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Review Article

The dietary impact of introducing new retailers of fruits and vegetables into a community: results from a systematic review

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Abstract

Objective: To investigate the potential dietary impact of the opening of new retailers of healthy foods.

Design: Systematic review of the peer-reviewed research literature.

Setting: References published before November 2015 were retrieved from MEDLINE, EMBASE and Web of Science databases using keyword searches.

Subjects: The outcome of the review was change in fruit and vegetable consumption among adults.

Results: Of 3514 references retrieved, ninety-two articles were reviewed in full text, and twenty-three articles representing fifteen studies were included. Studies used post-test only (*n* 4), repeated cross-sectional (*n* 4) and repeated measures designs (*n* 7) to evaluate the dietary impact of supermarket (*n* 7), farmers' market (*n* 4), produce stand (*n* 2) or mobile market (*n* 2) openings. Evidence of increased fruit and vegetable consumption was most consistent among adults who began shopping at the new retailer. Three of four repeated measures studies found modest, albeit not always statistically significant, increases in fruit and vegetable consumption (range 0·23–0·54 servings/d) at 6–12 months after baseline. Dietary change among residents of the broader community where the new retailer opened was less consistent.

Conclusions: The methodological quality of studies, including research designs, sampling methods, follow-up intervals and outcome measures, ranged widely. Future research should align methodologically with previous work to facilitate meta-analytic synthesis of results. Opening a new retailer may result in modest short-term increases in fruit and vegetable consumption among adults who choose to shop there, but the potential longer-term dietary impact on customers and its impact on the broader community remain unclear.

Keywords
Diet
Food supply
Fruit and vegetable consumption
Health promotion
Systematic review

Social ecological models of health suggest that community food environments must be structured to support healthy eating behaviours to effectively prevent chronic disease[1–4]. However, a growing body of research has documented disparities in access to healthy foods throughout the USA[5,6]. Neighbourhoods with predominantly low-income and racial and ethnic minority residents tend to have limited access to retailers of healthier food options, such as full-service supermarkets[7,8], and are instead disproportionately served by retailers of energy-dense processed foods, including fast-food outlets[9].

A growing focus on increasing access to healthy foods by opening new retailers in underserved communities is reflected in both national public health objectives and large-scale healthy food financing initiatives. For example, Healthy People 2020 includes an objective to increase the proportion of Americans who have access to a food outlet that sells foods recommended by federal dietary guidelines[10]. In 2010, the US Departments of Agriculture,

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Treasury, and Health and Human Services announced the Healthy Food Financing Initiative, which funds the development of new retailers of healthy foods in underserved communities throughout the country[11]. Additional public–private partnerships, such as the Pennsylvania Fresh Food Financing Initiative, the New York Fresh Retail Expansion to Support Health (FRESH) programme, the California FreshWorks Fund and the New Orleans Fresh Food Retailer Initiative[12–15], are emerging as models for improving local food environments. Among other activities, these initiatives incentivize the development of supermarkets and grocery stores in limited-access neighbourhoods through zoning reforms, loans and grants.

Introducing new retailers of healthy foods into limited-access communities is an intuitively appealing intervention strategy, and although multiple evaluations of such initiatives have been published, no known systematic reviews have synthesized this body of research. The present systematic review aims to answer the following research questions:

1. What types of retailers of fruits and vegetables have been evaluated and in what settings?
2. What methods have been used to evaluate these initiatives?
3. To what extent have these initiatives impacted fruit and vegetable consumption among adults?

Fruit and vegetable consumption among adults was identified as the outcome of interest because this was a commonly used outcome in relevant studies, as well as the broader epidemiological literature[6].

Methods

References were retrieved from MEDLINE, EMBASE and Web of Science databases from inception through November 2015 using a search strategy adapted from a previous systematic review about spatial access to food retailers and diet[6]. English-language references that contained at least one keyword related to the following three domains were retrieved: (i) food retailers (food retail*, food store*, food outlet*, grocer*, supermarket*, farmers market*, farm stand); (ii) the environment (access*, availab*, afford*, environment*, loca*, neighborhood*, neighbourhood*, communit*, urban, or rural); and (iii) diet (diet, fruit*, vegetable*, nutriti*, consum*, intake).

Two investigators (R.C.W. and I.G.R.) identified candidate articles by independently reviewing the titles of all references for eligibility, referring to the abstracts for additional details when a decision could not be made based on the title alone. References were excluded if they: (i) were not about the general topic area of access to healthy foods as a determinant of dietary behaviour; (ii) were not about an initiative intended to increase access to healthy foods; or (iii) were not about the introduction of a new retailer of healthy foods into a community. Additional references were identified by hand-searching the bibliographies of the candidate articles and entering their bibliographic information into Google Scholar to identify more recent articles that had cited them.

Once the pool of candidate articles was finalized, all were reviewed in full text. In instances in which multiple publications resulted from the same parent study (e.g. a baseline paper describing the retailer and one or more outcome evaluations), we grouped articles by parent study and determined eligibility at the study level. Studies were excluded if they were found to meet the exclusion criteria described previously, if the evaluation did not include change in fruit and vegetable consumption as an outcome, or if it focused exclusively on dietary change among children. Studies that focused exclusively on children were excluded because the causal mechanism through which the opening of a new retailer of healthy foods would impact diet was expected to differ for this group.

The data abstraction form was developed based on the Transparent Reporting of Evaluations with Nonrandomized Designs (TREND) statement and piloted with a sample of articles. Two investigators (R.C.W. and I.G.R.) independently abstracted the following information from all articles included in the review: bibliographic information, key characteristics of the retailer described in the article (e.g. type, location, date opened, setting, population served, etc.), the methods used to evaluate the retailer (e.g. sampling methods, sample size, data collection procedures, outcome measures, etc.) and its impact on fruit and vegetable consumption; discrepancies were resolved by consensus. For studies that used repeated measures designs, mean differences in fruit and vegetable consumption were the principal summary measure. Nine corresponding authors were contacted by email for additional information about the methods or results (89 % response rate).

Studies were the unit of analysis for the present review. Due to the heterogeneity in methods used, meta-analysis was not possible. Analysis involved organizing studies according to the type of evaluation design used and using descriptive statistics, including frequencies and percentages, to describe the types of retailers that were assessed, the methods used to evaluate them and change in fruit and vegetable consumption. In many cases, the number of references exceeds the number of studies because multiple publications resulted from individual studies.

Results

Of the 5657 references retrieved through keyword searches, 3514 were unique articles and 3437 were excluded based on the title/abstract review (Fig. 1). The remaining seventy-seven candidate articles and fifteen additional articles identified through hand-searching were reviewed in full text to assess eligibility. Of these, sixty-nine articles were excluded. The most common reasons for exclusion were that the article was

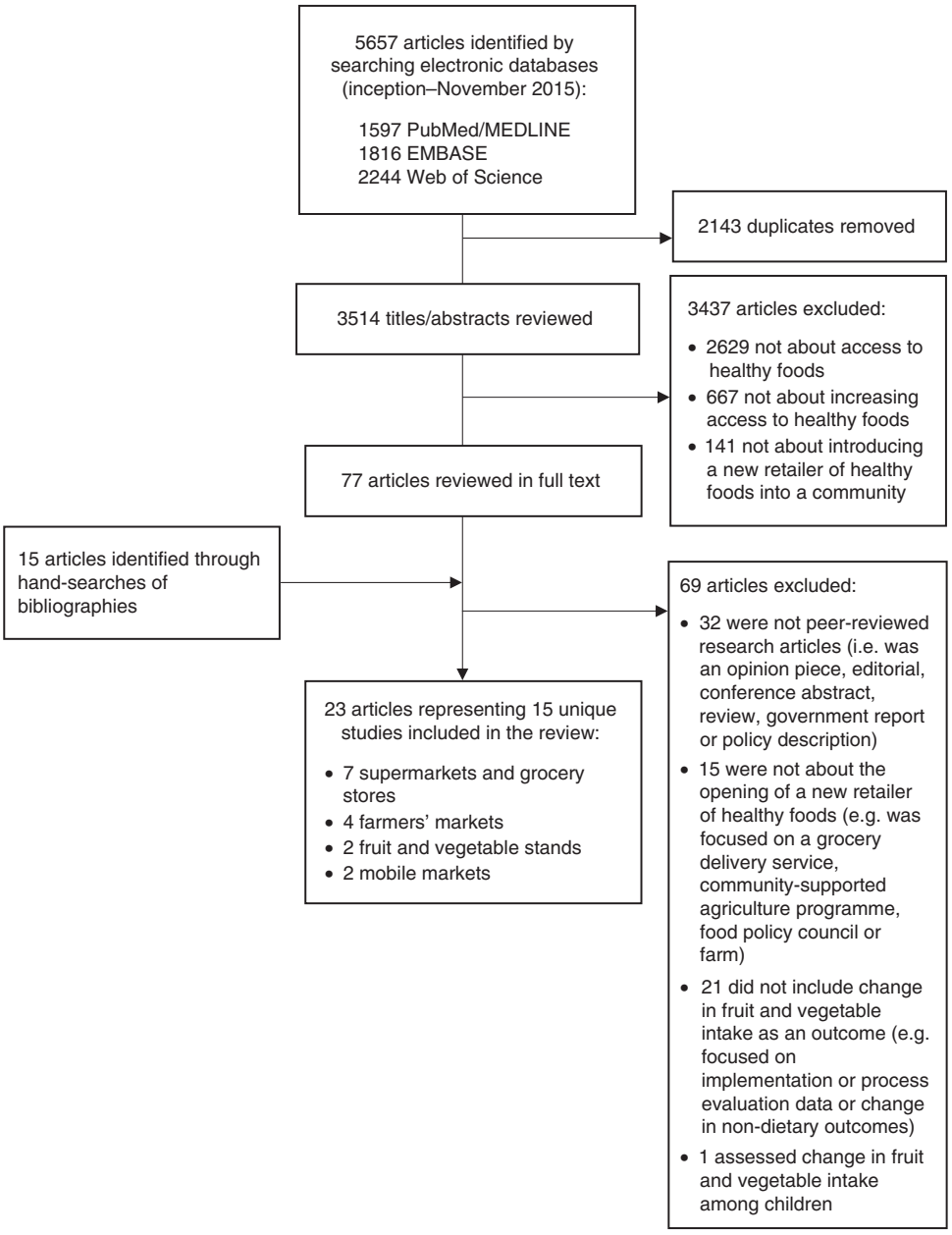

Fig. 1 Flow diagram depicting article selection for inclusion in the present systematic review on the dietary impact of introducing new retailers of fruits and vegetables into a community

not a peer-reviewed original research article (i.e. was an opinion piece, editorial, letter to the editor, conference abstract, review, government report or policy description; *n* 32); was not about the opening of a new retailer of healthy foods (e.g. was focused on a grocery delivery service, community-supported agriculture programme, food policy council or farm; *n* 15); or did not assess change in fruit and vegetable consumption among adults as part of the evaluation (*n* 22). The twenty-two articles in this latter category commonly reported implementation or process evaluation data (e.g. sales volume, demographic characteristics of shoppers, satisfaction with the retailer, etc.) or changes to other non-dietary outcomes (e.g. customers' shopping patterns, access to healthy foods, etc.). The present review focuses on the remaining twenty-three articles, which represented fifteen unique studies.

Description of retailers and settings

As shown in Fig. 1, the types of retailers assessed included supermarkets and grocery stores (*n* 7)[16–30], farmers' markets (*n* 4)[31–34], fruit and vegetable stands or markets (*n* 2)[35,36], and mobile markets (*n* 2)[37,38]. Supermarkets and grocery stores tended to be subsidized through public–private partnerships, including the Healthy Food Financing Initiative (*n* 2)[19,22,23] and the New York Food Retail Expansion to Support Health (FRESH) initiative

(*n* 1)[20,21], or were aligned with broader corporate initiatives to promote economic development or open supermarkets in deprived areas (*n* 2)[24–27,29,30]. The smaller retailers, such as farmers' markets, fruit and vegetable stands or markets, and mobile markets, tended to report community involvement in planning or operating the retailer, including having a community advisory board, collaborating with other local organization to implement the retailer, or that the project used a community-based participatory approach (*n* 7)[31–36,38].

Most of the retailers were located in low-income and/or economically deprived communities (*n* 13)[16–30,32,33,35–38] that had limited access to healthy foods (*n* 12)[16–31,33–36] in the USA (*n* 11)[19–23,28–33,35–37], the UK (*n* 3)[16–18,24–27,38] or Australia (*n* 1)[34]. Many studies also described the communities in which the new retailer opened as comprised of predominantly racial or ethnic minority residents (*n* 7)[19–23,29–33]. Most retailers were located in general community settings (*n* 11)[16–31,33,34,38], although some farmers' markets, fruit and vegetable stands, and mobile markets operated at local community organizations (*n* 3)[35–37], residential housing complexes (*n* 2)[35,37] and health centres (*n* 1)[32].

Evaluation methods

A variety of methods were used to evaluate the impact of the retailer on fruit and vegetable intake. Retailers were evaluated using post-test only designs (*n* 4)[28,33–35], repeated cross-sectional designs (*n* 4)[20,21,29–31,38] and repeated measures designs (*n* 7; Table 1)[16–19,22–27,32,36,37]. Studies assessed the impact of the retailer on fruit and vegetable consumption approximately six months (*n* 7)[24–28,31,32,35–37], one year (*n* 5)[16–23,29,30] or two years (*n* 2)[33,38] after the retailer opened, or at multiple follow-up intervals[33].

Eight studies used convenience sampling[20,21,28,31,33–35,37,38] and six used probability sampling methods[16–19,22,23,29,30,32,36]. The sampling method could not be determined for one study[24–27]. Six studies sampled shoppers at the new retailer[31,33–35,37,38] and three sampled residents of the neighbourhood where the new retailer opened[24–28,36]. An additional five studies sampled from both residents of the neighbourhood where the new retailer opened and a comparison neighbourhood that did not receive a new retailer[16–23,29,30]. One study sampled patients at a health clinic where the retailer was located[32]. Sample sizes ranged widely.

Outcome measures included retrospective items asking participants to what extent their fruit and vegetable intake changed over time (*n* 4)[28,33–35], two-item screeners assessing usual daily intake of fruits and vegetables (*n* 3)[19,31,38], brief fruit and vegetable intake screeners or FFQ (*n* 6)[16–18,20,21,29,30,32,36,37], or dietary recalls (*n* 3)[20–27]. One study used multiple methods of assessing fruit and vegetable intake[20,21].

Post-test only designs

Methodological overview

Four studies used post-test only designs to assess the dietary impact of the new retailer (Table 1). In these studies, cross-sectional surveys were administered to participants four months to two-and-a-half years after the opening of the retailer[28,33–35]. All studies focused on dietary change among a convenience sample of adults who were either shoppers at the retailer[33–35] or lived in the neighbourhood where the new retailer opened for business[28]. All of these studies used a retrospective approach to measure change in fruit and vegetable intake by asking participants to report changes in fruit or vegetable consumption as a result of shopping at the retailer[33–35] or generally within the past year[28].

Change in fruit and vegetable intake

Of the studies that surveyed shoppers at the retailer, most respondents reported that they were eating more fruits and/or vegetables at the time of the survey[33–35]. For example, of 100 shoppers at a farmers' market in Carnarvon, Western Australia who were surveyed approximately two-and-a-half years after its opening, 71 % reported that they were eating more fruits and vegetables since they started shopping there[34]. A survey of 100 returning customers who were surveyed approximately four months after the opening of a fruit and vegetable stand in Cobb County, Georgia, USA reported that they were eating more vegetables (65 %) and fruit (55 %) as a result of the market[35]. Another survey administered to shoppers at two farmers' markets in Los Angeles, California, USA between five months and two years after the markets opened reported that 97–98 % agreed or strongly agreed that they were eating more fruits and vegetables as a result of the market[33]. By contrast, the one study that assessed the impact of a new grocery store that opened in an unnamed city in California, USA on the dietary behaviours of residents of the neighbourhood where it opened (regardless of whether participants shopped there) found smaller changes in fruit and vegetable consumption. Relatively few respondents who lived 3·2 km (2 miles) from the new grocery store reported increased vegetable (10·3 %) or fruit (9 %, *n* 73) consumption over the previous year[28].

Repeated cross-sectional designs

Methodological overview

Four studies used repeated cross-sectional surveys at baseline and follow-up to assess the dietary impact of the new retailer (Table 1). Two studies used a convenience sample of market shoppers[31,38]; one used a random sample of households with landlines located within 2000 m of the store site and a nearby comparison neighbourhood[29,30]; and another recruited participants from busy intersections in the neighbourhood where the retailer

Table 1 Methodological summary of evaluations of the opening of a retailer of healthy foods on fruit and vegetable intake among adults (*N* 15)

Study design	Reference(s)	Retailer, year opened, setting	Sample description (sample size, response rate)	Data collection	Outcome measure	Results
Post-test only (*n* 4)	Woodruff *et al.*[35]	Fruit and vegetable stand 2014 Cobb County, Georgia, USA	Convenience sample of returning market shoppers aged ≥18 years (*n* 100, 99 %)	Self-administered surveys 4 months after market opening	Two-item retrospective measure	65 % reported eating more vegetables, 55 % reported eating more fruit as a result of shopping at the market
	Ruelas *et al.*[33]	Farmer's markets 2007 Los Angeles, California, USA	Convenience sample of market shoppers aged ≥18 years (*n* 415 at one location, *n* 1375 at second location, NR)	Surveys administered 5 months after market opening at one location and 2 years after opening at second location	Single-item retrospective measure	97–98 % agreed or strongly agreed that they eat more fruits and vegetables because of the market
	Payet *et al.*[34]	Farmers' market 2001 Rural community near Carnarvon, Western Australia	Convenience sample of market shoppers aged ≥18 years (*n* 100, 80·6 %*)	Surveys administered 2 years and 4 months after market opening	Single-item retrospective measure	71 % reported eating more fruits and vegetables since started shopping at the market
	Wang *et al.*[28]	Grocery store 2004 Northern California, USA	Convenience sample of adults aged ≥18 years who were the primary grocery shoppers for their homes and lived ~3·2 km (~2 miles) from the store (*n* 78, NR)	Surveys administered 6 months after store opening	Four-item measure assessing frequency of fruit and vegetable consumption currently and last year	10 % reported an increase in fruit consumption, 9 % reported an increase in vegetable consumption over the previous year*
Repeated cross-sectional (*n* 4)	Freedman[31]	Farmers' market 2006 Nashville, Tennessee, USA	Convenience sample of market shoppers	Surveys administered at baseline (*n* 29), mid-way through the season (*n* 15) and at the end of the season (*n* 16)	Two-item screener adapted from Youth Risk Behavior Surveillance System	Results are reported graphically, but suggest a pattern of greater fruit and vegetable consumption among follow-up sample relative to baseline sample
	Jennings *et al.*[38]	Mobile fruit and vegetable market 2008 Great Yarmouth and Waverly, England, UK	Convenience sample of shoppers (*n* 255, 62 %)	Surveys administered at baseline and 2 years after market began operating	Two-item screener measuring portions consumed per day	1·16-portion increase in mean fruit and vegetable consumption (95 % CI 0·83, 1·48, $P < 0·001$)
	Sadler *et al.*[29,30]	Grocery store 2010 Flint, Michigan, USA	Probability sample of adults aged ≥18 years who were the primary grocery store for their homes and either lived within 2000 m of the store or in a nearby comparison neighbourhood (*n* 150–200 per time point, 15 % response rate)	Interviewer-administered surveys at baseline and 12 months after store opening	BRFSS screener	0·0-serving change in fruit and vegetable consumption among intervention residents* 0·4-serving increase among comparison neighbourhood residents*
	Elbel *et al.*[20,21]	Supermarket 2011 South Bronx, New York, USA	Convenience sample of adults aged ≥18 years (approximately *n* 1300 per time point, NR)	Intercept surveys and dietary recalls administered at baseline, 1–5 months and 13–17 months after store opening	24 h dietary recall and the Eating and Physical Activity Survey	24 h dietary recall results: • 0·05-unit increase in fruit and 0·21-unit increase in vegetable consumption at final follow-up • Difference-in-differences: 0·10 for fruit and 0·32 for vegetable consumption Screener results: • 0·2-unit increase in fruit consumption and 0·1-unit increase in vegetable consumption at final follow-up • Difference-in-differences: 0·1 for fruit and 0·0 for vegetable consumption Note: No results reached statistical significance

Table 1 *Continued*

Study design	Reference(s)	Retailer, year opened, setting	Sample description (sample size, response rate)	Data collection	Outcome measure	Results
Repeated measures (*n* 7)	Abusabha *et al.*[37]	Mobile fruit and vegetable market 2007 Troy, New York, USA	Convenience sample of shoppers aged ≥55 years who lived at the senior housing complex served by the market (*n* 43, 54 % at follow-up*)	Surveys administered at baseline and 6 months after the market began serving the senior housing complex	Five-item screener adapted from BRFSS	0·45-serving increase in total fruit and vegetable intake (95 % CI −0·23, 1·14; *P* = 0·188)
	Freedman *et al.*[32]	Farmers' market 2001 Rural county in South Carolina, USA	Probability sample of adult patients at the health clinic where the farmers' market operated who had a diagnosis of diabetes (*n* 44, NR)	Interviewer-administered surveys at baseline, 2 and 5 months after the market opening	Nineteen-item screener adapted from the NCI FVS	0·54-serving increase in total fruit and vegetable intake at 5-month follow-up (95 % CI −1·14, 2·23; *P* = 0·52)
	Evans *et al.*[36]	Fruit and vegetable stand 2010 Austin, Texas, USA	Probability sample of adults aged ≥18 years who lived within 0·8 km (0·5 miles) of market recruited through door-to-door household sampling (*n* 61, 66 % at follow-up)	Interviewer-administered surveys at baseline and 2 months after the market opened	Seven-item screener adapted from the NCI FVS	0·42-serving increase in total fruit and vegetable intake among intervention community residents (SD = 2·49; *P* = 0·210)
	Wrigley *et al.* & Gill and Rudkin[24–27]	Supermarket 2000 Leeds, England, UK	Sample of adults who were responsible for domestic food arrangements for the household and who lived in the neighbourhood where the supermarket opened (*n* 615, 61 % at follow-up)	Self-administered food consumption diary at baseline and 6–7 months after the store opening	7 d food consumption diary	0·23-serving increase in fruit and vegetable intake among residents who began shopping at the new retailer (*P* = 0·034) 0·04-serving increase in fruit and vegetable intake in intervention community residents*
	Cummins *et al.*[16–18]	Supermarket 2001 Glasgow, Scotland, UK	Probability sample of adults aged ≥16 years who were the main food shopper for their homes and who lived in the neighbourhood where the supermarket opened or a comparison community (*n* 412, 68 % at follow-up)	Self-administered postal survey at baseline and 11 months after the store opening	Two-item screener assessing usual fruit and vegetable intake per day	0·29-portion increase in fruit and vegetable intake in the intervention community (*P* = 0·07) 0·44-portion increase in fruit and vegetable intake in the comparison community (*P* = 0·003)
	Cummins *et al.*[19]	Supermarket 2009 Philadelphia, Pennsylvania, USA	Probability sample of adults aged ≥18 years who lived near the new supermarket or were residents of a neighbouring community recruited through random directory listings and random digit dialling (*n* 656, 46 % at follow-up)	Interviewer-administered surveys at baseline and 6 months after store opening	Twenty-two-item screener adapted from Block Food Frequency Questionnaire	−0·16-serving difference between neighbourhoods at baseline −0·21-serving difference between neighbourhoods at follow-up Difference-in-differences: −0·05 (NS)
	Dubowitz *et al.*[22,23]	Supermarket 2013 Pittsburgh, Pennsylvania, USA	Probability sample of adults aged ≥18 years who were the primary food shopper for their household and lived in the neighbourhood where the supermarket opened or a comparison neighbourhood, recruited through door-to-door sampling (*n* 831, 65 % at follow-up)	Interviewer-administered surveys at baseline and 7–14 months after the store opening	Two 24 h dietary recalls administered 7–14 d apart	−0·32-serving change among adopters of the new retailer (NS) −0·27-serving change among residents of intervention community (SE = 0·08, *P* < 0·001) Difference-in-differences (intervention *v.* comparison neighbourhood residents): −0·14 (NS)

NR, not reported; BRFSS, Behavioral Risk Factor Surveillance System; NCI FVS, National Cancer Institute Fruit and Vegetable Intake Screener.
*Calculated by hand using information provided in the article.

opened, as well as a nearby comparison neighbourhood[20,21]. Measurement approaches included using a two-item fruit and vegetable intake screener[31,38]; the Behavioral Risk Factor Surveillance System (BRFSS) screener[29,30]; or a combination of a brief screener and a single 24 h dietary recall[20,21].

Change in fruit and vegetable intake

Results from studies in this category were difficult to summarize due to the heterogeneity in methodological approaches. For example, one evaluation of a farmers' market in Nashville, Tennessee, USA found that shoppers sampled at 1- and 2-month follow-ups reported higher levels of fruit and vegetable consumption relative to a different sample of shoppers sampled at baseline[31]. However, these results were reported graphically, and no estimates of mean intake were presented to quantify the difference in mean intake between the samples over time[31]. A different study of a convenience sample of shoppers at a mobile market in the UK found that those sampled at follow-up reported higher mean fruit and vegetable intake at follow-up than the baseline sample (mean difference = 1·16 portions, 95 % CI 0·83, 1·48, $P < 0·0001$)[38].

Two studies assessed community-level dietary change among residents of the neighbourhood that received the new retailer relative to those who lived in a comparison neighbourhood[20,21,29,30]. One of these studies conducted telephone surveys before and 12 months after a grocery store opened in Flint, Michigan, USA among a random sample of households located within 2000 m of the new store and those located in a comparison neighbourhood. That study found that mean intake of fruits and vegetables was the same among the baseline and follow-up samples in the intervention neighbourhood (mean intake = 2·6 servings/d among samples at both time points), although mean intake was higher among the comparison neighbourhood residents in the follow-up sample relative to the baseline sample (mean intake = 2·5 servings/d at baseline, mean intake = 2·9 servings/d at follow-up)[29,30]. Information about the precision and statistical significance of these estimates is unavailable.

Another study conducted surveys among adults recruited from busy intersections located in a neighbourhood that received a new supermarket and a comparison neighbourhood in the Bronx, New York City, USA[20,21]. Surveys were administered at baseline, 1–5 months and 13–17 months after the supermarket opened, and included two different methods of assessing fruit and vegetable intake. Results from the brief fruit and vegetable intake screener indicated among both intervention and comparison neighbourhood residents that mean fruit and vegetable intake was highest at baseline relative to either follow-up time point (e.g. mean change in vegetable consumption = −0·1 daily servings among intervention neighbourhood sample *v.* 0·0 among comparison neighbourhood sample). Results from the 24 h dietary recalls showed a different pattern of higher fruit and vegetable consumption at follow-up relative to baseline in both groups, although greater improvements among those sampled from the comparison community (e.g. mean change in vegetable consumption of 0·21 daily servings among intervention neighbourhood sample *v.* 0·58 daily servings among comparison neighbourhood sample)[20,21].

Repeated measures designs

Methodological overview

Seven studies used repeated measures to assess the dietary impact of the new retailer (Table 1). All of these studies collected data from participants at baseline and at either one (n 6)[16–19,22–26,36,37] or two (n 1)[32] follow-up time points. The majority of these studies used probability sampling methods to recruit participants[16–19,22,23,32,36], although one used convenience sampling methods[37] and the approach used by another could not be determined[24–27]. One study recruited shoppers at the new retailer[37], two recruited residents of the neighbourhood where the new retailer opened[24–26,36] and three recruited residents of both the intervention neighbourhood and a nearby comparison neighbourhood[16–19,22,23]. One study recruited patients from the clinic where the new retailer opened for business[32]. Studies in this category measured change in fruit and vegetable consumption using a two-item screener asking about usual intake of fruits and vegetables per day (n 1)[19], brief screeners or FFQ (e.g. BRFSS[37], the National Cancer Institute Fruit and Vegetable Screener[32,36] or the Block Food Frequency Questionnaire[16–18]; n 4), a 7 d food diary (n 1)[24–26] or multiple 24 h dietary recalls (n 1)[22,23].

Change in fruit and vegetable intake

With one exception[19], all studies in this category reported mean within-person change in fruit and vegetable intake from baseline to follow-up. Depending on the sampling strategy used, these results could be presented in three ways: (i) change in fruit and vegetable intake among shoppers at the new retailer; (ii) change in fruit and vegetable intake among residents of the neighbourhood where the new retailer opened; or (iii) the difference-in-differences comparing mean change in fruit and vegetable intake among residents of the intervention *v.* comparison neighbourhood (Table 2).

Of the five studies that reported change in fruit and vegetable intake among shoppers at the new retailer, most reported modest, albeit not always statistically significant, increases in mean intake (n 4)[24–26,32,37], although one study reported a small decrease[22,23]. For example, one study of forty-three shoppers at a mobile market in Troy, New York, USA reported a statistically insignificant 0·45-serving increase in daily fruit and vegetable intake six months after the market expanded its route to serve additional stops (95 % CI −0·23, 1·14)[37]. Another study of

Table 2 Effect sizes of the impact of the opening of a new retailer of healthy foods on within-person change in fruit and vegetable consumption among adults (*n* 6)

Reference(s)	Retailer	Country	Outcome measure	Sample	Mean difference	95 % CI or statistical significance	Follow-up interval
Change in fruit and vegetable intake among adult shoppers at the retailer							
Abusabha *et al.*[37]	Mobile market	USA	BRFSS screener	Forty-three adults aged ≥55 years	+0·45 servings	−0·23, 1·14	6 months
Freedman *et al.*[32]	Farmers' market	USA	NCI FVS	Forty-one adults with diagnosis of diabetes	+0·54 servings	−1·14, 2·23	5 months
Wrigley *et al.* & Gill and Rudkin[24–27]	Supermarket	UK	7 d food diaries	276 adults	+0·23 portions	$P = 0·034$	6–7 months
Dubowitz *et al.*[22,23]	Supermarket	USA	Two 24 h dietary recalls	368 adults	−0·32 servings	NS	7–14 months
Change in fruit and vegetable intake among adult residents of neighbourhood that received new retailer							
Evans *et al.*[36]	Fruit and vegetable stand/market	USA	NCI FVS	Sixty-one adults	+0·42 servings	SD = 2·49, $P = 0·210$	2 months
Wrigley *et al.* & Gill and Rudkin[24–27]	Supermarket	UK	7 d food diary	615 adults who were responsible for domestic food arrangements for the household	+0·04 portions*	NS	6–7 months
Cummins *et al.*[16–18]	Supermarket	UK	Two-item screener assessing usual daily intake	191 adults who were the main food shopper for their homes	+0·29 portions	$P = 0·07$	11 months
Dubowitz *et al.*[22,23]	Supermarket	USA	Two 24 h dietary recalls	571 adults who were the primary food shopper for their homes	−0·27 servings	SE = 0·08, $P < 0·001$	7–14 months
Difference-in-difference in fruit and vegetable intake comparing adult residents of intervention *v.* comparison neighbourhood							
Cummins *et al.*[16–18]	Supermarket	UK	Two-item screener assessing usual daily intake	412 adults	−0·15*	NR	11 months
Dubowitz *et al.*[22,23]	Supermarket	USA	Two 24 h dietary recalls	831 adults who were the primary food shopper for their homes	−0·14	NS	7–14 months

BRFSS, Behavioral Risk Factor Surveillance System; NCI FVS, National Cancer Institute Fruit and Vegetable Intake Screener; NR, not reported.
*Result was calculated by hand based on information provided in the article.

forty-one diabetic adults who shopped at a farmers' market in a health clinic in rural South Carolina, USA reported a statistically insignificant 0·54-serving increase in fruit and vegetable intake five months after it opened (95 % CI −1·14, 2·23)[32]. Another study of 276 shoppers at a new supermarket in Leeds, UK reported a statistically significant 0·23-portion increase in fruit and vegetable intake six to seven months after it opened ($P = 0·034$)[24–27]. However, a study of 368 shoppers at a new supermarket in Philadelphia, Pennsylvania, USA reported a statistically insignificant −0·32-serving decrease in intake seven to fourteen months after it opened[22,23].

Results were less consistent among the four studies that assessed change in intake among residents of the neighbourhood where the new retailer opened for business. For example, one study of 615 residents found essentially no change in fruit and vegetable consumption six to seven months after the opening of a new supermarket in their neighbourhood in Leeds, UK (mean difference = 0·04 portions/d)[24–27]. However, two studies found evidence of modest, but not statistically significant, increases in fruit and vegetable intake. The first reported a statistically insignificant 0·42-serving increase in daily intake among a probability sample of sixty-one adults who lived within 0·8 km (0·5) miles of a new fruit and vegetable stand in Austin, Texas, USA two months after it opened[36]. The other study found a 0·29-portion increase among a probability sample of 191 adults who were the main food shoppers for their homes and lived in a Glasgow, UK neighbourhood where a new supermarket was opened at 11-month follow-up ($P = 0·07$)[16–18]. In contrast to these results, a study that included a probability sample of 571 adults living in a neighbourhood in Philadelphia, Pennsylvania, USA where a new supermarket opened, reported a statistically significant 0·27-serving decrease in fruit and vegetable consumption at 6-month follow-up (SE = 0·08, $P < 0·001$)[22,23].

Two studies reported difference-in-differences comparing change among residents of the neighbourhood where the new retailer opened, relative to change among residents in a comparison neighbourhood. These studies evaluated supermarket openings in Pittsburgh, Pennsylvania, USA[22,23] and Glasgow, UK[16–18]. In both instances, results were the opposite of what was expected and indicated either greater increases in fruit and vegetable intake among the comparison neighbourhood residents (difference-in-differences = −0·15)[16–18] or smaller decreases in fruit and vegetable intake among comparison neighbourhood residents (difference-in-differences = −0·14)[22,23].

Discussion

Most studies included in the present review focused on recent openings of healthy food retailers in low-income communities with limited access to healthy foods. The methodological approaches to evaluating these initiatives, including the research designs, sampling approaches, follow-up intervals and outcome measures, varied widely. Although all study designs were limited in their ability to causally attribute any observed change in fruit and vegetable consumption to the opening of the retailer itself, evaluations of supermarket and grocery store openings tended to use more rigorous study designs (e.g. two-group repeated measure or repeated cross-sectional designs with larger representative samples), while evaluations of farmers' markets, fruit and vegetable stands, and mobile markets tended to use weaker designs (e.g. post-test only designs with smaller convenience samples).

Across study types, results suggest that the dietary impact of the new retailer may be greatest among adults who choose to shop there. For example, three out of four repeated measures studies of shoppers at the new retailer found modest increases in fruit and vegetable consumption, ranging from 0·23 to 0·54 daily servings at 6–12 months follow-up[24–27,32,37]. Although most of these effect sizes did not reach statistical significance, two reported small sample sizes, calling into question whether they were powered to detect dietary change of this magnitude. These effect sizes are similar in magnitude to those reported by a systematic review of behavioural interventions to increase fruit and vegetable intake[39], and prior research has documented that even small increases in fruit and vegetable intake may be related to reductions in energy density[40]. Additionally, results from all three post-test only designs that surveyed shoppers at the new retailer found that relatively high proportions of shoppers reported they were eating more fruits and vegetables since starting to shop there (55–98 %)[33–35].

The impact of the opening of a new retailer on fruit and vegetable consumption among the broader community of residents of the neighbourhood where the retailer opened was less clear. Studies that used either repeated measures or repeated cross-sectional designs found no evidence of change[24–27,29,30], modest increases[16–18,20,21,28,36] or decreases[20–23] in fruit and vegetable consumption. The variability in results may be explained in part by the heterogeneity in methodological approaches used, including eligibility criteria and methods used to sample intervention neighbourhood residents. Those that also sampled from a comparison neighbourhood were unable to detect a significant difference in mean change in fruit and vegetable consumption between the two groups.

We are limited in our ability to comment on differential dietary impact by retailer type due to the methodological heterogeneity among studies included in the present review. However, evaluations of one category of retailer – supermarkets – tended to have the most methodological consistency, with four out of five studies employing a repeated measures design. These studies found mixed results regarding the impact of the new retailer on fruit and vegetable consumption among shoppers[22–27], residents

of the intervention community[16–18,22–27], and differences between residents of intervention and comparison communities[16–18,22,23]. Although previous reviews have documented systematic disparities in access to supermarkets among many neighbourhoods throughout the USA[5], research regarding the causal links between access to supermarkets and improved dietary intake is inconclusive[6]. In the light of the large-scale initiatives focused on policy, systems and environmental changes to improve community retail food environments, many of which focus on introducing supermarkets into low-income communities, more rigorous research with greater methodological consistency is needed regarding the impact of supermarkets on dietary behaviour[12–15,41].

A strength of the present review is that it is the first to our knowledge to summarize the state of scientific knowledge regarding the potential dietary impact of opening new retailers of healthy foods within a community. Limitations of the review include potential publication bias and incomplete retrieval of relevant articles from the keyword search strategy. Additionally, most studies evaluated the dietary impact of the opening of new retailers within low-income neighbourhoods with limited access to healthy foods in the USA. The extent to which these findings would generalize to other geographic contexts (e.g. developing countries, non-Western contexts, etc.) is unknown. Additionally, the review focused exclusively on the impact of these retailers on fruit and vegetable intake among adults. The impact on fruit and vegetable intake among children or on other outcomes relevant to dietary behaviour or chronic disease prevention remains unknown. Many articles that were considered for[42,43] or included in the present review[20–23], or have been published since[44–46], assessed other outcomes of interest, including area-level access to healthy foods, change in other dietary behaviours (e.g. change in total energy intake, dietary quality, consumption of specific food groups) or BMI. These may be outcomes of potential interest for future reviews.

Results from the present review suggest that opening a new retailer of healthy foods in limited-access communities may be an appropriate strategy to improve short-term fruit and vegetable intake among adults who choose to shop there, although more research is needed to confirm these findings and to understand the potential impact of this approach on the broader community and/or over longer periods of time. Interventions that focus on other structural interventions, such as improving the in-store environments of existing retailers, may be a more appropriate strategy for improving population-level dietary behaviour[47,48]. Limitations of this body of research include a reliance on pre-experimental or quasi-experimental designs with limited ability to establish causality, potentially underpowered studies reliant on small sample sizes, and the use of a range of outcome measures and follow-up intervals that prevents meta-analytic synthesis of results. Recommendations for future research include designing adequately powered studies that are methodologically aligned with those of previous work, to facilitate comparisons and summary of these initiatives and strengthen the evidence base regarding this potential dietary impact of this approach to improving community food environments.

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