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# Retail Environments as a Venue for Obesity Prevention

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## Abstract

Increasing attention has been given to the role of retail food environments in shaping dietary behavior and obesity risk. Studies have generally shown an association between living in a neighborhood with or in close proximity to certain types of food outlets and/or the availability of healthy food options and better dietary quality, higher fruit/vegetable intakes, and a lower risk of overweight, even after controlling for individual/family level characteristics. However, research in this area has yielded mixed results, overall. Future research needs to identify consistent approaches for defining and measuring food retail environments.

### Keywords

Retail food environment; Dietary behaviors; Obesity

## Introduction

Obesity is associated with various adverse health outcomes including cardiovascular disease, diabetes, and certain types of cancers [1–3]. Despite recent evidence showing that obesity rates in the USA have stabilized, levels remain high [4]. Data from the most recent National Health and Nutrition Examination Survey (NHANES) 2013–2014 indicate that approximately 38 % of adults (over 20 years of age) and 17 % of youth (ages 2–19) are obese [4]. Additionally, while the high prevalence of obesity has continued to be a major public health issue in high income countries, increasing urbanization and westernization

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have contributed to the rising burden of obesity globally, with rates in low- and middle-income countries continuing to climb [5].

Evidence suggests that macro-level and public policy efforts have the greatest potential to lower the high prevalence of obesity worldwide [6, 7]. Although individual-level interventions to improve dietary behaviors have remained a popular strategy for obesity prevention and treatment, the vast scope of the problem underscores the importance of identifying population-based approaches that modify the structural and environmental contexts in which these behaviors occur [8]. Dramatic changes in the global food supply over the last several decades have greatly contributed to creating retail food environments that are more "obesogenic," with high levels of availability and accessibility of ultra-processed foods ("attractive, hyper-palatable, cheap, ready-to-consume food products" that are generally energy-dense and high in fat, sugar, or salt) [9, 10•]. In recent years, considerable attention in the literature has been given to understanding how wide availability of these types of food products within consumers' local retail food environments (and limited availability of more healthful food options) is associated with poor dietary intake, as well as related health outcomes [11••, 12••]. A recent search using the keyword "retail food environment" in PubMed yielded over 500 articles published in the last decade (2006–2016) compared to just 140 articles a decade before (1996–2005). A major focus of this work has centered on understanding the relationship between neighborhood retail food environments, including the types of foods and food outlets available, and dietary intake and/or weight status at the individual level [13, 14]. Several studies have reported an association between living in a neighborhood with or in close proximity to certain types of food outlets (such as chain supermarkets) and better dietary quality, higher fruit and vegetable intakes, and a lower risk of overweight, even after controlling for individual/family level characteristics [13, 14]. Much of the research in this area has focused on the contribution of food retail environments to racial/ethnic and socioeconomic disparities obesity specifically [15, 16]. As compared to white and more affluent neighborhoods, minority and low-income neighborhoods have been characterized as having limited availability of supermarkets, full-service restaurants, and healthy food options and high availability of corner/convenience stores, fast food establishments, and relatively inexpensive, highly palatable, energy-dense foods [15–23].

This aim of this review is to provide an overview of the evidence examining the relationship between retail food environments, dietary behaviors, and obesity risk. Additionally, we review the efficacy of small- and large-scale food retail interventions to improve obesity and related health outcomes particularly in communities that have traditionally been underserved by healthy food retail.

## Food Retail Environments and Dietary Behavior

Cummins and Macintyre (2006) propose two pathways in which food environments influence dietary behavior: (1) access to foods for home consumption from supermarkets and grocery stores, and (2) access to prepared food for home and out-of-home consumption from "carry outs" and restaurants [24]. Although a number of food environment studies have examined these pathways, research in this area has not yielded consistent results [12••, 25–

28]. Consequently, the mechanisms underlying relationships between food retail environments and food consumption and overall diet quality remain unclear. Potential explanations for inconsistent findings include differences in geographic context [29, 30], study population [31–33], study design [34], and measurement [33, 35]. Most of evidence considering retail food environments and dietary consumption has been cross-sectional, using individual-level data to observe associations between food outlet availability and dietary behaviors. Dietary outcomes commonly focus on specific food items such as fruit and vegetable intake, fast food intake, and sweetened beverage consumption. While many studies have shown that supermarket access is associated with increased diet quality [31, 36–39], findings from this research has been mixed [29, 32, 34, 40–42]. Several studies have found that supermarket access increases fruit and vegetable intake after adjusting for socioeconomic status [31, 36–39]. However, the strength of this relationship is often modified by factors such as community racial composition, socioeconomic status, and population density (i.e., urban vs. rural) [29, 33, 37]. A study using county level data found that distance to large supermarkets was negatively associated with fruit and vegetable consumption in metropolitan areas but not in non-metropolitan areas [36]. In contrast, Dean et al. (2009) found that distance to supermarket or supercenter was not significant in shaping fruit and vegetable consumption in urban settings, but was significant in rural populations [29]. In a study targeting a predominately African American sample, perceived access to a supermarket, defined as walking distances from an individuals' residential address, was strongly associated with increased fruit and vegetable intake [38]. These findings highlight the need to examine residents' perceptions and definition of access and how these perceptions and definitions vary across different populations. Results from a number of qualitative studies suggest that individuals' perceptions of food access may deviate from objective measures because they commonly consider factors beyond geographic proximity. Freeman, Blake, and Liese (2013) found that food access was defined based on economic access (e.g., household financing, store incentives), service delivery (e.g., foods sold, staff and services), spatial-temporal access (e.g., boundaries of local food environment, travel time), social access (e.g., culture, store relationships), and personal factors (e.g., health status, food and nutrition knowledge) [43]. This discrepancy may partially explain null findings in supermarket access and fruit and vegetable consumption in other studies.

Evidence suggests that fast food restaurant availability may have a greater impact on dietary intake compared to access to supermarkets [32, 35, 40, 42, 44, 45]. Several studies have observed a significant inverse association between fast food consumption and access to fast food outlets [32, 40, 42]. Using 15 years of longitudinal data, Boone-Heinonen et al. found that residing within 1 and 1–2.9 km of a fast food outlet was associated with a 0.13 and 0.34 % increase in fast food consumption frequency, respectively, among low-income men [32].

Recent studies suggest that retail food environment may also impact dietary intake by influencing food shopping behaviors such as food venue selection [41, 46, 47] and food purchasing expenditures [48]. Cannuscio et al. observed that most people did not shop at the supermarket closest to their home and often choose to shop at higher quality supermarkets further away [46]. Aggarwal et al. (2014) confirmed these findings in their study examining relationships between food retail environment and shopping behaviors in a sample of

predominantly non-Hispanic Whites (82 %) with high transportation access (93 % owned ≥1 car). This study also found that high-cost supermarket shoppers had higher fruit and vegetable intake compared to low-cost supermarket shoppers. The conclusion stated studies on food environments need to focus beyond neighborhood geographic boundaries to capture actual food shopping behaviors [47] such as venue selection. Gustafson et al. found residents who chose to shop at farmers' markets at least once a week reported significantly higher odds of fruit and vegetable consumption [41]. However the same study found that frequent shopping at supermarkets increased odds of sugar-sweetened beverages consumption nearly 40 %. This latter association was not observed in supermarkets with high availability of healthy foods. Other studies suggest that enrollment in food assistance programs, as well as food insecurity may influence relationships between food retail environments and shopping behavior. In a predominantly food insecure of Black (54 %) and Hispanic (40 %) adults, Martin et al. (2012) found that for each additional type of fruits or vegetables available at the store, the estimated odds of a customer purchasing fruits and vegetables increased by 12 and 15 %, respectively. Customers receiving the Supplemental Nutrition Assistance Program (SNAP) were 1.7 times as likely to purchase fruit as those that did not receive SNAP. However, greater availability of reduced-fat milk was not associated with customer's purchasing behavior [48].

## Food Retail Environment and Obesity Risk

As with dietary behavior, the scientific literature examining relationships between retail food environments and obesity risk has also increased exponentially in recent decades and been the subject numerous systematic reviews (with the most recent review being conducted by Cobb and colleagues in 2015) [12••, 49–60]. Authors typically hypothesize that greater access to "healthy" food retailers (i.e., supermarkets, grocery stores, specialty food stores, and full-service restaurants) and lower access to "unhealthy" food retailers (i.e., convenience stores and fast food restaurants) are associated with reduced risk for obesity among individuals [49, 54, 61–64]. Ahern and colleagues observed that availability of grocery stores was associated with increased adult obesity prevalence in non-metro counties [49]. Ford and colleagues reported that presence of a supermarket within 1 mi of a participant's residence was associated with increased risk of obesity among women living in areas with a moderate population density [55]. However, slightly more evidence exists supporting the latter. Studies by Gregson, Ingami, and colleagues and Mehata and colleagues both observed that access to fast food restaurants was associated with increased BMI [56, 65, 66]. Additionally, Morland and colleagues reported that the presence of convenience stores was associated with higher obesity prevalence [62]. Despite the studies yielding statistically significant results in the desired direction [51, 54, 56, 62, 65–68], a fair percentage of studies observed null findings [52, 55, 57, 58, 69–71]. Contrary to most findings, studies reporting unexpected or negative results also exist in the literature [49, 50, 55, 57].

Nonetheless, the review by Cobb and colleagues concluded that overall study quality is poor in this area of research, which suggests that methodological issues may explain the ambiguous findings [12••]. The vast majority of the studies conducted have employed a cross-sectional study design [12••, 49, 51, 54, 56, 62, 65–69]. Longitudinal studies in this area have been limited [50, 52, 58, 63, 71]. Thus, the lack of experimental studies and

longitudinal analyses make it difficult to assess underlying relationships between the food environment and obesity. Also, a wide array of methods have been employed to measure access to food retailers and overall healthiness of an area's food environment (e.g., indices, ratios, GIS-derived measures, ground-truthing, food-store auditing) [11••]. Studies suggest that these inconsistencies between measurement approaches might yield different results [68, 71]. For example, Shier and colleagues found that the relationship between child's residential retail food environment and BMI *z* score varied based on the type of measurement used (density of food outlets, ratios, and the Retail Food Environment Index) [71].

## Food Retail Environment Interventions

A number of intervention studies have examined the role of the food environment on obesity, particularly in the last 5 years [72–74]. These studies have primarily centered on modifying three types of food environments: corner stores, supermarkets, and fast food restaurants with fewer focused on other types of outlets such as farmer markets. Evidence suggests that super-market interventions may be helpful for reducing obesity, particularly in low-income communities [62]. Intervention studies in supermarkets have evaluated relationships with multiple outcomes including body mass index (BMI) specifically, and/or related dietary behaviors, such as fruit and vegetable intake [75–79]. Despite interventions being implemented across diverse populations and geographic areas, the majority of projects have employed common strategies including in-store demos, signage and flyers promoting healthy items, recipes, price discounts for healthy foods, and labeling of healthy foods [80]. Other studies have also featured employee training and community outreach [81]. We only identified three studies that assessed the impact of a newly opened full-service grocery store in a formerly under-served area. [75, 76, 78] All three studies looked at consumer awareness of the store, as well as changes in shopping behavior after the store had been opened. While a high percentage of residents reported knowing about the store, a smaller percentage adopted the new store as their main grocery store. Furthermore, overall evidence suggests that the addition of the new supermarket may significantly impact consumer purchasing patterns. In two of the studies, changes in consumer behavior via self-report or point of purchase sales data were also measured. Surkan and colleagues (2016) reported an increase in sales of healthy promoted food items [81]. However, Cummins and colleagues (2014) reported no statistically significant differences in fruit and vegetable purchasing, food consumption, or self-reported BMI 6 months after the opening of the store [76].

In addition to large retailers, a number of studies have focused on improving healthy food availability in corner, convenience, or small stores, with the majority of these being located in low-income communities or communities of color. Studies show that predominantly African American and low-income neighborhoods often have a high number of smaller, "corner" stores compared to predominately white and higher income communities. Extensive evidence has indicated that these stores frequently stock predominately high-calorie, high fat, and sugar-containing products with limited or low quality fruits and vegetables [82, 83]. Interventions were largely aimed at increasing healthy food availability, purchase, and consumption [72, 74, 84–89]. Several of these studies reported results from monitoring the process implemented by the corner stores and consumer perceptions of

change in the store environment [72, 88]. Strategies included increased stocking of healthy foods such as fresh fruits and vegetables, beans, lean meats, whole wheat bread and low-fat dairy, increased promotion of healthy items, decreased promotion or moving of less healthy items such as sugar-sweetened beverages, price discounts for healthy foods, grants for refrigeration units, training of managers/owners on how to stock, market healthy foods, social media, community, flyers, and signage [74, 84, 85, 87–89]. Four studies only reported preliminary results and did not include information on individual/consumer behavior [72, 84, 85, 89]. Of the five studies that looked at change in consumer purchases post-intervention, two studies found no change in purchases of healthy items, two studies found an increase in healthy food purchases, and one study had mixed results [74, 87, 88, 90••]. Although several interventions have targeted smaller stores, few have examined the impact of store changes on BMI. Of the two studies that measured BMI, neither found a significant changes in BMI post-intervention, although Gittelsohn et al. reported a trend toward lower BMI in the intervention group ($p = 0.06$) [82]. Consistent with findings from An [91], evidence suggests that the strategies most frequently associated with changes in consumer behavior associated with obesity are pricing discounts on healthier foods, with some support for promotion strategies/labeling and nutrition education initiatives [91].

Multiple intervention studies have also examined relationship between restaurants and obesity risk. The majority of these studies modified menus to add healthier items, highlighted/promoted existing healthful items, minimized/removed less healthy items, and/or provided price reductions on healthier menu items. [92–95] Specific strategies implemented in restaurant interventions included promoting lower calorie meals and side dishes, promoting items with lean meats and low-fat dairy, and reducing the marketing of sugar-sweetened beverages, particularly on children's menus [92–95]. Several of the interventions also featured social-marketing and promotion campaigns such as signage on tables/windows, flyers to the community, and/or social media pages or promotion. Point of sales (POS) data and customer surveys were collected to measure changes in consumer behavior; degree of implementation by the restaurants was also measured. Several of the studies included only preliminary results; only one of the studies, Lee-Kwan et al., measured sales receipts post-intervention; This study found that creating, promoting, and discounting healthier menu items led to an increase in consumers purchasing these options [92].

## Conclusion

Overall, evidence suggests that the retail food environment environment may, in fact, be contributing to obesity risk at the individual level; however, it is possible that individual-level health behaviors and attitudes may be dictating changes to the food landscape of US communities. Cross-sectional studies do not permit researchers to distinguish between these two pathways. Despite these methodological issues, some interesting insights have emerged from the scientific literature on associations between retail food environment and obesity that should affect the future of this research. First, there is the notion that retail food environment may not be associated with obesity risk the same way in every population. Although a study by Singleton and colleagues provided evidence that retail food environment might explain some of the racial/ethnic and socioeconomic disparities in adult obesity prevalence between US communities, relationships appear to vary between groups

(e.g., adults vs. children, white vs. minority, low income vs. high income, rural vs. urban) [11••]. For example, studies by Fiechtner and colleagues [54] and Zick and colleagues [59] reported that neighborhood median household income significantly modified associations between food environment features and obesity risk. Next, there is the belief that the dynamics of an individual's daily routine and diet-related behaviors should be examined. Most studies on the impact of retail food environment on obesity examined only the features study participants' residential food environment (i.e., the area immediately surround the home). Some studies have found that people often shop for food outside of their residential neighborhoods [69]. Researchers are starting to take a targeted approach to data collection by either measuring the food environment outside study participants' neighborhood, or asking each participant to list the food retailers in their cities they visit most. [70, 96] Finally, there is the idea that food store-level factors should be considered analytically. Measurement approaches such as indices, ratio measures, and GIS-derived measures do not permit researchers to actually verify the price or healthiness of the food being sold at outlets. Such verification often requires ground-truthing and food-store auditing. Studies by Drewnowski and colleagues and Ghosh-Dastidar and colleagues both found that proximity to a supermarket was associated with increased obesity risk; however, this association did not persist after statistically adjusting for supermarket pricing level (i.e., the typical price of staple food items being sold) [69, 70]. Future research on associations between retail food environment and obesity should consider these concepts and other individual- and environmental-level contextual factors that may be important to this relationship.

In summary, food retail environment may play an integral role in shaping obesity risk. However, the nature of that relationship is not fully understood. Future studies should include more longitudinal evidence to confirm directionality of the relationships identified with cross-sectional approaches. Also, qualitative studies could be used in this area to promote a deeper understanding of how availability translates to access across different demographic populations. More comprehensive measures for diet quality, obesity, and related outcomes should be applied (such as the Healthy Eating Index instead focusing on specific food items). For example, to date, only a few studies have examined overall diet quality [39, 40, 44, 97]. Lastly, while several intervention studies have recently been published, more attention needs to be given to which combination of strategies are the most effective and how these improvements to the food environment interacts with individual factors to influence dietary behaviors and obesity risk.

## References

Papers of particular interest, published recently, have been highlighted as:

• Of importance

•• Of major importance

1. Wise MR, Jordan V, Lagas A, et al. Obesity and endometrial hyperplasia and cancer in premenopausal women: A systematic review. American journal of obstetrics and gynecology. 2016
2. Nikolopoulou A, Kadoglou NP. Obesity and metabolic syndrome as related to cardiovascular disease. Expert Rev Cardiovasc Ther. 2012; 10:933–9. [PubMed: 22908926]

3. Garcia-Jimenez C, Gutierrez-Salmeron M, Chocarro-Calvo A, Garcia-Martinez JM, Castano A, De la Vieja A. From obesity to diabetes and cancer: epidemiological links and role of therapies. Br J Cancer. 2016; 114:716–22. [PubMed: 26908326]

4. Ogden CL, Carroll MD, Fryar CD, Flegal KM. Prevalence of obesity among adults and youth: United States, 2011–2014. NCHS Data Brief. 2015:1–8.

5. Poskitt EM. Childhood obesity in low- and middle-income countries. Paediatr Int Child Health. 2014; 34:239–49. [PubMed: 25203842]

6. Crammond B, Van C, Allender S, et al. The possibility of regulating for obesity prevention – understanding regulation in the Commonwealth Government. Obesity reviews: an official journal of the International Association for the Study of Obesity. 2013; 14:213–21. [PubMed: 23171416]

7. Swinburn B, Gill T, Kumanyika S. Obesity prevention: a proposed framework for translating evidence into action. Obesity reviews: an official journal of the International Association for the Study of Obesity. 2005; 6:23–33. [PubMed: 15655036]

8. Myers CA, Slack T, Martin CK, Broyles ST, Heymsfield SB. Change in obesity prevalence across the United States is influenced by recreational and healthcare contexts, food environments, and Hispanic populations. PloS one. 2016; 11:e0148394. [PubMed: 26849803]

9. Martinez Steele E, Baraldi LG, Louzada ML, Moubarac JC, Mozaffarian D, Monteiro CA. Ultra-processed foods and added sugars in the US diet: evidence from a nationally representative cross-sectional study. BMJ open. 2016; 6:e009892.

10•. Monteiro CA, Moubarac JC, Cannon G, Ng SW, Popkin B. Ultra-processed products are becoming dominant in the global food system. Obesity reviews: an official journal of the International Association for the Study of Obesity. 2013; 2:21–8. The focus of this study is to examine the prevalence of ultra-processed foods in the current food supply. This has several implications for food retail environments at the local level.

11••. Singleton CR, Affuso O, Sen B. Decomposing racial disparities in obesity prevalence: variations in retail food environment. Am J Prev Med. 2016; 50:365–72. This paper provides a recent review of the role of retail food environments in shaping health disparities. [PubMed: 26507301]

12••. Cobb LK, Appel LJ, Franco M, Jones-Smith JC, Nur A, Anderson CA. The relationship of the local food environment with obesity: a systematic review of methods, study quality, and results. Obesity (Silver Spring). 2015; 23:1331–44. The reference highlights some of the methodological issues with the literature in this area and how these issues impact study results. [PubMed: 26096983]

13. Caspi CE, Sorensen G, Subramanian SV, Kawachi I. The local food environment and diet: a systematic review. Health Place. 2012; 18:1172–87. [PubMed: 22717379]

14. Giskes K, van Lenthe F, Avendano-Pabon M, Brug J. A systematic review of environmental factors and obesogenic dietary intakes among adults: are we getting closer to understanding obesogenic environments? Obesity reviews: an official journal of the International Association for the Study of Obesity. 2011; 12:e95–e106. [PubMed: 20604870]

15. Lucan SC, Karpyn A, Sherman S. Storing empty calories and chronic disease risk: snack-food products, nutritive content, and manufacturers in Philadelphia corner stores. Journal of urban health: bulletin of the New York Academy of Medicine. 2010; 87:394–409. [PubMed: 20405225]

16. Borradaile KE, Sherman S, Vander Veur SS, et al. Snacking in children: the role of urban corner stores. Pediatrics. 2009; 124:1293–8. [PubMed: 19822591]

17. Morland K, Wing S, Diez Roux A, Poole C. Neighborhood characteristics associated with the location of food stores and food service places. Am J Prev Med. 2002; 22:23–9. [PubMed: 11777675]

18. Morland K, Filomena S. Disparities in the availability of fruits and vegetables between racially segregated urban neighbourhoods. Public Health Nutr. 2007; 10:1481–9. [PubMed: 17582241]

19. Morland K, Filomena S. The utilization of local food environments by urban seniors. Prev Med. 2008; 47:289–93. [PubMed: 18440626]

20. Izumi BT, Zenk SN, Schulz AJ, Mentz GB, Wilson C. Associations between neighborhood availability and individual consumption of dark-green and orange vegetables among ethnically diverse adults in Detroit. J Am Diet Assoc. 2011; 111:274–9. [PubMed: 21272702]

21. Powell LM, Chaloupka FJ, Bao Y. The availability of fast-food and full-service restaurants in the United States: associations with neighborhood characteristics. Am J Prev Med. 2007; 33:S240–5. [PubMed: 17884571]
22. Powell LM, Slater S, Mirtcheva D, Bao Y, Chaloupka FJ. Food store availability and neighborhood characteristics in the United States. Prev Med. 2007; 44:189–95. [PubMed: 16997358]
23. Gyawu R, Quansah JE, Fall S, Gichuhi PN, Bovell-Benjamin AC. Community food environment measures in the Alabama Black Belt: implications for cancer risk reduction. Prev Med Rep. 2015; 2:689–98. [PubMed: 26844138]
24. Cummins S, Macintyre S. Food environments and obesity— neighbourhood or nation? Int J Epidemiol. 2006; 35:100–4. [PubMed: 16338945]
25. Gordon-Larsen P. Food availability/convenience and obesity. Advances in nutrition. 2014; 5:809–17. [PubMed: 25398746]
26. Penney TL, Brown HE, Maguire ER, Kuhn I, Monsivais P. Local food environment interventions to improve healthy food choice in adults: a systematic review and realist synthesis protocol. BMJ open. 2015; 5:e007161.
27. Lucan SC. Concerning limitations of food-environment research: a narrative review and commentary framed around obesity and diet-related diseases in youth. J Acad Nutr Diet. 2015; 115:205–12. [PubMed: 25443565]
28. Gamba RJ, Schuchter J, Rutt C, Seto EY. Measuring the food environment and its effects on obesity in the United States: a systematic review of methods and results. J Community Health. 2015; 40:464–75. [PubMed: 25326425]
29. Dean WR, Sharkey JR. Rural and urban differences in the associations between characteristics of the community food environment and fruit and vegetable intake. J Nutr Educ Behav. 2011; 43:426–33. [PubMed: 21616721]
30. Greer S, Schieb L, Schwartz G, Onufrak S, Park S. Association of the Neighborhood retail food environment with sodium and potassium intake among US adults. Preventing chronic disease. 2014; 11:E70. [PubMed: 24784906]
31. Morland K, Wing S, Roux AD. The contextual effect of the local food environment on residents' diets: the atherosclerosis risk in communities study. Am J Public Health. 2002; 92:1761–8. [PubMed: 12406805]
32. Boone-Heinonen J. Fast food restaurants and food stores: longitudinal associations with diet in young to middle-aged adults: the CARDIA study. Archives of internal medicine. 2011:171.
33. Jack D, Neckerman K, Schwartz-Soicher O, et al. Socio-economic status, neighbourhood food environments and consumption of fruits and vegetables in New York City. Public Health Nutr. 2013; 16:1197–205. [PubMed: 23388104]
34. An R, Sturm R. School and residential neighborhood food environment and diet among California youth. Am J Prev Med. 2012; 42:129–35. [PubMed: 22261208]
35. Hattori A, An R, Sturm R. Neighborhood food outlets, diet, and obesity among California adults, 2007 and 2009. Preventing chronic disease. 2013; 10:E35. [PubMed: 23489640]
36. Michimi A, Wimberly MC. Associations of supermarket accessibility with obesity and fruit and vegetable consumption in the conterminous United States. Int J Health Geogr. 2010; 9:1–14. [PubMed: 20082711]
37. Zenk SN, Lachance LL, Schulz AJ, Mentz G, Kannan S, Ridella W. Neighborhood retail food environment and fruit and vegetable intake in a multiethnic urban population. Am J Health Promot. 2009; 23:255–64. [PubMed: 19288847]
38. Caspi CE, Kawachi I, Subramanian SV, Adamkiewicz G, Sorensen G. The relationship between diet and perceived and objective access to supermarkets among low-income housing residents. Soc Sci Med. 2012; 75:1254–62. [PubMed: 22727742]
39. Moore LV, Diez Roux AV, Nettleton JA, Jacobs DR. Associations of the local food environment with diet quality—a comparison of assessments based on surveys and geographic information systems: the multi-ethnic study of atherosclerosis. Am J Epidemiol. 2008; 167:917–24. [PubMed: 18304960]

40. He M, Tucker P, Irwin JD, Gilliland J, Larsen K, Hess P. Obesogenic neighbourhoods: the impact of neighbourhood restaurants and convenience stores on adolescents' food consumption behaviours. Public Health Nutr. 2012; 15:2331–9. [PubMed: 22390896]
41. Gustafson A, Christian JW, Lewis S, Moore K, Jilcott S. Food venue choice, consumer food environment, but not food venue availability within daily travel patterns are associated with dietary intake among adults, Lexington Kentucky 2011. Nutr J. 2013; 12:1–11. [PubMed: 23282226]
42. Mejia N, Lightstone AS, Basurto-Davila R, Morales DM, Sturm R. Neighborhood food environment, diet, and obesity among Los Angeles County adults, 2011. Preventing chronic disease. 2015; 12:E143. [PubMed: 26334715]
43. Freedman DA, Blake CE, Liese AD. Developing a multi-component model of nutritious food access and related implications for community and policy practice. Journal of community practice. 2013; 21:379–409. [PubMed: 24563605]
44. Moore LV, Diez Roux AV, Nettleton JA, Jacobs DR, Franco M. Fast-food consumption, diet quality, and neighborhood exposure to fast food: the multi-ethnic study of atherosclerosis. Am J Epidemiol. 2009; 170:29–36. [PubMed: 19429879]
45. Laska MN, Hearst MO, Forsyth A, Pasch KE, Lytle L. Neighbourhood food environments: are they associated with adolescent dietary intake, food purchases and weight status? Public Health Nutr. 2010; 13:1757–63. [PubMed: 20529405]
46. Cannuscio CC, Tappe K, Hillier A, Buttenheim A, Karpyn A, Glanz K. Urban food environments and residents' shopping behaviors. Am J Prev Med. 2013; 45:606–14. [PubMed: 24139774]
47. Aggarwal A, Cook AJ, Jiao J, et al. Access to supermarkets and fruit and vegetable consumption. Am J Public Health. 2014; 104:917–23. [PubMed: 24625173]
48. Martin KS, Havens E, Boyle KE, et al. If you stock it, will they buy it? Healthy food availability and customer purchasing behaviour within corner stores in Hartford, CT, USA. Public Health Nutr. 2012; 15:1973–8. [PubMed: 22230347]
49. Ahern M, Brown C, Dukas S. A national study of the association between food environments and county-level health outcomes. J Rural Health. 2011; 27:367–79. [PubMed: 21967380]
50. Block JP, Christakis NA, O'Malley AJ, Subramanian SV. Proximity to food establishments and body mass index in the Framingham Heart Study offspring cohort over 30 years. Am J Epidemiol. 2011; 174:1108–14. [PubMed: 21965186]
51. Bodor JN, Rice JC, Farley TA, Swalm CM, Rose D. The association between obesity and urban food environments. J Urban Health. 2010; 87:771–81. [PubMed: 20458548]
52. Chen HJ, Wang Y. Changes in the neighborhood food store environment and children's body mass index at peripuberty in the United States. J Adolesc Health. 2016; 58:111–8. [PubMed: 26707233]
53. Drewnowski A. Obesity and the food environment: dietary energy density and diet costs. Am J Prev Med. 2004; 27:154–62. [PubMed: 15450626]
54. Fiechtner L, Sharifi M, Sequist T, et al. Food environments and childhood weight status: effects of neighborhood median income. Childhood obesity. 2015; 11:260–8. [PubMed: 25923838]
55. Ford PB, Dzewaltowski DA. Limited supermarket availability is not associated with obesity risk among participants in the Kansas WIC Program. Obesity (Silver Spring). 2010; 18:1944–51. [PubMed: 20057363]
56. Inagami S, Cohen DA, Brown AF, Asch SM. Body mass index, neighborhood fast food and restaurant concentration, and car ownership. J Urban Health. 2009; 86:683–95. [PubMed: 19533365]
57. Laxy M, Malecki KC, Givens ML, Walsh MC, Nieto FJ. The association between neighborhood economic hardship, the retail food environment, fast food intake, and obesity: findings from the Survey of the Health of Wisconsin. BMC Public Health. 2015; 15:237. [PubMed: 25885908]
58. Lee H. The role of local food availability in explaining obesity risk among young school-aged children. Soc Sci Med. 2012; 74:1193–203. [PubMed: 22381683]
59. Zick CD, Smith KR, Fan JX, Brown BB, Yamada I, Kowaleski-Jones L. Running to the store? The relationship between neighborhood environments and the risk of obesity. Social science & medicine (1982). 2009; 69:1493–500. [PubMed: 19766372]
60. Kelly B, Flood VM, Yeatman H. Measuring local food environments: an overview of available methods and measures. Health Place. 2011; 17:1284–93. [PubMed: 21908229]

61. Lopez RP. Neighborhood risk factors for obesity. Obesity (Silver Spring). 2007; 15:2111–9. [PubMed: 17712130]
62. Morland K, Diez Roux AV, Wing S. Supermarkets, other food stores, and obesity: the atherosclerosis risk in communities study. Am J Prev Med. 2006; 30:333–9. [PubMed: 16530621]
63. Powell LM, Bao Y. Food prices, access to food outlets and child weight. Econ Hum Biol. 2009; 7:64–72. [PubMed: 19231301]
64. Bodor JN, Rose D, Farley TA, Swalm C, Scott SK. Neighborhood fruit and vegetable availability and consumption: the role of small food stores in an urban environment. Public Health Nutr. 2008; 11(4):413–20. [PubMed: 17617930]
65. Gregson J. Poverty, sprawl, and restaurant types influence body mass index of residents in California counties. Public Health Rep. 2011; 126(Suppl 1):141–9. [PubMed: 21563722]
66. Mehta NK, Chang VW. Weight status and restaurant availability a multilevel analysis. Am J Prev Med. 2008; 34:127–33. [PubMed: 18201642]
67. Rundle A, Neckerman KM, Freeman L, et al. Neighborhood food environment and walkability predict obesity in New York City. Environ Health Perspect. 2009; 117:442–7. [PubMed: 19337520]
68. Spence JC, Cutumisu N, Edwards J, Raine KD, Smoyer-Tomic K. Relation between local food environments and obesity among adults. BMC Public Health. 2009; 9:192. [PubMed: 19538709]
69. Drewnowski A, Aggarwal A, Hurvitz PM, Monsivais P, Moudon AV. Obesity and supermarket access: proximity or price? Am J Public Health. 2012; 102:e74–80. [PubMed: 22698052]
70. Ghosh-Dastidar B, Cohen D, Hunter G, et al. Distance to store, food prices, and obesity in urban food deserts. Am J Prev Med. 2014; 47:587–95. [PubMed: 25217097]
71. Shier V, An R, Sturm R. Is there a robust relationship between neighbourhood food environment and childhood obesity in the USA? Public Health. 2012; 126:723–30. [PubMed: 22898435]
72. Cavanaugh E, Green S, Mallya G, Tierney A, Brensinger C, Glanz K. Changes in food and beverage environments after an urban corner store intervention. Prev Med. 2014; 65:7–12. [PubMed: 24732720]
73. Lawman HG, Wilson DK, Van Horn ML, Zarrett N. The role of motivation in understanding social contextual influences on physical activity in underserved adolescents in the ACT Trial: a cross-sectional study. Childhood obesity. 2012; 8:542–50. [PubMed: 23181920]
74. Lawman HG, Vander Veur S, Mallya G, et al. Changes in quantity, spending, and nutritional characteristics of adult, adolescent and child urban corner store purchases after an environmental intervention. Prev Med. 2015; 74:81–5. [PubMed: 25498163]
75. Dubowitz T, Ghosh-Dastidar M, Cohen DA, et al. Diet and perceptions change with supermarket introduction in a food desert, but not because of supermarket use. Health Aff (Millwood). 2015; 34:1858–68. [PubMed: 26526243]
76. Cummins S, Flint E, Matthews SA. New neighborhood grocery store increased awareness of food access but did not alter dietary habits or obesity. Health Aff (Millwood). 2014; 33:283–91. [PubMed: 24493772]
77. Hollywood LE, Cuskelly GJ, O'Brien M, et al. Healthful grocery shopping. Perceptions and barriers Appetite. 2013; 70:119–26. [PubMed: 23831013]
78. Lotoski LC, Engler-Stringer R, Muhajarine N. Cross-sectio1al analysis of a community-based cooperative grocery store intervention in Saskatoon, Canada. Can J Public Health. 2015; 106:e147–53. [PubMed: 26125241]
79. Escaron AL. Underserved communities have the highest need for built environment interventions targeting obesity. Am J Public Health. 2009; 99:1159–60. [PubMed: 19443814]
80. Liberato SC, Bailie R, Brimblecombe J. Nutrition interventions at point-of-sale to encourage healthier food purchasing: a systematic review. BMC Public Health. 2014; 14:919. [PubMed: 25192584]
81. Surkan PJ, Tabrizi MJ, Lee RM, Palmer AM, Frick KD. Eat right-live well! Supermarket intervention impact on sales of healthy foods in a low-income neighborhood. J Nutr Educ Behav. 2016; 48:112–21.e1. [PubMed: 26584895]

82. Gittelsohn J, Laska MN, Karpyn A, Klingler K, Ayala GX. Lessons learned from small store programs to increase healthy food access. Am J Health Behav. 2014; 38(2):307–1583. [PubMed: 24629559]

83. Langellier BA, Garza JR, Prelip ML, Glik D, Brookmeyer R, Ortega AN. Corner store inventories, purchases, and strategies for intervention: a review of the literature. Calif J Health Promot. 2013; 11:1–13. [PubMed: 25374481]

84. Budd N, Cuccia A, Jeffries JK, et al. B'more healthy: retail rewards—design of a multi-level communications and pricing intervention to improve the food environment in Baltimore City. BMC Public Health. 2015; 15:283. [PubMed: 25885923]

85. Ortega AN, Albert SL, Sharif MZ, et al. Proyecto MercadoFRESCO: a multi-level, community-engaged corner store intervention in East Los Angeles and Boyle Heights. J Community Health. 2015; 40:347–56. [PubMed: 25209600]

86. Wong MS, Nau C, Kharmats AY, et al. Using a computational model to quantify the potential impact of changing the placement of healthy beverages in stores as an intervention to "nudge" adolescent behavior choice. BMC Public Health. 2015; 15:1284. [PubMed: 26700158]

87. Lent MR, Vander Veur SS, McCoy TA, et al. A randomized controlled study of a healthy corner store initiative on the purchases of urban, low-income youth. Obesity (Silver Spring). 2014; 22:2494–500. [PubMed: 25311881]

88. Dannefer R, Williams DA, Baronberg S, Silver L. Healthy bodegas: increasing and promoting healthy foods at corner stores in New York City. Am J Public Health. 2012; 102:e27–31.

89. Larson C, Haushalter A, Buck T, Campbell D, Henderson T, Schlundt D. Development of a community-sensitive strategy to increase availability of fresh fruits and vegetables in Nashville's urban food deserts, 2010–2012. Prev Chronic Dis. 2013; 10:E125. [PubMed: 23886044]

90••. Gittelsohn J, Rowan M, Gadhoke P. Interventions in small food stores to change the food environment, improve diet, and reduce risk of chronic disease. Prev Chronic Dis. 2012; 9:E59. This is one of the only review articles that describe the impact of corner store interventions on diet and obesity risk. [PubMed: 22338599]

91. An R. Effectiveness of subsidies in promoting healthy food purchases and consumption: a review of field experiments. Public Health Nutr. 2013; 16:1215–28. [PubMed: 23122423]

92. Lee-Kwan SH, Goedkoop S, Yong R, et al. Development and implementation of the Baltimore healthy carry-outs feasibility trial: process evaluation results. BMC public health. 2013; 13:638. [PubMed: 23837722]

93. Ayala GX, Baquero B, Pickrel JL, et al. A store-based intervention to increase fruit and vegetable consumption: The El Valor de Nuestra Salud cluster randomized controlled trial. Contemporary clinical trials. 2015; 42:228–38. [PubMed: 25924592]

94. Escaron AL, Martinez-Donate AP, Riggall AJ, et al. Developing and implementing "waupaca eating smart": a restaurant and super-market intervention to promote healthy eating through changes in the food environment. Health Promot Pract. 2016; 17:265–77. [PubMed: 26546508]

95. Martinez-Donate AP, Riggall AJ, Meinen AM, et al. Evaluation of a pilot healthy eating intervention in restaurants and food stores of a rural community: a randomized community trial. BMC Public Health. 2015; 15:136. [PubMed: 25885704]

96. Rose D, Hutchinson PL, Bodor JN, et al. Neighborhood food environments and body mass index: the importance of in-store contents. Am J Prev Med. 2009; 37:214–9. [PubMed: 19666158]

97. Pabayo R, Spence JC, Cutumisu N, Casey L, Storey K. Sociodemographic, behavioural and environmental correlates of sweetened beverage consumption among pre-school children. Public Health Nutr. 2012; 15:1338–46. [PubMed: 22269184]