Very Good	IG1	All	2.8	On meal: 17/31 (54.8)	Off meal: 19/39 (48.7)	1.13 (0.72 to 1.77)	0.50
	Depression symptoms (Range 0–24, lower is better)	IG1	All	2.8	On meal: -0.9 (NR), 31	Off meal: -1.0 (NR), 39	NR	0.96
	Diabetes distress (Range 17–102, lower is better)	IG1	All	2.8	On meal: -3.2 (NR), 31	Off meal: -3.3 (NR), 39	NR	0.96
	HRQoL- health interference (Range 0–30, lower is better)	IG1	All	2.8	On meal: -1.1 (NR), 31	Off meal: -1.4 (NR), 39	NR	0.89
	HRQoL- mental health (Range 0–30, lower is better)	IG1	All	2.8	On meal: -4.7 (NR), 31	Off meal: -0.8 (NR), 39	NR	0.03
	HRQoL- physical health (Range 0–30, lower is better)	IG1	All	2.8	On meal: 2.1 (NR), 31	Off meal: 0.3 (NR), 39	NR	0.50
Izumi, 2020 <sup>130</sup> (Pre-post) Poor	Health status Excellent or Very Good	IG1	All	5.3	Pre: 25/48 (52.1)	Post: 33/48 (68.8)	NA	0.039
	Feeling down, depressed, or hopeless	IG1	All	5.3	Pre: 29/48 (60.4)	Post: 20/48 (41.7)	NA	0.035
Kempainen, 2023 <sup>140</sup> (Pre-post) Poor	Health status: good, very good, or excellent	IG1	All	5.5	Pre: 34/106 (32)	Post: 43/106 (41.0)	NA	NR
	Depressive symptoms (Range 0-12, lower is better)	IG1	All	5.5	Pre: 2.3 (NR)	Chg: -0.4 (NR), 106	NA	NR
	Diabetes distress (Range 0-12, lower is better)	IG1	All	5.5	Pre: 2.8 (NR)	Chg: -0.3 (NR), 106	NA	NR
<b>Referrals</b>								
Kempainen, 2023 <sup>140</sup> (Pre-post) Poor	Health status: good, very good, or excellent	IG2	All	5.5	Pre: 39/108 (36)	Pre: 35/108 (32.0)	NA	NR
	Depressive symptoms (Range 0-12, lower is better)	IG2	All	5.5	Pre: 2.1 (NR)	Chg: -0.1 (NR), 108	NA	NR
	Diabetes distress (Range 0-12, lower is better)	IG2	All	5.5	Pre: 2.6 (NR)	Chg: -0.1 (NR), 108	NA	NR

\* Mean change from baseline values; baseline means are shown in Group 1 column if indicated with “Pre”

† Calculated unadjusted RR

‡ Only study rated moderate (vs. high) risk of bias

**Abbreviations:** CI=confidence interval; HRQoL=health-related quality of life; IG=intervention group; NA=not applicable; NR=not reported; RcoT=randomized crossover trial; RR=relative risk; SD=standard deviation



**Table 19. Physiologic Outcome Results (Food Security Only Interventions), Key Question 4**

FS Component; Study (design)	Outcome	Analyzed	Follow-up (mos)	Group 1 n/N (%) or Mean change* (SD), N	Group 2 n/N (%) or Mean change* (SD), N	Between-group effect (95% CI)	P-value
<b>Free Food provided</b>							
Berkowitz, 2019 <sup>117</sup> (RcoT)† Fair	SBP (mm Hg)	All	2.8	On meal: -0.6 (19.2), 31	Off meal: 2.4 (19.7), 39	NR	0.39
	DBP (mm Hg)			On meal: -1.5 (10.2), 31	Off meal: -0.2 (10.8), 39	NR	0.29
	LDL cholesterol (mg/dL)			On meal: -8.2 (36.8), 31	Off meal: -4.3 (40.8), 39	NR	0.93
	HDL cholesterol (mg/dL)			On meal: -0.5 (11), 31	Off meal: 0.1 (10.5), 39	NR	0.59
	Total cholesterol (mg/dL)			On meal: 2.9 (45.3), 31	Off meal: -1 (43.4), 39	NR	0.67
	Triglycerides (mg/dL)			On meal: NR, 31	Off meal: NR, 39	NR	0.16
	Hemoglobin A1c (%)			On meal: -0.2 (1.7), 31	Off meal: -0.1 (1.6), 39	NR	0.57
	Hypoglycemia			On meal: 14/31 (46.7)	Off meal: 25/39 (63.9)	RR <sup>c</sup> : 0.7 (0.45 to 1.11)	0.03
	BMI (kg/m <sup>2</sup> )			On meal: -0.9 (6.7), 31	Off meal: -0.3 (6.8), 39	NR	0.93
Kempainen, 2023 <sup>140</sup> (Pre-post, IG1) Poor	LDL cholesterol (mg/dL)	All	5.5	Pre: 94.4 (NR), 101	Chg: -0.5 (NR), 101	NA	NR
	Hemoglobin A1c (%)			Pre: 8.0 (NR), 101	Chg: -0.4 (NR), 101	NA	NR
	BMI (kg/m <sup>2</sup> )			Pre: 34.2 (NR), 101	Chg: -0.1 (.), 101	NA	NR
Ranjit, 2023 <sup>141</sup> (Pre-post) Poor	SBP (mm Hg)	≥1 visit to food pantry	6	Pre: NR	Chg: -1.8 (11.7), 213	NA	NR
	DBP (mm Hg)			Pre: NR	Chg: -0.9 (8.8), 213	NA	NR
	LDL cholesterol (mg/dL)			Pre: NR	Chg: -5.4 (22.2), 112	NA	NR
	Hemoglobin A1c (%)			Pre: NR	Chg: -0.5 (2), 389	NA	NR
	BMI (kg/m <sup>2</sup> )			Pre: NR	Chg: .1 (2.4), 342	NA	NR
Wetherill, 2018 <sup>138</sup> (Pre-post) Poor	DBP (mm Hg)	High BP at BL and received 4+ boxes	≤7	Pre: 90.9 (NR), 17	Post: -7 (.), 17	NA	<.05
Woo Baidal, 2023 <sup>142</sup> (NRSI)‡ Fair	BMI (kg/m <sup>2</sup> ) (Child's)	All	6	IG: 0.7 (1.8), 44	CG: 1 (1.7), 132	Mean Diff in Change: -0.68 (-1.2 to -0.2)	0.01
<b>Vouchers</b>							
Xie, 2021 <sup>139</sup> (Pre-post)	SBP (mm Hg)	All	12	Pre: 132.5 (16.3)	Post: NR, 353	NA	0.51
	Hemoglobin A1c (%)			Pre: 8.3 (2.2)	Post: NR, 353	NA	0.53

FS Component; Study (design)	Outcome	Analyzed	Follow-up (mos)	Group 1 n/N (%) or Mean change* (SD), N	Group 2 n/N (%) or Mean change* (SD), N	Between-group effect (95% CI)	P-value
Poor	BMI (kg/m <sup>2</sup> )			Pre: 36.2 (9.1)	Post: NR, 353	NA	0.54
<b>Application support</b>							
Morales, 2016 <sup>119</sup> (NRSI)	SBP (mm HG/wk)	All	Trend across pregnancy	NR, 145	NR, 145	Unstd ES: -0.076 (NR)	0.14
Poor	DBP (mm HG/wk)					Unstd ES: -0.039 (NR)	0.33
	Blood glucose (mg/dL/wk)					Unstd ES: -0.009 (NR)	0.91
<b>Referrals</b>							
Kempainen, 2023 <sup>140</sup> (Pre-post, IG2)	LDL cholesterol (mg/dL)	All	5.5	Pre: 97.2 (NR), 114	Chg: -1.7 (NR), 114	NA	NR
	Hemoglobin A1c (%)			Pre: 7.9 (NR), 114	Chg: -0.1 (NR), 114	NA	NR
Poor	BMI (kg/m <sup>2</sup> )			Pre: 34.8 (NR), 114	Chg: -0.3 (NR), 114	NA	NR

\* Mean change from baseline values

† Study rated moderate (vs. high) risk of bias

‡ Calculated unadjusted RR

**Abbreviations:** BP=blood pressure; BL=baseline; BMI=body mass index; CI=confidence interval; DBP=diastolic blood pressure; HDL=high-density lipoprotein; IG=intervention group; LDL=low-density lipoprotein; NA=not applicable; NR= not reported; NRSI=non-randomized studies of interventions; RcoT=randomized crossover trial; RR=relative risk; SD=standard deviation; SPB=systolic blood pressure; Unstd ES=unstandardized effect size

**Table 20. Healthcare Utilization Results (Food Security Only Interventions), Key Question 4**

Food security component; Study (design) Quality rating	Outcome	Analyzed	Follow-up (mos)	Group 1 n/N (%)	Group 2 n/N (%)	p-value
<b>Free food provided</b>						
Scher, 2022 <sup>134</sup> (Pre-post) Poor	ED visits	All	12	Pre: 123/256 (48.0)	Post: 122/256 (27.7)	NSD*
Scher, 2022 <sup>134</sup> (Pre-post) Poor	Hospitalizations	All	12	Pre: 30/256 (11.7)	Post: 26/256 (10.2)	NSD*

\* Exact p-value not provided

**Abbreviations:** ED=emergency department; NSD=no significant difference

**Table 21. Healthcare Decision-Making Results (Food Security Only Interventions), Key Question 4**

FS Component; Study (design), Quality rating	Outcome	Measure	Analyzed	Follow-up (mos)	Group 1 n/N (%)	Group 2 n/N (%)	Between-group RR* (95% CI)	p-value
<b>Free food provided</b>								
Berkowitz, 2019 <sup>117</sup> (RcoT), Fair	Food-medication tradeoffs	Items derived from Ippolito et al.	All	2.8	On-meal: 9/31 (29.0)	Off-meal: 9/39 (23.1)	1.26 (0.57 to 2.78)	0.12
Berkowitz, 2019 <sup>117</sup> (RcoT), Fair	Cost-related medication underuse	Items derived from National Health Interview Survey	All	2.8	On-meal 7/31 (22.6)	Off-meal: 11/39 (28.2)	0.8 (0.35 to 1.82)	0.52
Kempainen, 2023 <sup>140</sup> (Pre-post, IG1), Poor	Cost-related medication underuse	Self-report (details NR) (Range 0-5, Lower is better)	All	5.5	Pre: 0.4 (NR), 106	Chg: -0.1 (NR), 106	NA	NR
Seligman, 2015 <sup>135</sup> (Pre-post), Poor	Food-medication tradeoffs	Self-report (details NR)	All	6	Pre: 47/641 (7.3)	Post: 36/641 (5.6)	NA	<0.001

FS Component; Study (design), Quality rating	Outcome	Measure	Analyzed	Follow-up (mos)	Group 1 n/N (%)	Group 2 n/N (%)	Between-group RR* (95% CI)	p-value
Seligman, 2015 <sup>135</sup> (Pre-post), Poor	Food-medication tradeoffs	Self-report (details NR)	Uncontrolled HbA1c (>=7.5%) at baseline	6	Pre: 51/379 (13.5)	Post: 40/379 (10.6)	NA	<0.001
<b>Referrals</b>								
Kempainen, 2023 <sup>140</sup> (Pre-post, IG2), Poor	Cost-related medication underuse	Self-report (details NR) (Range 0-5, Lower is better)	All	5.5	Pre: 0.3 (NR), 108	Chg: 0 (NR), 108	NA	NR

\* Calculated unadjusted RR

**Abbreviations:** Chg=change; CI=confidence interval; IG=intervention group; NA=not applicable; NR=not reported; RCoT=randomized crossover trial; RR=relative risk

**Table 22. Summary of Evidence**

<b>Key Question</b>	<b>No. Studies Study Designs (No. Observations)</b>	<b>Summary of Findings</b>	<b>Consistency and Precision</b>	<b>Other Limitations</b>	<b>Strength of Evidence</b>	<b>Applicability</b>
<b>Key Question 1 (Benefits of screening)</b>	1 RCT (n=789)	No difference in the percent reporting food insecurity after 6 months (intervention group, 29.6%; usual care, 29.8%)	Consistency NA Imprecise	Attrition was fairly high (32% overall) and differential between groups (81% in the intervention group vs. 67% in control group)	Insufficient	Conducted in a US healthcare setting; race and ethnicity not reported; lower educational attainment (only 24% had attended any college)
<b>Key Question 2 (Accuracy of screening tools)</b>	10 accuracy studies (n=123,886)	Abbreviated screeners had adequate concordance with full instruments. Sensitivity was typically above 95% and specificity above 82% for 2-item screeners embedded in the reference standard or administered within the same larger instrument, as was the case for most studies, and likely overestimates accuracy. The 1-item screener had the lowest accuracy with sensitivity of 0.59 and specificity of 0.87 (95% CIs, not reported), but was also the only instance of the screener being administered independently from	Consistent Precise	Minimal evidence in which the screener is independently administered from the reference standard.	Moderate (adequate for detection)	8 of 10 studies conducted in or recruited from a US healthcare setting; among studies where race and ethnicity were reported, most studies reported that 50% or more of the participants were Black.

Key Question	No. Studies Study Designs (No. Observations)	Summary of Findings	Consistency and Precision	Other Limitations	Strength of Evidence	Applicability
		the reference standard.				
<b>Key Question 3 (Harms of screening)</b>	0 studies	NA	NA	NA	Insufficient	NA
<b>Key Question 4 (Benefits of interventions)</b>	29 studies (n=74,292): 1 Randomized crossover trial (n=44), 1 Cluster RCT (n=4,917), 3 NRSIs (n=513), 24 single cohort pre-post studies (n=68,818)	Effect sizes for food security at end of study were very wide-ranging but trended in the direction of benefit of reduced food insecurity over time in all 21 studies reporting this outcome. One study rated as “fair” (vs. “poor”) quality, a randomized crossover trial of meal delivery for people with diabetes, found that 41.9% were food insecure while “on-meals” vs 61.5% while “off-meals” (p=0.05). Consumption of fruits and vegetables generally increased after participating in interventions that provided either free food boxes or vouchers. Other outcomes were sparsely reported and rarely showed statistically significant improvements.	Consistent (Food security, fruit and vegetable consumption [for intervention providing free food or vouchers]) Other outcomes: Consistency NA or unclear due to heterogeneity in reporting Imprecise (all outcomes)	27 of 29 studies rated as “poor” quality for the outcomes of interest to this review, raising serious questions about the validity of the findings.	Food insecurity: Low (benefit) All other outcomes: Insufficient	All studies were in at least in part conducted in or recruited from a US healthcare settings; 30% of the included participants were Black, 18% were Hispanic, and 41% were White, among studies where race and ethnicity were reported; one study was limited to people of the Navajo Nation, but there appeared to be minimal other representation of Native Americans; 16 of the 23 studies gave participants free food or vouchers for food, which is unlikely to be feasible for most healthcare settings.

<b>Key Question</b>	<b>No. Studies Study Designs (No. Observations)</b>	<b>Summary of Findings</b>	<b>Consistency and Precision</b>	<b>Other Limitations</b>	<b>Strength of Evidence</b>	<b>Applicability</b>
<b>Key Question 5 (Harms of interventions)</b>	1 Randomized crossover trial (n=44)	1 person experienced gastrointestinal distress while "on-meal"	Consistency NA Imprecise	Minimal reporting of harms.	Insufficient	Conducted in a US healthcare setting

**Abbreviations:** NA=not applicable; NRSI=non-randomized studies of interventions; RCT=randomized controlled trial

**Table 23. Facilitators and Barriers Related to Assessment and Interventions for Food Insecurity (Contextual Questions 6 and 7)**

Type	Level	Facilitators	Barriers
<b>Assessments for Food Insecurity</b>	Patient	<ul style="list-style-type: none"> <li>• Patient awareness and perception</li> <li>• Trusting patient-provider relationship</li> <li>• Assurance of confidentiality</li> </ul>	<ul style="list-style-type: none"> <li>• Stigma or shame</li> <li>• Limited health literacy</li> <li>• Fear of consequences</li> </ul>
	Provider and staff	<ul style="list-style-type: none"> <li>• Provider training and education</li> <li>• Screening tools and protocols</li> <li>• Supportive environment</li> </ul>	<ul style="list-style-type: none"> <li>• Time constraints</li> <li>• Competing priorities</li> <li>• Lack of knowledge</li> <li>• Real or perceived lack of referral resources</li> </ul>
	Healthcare System	<ul style="list-style-type: none"> <li>• Policy support</li> <li>• Resource allocation</li> <li>• Integration of services</li> </ul>	<ul style="list-style-type: none"> <li>• Limited resources</li> <li>• Fragmented care</li> <li>• Resistance to change</li> <li>• Data collection, management, and privacy concerns</li> </ul>
<b>Interventions for Food Insecurity</b>	Patient	<ul style="list-style-type: none"> <li>• Patient awareness and perception</li> <li>• Motivation and readiness</li> <li>• Social support</li> </ul>	<ul style="list-style-type: none"> <li>• Stigma and shame</li> <li>• Lack of knowledge and skills</li> <li>• Limited resources</li> </ul>
	Provider and staff	<ul style="list-style-type: none"> <li>• Provider training and education</li> <li>• Screening and referral tools</li> <li>• Collaborative relationships</li> </ul>	<ul style="list-style-type: none"> <li>• Time constraints</li> <li>• Lack of knowledge</li> <li>• Inadequate reimbursement</li> </ul>
	Healthcare System	<ul style="list-style-type: none"> <li>• Policy support</li> <li>• Integration of services</li> <li>• Data collection and evaluation</li> </ul>	<ul style="list-style-type: none"> <li>• Limited resources</li> <li>• Fragmented systems</li> <li>• Inadequate policies and procedures</li> </ul>
	Community	<ul style="list-style-type: none"> <li>• Collaborative partnerships</li> <li>• Community engagement</li> <li>• Access to resources</li> </ul>	<ul style="list-style-type: none"> <li>• Limited resources</li> <li>• Cultural or language barriers</li> <li>• Geographic differences</li> </ul>



# Appendix A. Detailed Methods

## Literature Search Strategies

Original search – Date delivered 8/21/23

Sources Searched: database and platform	Number of items 2017/2018 -present
MEDLINE via Ovid	4173
CINAHL via Ebsco	3318
Cochrane Central Register of Controlled Clinical Trials via Wiley	1279

Search filters used:

- Ayiku L, Levay P, Hudson T. The NICE OECD countries' geographic search filters: Part 1- methodology for developing the draft MEDLINE and Embase (Ovid) filters. J Med Libr Assoc. 2021 Apr 1;109(2):258-266. <https://doi.org/10.5195/jmla.2021.978>. PMID: 34285668; PMCID: PMC8270368.
- Chris Cooper, Jo Varley-Campbell and Patrice Carter, Established search filters may miss studies when identifying randomized controlled trials. Journal of Clinical Epidemiology J Clin Epidemiol. 2019 Aug;112:12-19. <https://dx.doi.org/10.1016/j.jclinepi.2019.04.002>. PMID: 30986533.

Study design filters:

- Glanville JM, Lefebvre C, Miles JN, Camosso-Stefinovic J. How to identify randomized controlled trials in MEDLINE: ten years on. Journal of the Medical Library Association 2006; 94: 130-136. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1435857/>. PMCID: PMC1435857, PMID: 16636704
- Box 3.d Cochrane Highly Sensitive Search Strategy for identifying randomized trials in MEDLINE: sensitivity- and precision-maximizing version (2008 revision); Ovid format from: Lefebvre C, Glanville J, Briscoe S, Littlewood A, Marshall C, Metzendorf M-I, Noel-Storr A, Rader T, Shokraneh F, Thomas J, Wieland LS. Chapter 4: Searching for and selecting studies. In: Higgins JPT, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, Welch VA (editors). Cochrane Handbook for Systematic Reviews of Interventions version 6.2 (updated February 2021). Cochrane, 2021. Available from [www.training.cochrane.org/handbook](http://www.training.cochrane.org/handbook)
- Tudor Car L, Li L, Smith H, Atun R. Cochrane review: Search strategies to identify observational studies in MEDLINE and EMBASE. J Evid Based Med. 2019;12(3):225–226. <https://doi.org/10.1111/jebm.12358>

## Literature Search for Primary Literature

### MEDLINE via Ovid

Ovid MEDLINE(R) ALL <1946 to August 21, 2023>

ID	Search	Hits
1	Food insecurity/	1107
2	Hunger/ or Food deserts/ or Food Supply/ or Food security/	20812
3	((food or nutrition\$ or malnutrition\$ or hunger\$) adj2 (insecur\$ or unstable or stable or stabilit\$ or instabilit\$ or uncertain\$ or vulnerab\$ or hardship\$ or insufficien\$ or stress\$ or access or (secur\$ not (global or production or environment\$ or parasite\$ or microb\$ or bacteria\$ or climate))))).ti,ab,kf.	20461
4	(food desert\$ or food availability).ti,ab,kf.	4851
5	Food Assistance/ or Access to Healthy Foods/	1703
6	(food adj (aid or aide or assist\$ or bag\$ or bank\$ or box\$ or pantr\$ or shelf or shelves or benefit\$ or donation or donated)).ti,ab,kf.	1766
7	food.ti,ab,kf. and "Health Services Needs and Demand"/	510
8	((food or nutrition\$ or malnutrition\$ or hunger\$) adj (risk or risks)) and (geriatric or elderly or pediatric or paediatric or children).ti,ab,kf.	1696
9	limit 8 to ("in data review" or in process or publisher or "pubmed not medline")	213
10	or/1-7,9	41963
11	mass screening/ or (screen\$ or detect\$ or identif\$).ti,kf.	1058121
12	Needs Assessment/ or (need\$ adj1 assess\$).ti,ab,kf.	39440
13	(instrument\$ or tool\$ or measur\$ or assessment or survey or score or checklist or question\$).ti.	1084961
14	or/11-13	2123741
15	10 and 14	2911
16	(screen\$ and ((food or nutrition\$ or malnutrition\$ or hunger\$) adj2 (insecur\$ or unstable or stable or stabilit\$ or instabilit\$ or uncertain\$ or vulnerab\$ or hardship\$ or insufficien\$ or stress\$ or access or (secur\$ not (global or production or environment\$ or parasite\$ or microb\$ or bacteria\$ or climate))))).ti,ab,kf.	1022
17	(hunger vital sign or hunger screen).ti,ab,kf.	28
18	(Household Food Security or adult Food Security or cps Food Security).ti,ab,kf.	947
19	(Household Food Insecurity Access Scale or HFIAS).ti,ab,kf.	196
20	USDA food security.ti,ab,kf.	29
21	Geriatric Malnutrition Assessment.ti,ab,kf.	4
22	("Risk of Impaired Nutritional Status and Growth" or STRONGkids).ti,ab,kf.	67
23	or/16-22	2154
24	15 or 23	4626
25	(clinical trial or adaptive clinical trial or clinical trial, phase iii or clinical trial, phase iv or controlled clinical trial or randomized controlled trial or equivalence trial or pragmatic clinical trial or Meta-Analysis).pt.	1095328
26	clinical trials as topic/ or adaptive clinical trials as topic/ or clinical trials, phase iii as topic/ or clinical trials, phase iv as topic/ or controlled clinical trials as topic/ or non-randomized controlled trials as topic/ or randomized controlled	384182

	trials as topic/ or equivalence trials as topic/ or intention to treat analysis/ or pragmatic clinical trials as topic/ or meta-analysis as topic/	
27	control groups/ or double-blind method/ or single-blind method/ or random allocation/ or placebos/	323375
28	(random\$ or placebo or phase iii or phase 3).ti,ab.	1468330
29	(RCT or sham or dummy or single blind\$ or double blind\$ or allocated or allocation or triple blind\$ or treble blind\$).ti,ab.	429787
30	((control\$ or clinical) adj3 (study or studies or trial\$ or group\$)).ti,ab.	1779891
31	(Nonrandom\$ or non random\$ or non-random\$ or quasi-random\$ or quasirandom\$).ti,ab.	51166
32	((open label or open-label) adj5 (study or studies or trial\$)).ti,ab.	42341
33	((equivalence or superiority or non-inferiority or noninferiority) adj3 (study or studies or trial\$)).ti,ab.	10538
34	(pragmatic study or pragmatic studies).ti,ab.	539
35	((pragmatic or practical) adj3 trial\$).ti,ab.	5327
36	((quasiexperimental or quasi-experimental) adj3 (study or studies or trial\$)).ti,ab.	10959
37	(metaanaly\$ or meta analy\$).ti,ab.	247908
38	cohort studies/ or longitudinal studies/ or follow-up studies/ or prospective studies/ or retrospective studies/ or case-control studies/	2646629
39	longitudinal.ti,ab.	302501
40	(follow up or followup).ti,ab.	1159606
41	(prospective\$ or retrospective\$).ti,ab.	1699294
42	(comparison group\$ or (matched adj2 compar\$)).ti,ab.	33500
43	observational.ti,ab.	240901
44	population\$.ti,ab.	2035744
45	Registries/	106041
46	(registr\$ or register\$).ti,ab.	509851
47	cohort.ti,ab.	718291
48	(pool\$ or logistic regression or pre-post or "pre and post\$" or matching or subgroup analys\$ or "we observed").ti,ab.	1068328
49	or/25-48	8359962
50	(201806* or 201807* or 201808* or 201809* or 201810* or 201811* or 201812* or 2019* or 2020* or 2021* or 2022*).dt,da,ez.	7052516
51	24 and 49 and 50 [food insecurity screening]	1401
52	"Sensitivity and Specificity"/	366216
53	"Predictive Value of Tests"/	221536
54	ROC Curve/	69654
55	Receiver operat\$.ti,ab.	115984
56	ROC curve\$.ti,ab.	49449
57	sensitivit\$.ti,ab.	950799
58	specificit\$.ti,ab.	557873
59	predictive value.ti,ab.	108973
60	accuracy.ti,ab.	506434

61	False Negative Reactions/	18295
62	False Positive Reactions/	28578
63	Diagnostic Errors/	39472
64	"Reproducibility of Results"/	450748
65	Reference Values/	163592
66	Reference Standards/	45484
67	Observer Variation/	44762
68	Psychometrics/	86111
69	Psychometric\$.ti,ab.	56745
70	false positive\$.ti,ab.	66059
71	false negative\$.ti,ab.	37324
72	miss rate\$.ti,ab.	630
73	error rate\$.ti,ab.	17085
74	evaluation study/	261730
75	or/52-74	2786421
76	(2017* or 2018* or 2019* or 2020* or 2021* or 2022*).dt,da,ez.	8789453
77	24 and 75 and 76 [food insecurity screen accuracy]	288
78	(exp *Fruit/ or *Vegetables/ or Food/ or Cooking/ or exp Meals/) and (Prescriptions/ or (prevention or address\$ or prescription\$ or prescribe\$ or provision or provisions assistance).ti,kf.)	1090
79	((food adj1 medicine) or (food adj1 (aid or aide or assist\$ or bag\$ or bank\$ or box\$ or pantr\$ or shelf or shelves or benefit\$ or donation or donated))).ti,ab,kf.	2634
80	((food or fruit or vegetable or meals or foods or fruits or vegetables or meals) adj4 (prevention or address\$ or prescription\$ or prescribe\$ or provision or provisions assistance or afford\$)).ti,ab,kf.	6669
81	((Diet\$ or nutrition\$) adj (outcome\$ or counsel\$)).ti,ab,kf.	5864
82	supermarkets/ or (food store or food stores or grocery store or grocery stores or (meal deliver\$ adj program\$) or medically tailored or untailored food).ti,ab,kf.	2674
83	(EBT or WIC or " Women, Infants, and Children" or " Women, Infants, Children" or SNAP or food stamp\$).ti,ab,kf.	16096
84	Patient Education as Topic/ or "Referral and Consultation"/ or Patient Navigation/ or Health Promotion/ or (referral\$ or mitigat\$ or communityrx or (community adj2 information)).ti,ab,kf.	475825
85	or/78-84	507173
86	10 and 85	6774
87	(5 or 6 or 7) and (1 or 2 or 3 or 4 or 8)	1665
88	86 or 87	7034
89	49 and 50 and 88 [food insecurity interventions]	1832
90	"Social Determinants of Health"/	5839
91	*Social Conditions/	4036
92	*Poverty/ or *poverty areas/	20624
93	Socioeconomic Factors/ and Food/	670

94	*Employment/	26818
95	*Unemployment/	3837
96	((social\$ or socio\$) adj1 (environment\$ or determin\$) adj5 (screen\$ or detect\$ or identif\$ or question\$ or intervention\$ or refer\$ or assessment or services)).ti,ab,kf.	2012
97	((((determinant\$ or determinate\$) adj2 health) or ((social\$ or socio\$) adj1 (condition\$ or factor\$ or gradient\$ or need\$ or require\$ or equit\$ or inequit\$ or disparit\$ or equal\$ or inequal\$ or hardship\$ or depriv\$ or challeng\$ or difficult\$ or barrier\$ or vulnerab\$ or disadvantag\$ or risk\$ or status\$ or circumstance\$ or position\$ or class\$)) or ((economic\$ or income\$ or financ\$) adj2 (achieve\$ or status or attain\$ or equit\$ or inequit\$ or disparit\$ or equal\$ or inequalit\$ or level\$ or background\$ or opportunit\$ or disadvantage\$ or advantage\$ or marginal\$ or disenfranchis\$ or vulnerab\$ or strain\$ or strugg\$ or stable or unstable or stabilit\$ or instabilit\$ or difficult\$ or problem\$ or (low not (countries or country or lmic)))) or unemployment or unemployed or underemploy\$ or (occupation\$ adj2 (status or level or class)) or jobless\$ or workless\$ or (employment adj2 (status or securit\$ or insecurit\$ or marginal\$ or precarious\$ or terminat\$))) adj5 (screen\$ or detect\$ or identif\$ or question\$ or intervention\$ or refer\$ or assessment or services)).ti,kf.	2067
98	or/90-95	60514
99	10 or 14 or 85	2610519
100	98 and 99	8573
101	49 and 50 and (96 or 97 or 100) [targeted social needs screening]	2462
102	51 or 77 or 89 or 101	5157
103	limit 102 to english language	5088
104	103 not ((exp animal/ or nonhuman/) not exp human/)	5023
105	afghanistan/ or africa/ or africa, northern/ or africa, central/ or africa, eastern/ or "africa south of the sahara"/ or africa, southern/ or africa, western/ or albania/ or algeria/ or andorra/ or angola/ or "antigua and barbuda"/ or argentina/ or armenia/ or azerbaijan/ or bahamas/ or bahrain/ or bangladesh/ or barbados/ or belize/ or benin/ or bhutan/ or bolivia/ or borneo/ or "bosnia and herzegovina"/ or botswana/ or brazil/ or brunei/ or bulgaria/ or burkina faso/ or burundi/ or cabo verde/ or cambodia/ or cameroon/ or central african republic/ or chad/ or exp china/ or comoros/ or congo/ or cote d'ivoire/ or croatia/ or cuba/ or "democratic republic of the congo"/ or cyprus/ or djibouti/ or dominica/ or dominican republic/ or ecuador/ or egypt/ or el salvador/ or equatorial guinea/ or eritrea/ or eswatini/ or ethiopia/ or fiji/ or gabon/ or gambia/ or "georgia (republic)"/ or ghana/ or grenada/ or guatemala/ or guinea/ or guinea-bissau/ or guyana/ or haiti/ or honduras/ or independent state of samoa/ or exp india/ or indian ocean islands/ or indochina/ or indonesia/ or iran/ or iraq/ or jamaica/ or jordan/ or kazakhstan/ or kenya/ or kosovo/ or kuwait/ or kyrgyzstan/ or laos/ or lebanon/ or liechtenstein/ or lesotho/ or liberia/ or libya/ or madagascar/ or malaysia/ or malawi/ or mali/ or malta/ or mauritania/ or mauritius/ or mekong valley/ or melanesia/ or micronesia/ or monaco/ or mongolia/ or montenegro/ or morocco/ or mozambique/ or myanmar/ or namibia/ or nepal/ or nicaragua/ or niger/ or nigeria/ or oman/ or pakistan/ or palau/ or exp panama/ or papua new guinea/	1249029

	or paraguay/ or peru/ or philippines/ or qatar/ or "republic of belarus"/ or "republic of north macedonia"/ or romania/ or exp russia/ or rwanda/ or "saint kitts and nevis"/ or saint lucia/ or "saint vincent and the grenadines"/ or "sao tome and principe"/ or saudi arabia/ or serbia/ or sierra leone/ or senegal/ or seychelles/ or singapore/ or somalia/ or south africa/ or south sudan/ or sri lanka/ or sudan/ or suriname/ or syria/ or taiwan/ or tajikistan/ or tanzania/ or thailand/ or timor-leste/ or togo/ or tonga/ or "trinidad and tobago"/ or tunisia/ or turkmenistan/ or uganda/ or ukraine/ or united arab emirates/ or uruguay/ or uzbekistan/ or vanuatu/ or venezuela/ or vietnam/ or west indies/ or yemen/ or zambia/ or zimbabwe/	
106	"Organisation for Economic Co-Operation and Development"/	479
107	australasia/ or exp australia/ or austria/ or baltic states/ or belgium/ or exp canada/ or chile/ or colombia/ or costa rica/ or czech republic/ or exp denmark/ or estonia/ or europe/ or finland/ or exp france/ or exp germany/ or greece/ or hungary/ or iceland/ or ireland/ or israel/ or exp italy/ or exp japan/ or korea/ or latvia/ or lithuania/ or luxembourg/ or mexico/ or netherlands/ or new zealand/ or north america/ or exp norway/ or poland/ or portugal/ or exp "republic of korea"/ or "scandinavian and nordic countries"/ or slovakia/ or slovenia/ or spain/ or sweden/ or switzerland/ or turkey/ or exp united kingdom/ or exp united states/	3441235
108	European Union/	17388
109	Developed Countries/	21229
110	or/106-109	3456831
111	105 not 110	1160791
112	104 not 111	4194
113	remove duplicates from 112	4173

### Cochrane Central Register of Controlled Clinical Trials via Wiley

Date Run: 8/21/2317:43:43

ID	Search	Hits
#1	((food or nutrition* or malnutrition* or hunger*) NEAR/2 (insecur* or unstable or stable or stabilit* or instabilit* or uncertain* or vulnerab* or hardship* or insufficien* or stress* or access or (secur* not (global or production or environment* or parasite* or microb* or bacteria* or climate)))):ti,ab,kw	2211
#2	("food desert*" or "food availability"):ti,ab,kw	122
#3	(food NEAR (aid or aide or assist* or bag* or bank* or box* or pantr* or shelf or shelves or benefit* or donation or donated)):ti,ab,kw	746
#4	((((food or nutrition* or malnutrition*) NEAR (risk or risks)) and (geriatric or elderly or pediatric or paediatric or children)):ti,ab,kw	946
#5	#1 OR #2 OR #3 OR #4 with Cochrane Library publication date from Jan 2017 to present, in Trials	2657
#6	(screen* or detect* or identif*):ti,kw	37638
#7	(need* NEAR/1 assess*):ti,ab,kw	1309
#8	(instrument* or tool* or measur* or assessment or survey or score or checklist or question*):ti	51935

#9	(screen* and ((food or nutrition* or malnutrition* or hunger*) NEAR/2 (insecur* or unstable or stable or stabilit* or instabilit* or uncertain* or vulnerab* or hardship* or insufficien* or stress* or access or (secur* NOT (global or production or environment* or parasite* or microb* or bacteria* or climate))))):ti,ab,kw	201
#10	("hunger vital sign" or "hunger screen"):ti,ab,kw	3
#11	("Household Food Security" or "adult Food Security" or "cps Food Security"):ti,ab,kw	107
#12	("Household Food Insecurity Access Scale" or HFIAS):ti,ab,kw	25
#13	"USDA food security":ti,ab,kw	8
#14	Geriatric Malnutrition Assessment:ti,ab,kw	185
#15	("Risk of Impaired Nutritional Status and Growth" or STRONGkids):ti,ab,kw	8
#16	((food NEAR/1 medicine) or (food NEAR/1 (aid or aide or assist* or bag* or bank* or box* or pantr* or shelf or shelves or benefit* or donation or donated))):ti,ab,kw	391
#17	((food or fruit or vegetable or meals or foods or fruits or vegetables or meals) NEAR/4 (prevention or address* or prescription* or prescribe* or provision or provisions assistance or afford*)):ti,ab,kw	1131
#18	((Diet* or nutrition*) NEAR (outcome* or counsel*)):ti,ab,kw	12892
#19	((meal deliver* NEAR program*) or medically tailored or untailed food or "food store" or "food stores" or "grocery store" or "grocery store"):ti,ab,kw	417
#20	(EBT or WIC or " Women, Infants, and Children" or " Women, Infants, Children" or SNAP or food stamp*):ti,ab,kw	1104
#21	(referral* or mitigat* or communityrx or (community NEAR/2 information)):ti,ab,kw	21977
#22	{OR #6-#21}	122323
#23	#5 AND #22	1192
#24	((social* or socio*) NEAR/1 (environment* or determin*)):ti,ab,kw	2298
#25	(((((determinant* or determinate*) NEAR/2 health) or ((social* or socio*) NEAR/1 (condition* or factor* or gradient* or need* or require* or equit* or inequit* or disparit* or equal* or unequal* or hardship* or depriv* or challeng* or difficult* or barrier* or vulnerab* or disadvantag* or risk* or status* or circumstance* or position* or class*)) or ((economic* or income* or financ*) NEAR/2 (achieve* or status or attain* or equit* or inequit* or disparit* or equal* or inequalit* or level* or background* or opportunit* or disadvantage* or advantage* or marginal* or disenfranchis* or vulnerab* or strain* or strugg* or stable or unstable or stabilit* or instabilit* or difficult* or problem* or (low not (countries or country or lmic)))) or unemployment or unemployed or underemploy* or (occupation* NEAR/2 (status or level or class)) or jobless* or workless* or (employment NEAR/2 (status or securit* or insecurit* or marginal* or precarious* or terminat*))))):ti,kw	11419
#26	#24 OR #25 with Cochrane Library publication date from Jan 2017 to present	7331
#27	#23 AND #26	146
#28	#5 OR #27	2657
#29	#28 NOT (clinicaltrials or trialsearch):so	1647
#30	#29 NOT conference:pt	1279

**CINAHL via Ebsco**

ID	Search	Limits	Hits
S1	(MH "Food Security+") OR (MM "Hunger") OR (MM "Food Deserts") OR (MM "Food Supply") OR (MH "Food Assistance")	Expanders - Apply equivalent subjects	9,133
S2	TI ( ((food OR nutrition* OR malnutrition* OR hunger) N2 (insecur* OR unstable OR stable OR stabilit* OR instabilit* OR uncertain* OR vulnerab* OR hardship* OR insufficien* OR stress* OR access OR (secur* not (global OR production OR environment* OR parasite* OR microb* OR bacteria* OR climate)))) ) OR AB ( ((food OR nutrition* OR malnutrition* OR hunger) N2 (insecur* OR unstable OR stable OR stabilit* OR instabilit* OR uncertain* OR vulnerab* OR hardship* OR insufficien* OR stress* OR access OR (secur* not (global OR production OR environment* OR parasite* OR microb* OR bacteria* OR climate)))) )	Expanders - Apply equivalent subjects	9,104
S3	TI "food desert*" OR TI "food availability" OR AB "food desert*" OR AB "food availability"	Expanders - Apply equivalent subjects	874
S4	TI ( (food N1 (aid OR aide OR assist* OR bag* OR bank* OR box* OR pantr* OR shelf OR shelves OR benefit* OR stamp* OR donation OR donated)) ) OR AB ( (food N1 (aid OR aide OR assist* OR bag* OR bank* OR box* OR pantr* OR shelf OR shelves OR benefit* OR stamp* OR donation OR donated)) )	Expanders - Apply equivalent subjects	1,732
S5	TI ( (((food OR nutrition* OR malnutrition* OR hunger) N1 (risk OR risks)) and (geriatric OR elderly OR pediatric OR paediatric OR children)) ) OR AB ( (((food OR nutrition* OR malnutrition*) N1 (risk OR risks)) and (geriatric OR elderly OR pediatric OR paediatric OR children)) )	Expanders - Apply equivalent subjects	1,579
S6	(TI food OR AB food) AND (MH "Health Services Needs and Demand+")	Expanders - Apply equivalent subjects	312
S7	S1 OR S2 OR S3 OR S4 OR S5 OR S6	Expanders - Apply equivalent subjects	17,218
S8	(MH "Health Screening") OR TI ( screen* OR detect* OR identif* )	Expanders - Apply equivalent subjects	196,442
S9	(MH "Needs Assessment") OR TI need* N1 assess* OR AB need* N1 assess*	Expanders - Apply equivalent subjects	32,845
S10	TI (instrument* OR tool* OR measur* OR assessment OR survey OR score OR checklist OR question*)	Expanders - Apply equivalent subjects	392,505
S11	S8 OR S9 OR S10	Expanders - Apply equivalent subjects	596,417
S12	S7 AND S11	Expanders - Apply equivalent subjects	1,899
S13	TI ( (screen* AND ((food OR nutrition* OR malnutrition* OR hunger) N2 (insecur* OR unstable OR stable OR	Expanders - Apply equivalent subjects	601



	stabilit* OR instabilit* OR uncertain* OR vulnerab* OR hardship* OR insufficien* OR stress* OR access OR (secur* NOT (global OR production OR environment* OR parasite* OR microb* OR bacteria* OR climate)))) ) OR AB ( (screen* AND ((food OR nutrition* OR malnutrition* OR hunger) N2 (insecur* OR unstable OR stable OR stabilit* OR instabilit* OR uncertain* OR vulnerab* OR hardship* OR insufficien* OR stress* OR access OR (secur* NOT (global OR production OR environment* OR parasite* OR microb* OR bacteria* OR climate)))) ) )		
S14	TI ( "hunger vital sign" OR "hunger screen" ) OR AB ( "hunger vital sign" OR "hunger screen" )	Expanders - Apply equivalent subjects	17
S15	TI ( "Household Food Security" OR "adult Food Security" OR "cps Food Security" ) OR AB ( "Household Food Security" OR "adult Food Security" OR "cps Food Security" )	Expanders - Apply equivalent subjects	546
S16	TI ( "Household Food Insecurity Access Scale" OR HFIAS ) OR AB ( "Household Food Insecurity Access Scale" OR HFIAS )	Expanders - Apply equivalent subjects	116
S17	TI "USDA food security" OR AB "USDA food security"	Expanders - Apply equivalent subjects	13
S18	TI "Geriatric Malnutrition Assessment" OR AB "Geriatric Malnutrition Assessment"	Expanders - Apply equivalent subjects	3
S19	TI ( "Risk of Impaired Nutritional Status and Growth" OR STRONGkids ) OR AB ( "Risk of Impaired Nutritional Status and Growth" OR STRONGkids )	Expanders - Apply equivalent subjects	45
S20	S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19	Expanders - Apply equivalent subjects	1,252
S21	S12 OR S20	Expanders - Apply equivalent subjects	2,838
S22	(MH "Clinical Trials+") OR (MH "Meta Analysis") OR (MH "Placebos") OR (MH "Random Sample+") OR (MH "Control Group") OR (MH "Pretest-Posttest Design+") OR (MH "Cluster Sample+") OR (MH "Sample Size") OR (MH "Comparative Studies+") OR (MH "Crossover Design") OR PT (Clinical Trial OR Meta Analysis OR Meta Synthesis OR Randomized Controlled Trial OR Systematic Review) OR TI (random* OR placebo OR randomly OR "phase iii" OR "phase 3" OR RCT OR sham OR dummy OR double blind* OR allocated OR allocation OR triple blind* OR treble blind* OR Nonrandom* OR quasirandom* OR pragmatic study OR pragmatic studies OR metaanaly* OR meta analy*) OR AB (random* OR placebo OR randomly OR "phase iii" OR "phase 3" OR RCT OR sham OR dummy OR double blind* OR allocated OR allocation OR triple blind* OR treble blind* OR Nonrandom* OR quasirandom* OR pragmatic study OR pragmatic studies OR metaanaly* OR	Expanders - Apply equivalent subjects	1,359,639

	meta analy*) OR (TI ((control* OR clinical) N3 (study OR studies OR trial* OR group*))) OR (TI ((open label OR open-label) N5 (study OR studies OR trial*))) OR (TI ((equivalence OR superiority OR non-inferiority OR noninferiority) N3 (study OR studies OR trial*))) OR (TI ((pragmatic OR practical) N3 trial*)) OR (TI ((quasiexperimental OR quasi-experimental) N3 (study OR studies OR trial*))) OR (AB ((control* OR clinical) N3 (study OR studies OR trial* OR group*))) OR (AB ((open label OR open-label) N5 (study OR studies OR trial*))) OR (AB ((equivalence OR superiority OR non-inferiority OR noninferiority) N3 (study OR studies OR trial*))) OR (AB ((pragmatic OR practical) N3 trial*)) OR (AB ((quasiexperimental OR quasi-experimental) N3 (study OR studies OR trial*))) OR (MH (sample size) AND AB (assigned OR allocated OR control))		
S23	(MH "Case Control Studies+") OR (MH "Prospective Studies+") OR (MH "Evaluation Research+") OR (MH "Retrospective Design") OR (MH "Cross Sectional Studies") OR (MH "Multivariate Analysis") OR (MH "Chi Square Test+") OR (MH "Multiple Logistic Regression") OR (MH "Observational Methods+") OR (TI (case control* OR cohort OR longitudinal OR follow-up OR followup OR prospective* OR comparison group* OR control group* OR observational OR retrospective* OR database* OR nonrandomi* OR non-randomi* OR population* OR registr* OR register* OR cross-sectional OR multivariate OR pool* OR logistic regression OR pre-post OR "pre and post*" OR matching OR sub-group analys\$ or "we observed" OR (matched N2 compar\$))) OR (AB (case control* OR cohort OR longitudinal OR follow-up OR followup OR prospective* OR comparison group* OR control group* OR observational OR retrospective* OR database* OR nonrandomi* OR non-randomi* OR population* OR registr* OR register* OR cross-sectional OR multivariate OR pool* OR logistic regression OR pre-post OR "pre and post*" OR matching OR sub-group analys\$ or "we observed" OR (matched N2 compar\$)))	Expanders - Apply equivalent subjects	2,311,205
S24	S22 OR S23	Expanders - Apply equivalent subjects Limiters - Published Date: 20180601-; English Language; Publication Type: Journal Article, Research	697,191
S25	S21 AND S24	Expanders - Apply equivalent subjects	962

S26	(MH "Sensitivity and Specificity") OR (MH "Predictive Value of Tests") OR (MH "ROC Curve") OR (MH "Diagnostic Errors+") OR (MH "Reproducibility of Results") OR (MM "Reference Values") OR (MH "Evaluation Research+") OR (TI ("receiver operat*" OR "ROC curve*" OR "sensitivit*" OR "specificit*" OR "predictive value" OR "accuracy" OR "Psychometric*" OR "false positive*" OR "false negative*" OR "miss rate*" OR "error rate*" OR "likelihood ratio*" OR ((pre-test OR pretest OR post-test) N1 probability))) OR (AB ("receiver operat*" OR "ROC curve*" OR "sensitivit*" OR "specificit*" OR "predictive value" OR "accuracy" OR "Psychometric*" OR "false positive*" OR "false negative*" OR "miss rate*" OR "error rate*" OR "likelihood ratio*" OR ((pre-test OR pretest OR post-test) N1 probability)))	Expanders - Apply equivalent subjects Limiters - Published Date: 20170101-; English Language; Publication Type: Journal Article, Research	314,432
S27	S21 AND S26	Expanders - Apply equivalent subjects	251
S28	S25 OR S27	Expanders - Apply equivalent subjects	1,027
S29	((MH "Food") OR (MM "Fruit+") OR (MM "Vegetables+")) AND ((MH "Prescriptions, Non-Drug") OR (MH "Diet Therapy+") OR (MH "Therapeutics") OR (MH "Early Intervention+") OR (MH "Feeding Methods+") OR (MH "Nutritional Support+") OR (MH "Eating Behavior+") OR (TI (prevention OR address* OR prescription* OR prescribe* OR provision OR provisions assistance)) )	Expanders - Apply equivalent subjects	7,179
S30	TI ( ((food N1 medicine) OR (food N1 (aid OR aide OR assist* OR bag* OR bank* OR box* OR pantr* OR shelf OR shelves OR benefit* OR donation OR donated))) ) OR AB ( ((food N1 medicine) OR (food N1 (aid OR aide OR assist* OR bag* OR bank* OR box* OR pantr* OR shelf OR shelves OR benefit* OR donation OR donated))) )	Expanders - Apply equivalent subjects	2,085
S31	TI ( ((food OR fruit OR vegetable OR meals OR foods OR fruits OR vegetables OR meals) N4 (prevention OR address* OR prescription* OR prescribe* OR provision OR provisions assistance OR afford*)) ) OR AB ( ((food OR fruit OR vegetable OR meals OR foods OR fruits OR vegetables OR meals) N4 (prevention OR address* OR prescription* OR prescribe* OR provision OR provisions assistance OR afford*)) )	Expanders - Apply equivalent subjects	3,547
S32	TI ( ((Diet* OR nutrition*) N1 (outcome* OR counsel*)) ) OR AB ( ((Diet* OR nutrition*) N1 (outcome* OR counsel*)) )	Expanders - Apply equivalent subjects	4,235
S33	((MH "Grocery Stores") OR (MH "Convenience Stores")) OR (TI ( ((meal deliver* N1 program*) OR medically tailored OR untailored food OR "food store" or "food	Expanders - Apply equivalent subjects	1,256

	stores" or "grocery store" or "grocery store" ) OR AB ( ((meal deliver* N1 program*) OR medically tailored OR untailed food OR "food store" or "food stores" or "grocery store" or "grocery store" ) )		
S34	((MH "Meal Preparation+") OR (MH "Menu Planning") OR (MH "Meals+")) AND ((MH "Prescriptions, Non-Drug") OR (MH "Diet Therapy+") OR (MH "Therapeutics") OR (MH "Early Intervention+") OR (MH "Feeding Methods+") OR (MH "Nutritional Support+"))	Expanders - Apply equivalent subjects	5,559
S35	TI ( EBT OR WIC OR " Women, Infants, and Children" OR " Women, Infants, Children" OR SNAP OR food stamp* ) OR AB ( EBT OR WIC OR " Women, Infants, and Children" OR " Women, Infants, Children" OR SNAP OR food stamp* )	Expanders - Apply equivalent subjects	4,067
S36	(MH "Patient Navigation") OR (MH "Referral and Consultation") OR (MH "Patient Education") OR (MH "Health Promotion Methods") OR (TI ( referral* OR mitigat* OR communityrx OR (community N2 information) ) OR AB ( referral* OR mitigat* OR communityrx OR (community N2 information) ))	Expanders - Apply equivalent subjects	196,218
S37	S29 OR S30 OR S31 OR S32 OR S33 OR S34 OR S35 OR S36	Expanders - Apply equivalent subjects	221,035
S38	S7 AND S24 AND S37	Expanders - Apply equivalent subjects	1,300
S39	S11 OR S37	Expanders - Apply equivalent subjects	793,181
S40	((MH "Social Determinants of Health") OR (MM "Poverty+") OR (MH "Socioeconomic Factors+") OR (MM "Employment") OR (MM "Unemployment")) AND ((MH "Meal Preparation+") OR (MH "Menu Planning") OR (MH "Meals+") OR (MH "Fruit+") OR (MH "Vegetables+") OR (MH "Food") OR TI (food OR fruit OR vegetable OR meals OR foods OR fruits OR vegetables OR meals) OR AB (food OR fruit OR vegetable OR meals OR foods OR fruits OR vegetables OR meals))	Expanders - Apply equivalent subjects	14,072
S41	S39 AND S40	Expanders - Apply equivalent subjects	4,304
S42	TI ( (((social* or socio*) N1 (environment* or determin*)) N5 (screen* or detect* or identif* or question* or intervention* or refer* or assessment or services)) ) OR AB ( (((social* or socio*) N1 (environment* or determin*)) N5 (screen* or detect* or identif* or question* or intervention* or refer* or assessment or services)) )	Expanders - Apply equivalent subjects	2,070
S43	TI (((determinant* or determinate*) N2 health) or ((social* or socio*) N1 (condition* or factor* or gradient* or need* or require* or equit* or inequit* or disparit* or equal* or unequal* or hardship* or depriv* or challeng*	Expanders - Apply equivalent subjects	1,769

	or difficult* or barrier* or vulnerab* or disadvantag* or risk* or status* or circumstance* or position* or class*)) or ((economic* or income* or financ*) N2 (achieve* or status or attain* or equit* or inequit* or disparit* or equal* or inequalit* or level* or background* or opportunit* or disadvantage* or advantage* or marginal* or disenfranchis* or vulnerab* or strain* or strugg* or stable or unstable or stabilit* or instabilit* or difficult* or problem* or (low not (countries or country or lmic)))) or unemployment or unemployed or underemploy* or (occupation* N2 (status or level or class)) or jobless* or workless* or (employment N2 (status or securit* or insecurit* or marginal* or precarious* or terminat*)) N5 (screen* or detect* or identif* or question* or intervention* or refer* or assessment or services))		
S44	S41 OR S42 OR S43	Expanders - Apply equivalent subjects	7,821
S45	S24 AND S44	Expanders - Apply equivalent subjects	1,893
S46	S28 OR S38 OR S45	Expanders - Apply equivalent subjects	3,330
S47	(MH animals NOT MH humans)	Expanders - Apply equivalent subjects	96,769
S48	S46 NOT S47	Expanders - Apply equivalent subjects	3,318

**Appendix A Table 1. Inclusion and Exclusion Criteria**

Category	Include	Exclude
Condition	<b>KQs 1–5:</b> Food insecurity	<b>KQs 1–5:</b> <ul style="list-style-type: none"> <li>• Water insecurity</li> <li>• Other social risk factors (e.g., unemployment, financial strain, housing instability) in the absence of food insecurity</li> </ul>
Populations*	<b>KQs 1–5:</b> All ages <ul style="list-style-type: none"> <li>• Children and their caregivers</li> <li>• Adolescents</li> <li>• Adults</li> <li>• Perinatal, pregnant, and postpartum populations</li> <li>• Older adults and their caregivers</li> <li>• Persons with stable common chronic conditions (e.g., diabetes, hypertension)</li> </ul>	<b>KQs 1–5:</b> <ul style="list-style-type: none"> <li>• Persons with acute medical or psychiatric conditions</li> <li>• Persons undergoing treatment for cancer</li> <li>• Persons with severe malnutrition or nutritional deficiencies</li> </ul>
Assessment	<b>KQs 1–3:</b> Risk assessment or screening for food insecurity using tool that addresses food insecurity with other social risk factors or food insecurity alone	<b>KQs 1–3:</b> <ul style="list-style-type: none"> <li>• Nutrition assessment (anthropometric, biochemical, clinical, or dietary assessment)</li> <li>• Risk assessment or screening tools for social risk factors that do not explicitly address food insecurity</li> </ul>
Interventions	<b>KQs 4, 5:</b> <ul style="list-style-type: none"> <li>• Healthcare-related interventions<sup>†</sup> targeting food insecurity Individual or household-level (e.g., referral to social services, provision of information about resources)</li> <li>• Healthcare system–level (e.g., policies, programs, staff training, primary care collaboration with community services)</li> </ul>	<b>KQs 4, 5:</b> <ul style="list-style-type: none"> <li>• Interventions focused on adherence to dietary recommendations for management of chronic conditions</li> <li>• Public health/community-level policies</li> </ul>
Comparators	<b>KQs 1, 4:</b> Control group (can include historical control, active control/comparator) <sup>§</sup>  <b>KQ 2:</b> Any reference standard  <b>KQs 3, 5:</b> No comparator required if explicitly addresses harms	<b>KQs 1, 4:</b> No control/comparator  <b>KQ 2:</b> No reference standard
Outcomes	<b>KQs 1, 4:</b> <ul style="list-style-type: none"> <li>• Food and nutrition security outcomes</li> <li>• Access to food</li> <li>• Behavioral outcomes (e.g., dietary intake, substance use)</li> <li>• Physiologic outcomes (e.g., blood pressure, hemoglobin A1c, healthy weight gain in pregnancy)</li> <li>• Healthcare-related decision-making outcomes</li> <li>• Healthcare-related patient participation outcomes (e.g., medication compliance, attendance at medical appointments)</li> <li>• Healthcare utilization (e.g., emergency department visits, hospitalization)</li> <li>• Health or surrogate health outcomes (e.g., low birth weight, developmental outcomes in children, incident diabetes, mental health, cardiovascular events, quality of life)</li> </ul> <b>KQ 2:</b> Test accuracy, predictive validity, and discrimination	<b>KQs 1, 4:</b> <ul style="list-style-type: none"> <li>• Knowledge, skills, and self-efficacy outcomes</li> <li>• Provider-level outcomes (e.g., confidence in screening, awareness of resources)</li> <li>• Community-level outcomes (e.g., number of food pantries)</li> <li>• Cost outcomes</li> </ul> <b>KQ 2:</b> Test positivity or test yield only

Category	Include	Exclude
	<b>KQs 3, 5:</b> Any harms or unintended consequences	
Settings	<p><b>KQs 1–5:</b></p> <ul style="list-style-type: none"> <li>Any setting linked with healthcare system (e.g., primary care, behavioral health care, specialty care, emergency department)</li> <li>Conducted in the United States</li> </ul> <p><b>KQs 1–3:</b> Screening conducted in clinical setting or identified through healthcare delivery or payment system (e.g., health plan data)</p> <p><b>KQs 4, 5:</b> Interventions or programs integrated into, associated with, or referred from healthcare</p>	<p><b>KQs 1–5:</b></p> <ul style="list-style-type: none"> <li>No link with healthcare system</li> <li>Conducted outside the United States</li> </ul>
Study designs	<p><b>KQs 1, 4:</b></p> <ul style="list-style-type: none"> <li>Randomized or clinically controlled trials, nonrandomized studies with a contemporaneous control or comparison, quasi-experimental studies (e.g., pre-post studies)</li> <li>Minimum 12-week followup</li> </ul> <p><b>KQ 2:</b> Diagnostic test accuracy or risk assessment studies</p> <p><b>KQs 3, 5:</b> Randomized or clinically controlled trials, nonrandomized studies, and quasi-experimental studies</p>	<p><b>KQs 1, 4:</b> Randomized or clinically controlled trials, nonrandomized studies with less than 12- week followup</p> <p><b>KQ 2:</b> Test performance studies without reference standard</p> <p><b>KQs 3, 5:</b> Case series, case reports, or editorials</p>
Study quality	Fair to good	Poor

\* For all KQs, populations of interest include persons at higher risk for food insecurity (e.g., by age, race and ethnicity, health status, or other social risk factors).

† Healthcare-related interventions are those in which the patient’s food insecurity was identified through healthcare and/or the intervention itself is provided directly via a healthcare system, based within a healthcare system, or delivered in partnership with a healthcare system.

§ Does not apply to pre-post study design.

**Appendix A Table 2. Quality Rating Criteria**

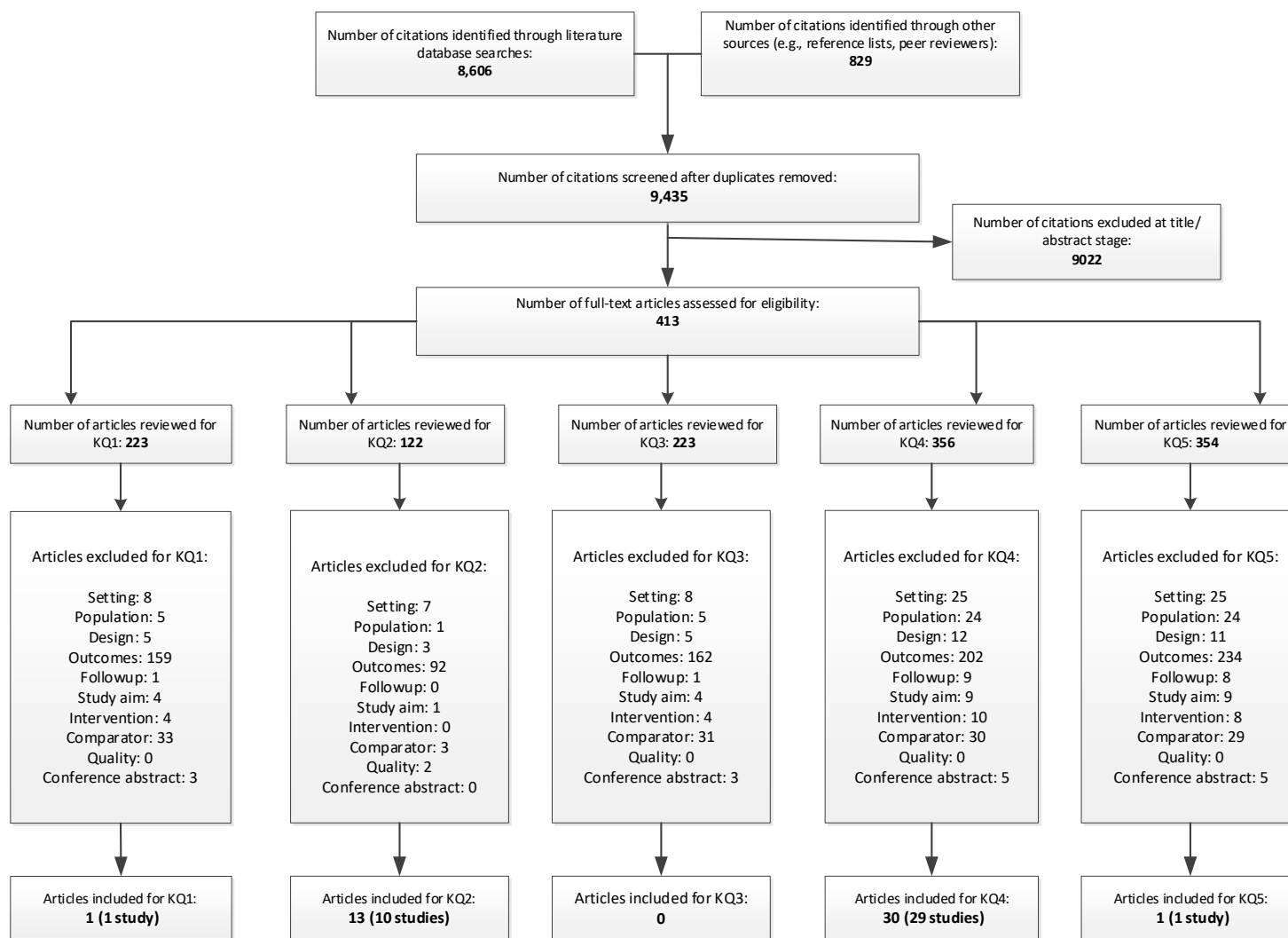
Study Design	Adapted Quality Criteria
<p>Adapted Risk Of Bias In Non-randomised Studies of Interventions (ROBINS-I)<sup>1</sup></p>	<p><b>Bias due to confounding</b></p> <ul style="list-style-type: none"> <li>• No baseline confounding</li> <li>• No time-varying confounding</li> </ul> <p><b>Bias in selecting participants into the study</b></p> <ul style="list-style-type: none"> <li>• No evidence of biased selection of sample</li> <li>• Start of followup and start of intervention coincide</li> </ul> <p><b>Bias in classifying interventions</b></p> <ul style="list-style-type: none"> <li>• Intervention groups are clearly defined</li> <li>• Information used to define intervention groups was recorded at the start of the intervention</li> <li>• Classification of intervention status is unaffected by knowledge of the outcome or risk of the outcome</li> </ul> <p><b>Bias due to deviations from intended interventions</b></p> <ul style="list-style-type: none"> <li>• No deviations from intended intervention</li> <li>• Important co-interventions are balanced across intervention groups</li> <li>• Analysis adjusts for deviations from intended intervention that could have affected outcomes</li> </ul> <p><b>Bias from missing data</b></p> <ul style="list-style-type: none"> <li>• Outcome data are available for all, or nearly all, participants</li> <li>• Proportion of participants and reasons for missing data are similar across groups</li> <li>• Appropriate statistical methods used to account for missing data or there was evidence that results were robust to the presence data</li> </ul> <p><b>Bias in measurement of outcomes</b></p> <ul style="list-style-type: none"> <li>• Blinding of participants</li> <li>• Blinding of outcome assessors</li> <li>• Methods of outcome assessment are comparable across intervention groups</li> <li>• No systematic errors in measurement of the outcome related to intervention received</li> </ul> <p><b>Bias in reporting results selectively</b> No evidence that the measures, analyses, or subgroup analyses are selectively reported</p>
<p>Diagnostic accuracy studies, adapted from the Quality Assessment of Diagnostic Accuracy Studies (QUADAS) II instrument<sup>2</sup></p>	<p><b>Patient Selection</b></p> <ul style="list-style-type: none"> <li>• Was a consecutive or random sample of patients enrolled?</li> <li>• Did the study avoid inappropriate exclusions?</li> </ul> <p><b>Index Test</b></p> <ul style="list-style-type: none"> <li>• Were the index test results interpreted without knowledge of the reference standard results?</li> <li>• If a threshold was used, was it prespecified or was a range of values presented?</li> </ul> <p><b>Reference Standard</b></p> <ul style="list-style-type: none"> <li>• Is the reference standard likely to correctly classify the target condition?</li> <li>• Were the reference standard results interpreted without knowledge of the index test?</li> <li>• Were staff trained in the use of the reference standard?</li> <li>• Was fidelity of the reference standard monitored or reported?</li> </ul>



Study Design	Adapted Quality Criteria
	<p><b>Flow and Timing</b></p> <ul style="list-style-type: none"> <li>• Was there an appropriate interval between the index test and reference standard?</li> <li>• Did all patients receive a reference standard?</li> <li>• Did all patients receive the same reference standard? <ul style="list-style-type: none"> <li>○ Were all patients included in the analysis?</li> </ul> </li> </ul>
<p>Randomized clinical trials, adapted from U.S. Preventive Services Task Force Manual<sup>3</sup></p>	<p><b>Bias arising in the randomization process or due to confounding</b></p> <ul style="list-style-type: none"> <li>• Valid random assignment/random sequence generation method used</li> <li>• Allocation concealed</li> <li>• Balance in baseline characteristics</li> </ul> <p><b>Bias in selecting participants into the study</b></p> <ul style="list-style-type: none"> <li>• CCT only: No evidence of biased selection of sample</li> </ul> <p><b>Bias due to departures from intended interventions</b></p> <ul style="list-style-type: none"> <li>• Fidelity to the intervention protocol</li> <li>• Low risk of contamination between groups</li> <li>• Participants were analyzed as originally allocated</li> </ul> <p><b>Bias from missing data</b></p> <ul style="list-style-type: none"> <li>• No, or minimal, post-randomization exclusions</li> <li>• Outcome data are reasonably complete and comparable between groups</li> <li>• Reasons for missing data are similar across groups</li> <li>• Missing data are unlikely to bias results</li> </ul> <p><b>Bias in measurement of outcomes</b></p> <ul style="list-style-type: none"> <li>• Blinding of outcome assessors</li> <li>• Outcomes are measured using consistent and appropriate procedures and instruments across treatment groups</li> <li>• No evidence of biased use of inferential statistics</li> </ul> <p><b>Bias in reporting results selectively</b></p> <ul style="list-style-type: none"> <li>• No evidence that the measures, analyses, or subgroup analyses are selectively reported</li> </ul>
<p>Pre-Post, adapted from National Heart, Lung, and Blood Institute Study Quality Assessment Tool for Before-After (Pre-Post) Studies With No Control Group<sup>4</sup></p>	<p><b>Critical signaling question (if answered no, then no other questions addressed):</b>  <i>Interrupted Time-Series Design</i>  Were outcome measures of interest taken multiple times before the intervention and multiple times after the intervention (i.e., did they use an interrupted time-series design)?</p> <p><b>Further questions:</b></p> <p>Was the study question or objective clearly stated?</p> <p>Were eligibility/selection criteria for the study population prespecified and clearly described?</p> <p>Were the participants in the study representative of those who would be eligible for the test/service/intervention in the general or clinical population of interest?</p> <p>Were all eligible participants that met the prespecified entry criteria enrolled?</p> <p>Was the sample size sufficiently large to provide confidence in the findings?</p> <p>Was the test/service/intervention clearly described and delivered consistently across the study population?</p> <p>Were the outcome measures prespecified, clearly defined, valid, reliable, and assessed consistently across all study participants?</p> <p>Were the people assessing the outcomes blinded to the participants' exposures/interventions?</p> <p>Was the loss to followup after baseline 20% or less? Were those lost to followup accounted for in the analysis?</p>

Study Design	Adapted Quality Criteria
	<p data-bbox="427 222 1395 306">Did the statistical methods examine changes in outcome measures from before to after the intervention? Were statistical tests done that provided p values for the pre-to-post changes?</p> <p data-bbox="427 331 1344 415">If the intervention was conducted at a group level (e.g., a whole hospital, a community, etc.) did the statistical analysis take into account the use of individual-level data to determine effects at the group level?</p>

## Appendix A Figure 1. Literature Flow Diagram



**Appendix A Figure 2. Quality Assessment Ratings, by Domain, Key Questions 1 and 4**

Study design	Final Quality Rating	Study	Intervention performance bias	Measurement/detection bias	Attrition bias	Sequence generation bias	Selective reporting bias	Selection bias	Classification of interventions bias	Confounding	Interrupted time-series design
RCT	Fair	Lane, 2014	✗	✓	✗	✓	✓	○	○	○	○
Cluster RCT	Poor	Wu, 2019	✗	✗	✓	✓	✗	○	○	○	○
Crossover RCT	Fair	Berkowitz, 2019	✓	✓	✗	✗	✓	○	○	○	○
NRSI	Fair	Woo Baidal, 2023	✓	✓	▲	○	○	✓	✓	▲	○
	Poor	Morales, 2016	✗	✓	✓	○	○	✓	✓	✗	○
		Slagel, 2022	▲	✓	✗	○	○	✓	✓	▲	○
Pre-post	Poor	Aiyer, 2019	○	○	○	○	○	○	○	○	✗
		Berkowitz, 2018	○	○	○	○	○	○	○	○	✗
		Byker Shanks, 2022	○	○	○	○	○	○	○	○	✗
		Cohen, 2017	○	○	○	○	○	○	○	○	✗
		Cook, 2021	○	○	○	○	○	○	○	○	✗
		Fischer, 2022	○	○	○	○	○	○	○	○	✗
		Freedman, 2013	○	○	○	○	○	○	○	○	✗
		Gottlieb, 2018	○	○	○	○	○	○	○	○	✗
		Gottlieb, 2020	○	○	○	○	○	○	○	○	✗
		Hager, 2023	○	○	○	○	○	○	○	○	✗
		Izumi, 2020	○	○	○	○	○	○	○	○	✗
		Jones, 2020	○	○	○	○	○	○	○	○	✗
		Kempainen, 2023	○	○	○	○	○	○	○	○	✗
		Orsega-Smith, 2020	○	○	○	○	○	○	○	○	✗
		Ranjit, 2023	○	○	○	○	○	○	○	○	✗
		Renaud, 2023	○	○	○	○	○	○	○	○	✗
		Rivera, 2023	○	○	○	○	○	○	○	○	✗
		Saxe-Custack, 2019	○	○	○	○	○	○	○	○	✗
		Scher, 2022	○	○	○	○	○	○	○	○	✗
		Seligman, 2015	○	○	○	○	○	○	○	○	✗
Shankar, 2022	○	○	○	○	○	○	○	○	✗		
Singer, 2022	○	○	○	○	○	○	○	○	✗		
Wetherill, 2018	○	○	○	○	○	○	○	○	✗		
Xie, 2021	○	○	○	○	○	○	○	○	○	✗	

Rating  
 ✗ High risk of bias  
 ▲ Moderate risk of bias  
 ✓ Low risk of bias  
 ○ NA

**Note:** Interrupted time-series design indicates multiple observations before and after the intervention; all included studies included only one observation prior to the intervention and one observation after the intervention, which we considered high risk of bias, and were not further evaluated.

**Abbreviations:** RCT=randomized controlled trial; NRSI=nonrandomized studies of interventions

**Appendix A Figure 3. Quality Assessment Ratings, by Domain, Key Question 2**

Final Quality Rating	Study	Patient selection	Index test	Reference standard	Patient flow
Fair	Baer, 2015	▲	✓	✓	✓
	Blumberg, 1999	✓	▲	✓	▲
	Gattu, 2019	▲	✓	✓	✓
	Gundersen, 2017	✓	✓	✓	▲
	Hager, 2010	▲	✓	✓	✓
	Harle, 2023	▲	✓	✓	▲
	Harrison, 2021	▲	✓	✓	✓
	Lane, 2014	✓	✓	✓	▲
	Makelarski, 2017	▲	✓	✓	▲
	Radandt, 2018	▲	✓	✓	✓

**Rating**

▲ Medium

✓ Low

## Appendix B. Included Studies List

1. Aiyer JN, Raber M, Bello RS, et al. A pilot food prescription program promotes produce intake and decreases food insecurity. *Translational Behavioral Medicine*. 2019;9(5):922-30. PMID: 31570927. <http://dx.doi.org/10.1093/tbm/ibz112>
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  - b. Wylie SA, Hassan A, Krull EG, et al. Assessing and referring adolescents' health-related social problems: qualitative evaluation of a novel web-based approach. *J Telemed Telecare*. 2012;18(7):392-8. <http://dx.doi.org/10.1258/jtt.2012.120214>
2. Baer TE, Scherer EA, Fleegler EW, et al. Food Insecurity and the Burden of Health-Related Social Problems in an Urban Youth Population. *J Adolesc Health*. 2015;57(6):601-7. PMID: 26592328. <https://dx.doi.org/10.1016/j.jadohealth.2015.08.013>
3. Berkowitz SA, Delahanty LM, Terranova J, et al. Medically Tailored Meal Delivery for Diabetes Patients with Food Insecurity: a Randomized Cross-over Trial. *J Gen Intern Med*. 2019;34(3):396-404. PMID: 30421335. <https://dx.doi.org/10.1007/s11606-018-4716-z>
4. Berkowitz SA, Hulberg AC, Placzek H, et al. Mechanisms Associated with Clinical Improvement in Interventions That Address Health-Related Social Needs: A Mixed-Methods Analysis. *Popul Health Manag*. 2018. PMID: 30562141. <https://dx.doi.org/10.1089/pop.2018.0162>
5. Blumberg SJ, Bialostosky K, Hamilton WL, et al. The effectiveness of a short form of the Household Food Security Scale. *Am J Public Health*. 1999;89(8):1231-4. PMID: 10432912. <https://dx.doi.org/10.2105/ajph.89.8.1231>
6. Byker Shanks C, Vanderwood K, Grocke M, et al. The UnProcessed Pantry Project (UP3): A Community-Based Intervention Aimed to Reduce Ultra-Processed Food Intake Among Food Pantry Clients. *Fam Community Health*. 2022;45(1):23-33. PMID: 34783688. <https://dx.doi.org/10.1097/FCH.0000000000000310>
7. Cohen AJ, Richardson CR, Heisler M, et al. Increasing Use of a Healthy Food Incentive: A Waiting Room Intervention Among Low-Income Patients. *American journal of preventive medicine*. 2017;52(2):154-62. PMID: 28109458. <https://dx.doi.org/10.1016/j.amepre.2016.11.008>
8. Cook M, Ward R, Newman T, et al. Food Security and Clinical Outcomes of the 2017 Georgia Fruit and Vegetable Prescription Program. *Journal of Nutrition Education and Behavior*. 2021;53(9):770-8. PMID: 34509277. <https://dx.doi.org/10.1016/j.jneb.2021.06.010>
9. Fischer L, Bodrick N, Mackey ER, et al. Feasibility of a Home-Delivery Produce Prescription Program to Address Food Insecurity and Diet Quality in Adults and Children. *Nutrients*. 2022;14(10):10. PMID: 35631144. <https://dx.doi.org/10.3390/nu14102006>
10. Freedman DA, Choi SK, Hurley T, et al. A farmers' market at a federally qualified health center improves fruit and vegetable intake among low-income diabetics. *Prev Med*. 2013;56(5):288-92. PMID: 23384473. <https://dx.doi.org/10.1016/j.yjmed.2013.01.018>
11. Gattu RK, Paik G, Wang Y, et al. The Hunger Vital Sign Identifies Household Food Insecurity among Children in Emergency Departments and Primary Care. *Children (Basel)*. 2019;6(10). PMID: 31581751. <https://dx.doi.org/10.3390/children6100107>

12. Gottlieb L, Hessler D, Long D, et al. Are acute care settings amenable to addressing patient social needs: A sub-group analysis. *The American journal of emergency medicine*. 2018;36(11):2108-9. PMID: 29576258. <https://dx.doi.org/10.1016/j.ajem.2018.03.034>
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15. Hager ER, Quigg AM, Black MM, et al. Development and validity of a 2-item screen to identify families at risk for food insecurity. *Pediatrics*. 2010;126(1):e26-32. PMID: 20595453. <https://dx.doi.org/10.1542/peds.2009-3146>
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21. Kempainen S, Cutts DB, Robinson-O'Brien R, et al. A Collaborative Pilot to Support Patients With Diabetes Through Tailored Food Box Home Delivery. *Health Promot Pract*. 2023;15248399221100792. PMID: 36627767. <https://dx.doi.org/10.1177/15248399221100792>
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32. Seligman HK, Lyles C, Marshall MB, et al. A pilot food bank intervention featuring diabetes-appropriate food improved glycemic control among clients in three states. *Health affairs (Project Hope).* 2015;34(11):1956-63. PMID: 26526255. <https://dx.doi.org/10.1377/hlthaff.2015.0641>
33. Shankar KN, Dugas JN, Flacks J, et al. High touch, high trust: Using community health advocates and lawyers to address ED high utilizers. *American Journal of Emergency Medicine.* 2022;60:171-6. PMID: 36037733. <https://dx.doi.org/10.1016/j.ajem.2022.07.049>
34. Singer C, Porta C. Improving patient well-being in the United States through care coordination interventions informed by social determinants of health. *Health Soc Care Community.* 2022;17:17. PMID: 35301764. <https://dx.doi.org/10.1111/hsc.13776>
35. Slagel N, Newman T, Sanville L, et al. Effects of a Fruit and Vegetable Prescription Program With Expanded Education for Low-Income Adults. *Health Education & Behavior*2022. p. 849-60. PMID: 35535592. <https://dx.doi.org/10.1177/10901981221091926>
36. Wetherill MS, Chancellor McIntosh H, Beachy C, et al. Design and Implementation of a Clinic-Based Food Pharmacy for Food Insecure, Uninsured Patients to Support Chronic Disease Self-Management. *J Nutr Educ Behav.* 2018;50(9):947-9. PMID: 30064811. <https://dx.doi.org/10.1016/j.jneb.2018.05.014>
37. Woo Baidal JA, Duong N, Goldsmith J, et al. Association of a primary care-based mobile food pantry with child body mass index: A propensity score matched cohort study. *Pediatric Obesity.* 2023;18(6):e13023. PMID: 36939408. <https://dx.doi.org/10.1111/ijpo.13023>



38. Wu AW, Weston CM, Ibe CA, et al. The Baltimore Community-Based Organizations Neighborhood Network: Enhancing Capacity Together (CONNECT) Cluster RCT. *American journal of preventive medicine*. 2019;57(2):e31-e41. PMID: 31248746. <https://dx.doi.org/10.1016/j.amepre.2019.03.013>
39. Xie J, Price A, Curran N, et al. The impact of a produce prescription programme on healthy food purchasing and diabetes-related health outcomes. *Public Health Nutr*. 2021/04/28 ed2021. p. 3945-55. PMID: 33902771. <https://dx.doi.org/10.1017/s1368980021001828>

## Appendix C. Excluded Studies List

Reason for Exclusion
E1. Setting
E1a: Study conducted outside the US
E1b: No link with healthcare system
E2. Population
E2a. % of population food insecure <50% or not reported
E3. Study design
E4. No relevant outcomes
E4a. Multidomain/multicomponent study without food insecurity outcome
E4b. <12 weeks followup
E5. Study aim
E6. Intervention
E7. Comparator
E7a: No control/comparator (KQ1 and KQ4)
E7b: No reference standard (KQ2 only)
E8. Language: not in English
E9. Poor study quality
E10. Unable to locate article
E11. Publication type: Conference abstract only

- Abel, Dori, Drucker, Gabriela, et al. Assessment of a Fruit and Vegetable Prescription Program in the Northern Manhattan Community. *American Journal of Health Promotion*. 36(6): 1014-1018. 2022. <https://dx.doi.org/10.1177/08901171221076778> **KQ4E4, KQ5E4**
- Ackermann, RT, Liss, DT, et al. A randomized comparative effectiveness trial of a primary care-community linkage for preventing type 2 diabetes. *Journal of general internal medicine*. 30: S88-S89. 2015. **KQ4E6, KQ5E6**
- Adams, E, Hargunani, D, et al. Screening for Food Insecurity in Pediatric Primary Care: A Clinic's Positive Implementation Experiences. *J Health Care Poor Underserved*. 28(1): 24-29. 2017. <https://dx.doi.org/10.1353/hpu.2017.0004> **KQ2E4**
- Agarwal, Gina, Pirrie, Melissa, et al. Legal needs of patients attending an urban family practice in Hamilton, Ontario, Canada: an observational study of a legal health clinic. *BMC Fam Pract*. 21(1). 2020. **KQ1E7, KQ3E7, KQ4E7, KQ5E7**
- Akiya, K, Fisher, E, et al. Aligning Health Care and Social Services to Reduce Hospitalizations and Emergency Department Visits: An Evaluation of the Community Care Connections Program. *Med Care*. 59(8): 671-678. 2021. PMID: 34054026. <https://dx.doi.org/10.1097/mlr.0000000000001578> **KQ1E4a, KQ3E4a, KQ4E4a, KQ5E4a**
- Amezquita, Lillian, George, Paul. Food insecurity: how to recognize and address it. *J Fam Pract*. 69(2): 74;78;80;81. 2020. **KQ1E3, KQ2E3, KQ3E3, KQ4E3, KQ5E3**
- Anderson, Della, Patch, Enedina, et al. Nursing student coaches for emergency department super utilizers. *J Nurs Educ*. 56(1): 27-30. 2017. **KQ4E4a, KQ5E4a**
- Arbour, Mary Catherine, Floyd, Baraka, et al. Cross-Sector Approach Expands Screening and Addresses Health-Related Social Needs in

- Primary Care. *Pediatrics*. 148(5). 2021. <https://dx.doi.org/10.1542/peds.2021-050152> **KQ1E4, KQ3E4, KQ4E4, KQ5E4**
9. Arbour, MaryCatherine, Fico, Placidina, et al. Benefits of a Universal Intervention in Pediatric Medical Homes to Identify and Address Health-Related Social Needs: An Observational Cohort Study. *Acad Pediatr*. 18: 18. 2022. <https://dx.doi.org/10.1016/j.acap.2022.06.013> **KQ1E4a, KQ3E4a, KQ4E4a, KQ5E4a**
  10. Arevian, Ac, Jones, F, et al. Depression Remission From Community Coalitions Versus Individual Program Support for Services: findings From Community Partners in Care, Los Angeles, California, 2010-2016. *Am J Public Health*. 109(S3): S205-s213. 2019. PMID: 31242001. <https://dx.doi.org/10.2105/AJPH.2019.305082> **KQ4E4a, KQ5E4a**
  11. Bailey-Davis, L, Moore, Am, et al. Comparing enhancements to well-child visits in the prevention of obesity: ENCIRCLE cluster-randomized controlled trial. *BMC Public Health*. 22(1): 2429. 2022. <https://dx.doi.org/10.1186/s12889-022-14827-w> **KQ4E6, KQ5E6**
  12. Bakre, S, Shea, B, et al. Changes in Food Insecurity Among Individuals Using a Telehealth and Nutrition Platform: Longitudinal Study. *JMIR Formative Research*. 6(10): e41418. 2022. PMID: 36282563. <https://dx.doi.org/10.2196/41418> **KQ4E6, KQ5E4**
  13. Bakshi, S, Carlson, LC, et al. Improving care coordination and reducing ED utilization through patient navigation. *Am J Manag Care*. 28(5): 201-206. 2022. PMID: 35546582. <https://dx.doi.org/10.37765/ajmc.2022.89140> **KQ1E4a, KQ3E4a, KQ4E4a, KQ5E4a**
  14. Barcelos Winchester, Suzy. Social Determinants of Health Assessment Tool: Implications for Healthcare Practice. *Soc Work Public Health*. 34(5): 395-408. 2019. <https://dx.doi.org/10.1080/19371918.2019.1614507> **KQ2E4**
  15. Barnidge, E, LaBarge, G, et al. Screening for Food Insecurity in Pediatric Clinical Settings: Opportunities and Barriers. *J Community Health*. 42(1): 51-57. 2017. <https://dx.doi.org/10.1007/s10900-016-0229-z> , **KQ3E4**
  16. Bayoumi, Imaan, Birken, CatherineS, et al. Screening for marginal food security in young children in primary care. *BMC Pediatr*. 21(1): 196. 2021. <https://dx.doi.org/10.1186/s12887-021-02674-4> **KQ1E1a, KQ2E1a, KQ3E1a, KQ4E1a, KQ5E1a**
  17. Bazos, DA, Weeks, WB, et al. The development of a survey instrument for community health improvement. *Health Serv Res*. 36(4): 773-92. 2001. **KQ1E4, KQ3E4**
  18. Beavis, Anna Louise, Sanneh, Awa, et al. Basic social resource needs screening in the gynecologic oncology clinic: a quality improvement initiative. *Am J Obstet Gynecol*. 223(5): 735.e1-735.e14. 2020. **KQ1E4, KQ3E4, KQ4E4, KQ5E4**
  19. Bechtel, Nancie, Jones, Alexandria, et al. Evaluation of the core 5 social determinants of health screening tool. *Public Health Nurs*. 39(2): 438-445. 2022.

- <https://dx.doi.org/10.1111/phn.12983>  
**KQ1E4a, KQ3E4a, KQ4E4a, KQ5E4a**
20. Beck, AF, Henize, AW, et al. Forging a pediatric primary care-community partnership to support food-insecure families. *Pediatrics*. 134(2): e564-71. 2014.  
<https://dx.doi.org/10.1542/peds.2013-3845> **KQ4E4a, KQ5E4a**
  21. Beck, AF, Klein, MD, et al. Identifying and treating a substandard housing cluster using a medical-legal partnership. *Pediatrics*. 130(5): 831-8. 2012.  
<https://dx.doi.org/10.1542/peds.2012-0769> **KQ1E4a, KQ3E4a, KQ4E4a, KQ5E4a**
  22. Beck, AF, Klein, MD, et al. Identifying social risk via a clinical social history embedded in the electronic health record. *Clin Pediatr (Phila)*. 51(10): 972-7. 2012.  
<https://dx.doi.org/10.1177/0009922812441663> **KQ1E4, KQ3E4**
  23. Berkowitz, SA, Basu, S, et al. Eliminating Food Insecurity in the USA: a Target Trial Emulation Using Observational Data to Estimate Effects on Health-Related Quality of Life. *J Gen Intern Med*. 38(10): 2308-2317. 2023. PMID: 36814050.  
<https://dx.doi.org/10.1007/s11606-023-08095-6> **KQ1E3, KQ3E3, KQ4E3, KQ5E3**
  24. Berkowitz, SA, Hulberg, AC, et al. Addressing basic resource needs to improve primary care quality: a community collaboration programme. *BMJ Qual Saf*. 25(3): 164-72. 2016.  
<https://dx.doi.org/10.1136/bmjqs-2015-004521> **KQ1E4a, KQ3E4a, KQ4E4a, KQ5E4a**
  25. Berkowitz, SA, Hulberg, AC, et al. Addressing Unmet Basic Resource Needs as Part of Chronic Cardiometabolic Disease Management. *JAMA Intern Med*. 177(2): 244-252. 2017.  
<https://dx.doi.org/10.1001/jamainternmed.2016.7691> **KQ1E4a, KQ3E4a, KQ4E4a, KQ5E4a**
  26. Berkowitz, SA, O'Neill, J, et al. Health Center-Based Community-Supported Agriculture: An RCT. *Am J Prev Med*. 57(6 Suppl 1): S55-S64. 2019. PMID: 31522922.  
<https://dx.doi.org/10.1016/j.amepre.2019.07.015> **KQ4E2a, KQ5E2a**
  27. Berkowitz, SA, Terranova, J, et al. Association Between Receipt of a Medically Tailored Meal Program and Health Care Use. *JAMA Intern Med*. 179(6):786-783. 2019.  
<https://dx.doi.org/10.1001/jamainternmed.2019.0198> **KQ1E2, KQ3E2, KQ4E2, KQ5E2**
  28. Berkowitz, SA, Terranova, J, et al. Meal Delivery Programs Reduce The Use Of Costly Health Care In Dually Eligible Medicare And Medicaid Beneficiaries. *Health Aff (Millwood)*. 37(4): 535-542. 2018.  
<https://dx.doi.org/10.1377/hlthaff.2017.0999> **KQ4E3, KQ5E3**
  29. Bikson, K, McGuire, J, et al. Psychosocial problems in primary care: patient and provider perceptions. *Soc Work Health Care*. 48(8): 736-49. 2009.  
<https://dx.doi.org/10.1080/00981380902929057> **KQ1E4, KQ3E4, KQ4E4, KQ5E4**
  30. Billioux, A, Verlander, K, et al. Standardized screening for health-related social needs in clinical settings:

- The accountable health communities screening tool. 2017. **KQ1E4, KQ3E4**
31. Birkhead, GS, LeBaron, CW, et al. The immunization of children enrolled in the Special Supplemental Food Program for Women, Infants, and Children (WIC). The impact of different strategies. *Jama*. 274(4): 312-6. 1995. PMID: 7609260. **KQ1E4a, KQ3E4a, KQ4E4a, KQ5E4a**
  32. Blancafort Alias, Sergi, Monteserin Nadal, Rosa, et al. Promoting social capital, self-management and health literacy in older adults through a group-based intervention delivered in low-income urban areas: results of the randomized trial AEQUALIS. *BMC Public Health*. 21(1): 84. 2021. <https://dx.doi.org/10.1186/s12889-020-10094-9> **KQ1E1a, KQ2E1a, KQ3E1a, KQ4E1a, KQ5E1a**
  33. Blitstein, JL, Lazar, D, et al. Foods for Health: An Integrated Social Medical Approach to Food Insecurity Among Patients With Diabetes. *Am J Health Promot*. 35(3): 369-376. 2021. PMID: 33043687. <https://dx.doi.org/10.1177/0890117120964144> **KQ4E2a, KQ5E2a**
  34. Borden, CG, Ashe, EM, et al. A novel pharmacy liaison program to address health-related social needs at an urban safety-net hospital. *Am J Health Syst Pharm*. 80(16): 1071-1081. 2023. PMID: 37210728. <https://dx.doi.org/10.1093/ajhp/zxad113> **KQ4E4a, KQ5E4a**
  35. Bottino, CJ, Rhodes, ET, et al. Food Insecurity Screening in Pediatric Primary Care: Can Offering Referrals Help Identify Families in Need?. *Acad Pediatr*. 17(5): 497-503. 2017. <https://dx.doi.org/10.1016/j.acap.2016.10.006> **KQ1E4, KQ3E4, KQ4E4, KQ5E4**
  36. Bourgois, P, Holmes, SM, et al. Structural Vulnerability: Operationalizing the Concept to Address Health Disparities in Clinical Care. *Acad Med*. 92(3): 299-307. 2017. <https://dx.doi.org/10.1097/ACM.0000000000001294> **KQ1E4, KQ3E4**
  37. Briefel, RonetteR, Chojnacki, GregoryJ, et al. A Cluster Randomized Controlled Trial of a Home-Delivered Food Box on Food Security in Chickasaw Nation. *J Acad Nutr Diet*. 121(1S): S46-S58. 2021. <https://dx.doi.org/10.1016/j.jand.2020.07.021> **KQ4E1b, KQ5E1b**
  38. Brown, AF, Behforouz, H, et al. The care connections program: a randomized trial of community health workers to improve care for medically and socially complex patients. *J Gen Intern Med*. 35(SUPPL 1): S288-. 2020. <https://dx.doi.org/10.1007/s11606-020-05890-3> **KQ4E4, KQ5E4**
  39. Brown, E, Bloom, JR. The nurse practitioner and hypertension control: a pilot study. *Eval Health Prof*. 2(1): 87-99. 1979. **KQ4E4a, KQ5E4a**
  40. Brown, Onikia, Mukigi, Dorcas. O9 A Text-Delivered Intervention to Improve Dietary Habits, Stress Management Behaviors and Create Awareness of Food Assistance Resources Among College Students. Society for Nutrition Education and Behavior, 52nd Annual Conference, Nutrition Education: Rooted in Food, July 27-30, 2019, Orlando, Florida. *J Nutr Educ Behav*. 51: S4-S5. 2019. <https://dx.doi.org/10.1016/j.jneb.2019.>

- 05.315 **KQ1E11, KQ3E11, KQ4E11, KQ5E11**
41. Brown, Rachel, Reilly, Georgia, et al. Farm to Families: Clinic-based Produce Provision to Address Food Insecurity During the Pandemic. *Pediatrics*. 150(4): 01. 2022. <https://dx.doi.org/10.1542/peds.2022-057118> **KQ4E4, KQ5E4**
  42. Bryce, R, Guajardo, C, et al. Participation in a farmers' market fruit and vegetable prescription program at a federally qualified health center improves hemoglobin A1C in low income uncontrolled diabetics. *Prev Med Rep*. 7: 176-179. 2017. PMID: 28702315. <https://dx.doi.org/10.1016/j.pmedr.2017.06.006> **KQ1E4a, KQ3E4a, KQ4E4a, KQ5E4a**
  43. Buchanan, D, Doblin, B, et al. The effects of respite care for homeless patients: a cohort study. *Am J Public Health*. 96(7): 1278-81. 2006. <https://dx.doi.org/10.2105/ajph.2005.067850> **KQ1E4a, KQ3E4a, KQ4E4a, KQ5E4a**
  44. Buitron de la Vega, P, Losi, S, et al. Implementing an EHR-based Screening and Referral System to Address Social Determinants of Health in Primary Care. *Med Care*. 57 Suppl 6 Suppl 2: S133-s139. 2019. <https://dx.doi.org/10.1097/mlr.0000000000001029> **KQ1E7, KQ3E7, KQ4E7, KQ5E7**
  45. Burkhardt, MC, Beck, AF, et al. Enhancing accurate identification of food insecurity using quality-improvement techniques. *Pediatrics*. 129(2): e504-10. 2012. <https://dx.doi.org/10.1542/peds.2011-1153> **KQ1E4, KQ3E4, KQ4E4, KQ5E4**
  46. Burnam, MA, Morton, SC, et al. An experimental evaluation of residential and nonresidential treatment for dually diagnosed homeless adults. *J Addict Dis*. 14(4): 111-34. 1995. PMID: 8929936. [https://dx.doi.org/10.1300/j069v14n04\\_07](https://dx.doi.org/10.1300/j069v14n04_07) **KQ1E4a, KQ3E4a, KQ4E4a, KQ5E4a**
  47. Burrington, ChristineM, Hohensee, ThomasE, et al. A pilot study of an online produce market combined with a fruit and vegetable prescription program for rural families. *Preventive Medicine Reports*. 17: 101035. 2020. <https://dx.doi.org/10.1016/j.pmedr.2019.101035> **KQ4E5, KQ5E5**
  48. Byhoff, Elena, Guardado, Rubeen, et al. A Community Partnership to Reduce Food Insecurity and Improve Patient-Reported Depression. *NEJM Catalyst Innovations in Care Delivery*. 4(2): 1-11. 2023. <https://dx.doi.org/10.1056/CAT.22.0330> **KQ4E2a, KQ5E2a**
  49. Caldwell, JuliaI, Kuo, Tony, et al. Health Behavior Changes Among Adults in the Supplemental Nutrition Assistance Program Education, Los Angeles County, California. *Prev Chronic Dis*. 18: E102. 2021. <https://dx.doi.org/10.5888/pcd18.210221> **KQ4E1b, KQ5E1b**
  50. Calloway, EE, Carpenter, LR, et al. Development of three new multidimensional measures to assess household food insecurity resilience in the United States. *Frontiers in Public Health*. 10: 1048501. 2022. PMID: 36589949. <https://dx.doi.org/10.3389/fpubh.2022.1048501> **KQ2E4**
  51. Calloway, EE, Carpenter, LR, et al. New measures to assess the "Other"

- three pillars of food security-availability, utilization, and stability. *International Journal of Behavioral Nutrition & Physical Activity*. 20(1): 51. 2023. PMID: 37101157. <https://dx.doi.org/10.1186/s12966-023-01451-z> **KQ2E4**
52. Calloway, EricE, Carpenter, LeahR, et al. Development of new measures to assess household nutrition security, and choice in dietary characteristics. *Appetite*. 179: 106288. 2022. <https://dx.doi.org/10.1016/j.appet.2022.106288> **KQ2E4**
53. Calvo-Friedman, Alessandra, Clapp, Jenifer, et al. Scaling Primary Care Social Needs Screening and Referrals in New York City's Safety-Net Health System. *NEJM Catalyst Innovations in Care Delivery*. 4(3): CAT. 22.0371. 2023. **KQ1E4, KQ3E4, KQ4E4, KQ5E4**
54. Chagin, Kevin, Choate, Franklin, et al. A Framework for Evaluating Social Determinants of Health Screening and Referrals for Assistance. *J Prim Care Community Health*. : 1-8. 2021. <https://dx.doi.org/10.1177/21501327211052204> **KQ1E4, KQ3E4, KQ4E4, KQ5E4**
55. Chase, J, Bilinski, J, et al. Caring for Emergency Department Patients With Complex Medical, Behavioral Health, and Social Needs. *JAMA*. 324(24): 2550-2551. 2020. PMID: 33351045. <https://dx.doi.org/10.1001/jama.2020.17017> **KQ1E4a, KQ3E4a, KQ4E4a, KQ5E4a**
56. Chatterjee, Avik, Brown, Rory, et al. "Feastworthy is Something That Gives Us Our Dignity Back:" Feasibility of A Delivered Prepared Meal Program for Families in Motel-Shelters. *J Health Care Poor Underserved*. 29(4): 1333-1355. 2018. <https://dx.doi.org/10.1353/hpu.2018.0099> **KQ4E1b, KQ5E1b**
57. Cho, Jinmyoung, Marishak-Simon, Sherry, et al. The impact of a nutrition counseling program on the use of hospital services for Meals on Wheels clients. *J Prev Interv Community*. 51(3): 225-237. 2023. <https://dx.doi.org/10.1080/10852352.2021.1930818> **KQ1E7a, KQ3E7a, KQ4E4, KQ5E4**
58. Ciaranello, AL, Molitor, F, et al. Providing health care services to the formerly homeless: a quasi-experimental evaluation. *J Health Care Poor Underserved*. 17(2): 441-61. 2006. PMID: 16702726. <https://dx.doi.org/10.1353/hpu.2006.0056> **KQ1E4a, KQ3E4a, KQ4E4a, KQ5E4a**
59. Clark, CR, Baril, N, et al. Addressing social determinants of health to improve access to early breast cancer detection: results of the Boston REACH 2010 Breast and Cervical Cancer Coalition Women's Health Demonstration Project. *Journal of Women's Health*. 18(5): 677-90. 2009. <https://dx.doi.org/10.1089/jwh.2008.0972> **KQ1E7a, KQ3E7a, KQ4E7a, KQ5E7a**
60. Clark, CR, Baril, N, et al. Case management intervention in cervical cancer prevention: the Boston REACH coalition women's health demonstration project. *Prog Community Health Partnersh*. 5(3): 235-47. 2011. <https://dx.doi.org/10.1353/cpr.2011.0034> **KQ1E4, KQ3E4, KQ4E4, KQ5E4**

61. Clerkin, KirstenD, Pohl, CarlaJ, et al. Influencing nutritional habits of college students using a food pantry. *Journal of American College Health*. 69(8): 937-941. 2021. <https://dx.doi.org/10.1080/07448481.2020.1721506> **KQ4E1b, KQ5E1b**
62. Cohen, DA, Estrada, EL, et al. Food prescription pilots: feasibility, acceptability and affordability of improving diet through menu planning and grocery delivery. *J Hum Nutr Diet*. 36(4): 1556-1563. 2023. PMID: 36653939. <https://dx.doi.org/10.1111/jhn.13142> **KQ4E4, KQ5E4**
63. Cohen-Silver, J, Adams, S, et al. Development of the Pediatric Social Risk Instrument Using a Structured Panel Approach. *Clin Pediatr (Phila)*. 57(12): 1414-1422. 2018. PMID: 30003793. <https://dx.doi.org/10.1177/0009922818784959> **KQ2E4**
64. Colvin, JD, Bettenhausen, JL, et al. Caregiver Opinion of In-Hospital Screening for Unmet Social Needs by Pediatric Residents. *Acad Pediatr*. 16(2): 161-7. 2016. <https://dx.doi.org/10.1016/j.acap.2015.06.002> **KQ1E4, KQ3E4**
65. Colvin, JD, Bettenhausen, JL, et al. Multiple Behavior Change Intervention to Improve Detection of Unmet Social Needs and Resulting Resource Referrals. *Acad Pediatr*. 16(2): 168-74. 2016. <https://dx.doi.org/10.1016/j.acap.2015.06.001> **KQ1E4, KQ3E4**
66. Cook, CA, Freedman, JA, et al. Screening for social and environmental problems in a VA primary care setting. *Health Soc Work*. 21(1): 41-7. 1996. <https://dx.doi.org/10.1093/hsw/21.1.41> **KQ1E4, KQ3E4, KQ4E4, KQ5E4**
67. Cook, M, Taylor, K, et al. Participation in the Georgia Food for Health program and cardiovascular disease risk factors: A longitudinal observational study. *Public Health Nutr*. : 1-30. 2023. PMID: 37548244. <https://dx.doi.org/10.1017/S1368980023001611> **KQ4E4, KQ5E4**
68. Corey, JenelleR, Courts, KellyA, et al. Understanding Caregiver Perspective on Social Determinants of Health Interventions in Pediatric Primary Care. *Popul Health Manag*. 25(2): 172-177. 2022. <https://dx.doi.org/10.1089/pop.2021.0317> **KQ4E4b, KQ5E4b**
69. Corney, RH. The effectiveness of attached social workers in the management of depressed female patients in general practice. *Psychological Medicine - Monograph Supplement*. 6: 1-47. 1984. **KQ4E6**
70. Costich, MA, Peretz, PJ, et al. Impact of a Community Health Worker Program to Support Caregivers of Children With Special Health Care Needs and Address Social Determinants of Health. *Clin Pediatr (Phila)*: 9922819851263. 2019. <https://dx.doi.org/10.1177/0009922819851263> **KQ1E2, KQ3E2, KQ4E2, KQ5E2**
71. Crichton, EmmaS, Manhan, AndrewJ, et al. The Potential Impact of Food Insecurity in an Urban Trauma Population. *Am Surg*. 88(8): 2045-2049. 2022. <https://dx.doi.org/10.1177/00031348221094217> **KQ2E7b**
72. Cueva, Katie, Lovato, Ventura, et al. Increasing Healthy Food Availability, Purchasing, and Consumption:



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## Appendix D. Additional Evidence Tables

Appendix D Table 1. Results, Key Question 2

Study	Screener	Group	Reference Standard	Independence of screener*	Sensitivity (95% CI)	Specificity (95% CI)
Lane, 2014 <sup>5</sup>	HFSS-1	All	HFSS-18	Administered independently	0.59 (NR to NR)	0.87 (NR to NR)
Makelarski, 2017 <sup>6</sup>	HFSS-2 (AAP)	All	HFSS-6	Partially embedded	0.76 (0.65 to 0.85)	0.93 (0.85 to 0.97)
Makelarski, 2017 <sup>6</sup>	HFSS-2 (AAP)	Households with children	HFSS-6	Partially embedded	0.78 (0.61 to 0.9)	NR (NR to NR)
Makelarski, 2017 <sup>6</sup>	HFSS-2 (AAP)	Households without children	HFSS-6	Partially embedded	0.71 (0.52 to 0.86)	NR (NR to NR)
Gattu, 2019 <sup>7</sup>	HFSS-2 (HVS)	All	HFSS-18	Fully embedded	0.97 (0.96 to 0.98)	0.86 (0.85 to 0.87)
Gundersen, 2017 <sup>8</sup>	HFSS-2 (HVS)	All	HFSS-18	Fully embedded	0.97 (NR to NR)	0.93 (NR to NR)
Hager, 2010 <sup>9</sup>	HFSS-2 (HVS)	All	HFSS-18	Fully embedded	0.97 (0.96 to 0.97)	0.83 (0.82 to 0.83)
Harrison, 2021 <sup>10</sup>	HFSS-2 (HVS)	All	HFSS-18	Fully embedded	0.98 (0.94 to 1)	0.91 (0.87 to 0.94)
Harle, 2023 <sup>11</sup>	HFSS-2 (HVS)	All	HFSS-6	Asked in different sections of same larger questionnaire	0.95 (0.91 to 0.97)	0.93 (0.91 to 0.95)
Makelarski, 2017 <sup>6</sup>	HFSS-2 (HVS)	All	HFSS-6	Partially embedded	0.94 (0.86 to 0.98)	0.82 (0.72 to 0.9)
Radandt, 2018 <sup>12</sup>	HFSS-2 (HVS)	All	HFSS-6	Fully embedded	0.95 (0.85 to 0.99)	0.84 (0.75 to 0.9)
Baer, 2015 <sup>13</sup>	HFSS-2 (HVS)	All	USDS-FSS	Fully embedded	0.88 (0.82 to 0.93)	0.84 (0.79 to 0.88)
Gundersen, 2017 <sup>8</sup>	HFSS-2 (HVS)	Households with children	HFSS-18	Fully embedded	0.97 (NR to NR)	0.9 (NR to NR)
Makelarski, 2017 <sup>6</sup>	HFSS-2 (HVS)	Households with children	HFSS-6	Partially embedded	0.94 (0.81 to 0.99)	NR (NR to NR)
Makelarski, 2017 <sup>6</sup>	HFSS-2 (HVS)	Households without children	HFSS-6	Partially embedded	0.94 (0.79 to 0.99)	NR (NR to NR)
Gundersen, 2017 <sup>8</sup>	HFSS-2 (HVS)	Households with respondent age >60 years	HFSS-18	Fully embedded	0.97 (NR to NR)	0.94 (NR to NR)
Gundersen, 2017 <sup>8</sup>	HFSS-2 (HVS)	Black respondent	HFSS-18	Fully embedded	0.98 (NR to NR)	0.86 (NR to NR)

Study	Screener	Group	Reference Standard	Independence of screener*	Sensitivity (95% CI)	Specificity (95% CI)
Gundersen, 2017 <sup>8</sup>	HFSS-2 (HVS)	Hispanic respondent	HFSS-18	Fully embedded	0.98 (NR to NR)	0.87 (NR to NR)
Gundersen, 2017 <sup>8</sup>	HFSS-2 (HVS)	Everyone in household speaks Spanish	HFSS-18	Fully embedded	0.97 (NR to NR)	0.82 (NR to NR)
Gundersen, 2017 <sup>8</sup>	HFSS-2 (HVS)	Respondent is an immigrant	HFSS-18	Fully embedded	0.97 (NR to NR)	0.9 (NR to NR)
Gundersen, 2017 <sup>8</sup>	HFSS-2 (HVS)	Respondent has a disability	HFSS-18	Fully embedded	0.98 (NR to NR)	0.87 (NR to NR)
Gundersen, 2017 <sup>8</sup>	HFSS-2 (HVS)	Incomes <100% of FPL	HFSS-18	Fully embedded	0.98 (NR to NR)	0.8 (NR to NR)
Gundersen, 2017 <sup>8</sup>	HFSS-2 (HVS)	Incomes <200% of FPL	HFSS-18	Fully embedded	0.98 (NR to NR)	0.84 (NR to NR)
Blumberg, 1999 <sup>14</sup>	HFSS-6	All	HFSS-18	Fully embedded	0.92 (NR to NR)	0.99 (NR to NR)
Blumberg, 1999 <sup>14</sup>	HFSS-6	Households with children	HFSS-18	Fully embedded	0.86 (NR to NR)	1 (NR to NR)
Blumberg, 1999 <sup>14</sup>	HFSS-6	Households without children	HFSS-18	Fully embedded	1 (NR to NR)	0.99 (NR to NR)
Gundersen, 2017 <sup>8</sup>	Items 1 & 3	All	HFSS-18	Fully embedded	0.99 (NR to NR)	0.91 (NR to NR)
Gundersen, 2017 <sup>8</sup>	Items 1 & 3	Households with children	HFSS-18	Fully embedded	0.99 (NR to NR)	0.9 (NR to NR)
Gundersen, 2017 <sup>8</sup>	Items 1 & 3	Households with respondent age >60 years	HFSS-18	Fully embedded	0.99 (NR to NR)	0.93 (NR to NR)
Gundersen, 2017 <sup>8</sup>	Items 1 & 3	Black respondent	HFSS-18	Fully embedded	0.99 (NR to NR)	0.86 (NR to NR)
Gundersen, 2017 <sup>8</sup>	Items 1 & 3	Hispanic respondent	HFSS-18	Fully embedded	0.99 (NR to NR)	0.85 (NR to NR)
Gundersen, 2017 <sup>8</sup>	Items 1 & 3	Everyone in household speaks Spanish	HFSS-18	Fully embedded	1 (NR to NR)	0.78 (NR to NR)
Gundersen, 2017 <sup>8</sup>	Items 1 & 3	Respondent is an immigrant	HFSS-18	Fully embedded	0.99 (NR to NR)	0.89 (NR to NR)
Gundersen, 2017 <sup>8</sup>	Items 1 & 3	Respondent has a disability	HFSS-18	Fully embedded	0.99 (NR to NR)	0.85 (NR to NR)
Gundersen, 2017 <sup>8</sup>	Items 1 & 3	Incomes <100% of FPL	HFSS-18	Fully embedded	0.99 (NR to NR)	0.78 (NR to NR)
Gundersen, 2017 <sup>8</sup>	Items 1 & 3	Incomes <200% of FPL	HFSS-18	Fully embedded	0.99 (NR to NR)	0.82 (NR to NR)
Gundersen, 2017 <sup>8</sup>	Items 2 & 3	All	HFSS-18	Fully embedded	0.97 (NR to NR)	0.94 (NR to NR)
Gundersen, 2017 <sup>8</sup>	Items 2 & 3	Households with children	HFSS-18	Fully embedded	0.97 (NR to NR)	0.9 (NR to NR)
Gundersen, 2017 <sup>8</sup>	Items 2 & 3	Households with respondent age >60 years	HFSS-18	Fully embedded	0.98 (NR to NR)	0.94 (NR to NR)
Gundersen, 2017 <sup>8</sup>	Items 2 & 3	Black respondent	HFSS-18	Fully embedded	0.97 (NR to NR)	0.89 (NR to NR)
Gundersen, 2017 <sup>8</sup>	Items 2 & 3	Hispanic respondent	HFSS-18	Fully embedded	0.96 (NR to NR)	0.89 (NR to NR)
Gundersen, 2017 <sup>8</sup>	Items 2 & 3	Everyone in household speaks Spanish	HFSS-18	Fully embedded	0.97 (NR to NR)	0.85 (NR to NR)

Study	Screener	Group	Reference Standard	Independence of screener*	Sensitivity (95% CI)	Specificity (95% CI)
Gundersen, 2017 <sup>8</sup>	Items 2 & 3	Respondent is an immigrant	HFSS-18	Fully embedded	0.97 (NR to NR)	0.92 (NR to NR)
Gundersen, 2017 <sup>8</sup>	Items 2 & 3	Respondent has a disability	HFSS-18	Fully embedded	0.98 (NR to NR)	0.88 (NR to NR)
Gundersen, 2017 <sup>8</sup>	Items 2 & 3	Incomes <100% of FPL	HFSS-18	Fully embedded	0.98 (NR to NR)	0.83 (NR to NR)
Gundersen, 2017 <sup>8</sup>	Items 2 & 3	Incomes <200% of FPL	HFSS-18	Fully embedded	0.98 (NR to NR)	0.86 (NR to NR)

**Abbreviations:** AAP=American Academy of Pediatrics; CI=confidence interval; FPL=federal poverty line; HFSS=Household Food Security Survey; HVS=Hunger Vital Sign; NR=not reported

\* Fully embedded: all items in the screener were administered as part of the reference standard, the sensitivity and specificity reflect agreement of the subset of items with the full scale; Partially embedded: one or more items (but not all) were administered as part of the reference standard

**Appendix D Table 2. Detailed Descriptions of Interventions, Key Question 4**

Study (Quality rating)	Study design	Intervention	Detailed description	Duration (weeks)
Aiyer, 2019 <sup>15</sup> (Poor)	Pre-post	IG1: "Food Rx" card for 30+ lbs produce + 4 non-perishable healthy items, for redemption at food pantry every 2 weeks for 12 redemptions, plus educational materials	"Food Rx" card valid for redemption at food pantry every 2 weeks for 12 redemptions of up to 30 pounds of produce each plus four nonperishable items. Orientation, labeling, messaging, and nutrition education booklets geared towards healthfulness and preparation of food. A "client choice model" was used, where participants could choose two or more varieties of both fruits and vegetables and could choose the nonperishable items.	26
Berkowitz, 2018 <sup>16</sup> (Poor)	Pre-post	IG1: Patient navigation	Patient advocate worked with patients to understand each individual's needs, situation, and preferences and to determine what resources were available. Advocate maintained contact in person or by phone until resolution of needs, until it was determined the needs could not be resolved, or until individual chose to discontinue. Social needs addressed included food insecurity, lack of transportation, and cost-related medication underuse.	8.7
Berkowitz, 2019 <sup>17</sup> (Fair)	Randomized crossover trial	IG1: Home delivery of medically tailored meals	The intervention in the study consisted of home delivery of medically tailored meals by Community Servings, a local nonprofit organization. Meals were prepared under the guidance of a registered dietitian to be suitable not only for the participant's diagnosis of diabetes but also for other medical conditions the participant might have across 17 possible "tracks" (e.g., chronic kidney disease or anticoagulation using warfarin). Each individual could receive meals that followed up to 3 "tracks" (e.g., diabetes and chronic kidney disease and anticoagulation using warfarin), allowing for meals closely tailored to the specific medical needs of the individual. While receiving the intervention, the participant received a once weekly delivery consisting of 10 refrigerated and/or frozen meals, designed to represent 5 lunches and 5 dinners (approximately half of the participant's weekly food intake). Meals were fully prepared and could be simply heated and consumed. Food was provided only for the study participant. To test the impact of meal delivery, no additional educational intervention was included during the "on-meals" period.	12
Byker Shanks, 2022 <sup>18</sup> (Poor)	Pre-post	IG1: Weekly provision of unprocessed food from local food bank, plus 8 biweekly 20- to 30-minute nutrition education sessions	Every week, participants obtained unprocessed food at the food pantry according to a study shopping list, with quantities that included food groups and serving sizes for 50% of the household diet. Study staff guided participants' choices for the first 6 weeks and subsequently were available to assist with questions about food selection and preparation while participants shopped. Every other week, participants attended group nutrition education sessions (20-30 min) targeting knowledge, attitudes, and perceptions about increasing unprocessed food intake and decreasing ultraprocessed food intake. Participants met 1:1 with a researcher for check in on weeks when nutrition education was not conducted, for 6 occasions or a total of ~1.5 hours.	16



Study (Quality rating)	Study design	Intervention	Detailed description	Duration (weeks)
Cohen, 2017 <sup>19</sup> (Poor)	Pre-post	IG1: Educational materials about Double Up Food Bucks (DUFB) + one-time \$10 voucher for farmers market	In the waiting room, study staff provided participants a brief verbal explanation of DUFB including program eligibility requirements, where and how to use the program, and rules and limitations. Participants were given print copies of branded DUFB promotional materials, a map of eight local farmers markets specifying locations and hours, a list of frequently asked questions about DUFB, and a one-time \$10 voucher redeemable for fruits and vegetables to use at their first farmers market visit as an additional financial incentive. Vouchers were not eligible for DUFB match.	0.14
Cook, 2021 <sup>20</sup> (Poor)	Pre-post	IG1: Group-based nutrition and cooking education plus subsidies for fresh produce (\$1/day/family member)	Six-month program offering group-based nutrition and cooking education (topics included goal setting, constructing healthy meals on a budget, cooking skills, substituting healthier ingredients, reading nutrition labels) along with subsidies for fresh produce worth \$1 per family member per day, redeemable weekly.	26
Fischer, 2022 <sup>21</sup> (Poor)	Pre-post	IG1: 24 biweekly fruit and vegetable delivery (~8 pounds) plus ~24 hours of virtual nutrition education	Enrolled families received ~8 pounds of fresh, seasonal, local produce every 2 weeks for 12 months. Virtual nutrition education offered ~24 hours of content in the form of monthly virtual cooking classes, bi-weekly brief video-based education, brief recipe videos, and recipe and skill-building instruction cards with every delivery. Education was approximately 24 hours of content total. This content was culturally tailored to target audience (African American community). At the end of 12 months, patient navigators and local community organization offered additional nutrition education resources and support accessing federal and local nutrition programs.	52
Freedman, 2013 <sup>22</sup> (Poor)	Pre-post	IG1: Vouchers for up to \$50 for on-site farmers market	On-site farmers market at the FQHC operated once weekly for 22 weeks. SNAP vouchers were accepted, and in some cases, Senior and WIC Farmers Market Nutrition Program vouchers. Study participants enrolled in a personal financial incentive program that provided up to \$50 in vouchers to purchase fruit and vegetables at the farmers' market. Vouchers to shop at the farmers' market were provided to participants after completing surveys at T1 and T2 (\$25 each time). A stipend of \$40 was provided after the third survey (post study).	22
Gottlieb, 2018 <sup>23</sup> (Poor)	Pre-post	IG1: Met with patient navigators every 2 weeks for up to 3 months to address a wide range of social needs	Patient navigators provided targeted information related to community, hospital, or government resources addressing needs that participants had prioritized, either in person or by telephone. Followup meetings offered every 2 weeks for up to 3 months until identified needs were met or caregivers declined further assistance.	13
Gottlieb, 2018 <sup>23</sup> (Poor)	Pre-post	IG2: Preprinted handouts listing local community-based social service resources	Participants who endorsed any social needs were provided with preprinted information about relevant resources available in their communities. County-specific resource guides were developed by local social service agencies and downloaded from the internet to distribute to participating families.	13

Study (Quality rating)	Study design	Intervention	Detailed description	Duration (weeks)
Gottlieb, 2020 <sup>24</sup> (Poor)	Pre-post	IG1: In-person navigation every 2 weeks up for up to 3 months to address a wide range of social needs	Received written information about relevant local government, hospital, and community social services. Navigators helped schedule appointments, complete forms, or provide other social services-related counseling and assistance. Caregivers were contacted by phone, text, or email every 2 weeks for 3 months until identified needs were met or caregivers declined further assistance.	13
Gottlieb, 2020 <sup>24</sup> (Poor)	Pre-post	IG2: Written resources	Received written information about relevant local government, hospital, and community social services. Navigators highlighted resources most closely related to the top 3 priority social risk factors endorsed by the caregiver and providing contact names when available.	0.14
Hager, 2023 <sup>25</sup> (Poor)	Pre-post	IG1: 22 produce prescription programs across the U.S.	Enrolled participants received financial incentives (paper vouchers or electronic cards) ranging from \$15 to \$300/month (median=\$63/month) to purchase fruits and vegetables at food retailers such as grocery stores and farmers markets. Two of 3 pediatric programs and 2 of 4 adult programs scaled the produce prescription based on household size, although the dollars per household member differed by program. Program duration ranged from 4 to 10 months. In addition to financial incentives, all pediatric and adult programs provided in-person or online nutrition education classes. Education varied from in-person, online, individual instruction, and group lessons as well as tours of grocery stores.  The median monthly produce prescription received by adults was \$43 (IQR, \$31–\$60) with actual, observed program participation lasting for a mean (SD) of 6.4 (1.7) months, ranging from 1.0 to 10.0 months. The median monthly amount received in pediatric programs was \$112 (IQR, \$85–\$133) with actual, observed program participation lasting for a mean (SD) of 5.4 (1.9) months, ranging 2.0 to 9.4 months.	17-43
Izumi, 2020 <sup>26</sup> (Poor)	Pre-post	IG1: Weekly food box	Members picked up a weekly CSA membership box consisting of fresh fruits and vegetables and dried beans, grains, or legumes, plus a newsletter with educational information and recipes. Cooking demonstrations were given at the time of pickup. A "client choice model" was used, where participants could choose two or more varieties of both fruits and vegetables and could choose the nonperishable items.	23
Jones, 2020 <sup>27</sup> (Poor)	Pre-post	IG1: Fruit and vegetable prescriptions valued at up to \$5/day plus monthly health information sessions	Participants received an enrollment packet with list of participating retailers and allowable food items. Providers prescribed vouchers valued at \$1 per household member per day up to \$5/day. Child and primary caregiver attended monthly health coaching sessions (usually group sessions) on nutrition, food demonstrations, and goal setting. Families were required to attend sessions to be eligible for monthly vouchers. While FVRx teams were not required to use any specific curriculum, all of the sites represented in this report used Healthy Habits, Happy Homes curriculum.	26

Study (Quality rating)	Study design	Intervention	Detailed description	Duration (weeks)
Kempainen, 2023 <sup>28</sup> (Poor)	Pre-post	IG1: Home-delivered ethnically tailored food boxes biweekly for 24 weeks, plus information and assistance with food resources (including SNAP)	Participants chose between American, Somali, or Hispanic food boxes. Each box (30-33 pounds) included shelf stable foods (whole grains, lean proteins, fruits, and vegetables), recipes, and diabetes education materials in the language corresponding to box type. Boxes were delivered every 2 weeks for 24 weeks. Participants were also offered information and assistance on food resources including SNAP.	24
Kempainen, 2023 <sup>28</sup> (Poor)	Pre-post	IG2: Information and assistance with food resources (including SNAP)	Participants were offered information and assistance on food resources including SNAP.	24
Morales, 2016 <sup>29</sup> (Poor)	NRSI	IG1: Referrals & support with community food resources or government assistance programs (e.g., SNAP, WIC)	Patients assisted with obtaining food resources tailored to their specific situation, considering patient preferences, cultural appropriateness, where they lived, and program eligibility. Examples include support with SNAP or WIC enrollment or provision of information regarding local food pantries	NR
Orsega-Smith, 2020 <sup>30</sup> (Poor)	Pre-post	IG1: 24 Biweekly produce boxes, ~15-25 pounds/month with nutrition education (format, intensity NR)	Free produce boxes were delivered twice monthly via mobile food pantry trucks at the clinics. The produce boxes amounted to approximately 15-25 pounds/month of produce. Participants also received nutrition education on the benefits of consumption of fruits and vegetables, proper storage and preservation, and demonstrations on cooking/preparing food. Sometimes boxes included tools such as a food peeler or slicer.	52
Ranjit, 2023 <sup>31</sup> (Poor)	Pre-post	IG1: Twice monthly redemption of produce and other foods at food pantry.	Food Rx includes a bi-monthly redemption of around 30 pounds of fresh produce, plus a client choice of four "Food Rx" friendly items consisting of whole grains, lean protein, and low-fat dairy, as available at one of 15 participating food pantries. Participants receive guidance from pantry staff on food selection, and indirect nutrition education through nudges, labeling, and messaging around the pantry in English and Spanish.	NR
Renaud, 2023 <sup>32</sup> (Poor)	Pre-post	IG1: Referrals + navigation + advisory board	Participants received referrals and navigation. Navigation involved contact at least once per month for up to 12 months. This group was overseen by an advisory board composed of beneficiaries, healthcare partners, and community service organizations that was charged with identifying and addressing gaps in community services relative to community needs.	52
Renaud, 2023 <sup>32</sup> (Poor)	Pre-post	IG2: Referrals + navigation	Participants received a community referral summary plus navigation. Navigation involved contact at least once a month for up to 12 months.	52
Renaud, 2023 <sup>32</sup> (Poor)	Pre-post	IG3: Community resource referrals	Participants received a community resource referral summary	0.14

Study (Quality rating)	Study design	Intervention	Detailed description	Duration (weeks)
Rivera, 2023 <sup>33</sup> (Poor)	Pre-post	IG1: 16-week dietitian-led lifestyle and cooking intervention with medically tailored meal delivery	16-week dietitian-led lifestyle intervention that incorporates a hypertensive self-management education and support program. 22 classes delivered via video telehealth including cooking classes instructing on 25 meals/recipes using culturally appropriate and familiar foods. Participants received a delivered meal kit for the class and also selected other medically tailored meals for non-cooking days. Meals were provided for up to three additional servings based on household size. Participants also received a kitchen toolkit (e.g., chef's knife, measuring spoons, saucepan) to keep after the end of the study.	16
Saxe-Custack, 2019 <sup>34</sup> (Poor)	Pre-post	IG1: Fruit and vegetable voucher for \$15 by pediatricians at every clinic visit	Pediatric fruit and vegetable prescriptions were written by pediatricians and given to parents. The \$15 vouchers were given at the conclusion of every clinic visit to be redeemed at a farmers market or local mobile market.	26
Scher, 2022 <sup>35</sup> (Poor)	Pre-post	IG1: Twice monthly food box delivery for 12 months	Food supplementation twice per month for a total of 12 months, usually by home delivery (though some patients picked up at the food bank). Food boxes also included recipes, cooking tips, and food storage information.	52
Seligman, 2015 <sup>36</sup> (Poor)	Pre-post	IG1: Diabetes-appropriate food boxes, diabetes self-management support, and primary care referrals as needed.	Once or twice monthly (depending on household size) box of diabetes-appropriate food boxes, including recipes and cooking tips to encourage healthy eating. Also included blood sugar monitoring, primary care referral, and self-management support.	26
Shankar, 2022 <sup>37</sup> (Poor)	Pre-post	IG1: Community health advocate and legal support	Enrolled patients completed a questionnaire regarding their social determinants of health and ongoing issues and were asked to decide what issues they would like a community health advocate's (CHA)'s help with. For 3 months, CHA reached out weekly, then every other week for an additional 2 months. Encounters took place in clinic, at patient's home, or by phone.	26
Singer, 2022 <sup>38</sup> (Poor)	Pre-post	IG1: Care coordination	Care coordination was provided via an initial phone-based visit and monthly followup visits by phone or in person for 6 months. Care coordination staff used NowPow database to identify community resources that could help reduce barriers to care based on barriers identified during the interview. Coordinator and patient developed a plan of care and the coordinator processed community referrals using integrated community resource technology.	26
Slagel, 2022 <sup>39</sup> (Poor)	NRSI	IG1: Fruit & vegetable vouchers (1\$/day/household member) plus 10 60- to 90-minute food/nutrition classes, 4 financial literacy classes	Produce prescription (\$1/day/family member, redeemable weekly at farmers market) plus educational components: 1) SNAP-Ed "Food Talks" (six 60-minute weekly classes, 2) SNAP-Ed "Food Talk: Better U" (four 90-minute monthly classes), and 3) Extension Financial Literacy (four 60-minute monthly classes)	26

Study (Quality rating)	Study design	Intervention	Detailed description	Duration (weeks)
Wetherill, 2018 <sup>40</sup> (Poor)	Pre-post	IG1: Up to 7 monthly food prescription boxes (DASH diet)	Participants received up to 7 total monthly shelf-stable food boxes with foods aligned with the DASH diet, which included beans, nuts and seeds, no-sugar added dried fruit, low-sodium vegetable juice, whole grains, olive oil, canned fatty fish, spices, and a set of recipe cards. With the initial box, participants also received an educational booklet covering healthy eating principles for cardiometabolic disease, including how food choices relate to blood pressure, lipid levels, and blood sugar. Medical and social work students who received training in the curriculum by the project's dietitian oriented patients to the booklet and sample items from the food box.	NR
Woo Baidal, 2023 <sup>41</sup> (Fair)	NRSI	IG1: Twice-monthly food selection with SNAP/WIC enrollment assistance and nutrition education	Registered families attended twice-monthly food selection sessions for up to 6 months. Participants selected foods in alignment with U.S. Department of Agriculture (USDA) MyPlate guidelines. Fruits and vegetables provided were predominately fresh, local, and seasonal. The food selected provided approximately 12 meals per household member for up to five household members. Food FARMacia staff provided referrals and enrollment assistance in WIC and SNAP as applicable. Cooking demonstrations with nutrition education and recipe distribution occurred at food selection session.	26
Wu, 2019 <sup>42</sup> (Poor)	Cluster RCT	IG1: Support for community-based organizations to make referrals to community resources and social services	Community based organizations (CBOs) were provided with a paid subscription to Healthify, a search engine for assisting with referrals to community resources and social services. CBOs also had access to a website with resources such as health education material for clients, and a designated research assistant who spent 3-10 hours/week on site. Meet-and-greet sessions were also organized between CBO staff and healthcare staff.	52
Xie, 2021 <sup>43</sup> (Poor)	Pre-post	IG1: Vouchers for \$40/month for fruits and vegetables at local grocery store	Participants received \$40/month for up to 1 year to spend at partner grocery store on WIC-approved fruits and vegetables (i.e., fresh, frozen, or canned without added salt, sugar, or fat).	52

**Abbreviations:** CSA= community-supported agriculture; DASH= Dietary Approaches to Stop Hypertension; FQHC= Federally Qualified Health Center; FVRx=fruit & vegetable prescription; IG=intervention group; NR= not reported; NRSI=nonrandomized studies of interventions; RCT=randomized controlled trial; SNAP= Supplemental Nutrition Assistance Program; SNAP-Ed= Supplemental Nutrition Assistance Program- Education; WIC= Special Supplemental Nutrition Program for Women, Infants, and Children

**Appendix D Table 3. All Food Insecurity Outcome Results, Key Question 4**

Study (design)	Most intensive food component	Outcome	Measure	Grp	Analyzed	Fup (mos)	Group 1 n/N (%) or Mean change* (SD), N	Group 2 n/N (%) or Mean change* (SD), N	Between-group RR <sup>†</sup> (95% CI)	p-value
<b>Food security only interventions</b>										
Berkowitz, 2019 <sup>17</sup> (RCoT)	Free food	Food insecurity	USDA Food Security Survey Module	IG1	All	2.8	On meal: 13/31 (41.9)	Off meal: 24/39 (61.5)	0.68 (0.42 to 1.1)	0.047
Woo Baidal, 2023 <sup>41</sup> (NRSI)	Free food	Food insecurity	HFSS-6 (scored 0-6, higher is worse)	IG1	IG only (Pre-post)	6	Pre: 4.3 (1.8), 48	Post: -1 (1.9), 39	NA	NR
Aiyer, 2019 <sup>15</sup> (Pre-post)	Free food	Food insecurity	Hunger Vital Sign	IG1	All	1.5	Pre: 242/242 (100)	Post: 18/172 (10.2)	NA	NR
						6	Pre: 242/242 (100)	Post: 10/172 (5.9)	NA	NR
Izumi, 2020 <sup>26</sup> (Pre-post)	Free food	Could not afford to eat healthy meals	Self-report (details NR)	IG1	All	5.3	Pre: 36/48 (75)	Post: 25/48 (52.1)	NA	0.003
		Food insecurity	HVS (modified to last 30 days)	IG1	All	5.3	Pre: 42/48 (87.5)	Post: 35/48 (72.9)	NA	0.48
Kempainen, 2023 <sup>28</sup> (Pre-post)	Free food	Food insecurity	Hunger Vital Sign	IG1	All	5.5	Pre: 106/106 (100)	Post: 83/106 (78.0)	NA	NR
Orsega-Smith, 2020 <sup>30</sup> (Pre-post)	Free food	Money to purchase fruits and veg ran out	Self-report (details NR)	IG1	All	12	Pre: 33/41 (80.5)	Post: 28/41 (68.3)	NA	NR
		Cost-related fruit & veg purchase avoidance	Self-report (details NR)	IG1	All	12	Pre: 27/41 (65)	Post: 21/41 (51.2)	NA	NR
Wetherill, 2018 <sup>40</sup> (Pre-post)	Free food	Food insecurity	HFSS-6	IG1	Received 4+ boxes	≤7	Pre: NR	Post: NR	NA	NSD
Kempainen, 2023 <sup>28</sup> (Pre-post)	Referrals	Food insecurity	Hunger Vital Sign	IG2	All	5.5	Pre: 108/108 (100)	Post: 94/108 (87.0)	NA	NR
<b>Food security + nutrition education interventions</b>										
Byker Shanks, 2022 <sup>18</sup> (Pre-post)	Free food	Food insecurity	Hunger Vital Sign	IG1	All	3.5	Pre: 34/37 (91.9)	Post: 31/37 (83.8)	NA	NR
Fischer, 2022 <sup>21</sup> (Pre-post)	Free food	Food insecurity	HFSS-6 (scored 0-6, higher is worse)	IG1	All	12	Pre: 2.8 (1.9), 25	Post: -0.4 (1.7), 15	NA	NR

Study (design)	Most intensive food component	Outcome	Measure	Grp	Analyzed	Fup (mos)	Group 1 n/N (%) or Mean change* (SD), N	Group 2 n/N (%) or Mean change* (SD), N	Between-group RR <sup>†</sup> (95% CI)	p-value
		Very high food insecurity	HFSS-6	IG1	All	12	Pre: 8/25 (32)	Post: 1/15 (7.0)	NA	0.10
Rivera, 2023 <sup>33</sup> (Pre-post)	Free food	Food insecurity	HFSS-18 (range NR, higher is worse)	IG1	All	3.7	Pre: 7.4 (3.7), 13	Post: -6 (3.7), 13	NA	NR
Cook, 2021 <sup>20</sup> (Pre-post)	Vouchers	Marginal food security	HFSS-6	IG1	All	6	Pre: 7/120 (5.8)	Post: 0/120 (0.0)	NA	0.02
		High food security					Pre: 37/120 (30.8)	Post: 64/120 (64.0)	NA	<0.001
		Very low food security					Pre: 24/120 (20)	Post: 25/120 (25.0)	NA	0.23
		Low food security					Pre: 52/120 (43.3)	Post: 11/120 (11.0)	NA	<0.001
		Food insecurity					Pre: 76/120 (63.3)	Post: 36/120 (30.0)	NA	NR
Hager, 2023 <sup>25</sup> (Pre-post)	Vouchers	Food insecurity	HFSS-6	IG1	All	4 to 10 (varied)	2042/3881 (52.6)	NR	NA	<0.001
					Female		NR	NR	NA	<0.05
					Male		NR	NR	NA	<0.05
					Children 2-17		NR	NR	NA	<0.05
					Adults 18-64		NR	NR	NA	<0.05
					Adults 65+		NR	NR	NA	<0.05
					Hispanic		NR	NR	NA	<0.05
					Non-Hispanic Black		NR	NR	NA	<0.05
Non-Hispanic White		NR	NR	NA	NSD					
Jones, 2020 <sup>27</sup> (Pre-post)	Vouchers	Food insecurity	HFSS-6	IG1	All	6	Pre: 161/212 (80)	Post: 79/122 (65.0)	NA	0.001

Study (design)	Most intensive food component	Outcome	Measure	Grp	Analyzed	Fup (mos)	Group 1 n/N (%) or Mean change* (SD), N	Group 2 n/N (%) or Mean change* (SD), N	Between-group RR <sup>†</sup> (95% CI)	p-value
<b>Multidomain interventions</b>										
Slagel, 2022 <sup>39</sup> (NRSI)	Vouchers	Food insecurity	HFSS-6	IG1	All	6	IG: 5/18 (27.8)	CG: 4/10 (40.0)	0.69 (0.24 to 2.01)	NSD
Gottlieb, 2018 <sup>23</sup> (Pre-post)	Appl support	Food insecurity	Self-report (details NR)	IG1	All	4	Pre: 39.6% <sup>‡</sup>	Post: -23% change in participants endorsing <sup>§</sup>	NA	NR
Gottlieb, 2020 <sup>24</sup> (Pre-post)	Appl support	Food insecurity	Self-report (details NR)	IG1	All	6	Pre: 77/216 (35.8)	Post: 51/216 (23.6)	NA	<.001
Renaud, 2023 <sup>32</sup> (Pre-post)	Appl support	Food insecurity	Hunger Vital Sign	IG1	Food insecurity at BL	12	Pre: 100%	Post: 2247/2929 (76.7)	NA	NR
				IG2			Pre: 100%	Post: 2750/3671 (74.9)	NA	NR
Wu, 2019 <sup>42</sup> (Cluster RCT)	Referrals	Experienced difficulty getting the food needed	Self-report (details NR)	IG1	All	12	IG: 50/198 (25.5)	CG: 45/186 (24.2)	1.04 (0.74 to 1.48)	.59
Berkowitz, 2018 <sup>16</sup> (Pre-post)	Referrals	Food insecurity	HFSS-6 (modified to last 30 days)	IG1	All	3	Pre: 57/141 (40.4)	Post: 53/138 (38.2)	NA	0.73
Gottlieb, 2018 <sup>23</sup> (Pre-post)	Referrals	Food insecurity	Self-report (details NR)	IG2	All	4	Pre: 39.6% <sup>‡</sup>	Post: -9% change in participants endorsing <sup>§</sup>	NA	NR
Renaud, 2023 <sup>32</sup> (Pre-post)	Referrals	Food insecurity	Hunger Vital Sign	IG3	Food insecurity at BL	12	Pre: 100%	Post: 1132/1522 (74.4)	NA	NR
Gottlieb, 2020 <sup>24</sup> (Pre-post)	Referrals	Food insecurity	Self-report (details NR)	IG2	All	6	Pre: 88/225 (39.1)	Post: 60/225 (26.6)	NA	<.001
Shankar, 2022 <sup>37</sup> (Pre-post)	Referrals	Mitigation of food insecurity	Self-report (details NR)	IG1	All	12	Pre: 101/127 (79.5)	Mitigated at Post: 27/127 (26.7)	NA	NR
Singer, 2022 <sup>38</sup> (Pre-post)	Referrals	Food barrier	PRAPARE questionnaire (Higher is better)	IG1	All	6	Pre: 0.4 (0.5), 216	Post: 0.2 (0.4), 216 <sup>  </sup>	NA	NR

\* Change from baseline values

† Calculated unadjusted risk ratio

‡ Baseline value is for both groups combined

§ We could not determine whether this was a relative or absolute percent change

|| Post-test score was described as a 19.4% improvement, but the scores reported were declining, suggesting a possible typo



**Abbreviations:** Fup=followup; RR=risk ratio; RCoT=randomized crossover trial; USDA=U.S. Department of Agriculture; IG=intervention group; CG=control group; NR=not reported; HVS= Hunger Vital Sign; HFSS=Household Food Security Survey; NA=not applicable; NRSI=nonrandomized studies of interventions; NSD=no significant difference; PRAPARE=Protocol for Responding to & Assessing Patients' Assets, Risks & Experience; RCT=randomized controlled trial

**Appendix D Table 4. Behavioral Outcome Results (Food Security Only Interventions), Key Question 4**

Study (design) Intervention category	Outcome	Measure	Analyzed	Fup (mos)	IG n/N (%) or Mean change* (SD), N	CG n/N (%) or Mean change* (SD), N	p-value
<b>Free food provided</b>							
Berkowitz, 2019 <sup>17</sup> (RCoT) <sup>†</sup>	HEI-Total	Healthy Eating Index (Range 0-100, higher is better; change > 5 points = clinically significant)	All	2.8	On meals: 14.1 (12), 42	Off meals: -17.3 (12.1), 31	< 0.0001
	HEI- whole grain	Healthy Eating Index (Range 0-5, higher is better)	All		On meals: 2.1 (3), 42	Off meals: -1.4 (2.9), 31	< 0.0001
	HEI- total fruit				On meals: 0.9 (2), 42	Off meals: -1.3 (2), 31	< 0.0001
	HEI- greens and beans				On meals: 1.6 (2.1), 42	Off meals: -1.4 (2.1), 31	< 0.0001
	HEI- total vegetables				On meals: 1.4 (1.5), 42	Off meals: -0.5 (1.5), 31	< 0.0001
	HEI-empty calories				On meals: 2.4 (4.3), 42	Off meals: -7.0 (4.4), 31	< 0.0001
Woo Baidal, 2023 <sup>41</sup> (NRSI)	Fruit-veg intake	School Physical Activity and Nutrition (SPAN) monitoring system (servings in previous day)		IG only	6	Pre: 2.2 (1.5), 48	Post: -0.1 (1.4), 39
Izumi, 2020 <sup>26</sup> (Pre-post)	Fruit intake	NCI Food Attitudes and Behaviors Survey (Cups/day)	All	5.3	Pre: 1.6 (NR), 48	Post: 0 (NR), 48	0.973
	Vegetable intake				Pre: 1.7 (NR), 48	Post: +0.5 (NR), 48	0.030
	Dark green veg intake	BRFSS FV intake module (Frequency/day)			Pre: 0.6 (NR), 48	Post: 0 (NR), 48	0.796
	Orange veg intake				Pre: 0.3 (NR), 48	Post: +0.2 (NR), 48	0.004
Orsega-Smith, 2020 <sup>30</sup> (Pre-post)	Child fruit intake	Self-report (details NR) (Servings/day)	All	12	Pre: 2.5 (1.2), 41	Post: +0.3 (1.2), 41	<0.05
	Adult fruit intake				Pre: 2.0 (1.0), 41	Post: +0.4 (.9), 41	<0.05
	Child vegetable intake				Pre: 2 (1.1), 41	Post: +0.3 (1.1), 41	0.15
	Adult vegetable intake				Pre: 2.2 (1.2), 41	Post: +0.2 (1.1), 41	< 0.001
Wetherill, 2018 <sup>40</sup> (Pre-post)	Fruit-veg intake	Block Fruit/ Vegetable/ Fiber Screener (Cups/day)	Received 4+ boxes	≤7	Pre: 3.4 (NR), 43	Post: +0.2 (NR), 43	0.12
	Dietary fiber intake	Block Fruit/ Vegetable/ Fiber Screener (Grams/day)			Pre: 14 (NR), 43	Post: +3.1 (NR), 43	<0.001
	Consumed fruit or fruit juice daily	Self-report (details NR)	All	5.5	Pre: 87/106 (82)	Post: 102/106 (96.0)	NR

Study (design) Intervention category	Outcome	Measure	Analyzed	Fup (mos)	IG n/N (%) or Mean change* (SD), N	CG n/N (%) or Mean change* (SD), N	p-value
Kempainen, 2023 <sup>28</sup> (Pre-post, IG1)	Consumed vegetables or vegetable juice				Pre: 97/106 (91)	Post: 99/106 (93.0)	NR
<b>Vouchers</b>							
Cohen, 2017 <sup>19</sup> (Pre-post)	Fruit-veg intake	Self-report (details NR) (Servings/day)	All	3	Pre: 3.6 (1.8), 177	Post: +0.6 (.), 146	<0.001
				5		Post: +0.6 (.), 138	<0.001
Freedman, 2013 <sup>22</sup> (Pre-post)	Fruit intake	Modified NCI FV screener (Frequency/day, MyPyramid servings)	All	2.5	Pre: 3.2 (2.4), 41	Post: +0.9 (2.8), 41	0.10
				5		Post: +0.1 (2.4), 41	0.89
	Vegetable intake			2.5	Pre: 2.7 (1.4), 41	Post: +0.6 (2), 41	0.16
				5		Post: +0.5 (1.9), 41	0.29
	Fruit-veg intake			2.5	Pre: 5.9 (3.3), 41	Post: +1.6 (3.9), 41	0.07
				5		Post: +0.5 (3.6), 41	0.52
Saxe-Custack, 2019 <sup>34</sup> (Pre-post)	Increased daily whole fruit consumption by at least 1/4 cup	Block Kids Food Screener	Children with food insecurity	6	Pre: NA	15/43 (34.9)	NR
<b>Referrals</b>							
Kempainen, 2023 <sup>28</sup> (Pre-post, IG2)	Consumed fruit or fruit juice daily	Self-report (details NR)	All	5.5	Pre: 92/108 (85)	Post: 97/108 (90.0)	NR
	Consumed vegetables or vegetable juice				Pre: 100/108 (93)	Post: 102/108 (94.0)	NR

\* Change from baseline values

† No between-group parameters were reported

**Abbreviations:** BRFSS=Behavioral Risk Factor Surveillance System; CG=control group; Fup=followup; FV=fruit & vegetable; IG=intervention group; HEI=Healthy Eating Index; NCI=National Cancer Institute; NR=not reported; RCoT=randomized crossover trial; SD=standard deviation

## Appendix E. Background & Discussion Tables and Figures

**Appendix E Table 1. Multi-Domain Social Risk Factor Assessment Tools That Include Screening for Food +/- Nutrition Insecurity**

Name of Tool	Target population	Total # of questions (# of food insecurity questions)
AAFP Tool <sup>44</sup>	Non-specified	15 (2)
AccessHealth: Spartanburg <sup>45</sup>	Non-specified	26 (1)
Accountable Health Communities (AHC) Tool <sup>46, 47</sup>	Medicare and Medicaid beneficiaries	26 (2)
Arlington Screening Tool <sup>48</sup>	Non-specified	11 (1)
BMC-Thrive <sup>49</sup>	Non-specified	11 (3)
HealthBegins <sup>49, 50</sup>	Non-specified	28 (3)
Health Leads Social Needs Screening Toolkit <sup>51, 52</sup>	Non-specified	43 (1)
HelpSteps <sup>13, 53</sup>	Pediatrics/young adults	130 (2)
Medicare Total Health Assessment Questionnaire <sup>54</sup>	Medicare beneficiaries	39 (2)
NC Medicaid <sup>55</sup>	Medicaid beneficiaries	11 (2)
Income, Housing, Education, Legal status, Literacy, Personal Safety (IHELLP) <sup>56</sup>	Pediatrics	17 (3)
iScreen <sup>57</sup>	Pediatrics	23 (4)
Legal Checkup <sup>58</sup>	Pediatrics	18 (1)
LIFESCREEN-C <sup>59</sup>	College students	18 (1)
Medical-Legal Partnership (MLP) <sup>60</sup>	Non-specified	10 (3)
Protocol for Responding to and Assessing Patient Assets, Risks, and Experiences (PRAPARE) <sup>61</sup>	Community Health Center patients	36 (1)
Safe Environment for Every Kid (SEEK) <sup>62</sup>	Pediatrics	20 (2)
Screener for Intensifying Community Referrals for Health (SINCERE) <sup>63</sup>	Adults with low literacy	10 (1)
Social History Template <sup>64, 65</sup>	Pediatrics	7 (1)
Structural Vulnerability Assessment Tool <sup>66</sup>	Non-specified	43 (1)
Survey of Well-Being of Young Children (SWYC) <sup>67</sup>	Pediatrics	10 (1)
Total Health Assessment Questionnaire for Medicare Members <sup>68</sup>	Medicare beneficiaries	36 (3)
WE CARE Survey <sup>69</sup>	Pediatrics	10 (2)
WellRx Questionnaire <sup>70</sup>	Primary care patients	11 (1)
Your Current Life Situation <sup>49</sup>	Non-specified	32 (2)

**Appendix E Table 2. Recommendations of Others Related to Assessing for and Intervening on Food Insecurity**

Organization	Year	Recommendation
AARP <sup>71</sup>	2016	AARP stresses the importance of routine food insecurity screening and referral in primary care practice and developed a resource guide and toolkit to support implementation of screening.
Academy of Nutrition and Dietetics <sup>72</sup>	2017	The Academy of Nutrition and Dietetics recommends conducting screening and measuring food security status in all settings, and endorses the use of screening tools such as the Hunger Vital Sign, and referral to appropriate healthcare and community-based resources.
American Academy of Family Physicians <sup>73</sup>	2019	The American Academy of Family Physicians endorses screening patients for social needs, and its EveryONE Project™ initiative offers a social needs screening tool that includes housing, <b>food</b> , transportation, utilities, personal safety, employment, education, child care, and financial strain.
American Academy of Pediatrics <sup>74</sup>	2015	The American Academy of Pediatrics recommends that pediatricians screen and identify children at risk for <b>food insecurity</b> (using 2-item Hunger Vital Sign screener); connect families to needed community resources; and advocate with other key partners and stakeholders for federal, state, and local policies that support access to adequate and healthy food.
American College of Cardiology/American Heart Association <sup>75</sup>	2019	In their recommendations for patient-centered approaches to comprehensive cardiovascular disease prevention, the American College of Cardiology and American Heart Association state that risk factors tied to socioeconomic status, such as <b>food insecurity</b> , should inform treatment advice; therefore, cardiovascular disease prevention would benefit from social needs screening.
American College of Obstetricians and Gynecologists <sup>76</sup>	2018	<p>The American College of Obstetricians and Gynecologists recommends obstetrician–gynecologists and other healthcare providers:</p> <ul style="list-style-type: none"> <li>• Inquire about and document social and structural determinants of health that may influence a patient’s health and use of healthcare, such as access to stable housing, access to <b>food</b> and safe drinking water, utility needs, safety in the home and community, immigration status, and employment conditions;</li> <li>• Maximize referrals to social services to help improve patients’ abilities to fulfill these needs; and</li> <li>• Advocate for policy changes that promote safe and healthy living environments.</li> </ul>
American College of Physicians <sup>77</sup>	2022	<p>The American College of Physicians believes that physicians and other medical professionals should undertake activities to better understand and mitigate food insecurity experienced by their patients.</p> <ul style="list-style-type: none"> <li>• Healthcare teams should screen for food insecurity as part of office and hospital visits, with financial, technical, and policy support from policymakers and payers.</li> <li>• Screening tools and resources for addressing food insecurity should be developed and validated.</li> <li>• Practices and hospitals should establish referral mechanisms to community and government resources, with financial, technical, and policy support from policymakers and payers.</li> </ul>
American Diabetes Association <sup>78</sup>	2023	<p>The section on Tailoring Treatment for Social Context in the American Diabetes Association’s 2023 Standards of Medical Care in Diabetes recommends:</p> <p>Assess <b>food insecurity</b>, housing insecurity/homelessness, financial barriers, and social capital/social community support and apply that information to treatment decisions, with referral to appropriate local community resources.</p>

Organization	Year	Recommendation
		<p>Food insecurity can be assessed using the 2-item Hunger Vital Sign screener.</p> <p>Provide patients with additional self-management support from lay health coaches, navigators, or community health workers when available.</p> <p>Interventions such as food prescription programs are considered promising practices to address food insecurity.</p> <p>Consider the involvement of community health workers to support the management of diabetes and cardiovascular risk factors, especially in underserved communities and healthcare systems.</p> <p>In those with diabetes and food insecurity, priority is to mitigate the increased risk of uncontrolled hyperglycemia (from steady consumption of inexpensive carbohydrate-rich processed foods, binge eating, financial constraints to filling diabetes medication prescriptions, and anxiety/depression leading to poor diabetes self-care behaviors) or severe hypoglycemia as a result of inadequate or erratic carbohydrate consumption following the administration of sulfonylureas or insulin.</p>
Task Force on Hunger, Nutrition, and Health <sup>79</sup>	2022	<p>In its report, the Task Force makes the following recommendations about healthcare:</p> <ul style="list-style-type: none"> <li>• Accelerate access to “Food Is Medicine” services to prevent and treat diet-related illness.</li> <li>• Increase access to and insurance coverage for behavioral interventions and nutritional counseling to improve diet and health.</li> <li>• Build a diverse healthcare workforce with appropriate training and expertise in diet and health.</li> <li>• Facilitate health system <b>screening for food and nutrition insecurity</b> and followup referrals to appropriate interventions.</li> <li>• Leverage the integral role hospitals play in regional food systems and local communities to improve food and nutrition security for community members.</li> </ul>

## Appendix F. Contextual Questions

### **Contextual Question 1: What risk assessment or screening tools are commonly used in clinical practice to identify food insecurity? What are the benefits and limitations of these tools (e.g., ease of administration)?**

Historically, the U.S. Department of Agriculture's (USDA) Household Food Security Survey Module (HFSSM) has served as the primary tool for the assessment of food insecurity in the United States.<sup>80</sup> The HFSSM includes a series of 10 questions for households with no children and 18 questions for households with children that elicit information on household difficulty in meeting basic food needs due to lack of resources. These questions have been included as part of the Community Population Survey (distributed by the U.S. Census Bureau) since 1995. The 18-item scale has been further developed to incorporate subscales, including a 6-item set that has been used to measure food insecurity and hunger in state surveillance systems.<sup>80</sup> Brief (1- or 2-item) screening tools to identify household food insecurity used in healthcare delivery settings are all derived from and validated against the HFSSM (**Table 2**).<sup>81</sup> The most frequently used and studied single domain screening tool for food insecurity is the 2-item Hunger Vital Sign tool.<sup>6, 7, 9</sup> It is also currently available in one of the most widely used electronic health records systems (i.e., EPIC). These brief screening tools have primarily been validated in caregivers of young children.<sup>81</sup> Screeners derived from the HFSSM focus on food insecurity because of the lack of financial resources and may therefore not capture other facets of food insecurity such as psychosocial aspects (e.g., self-efficacy), duration and transience, and trade-off behaviors individuals may employ to address financial hardship.<sup>82</sup>

Multiple social risk factors are often assessed using multidomain tools, rather than screening for food insecurity in isolation. For example, in 2017, the Centers for Medicare & Medicaid Services (CMS) developed a screening tool for use in clinical settings that focuses on a select number of social risk factors, including five core patient social risk factors: food insecurity, housing instability, transportation difficulties, utility needs, and interpersonal safety.<sup>83</sup> Most of the commonly used multidomain screening tools include question(s) on screening for food +/- nutrition insecurity (**Appendix F Table 1**), and many of these tools have been used in intervention studies to identify people with social risk factors.<sup>84</sup> However, gold standard methods were rarely reported or used in development of these tools, and few included reliability and validity testing with a representative sample, although many tools have pragmatic assessments to show favorable readability and ease of administration, including low cost.<sup>85</sup>

Overall, whether as part of a single or multidomain assessment tool, the questions targeting food or nutrition insecurity vary in the time frame of reference (e.g., previous 3 to 12 months, current concerns, next 2 months), types of questions asked (e.g., enough food, fruit and vegetable or healthy food intake, eligibility for or denial from Special Supplemental Nutrition Program for Women, Infants, and Children [WIC] or Supplemental Nutrition Assistance Program [SNAP] benefits), and mode of delivery (e.g., in person, electronically, by telephone, multiple modes).<sup>84, 86</sup> These tools can be administered by a variety of staff (e.g., case manager, community health worker, navigator, nurse).<sup>87</sup> Self-administered assessments can be done on paper or electronically and be distributed by front desk staff or medical assistants at check-in or while rooming patients. In some models of care, staff are available to assist patients in completing questions.<sup>87</sup> Evaluation of the Accountable Health Communities (AHC) model found that tailoring social risk screening practices (e.g., timing, location, staff responsibility, and mode of administration) to each clinical site's workflows, staffing, and intake processes was important.<sup>88</sup> Patients appear to prefer self-administered formats, and sparse evidence does not suggest a difference between formats specifically for the identification of food insecurity.<sup>81, 87 89-91</sup>

## **Contextual Question 2: What factors inform the appropriate reassessment interval for food insecurity?**

Limited information is available to inform the appropriate reassessment interval for food insecurity. Food and nutrition insecurity change over time, and research to date has not addressed the appropriate frequency of screening for food and nutrition insecurity.<sup>81,87</sup> Furthermore, most screening tools do not assess the duration of food insecurity, and therefore cannot assess if it is temporary or chronic.<sup>86</sup>

One retrospective study in an academic pediatric primary care clinic over a 2-year period demonstrated that food insecurity is transitional. Among caregivers reporting food security in year 1, 7.7 percent screened positive for food insecurity in year 2. There was a significant decrease in the percentage of caregivers reporting food insecurity between years 1 and 2 in all racial and ethnic groups, with Black participants reporting the largest decrease.<sup>92</sup> Similar findings were identified in a review of electronic health record food insecurity recordings, with 9.5 percent of patients transitioning between food security statuses (5.0% to food security and 4.5% to food insecurity). These transitions were most notable among families whose previous screen occurred more than a year before, compared with those screened 0 to 6 months prior (odds ratio [OR], 1.91 [95% CI, 1.05 to 3.47]), leading the authors to believe that screening more often than annually may not substantially contribute to the identification of transitions in food security status.<sup>93</sup> A cohort study among middle aged participants in South Carolina (primarily female, African American, and living in food deserts) found transient food security in 36 percent of households and 37 percent with persistent food insecurity over 3 years of repeated measurements. The only predictors of transient food security status were income less than \$10,000 (compared with >\$20,000) and fair, good, or poor self-reported health (compared with very good or excellent health).<sup>94</sup>

## **Contextual Question 3: What are important moderators that affect the effectiveness or harms of food insecurity assessment and healthcare-related interventions?**

Greater use of services and high initial need were associated with larger benefits of food security interventions among studies included in this review.

### *Use of Intervention Services*

Four of the included studies of interventions to improve food security noted that higher participation in the intervention was associated with more positive outcomes.<sup>19, 20, 22, 43</sup> One study that provided information to participants about Double Up Food Bucks (DUFEB), a national program to double a portion of their SNAP benefits when used at participating farmers markets, along with a \$10 farmers market voucher, found that greater use of the program was associated with greater increases in fruit and vegetable consumption.<sup>19</sup> In this study, those who used the option to double their benefit three or more times increased fruit and vegetable consumption by 1.2 servings/day after 5 months ( $p < 0.001$  for change from baseline), versus a small increase among those using the program one or two times ( $\sim 0.6$  servings/day, estimated from a figure;  $p = 0.039$ ) and no change in those who did not use the program. Similarly, in a study of people with diabetes receiving up to \$50 in vouchers for use at a farmers market, the odds of increasing fruit and vegetable consumption were higher for those who visited the farmers market more often (OR, 2.07 [95% CI, 1.09 to 3.95]).<sup>22</sup> Finally, a study that provided \$40/month in vouchers for fruits and vegetables at a local grocery store chain found that participants who used the vouchers more often (“frequent” vs. “sometimes” spenders) showed greater increases in expenditures on fruits and vegetables (3.3% increase in the full sample, 3.8% increase among those with diabetes) and greater fruit and vegetable diversity (2.5 more unique items per month in the full sample, 2.3 more unique items per month among those with diabetes), compared with their baseline use.<sup>43</sup> This study also found that participants who were female and who were older were more likely to be “frequent” spenders.



This finding is consistent with a study of an intervention addressing a broad array of social needs that was not included in our review because it did not report food security outcomes.<sup>95</sup> This study of patient navigation found that a higher number of contacts with the patient navigator was associated with greater resource connections, after adjusting for the patient and site characteristics and the number of needs. In-person contact, although received by only 25 percent of the patients in this study, was associated with the highest probability of optimal success (e.g., OR, 2.89 [95% CI, 2.71 to 3.08] for a result of “optimal success”). This was a study of broad social needs screening, and 31.8 percent of the sample had food-related needs.

#### *Acuity of Need*

Two of our included studies found greater improvements among those with higher baseline need. The study cited above that provided information about DUFB found larger improvements in fruit and vegetable consumption among people with lower initial fruit and vegetable consumption (increase of 0.9 servings/day after 1.5 months among people consuming 0 to 3 servings/day at baseline vs. decrease of 0.5 servings/day among those consuming 4+ servings/day at baseline).<sup>19</sup> Another study conducted qualitative interviews among participants of their multidomain patient navigation intervention and found that those with a positive response to the intervention tended to have higher acuity of need than those who did not have a positive response.<sup>16</sup> In this study, 40.1 percent of the participants had screened positive for food insecurity.

#### *Other Potential Moderators*

Finally, one study that offered parents \$15 fruit and vegetable vouchers at every visit to a pediatrician found that the program had a consistent effect on change in mean daily intake of whole fruits across child or caregiver race and age, child gender, and caregiver education level among the full sample of participants with and without food insecurity (37.7% of families reported low or very low food security).<sup>34</sup>

## **Contextual Question 4: What is the acceptability (e.g., satisfaction) of food insecurity assessment and healthcare-related interventions to patients and providers?**

Acceptability of food insecurity assessment and interventions for both patients and providers is a key aspect of implementation. The many studies that have examined these issues generally report high levels of acceptability.

#### *Acceptability to Patients*

Several studies have reported high levels of patient satisfaction with assessment of food insecurity in healthcare, with or without broader social needs assessment. A systematic review of assessment of food insecurity in healthcare found that between 66 and 88 percent of caregivers and between 80 and 84 percent of young adult patients found it acceptable to be asked about food insecurity during healthcare visits.<sup>96</sup> However, there is some evidence that patients may experience some level of discomfort when being asked about food insecurity;<sup>97, 98</sup> and for caregivers of children, there is an additional layer of stigma, shame, and/or fear about being perceived as unable to care for their child.<sup>99, 100</sup> Acceptability may be affected by a patient’s preexisting relationship with the provider,<sup>98</sup> provider communication and empathy,<sup>99, 101</sup> cultural sensitivity of healthcare providers,<sup>101</sup> and whether the patient had been exposed to social needs screening before. While one study found that self-administered questionnaires yielded higher rates of social risk factors for sensitive topics, suggesting a greater willingness to self-disclose with a self-administered instrument, the yield for food insecurity was similar across modes of administration.<sup>57</sup> Some studies have also suggested that social needs assessments may help to establish trust and rapport between patients and providers.<sup>98, 102, 103</sup>

Studies reporting the acceptability of healthcare-related interventions for food insecurity indicate that patients generally give positive feedback for such interventions, both broadly<sup>16, 21, 37, 104-106</sup> and when queried about specific components.<sup>15, 26, 107</sup>

#### *Acceptability to Providers*

Several studies have reported that providers believe that social needs, including food insecurity, should be addressed in healthcare.<sup>108-110</sup> A systematic review that examined acceptability of food insecurity screening found that between 80 and 89 percent of clinicians were willing to include food insecurity screening during patient encounters.<sup>96</sup> In some cases, providers saw this type of assessment as an opportunity to build relationships with patients.<sup>108, 111</sup> Several studies reported low levels of provider discomfort around screening,<sup>103, 108, 112, 113</sup> though some reported provider concern about embarrassing patients or not being able to provide adequate resources.<sup>103, 114</sup>

### **Contextual Question 5: What is the uptake of services (e.g., rate of adoption, receipt of benefits) after food insecurity is identified?**

Enrollment in federal food assistance programs and use of local services was highly variable following identification in healthcare settings (7.5% to 97%) but was higher with the assistance of navigators or other staff. Vouchers were associated with increased purchasing of produce at farmers markets, and most free food was eaten.

#### *Receipt of SNAP and WIC Benefits*

We identified four studies that implemented screening for food insecurity (with or without other social needs) and reported on subsequent enrollment in government food assistance programs (SNAP or WIC).<sup>5, 69, 115, 116</sup> All four provided information and referrals for food resources, and three also provided support for completing applications for government assistance.<sup>5, 116</sup> The largest effect was seen in the included KQ1 trial, a randomized trial of screening for child maltreatment risk factors that offered referrals and application support for those screening positive for food insecurity. At 6-month followup, 97 percent of the intervention participants were receiving SNAP benefits, compared with 81 percent in the control group.<sup>5</sup> Two pre-post studies that included application support along with referrals had lower levels of SNAP enrollment after screening. One of these reported that 20% of participants with food insecurity were enrolled in SNAP.<sup>116</sup> The other, which referred those screening positive for food insecurity to a partnering food bank for SNAP enrollment assistance, found that 30 of the 40 participants agreed to the referral and three ultimately enrolled (7.5% of those screening positive).<sup>115</sup> The final study we found was a randomized trial of broad social needs screening with referral to relevant resources but no application support. In this study, 11 percent of patients who screened positive for food insecurity had enrolled in SNAP or WIC benefits after 1 month, compared with 9 percent in the usual care group. The difference between groups was not statistically significant after adjustment for race, marital status, maternal employment, and followup time (adjusted OR, 0.9 [95% CI, 0.4 to 2.1]).<sup>69</sup>

#### *Use of Local Food Resources*

Eight studies reported the proportion of participants who connected with local food resources.<sup>69, 116-122</sup> At the high end, 67 percent of clinic patients who reported being screened for food insecurity and receiving a referral reported that they had contacted a community agency.<sup>118</sup> Rates were lower in pre-post studies that prospectively followed patients who had been screened and given referrals, but showed higher rates when staff helped facilitate connections with local resources. A pre-post study of a screening and referral program in a diabetes clinic affiliated with a safety-net hospital found that provision of information alone about community food resources resulted in low uptake (0% to 4%), even with individually tailored referrals. On the other hand, 31 percent of participants connected with local resources with personnel-guided, in-clinic enrollment to a food resource.<sup>119</sup> Similarly, one of the studies included in our review that

addressed multiple social domains found a greater reduction in the number of unmet social needs with active patient navigation compared with simply providing referral information.<sup>123</sup> In another program in which a community health worker helped address social needs, 21.5% of participants newly connected with relevant resources in the year after screening.<sup>117</sup> Yet another study found that 27 percent of cases of food insecurity that were accepted by a community organization were ultimately resolved, and rates of resolution did not differ by age (<65 vs. ≥65), race (White, Black), or gender (male, female).<sup>120</sup>

Four of these studies specifically describe use of food pantries, finding that 21 to 51 percent of participants visited a food pantry after receiving a referral.<sup>69, 116, 121, 122</sup> An RCT of broad social needs screening with referral to relevant resources found that 4 percent of intervention participants visited a food pantry, compared with 2 percent in the control group (adjusted OR, 2.2 [95% CI, 0.7 to 6.7]), or 23 percent in the intervention group versus 11 percent in the control group among those with food insecurity at baseline.<sup>69</sup> Other studies found that 21 percent<sup>116</sup> and 51 percent<sup>122</sup> had visited a food pantry. The latter reported that those who visited a food pantry were more likely to be older, have diabetes, and have visited a food pantry before their referral.<sup>122</sup> A separate study found that 29 percent of participants given a referral registered for a mobile food pantry, and that the demographic characteristics of the mobile pantry participants were similar to those of the target population, which was majority Hispanic and Spanish-speaking.<sup>121</sup>

#### *Use of Free Food and Vouchers*

Five of the studies included in this review reported on whether vouchers were redeemed<sup>15, 19, 22</sup> or free food was eaten.<sup>26, 35</sup> The program that focused on informing eligible participants that they could double their benefit at farmers markets found that 61 percent who had never used this benefit before used it at least once by the end of the season and 27 percent used it three or more times.<sup>19</sup> Another study of a food prescription program found that 71 percent of participants redeemed their prescription at the food pantry at least once, and the average number of redemptions was 6.5 of the available 12 redemptions.<sup>15</sup> Another study, which provided vouchers for up to \$50 for an on-site farmers market, found that all participants attended the farmers market on at least 2 days (average of 4.5 days) and made an average of 10.7 sales transactions.<sup>22</sup> Two studies found that 73 percent<sup>26</sup> to 91 percent<sup>35</sup> of participants were able to use most or all of the food provided.

## **Contextual Question 6: What are the patient, provider, and health system facilitators and barriers to implementing assessment for food insecurity?**

Assessment for food insecurity involves identifying individuals or households who lack consistent access to nutritious and culturally appropriate food. The facilitators and barriers to implementing effective assessment programs may vary depending on the specific context and healthcare setting.

#### *Facilitators to Implementing Effective Assessment Programs*

Multiple factors at the patient, provider, and health system levels may impact the implementation of food insecurity assessment in healthcare settings (**Table 23**).<sup>84</sup> Patient-level factors that may facilitate implementation include increased patient awareness, trusting relationships, and confidentiality.<sup>124, 125</sup> When patients are aware of the potential impacts of food insecurity on their health, they may be more receptive to assessment and support. Strong relationships between patients and healthcare providers can encourage patients to disclose their food insecurity status.<sup>126, 127</sup> Likewise, assurances of confidentiality can help patients feel more comfortable sharing sensitive information about their unmet social needs.<sup>124</sup>

Provider-level facilitators include adequate training and education, access to screening tools and protocols, and a supportive work environment.<sup>128</sup> Healthcare providers who receive training on food insecurity screening and interventions, including trauma-informed care, can better address the issue sensitively and effectively.<sup>124, 125</sup> Having standardized screening tools and protocols in place can guide

providers in identifying and addressing food insecurity.<sup>126, 127</sup> An organizational culture that values food insecurity assessment and offers resources and support for providers can also help facilitate implementation.<sup>127</sup>

Health system-level facilitators include policy support, resource allocation, and integration of services. Supportive policies at the health system level, such as guidelines or incentives for food insecurity screening, can encourage implementation. Sufficient resources, including appropriate staffing (e.g., community health workers, translation services), training, and funding can enable health systems to implement food insecurity assessment more effectively.<sup>126, 127, 129</sup> Integrating food security assessment with existing organizational practices, such as use of electronic health records or social work referrals, can enhance implementation.<sup>130-132</sup>

### *Barriers to Implementing Effective Assessment Programs*

Patient-level barriers to implementing food insecurity assessment programs may include stigma or shame, limited health literacy, or fear of consequences.<sup>124</sup> Patients may feel embarrassed or stigmatized about their food insecurity, causing hesitation to disclose this information.<sup>84</sup> In one qualitative study of patients recruited at family medicine and pediatric clinics, a patient responded, “Feeling as though you can’t provide for yourself or you can’t take care of yourself...and people look down on you when you can’t take care of yourself or you don’t have those basic needs or, like, housing...there’s already kind of a stigma just in general with low income, low socioeconomic status, things of that nature.”<sup>125</sup> Furthermore, patients with limited health literacy may struggle to understand the purpose and importance of food insecurity assessments, impeding their participation. While most patients express a preference for written versus verbal assessment of unmet social needs,<sup>130</sup> patients with limited health literacy may need to be offered alternative forms of assessment. Finally, patients may fear that admitting food insecurity could lead to negative repercussions, such as involvement of Child Protective Services. In one recent study exploring parental perspectives of screening for adverse child experiences and unmet social needs, parents expressed concerns about potential consequences of assessment. For example, one participant stated, “We want to tell you about it. We need help more than anything in the world, but we’re afraid by asking for help our kids are in danger of being taken away from us.” Another parent noted, “I am in the process of legalizing my documents...my children are stressed because of that. They think that someone is going to take them, or that I won’t be here anymore.”<sup>124</sup>

Common provider-level barriers to assessment include time constraints, competing priorities, lack of knowledge or comfort level, and concerns about lack of referral resources.<sup>128</sup> Providers often have limited time during patient visits, making it challenging to incorporate food insecurity assessment into their workflow.<sup>130, 133</sup> Likewise, providers may also feel overwhelmed by other clinical tasks, leading them to deprioritize food insecurity assessment.<sup>133</sup> Providers who are unfamiliar with the prevalence and impact of food insecurity may not prioritize or understand the need for assessment, may feel uncomfortable asking patients about unmet social needs, or may have concerns that there are inadequate organizational or community resources for appropriate referral.<sup>84, 131</sup>

Health system-level barriers commonly include limited organizational resources, fragmented care, resistance to change, and data management issues.<sup>130</sup> Health systems with constrained budgets and resources may struggle to allocate the necessary support for food insecurity assessment.<sup>129</sup> Lack of coordination and communication between different healthcare providers and community organizations can impede effective implementation, and resistance to adopting new practices or screening tools may arise from entrenched systems and routines within a given health system.<sup>133</sup> Finally, health systems may have concerns about social risk data collection, management, and privacy by their own and partnering organizations.<sup>84</sup>

## **Contextual Question 7: What are the patient, provider, health system, and community facilitators and barriers to implementing interventions to address food insecurity?**

Implementing interventions to address food insecurity requires consideration of facilitators and barriers at various levels, including the patient, provider, health system, and community (**Table 23**). Here we discuss commonly recognized facilitators and barriers; note that these facilitators and barriers are general and may vary based on the specific context, healthcare setting, and community.

### *Facilitators to Implementing Effective Intervention Programs*

Multiple factors may influence the implementation of interventions for food insecurity, including patient-, provider-, health system-, and community-level factors.<sup>84</sup> Patient-level facilitators may include awareness and perception, motivation and readiness, and social support. When patients understand the benefits of interventions for food insecurity and perceive them as valuable, they are more likely to engage and participate.<sup>134</sup> Patients motivated to improve their food security and ready to make changes in their lives are more likely to actively engage in interventions.<sup>124</sup> Finally, having a supportive network of family, friends, or community members can enhance patient engagement and adherence to interventions, particularly for food insecurity interventions with a focus on healthy eating.<sup>135</sup>

Common provider-level facilitators include training and education, screening and referral tools, and collaborative relationships.<sup>127</sup> Providers who receive training on food insecurity, its impact on health, and available interventions can address the issue more effectively.<sup>136, 137</sup> One qualitative study reported that nurses responsible for implementing a clinic-integrated food prescription program desired additional training to better understand culturally specific beliefs, values, and customs as well as behavioral change theory.<sup>135</sup> Having standardized screening tools and referral systems in place can help providers identify and connect patients with appropriate interventions. Building relationships and collaborating with community organizations, food banks, and social services can enhance providers' ability to refer patients to relevant interventions.

Health system-level facilitators include policy support, integration of services, and data collection and evaluation. Supportive policies that recognize the importance of addressing food insecurity and allocate resources for interventions are important to facilitate implementation.<sup>127, 138</sup> Integrating food insecurity interventions into existing healthcare services, such as embedding nutrition counseling within primary care, can improve access and delivery.<sup>139</sup> Establishing systems to collect data on food insecurity and evaluate the impact of interventions can drive continuous improvement and accountability.<sup>138, 140</sup>

Finally, community-level facilitators may include collaborative partnerships, community engagement, and access to resources. Building collaborations between healthcare organizations, community-based organizations, and local government entities can enhance the reach and effectiveness of interventions.<sup>138</sup> Engaging community members in the design and implementation of interventions fosters trust, buy-in, and sustainability.<sup>141</sup> Availability of food pantries, community gardens, farmers markets, and other local food initiatives can improve access to affordable and nutritious food.<sup>127</sup>

As previously noted, strong collaborations between health systems and community partners are critical to successful implementation of interventions to address food insecurity. For example, a pilot study of a food prescription program implemented in two school-based clinics and one federally qualified health center in an area with a high rate of food insecurity conducted surveys and key informant interviews to assess perceptions of healthcare providers and implementation staff. Implementation partners included a food bank, two food pantries, and a healthcare implementation partner. Responses highlighted the importance of training, ongoing support for programming, and effective communication between implementation partners as important predictors of implementation success.<sup>15</sup> One interviewee stated, "Overall, I think the trainings, particularly with the clinics, went extremely well because we had to rely on them a lot." Another participant highlighted the importance of trust and communication between

organizational partners, noting, “Once you build a relationship with them, it’s all about community trust, and if you do not close that loop of communication, you’re going to break that trust.”

### *Barriers to Implementing Effective Intervention Programs*

Patient-level barriers to implementing effective intervention programs include stigma or shame, lack of knowledge or skills, and limited resources. The perceived stigma associated with receiving assistance for food insecurity may deter patients from seeking or accepting interventions.<sup>119, 136</sup> Patients may lack knowledge about available resources and how to access them, or they may lack the necessary skills to prepare and access healthy food.<sup>135</sup> Finally, financial constraints, work conflicts, physical limitations, transportation challenges, or lack of access to grocery stores and fresh produce can hinder patients' ability to engage in interventions.<sup>119, 134, 136, 142</sup>

Common provider-level barriers may include time constraints, limited awareness and resources, and inadequate reimbursement. Providers may have limited time during patient visits, making it challenging to discuss food insecurity comprehensively and provide detailed interventions.<sup>143</sup> Providers may also have limited knowledge of available community resources or face challenges in accessing and coordinating appropriate interventions for their patients.<sup>144</sup> Furthermore, the lack of financial incentives or reimbursement for addressing food insecurity can undermine providers' (and health systems') motivation to prioritize and invest time in interventions.<sup>145</sup>

Health system-level barriers can include limited resources, fragmented systems of care, and inadequate policies and procedures.<sup>140</sup> Insufficient funding, staffing, and infrastructure can hinder the development and implementation of effective interventions at the health system level. Lack of coordination and communication between healthcare providers, community organizations, and social services can also create barriers to accessing and delivering interventions. Absence of policies or regulations that mandate or support interventions to address food insecurity can impede implementation efforts.

Common community-level barriers may include limited resources, cultural or language barriers, and geographic disparities between communities. Communities with limited infrastructure, funding, and resources may struggle to develop and sustain interventions to address food insecurity.<sup>127</sup> Cultural and linguistic diversity within communities can present challenges in delivering culturally appropriate interventions and engaging diverse populations.<sup>130</sup> Finally, rural communities may face unique challenges, such as limited access to transportation and a scarcity of food retail options, making it difficult to implement interventions effectively.

## Appendix G. Ongoing Studies

Appendix G Table 1. Ongoing Studies

Study Name Trial identifier	Design	Aim	Relevant Outcome(s)	Country	Estimated N	Status in 2023
Maximizing Nutrition Education to Meet Dietary and Food Security of Children and Parents <a href="#">NCT05196763</a>	RCT	Determine effect of adult-focused direct SNAP-education intervention on child diet quality and household food insecurity.	Food insecurity, dietary quality	US	300	Recruiting  Estimated completion date: Dec. 2025
Healthy Food Prescription Incentive Program <a href="#">NCT04725630</a>	RCT	Investigate impact of a healthy food prescription incentive program among adults who are experiencing food insecurity and persistent hyperglycemia.	HbA1c, diet quality, fruit & vegetable intake, blood lipid levels, waist circumference, BMI, food insecurity, medication adherence	Canada	594	Recruiting  Estimated completion date: Dec. 2023
Home Food Delivery for Diabetes Management in Patients of Rural Clinics <a href="#">NCT04876053</a>	RCT	Evaluate impact of food delivery intervention among rural food insecure patients with type 2 diabetes.	HbA1c	US	400	Recruiting  Estimated completion date: Jun. 2025
Eat Well Produce Benefit for Diabetes and Food Insecurity <a href="#">NCT05896644</a>	RCT	Assess impact of participation in a produce prescription program with diabetes education materials in diabetes patients at risk of food insecurity.	HbA1c, ED visits, outpatient visits, hospitalizations, BMI, cholesterol, medication adherence, blood pressure	US	3000	Recruiting  Estimated completion date: Dec. 2025
CommunityRx-Hunger <a href="#">NCT04171999</a>	RCT	Evaluate impact of a hospital-based intervention to address food security and other health-related social needs among caregivers	Caregiver satisfaction	US	660	Not recruiting  Estimated completion date: Aug. 2023

Study Name Trial identifier	Design	Aim	Relevant Outcome(s)	Country	Estimated N	Status in 2023
		experiencing food insecurity.				
Food As Medicine Study <a href="#">NCT05407376</a>	RCT	Assess the effect of a produce prescription intervention for patients enrolled in Medicaid who experience consistently uncontrolled HbA1c.	Food insecurity, HbA1c, food-related self-management, diet quality, nutrition security	US	450	Not recruiting  Estimated completion date: Jun. 2023
Addressing Diabetes by Elevating Access to Nutrition (ADELANTE) <a href="#">NCT05228860</a>	RCT	To determine whether a multilevel intervention to improve household food insecurity and glycemic control is effective for Latino patients with diabetes.	Food insecurity, HbA1c, cholesterol, blood pressure, BMI, waist-height ratio, HRQoL, depression, anxiety, loneliness, dietary intake, diet-related behaviors, physical activity, nutrition security	US	360	Recruiting  Estimated completion date: Jun. 2027
addressInG iNcome securITy in Primary care (IGNITE) <a href="#">NCT02459184</a>	RCT	Evaluate the impact of an income-focused health promoter for adults living in poverty.	Food insecurity, QoL, HRQoL	Canada	284	Not recruiting  Estimated completion date: Jan. 2022
Intervening in Food Insecurity to Reduce and Mitigate (InFoRM) Childhood Obesity <a href="#">NCT05586269</a>	Randomized crossover comparative effectiveness	Compare impact of a meal kit delivery intervention with a newsletter and pantry referral in families and children with food insecurity and obesity.	Food security, child BMI	US	30	Not recruiting  Estimated completion date: Dec. 2024



Study Name Trial identifier	Design	Aim	Relevant Outcome(s)	Country	Estimated N	Status in 2023
Delivering Food Resources & Kitchen Skills (FoRKS) to Adults With Food Insecurity and Hypertension <a href="#">NCT05856591</a>	Randomized comparative effectiveness	Compare impact of a home-delivered foods and kitchen skills program with enhanced usual care on health and nutrition in adults with high blood pressure and food insecurity.	Blood pressure, HbA1c	US	200	Recruiting  Estimated completion date: July 2027
Indigenous Supported Agriculture "Go Healthy" <a href="#">NCT05773833</a>	Randomized comparative effectiveness	Compare effects of an indigenous supported agriculture program vs. monetary compensation of equal value among Native Americans with overweight or obesity.	Food insecurity, diet quality, blood pressure, BMI, HbA1c	Osage Nation (US)	400	Recruiting  Estimated completion date: April 2025
Fresh RX: NHS 2020 <a href="#">NCT04845230</a>	Randomized comparative effectiveness	Compare impact of a program providing food delivery with or without integrative care services with facilitated referrals to food insecure pregnant women.	Food insecurity, physical and mental health, birth weight	US	750	Recruiting  Estimated completion date: Sept. 2026
Food As MedicinE for Diabetes (FAME-D) <a href="#">NCT04828785</a>	Randomized comparative effectiveness	Evaluate impact of a medically tailored meal intervention or usual care + monthly food subsidy for adults with food insecurity and type 2 diabetes mellitus.	Food insecurity, HbA1c, health-related quality of life, depressive symptoms, hypoglycemia	US	200	Recruiting  Estimated completion date: Jan. 2025
Fruit and Vegetable Rx (FVRx) + Home Plate <a href="#">NCT04986046</a>	Randomized comparative effectiveness	Compare the impact of fruit and vegetable prescription vouchers with or without a cooking skills program among adults with type 2 diabetes and BMI $\geq 25$ .	Food insecurity, diet quality, caregiver mental health	US	90	Recruiting  Estimated completion date: Dec. 2023
Nourishing Beginnings: Addressing Food Insecurity During Pregnancy	Randomized comparative effectiveness	Compare effectiveness of a food delivery program vs. financial support and navigation	Food insecurity, maternal depression, infant birthweight,	US	124	Recruiting  Estimated completion date: Jul. 2024

Study Name Trial identifier	Design	Aim	Relevant Outcome(s)	Country	Estimated N	Status in 2023
<a href="#">NCT05341960</a>		during pregnancy among Medicaid eligible .	infant gestational age at birth			
Linking Education, Produce Provision, and Community Referrals to Improve Diabetes Care (LINK) <a href="#">NCT05472441</a>	Randomized comparative effectiveness	Compare the effects of produce provision, diabetes education, and/or community referrals in individuals with type 2 diabetes experiencing food insecurity.	Food security, HbA1c	US	568	Recruiting  Estimated completion date: Oct. 2026
At-risk and vulnerable Individuals To Infection With COVID-19 and ProActive inTervention With intEgrated Health and Social Care (ANTICIPATE) <a href="#">NCT05197608</a>	Randomized comparative effectiveness	Compare the impact of an embedded System Navigator with a list of tailored community resources among at-risk and vulnerable patients age 60 years or older.	Social needs met, emotional distress, mortality, and hospitalizations	Canada	180	Not yet recruiting  Estimated completion date: Dec. 2022
The Good Food Rx: Food-as-medicine Program <a href="#">NCT05541458</a>	Pre-post	Determine impact of nutritional food boxes partnered with nutrition education classes among adults with hypertension, elevated HbA1c, hyperlipidemia and/or obesity.	Blood pressure, HbA1c, cholesterol, body weight	US	25	Not recruiting  Estimated completion date: Apr. 2024
Feasibility and Impact of the FOOD4MOMS Produce Prescription Program Among Pregnant Latina Women <a href="#">NCT05907616</a>	Pre-post	Evaluate impact of 10 months of produce provision with education sessions in pregnant Latina women.	Produce intake, household food insecurity	US	150	Not yet recruiting  Estimated completion date: July 2024

Abbreviations: BMI=body mass index; ED=emergency department; HbA1c=hemoglobin A1c; HRQoL=health-related quality of life; RCT=randomized controlled trial; SNAP=Supplemental Nutrition Assistance Program

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