TBM

SYSTEMATIC REVIEWS

The introduction of new food retail opportunities in lower-income communities and the impact on fruit and vegetable intake: a systematic review

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Abstract

A lack of access to fresh fruits and vegetables (F&Vs) is associated with consumption of fewer F&Vs and higher risk of obesity, especially for lower-income individuals. It is widely believed that the addition of new food retail opportunities could improve F&V consumption and subsequently reduce the chronic disease burden. Observational studies provide some support for these hypotheses, but contradictions exist. In this study we sought to examine if the introduction of a food retailer affects F&V consumption in lower-income communities. We used a systematic PRISMA approach to conduct this study. We searched PubMed, EMBASE, and ProQuest Dissertations & Theses for academic journal references and gray literature published before August 2018. Included studies were those looking at the effect of the introduction of a new food retailer on F&V consumption. Studies were also categorized based on which dimensions of food access were targeted by the food retailer. We identified 15 studies meeting inclusion criteria: 11 studies reported a positive increase in F&V consumption attributable to the introduction of a new food retailer, of which 6 were statistically significant. The remaining 4 studies, all of which examined the impact of introducing a new retail supermarket, showed no change or a decrease in F&V intake. Results from studies which change the food environment generally support the idea that increased access to healthy food improves diet, but more studies are needed in order to assess the differences between the various types of retailers, and to identify strategies for improving impact. Understanding which types of new food retail programs are most likely to impact diet has implications for policies which incentivize new food retail.

Keywords

Food access, Food interventions, Diet outcomes, Food retail

Implications

Practice: Mobile produce markets and farmers' markets may increase the consumption of fresh fruits and vegetables in lower-income communities.

Policy: Policymakers who want to increase fruit and vegetable intake and improve population health should focus on funding mobile produce markets and farmers' markets that address multiple aspects of food access and incentivize or promote the sale of fresh fruits and vegetables.

Research: Larger cluster randomized controlled trials of food retail interventions that include objective measures of fruit and vegetableintake should be the priority of future research.

BACKGROUND

Researchers have identified many factors that may contribute to disparities in fruit and vegetable (F&V) purchasing and intake, including individual and neighborhood socioeconomic factors [1,2], food prices [3], and store type [4,5]. Increasing attention has been paid to the role of the built environment because lower-income neighborhoods and those that are predominantly Black and Hispanic have less access to supermarkets and healthy food retailers [6–8], which may be one reason for the disparities in diet quality [9,10] and health outcomes [11] among those populations. However, observational research is unclear on whether "access" as defined solely by geographic proximity significantly influences F&V consumption. A 2009 systematic review focusing on neighborhood food environments and health outcomes found that the presence of grocery stores was associated with healthier diets and lower body mass index [12], but other studies have shown that distance from a food store does not relate to diet quality [13,14].

Further complicating the observational research is the use of different spatial measures and distances (e.g. 5 miles, 1 mile) when defining the independent variable [15]. In one study, researchers sought to determine areas of high and low food access using multiple spatial measures and found little consistency between the different measures [16]. Some researchers have also suggested that if a store is over a mile away in a low-income zip code it may be inaccessible due to a lack of reliable vehicular transportation [17]. Using Geographic information

system-data, it is difficult to discern what is and is not walkable (e.g. whether there are dangerous or busy streets one would have to cross within that mile, if proper lighting is available, if sidewalks are stable) [17]. Given these complexities, our understanding of the influence that the built environment has on F&V intake is limited by challenges in measuring the built environment and shopping behavior. In addition, many studies define access as the distance one has to travel to purchase from a food retailer, but fail to consider the other dimensions of food access.

As first proposed in 2012 by Caspi et al [18], the "5 A's of Food Access" were developed from a theoretical model used to conceptualize health care access and include: access, availability, affordability, accommodation, and acceptability. Caspi et al explain that when quantifying and discussing food access, it's important to consider whether health-promoting options are available (availability), the cost of the food (affordability), if the retailer(s) accommodate the population served with convenient hours and forms of payment (accommodation), and whether the population wants to buy and eat the food that is being sold (acceptability) [18,19]. Geographical data may suggest that an area is densely populated with various food stores, but it provides no indication about the healthfulness or quality of the food provided, how easy it is for residents to actually get there and leave with many grocery bags of food, or whether the foods are culturally appropriate and regularly consumed by patrons.

Observational studies can only tell us so much because they do not account for all of the environmental and individual factors that may differ between respondents and they do not usually include measurement of the other dimensions of food access. The best way to understand the impact that food stores have on diet is through interventions that change the food environment. These usually fall into two categories: changes to existing food retail and the introduction of new food retail. Previous research has looked at interventions to improve retail offerings in small stores (i.e. convenience and corner stores) [20] and found evidence that an increase in healthy food supply (e.g. stocking, promotions of the stock) leads to an increase in healthy food demand (purchasing and consumption by consumers). The goal of this article is to review the literature looking at the impact of *new* food retail on F&V intake in lower-income communities. This study synthesizes and analyzes current empirical research that examines the influence of new food retail opportunities on F&V consumption as well as assesses the 5 A's of each study. We investigate which components of these interventions were successful and identify gaps in the literature.

METHODS

Search strategy

A PICO search is an evidence-based literature search strategy. The "P" stands for "patient, problem, or population," the "I" indicates the intervention, the "C" is the "comparison, control, or comparator," and the "O" is the outcome of interest [21]. Author K.H. used a PICO framework to identify terms related to the research question; these terms were then compared to PubMed's subject headings [21]. Using terms from the PICO search strategy, authors K.H. and M.Z. built boolean search algorithms for PubMed, EMBASE, and ProQuest Dissertations & Theses. The PICO framework and boolean search algorithms can be found in Supplementary Material S1. Two independent reviewers (authors K.H. and L.V.) searched databases using the key word searches. We also looked at the citations of relevant papers. The current study includes all studies published or available online by August 24, 2018. Our search resulted in 1,417 articles to start and we then screened the relevant studies first by title and abstract, and finally by full text. A PRISMA flow diagram is included in Supplementary Material S2 [22].

Selection criteria

The inclusion criteria are as follows: (a) Studies that examined the introduction of new food retail into a lower-income community in the United States, this would have included any Community Supported Agriculture, farmers' market, farm stand, mobile produce market, healthy corner store, or grocery store (we considered the study to be carried out in a low-income or low-access area or for a low-income population if the study's author indicated as such). (b) Studies that included F&V intake as an outcome. All of the included studies determined "diet quality" as consumption of F&Vs. Although some studies include measures of added sugars or processed foods (e.g. supermarket studies), we set out to focus on F&Vs because other retailers (e.g. mobile markets) predominantly or solely sell fresh F&V.

The exclusion criteria are as follows: (a) Study interventions that do not include healthy food retail operations, meaning the study had to involve the *sale* of healthy foods (i.e. rather than free food distribution). (b) Studies where authors investigated the influence of an already existing retailer or the transition of an existing retailer (e.g. one that was introduced before the onset of the study and/or baseline measures). (c) Studies that included other related measures, but did not include diet quality as one of the outcomes (e.g. sales data, perception of access). (d) Studies not published in the United States, as this special issue of *Translational Behavioral Medicine* focused on food access and translational interventions in the United States specifically. (e) Studies not published in English.

The first reviewer (K.H.) selected the 48 most relevant articles and all were examined in-depth by both reviewers. 100% consensus had to be reached between the two reviewers for the study to be included, which resulted in 15 studies eligible for analysis.

Data collection and analysis

We identified the setting, type of intervention or program, study population, study design, measurement variables and tools, and strengths or limitations for each of the included studies (Table 1). In Table 1, studies were organized by publication date, with the most recent studies appearing first. We calculated effect sizes from those studies which included pre-and-post measures of F&V intake as well as standard deviations (Table 2) which was organized first by the type of intervention and then by publication date. We also classified studies by whether they accounted for or measured the five dimensions of food access (Supplementary Material S3) organized first by the type of intervention and then by publication date. The assessment of the 5A's [18] is based on what was explicitly measured and/or reported by the study authors, therefore, it is possible that some studies may address these components, but authors did not report it.

RESULTS

Key findings from the included articles ($n = 15$) are described in Tables 1 and 2, and Supplementary Material S3. Six studies identified a positive and statistically significant relationship between a new healthy retail intervention or program and an increase in F&V intake ($n = 6$, 40.0%) [23–28]. An additional four studies also identified a positive relationship, but were not statistically significant or did not use a statistical test of significance ($n = 4$, 26.67%) [28–31]. Only one study found a mixed result as there were three intervention sites—one of the sites had an increase in F&V intake, a second site showed no change, and a third site showed a decrease in F&V intake ($n = 1$, 6.67%) [32]. The remaining four studies were all studies of retail supermarkets, one of which resulted in no change ($n = 1$, 6.67%) [33] and three that resulted in a reduction of F&V consumption ($n = 3$, 20.00%) [34–37].

Mobile markets

Mobile produce markets have the most consistent and positive effects on F&V consumption with increases ranging from 0.30 to 0.44 cups/day and Cohen's d effect sizes ranging from 0.15 to 0.36 across six studies [27,23–26,28].

Access and Availability. All of the mobile market studies brought produce directly to the population they were targeting by nature of the program design (e.g. mobile produce retail), but only two of the studies explicitly measured perceived access to F&Vs, which did not change from baseline to follow-up [25,26]. Availability of produce was only measured in one study, and there was a significant increase in the number of participants who indicated a market selling F&V was close to their home ($p = .001$) [27].

Affordability. All of the mobile market studies indicated that produce was sold at a reduced price or below the local retail value, and four explicitly measured perceived affordability or participant food spending. In the "Live Well, Viva Bien" study researchers reported that 90% of participants indicated the cost of F&Vs sold at the market was "good, very good, or excellent" [23]. In the Veggie Van studies, F&V produce boxes were sold on a sliding scale to allow low-income community members to purchase the boxes at lower rates ($8–$12) than the current market value ($18–$24). In the initial Veggie Van pilot researchers found a 20-point increase in affordability of F&V from baseline to follow-up [26], whereas the efficacy study reported no significant change in affordability [25]. In the Veggie Mobile study seniors reported spending an average of $29.00 fewer dollars at the supermarket each month ($p < .06$) [28].

Accommodation. All of the mobile market studies mentioned elements of accommodative programming, such as accepting Supplemental Nutrition Assistance Program Electronic Benefit Transfers as a method of payment and operating in frequently visited locations in the community (e.g. housing complexes, centrally located neighborhood parks and/or green spaces, federally qualified health centers), but no studies measured accommodation. One aspect of accommodation that may not be fulfilled by mobile markets would be convenient hours of operation. For example, in one study researchers wrote that the market was held in the middle of the day, which was identified as a barrier for community members who work during the day [27].

Acceptability. Most of the markets delivered fresh, locally grown F&Vs and many reported that the F&Vs were organic and selected based on discussions with the community [23,25,26,28]. Acceptability was only explicitly measured in two of the studies. "Live Well, Viva Vien" researchers reported that 97% of participants indicated that the quality of the F&V was "good, very good, or excellent," and 80% indicated that the market "often or always" had F&V they like to eat [23]. Authors of the Veggie Van efficacy trial wrote that there was no change in perceived quality of F&V [25].

Farmers' markets

Five studies examined the introduction of new farmers' markets, however we could only calculate effect sizes for two studies [30,32] representing new markets with F&V changes ranging from −0.70 to +0.70 cups/day and Cohen's d effect sizes ranging from 0.15–0.38. The remaining three studies do not provide pre-and-post data, but instead report findings graphically or with frequencies [29,31,38]. Although these studies suggest improvements in F&V consumption, sufficient data are not available to make a conclusion.

Table 1 | Study characteristics

Author, journal, year	Type of program (e.g. retail store, farmers' market)	Setting and population	*N*	Study measure and outcome	Study design	Comments (e.g. strengths, limitations)
1. Gans et al., *Int J Behav Nutr Phy Act*, 2018	Mobile market[a]	15 Subsidized housing complexes in Rhode Island, adults ≥18 years	1,275	F&V intake, National Cancer Institute (NCI) "Eating at America's Table All Day Screener"	12 month cluster randomized controlled trial, 8 intervention sites and 7 control sites	
2. Leone et al., *Int J Behav Nutr Phy Act*, 2018	Mobile market[a]	12 low-income sites in North Carolina, adults ≥18 years	142	F&V intake, NCI "10-item dietary screener"; Added-sugar, 7 items selected from the "National Health and Nutrition Examination Dietary Screener"	Cluster randomized controlled trial, sites received the market immediately or after 6 months (delayed intervention control)	
3. Elbel et al., *Am J Health Promot*, 2017 and *Public Health Nutr*, 2015	Government-subsidized supermarket[b]	2 low-income neighborhoods in the Bronx matched using a cluster analysis of 2010 census characteristics; Participants were adults ≥18 years from each neighborhood	3,998 (2017) 2,230 (2015)	F&V intake, self-report "Eating and Physical Activity Questionnaire" and 24-hr dietary recall during follow-up phone call; household food availability, modified "5-a-Day Power Plus Program"	Quasi-experimental study, separate cross-sections	Limitation: Different participants surveyed at baseline, 1–5 months post-opening, and 13–17 months post-opening
4. Leone et al., *J Hunger Environ Nutr*, 2017	Mobile market[a]	North Carolina, all participants were ≥18 years and primary food shoppers; 37% had yearly household income below $30,000	59	Phase 1: F&V intake, 2-item self-report on usual F&V intake on a typical day over the last month Phase 2: F&V intake, "NCI screener" and 12-item "food frequency questionnaire" Phase 1 & 2: perceptions of F&V access, validated 4-item self-report questionnaire	Pre-and-post design; Phase 1 lasted 4 months and was assessed using paper surveys; Phase 2 was 10 months and expanded to a telephone survey; the study population was split into two groups rare/never users (n = 27) and frequent users (n = 32)	
5. Jilcott Pitts et al., *J Nutr Educ Behav*, 2016	Farmers' Market[b]	Rural North Carolina, adults ≥18 years, 30%–50% with less than a college degree (income data unavailable)	607	F&V intake, self-report from the "Block Fruit, Vegetable and Fiber" screener and the "Behavioral Risk Factor Surveillance System (BRFSS)" questionnaire	Separate cross-sections from three different countries (e.g. mostly different participants) in 2013 and 2014 using random digit dialing	Limitation: About half of the respondents surveyed had ever used the farmers' markets. Participants were different at each cross-section (% new at follow-up: County A 95%, County B 97%, and County C 99%) County A had 3 new markets and 14 "enhanced" markets, County B had 9 new markets and 14 enhanced markets, and County C had 9 new markets and 2 enhanced markets

(Continued)

Table 1 | Continued

Author, journal, year	Type of program (e.g. retail store, farmers' market)	Setting and population	*N*	Study measure and outcome	Study design	Comments (e.g. strengths, limitations)
6. Woodruff et al., *Prev Chronic Dis*, 2016	Farmers' Market[b]	Cobb County Georgia, adults ≥18 years, 29.6% of residents and 42.4% of children live below the poverty line	100	Change in fruit and vegetable intake using two items on "whether participants indicated they eat fewer, the same amount, or more fruits and vegetables at the time of the survey than they did before they began shopping at the farmers' market	Cross-sectional intercept surveys at the market	Limitation: Nonrandom sample with no comparison group
7. Dubowitz et al., *Health Aff*, 2015 and *Health Educ Behav*, 2015	Retail supermarket[b]	2 Pittsburgh neighborhoods matched on sociodemographics; Participants were ≥18 years and median household income was <$15,000	831	Healthy-eating-index-2010 scores were used as a measure of overall diet quality and were devolved from an automated 24-hr dietary recall; perceived access to healthy foods was measured using a validated 10-item questionnaire	Quasi-experimental longitudinal design	
8. Gorham et al., *Preventing Chronic Disease*, 2015	Mobile market[a]	6 community organizations in Rhode Island, low-income families, parents of children (3–13 years)	378	F&V intake, validated self-report questionnaire; post- intervention focus groups	5 month cohort study; 23 produce items were delivered to the markets weekly; markets lasted up to 2 hr	
9. Cummins et al., *Health Aff*, 2014	Retail supermarket (41,000 sq. feet)[b]	2 Philadelphia neighborhoods matched on race/ethnicity, income, access, demographics; Participants were ≥18 years and primary food shoppers	656	F&V intake, BMI, perceptions of food access; "Block Food Frequency Questionnaire"; 5-item scale on food access; self-report	Prospective controlled quasi-experimental study; pre-and-post data; intervention (n = 311, received new grocery store) and control group (n = 345, no store)	Limitation: Potentially underpowered, store delays of 3 years generated a gap from baseline to follow-up
10. Freedman et al., *Preventive Medicine*, 2013	Farmers' market[a]	Federally Qualified Health Center; Low-income diabetics in rural South Carolina	41	F&V intake; self-report NCI guidelines on F&V questionnaires	Mixed methods; one group (no control); repeated measures; Markets were held once per week and lasted 4 hours for 22 weeks	Strength: Study highlights the effectiveness of a financial incentive and the importance of visit frequency
11. Sadler et al., *Int. J Environ Res Public Health*, 2013	Retail supermarket (41,000 sq. feet)[b]	Low-income neighborhoods in Flint, Michigan; ≥18 years and primary food shoppers	166	F&V intake, nutrition; self-report "BRFSS questionnaire"	Pre-and-post data with *different* respondents; control was not well matched for all categories	Limitation: Different respondents for post-data, control had a grocery store before intervention and the two groups varied on eating behaviors (i.e. intervention site ate more pre-packaged food)

(Continued)

Table 1 | Continued

Author, journal, year	Type of program (e.g. retail store, farmers' market)	Setting and population	*N*	Study measure and outcome	Study design	Comments (e.g. strengths, limitations)
12. Evans et al., *Health & Place*, 2012	Mobile Market[a]	2 low-income and low-access urban communities in East Austin, TX	61	F&V intake; self-report "Farmers' Market Questionnaire"	Longitudinal pilot study; one-group (no control); pre-and-post data; Stands were placed outside local community sites for 2–3 hr once per week for 12 weeks	Limitation: No advertisement of the farm stands occurred during the study
13. Ruelas et al., *J Comm Health, 2012*	Farmers' market[b]	2 low-income urban communities in East and South Los Angeles	1,789	Family food consumption behavior (including F&V intake), food insecurity, physical activity. The Community Food Security Coalition survey instrument on measures of market utilization impact and satisfaction	Convenience sample of customers on a rolling basis from 2007–2009	Limitation: Posttest convenience sample
14. Abusabha et al., *J Am Diet Assoc*., 2011	Mobile market[a]	2 low-income senior housing sites in Albany, NY; participants were ≥55 years	43	F&V intake; six-items on F&V from BRFSS questionnaire; self-report	Cross-sectional study; a cohort of seniors ($n = 43$) were identified by date of birth and provided pre-and-post data; No control group; Program lasted 3–5 months; The Veggie Mobile stopped weekly at each site for 1-hr	Strength: At post-intervention, seniors visited the supermarket less often ($p < 0.001$) and spent an average of $14.92 less during their last visit. 24 out of 63 total participants used the market every week
15. Freedman, *Comm Psychologist*, 2007	Farmers' market[b]	Low-income neighborhoods and a housing complex in Nashville, TN; participants were ≥18 years	60	F&V intake, two items from the "national Youth Risk Behavior Surveillance System" on number of times fruits and vegetables were eaten in the past 7 days	Cross-sectional data with different respondents at Time 1 (baseline), Time 2 (midway through the project), and Time 3 (end of the project)	Limitation: Each sample is relatively small ([Time 1, $n = 29$, Time 2, $n = 15$, Time 3, $n = 16$]) and data are from different respondents

F&V fruit and vegitable.
[a]Researcher led experiment.
[b]Natural experiment.

Table 2 | Key findings and effect sizes

Intervention type	Study	Change in fruits and vegetables	Effect size[a], *p*
Farmer's market			
	Jilcott Pitts et al., 2016[b]	Total (County A): +0.70 servings/week	$d = 0.38$, $p = .01$,
		Total (County B): +0.30 servings/week	$d = 0.15$, $p = 0.29$
		Total (County C): −0.70 servings/week	$d = 0.39$, $p = .01$,
	Woodruff etal., 2016	Vegetables: 65% reported eating more vegetables as a result of the Farmers' market	$p = .63$
		Fruit: 55% reported eating more fruit as a result of the Farmers' market	$p = .98$
	Freedman et al., 2013[c]	Total (T2−T1): +1.58 servings/day	$d = 0.41$, $p = .07$,
		Vegetables (T2−T1): +0.63 servings/day	$d = 0.33$, $p = .16$
		Fruit (T2−T1): +0.95 servings/day	$d = 0.35$, $p = .10$
		Total (T3−T1): +0.54servings/day	$d = 0.15$, $p = .89$
		Vegetables (T3−T1): +0.46 servings/day	$d = 0.26$, $p = .29$
		Fruit (T3−T1): +0.08 servings/day	$d = 0.03$, $p = .23$
	Ruelas et al., 2012	Total (East LA): 97% indicated that because of the market they now eat more fruits and vegetables Total (South LA): 98%	—
	Freedman, 2007	Findings presented graphically, and suggest an increase in fruit and vegetable consumption; no means reported	—
Mobile produce market			
	Gans et al., 2018	Total: +0.44 cups/day	$p < .01$,
		Vegetables: +0.28 cups/day	$p < .05$,
		Fruit: +0.16 cups/day	$p = .06$,
	Leone et al., 2018	Total (with outliers): +0.30 cups/day	$p < .01$,
		Total (without): +0.14 cups/day	$p = .11$
	Leone et al., 2017	Total: +0.41 servings/day	$d = 0.20$, $p = .01$,
	Gorham et al., 2015	Total: +0.48 cups/day	$p < .001$
		Vegetables: +0.28 cups/day	$p < .01$,
		Fruit: +0.20 cups/day	$p < .01$,
	Evans et al., 2012	Total: +0.42 servings/day	$d = 0.17$, $p = 0.21$
		Whole fruit: +0.46 servings/day	$d = 0.69$, $p < .001$
		Green salad: +0.14 servings/day	$d = 0.30$, $p < .05$,
		Tomatoes: +0.20 servings/day	$d = 0.38$, $p < .01$,
		Vegetable soup: −0.04 servings/day	$d = 0.10$, $p = .39$
		Other vegetables: +0.23 servings/day	$d = 0.42$, $p < .01$,
		Potatoes: −0.03 servings/day	$d = 0.08$, $p = .52$
		Fruit juice (100%): +0.31 servings/day	$d = 0.53$, $p < .001$
	Abusabha et al., 2011	Total: +0.45 servings/day	$d = 0.19$, $p = .19$
		Vegetables: +0.60 servings/day	$d = 0.36$, $p < .05$,
		Fruits: −0.23 servings/day	$d = 0.15$, $p = .36$
Retail supermarket			
	Elbel et al., 2015 & 2017	Fruit (15): −0.39 servings/day	$p < .01$,
		Vegetables (15): −0.25 servings/day	$p < .05$,
		Fruit (17): −0.30 servings/day	$p < .01$,
		Vegetables (17): −0.10 servings/day	$p < .05$,
	Dubowitz et al., 2015	Total: −0.27 servings/days	$p < .001$
	Cummins et al., 2014	Total: −0.20 servings/day	$d = 0.18$, $p = .34$
	Sadler et al., 2013	Total: 0.00 servings/day	$\Delta R^2 = .0023$, NS

[a]For some of these studies an effect size was incalculable with the provided results (e.g. no standard deviations reported or able to be calculated), but effect sizes were calculated for those that reported sufficient data. Effect sizes were calculated using G*Power, we calculated effect sizes using the mean and standard deviations for the intervention group.

[b]The Jilcott Pitts study had three intervention groups in three different counties with each county getting a different quantity of new farmers markets (e.g. County A received three new markets, County B received nine new markets, and County C received nine new markets), the results are reported by county.

[c]The Freedman study from 2013 looks at Time 1 (May/June 2011), Time 2 (August 2011), Time 3 (November 2011). At the follow-up (T3) the market had ended and was no longer serving fruits and vegetables.

Access and Availability. Although some of the farmers' market studies used tactics to increase access and availability, such as using a community advisory board to determine the location of the new food retail [29], only one included an explicit measure of access or availability [31]. In that study, 97%–98% of participants reported that the market was located in a convenient location [31].

Affordability. In many of the farmers market studies cost reduction tactics were reported, such as providing $50.00 in Supplemental Nutrition Assistance Program vouchers to the participants [30] and selling the F&Vs far below the current market value [29,38]. In the Jilcott Pitt et al. [32] study of farmers markets across three counties, results from the qualitative analysis conducted in County B suggested that participants perceived that the produce sold at the markets had better prices. In addition, in the Ruelas et al study, 79%–80% of participants indicated that the value for the cost of produce sold was "good" or "excellent" and 79%–83% indicated that because of the market they now spend less money on food [31].

Accommodation. In a study of rural farmers markets, participants indicated that the markets were out of the way and that the days and times of operation were not convenient for them [32]. Conversely, patrons of farmers markets in urban Los Angeles reported that the farmers markets were accommodative and 93%–96% indicated that the hours of operation were "good" or "excellent" [31]. Two of the other studies indicated that preliminary qualitative research with the target community informed their market's hours of operation [29,30], but did not measure the construct of accommodation, and Freedman et.al's small pilot study was unable to accept government benefits due to logistical issues [29].

Affordability. Four of the farmers' markets did not mention addressing acceptability. The two studies that did mention acceptability found that participants thought produce from the market was "fresher, higher quality, and better tasting" than F&Vs available at other retailers [32]. The second study reported that more than 90% of participants feel "good" or "excellent" about the quality and variety of products sold at the market [31].

Retail supermarkets

We reviewed four supermarket studies and found that none of the retail supermarket studies reported a positive impact on F&V consumption. Two of the studies reported statistically significant inverse findings that suggest the introduction of a new retail supermarket may have decreased F&V consumption [34–36], with a third study also reporting an inverse finding that was not statistically significant [37]. The last study reported no statistically significant changes from baseline to follow-up [33].

Access and Availability. In two supermarket studies participants indicated an increase in perceived food access after the introduction of a new grocery store in their neighborhood [34,37].

Affordability, Accommodation, and acceptability. Most of the supermarket studies did not mention or address issues of affordability, accommodation, or acceptability. In the one study that measured affordability and acceptability, participants indicated a decrease in the perceived cost of F&Vs and an increase in the variety and quality of available produce after the supermarket opened [37]. In the other study that measured acceptability there was a positive change in produce variety, but not quality [34].

DISCUSSION

The goal of this review was to identify whether introducing a new food retailer into a low-income community increases fruit and vegetable consumption. We found that introducing a new farmers' market or mobile produce market generally leads to a positive, albeit small, effect on F&V consumption while introducing a large supermarket seems to have no effect or an inverse effect on F&V consumption. This difference by retailer may be biased by the outcome measure; mobile markets and farmers' markets predominately sell F&V, thus people in those studies may be more likely to increase their consumption while participants shopping in supermarkets are purchasing multiple food groups and food types. At the time of this review, all of the studies examining the impact of new food retail used F&V as their main outcome. The absence of a positive effect on F&V may also be due to the more complicated nature of starting a brick and mortar store versus a mobile or farmers' market, such as longer time between pre-and-post measurement, difficulty randomizing communities, and larger catchment areas. One of the supermarket studies did look at other dietary outcomes and found improvements in overall diet quality, total calories, added sugars, and solid fats [34] and two showed improvements in participant's perceived access to healthy foods [34,37].

Grocery, convenience, and specialty stores have been found to account for a majority (70.3%) of American's energy intake [39] which suggest they are American's primary food retailers and food source. Another reason grocery stores may lead to a decrease in F&V consumption is due to greater demand (e.g. people will spend more) for high-energy dense foods (e.g. "junk" foods) than low-calorie nutrient dense foods (e.g. F&Vs) [40]. Most grocery stores provide calorie dense cold and hot prepared foods as well as a number of highly reinforcing prepackaged processed foods that may compete with the purchase of fresh F&Vs when shopping in a supermarket [41].

Research on the impact of food retail interventions is still in its infancy and more high quality studies are needed to make decisive conclusions based on retailer type and included intervention components. Many of the studies included in this review were pilot studies, and only two used a cluster randomized controlled trial design. Of the remaining 13, only 4 included a control or comparison group. Ideally future studies would be larger cluster

randomized controlled trials or follow best practice recommendations for natural experiments [42]. Researchers could also consider including a more objective measure of F&V intake if feasible (e.g. food consumption records, biomarkers [43,44]). In addition, reporting mean changes and standard deviations in F&V intake should be a priority of future research, as it allows researchers to calculate comparable effect sizes and provides the data needed for forest plots and a true meta-analysis.

TRANSLATIONAL IMPLICATIONS

In 2010, the Healthy Food Financing Initiative was introduced by the Obama Administration to tackle disparities in access to healthy food by providing government assistance and private investment to grocers and developers opening healthy food retail operations in underserved communities. The findings of this study and existing research indicate that improving small store offerings [20] and expanding mobile and farmers' markets may have a better impact on diet in lower-income and underserved communities than funding the construction of new supermarkets. A main reason why mobile and farmers' markets may change consumption is that they address other aspects of food access, such as reducing transportation burden and providing F&Vs at a lower cost. If supermarkets are supported, ensuring that they address multiple aspects of food access may increase their impact. Our findings suggest that although many food retailers address some elements of the access and availability components of the 5 A's [18], many (especially supermarket retailers) are not fully addressing affordability, accommodation, and acceptability. To have the greatest impact on diet, it is important the Healthy Food Financing Initiative and food funders consider alternative options for increasing healthy food access other than new supermarket retail and/or ensure that new retail appropriately addresses affordability, accommodation and acceptability. Furthermore, municipalities should ensure that their laws and zoning can accommodate new and alternative food sources.

Many low-income communities are food insecure, consuming well below the recommended levels of F&Vs [45]. Not having enough to eat generally, and specifically not eating enough F&Vs, is consistently related to a number of poor health outcomes [46,47]. If we introduce F&V retailers into the local food environment we may increase the likelihood that residents will buy and eat F&Vs. Most of the studies included in this review were community-based projects and programs implemented directly into low-income housing complexes, federally qualified health centers, doctor's offices, and local community parks. Introducing a new F&V retailer, in particular a farmers' market or a mobile market, may be a translational approach toward improving the community food environment which has the potential to improve dietary behaviors and diet-related health outcomes for at-risk populations.'

SUPPLEMENTARY MATERIAL

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

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Compliance with Ethical Standards

Conflicts of Interest: All authors declare that they have no conflicts of interest.

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