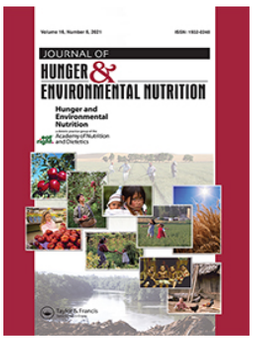

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# Community-Based and System-Level Interventions for Improving Food Security and Nutritious Food Consumption: A Systematic Review

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**ABSTRACT**

As studies examining the effectiveness of food security interventions collectively are sparse, this review examined the most effective community-based and system-level interventions that have increased nutritious food consumption across food-insecure populations. Following PRISMA-guidelines, 22 articles included were classified into six categories: Educational and Behavioral Programs; Fresh Fruit and Vegetable Programs; Summer Electronic Benefits Transfer; Discounted Food Options; Emergency Food Assistance Programs; and Multicomponent Programs. This review concludes that future considerations for positively impacting food security and nutritious food intake should give attention to community and system-level multicomponent interventions that address the specific social and economic barriers facing the target population.

**KEYWORDS**

Food insecurity; nutritious food; community-based interventions; system-level interventions; systematic review

## Introduction

Food insecurity, a condition in which households/individuals have uncertain or limited access to adequate food because of economic or social factors, is currently one of the leading health issues in the United States. The two labels that broadly define food security include food security and food insecurity. Food security is further classified into high food security, where there is a lack of any reported indications of food-access issues or limitations and marginal food security, where there are one or two reported indications of food-access issues with minimal or no indication of variations in food intake.[1] Food insecurity comprises of low food security and very low food security. Low food security is when an individual report reduced quality, variety, or

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desirability of the diet with minimal or no indication of diminished food intake.[1] In 2017, a little over one-third of the food-insecure households in the U.S. were noted to be at a more severe level known as "very low food security," a condition when the food intake is reduced and eating patterns are disturbed due to the lack of resources for obtaining food.[2] Research suggests that 54 million Americans were projected to be food insecure in 2020, indicating an increase of 17 million individuals since 2018 that is largely attributed to increased unemployment and poverty due to COVID-19.[3]

Food insecurity is a significant public health issue, and its prevalence is higher for vulnerable populations, such as homeless individuals, older adults, recent immigrants, households with income near or below the Federal poverty line, African American and Hispanic-headed households, women, and men living alone, and households with children headed by single women or single men.[2,4,5] Both food insecurity and low socioeconomic status are associated with lower food expenditures,[6] one of the coping strategies for food-insecure individuals.[7]

Access to adequate, nutritious, and safe food affects not only the wellbeing of people who face food insecurity but also hampers their ability to prevent and manage health conditions, such as type 2 diabetes mellitus, heart disease, hypertension, influenza, and many more.[5,8] Food-insecure individuals are two to three times more likely to have diabetes than individuals who are food-secure, even after controlling for relevant risk factors such as employment status, income, physical measures, and lifestyle factors.[9] The adverse health outcomes are further compounded by the prevalence of food security problems.

Many interventions or programs targeted at providing food assistance to the food insecure populations have been implemented in the United States. These interventions include but are not limited to food pantries, soup kitchens, emergency kitchens, the Supplemental Nutrition Assistance Program (SNAP), the Food Stamps Program, the National School Lunch Program, the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), WIC Farmers' Market Nutrition Program, and the Seniors' Farmers Market Nutrition Program.[2,4,10–12] It is important for such programs to address the underlying causes contributing to lack of access to food and more specifically, nutritious food options. The vulnerable populations noted to be more significantly impacted highlights the role of structural racism as a root cause of food insecurity.[13,14] Moreover, Holben & Marshall[15] proposed that in addition to providing food assistance and nutrition education to food insecure individuals, it is crucial to address other underlying causes of food insecurity such as lack of resources, underemployment, unemployment, poor health, poverty, and low education, which are further compounded by racial discrimination.[13,14]

While some literature has identified a few of these programs as valuable sources to bridge the food security gap for food insecure populations,[4,10] to the best knowledge of the authors, there has been no known research study that has examined the effectiveness of these programs collectively within the United States. The purpose of this systematic review is to examine the most effective community-based and system-level interventions or programs that have increased consumption of nutritious food among the food-insecure population.

## Methodology

The methodological process of this systematic review was conducted and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines for reporting the results of research synthesis. The details on the search strategy for identifying studies are outlined in Figure 1.

Articles included in this review consist of peer-reviewed empirical studies that assessed the most effective programs for addressing food insecurity in the United States. Four databases were searched for articles, including Agricola, EBSCOhost, ProQuest, and PubMed. Several combinations of the following

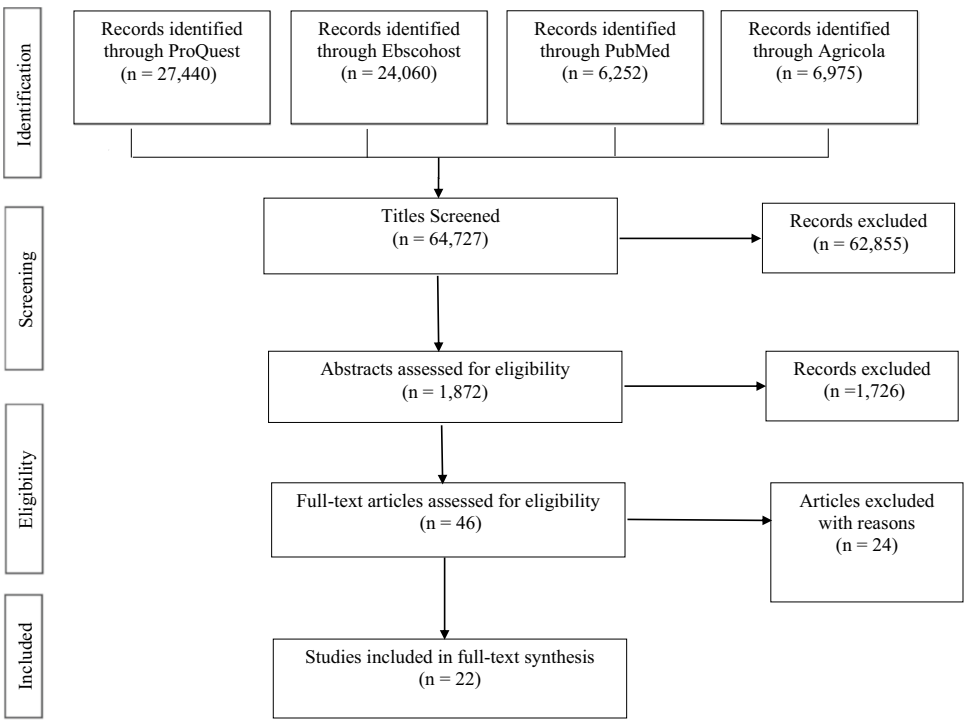


**Figure 1.** Search strategy for identifying studies for the systematic review.

keywords were used: "*food accessibility,*" "*food security,*" "*food consumption,*" "*food affordability,*" "*nutritious food,*" "*system-based interventions,*" and "*community-based interventions.*" The keywords were selected in view of the study's objective, as noted in the introduction section. The inclusion criteria for the systematic review included articles only from the United States, peer-reviewed articles published between January 1, 2009, and December 31, 2018, and articles written in the English language. The landmark report by Haering & Syed in 2009[16] previously evaluated relevant literature on community food security as the authors synthesized and documented effective community food security measures and interventions in the U.S. to that point. Additionally, in 2015, the Johns Hopkins Center for a Livable Future released a subsequent report on the literature around community food security in the United States.[17] Thus, our review builds on and extends the findings of these earlier reports.

On applying the inclusion criteria, a total of 64,727 articles were initially identified from the database search, of which 62,855 articles were removed after the title screening. Abstracts of the remaining 1,872 articles were read, and 1,726 were discarded based on lack of relevance to the research question. The full text of the remaining 46 articles underwent an in-depth review, and 24 research articles were removed as they did not measure the effectiveness of interventions to address food insecurity issues in the community. Finally, the remaining 22 articles were included in this systematic review. Data were systematically extracted from the included research studies, such as the objective of the study, data source, study period, study design, the statistical method used, if any, study population, outcome variable, results, conclusion, and funding source.

## Results

The 22 studies included in this systematic review assessed the dimension of food security and nutritious food consumption using different measurement tools, as shown in Table 1. Depending on the interventions that were used to assess the improvements of food security level or consumption of nutritious foods, all the studies were classified into six categories: Educational and Behavioral Programs; Fresh Fruit and Vegetable Programs; Summer Electronic Benefits Transfer; Discounted Food Options; Soup Kitchens; and Multicomponent Programs. Both quantitative and qualitative research studies were included in this review. Also, nine (40.9%) studies assessed food security, while eight (36.4%) studies assessed nutritional food intake. In addition, five (22.7%) studies examined food security together with nutritional food intake. Table 1 summarizes the specific measurement tools, outcome measures, and magnitude of outcomes as described by each article, which are more explicitly discussed in the following sections.

**Table 1.** Summary of included studies.

| Study | Study Design | Level of Study | Intervention category | Metric | Metric Category | Findings |
|---|---|---|---|---|---|---|
| Bowling et al.[18] | Quasi-experimental study | Household | Multicomponent: Healthy Foods, Healthy Families (HFHF) | Survey questions- food assistance expenditure patterns, F & V intake and soda intake. | Nutritional food intake | • An increase in vegetable consumption and a decrease in soda consumption in participants.<br>• Family consumption of F&V improved by 70%. |
| Collins et al.[33] | Randomization design | Household | Summer Electronic Benefits Transfer for Children (SEBTC) | The USDA's 18-item US Household Food Security Survey Module with a 30-day reference period. | Food security | • A one-third decrease in the occurrence of very low food security in children.<br>• Out of eight child nutrition outcomes measured, six showed positive change. |
| Coughenour et al.[35] | Cross-sectional study | Community | Discounted food option | NEMS-S; availability, quality, price of healthier versus regular food, and a summary score. | Food security | • Diminished availability of healthier food choices at dollar-discount stores.<br>• Reduced likelihood of lower pricing of healthier food options at dollar-discount stores. |
| Cullen et al.[19] | Randomized control trial. | Individual | Educational and Behavioral Program: EFNEP | Client surveys, height and weight were measured using CDC stadiometer. | Nutritional food intake | • Significant reduction in BMI was only recorded in the intervention group.<br>• Both groups showed significant improvements in food and nutrients consumption. |
| Davis et al.[29] | Quasi experimental design | School- based | Fresh Fruit and Vegetable Program (FFVP) | Fruit and vegetable intake data were collected with seven questions from (Youth Risk Behavior Survey) YRBS. | Nutritional food intake | • Increased likelihood of intervention group to report consuming fruit and 100% fruit juice at least twice daily. |
| Dollahite et al.[20] | Switching replications randomized experimental design | Individual | Educational and Behavioral Program: | Ten-item self-reported behavior checklist on nutrition, food resource management, food safety, and food security; responses on a 5-point scale. | Food security | • Improved behaviors were seen in both groups.<br>• Reported behavior changes continued for a minimum of two months. |
| Eicher-Miller et al.[21] | Single-blind randomized design | Individual | Educational and Behavioral Program: FSNE | Six-item United States Household Food Security Scale and USDA Food Insufficiency Question. | Food security | • Experimental group participants showed significant improvement in food insecurity and food insufficiency. |

(*Continued*)

**Table 1.** (Continued).

| Study | Study Design | Level of Study | Intervention category | Metric | Metric Category | Findings |
|---|---|---|---|---|---|---|
| Gans et al.[22] | Randomized control trial | Community | Multicomponent: Mobile F&V markets plus nutrition education | F&V consumption measured by National Cancer Institute's 'Eating at America's Table All Day Screener'. | Nutritional food intake | • Post-intervention, F &V consumption among the intervention group increased by 0.44 cups while the consumption decreased by 0.08 cups among the control group.<br>• Improvement in F &V consumption behavior was recorded in the intervention group. |
| Gordon et al.[34] | Random-assignment design | Household | Summer Electronic Benefit Transfers for Children (SEBTC) | Children's food security (assessed using the USDA food security scale) and food consumption (assessed using food frequency questions). | Food security & Nutritional food intake | • SEBTC benefits redeemed by benefit-group households in WIC sites were fewer compared to the SNAP sites.<br>• Both sites benefit groups showed reductions in very low food security among children. |
| Hosseini et al.[37] | Qualitative study | Individual | Soup Kitchens | Survey questions. | Food security | • Older women groups had uniquely different usage trends and needs as compared to other groups using soup kitchens.<br>• They also had the highest use of soup kitchens. |
| Huang et al.[39] | Panel design | Household | Multicomponent: National School Lunch Program (NSLP) | Five food security questions excerpted from the 18-item USDA Food Security Scale (FSS). | Food security | • The addition of one month to the reference period improves the difference rates in low food security by approximately 1.5 percentage points amongst NSLP recipients and eligible non-recipients. |
| Kegler et al.[23] | Quasi-experimental | Household | Educational and Behavioral Program; Coach-based | Data collected via telephone interviews at baseline, 2- and 4-months post-baseline. | Food security & Nutritional food intake | • Significant improvements in household food inventories, F&V purchase, making healthier meals, and familial support for healthy food consumption in the intervention group. |
| Lohse et al.[24] | Randomized Controlled Trial | Individual | About Eating (AE) | Food security was assessed with the USDA 6-item food security screener to reduce respondent burden. Food resource management skills and eating competence were also evaluated. | Food security | • Participants had improved food resource management skills.<br>• Participants classified as food secure had increased confidence in food money management and monitoring of food-related purchases. |

(*Continued*)

**Table 1.** (Continued).

| Study | Study Design | Level of Study | Intervention category | Metric | Metric Category | Findings |
|---|---|---|---|---|---|---|
| Martin et al.[38] | Randomized parallel-group study with equal randomization | Individual | Multicomponent: Freshplace | The validated USDA's 18-item U.S. Household Food Security Module was used. | Food security | • The Intervention group had improved self-sufficiency and a rise in consumption of F & V by one serving per day and were less likely to report very low food security. |
| Nagata et al.[25] | Quasi-experimental study | School-based | Multicomponent: Fresh Fruit, Vegetable and nutrition education Program | Surveys were adapted from the 2005 dietary Guidelines for Americans from the U.S. Department of Health and Human Services and the Department of Agriculture. | Nutritional food intake | • Consumption of soft drinks and candy was lower in the intervention group.<br>• No significant changes in F & V consumption were recorded in the intervention group. |
| Ohri-Vachaspati et al.[30] | Cross-sectional study | School-based | Fresh Fruit and Vegetable Program (FFVP) | Mail-back surveys, items from existing survey and expert advice were employed. | Nutritional food intake | • An increase in the likelihood of FFVP participating schools to provide students with fresh fruit during lunch. |
| Prelip et al.[26] | Quasi-experimental | School-based | Educational and Behavioral Program | Questionnaire completed at baseline and post- intervention. | Nutritional food intake | • Significant positive influence of teachers on the children's attitudes regarding F & V.<br>• Positive development of student knowledge and attitudes related to vegetables. |
| Ridberg et al.[31] | Panel design | Household | FFVP | Change was measured in 5 household-level behaviors, adapted from the USDA's 18-item Household Food Security Survey. | Food security & Nutritional food intake | • The Study recorded a 72% increase in summative food security score. |
| Saxe-Custack et al.[32] | Qualitative study | Household | FFVP | Semi-structured interview with 8- question guide and analyzed using thematic analysis. | Food security & Nutritional food intake | • Program perceived as beneficial in increasing food security, food accessibility and consumption of fresh F & V in children. |
| Torrence et al.[27] | Quasi experimental design | Community | Educational and Behavioral Program: The Faithful Families Cooking and Eating Smart and Moving for Health (FFCESMH) | The validated Cooking Matters scales, the Faithful Families Eating Smart and Moving More Self-Efficacy for Healthy Behaviors Scale, and the validated Rapid Assessment of Physical Activity (RAPA). | Food security & Nutritional food intake | • Significant changes were observed in participant perception of food security, confidence in cooking, and self-efficacy. |
| Trude et al.[28] | Randomized Controlled trial | Individual and Community | Multicomponent: Discounting, increased availability, promotion and nutrition education | Block Kids food frequency Questionnaire and self-reports. | Nutritional food intake | • The Intervention group showed 1.4 times rise in healthier food and beverages purchases and a 3.5% reduction in kcal from sweets. |

(*Continued*)

**Table 1.** (Continued).

| Study | Study Design | Level of Study | Intervention category | Metric | Metric Category | Findings |
|---|---|---|---|---|---|---|
| White et al.[36] | Qualitative study | Household and Community | Discounted Food Options: Cost-offset community-supported agriculture (CO-CSA) | Focus groups were conducted at the end of the first CO-CSA season. Participants were interviewed about program Experiences. Discussion guide was based on the 5A framework of food access. | Food security | • The amount of produce was abundant, accessible, and affordable to most participants.<br>• Payment timing was recorded as a barrier for some participants. |

### Educational and Behavioral Programs

Eleven studies (50%)[18–28] assessed food security using educational and behavioral interventions. These studies reported significant improvement in food security from these interventions. Nine of these studies[18–22,24–26,28] focused on educational intervention while two[23,27] assessed behavioral interventions at the community level. Eich-Miller et al.[21] quantified food insecurity outcomes by employing the United States Department of Agriculture (USDA) Household Food Security Survey in evaluating the Food Stamp Nutrition Education (FSNE) in Indiana. They found FSNE significant in improving participants' food insecurity ($p$ = .03) and food insufficiency ($p$ = .04) in the experimental group compared to the control group.

Two studies[19,20] assessed the Expanded Food and Nutrition Education Program (EFNEP), and both found a significant positive effect of these programs. Cullen et al.[19] recorded a significant improvement ($p$ = .03) in nutritional status assessed in Body Mass Index (BMI) in the intervention group. The intervention included six-short videos, with goal setting, self-efficacy, guided discussion, and handouts into existing EFNEP classes. Post-intervention, a significant decrease in emotional feeding, low-fat food, fruit, and vegetable barriers, was reported across the intervention and control groups. The findings in both the intervention and control groups were likely a result of the latent benefit of the existing EFNEP classes conducted for the control group despite not having the full intervention components of the experimental groups.

Similarly, in the randomized controlled trial of a Community-Based Nutrition Education Program for Low-Income Parents,[20] the EFNEP was assessed, and significant improvement ($p < .05$) in nutrition behaviors and food security was found in the groups which received the intervention. The intervention entailed eight-weekly workshops based on eating right and was adapted to incorporate more visuals and dialogue approach with experiential learning.

Additionally, two studies[23,27] assessed the effects of modifying community and family feeding behaviors. They both reported improved health behaviors, purchase, and consumption of nutritious foods improved enabling environment for healthy eating and activities, and an overall increase in food security.

Three of these studies included education as part of their interventions[18,25,28] and recorded improvement in food security and nutritional status post-intervention. Lohse et al.[24] conducted a randomized control trial for an online education program and assessed food security with the USDA 6-item food security screener, finding that post-intervention, study participants had improved food security status. Moreover, participants had increased use of food resource management skills (for budget $p$ = .008 and for

planning meals $p = .002$), and the participants classified as food secure had increased confidence in food money management ($p = .002$) and keeping track of food-related purchases ($p = .02$).

### Fresh Fruit and Vegetable Programs

FFVP is a federal program initiated in 2002 by the USDA to increase fruit and vegetable (F&V) consumption in people with low socioeconomic status and tackle obesity in these populations.[25] Seven studies (31.8%) evaluated Fresh Fruits and Vegetable Program (FFVP) impact on food security.[18,22,25,29–32] These studies found a significant increase in F & V intake post-intervention. These studies employed a quasi-experimental design[21,24] cross-sectional design,[29] panel design,[30] qualitative,[31] and a cluster randomized control trial[22] to assess the program's effect on F&V consumption.

Five[18,22,25,29,30] of these studies assessed nutritional food intake, while two[31,32] examined food security and nutritional food intake. Ridberg et al.[31] adopted the USDA's 18-item Household Food Security Survey in assessing the impact of a pediatric fruit and vegetable prescription program on household food security and found significant improvement (72% of participants increased their total food security scores; $p = < 0.001$) in household food security post-intervention. A concurrent improvement in household food security with increased participation in the fresh fruit and vegetable prescription program was also reported.

Table 2 shows the effect of FFVP on F&V consumption in studies that included a control group in the analysis.[22,25,29,30] Three of these studies[22,29,30] recorded a significant increase in the consumption and availability of fruits within the intervention group. Although one study did not find any significant difference in fruit intake post-intervention, improved dietary behavior and a significant reduction in the consumption of low nutritious foods such as soft drinks and candy were found among participants in the intervention group as compared to control group (3.1% vs. 8.9%, $p = .01$).[25] As it relates to vegetable consumption, results among the included studies varied, with two studies finding an increase in vegetable consumption post-intervention[20,29] and two studies not finding a significant increase in consumption.[25,29] More specifically, Davis et al.[29] noted that vegetable consumption was low, with only about 13% of students in both intervention and control groups meeting the

**Table 2.** Effects of fresh fruits and vegetable programs on F & V consumption.

| | Fruits | | | Vegetables | | |
|---|---|---|---|---|---|---|
| Study | Intervention | Control | P-value | Intervention | Control | P-value |
| Davis et al.[29] | 59.1% | 40.9% | < 0.05 | 12.5% | 13.4% | > 0.05 |
| Gans et al.[22] | 1.39 | 1.31 | 0.056 | 2.32 | 2.10 | 0.01 |
| Nagata et al.[25] | 43.5% | 42.8% | 0.71 | 13.0% | 10.5% | 0.41 |
| Ohri-Vachaspati et al.[30] | 79.2% | 62.0% | < 0.01 | 81.9% | 77.2% | < 0.01 |

recommended guideline of consuming three or more vegetables daily. Similarly, Nagata et al.[25] found that only 13.0% and 10.5% of students in the intervention and control groups, respectively, consumed three or more vegetables daily.

### Summer Electronic Benefits Transfer Programs

Two studies (9.1%) assessed the food security using the Summer Electronic Benefits Transfer for Children (SEBTC) at the household level.[33,34] Both studies used the USDA's Food Security Scale as a tool for measuring the impact of the program on the household food security level. Additionally, Gordon et al.[34] also used the food frequency questions used in the National Health and Nutrition Examination Survey Dietary Screener Questionnaire to examine the food consumption and nutrition outcomes for children. Post-intervention, SEBTC was reported to have decreased the prevalence of very low food security among children in the intervention group and was approximately one-third lower, relative to the control group; thus, showing a positive impact on addressing food security issues in the population.[34]

### Discounted Food Options

Two studies (9.1%) evaluated the issues related to access of discounted food options on food security using dollar discount stores[35] and community-supported agricultural program (CO-CSA).[36] Coughenour et al.[35] employed the Nutrition Environment Measures Survey in stores (NEMS-S), a protocol that, in addition to an overall summary score, is comprised of three sub-scores – price, availability, and quality, of healthier versus regular food to assess food security. According to the NEMS-S scoring, when compared to regular foods, healthier foods are generally characterized as being leaner, containing whole grains, and/or being lower in fat content and sodium, among other criteria.[35] The NEMS-S tool was employed to measure the price differences between the healthier and regular food choices by allotting higher points to the healthier food choice if its cost was lower than the regular food choice and deducting points if the healthier choice cost more than the regular food option. Further, the NEMS-S tool assessed availability by allotting higher points to stores offering greater variety of healthier foods and quality by assigning more points to stores with a greater proportion of acceptable fruit and vegetables.[35] When compared to the dollar discount stores, the availability of variety in food choices was significantly higher ($p < .001$), and prices of healthier food choices were significantly lower ($p < .001$) in grocery stores. However, over 80% of food items were less expensive at dollar discount stores as compared to grocery stores, and there was no significant difference ($p = .34$) in the quality of produce between dollar discount stores and grocery stores. Study findings indicated that dollar discount stores could serve as a community asset, as

well as assist in efforts to restore food security.[35] In a qualitative analysis, it was observed that although the CO-CSA facilitated improved access to F&V for families of low socioeconomic status, the knowledge amongst the target population regarding a healthy diet might be restricted by barriers including transportation challenges to share pick-up and lack of organization at the pick-up venue. Food waste concerns were acute for families with limited resources.

### *Emergency Food Assistance Programs*

Two studies (9.1%) examined the impact of a soup kitchen/food pantry on an individual's food security level.[37,38] One study employed a qualitative research study design to investigate the factors necessary to satisfy the needs of the people suffering from food insecurity,[37] while the other study used a randomized parallel-group study with equal randomization to evaluate the impact of a food pantry intervention in promoting food security.[38] Hosseini et al.[37] found that to relieve the burden borne by the U.S. nonprofit food assistance organizations, soup kitchens need to offer information about the various federal programs for food security, transportation, and other resources tailored to senior women at soup kitchens to promote their wellbeing. Martin et al.[38] found that the food pantry intervention increased the participants' food self-sufficiency and F&V consumption by one serving per day. Participants were less than half as likely to experience very low food security in the intervention group than the control group. All the outcomes were found to be significant ($p < .01$).

### *Multicomponent Programs*

Six studies (27.3%)[18,22,25,28,38,39] used multiple components to evaluate the impact of interventions on the food security level and nutritional food intake. That is, these studies used some combination of interventions. Three of these studies used randomization, and two used quasi-experimental design to evaluate changes to food security. Multicomponent programs included F&V tastings, cooking demonstrations, discounts, mobile fresh F&V markets in conjunction with nutrition education, client-choice pantries, monthly meetings with a project manager to receive motivational interviewing, targeted referrals to community services, distribution of fruits biweekly, nutrition education, and improving availability of healthier alternatives to high-sugar, high-fat beverages and snacks in small food stores.

Interventions combining food tasting opportunities, modest financial incentives at farmers'/local markets in low-income neighborhoods, and nutrition education showed great potential[18,22] to enhance families' diet quality rather than short-term assistance. That is because vegetable consumption increased significantly for participants post-intervention, and 70% of

participants even reported significant improvements in family consumption of F&V.[18] However, discontinuation of financial and food-based incentives from the intervention can lead to challenges in maintaining the positive outcomes over an extended time. Most of the studies[22,25,28,38] in this category had at least 12 months of follow-up of the study participants. Beyond the educational components of many of these interventions, they also targeted multifaceted causes of food insecurity, such as policy, systems, and environmental (PSE) components related to the participants. Multicomponent interventions reported long-term increases in food security as high as over 4 points ($p$ = .03) increase in self-sufficiency, and a greater than 50% decrease in very low food insecurity.[38] Also, over a 40% increase in nutritious food intake[28] and a significant reduction in the consumption of low nutritious/ less healthy foods[25] were recorded.

## Discussion

This systematic review aimed to understand the effective community and system-level interventions that have successfully improved food security within the United States. Community and system-level interventions comprise nutrition education, public health, community and system nutrition, environmental planning, and community development.[16,17,40] Food assistance by itself has been seen as incapable of effectively resolving food insecurity.[39] This necessitates the need for additional strategies that are required to supplement food assistance programs.

Education and behavioral interventions are known methods that significantly improve food security. The positive effects of EFNEP and FSNE, seen in the studies in this review, concurs with previous literature[10,38] that has established that these programs significantly improve food security status. The EFNEP was established in 1968 and has been reported to improve participants' diets, reduce the consumption of low nutritious foods, and increase healthy eating habits. Also, the FSNE program provides nutrition education to people with low-income and who are food-insecure. The FSNE program has similarly been shown to improve food security status and food insufficiency.[17]

In addition, online educational and behavioral interventions are well documented to improve nutritional status. For example, About Eating (AE) was adapted from the scatter model of eating competence and is an individual-based approach that modifies feeding behaviors through food selection, management, and skillful regulation of food intake.[23] Online programs may be another avenue for improving nutritional intake. However, these programs' success also requires that individuals have access to the internet and capable devices, which may preclude certain populations from participation.

Furthermore, most of the studies in this review found a significant increase in F&V consumption as well as an increase in nutritional status. Similarly, the fruit and vegetable prescription program, which is a partnership model where health personnel prescribes F&V in the form of coupons to selected individuals with low income, has yielded a positive increase in the consumption of F&V and improved nutrition status.[41] Despite the success of these FFVPs, it is of particular note that F&V consumptions were generally low across groups, and significantly lower in control groups. This has been a prevalent trend nationally. As of 2018, the CDC reported that only 12.2% and 9.3% of adults nationwide meet the daily F&V intake recommendation, respectively.[42] Similarly, only 9% and 2% of high school students nationwide meet the F&V intake recommendation, respectively.[42] This situation further highlights the need for the implementation and sustainability of FFVPs nationally.

Emergency food assistance programs such as food pantries and food kitchens make up a crucial part of food networks, which are seen across the United States. These programs are normally funded through public donations and government programs such as the Federal Emergency Food Assistance Program, in which the stock of food is mainly received from food banks. These food banks are typically community-based and nonprofit agencies.[16,43] Food banks and food pantries are found to considerably improve food security and dietary intake.[37,38,44] However, they have been reported to have limited abilities to support healthy diets due to their limited provisions of highly nutritious foods.[4,45] Food banks and food pantries were found to provide inadequate nutrient-rich foods such as fruits, vegetables, and dairy.[4] In another study, food panties were found to offer low amounts of milk products and products containing calcium, zinc, vitamin A, and vitamin C.[45]

Although not many studies have been published that assessed the effects of SEBTC, the two articles included in this systematic review showed that implementing SEBTC can improve food security.[33,34] Similarly, the National School Lunch Program (NSLP), which is a crucial federally funded food assistance program in the United States, was found to significantly improve household food security and nutrition status for low-income school-age children.[40]

The success of interventions recorded from programs such as the FSNE, EFNEP, FFVP, SEBTC, and related programs aimed at advancing the role of PSE, underscores its potential in addressing food insecurity and nutritional intake. PSE interventions are recognized to successfully improve food security and nutritional intake.[46,47] In addition, the literature shows that interventions or programs with a multicomponent approach are more effective in addressing the issue of food insecurity in the population. Furthermore, many of the interventions in our study used a multidimensional approach- educational and behavioral programs (50%), multicomponent programs (27.3%) in addressing food insecurity and nutritional intake. When financial assistance

provided to participants is combined with nutritional and behavioral education, the interventions to address food security are seen to have a more positive and sustainable effect on the population. Community and system-based interventions must account for the different barriers encountered by the target populations related to availability, accessibility, affordability, acceptability, and accommodation.[35] It is vital to adopt solutions that address such barriers.

## Recommendations and Implications

The findings from this study show that food security interventions are best tailored to the specific population being targeted, as there is not a one-size-fits-all solution to food insecurity. Multicomponent interventions leverage the strengths of these individual interventions and appear more effective in remedying food insecurity. Also, most successful programs have a recurring trait of possessing some form of educational and behavioral interventions. They should be focused on promoting skills such as self-efficacy for healthy eating, self-regulation skills, and creating an enabling environment for healthy feeding. In addition, these programs are more useful when they are designed to include respect for the dignity of the participants, incorporate participants or representatives from the population in the design of the intervention, and build skills that can be immediately applied in participants' lives. Moreover, the significant positive influence of PSE intervention programs[47] highlights the need for continuous research, development, evaluation, and implementation of PSE changes in addressing food insecurity and improving nutritional intake.

Furthermore, areas for future studies should entail evaluating how to prioritize among competing food programs. Such studies will likely require further analysis, such as cost-effectiveness and cost-benefit analysis of these interventions. Lastly, the summative points raised in this review are further heightened by the COVID-19 pandemic, which demands that future research explore how such interventions have been adapted to better meet food security needs. Indeed, there are lessons to be gleaned from how programs have innovatively overcome present-day barriers to service delivery amid governmental and health-related restrictions.

## Limitations

Several limitations in this study have been identified. Only studies published in the last ten years were examined; this may have excluded effective interventions that were reported in studies published before 2009. Although an objective assessment of study bias was conducted, this is prone to human

errors. This limitation was controlled for by the authors examining all the studies individually, and several meetings were held to ensure consensus in the findings and characteristics of these studies.

Furthermore, this review focused on studies within the U.S; this was done to enable examination of interventions that have been successfully implemented within the country. This may have excluded interventions that have been successfully established, though they may not necessarily be applicable in the U.S. However, there are successful interventions that have emerged internationally and may need to be explored further. Land tenure interventions (to improve land tenure security), home garden programs, aquaculture, and small fisheries interventions have been reported to improve food security in low-income families internationally.[40,48] Yet, there have been noted racial, ethnic, and gender disparities in the agricultural sector related to farmland ownership and farming in the U.S.[49] Such disparities are indicative of the larger issue of structural racism that has been recorded across the U.S. food system.[13] Thus, efforts to mitigate these existing disparities and address racism in the broader food system should also be given considerable attention. Lastly, this study did not examine the impact of the COVID-19 pandemic on food insecurity interventions. The ongoing pandemic is reported to have influenced an increase in food insecurity,[50] including the delivery of nutritional education programs from in-person to virtual and hybrid delivery.[51] Future studies exploring virtual and hybrid nutritional education interventions and their respective outcomes will be needed.

Despite these limitations, this study has significant strength in the stringent quality of studies that were examined. In addition, it was structured in accordance with the PRISMA-guidelines, which meets international standard, endorsed by over 200 journals worldwide and five editorial organizations.[52]

## Conclusion

Food insecurity remains a persistent challenge with numerous deleterious consequences in the United States. However, it remains a condition that can be objectively assessed and remediable with effective policy interventions. Our review has coherently identified effective contemporary interventions that have been operationalized in the U.S. and include: educational and behavioral programs, fresh fruits and vegetable programs, multicomponent, summer electronic benefits transfer, discounted food options, and emergency food assistance programs. The multicomponent approach stands out as it combines the beneficial effects of different interventions in improving food security across the target population. Moreover, in a COVID era that has seen a rise in food insecurity,[50] with a projected additional 17 million individuals being food insecure in the U.S in 2020,[3] more virtual and hybrid interventions[53,54] should be explored. It is yet unknown how organizations

will respond as social distancing guidelines become less stringent. Virtual and hybrid services, although borne out of necessity, have had benefits that proved advantageous in the absence of in-person services and warrant further investigation as a continued approach to the delivery of nutrition-related interventions. In addition, it is crucial to implement community and system-based interventions that account for the various barriers encountered by the target populations. At the same time, it is necessary to obtain community support and employ strategies that address broader structural issues that result in food insecurity such as structural racism and discrimination.[14]

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