

Fruit and Vegetable Purchases and Consumption among WIC Participants after the 2009 WIC Food Package Revision: A Systematic Review

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ABSTRACT

To promote fruit and vegetable (FV) intake among participants, the USDA Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) implemented a comprehensive food package revision in 2009. However, to our knowledge, no studies have systematically explored the factors related to FV purchases and/or consumption among WIC participants in the post-2009 revision era. To fill this knowledge gap, we conducted a systematic literature review using PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Cochrane Central Register of Controlled Trials, and Web of Science using key search terms. Studies published from January 1, 2007, through February 28, 2019, were included, since an interim rule for the WIC food package revision was issued in 2007. This review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses format. The articles were grouped based on main themes or factors, settings, design, study years, and sample size. Thirty-nine articles met the inclusion criteria. Seven main themes or factors related to FV purchases and/or consumption in WIC participants were identified in these articles. The 2009 WIC food package revision was the most-studied factor ($n = 9$). National and state-level studies showed a consistently positive relation between the 2009 revision and FV purchases and/or consumption. However, some studies did not find a positive relation. State-level policy variations can be exploited as natural experiments to assess the causality of state-level factors in WIC participants' FV purchases or consumption. The majority of the included studies were limited in being local ($n = 26, 66.7\%$), cross-sectional ($n = 29, 74.4\%$), or having sample sizes <1000 ($n = 25, 64.1\%$), which could explain the diverse results regarding the relation between FV purchases and/or consumption and various factors, including individual, store, and program characteristics. *Adv Nutr* 2020;11:1646–1662.

Keywords: WIC, cash value voucher, fruit, vegetable, 2009 WIC food package revision

Introduction

The ultimate goal of the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) is to serve the nutritional needs of low-income women who are pregnant, breastfeeding, and postpartum, as well as of infants and children aged ≤ 5 y in the United States (1, 2). This has been pursued through nutrition education and by providing nutritious food packages to participants. Beginning in 2009, the WIC food package has included cash value voucher (CVV) benefits to buy fruit and vegetables (FVs). However, FV consumption remains low among WIC participants, as in other low-income populations, compared with the recommended levels in the 2015–2020 Dietary Guidelines for Americans (1, 3). Because WIC had >7.3 million participants monthly in fiscal year 2017, it is important to assess how effectively it promotes FV consumption to meet the national dietary guidelines.

Although WIC is a federally funded nutritional assistance program, it is operated by the states according to specific policies and guidelines for implementation (1). WIC state agencies have flexibility regarding several aspects of program operations; for example, they can authorize the stores at which WIC benefits can be redeemed, establish rules concerning signage that identifies WIC-eligible products, and determine the food brands that can be redeemed. Therefore, FV consumption among WIC participants can be influenced by both federal policies and state regulations.

To update the WIC package to be more consistent with newer nutrition knowledge, as stated in the Dietary Guidelines for Americans, in 2004 the USDA designated an Institute of Medicine (IOM) committee to review the existing food packages in order to redesign and improve WIC participants' diets (3). The IOM report, entitled *WIC Food Packages: Time for a Change*, highlighted the need for WIC

participants to increase FV consumption (3). At that time, only 1 WIC food package offered FVs other than juices—the breastfeeding woman package included carrots. In some states, the WIC Farmers’ Market Nutrition Program (FMNP) offered vouchers that could be redeemed at participating markets, but this program was comparatively small, reaching a minority of WIC participants.

The USDA published an interim rule for food package revision on December 6, 2007, which was to be implemented by October 1, 2009 (4). The revisions included new food categories, such as FVs, and added CVVs for participants to buy fresh, frozen, or canned FVs (\$6/mo for children; \$10/mo for women). In 2010, the 110th Congress passed the Healthy, Hunger-Free Kids Act (42U. S.C. §1786), and the USDA published the final rule in 2014, expanding FV availability, increasing CVV benefits for children from \$6/mo to \$8/mo, requiring the 49,000 WIC-affiliated stores to stock fresh FVs in certain varieties, and reducing the 100% fruit juice monthly allowance to children and women by approximately half while eliminating it from the infant food package (5, 6). In 2015, the USDA issued another memorandum to increase CVV benefits for women from \$10/mo to \$11/mo, whereas the child’s CVV benefits increased from \$8/mo to \$9/mo in fiscal year 2019 (7). Although the WIC FMNP has expanded, only 23% of participants received benefits through this program in 2017, making the CVV the most important mechanism for adding FVs to WIC participants’ diets (8).

In summary, the 2009 WIC food package revision was the first comprehensive revision since the program began, adopting a series of notable changes that included CVV benefits to promote FV consumption.

In 2017, the Committee to Review WIC Food Packages at the National Academies of Sciences, Engineering, and Medicine (NASEM) published a report entitled Review of WIC Food Packages: Improving Balance and Choice: Final Report; this assessed how well the 2009 WIC food package changes had acted to improve the diets of WIC participants. It recognized the importance of increasing CVVs to foster improvements in FV intake and praised these benefits as

TABLE 1 PubMed search strategy related to fruit and vegetable (FV) purchases and consumption among WIC participants¹

Search ID number	Query	Items found
#7	Search (#5 AND #6) Filters: Publication date from 01/01/2007 to 02/18/2019	117
#6	Search (#1 OR #2 OR #3 OR #4)	188,319
#5	Search WIC	1363
#4	Search cash value voucher	20
#3	Search CVV	124
#2	Search vegetable	70,064
#1	Search fruit	141,675

¹WIC, Special Supplemental Nutrition Program for Women, Infants, and Children.

giving significant flexibility to meet cultural needs across participants (1). However, the NASEM report also raised the issue of underredemption of CVV benefits, especially for vegetables, as 1 of the 3 major issues in the WIC revision. The report also pointed out the sparse information available that thoroughly explores the specific factors contributing to or preventing WIC participants from consuming more FV. Although abundant literature is available on various factors related to FV purchases or consumption (9–13), no systematic review exists that analyzes the factors related to WIC participants’ FV purchases or consumption in the post-2009 WIC food package revision era.

To fill this knowledge gap and provide insights on the multifaceted factors associated with FV purchases or consumption among WIC participants, this study systematically examined these factors after the 2009 WIC food package revision, when FV purchases included the WIC CVV benefit redemption. The findings could help policy makers to develop more effective interventions to promote FV consumption in the United States, especially helping low-income women, infants, and children to meet the National Dietary Guidelines for Americans.

Methods

Literature search

This systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) format to guide the selection of articles that met inclusion criteria (14). Four search databases were used to extract relevant peer-reviewed articles: PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Cochrane Central Register of Controlled Trials, and Web of Science. Search terms were identified based on the objectives of this systematic review and were refined through a preliminary search to ensure that the key terms were appropriate and sufficient. The identified search terms were WIC, fruit, vegetable, Cash Value Voucher, or CVV. These key terms were combined using Boolean operators (i.e., WIC AND fruit OR vegetable OR Cash Value Voucher OR CVV). See Table 1 for an example of the complete search strategies using the PubMed database.

This research is partially funded by the US Department of Agriculture/Economic Research Service (#58-4000-8-0038-R, #58-4000-6-0061-R) and the National Institutes of Health/Eunice Kennedy Shriver National Institute of Child Health and Human Development (R03HD090387-01).

Author disclosures: The authors report no conflicts of interest.

The findings and conclusions in this preliminary publication have not been formally disseminated by the USDA and should not be construed to represent any agency determination or policy. The views expressed in this paper are the authors’ and should not be interpreted as those of CBO.

Supplemental Tables 1 and 2 are available from the “Supplementary data” link in the online posting of the article and from the same link in the online table of contents at <https://academic.oup.com/advances>.

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Abbreviations used: CINAHL, Cumulative Index to Nursing and Allied Health Literature; CVV, cash value voucher; EBT, electronic benefits transfer; FMNP, Farmers’ Market Nutrition Program; FTC, farm-to-consumer; FV, fruit and vegetables; HEI, the Healthy Eating Index; IOM, Institute of Medicine; NASEM, the National Academies of Sciences, Engineering, and Medicine; PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses; SNAP, Supplemental Nutrition Assistance Program; WFS, WIC Fresh Start; WIC, Special Supplemental Nutrition Program for Women, Infants, and Children.

Study inclusion and exclusion criteria

Inclusion criteria for this review were: 1) peer-reviewed research articles in scientific journals; 2) written in the English language; and 3) conducted in the United States. They had to include WIC participants as a part of their study populations and had to measure FV purchases or consumption. Articles were excluded if they were: 1) published or collected their data only prior to the food package revision; 2) review articles; 3) abstracts; or 4) focused on infant FV intake, that is, jarred FV consumption, because CVV benefits cannot be used to redeem infant FV products. This review did not include government reports or organizational reports, such as the USDA's series report on WIC participants (15–19), because the quality of the reports varies and there is no reliable measure to classify them as belonging in or out of the review.

Two of the coauthors (MW and MAA) independently searched the databases and screened the articles for eligibility (e.g., title and abstract) and inclusion (e.g., full-text). Eligibility of articles was determined through screening the title and abstract, after which full article screening was performed to determine suitability for inclusion in the systematic review. Agreement between the 2 authors regarding eligible and included articles was reached according to the PRISMA flow chart. In cases of disagreement, a third author joined the discussion and made the final decision.

Search results

The search for qualified studies was conducted during May 2018 to February 2019, and yielded 354 articles (PubMed = 117, CINAHL = 89, Cochrane = 12, and Web of Science = 136), of which 186 were duplicates. Articles screened for eligibility thus numbered 168, of which 50 were determined to be eligible and 118 were excluded (see [Figure 1](#)). The authors screened the full text of the 50 eligible articles. Of these, 39 met inclusion criteria and 11 were excluded. The references of the included studies were hand-searched to identify any other relevant studies, but no additional studies were found.

Data abstraction

Each article was abstracted into 13 fields, including the first author's name, publication year, main theme or factor, setting, design, study timeline, sample size, race/ethnicity, study population, comparison group, data source, outcomes, and results. The 39 articles were grouped and ordered by main theme (first), the settings (national, state, local) (second), the design (randomized controlled trial, cohort, pre-post, cross-sectional, and qualitative) (third), study years (fourth), and sample size (in descending order) (fifth). After the search was completed, the 2 coauthors reviewed the abstracts of the included studies to identify potential themes based on those used in prior literature and the authors' knowledge about FV consumption related to the WIC program. The studies were first grouped by the 2 authors (MAA and MW) independently by potential themes. A third author (QZ) reconciled any grouping discrepancy between

the 2 authors, if necessary. For each group of the studies, the 3 authors used the Delphi method to discuss potential themes until the agreement on 1 theme was reached.

National, state, and local studies were defined as follows: national studies covered sites from ≥ 2 census regions (Northeast, Midwest, South, West) (20); state studies covered sites from 1 or 2 states in the same census region (no included studies other than national studies covered sites from ≥ 3 states in the same census region); and local studies covered sites based on communities, grocery stores, or clinics within 1 geographic region in a state. Outcomes of FV purchases or consumption were defined by measurement units, for example, servings/day, and by measurement method, for example, self-reported compared with objectively measured. The self-reporting method included 24-h dietary recall and FFQs, whereas the objective measure was based on the food purchase data or WIC redemption data. Remarks were added about whether the measurement of FVs included or excluded fruit juice. To highlight the direction of the relations and ease reading, the results in the table use \uparrow or \downarrow to indicate positive or negative relation (not related to significance). We also summarized these positive or negative relations based on the outcomes (fruit, vegetable, or both) and the study levels (national, state, and local levels).

Quality assessment

The quality of each article was assessed using Joanna Briggs Institute critical appraisal tools for qualitative and quantitative designs (21–23). Two of the coauthors independently assessed the articles. There was a disagreement about the criteria of 12 included studies between the coauthors, so a third author joined the discussion to make the final decision. The score of each article was calculated in percentages, and the quality level of the articles was classified into good ($\geq 90\%$), fair (60–89%), and poor ($< 60\%$).

Results

Overview of the included studies

The 39 articles included in this review covered 7 themes with various settings and research designs (see [Table 2](#)). More details about these articles are provided in [Supplemental Table 1](#). The qualities of these articles are summarized in [Supplemental Table 2](#). The results provided a comprehensive overview of factors related to FV purchases and/or consumption after the 2009 WIC food package revision. The relation between these factors and WIC participants' FV purchases and/or consumption varied by specific participant groups, research settings, and study designs. The 39 articles were ranked by their main themes, quality, settings, and study years. The 7 main themes or factors studied in the literature included: the 2009 WIC food package revision on WIC participants' diets (“WIC package change”) (24–32); WIC participation (33–39); characteristics of WIC participants (“individual factors”) (40–48); farmers' markets (49–54); store- and clinic-level factors (55–57); program interventions including alternative approaches to deliver WIC benefits

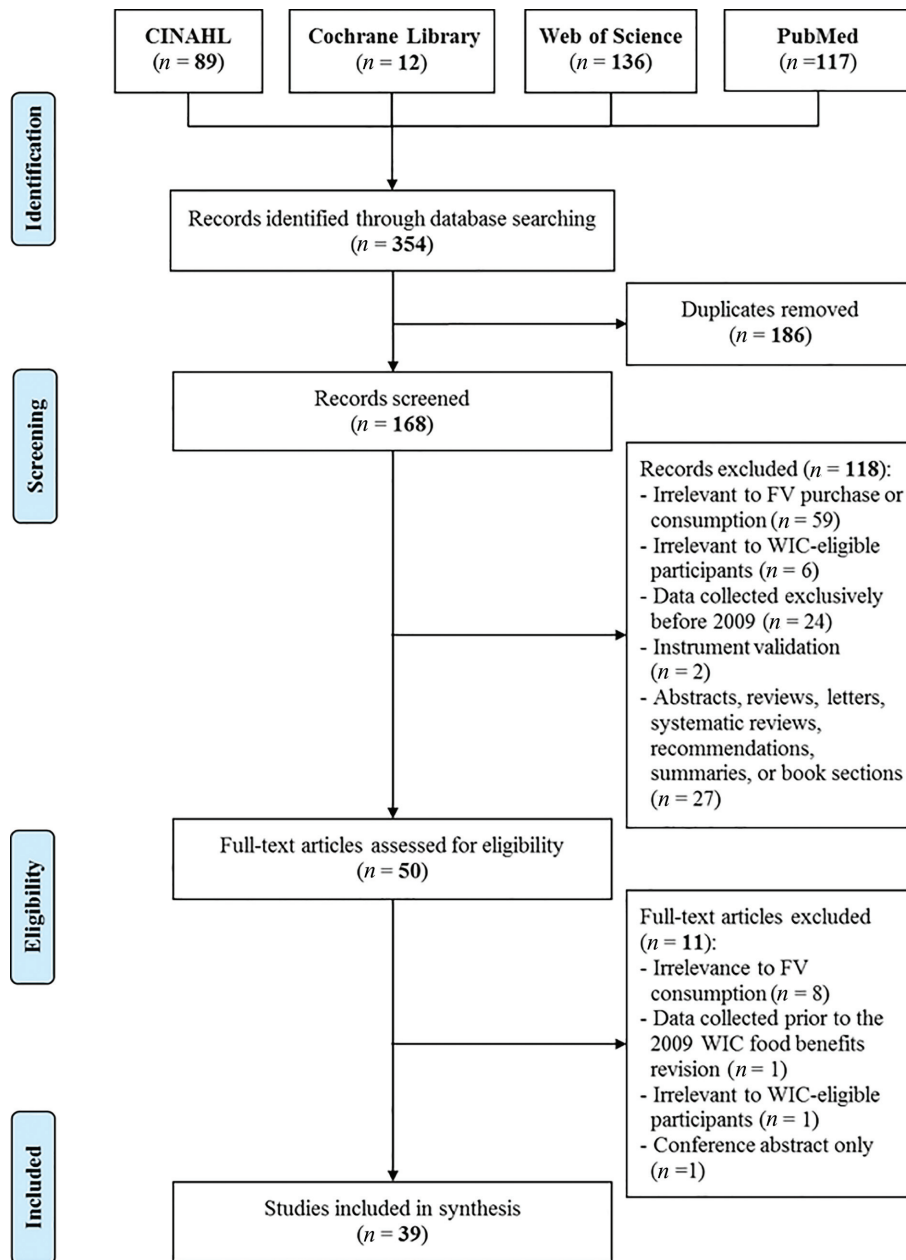


FIGURE 1 Flow diagram of article selection process for a systematic review on fruit and vegetable (FV) purchases and consumptions among WIC participants after 2009 WIC food package revision based on Preferred Reporting Items for Systematic Reviews and Meta-Analyses. WIC, Special Supplemental Nutrition Program for Women, Infants, and Children.

and nutrition education (“alternative interventions”) (58–61); and FV prices with 1 study (62). Of the 39 studies, 25 were at the local level, whereas only 6 and 8 studies were at the state and national levels, respectively. Based on these 3 levels, we summarized in **Table 3** the positive/negative/neutral findings with regard to FV consumption and/or purchases among WIC participants. Notably, any 1 study can present findings different from other studies based upon alternative outcome measures, for example, fruit only, vegetable only, or fruit and vegetable together.

Specific factors associated with FV purchases or consumption among WIC participants

The main results are summarized as follows, with more details provided by themes:

- National or state studies found the 2009 food package revision was associated with positive FV consumption or purchases among WIC participants, whereas the results from local studies were diverse.

TABLE 2 Thematic summary of all included studies related to fruit and vegetable (FV) purchases and consumption among WIC participants¹

Main themes or hypothesis	Study setting	Study population	Comparison group	Outcome (FV purchases or FV intake)	Results	Rank, author(s), year, quality ²
I. 2009 WIC food package revision	National	WIC children aged 2–4 y	Self (post-revision) and income-eligible nonparticipants' children aged 2–4 y	Dietary intake ³ (HEI-2010 component scores of FV)	<ol style="list-style-type: none"> 1. WIC children had significant ↑ of 3.7 HEI-2010 points (95% CI: 0.6, 6.9) after the 2009 revision compared with income-eligible nonparticipating children 2. WIC children had significant 3.4-fold ↑ (95% CI: 1.3, 9.4) in greens and beans compared with income-eligible nonparticipating children 3. No significant change in HEI-2010 component scores of total fruit (including 100% fruit juice), whole fruit (not including 100% fruit juice), ($P = 0.73$), and total vegetables comparing WIC children and income-eligible nonparticipating children ($P = 0.47$) 	1. Tester et al., 2016 (25)***
	National	All WIC participants	Self (post-revision) and income-eligible nonparticipants	FV per capita purchase ⁴ (g/d) [100% fruit juice assessed separately]	1. Significant ↑ in purchase of FV without additions (eg, sugar, fat, and salt) over time in both WIC and income-eligible nonparticipants	2. Ng et al., 2018 (24)***
	State (California)	Pregnant or postpartum women and/or caregivers of children enrolled in WIC	Self (post-revision)	FV intake ³ (frequency: times/d; daily servings) [100% fruit juice assessed separately]	<ol style="list-style-type: none"> 1. Proportion of families eating more vegetables compared with 6 mo ago significantly ↑ by 7.2% after WIC revision; no significant changes on fruits ($P = 0.11$) 2. Mean frequency of fruit intake for respondents ↑ significantly by 0.1 servings/d after WIC revision; no change on vegetable ($P = 0.12$) 	3. Whaley et al., 2012 (27)***
	State (Connecticut and Massachusetts)	WIC participants	Self (post-revision)	FV purchased amount ⁴ (g/mo) and FV expenditure ⁴ (\$/mo)	1. Significant ↑ in FV (fresh vegetable, frozen vegetable, and fresh fruit) purchased amount and expenditure per household	4. Andreyeva and Luedicke, 2015 (26)***
	Local (Head Start centers in rural communities in New Mexico)	Preschool children from WIC-participating households	Self (post-revision)	FV intake ³ (cups/d) [fruit measurement excluding fruit juice]	1. Significant ↓ vegetable without potatoes intake for preschool children after the 2009 revision; decrease not significant if including potatoes as vegetables ($P > 0.05$)	5. Morshed et al., 2015 (28)***
	Local (local agencies in Texas)	WIC participants with a child aged 2–5 y	Self (post-revision)	FV consumption frequency ³ (times/d) [100% fruit juice assessed separately]	2. No change in fruit intake for preschool children ($P > 0.05$)	6. Diep et al., 2015 (29)***
	Local (12 WIC clinics in Chicago, IL)	WIC-participating mothers and children	Self (post-revision)	FV intake ³ (fruit: % participants with >0 servings/d; vegetable: % participants with >0.5 servings/d) [100% fruit juice assessed separately]	<ol style="list-style-type: none"> 1. Nonsignificant ↑ % of black and Hispanic children and mothers with >0 servings/d of fruits ($P > 0.05$); nonsignificant ↑ % of black and Hispanic children and black mothers with >0.5 servings/d of vegetables ($P > 0.05$); nonsignificant ↓ % of Hispanic mothers with >0.5 servings/d of vegetables ($P > 0.05$) 	7. Kong et al., 2014 (30)***

(Continued)

TABLE 2 (Continued)

Main themes or hypothesis	Study setting	Study population	Comparison group	Outcome (FV purchases or FV intake)	Results	Rank, author(s), year quality ²
II. WIC participation	Local (12 WIC clinics in Chicago, IL)	WIC-participating mother/child (2–3 y) dyads	Self (post-revision)	Dietary intake ³ (servings/d) [100% fruit juice assessed separately]	1. Significant ↑ fruit intake among Hispanic mothers 2. No significant change in fruit or vegetable intake in any African mothers ($P = 0.15$ and 0.53 , respectively), and children ($P = 0.95$ and 0.28 , respectively), and in Hispanic children ($P = 0.47$ and 0.09 , respectively)	8. Odoms-Young et al., 2014 (31)**
	Local (WIC clinic in south central Texas)	WIC-participating infants and toddlers (4–24 mo)	Self (post-revision)	FV exposure ³ (any consumption, regardless of portion size) [100% fruit juice assessed separately]	1. Significant ↓ daily exposure of fresh vegetables among toddlers (12–24 mo) after the 2009 package revision 2. No significant change in daily exposure to fresh fruits among toddlers ($P > 0.05$) 3. Significant ↑ in % of toddlers who had zero exposures to FV after 2009 package revision	9. Reat et al., 2015 (32)**
	National	WIC children aged 13 and 24 mo	Self (longitudinal)	HEI-2015 component scores ³	1. Maximum on both total fruit (including 100% fruit juice) and whole fruit (excluding 100% fruit juice) scores, but low on total vegetable and greens and beans scores in children	10. Au et al., 2018 (35)***
	National	WIC children aged 2–4 y	WIC income-eligible nonparticipants' children aged 2–4 y	FV intake ³ (cups/d)	1. No difference in whole fruit or total vegetable intake between WIC children and income-eligible nonparticipants ($P > 0.05$) 2. WIC children consumed significantly ↑ total fruit (including 100% fruit juice) compared with income-eligible nonparticipating children	11. Vercaemmen et al., 2018 (34)***
	Local (Los Angeles County, CA)	WIC-only children	Participating children in dual programs (SNAP and WIC)	FV intake ³ (servings/d)	1. Children who participated in dual programs (WIC + SNAP) consumed ↑ FVs than those who participated in WIC only	12. Liu et al., 2017 (37)***
	Local (2 supermarkets in 2 small urban areas in North Carolina—Wilson and Greenville, NC)	WIC adult grocery shoppers	WIC nonparticipants (eligible and noneligible)	FV consumption ⁴ (skin carotenoids)	WIC participants had significant ↑ skin carotenoids score than nonparticipants	13. McGuirt et al., 2018 (38)***
	National	WIC children 12–23 mo	WIC income-eligible and high-income nonparticipants' children 12–23 mo	FV intake ³ (consumed on a given day)	1. Significant ↑ % of fruit and vegetable (excluding white potatoes) intake among WIC-participating children compared with income-eligible nonparticipating children	14. Hamner et al., 2019 (33)**
	National	WIC children 12–47.9 mo	WIC nonparticipating children 12–47.9 mo	Any FV consumed ³	1. Significant ↓ % of WIC children consumed fruit compared with low- or high-income nonparticipating children aged 12–47.9 mo 2. No significant difference in vegetable consumption across WIC participation ($P > 0.05$)	15. Guthrie et al., 2018 (36)**

(Continued)

TABLE 2 (Continued)

Main themes or hypothesis	Study setting	Study population	Comparison group	Outcome (FV purchases or FV intake)	Results	Rank, author(s), year, quality ²
III. Individual factors	Local (grocery stores in 7 low-income communities in the northern Great Plains region)	WIC grocery shoppers	WIC-eligible or ineligible nonparticipants	FV consumption ³ (daily servings: scores from 1 = 0 serving to 10 = >8 servings)	Positive but nonsignificant relation between WIC participation and FV consumption ($P > 0.05$)	16. Chang et al., 2015 (39)**
	Local (Los Angeles County, CA)	WIC children living in the USA < 10 y (36–60 mo)	WIC children of Hispanic immigrants living in USA ≥ 10 y and Hispanic US-born parents	FV intake ³ (servings/d) [fruit juice assessed separately]	1. Children of Hispanic immigrants (living in the USA < 10 y) consumed significant ↓ FV than children of Hispanic immigrants (living in USA ≥ 10 y) 2. Children of Hispanic immigrants (living in the USA < 10 y) consumed significant ↓ vegetables than children of Hispanic US-born parents	17. Chaparro et al., 2015 (40)***
	Local (WIC clinic in Birmingham, AL)	WIC participants (women), regular CWV redeemers	Low CWV redeemers	FV intake ³ (servings/d) [fruit juice assessed separately]	Regular CWV redeemers consumed significant ↑ daily servings of FVs compared with low CWV redeemers	18. Singleton et al., 2018 (47)***
	Local (WIC clinic in urban New Jersey)	WIC participants (Hispanic women)	WIC non-Hispanic and US-born Hispanic women	FV intake frequency ³ (times/d) [100% fruit juice assessed separately]	1. Race/ethnicity was significant predictor of vegetable intake (eg., Hispanic women consumed ↑ orange-colored vegetables compared with non-Hispanic black women) 2. Hispanic origin and birth place significant predictors of vegetable intake among Hispanics (eg., foreign-born consumed ↑ orange-colored vegetables compared with US-born)	19. Di Noia et al., 2015 (41)***
	Local (2 WIC clinics in Atlanta, GA)	WIC mothers and their oldest children	Within-group comparison	FV intake ³ (servings/d; indicator of > 5 servings/d) [fruit juice assessed separately]	1. "Already eat plenty of FV" significant ↓ FV consumption in mothers and oldest children 2. "Knowing FV often spoil before eating" significant ↑ FV consumption among mothers 3. "Not knowing how to prepare most FV" significant ↑ FV consumption in mothers 4. "Concerned about money" significant ↑ FV consumption in oldest children	20. Chen and Gazmararian, 2014 (43)**
	Local (WIC clinic in Milwaukee, WI)	WIC parents/caregivers	Within-group comparison	FV purchases ³ (times/wk) and FV type consumed ³ (type) [juice assessed separately]	1. 89% of participants redeemed CWVs regularly and 39% of participants bought FVs less than once a week 2. 96% of participants consumed raw, boiled, and steamed vegetables	21. Kharofa et al., 2014 (48)**
	Local (WIC clinic in urban New Jersey)	WIC women	Within-group comparison	FV intake ³ (cups/d) and consumption frequency ³ (times/d) [100% fruit juice assessed separately]	1. Significant positive association between social desirability trait and daily vegetable consumption frequency among nonbreastfeeding women	22. Di Noia et al., 2016 (44)**

(Continued)

TABLE 2 (Continued)

Main themes or hypothesis	Study setting	Study population	Comparison group	Outcome (FV purchases or FV intake)	Results	Rank, author(s), year, quality ²
	Local (2 WIC clinics in Phoenix, AZ)	WIC women or mothers of WIC children	Within-group comparison	CW redemption ³	Perceived facilitators and barriers for FV redemption: 1. Positive experiences and facilitators: <ul style="list-style-type: none"> • Flexibility of CW benefits • Inclusion of fresh and processed FV 2. Barriers: <ul style="list-style-type: none"> • Negative interactions with cashier or other shoppers • Cashiers' lack of training • Varying enforcement of WIC rules across stores • Embarrassed to be identified as using WIC CW benefits 	23. Bertmann et al., 2014 (42)**
	Local (Hartford, CT)	WIC-eligible pregnant women	Within-group comparison	Prenatal FV intake ³	10 factors related to prenatal FV intake (social support, family structure, FV access, FV preferences, FV knowledge, FV health outcome expectations, self-efficacy, intentions, FV action/coping planning strategies, maternal health status)	24. Hromi-Fiedler et al., 2016 (45)**
	Local (Tulare, Alameda, and Riverside counties, CA)	WIC participants	Within-group comparison	FV purchase decision ³	Ranking of perceived factors affecting FV purchase decisions from most important to least important: highest quality produce; can see, smell, touch before buying; best bargains on produce; convenience; clearly displayed prices	25. Kaiser et al., 2015 (46)*
IV. Farmers' markets	State (California)	WIC households	WIC households redeemed at a full-line grocery	CW full redemption ⁴	Probability of CW full redemption was 99.1% at farmers' markets compared with 66.8% at a full-line grocery with 6–9 cash registers	26. Saitone et al., 2018 (54)**
	Local (WIC clinics in Birmingham, AL)	WIC women	Within-group comparison	FV intake ³ (servings/d)	1. Farmer-to-consumer (FTC) retail outlet usage associated with significant ↑ FV daily intake and significant ↑ odds of consuming ≥ 5 servings/d among WIC women	27. Singleton et al., 2016 (49)***
	Local (2 WIC clinics Atlanta, GA)	WIC FMNP participants (women and their children)	WIC non-FMNP participants (women and their children)	FV intake frequency ³	1. No significant difference on FV intake of mothers and children detected between FMNP groups and non-FMNP groups ($P > 0.05$)	28. Stallings et al., 2016 (51)***
	Local (WIC clinic in Urbana, IL)	WIC FMNP participants	WIC non-FMNP participants	FV intake ³ (eaten as snacks and servings/d)	1. Significant ↑ participants receiving FMNP vouchers eating vegetables as snacks and eating > 1 vegetable daily compared with those not receiving the voucher 2. No significant difference in fruit intake, citrus fruit, or juice, between the voucher and nonvoucher group ($P > 0.05$)	29. Wheeler and Chapman-Novakofski, 2014 (52)**

(Continued)

TABLE 2 (Continued)

Main themes or hypothesis	Study setting	Study population	Comparison group	Outcome (FV purchases or FV intake)	Results	Rank, author(s), year, quality ²
V. Store- and clinic-level factors	Local (WIC clinic in Birmingham, AL)	WIC FITC outlet women users	WIC non-FITC outlet women users	FV intake ³ (≥ 5 servings/d) [fruit juice assessed separately] FV purchase at farmers' markets ³	Significant \uparrow % of FITC outlet users consuming ≥ 5 servings FVs per day compared with nonusers	30. Singleton et al., 2017 (50)**
	Local (WIC clinic in urban New Jersey)	WIC women	Within-group comparison		Usage 1. Barriers: <ul style="list-style-type: none"> • Transportation • Not knowing market location • Market barriers • Time constraints • FMNP limitations (access, availability, and utilizing vouchers) • Unhealthy diet habits 2. Facilitators: <ul style="list-style-type: none"> • Convenience • Variety of FVs • Information about healthy eating • FV incentives 	31. Di Noia et al., 2017 (53)**
VI. Program intervention	State (New Jersey)	WIC participants	Within-group comparison	CW complete redemption, ⁴ defined as redemption rate $\geq 90\%$ CW redemption ⁴	Minimum stocking of FVs in stores; significant but small \uparrow (10%) in the odds of complete CW redemption after the policy change	32. Okeke et al., 2017 (55)**
	State (212 WIC clinics in Washington state) Local (Chelsea, MA)	WIC nontribal clinics Corner store adult customers (WIC participants and nonparticipants)	Tribal WIC clinics Control stores	WIC CW sale at store level ⁴ (\$/mo) and % of customer who purchased fresh FVs ³ FV intake frequency ³ (times/d) and self-reporting eating more FVs ³ [100% fruit juice assessed separately]	Nontribal WIC clinics had significant \uparrow CWVs redeemed compared with tribal WIC clinics 1. WIC CW sales significantly \uparrow in intervention stores with improved visibility and quality of FVs compared with control stores 2. Nonsignificant \uparrow in the proportion of WIC participants who purchased fresh FVs in intervention stores compared with control stores ($P = 0.11$)	33. McLaury et al., 2016 (56)** 34. Thorndike et al., 2017 (57)**
	State (California)	WIC women or caregivers of children	Within-group comparison	FV expenditure ⁴ and frequency share by FV food groups ⁴	1. \uparrow % of participants reported their family having more fruit intake after nutrition education curriculum state-wide implementation, but no significant difference in eating more vegetables ($P = 0.31$) 2. Significant \downarrow in vegetable mean frequency intake for respondents after education, but not significant for fruit ($P = 0.97$) With an additional FV voucher (\$25/mo/household): 1. Fruit expenditure constitutes 55% of the spending but 45% of the frequency share 2. Low % of mean expenditure share on dark-green and/or red and orange vegetables	35. Ritchie et al., 2010 (61)*** 36. Hanbury et al., 2017 (60)***

(Continued)

TABLE 2 (Continued)

Main themes or hypothesis	Study setting	Study population	Comparison group	Outcome (FV purchases or FV intake)	Results	Rank, author(s), year, quality ²
	National (school food authorities in Cherokee Nation and Chickasaw Nation and 8 states)	WIC children	Respondents in SNAP benefit model	FV intake ³ (cup-equivalent/d) including fruit, juice and vegetable juice	FV consumption among respondents in WIC benefit model 2 times ↑ compared with that in SNAP benefit model	37. Briefel et al., 2018 (58)**
	Local (WIC clinic in urban New Jersey)	WIC Fresh Start (WFS) women	WFS nonparticipating women	FV intake ³ (cups/d) [fruit juice included]	WFS participating women consumed significantly ↑ fruit and ↓ vegetables compared with WIC participants nationwide	38. Di Noia et al., 2016 (59)**
VII. FV prices	National	WIC participants	Within-group comparison	Purchasing power of CWV ⁴	Purchasing power of CWV varied across regions	39. Çakıret et al., 2018 (62)***

¹ CWV, cash value voucher; FMNP, Farmers' Market Nutrition Program; FTC, farm-to-consumer; FV, fruit and vegetables; HEI, Healthy Eating Index; SNAP, Supplemental Nutrition Assistance Program; WFS, WIC Fresh Start; WIC, Special Supplemental Nutrition Program for Women, Infants, and Children.

² *** = good quality; ** = fair quality; * = poor quality.

³ Self-reported outcome variable.

⁴ Measured outcome variable.

- No consistent results were found about the relation between WIC participation and FV consumption or purchase.
- Race/ethnicity, birth places, and immigration status were significant predictors of FV purchases or consumption.
- Emerging evidence supported a positive association between farmer-to-consumer (FTC) sales and FV consumption or purchases among WIC participants.
- A minimum stocking policy or increase in FV visibility might increase FV purchases among WIC participants, but the evidence was limited.
- Some pilot programs, such as nutrition education or economic incentives, might increase FV consumption or purchases, but the evidence was still limited.

The 2009 WIC food package revision (n = 9).

These studies compared WIC participants before and after the 2009 WIC food package revision, with their results varying by the settings (24–32). Two of these studies also compared the participants with eligible nonparticipants (24, 25). National or state studies suggested a positive relation between the WIC food package revision and FV purchases or consumption, whereas local studies generated more diverse results (Table 3). For example, Tester et al. (25) found that after the 2009 revision, the greens and beans component scores of the Healthy Eating Index (HEI-2010) among a nationally representative sample of WIC children aged 2–4 y achieved a 3.4-fold relative increase (95% CI: 1.3, 9.4) compared with income-eligible nonparticipating children. A California study suggested that the proportion of WIC women eating more vegetables increased by 7.2% after the 2009 revision (27). Similarly, national studies and state studies in Connecticut and Massachusetts found an increase in FVs purchased after the 2009 WIC revisions among WIC participants (24, 26). However, whether this purchase increase was caused by the 2009 WIC revisions should be viewed with caution, because a similar increase in FV purchases was observed among income-eligible nonparticipants as well in a national study (24).

However, none of the 5 local studies found consistent evidence of a positive relation between the 2009 WIC revision and FV purchases or consumption (28–32). For example, no significant increase in FV intake was observed after the 2009 WIC revision among Head Start children in rural New Mexico (28), Asian-American children in Texas (29), or Hispanic and African-American children in Chicago, Illinois (30, 31). Another study in a WIC clinic in south central Texas found the proportion of toddlers (aged 12–24 mo) who consumed any fresh vegetables on the study day was significantly reduced after the 2009 WIC revision, although there was no significant change in the proportion of toddlers who consumed any fresh fruits on the study day (32). The limitation of these studies was their small sample sizes (ranging between 68 and 373). Thus, these studies might not be powered adequately to detect small but significant changes after the 2009 WIC revision.

TABLE 3 Summary results of factors related to fruit and vegetable consumption and purchase among WIC participants based on national, state, and local level¹

Themes	National			State			Local		
	Positive, ² n, outcome (references)	Negative, ³ n, outcome (references)	Neutral, ⁴ n, outcome (references)	Positive, n, outcome (references)	Negative, n, outcome (references)	Neutral, n, outcome (references)	Positive, n, outcome (references)	Negative, n, outcome (references)	Neutral, n, outcome (references)
1. 2009 WIC Revision	2 FV (24, 25)	0	0	2 FV (26, 27)	0	0	1 F (31)	1 V (28), 1 FV (32)	1 F (28), 3 FV (29–31)
2. WIC participation	2 F (34, 35), 1 FV (33)	1 F (36)	1 FV (34), 1 V (36)	0	0	0	2 FV (38, 39)	0	1 FV (40)
3. Individual factors	0	0	0	0	0	0	2 FV (43, 47), 2 V (41, 44)	1 FV (41)	0
4. Farmers' markets	0	0	0	0	0	0	4 FV (49, 50, 52, 54)	0	1 FV (51)
5. Store- and clinic-level factors	0	0	0	2 CVV (55, 56)	0	0	1 CWV (57)	0	0
6. Program intervention	1 FV (58)	0	0	0	1 V (61)	1 F (61)	1 F (59)	1 V (59)	0
7. FV price	0	1 (62)	0	0	0	0	0	0	0

¹Qualitative and descriptive studies were excluded; any one study can present positive, negative, or neutral results depending on the outcomes. CW, cash value voucher; F, fruits; FV, fruits and vegetables; V, vegetables.

²Positive = significant positive association with the outcome.

³Negative = significant negative association with the outcome.

⁴Neutral = no significant association with the outcome.

WIC participation (n = 7).

The focus of this theme was to compare FV intake of WIC participants with that of income-eligible nonparticipants. No consistent findings were identified between WIC participation and FV consumption in national or local studies (33–39); no state-level studies have been conducted under this theme. No difference in FV intake (excluding 100% fruit juice) was found in a national sample of children aged 2–4 y, whereas a higher percentage of WIC-participating toddlers aged 12–23 mo consumed FV (excluding white potatoes) (33, 34). However, in another national sample of children aged 1–4 y, a lower percentage of WIC participants consumed fruits than income-eligible nonparticipants, whereas no difference was found in vegetable consumption (36). In a national longitudinal study, the WIC-participating children aged 7–24 mo achieved the maximum component score on the HEI-2015-fruit, but the HEI-vegetable score was still low (35). Therefore, even at a national level, there was no conclusive evidence on the relation between WIC participation and FV purchases or consumption.

Two of the 3 local studies found positive relations between WIC participation and FV purchases or consumption (37, 38). McGuiert et al. (38) used the Veggie Meter (Longevity Link Corporation, Salt Lake City, UT, USA) to measure skin carotenoids as a proxy for FV intake, which was significantly higher among WIC participants than among nonparticipants. Liu et al. (37) found that dual enrollment in WIC and the Supplemental Nutrition Assistance Program (SNAP) increased WIC participants' FV consumption, compared with WIC-only participants. Chang et al. (39) found a positive but nonsignificant relation between WIC participation and FV consumption. Notably these studies were not intended to be representative, and 2 of the studies had small sample sizes: 136 subjects in McGuiert et al. (38) and 257 subjects in Chang et al. (39).

Individual factors (n = 9).

Studies with this theme examined various individual factors related to WIC participants' FV purchases or consumption, including sociodemographics as well as personal and perceived facilitators and barriers (40–48). Race/ethnicity, birth places, and immigration status were significant predictors of FV purchases or consumption (40, 41). WIC-participating children of new Hispanic immigrants (<10 y of residence) consumed less FVs than their peers among older Hispanic immigrants (≥10 y of residence) (40). Hispanic or foreign-born women consumed more orange-colored vegetables compared with non-Hispanic or US-born women (41). Other personal facilitators of FV purchases or consumption included FV knowledge, frequent CVV redemption, FV social desirability (i.e., perception of FVs as socially desirable), and self-efficacy (40–44). Various perceived barriers existed, including FV cost, time constraints, accessibility, lack of knowledge about FVs, negative store redemption experiences, and varying CVV rules across stores (42, 45, 48). This line of research helps explain how WIC participation can have positive and negative effects on FV purchases or

consumption, elucidating the inconclusive results found in the national studies.

All studies were limited to local areas and used a mixed method approach: 6 studies were cross-sectional surveys (40, 41, 43, 44, 47, 48), whereas 3 studies were qualitative (42, 45, 46). The sample sizes of the former varied from 41 to 2352, whereas the qualitative studies tended to have smaller sample sizes.

Farmers' markets (n = 6).

Direct FTC sales, such as farmers' markets or roadside stands, were identified as an effective strategy to improve fresh FV intake in low-income communities compared with similar communities without FTC sales (63, 64). All studies of this theme were at the local level, and 4 studies found a positive association between FTC sales and FV consumption or purchases among WIC participants (49–54). The WIC program interacts with farmers' markets on 2 fronts: First, farmers' markets can be authorized by WIC agencies to accept CVVs (54); second, most WIC agencies provide FMNP vouchers \leq \$30/y per participant, and these vouchers can be redeemed at WIC-approved farmers' markets for fresh FV purchases (51). A state-level study in California suggested that participants were significantly more likely to redeem full CVV benefits in farmers' markets compared with redemption in a full-line grocery store with 6–9 cash registers (99.1% compared with 66.8%) (54). Even if the CVV could not be redeemed at FTC outlets, WIC participants who patronized the FTC outlets were significantly more likely to consume \geq 5 daily servings of FVs than participants who did not (49, 50).

Two studies assessed the association between FMNP vouchers and FV consumption (51, 52). One study found that FMNP groups were more likely to consume $>$ 1 vegetable per day than no-FMNP groups (52), whereas another study did not find significant differences in FV consumption between these groups (51). A qualitative study identified various barriers to farmers' markets, including accessibility, availability, and time constraints, as well as noting limitations of FMNP (e.g., FMNP vouchers not allowing participants to receive change back) (53). Although local studies indicated that farmers' markets were promising to promote FV purchases and consumption among WIC participants, more studies are needed to evaluate the effectiveness of farmers' markets and FMNP at the state or national level.

Store- and clinic-level factors (n = 3).

State- and local-level studies found the characteristics of stores and WIC clinics associated with positive FV consumption or purchases among WIC participants (55–57). For example, the requirement in New Jersey that WIC-approved stores stock a minimum of 2 fresh fruits and 2 fresh vegetables was associated with a small but significant increase in full CVV redemption (55). At the clinic level, after evaluating the 212 WIC clinics in Washington state, McLaury et al. (56) found that nontribal clinics had higher CVV redemption rates than tribal clinics. Thorndike et al. (57) evaluated the

effect of a local-level randomized intervention to improve FV visibility and stocking and found a significant increase in CVV sales but a nonsignificant increase in the proportion of WIC participants who purchased fresh FV. Compared with previous themes, this theme still has sparse evidence, which indicates a knowledge gap in vendor- or clinic-based research to understand how these venues' factors are related to FV purchases or consumption among WIC participants.

Program intervention (n = 4).

Specific program interventions were designed to promote WIC participants' FV consumption in general, although the positive effect might vary between fruits and vegetables (58–61). A national study involving 8 states and 2 Indian tribes tested 2 different benefit delivery modules for summer electronic benefits transfer for children: either the SNAP or the WIC model (58). The results indicated that electronic benefits transfer (EBT) delivered in the WIC model achieved twice the FV consumption that EBT delivered in the SNAP model (58). One state study used a pre-post design to examine the effect of state-wide implementation of a nutrition education curriculum, Healthy Habits Every Day, highlighting culturally relevant messages on FV consumption (61). Although a higher percentage of participants reported more fruit intake in their households after the intervention, no significant change was found in the consumption of vegetables.

One local-level study (60) tested giving \$25/mo to low-income rural Mexican-heritage families who were currently or previously enrolled in WIC or SNAP and had \geq 1 child aged 3–8 y. The \$25 EBT card could be used to purchase FV on the WIC CVV lists. The families receiving \$25/mo allocated 55% of the expenditure to fruits but only 7–9% to dark-green and/or red or orange vegetables. Another local study in the state of New Jersey examined a web-based WIC Fresh Start (WFS) program (59) promoting farmers' market purchases and FV consumption; it, too, found more fruit consumption but less vegetable consumption among WFS participants compared with average WIC participants in the nation (59). In summary, how to induce participants to purchase or consume more vegetables remained a challenge.

FV price (n = 1).

Although price was significantly related to FV purchases or consumption, only 1 study examined variations in the CVV's purchasing power (62). Using national retail scanner data, Çakır et al. (62) showed that the increasing FV prices over time and regional differences in FV prices were consequential factors in the CVV's purchasing power, indicating that participants living in high-cost regions or facing higher inflation of FV prices make fewer FV purchases and consume less due to decreasing purchasing power.

Discussion

To our knowledge, this is the first comprehensive review of the factors related to FV purchases and/or consumption among WIC participants after the 2009 WIC revision in

the United States. The data abstraction process helped organize the studies in a consistent way, thus revealing some related common results and themes that can be identified and highlighted. Moreover, multilevel and multifacet review provides a comprehensive examination of the often inconsistent evidence in the literature regarding factors related to FV purchases or consumption in WIC participants. The 7 identified factors (or “themes”) covered a wide range of aspects, from the 2009 WIC revision to store and clinic factors that can be affected by state policies, and from individual-level factors to the venues’ environmental factors.

This report can serve as an important reference for policy makers and researchers to understand the various factors that can facilitate or discourage WIC participants’ FV purchases or consumption. Furthermore, this study has identified the limitations and knowledge gaps of the studies in this field. Some of the study’s limitations are discussed below. These, too, indicate research opportunities to examine FV purchases or consumption in WIC programs.

Lack of national and state studies

The majority of the included studies were local-level studies ($n = 26$), whereas there was a lack of national ($n = 7$) and state ($n = 6$) studies. California is still the most-studied state ($n = 3$); most of the WIC states did not have any research. Local-level studies require fewer resources to implement and can be time sensitive to a natural experiment, such as the consequences of the 2009 WIC food package revision. Local studies can also more easily use qualitative research methods to generate insights about individual factors. However, such an approach can be underpowered to quantitatively examine the effects of a structural change, such as the 2009 WIC revision. Given these limitations of smaller-scale studies and the varying operation of the WIC program in different states, more state-based studies are needed to provide a comprehensive view of all WIC participants’ FV purchases or consumption.

The importance of study setting (national, state compared with local) can be seen in the way it can influence the consistency of the conclusions. For example, national or state studies indicated that the 2009 revision was associated with positive changes in FV intake (24, 25, 27), whereas local studies all failed to generate any significant evidence to substantiate that conclusion (26, 28–32). However, national studies did not identify a consistent relation between participating in WIC and FV purchases or consumption (33, 34, 36), whereas local studies documented a positive association between WIC participation and FV intake (37, 38, 43).

The inconsistency in the conclusions across settings can be due to the following reasons. First, local studies might not have had a sufficiently representative sample. Even if the sample was representative of local participants, it might not have represented participants in the state or the nation. Second, the sample size of local studies tended to be small, often at the hundreds level, whereas national and state

samples were at the thousands level. This meant that some local studies might not have had the power to detect the studied relation. Third, local studies tended to focus more on a specific race/ethnic group or certain age groups of the participants, whereas state or national studies included diverse populations among the WIC participants. The different results reflect all these disparities in the underlying study samples. Finally, alternative measures of FV consumption or purchases and data collection methods (e.g., 24-h dietary recall or FFQ), might explain part of the difference in findings. The inconsistency of results across settings should alert policy makers and researchers to interpret the findings in the context of their different settings instead of attempting to draw general conclusions.

Reliability of the studies

Given the heterogeneity of the study designs, we need to interpret the results carefully. Careful experimental design is necessary to establish causality, but this was adopted only in 1 study (57). The majority of the included studies adopted either a pre-post design or a cross-sectional design ($n = 31$), neither of which can establish causality between the studied factors. The lack of randomized controlled trials among the studies we examined could be due to ethical reasons and logistical concerns. Longitudinal studies can also provide reliable information about causality, but they require panel data at the state or national level (35, 55, 62). Four qualitative studies (42, 45, 46, 53) were exploratory research with small sample sizes and local settings. Therefore, their findings require more rigorous studies to confirm them.

Another challenge to the reliability of these studies is “self-selection bias”; that is, individuals with observable or unobservable characteristics related to FV purchases or consumption might be more or less likely to be selected into the WIC program or use the farmers’ market. Therefore, observing a negative relation between WIC participation and FV purchases or consumption might not be justifiably interpreted as the negative impact of WIC programs on participants’ healthy eating (36); it could simply reflect these unseen characteristics. Similarly, the higher FV purchases or consumption observed in farmers’ market users might be due to “selection bias” in that these participants might prefer fresh FV and thus be more motivated to take advantage of the farmers’ markets. Proper methods are needed to address self-selection bias in WIC studies. Researchers can adopt alternative research designs, such as a cohort study (65), or more rigorous statistical methods, for example, regression discontinuity (66) or instrumental variable (67), to control for self-selection bias without using a randomized trial, although an appropriate instrumental variable for WIC participation might not be easily identified. Without the proper control, it is challenging to draw a conclusion about the effectiveness of the WIC program and various interventions on FV purchases or consumption among participants.

Understudied facilitators and barriers for FV purchases or consumption

This review indicated that the 2009 WIC revision and general WIC participation were still the primary focuses for researchers examining the factors that could contribute to FV purchases or consumption among WIC participants. Other factors were examined on an ad hoc basis, which is unlikely to generate consistent findings. For example, the store experience, finding high-quality produce at WIC-authorized vendors, and the convenience of redeeming benefits can all affect FV purchases and/or consumption among participants, but the review showed that only a few studies have addressed these factors. Some of these factors could be affected by WIC state agency policy—for example, store authorization and training (required for WIC state agencies) could be used to improve the convenience and other aspects of the WIC shopping experience. Studies that examine state policy and policy variation across states might shed more light on the value of such factors and inform state agency policy decision-making.

Notably, some of the factors associated with FV consumption among WIC participants that were identified in these reviews can also be determinants of FV consumption in other low-income groups or a general population of women and children (68–72). For example, race/ethnicity was a consistent factor associated with children's FV consumption, although caregivers' places of birth might not be a significant factor (68, 70–72). Higher availability and accessibility of FVs can be associated with improved FV consumption among low-income preschoolers in general (69). Parental factors, such as mother's education and parental FV consumption, were also important for children's FV consumption (69, 70). It is worthwhile to explore any overlapping or unique factors associated with FV consumption among the WIC population and the general population. Due to the complexity of the WIC programs and fast-changing policy and implementation guidelines, more factors should be included in the studies. For example, with the approaching October 2020 deadline for EBT implementation across WIC agencies, WIC participants are likely to be able to redeem their CVVs more easily, and the WIC agencies will have a higher quality of EBT data. (The different stages of this EBT implementation in different states could also explain the inconsistent results across studies.) Future research will be able to take advantage of these newly available data to analyze various factors, such as participation history, that might contribute to FV purchases or consumption among WIC participants.

More than 30 state agencies have implemented WIC-related apps with various functions for participants to check their CVV balances and identify WIC-approved stores (73). However, there has been little research specifically examining how WIC app usage has affected participants' FV purchases or consumption. Transforming the traditional CVV into cash value benefits could make the benefit redemption more convenient, but little empirical research in the literature has examined how this major system change has affected participants' FV purchases or consumption to date (74, 75).

Study limitations

This study has several limitations. A standard quality control matrix was not applied due to 2 considerations: First, the included studies have mixed research designs, for example, observational or qualitative studies, but there is no consistent framework to assess quality and compare it across these designs. Second, the main focus of this review is on the themes instead of specific outcomes as in meta-analysis. The quality assessment also did not take into account how fruits and vegetables were assessed, for example, the use of valid tools, which is a source of potential bias in the results. Moreover, not separating 100% fruit juice consumption from total fruit consumption can result in an inconsistent assessment of fruit consumption. Only 2 articles included fruit juice in the fruit measurement (58, 59); results from these 2 articles were unlikely to affect the main findings of this review. Nevertheless, this study provided a comprehensive view of the latest research addressing FV purchases or consumption related to the WIC program.

Conclusions

This systematic review identified several main factors that might affect FV purchases or consumption among WIC participants, including the 2009 WIC food package revision and farmers' market usage. However, the existing studies varied considerably regarding study setting, study design, data collection, data analysis, measures of FV purchases or consumption, and reported results, making generalization of their findings challenging. In addition, causality can hardly be determined based upon these studies, because most of them are based on cross-sectional data. Because states are the main agencies to operate the WIC program and can establish policies and practices that can influence purchase and consumption, more state-level studies that can shed light on the relative influence of policy and practice choices on FV purchases or consumption among WIC participants are needed.

Acknowledgments

The authors' responsibilities were as follows—QZ and YW: conceptualized the study; MAA and MW: collected the data and conducted the data abstraction; QZ: wrote the first draft, with significant revisions contributed by MAA, MW, YW, and XC; and all authors: read and approved the final manuscript.

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