Translational Behavioral Medicine, 2025, **15**, ibaf060
https://doi.org/10.1093/tbm/ibaf060
Systematic Reviews

TBM OXFORD

Food is medicine programs for pregnant women in the United States: a systematic review

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Abstract

Background: Approximately 12.5% of households with children in the United States are food insecure. As national priorities evolve to address food insecurity, food is medicine (FIM) programs may be a part of the solution. However, there is a gap in evidence on the maternal and birth outcomes of FIM programs.

Purpose: The goal of this systematic review was to understand the overall public health impacts of FIM programs for pregnant populations.

Methods: This systematic review was conducted in accordance with PRISMA guidelines. A search strategy was used to locate peer-reviewed literature through EBSCOhost and PubMed, and grey literature (e.g. websites, reports, booklets, and presentations) through a custom Google search in October 2022 and again in October 2024. Sources were independently screened by two researchers. Data were extracted independently by two researchers according to the Reach, Effectiveness, Adoption, Implementation, and Maintenance (RE-AIM) framework.

Results: Nine peer-reviewed and 20 grey literature programs met inclusion criteria. Limited data made it difficult to determine FIM program reach (demographics) or maintenance. Effectiveness outcomes included fruit and vegetable intake, food security, and birth outcomes. Programs were adopted by healthcare providers across all regions of the United States. The core provisions and components implemented included fruits and vegetables or ready-to-eat meals, which were provided through vouchers, coupons, or prepackaged boxes.

Conclusions: This review offers a timely summary of FIM programs for pregnant women. Future research should focus on consistent reporting of measures and metrics. Additionally, longer-term studies are needed to build evidence for program sustainability.

Lay Summary

Food is medicine (FIM) programs have emerged as a solution to improve food and nutrition security while preventing, managing, and treating illness. Pregnant women and children may benefit from emerging FIM programming; however, more information on populations reached, adopting staff and settings, program components, and funding sources is necessary for a more complete understanding of the public health impacts of these interventions. This systematic review provides valuable insights into the current state of evidence on FIM programs for pregnant individuals. While the studies reviewed demonstrate promising outcomes, limitations in reporting, funding, and program implementation highlight the need for additional research.

Keywords: food security; nutrition security; pregnancy; food as medicine; food is medicine

Implications

Practice: Collecting and reporting full results of food is medicine (FIM) programs, including how they are implemented and adapted, is recommended to build the evidence base.
Policy: Funders should consider funding long-term, multiyear FIM interventions to allow sufficient time for implementers to build partnerships and develop infrastructure.
Research: To fully understand the impact of FIM programs for pregnant women, future studies should prioritize reporting of outcomes including populations reached and long-term individual- and organizational-level maintenance.

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Introduction

Food insecurity—defined as inconsistent access to enough food for every person in a household to live an active, healthy life [1]—is linked to negative health outcomes across the life span [2]. In 2021, approximately 10.2% of all households in the United States and 12.5% of households with children were food insecure [3]. Adults enrolled in Medicaid—a federal health insurance program for people with low income [4]—reported even higher rates of food insecurity. As of 2020, 20% of households enrolled in Medicaid did not have enough to eat [5]. Nutrition security is defined as consistent access, availability, and affordability of food that promote well-being and prevent disease [6]. Food and nutrition security are key social determinants of health (SDOH) [7], and are objectives of Healthy People 2030 [2].

Food is medicine (FIM) programs have emerged as a solution to improve food and nutrition security while preventing, managing, and treating illness [8, 9]. FIM programs include: (i) population-level healthy food policies and programs, (ii) government nutrition security programs such as the special supplemental nutrition assistance program (SNAP) for women, infants, and children (WIC) or the SNAP, (iii) produce prescription programs, (iv) medically tailored groceries, and (v) medically tailored meal programs [10]. Recent evidence has demonstrated the effectiveness of FIM programs on improving dietary intake [11, 12], while improving healthcare utilization and outcomes [13, 14].

An example of a well-established FIM program is WIC, a Federal food assistance program, established in 1975 to provide vouchers for supplemental nutritious food packages, nutrition education, and breastfeeding support to pregnant women, infants, and young children at nutrition risk with inadequate incomes [15]. Previous evidence supports that WIC leads to better maternal and child nutrition and health outcomes (e.g. full-term pregnancy, appropriate infant birth weight, promotion and support of breastfeeding, and improved food security) [16].

FIM program implementation has expanded since the initiation of WIC, and now includes discounted or free produce, foods tailored for specific individual needs, and prepared medically tailored meals for priority populations with nutrition-related chronic diseases, people with inadequate income, or people who are food insecure [10]. Medicaid 1115 demonstration waivers, established in 2022 [17], have supported the expansion of FIM programs. Under these waivers, states have the flexibility to tailor services such as case management, nutrition counseling and instruction, home-delivered meals, nutrition prescriptions, and grocery provisions for recipients of Medicaid. This facilitates piloting novel FIM programs that are more comprehensive than standard government food security programs, as they provide foods to address individual-level health needs, such as managing a chronic disease or food insecurity. FIM programs that provide individualized foods have recently begun reaching pregnant women (e.g. through being added to traditional WIC services [18, 19]).

Pregnant women have unique nutritional needs [20], and providing proper nutrition during pregnancy can help prevent pregnancy complications and improve birth outcomes [21, 22]. Conditions prior to pregnancy such as being underweight [23] or overweight [24], as well as conditions during pregnancy such as high blood pressure [25, 26], unmanaged gestational diabetes [27], excess gestational weight gain [28], and psychological stress [29], may lead to pregnancy complications and adverse birth outcomes [30]. Birth outcomes such as low birthweight, delivering preterm, or infants of small-for-gestational age, among other birth defects may also be impacted by food insecurity [21, 31]. These birth outcomes can continue to impact children later in life, as low birthweight has been seen to show poor performance in school [32].

Taken together, pregnant women and the children born may benefit from emerging FIM produce prescription programs, medically tailored food packages, and medically tailored meal programs. However, more information on populations reached, adopting staff and settings, program components, and funding sources is necessary for a complete understanding of the public health impacts of these interventions [8]. To the author's knowledge, there are currently no systematic reviews of the literature on FIM programs beyond WIC specifically for pregnant women. Therefore, the goal of this review was to systematically review both peer-reviewed and grey literature to understand the overall public health impacts, including both maternal and birth outcomes, of FIM produce prescription programs, medically tailored food packages, and medically tailored meal programs for pregnant populations.

Methods

Conducting the review

This systematic review included peer-reviewed and grey literature sources detailing FIM programs for pregnant women [33, 34]. Both types of literature were included to capture traditional peer-reviewed sources of evidence and practice-based evidence not disseminated through academic publication routes [34–37]. Due to a lack of peer-reviewed publications and recent developments in the literature, this search method was essential to capture broad impacts across FIM programs. The preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines were followed [38]. Due to the pragmatic nature of the review and the need to adapt the search strategy for grey literature, a review protocol was not registered.

Searches were conducted in October 2022 and again in October 2024. EBSCOhost and PubMed databases were searched to locate peer-reviewed articles. Given that FIM programming for pregnant women is a newer field, all articles were screened, and no specific time cutoff was set. Experts in the field of FIM and maternal populations developed key terms in consultation with a reference librarian. Additionally, a custom internet search using the Google search engine located grey literature sources [35, 36, 39, 40]. A simplified version of the peer-reviewed literature search terms were used to accommodate the search engine's capabilities (see Supplementary File—Search String).

Study selection

The inclusion criteria were: (i) a novel FIM program beyond standard programming (practice, process, or policy) such as the additional provision of vouchers to purchase produce [41], (ii) aims of improving food access, food security, nutrition security, gestational diabetes, birth outcomes, or hypertension outcomes, (iii) pregnant women as one of the priority populations, (iv) took place in the United States, and (v) reported in English. Sources were excluded if they (i) did not describe a novel FIM program beyond standard programming, (ii) were

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not focused on improving food access or FIM, (iii) did not include pregnant women as one of the priority populations, (iv) took place outside of the United States, (v) were not available in English, (vi) were a systematic review, (vii) were a protocol paper, or (viii) were not available as full text (e.g. grey literature source with broken link, paywall, or conference abstract). WIC programs were not included (unless they were innovative programs testing additional components), as this review aimed to understand emerging evidence of novel FIM programs.

For the peer-reviewed literature, a team of four trained researchers (L.B., S.P., P.L., and E.S.) independently screened titles, then abstracts, and finally full-text studies, as recommended by the Cochrane Handbook [37]. Researchers independently screened each article and reached consensus before moving to the next stage of the screening process. Researchers used DistillerSR [42] for peer-reviewed screening. For the grey literature screening, the same team of four researchers independently screened full text of each source, as a descriptive title or abstract was not typically provided. Researchers independently screened each source and reached consensus before moving to data extraction. Microsoft Excel records helped facilitate the grey literature screening. Assignments remained the same for all researchers throughout the screening and data extraction process.

Data extraction

Researchers developed the data extraction guide, based on the expanded RE-AIM (reach, effectiveness, adoption, implementation, maintenance) framework [43, 44]. The RE-AIM framework translates research to practice and balances internal and external validity. The framework assesses whether interventions reach priority populations, are effective in achieving their key outcomes, are adopted broadly by staff and settings, are implemented with high fidelity and at a reasonable cost, lead to participant outcomes that are maintained over time, and are maintained long-term in organizations. Additionally, the expanded RE-AIM framework includes the implementation of acceptability, appropriateness, and feasibility, which are theorized to lead to improved intervention adoption, implementation, and maintenance [45, 46]. By using the expanded RE-AIM framework, program planners, funders, researchers, and policymakers can understand how interventions are delivered in real-world settings. To appraise the quality of sources, the research team used the PRECIS-2 (PRagmatic Explanatory Continuum Indicator Summary) tool [47]. This tool captures internal and external validity and degree of pragmaticism (i.e., whether an intervention will work under real-world rather than ideal conditions) and has been recommended for generating better evidence for decision makers who must determine if the results are applicable and can be used in practice [48]. The PRECIS-2 tool assesses the degree to which studies are pragmatic (real-world conditions) versus explanatory (ideal conditions) through nine domains: eligibility criteria, recruitment, setting, organization, flexibility (delivery), flexibility (adherence), follow-up, primary outcome, and primary analysis. For each domain, sources were rated on a 5-point Likert scale from 1 (very explanatory) to 5 (very pragmatic). For all of the literature sources, two researchers independently extracted information according to the data extraction guide and appraised the quality (L.B., S.P., P.L., and E.S.). Researchers reached consensus between areas of disagreement. Variables that were not reported were marked N/A in the final dataset.

Results

Study characteristics

Figure 1 shows the PRISMA diagram. The initial search for peer-reviewed studies yielded 1129 studies and the updated search yielded an additional 467, for a total of 1596 studies. Duplicates were removed ($n=624$), yielding a total of 972 study titles to screen. Nine hundred twenty-six titles were excluded because they did not meet inclusion criteria. A total of 46 study abstracts were screened, and 38 were excluded as they were not novel FIM programs ($n=20$), outside of the United States ($n=6$), abstract only ($n=5$), systematic reviews ($n=3$), not focused on pregnant women participants ($n=3$), and not focused on improving food access or FIM ($n=1$). Overall, six peer-reviewed studies met inclusion criteria. Three additional peer-reviewed studies were identified from the grey literature search; a total of nine peer-reviewed studies are included in this review [49–57].

The initial search for grey literature records yielded 200 sources and the updated search yielded an additional 200 sources for a total of 400 sources. Three hundred and eighty-four sources were excluded because they were not novel FIM programs ($n=253$), duplicates ($n=61$), not focused on pregnant women ($n=45$), not focused on improving food access or FIM ($n=12$), not available as full text ($n=10$), and systematic reviews ($n=3$). This left 16 grey literature, and three sources were removed and included in the review as peer-reviewed articles, not grey literature sources. This left 13 grey literature sources that met inclusion criteria for the review. As these sources were reviewed, some contained multiple FIM programs (e.g. a report containing programs in two cities). These additional programs ($n=7$) were extracted into new records for data extraction. The final number of programs included in the grey literature was 20 [58, 59, 60–70].

The quality appraisal in Table 1 shows that the peer-reviewed literature sources ($n=9$) were rated as very pragmatic in terms of eligibility, recruitment, setting, and organization.

Only one study reported flexibility (delivery) or follow-up. No studies reported flexibility (adherence) or primary analysis. For the grey literature ($n=20$ programs), eligibility, recruitment, setting, and organization were rated as very pragmatic. Flexibility (delivery), flexibility (adherence), and primary analysis were only reported in one source each and rated as very explanatory. Follow-up was not reported in any sources.

The following sections report the results according to RE-AIM framework dimensions. Detailed results by study are shown in Table 2. The Supplementary Table S1 shows reach, effectiveness, and adoption characteristics of FIM programs for pregnant women. The Supplementary Table S2 shows implementation, maintenance, and implementation outcome characteristics of FIM programs for pregnant women.

Reach variables

All of the peer-reviewed literature reported reach (i.e. at least the number of participants in the program). Race and ethnicity were reported in all of the studies ($n=9$). Six studies reported the education level of the participants. Among the grey literature, reach was reported for 16 programs, with many of the

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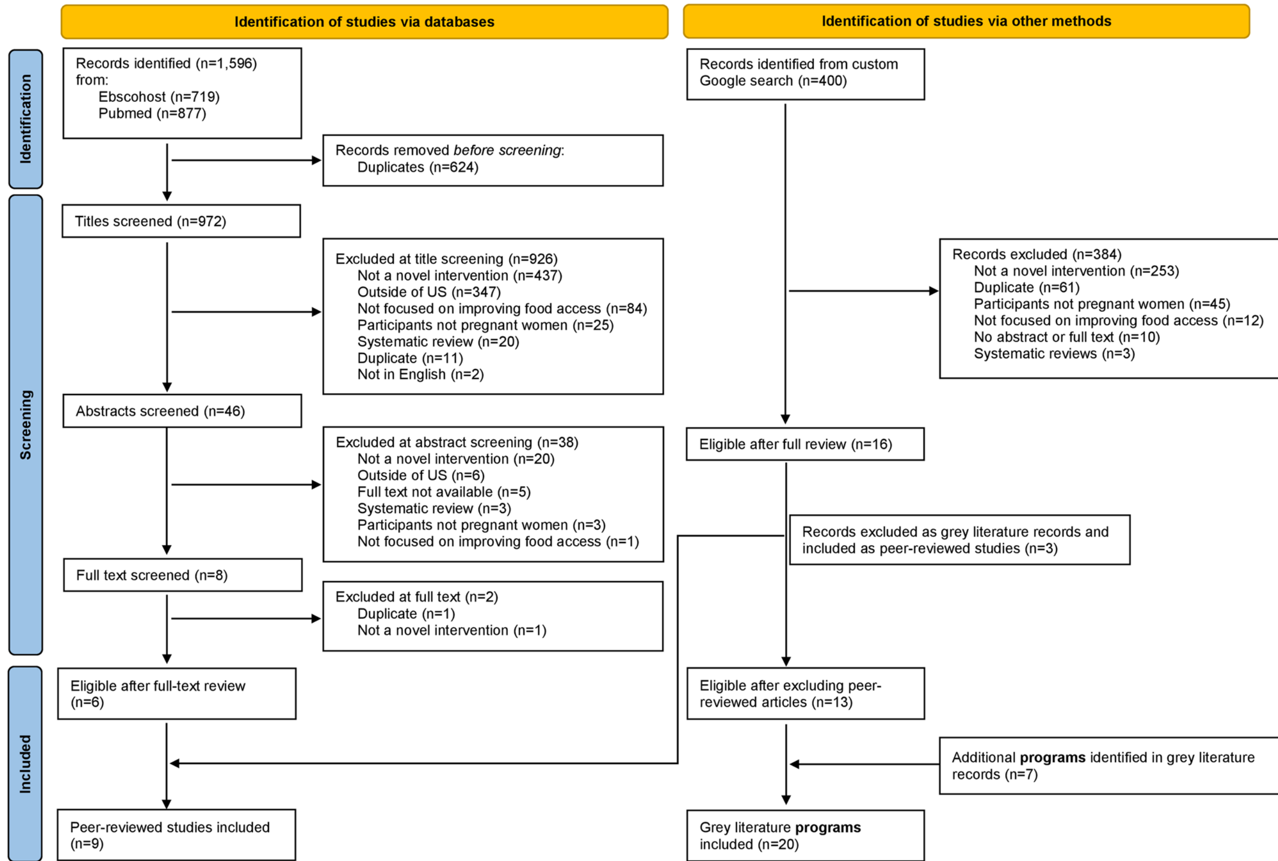

Figure 1. PRISMA flow chart of the study screening process.

Table 1 Internal and external validity of food as medicine programs for pregnant women, rated with the PRECIS-2 tool

PRECIS dimension	Peer-reviewed literature (n=9)	Grey literature (n=20)	Total (n=29)
	(M, SD)		
Eligibility	5 (0) (n=9)	5 (0) (n=14)	5 (0) (n=23)
Recruitment	5 (0) (n=9)	5 (0) (n=10)	5 (0) (n=19)
Setting	5 (0) (n=9)	5 (0) (n=18)	5 (0) (n=27)
Organization	5 (0) (n=9)	5 (0) (n=12)	5 (0) (n=21)
Flexibility delivery	5 (0) (n=1)	1 (0) (n=1)	3 (2) (n=2)
Flexibility adherence	Not reported (n=0)	1 (0) (n=1)	1 (0) (n=1)
Follow-up	5 (0) (n=1)	Not reported (n=0)	5 (0) (n=1)
Primary outcome	4.7 (0.7) (n=9)	4.8 (0.7) (n=8)	4.7 (0.7) (n=17)
Primary analysis	Not reported (n=0)	1 (0) (n=1)	1 (0) (n=1)

Note: Each domain was rated on a 5-point Likert scale from 1 (very explanatory/ideal conditions) to 5 (very pragmatic/real world conditions). The number of peer-reviewed sources reporting was n=9, grey literature programs n=20, and total number of programs n=29, unless otherwise noted.

sources only including the number of participants. Additional demographic characteristics of the participants, such as age, race and ethnicity, education, and household composition, were not reported in any of the grey literature programs.

Effectiveness variables

All of the peer-reviewed literature reported effectiveness (i.e. at least some information on the impact of the intervention on its primary outcomes). As for the study design, sources used a pre–post (n=5) or other designs (n=4). Quantitative data were collected in a majority (n=6) of studies, while a minority (n=3) included both quantitative and qualitative data. Primary outcomes of interest to this review included food security (n=5), fruit and vegetable intake (n=3), birth outcomes (n=3), maternal health (n=3), fruit and vegetable access (n=2), and other (n=3). Positive outcomes were reported in the majority of studies (n=8) while one study reported no change in outcomes. Reported barriers to program effectiveness include long distance to the farmers' market to procure foods, redemption relocations due to COVID, and inadequate training of healthcare providers to discuss nutrition education with patients.

All of the grey literature programs reported effectiveness. As for the intervention design, half of the programs (n=11) did not report a study design, less than half (n=6) used a pre–post design study design, and fewer (n=3) used a post-only design. Programs that reported study design collected quantitative data (n=5) or both qualitative and quantitative data (n=5). Study outcomes included fruit and vegetable intake (n=13), healthy food intake (n=3), self-efficacy of health behaviors (n=3), birth outcomes (n=2), likelihood of seeking medical care at clinics with food pharmacies (n=2), inpatient hospital admissions (n=2), food security (n=2), quality of eating habits and food choices (n=2), maternal health (n=2), access to produce (n=1),

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Table 2 RE-AIM and implementation outcomes reported by food as medicine programs among pregnant people

Study characteristic	Peer-reviewed literature ($n=9$)	Grey literature ($n=20$)	Total ($n=29$)
Number of studies reporting reach, n (%)	9 (100%)	16 (80%)	25 (86%)
Number of individuals impacted by the intervention (mean, SD)	1842 (5124)	433 (952)	940 (3130)
Not reported, n (%)	0	4 (20%)	4 (14%)
Number of studies reporting age, n, %	8 (89%)	0 (0%)	8 (28%)
Race and ethnicity, n (%)[a]			
Black	8 (89%)	1 (5%)	9 (31%)
Asian	3 (33%)	0 (0%)	3 (10%)
Hispanic/Latino	6 (67%)	0 (0%)	6 (21%)
White	7 (78%)	1 (5%)	8 (28%)
Other	4 (44%)	1 (5%)	5 (17%)
Not reported	0 (0%)	18 (90%)	18 (62%)
Education, n (%)[a]			
Did not complete high school	2 (22%)	0 (0%)	2 (7%)
Completed high school/GED	6 (67%)	0 (0%)	6 (21%)
Completed some college or more	6 (67%)	0 (0%)	6 (21%)
Not reported	3 (33%)	20 (100%)	23 (79%)
Effectiveness			
Study design, n (%)			
Pre–post	5 (56%)	6 (30%)	11 (38%)
Post only	0 (0%)	3 (15%)	3 (10%)
Other	4 (44%)	0 (0%)	4 (14%)
Not reported	0 (0%)	11 (55%)	11 (38%)
Primary outcome, n (%)[a]			
Fruit and vegetable intake	3 (33%)	13 (65%)	15 (52%)
Healthy food intake	0 (0%)	3 (15%)	3 (10%)
Food security	5 (56%)	2 (10%)	7 (24%)
Maternal health	3 (33%)	2 (10%)	5 (17%)
Birth outcomes	3 (33%)	2 (10%)	5 (17%)
Other	3 (33%)	16 (80%)	19 (66%)
Not reported	0 (0%)	0 (0%)	0 (0%)
Data type, n (%)			
Qualitative	0 (0%)	0 (0%)	0 (0%)
Quantitative	6 (67%)	5 (25%)	11 (38%)
Combination	3 (33%)	5 (25%)	8 (28%)
Not reported	0 (0%)	10 (50%)	10 (34%)
Outcomes, n (%)			
Positive findings	8 (89%)	13 (65%)	21 (72%)
No change in outcomes	1 (11%)	1 (5%)	2 (7%)
Not reported	0 (0%)	6 (30%)	6 (21%)
Adoption			
Organization type, n (%)[a]			
Managed care organization	0 (0%)	4 (20%)	4 (14%)
Nonprofit	2 (22%)	4 (20%)	6 (21%)
Healthcare provider	8 (89%)	12 (60%)	20 (69%)
Not reported	0 (0%)	2 (10%)	2 (7%)
U.S. region, n (%)			
Midwest	3 (33%)	10 (50%)	13 (45%)
Northeast	2 (22%)	4 (20%)	6 (21%)
South	2 (22%)	1 (5%)	3 (10%)
West	2 (22%)	5 (25%)	7 (24%)
Implementation			
Intervention provisions, n (%)[a]			
Fruits and vegetables	5 (56%)	14 (70%)	19 (66%)
Food other than fruits and vegetables	1 (11%)	3 (15%)	4 (14%)
Ready to eat meals	1 (11%)	4 (20%)	5 (17%)
Other	3 (33%)	3 (15%)	36 (21%)
Intervention components, n (%)[a]			
Vouchers	5 (56%)	9 (45%)	14 (48%)
Coupons	0 (0%)	2 (10%)	2 (7%)
Packaged	2 (22%)	11 (55%)	13 (45%)
Other	0 (0%)	1 (5%)	1 (3%)
Not reported	2 (22%)	0 (0%)	2 (7%)

(Continued)

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Table 2 Continued

Study characteristic	Peer-reviewed literature (*n* = 9)	Grey literature (*n* = 20)	Total (*n* = 29)
Intervention frequency, *n* (%)			
Bi-monthly	0 (0%)	1 (5%)	1 (3%)
Monthly	4 (44%)	7 (35%)	11 (38%)
Weekly	3 (33%)	6 (30%)	9 (31%)
Not reported	2 (22%)	6 (30%)	8 (28%)
Intervention setting, *n* (%)[a]			
Grocery store	2 (22%)	8 (40%)	10 (34%)
Farmer's market	4 (44%)	9 (45%)	13 (45%)
Other	4 (44%)	3 (15%)	7 (24%)
Not reported	0 (0%)	7 (35%)	7 (24%)
Adaptation, *n* (%)			
Reported	0 (0%)	1 (5%)	1 (3%)
Not reported	9 (100%)	19 (95%)	28 (97%)
Cost, *n* (%)			
Reported	0 (0%)	1 (5%)	1 (3%)
Not reported	9 (100%)	19 (95%)	28 (97%)
Fidelity, *n* (%)			
Reported	0 (0%)	0 (0%)	0 (0%)
Not reported	9 (100%)	20 (100%)	29 (100%)
Maintenance (organizational)			
Reported, *n* (%)	0 (0%)	4 (22%)	4 (17%)
Not reported	6 (100%)	14 (78%)	20 (83%)
Implementation outcomes			
Acceptability, *n* (%)			
Reported	2 (22%)	2 (10%)	4 (14%)
Not reported	7 (78%)	18 (90%)	25 (86%)
Appropriateness, *n* (%)			
Reported	1 (11%)	0 (0%)	1 (3%)
Not reported	8 (89%)	20 (100%)	28 (97%)
Feasibility, *n* (%)			
Reported	2 (22%)	0 (0%)	2 (7%)
Not reported	7 (78%)	20 (100%)	27 (93%)

[a]Percentages do not add up to 100, as multiple categories could be reported.

emergency department visits (*n* = 1), sense of community (*n* = 1), and economic growth (*n* = 1). Positive outcomes were reported in more than half of the programs (*n* = 13) and one program reported no change in outcomes. Barriers to program effectiveness included transportation to procure foods, feeling unsafe when shopping at local corner stores, high cost of foods at the farmers' market, misunderstanding program operations, recipients' perceived lack of cooking knowledge, missing vouchers for redemption, limited farmers' market hours of operation, and few grocery stores accepting vouchers.

Adoption variables

All of the peer-reviewed literature reported adoption (i.e. at least some information on where and by whom programs were delivered). The studies took place across the four regions [71] of the United States: South (*n* = 2), West (*n* = 2), Midwest (*n* = 3), and Northeast (*n* = 2). The majority of the studies (*n* = 8) were administered through a healthcare provider and two were administered through nonprofit organizations.

All of the grey literature programs reported adoption. The programs took place across the Midwest (*n* = 10), West (*n* = 5), Northeast (*n* = 4), and South (*n* = 1). Delivering organizations included healthcare providers in a majority of programs (*n* = 12), followed by managed care organizations (*n* = 4) and nonprofit organizations (*n* = 4).

Implementation variables

All of the peer-reviewed literature reported at least one implementation metric (i.e. core components, fidelity, costs, or adaptations made during delivery). Considering program provisions (i.e. what exactly was provided to participants), studies provided fruits and vegetables (*n* = 5), included other provisions, such as connecting participants with food-related resources (*n* = 2), and provided medically tailored meals (*n* = 1). As for program components (i.e. how the provisions were distributed), studies provided vouchers to access food (*n* = 5), medically tailored meals (*n* = 1), fresh food (*n* = 1), or did not report components (*n* = 2). Of the studies reporting the distribution frequency, components were distributed monthly (*n* = 4), weekly (*n* = 3), and not reported (*n* = 2). Program settings primarily included farmers' markets (*n* = 4) and grocery stores (*n* = 2). Education from a healthcare provider was included in about half of the studies (*n* = 4).

All of the grey literature programs reported at least one implementation metric. Programs provided fruits and vegetables (*n* = 14), medically tailored meals (*n* = 4), and food beyond fruits and vegetables such as items to make a complete meal (*n* = 3). Components were provided through packaged food (e.g. produce boxes and medically tailored meals) (*n* = 11), vouchers in (*n* = 9), and coupons (*n* = 2). Of the programs reporting distribution frequency, components were distributed

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monthly ($n=7$), weekly ($n=6$), twice a month ($n=1$), and not reported ($n=0$). Programs were primarily delivered in grocery stores ($n=8$), farmers' markets ($n=9$), and other ($n=3$). Half of the programs reported in the grey literature ($n=10$) included an education component which was usually ($n=9$) delivered by a health care provider. As for implementation across the peer reviewed and grey literature programs, outcomes, acceptability ($n=4$), appropriateness ($n=1$), and feasibility ($n=2$) were rarely reported.

Maintenance variables

None of the peer-reviewed literature reported maintenance (i.e. the extent to which the intervention became institutionalized within ongoing operations, or whether participant outcomes were maintained 6 months or more after the intervention ended). Maintenance was reported in few of the grey literature programs ($n=4$). Maintenance was reported at the organizational level with ongoing strategies including leveraging community-based organizations, expanding on existing partnerships, and securing the funding and infrastructure for multiyear programs.

Discussion

The aim of this systematic review was to summarize the literature on FIM programs for pregnant women. Overall, robust reporting of outcomes was limited across the nine peer-reviewed and 20 grey literature sources, and the missing RE-AIM outcome data made it difficult to replicate and draw conclusive findings about FIM programming for pregnant women. However, the inclusion of grey literature helped support the understanding of real-world application of FIM programs. The outcomes reported revealed that program implementation varies by delivery organization, and more consistent reporting is needed to build evidence to support long-term programming.

Program implementation (components, setting, delivery frequency, and whether education was provided) varied across programs. For example, core components reported included fruits and vegetables or other food and ready-to-eat meals redeemed via vouchers, coupons, or pre-packaged boxes. Related information about fidelity to the core components was missing. Documenting fidelity—that is, the extent to which interventions are implemented as intended—is essential for interpreting findings and assessing adaptations. Clarifying the adherence to the intervention, including the frequency, duration, and dose delivered is essential to replicating studies and moving from pilot studies to broader effectiveness trials [72]. In addition, reporting any adaptations to the intervention for specific priority populations is also necessary, but was not included in the programs reported here [73]. Future research could expand on program adaptations for pregnant women. Some examples include ensuring pregnancy-safe foods, altering food components (e.g. changing from food boxes to ready-to-eat meals after birth), delivery versus pick up, extending components through the postpartum period, providing pregnancy-specific educational materials, enabling online shopping, or developing online forums for families to create a sense of community [74]. These adaptations may help overcome barriers such as transportation, feelings of isolation, and program access.

It is essential to document the cost and duration of interventions. The cost of implementation was not well-documented in the current literature, and the length of programs reported varied substantially [75, 76]. Future research should assess the most cost-effective dose necessary to obtain the intended health outcomes. Although specific costs to implement programs were not detailed, the sources of funding were provided. Each of the current studies reported different funding sources (e.g. Foundation dollars, public health departments, Robert Wood Johnson Foundation), and several paired multiple sources of funds together, including short-term grants. Overall, funding longevity is essential to program sustainability. Maintenance was not mentioned in any peer-reviewed studies and in few of the grey literature sources, making it difficult to conclude the sustainability of current programs. In future work to promote consistent reporting, FIM implementers could partner with researchers and program evaluators to ensure the most relevant and up-to-date measures are being used. Additionally, FIM program funders could prioritize the reporting of effectiveness and plan for maintenance upon the completion of the program.

Additional gaps in the current review including reach and effectiveness make it difficult to conclude outcomes relevant to pregnant women. The majority of the studies in the current review were pilot studies, retrospective studies, or programs not yet assessed through robust evaluation. Reviews of FIM programs with different priority populations reported similar findings of poor-quality studies [77, 78]. To build strong evidence for intervention effectiveness, future research should include robust experimental designs and longitudinal data to document the effect of FIM programs on maternal and child health. Research designs that respect community partners' preferences (e.g. stepped-wedge designs) [41] are recommended, as are data collection methods that decrease participant burden (e.g. working with healthcare clinics to rely on electronic health record data) [20, 79]. Once the empirical evidence base has been expanded, a meta-analysis could be conducted to assess the effect sizes and draw conclusions about FIM program effectiveness.

This work is not without limitations. First, the low number of peer-reviewed articles and inconsistent reporting of RE-AIM dimensions across studies made it difficult to summarize outcomes and draw conclusions. Additionally, conclusions could not be made based on the effect size of the studies, as there were many grey literature sources and few rigorous study designs. Second, although the peer-reviewed search databases were chosen for this review due to relevancy, additional sources may have been missed if they were published on other databases or in another language than English. Sources reporting null or negative results after implementation may not have been found in the search as they are oftentimes not published. Third, there are many recommendations for searching grey literature sources [35, 36, 40]. In the current study, the decision was made to limit the number of records to 200 per search to generate the most relevant results while balancing feasibility. With this method, the authors may have missed sources ranking lower in the search algorithm. In addition, grey literature not available online (e.g. retrieved through contacting members of relevant professional societies) may have also been missed. Additionally, one potential source of bias in the studies included in this systematic review is selection bias or measurement bias. For example, participants who opted into the FIM programs may have been more motivated to improve their health and

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thus may not be representative of the larger population of pregnant women. Moreover, some studies may have relied on self-reported measures of dietary intake, which could be subject to measurement bias if participants did not accurately report their food consumption.

Conclusions

In conclusion, this systematic review provides valuable insights into the current state of evidence on FIM programs for pregnant individuals. While the studies reviewed demonstrate promising outcomes, limitations in reporting, funding, and program implementation highlight the need for additional research. To fully understand the impact of FIM programs for pregnant women, future studies should prioritize consistent reporting of outcomes, as well as representation across populations and longitudinal follow-up. Furthermore, efforts to secure sustainable funding and partnerships with community organizations and healthcare providers can help ensure that these programs are accessible and impactful for those who need them most. Overall, this systematic review highlights the potential benefits of FIM programs for promoting maternal and child health, while also providing important directions for future research.

Acknowledgements

The authors would like to thank Caron Gremont and Bethann Mwombela from Share Our Strength for their support and feedback. The authors would also like to thank Randa Morgan, a librarian, for professional assistance with the development of the literature review search strategy. The authors have received permission for this acknowledgment.

Supplementary data

Supplementary material is available at *Translational Behavioral Medicine* online.

Funding Source

This systematic review was funded by Share Our Strength. Funders had a role in conceptualizing the research and providing feedback on study design.

Conflicts of Interests

Co-authors are supported by Gus Schumacher Nutrition Incentive Program grant no. 2019-70030-30415/project accession no. 1020863 from the USDA National Institute of Food and Agriculture, as well as funding from Feeding America and Elevance to support FIM programming.

Author Contributions

Shelly Palmer (Investigation, Writing—original draft), Carmen Byker Shanks (Conceptualization, Writing—review & editing, Funding acquisition), Laura Balis (Methodology, Investigation, Writing—review & editing, Project administration), Emily Shaw (Investigation, Writing—review & editing), Paloma Lima Dos Santos (Investigation, Writing—review & editing), Amy L. Yaroch (Conceptualization, Writing—review & editing, Funding acquisition)

Human Rights

This article does not contain any studies with human participants performed by any of the authors.

Informed Consent

This study does not involve human participants and informed consent was therefore not required.

Welfare of Animals

This article does not contain any studies with animals performed by any of the authors.

Transparency Statement

Study Registration

This study was not formally registered.

Analytic Plan Pre-registration

The analysis plan was not formally pre-registered.

Analytic Code Availability

There is no analytic code associated with this study.

Materials Availability

Materials used to conduct the study are not publicly available.

Data Availability

De-identified data from this study are not available in a public archive. De-identified data from this study will be made available (as allowable according to institutional IRB standards) by emailing the corresponding author.

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