Preventive Medicine Reports 39 (2024) 102664

Contents lists available at ScienceDirect

Preventive Medicine Reports

journal homepage: www.elsevier.com/locate/pmedr

A natural experiment: The opening of a supermarket in a public housing community and impacts on children's dietary patterns

Sydney Miller[a,b,*], Victoria Shier[c], Elizabeth Wong[d], Ashlesha Datar[d]

[a] Dornsife School of Public Health, Drexel University, United States
[b] Keck School of Medicine, University of Southern California, United States
[c] Price School of Public Policy, Schaeffer Center for Health Policy and Economics, University of Southern California, United States
[d] Center for Economic and Social Research, University of Southern California, United States

ARTICLE INFO

Keywords:
Food environments
Public housing residents
Child health
Dietary patterns
Supermarket intervention
Natural experiment

ABSTRACT

Objective: The aim of the present study is to utilize a natural experiment and examine changes in dietary patterns of predominantly low-income, racial and ethnic minority children who live in a public housing community following the opening of a new supermarket.
Methods: Data comes from the Watts Neighborhood Health Study (WNHS), an ongoing study in South Los Angeles, United States, that follows residents of Jordan Downs, a public housing community undergoing redevelopment. Surveys were administered to children aged 9–17 years (n = 297), as well as an adult in the household. The second baseline data collection was conducted June-December 2019, and follow-up was conducted June 2020-April 2021, shortly after the introduction of the new supermarket in January 2020. ANCOVA linear regression models were estimated to examine the association between children's proximity to the new supermarket with dietary outcomes at follow-up. Interactions with barriers to food access were also explored.
Results: Living close to the new supermarket was not significantly associated with dietary outcomes at follow-up. However, for children who lived in households with no vehicle access, living close to the new supermarket was associated with increased fruit and vegetable consumption, compared to children in the comparison group.
Conclusion: Proximity to the new supermarket was not associated with improved dietary outcomes among children unless they had transportation barriers. This adds to the growing body of literature that suggests that the effects of neighborhood food environments may be modified by individuals' mobility, and that comprehensive interventions are needed.

1. Introduction

In the United States, among children aged 2–19 years old, 29.1 % of non-Hispanic Black and 23.0 % of Hispanic children have obesity, compared to only 14.8 % of non-Hispanic white children (Fryar et al., 2018). These disparities can have life-long consequences, as childhood obesity often persists into adulthood, leading to an increased risk for comorbid diseases such as heart disease and type II diabetes (Dietz, 1998; Singh et al., 2008). One major risk factor for obesity and related diseases is inadequate nutrition (Juul et al., 2018; Malik et al., 2013; Center for Disease Control, 2020), such as a diet high in added sugar, sodium, and saturated fat, and low in nutrient-dense foods like vegetables, fruits and whole grains (USDA, 2019). However, individuals that live in food deserts (i.e., areas with limited access to affordable and nutritious food) may have difficulty acquiring adequate and nutritious foods (ver Ploeg et al., 2009b). Rather than large grocery stores or supermarkets, food deserts tend to have small stores with more expensive, lower quality, and reduced availability of healthy foods (Hendrickson et al., 2006; Morland et al., 2002; Walker et al., 2010). Low-income and racial or ethnic minority individuals are more likely to live in food deserts (James et al., 2017; Morland and Evenson, 2009; Walker et al., 2010)' and lack personal transportation (Scammell et al., 2015; Ver Ploeg et al., 2015a; Ver Ploeg et al., 2015b). This may create substantial barriers to finding adequate and affordable food (D'Angelo et al., 2011; Ver Ploeg et al., 2019; Zachary et al., 2013). This is concerning, since individuals with limited access to a supermarket tend to shop at nearby small markets or convenience stores with fewer healthy foods, or they buy more packaged, processed foods with longer shelf lives to

* Corresponding author at: Nesbitt Hall, 3215 Market Street, Philadelphia, PA 19104, United States.
E-mail address: sydneynm@usc.edu (S. Miller).

https://doi.org/10.1016/j.pmedr.2024.102664
Received 7 November 2023; Received in revised form 19 February 2024; Accepted 20 February 2024
Available online 21 February 2024

accommodate infrequent supermarket trips (Cannuscio et al., 2014; MacNell et al., 2017; Zachary et al., 2013).

One approach to reduce barriers in access and potentially improve dietary patterns is to introduce a new supermarket into food deserts (Adam and Jensen, 2016; Dubowitz et al., 2015; Ghosh-Dastidar et al., 2017). Few studies have examined how the introduction of a new supermarket to a food desert influences children's dietary patterns, and these studies have had mixed findings (Elbel et al., 2015; Zeng et al., 2019). These mixed findings are likely due to the complexity of families' food purchasing decisions that are based off a range of factors including proximity, price, convenience, and personal preference (Elbel et al., 2015; Ghosh-Dastidar et al., 2014, 2017). For example, low-income families with young children who have limited transportation may choose to shop at the closest small market, rather than travel further to a new supermarket in their neighborhood (Miller et al., 2022). Additionally, though supermarkets are an ideal source of fresh fruits and vegetables, they also increase access to other unhealthy foods. These unhealthy foods are often available at a lower price than healthier alternatives, especially in low-income neighborhoods (Ghosh-Dastidar et al., 2014, 2017; Jewell et al., 2019). Given these complexities and the sparsity of studies focused on children, there is a need to untangle the relationship between supermarket availability and the dietary patterns of children with related health risks.

Children living in public housing are a particularly interesting population with which to study this relationship, given their relatively high risk for chronic health conditions (Caspi et al., 2012a, 2012b; Chambers and Rehm, 2019; Digenis-Bury et al., 2008; Manjarrez et al., 2007), and the substantial barriers their households face in accessing healthy and affordable foods (Bowen et al., 2018; Gans et al., 2016; Rogers et al., 2018; Scammell et al., 2015). The Jordan Downs public housing redevelopment in the Watts neighborhood of South Los Angeles offers a unique opportunity to better understand this population (Datar et al., 2022). One of the first components of the redevelopment was the opening of a new full-service supermarket chain, Smart and Final Extra, in a large new retail plaza (Datar et al., 2022). The aim of the present study is to examine changes in dietary patterns of low-income, racial and ethnic minority children who live in the Jordan Downs community after the opening of the supermarket. Leveraging the plausibly exogenous variation in proximity to the new supermarket that resulted from the redevelopment plans, we examine whether proximity to supermarket was associated with greater dietary improvements for children. We further examine the moderating role of key barriers to healthy eating at baseline: access or cost barriers and no access to a vehicle.

2. Methods

Data comes from the Watts Neighborhood Health Study (WNHS), an ongoing longitudinal cohort study of residents from three public housing sites in South Los Angeles (Datar et al., 2022). The WNHS tracks a cohort of residents as one public housing community, Jordan Downs, undergoes redevelopment, during which public housing units are being replaced with new housing, additional housing is being built for new mixed-income residents, and new community amenities (e.g., park space, community center) and businesses (e.g., supermarket, restaurants) are being introduced. Participants from the Jordan Downs community are surveyed annually, along with resident participants from two other neighboring public housing communities: Nickerson Gardens and Imperial Courts. These two neighboring communities in Watts serve as a comparison group, since neither will experience any change in housing or the built environment (see Datar et al., 2022 for more details about the study and redevelopment process). The study was approved by the institutional review board at the University of Southern California (UP-17–00842). All study procedures were in accordance with the ethical standards of the institutional review board and with the Declaration of Helsinki. Written informed consent was obtained from all adult subjects and verbal assent was obtained from all child subjects prior to participation.

From May 2018 through December 2019, English and Spanish-speaking adult and child residents from the three public housing communities were recruited using a multi-pronged approach developed and implemented in collaboration with resident leaders from each site. This included distributing flyers and letters to homes, promoting the study at onsite events, and visiting homes door-to-door. Participants could participate in up to two rounds of baseline data collection depending on whether they were recruited in the first or second baseline wave.

A total of 466 children aged 9–17 years were recruited over the two baseline waves to participate in interviewer-administered surveys. Surveys asked about participants' obesity-related behaviors and risk factors including dietary intake, physical activity, psychosocial risk factors related to health, health and well-being, and socio-demographics. In addition, adults provided information about the household, including food shopping behaviors and barriers to healthy eating. Baseline surveys (in English or Spanish for adults) were completed at an on-site community space or in the participant's home. The first follow-up surveys began in June 2020, after the opening of the full-service supermarket (January 2020), and adults and children completed similar interviewer-administered surveys by phone (due to COVID-19 restrictions).

The dietary measures used in the present study were first collected in the second baseline wave (Jun 2019-Dec 2019) when 354 children participated in the survey. Of these, 297 children participated in the first follow-up survey (Jun 2020-Apr 2021; 84 % retention). The final analysis sample for the current study includes 256 children who had complete data on dietary measures and covariates in the second baseline wave (hereafter, baseline) and first follow-up (hereafter, follow-up) wave.

2.1. Measures

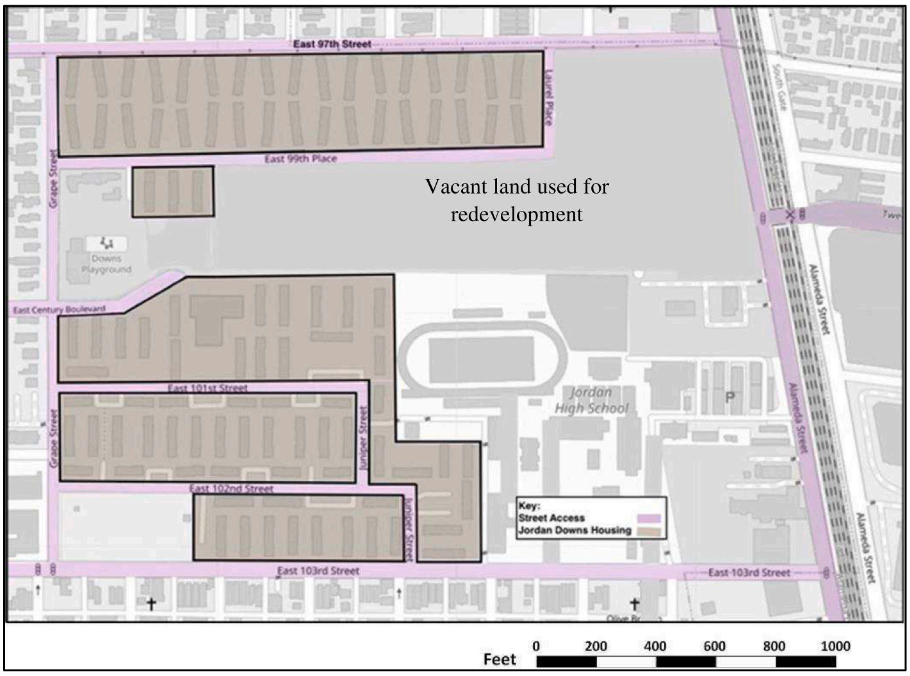
2.1.1. Dietary outcomes

At baseline and follow-up, children completed a modified version of the Beverage and Snack Questionnaire (BSQ) (Neuhouser et al., 2009). The BSQ is a validated instrument for assessing the frequency of consumption of fruits and vegetables, sweets, salty snacks, sugar sweetened beverages, and other foods and beverages. Children were asked about their consumption of a total of 21 items during the past seven days. For each item, responses included: Never; 1–3 in the past 7 days; 4–6 in the past 7 days; 1 per day; 2 per day; 3 per day; and 4 + per day. We converted these responses to measure consumption (0, 2, 3, 7, 14, 21, 28) of each item in the past week, and then added the responses to individual items to obtain total weekly consumption of four food groups: (1) fruits and vegetables, (2) sweets (i.e., candy; doughnuts or other pastries; cookies, brownies, pies and cakes; ice cream), (3) salty snacks (i.e., low-fat or nonfat chips; regular chips; other salty snacks), and (4) sugar-sweetened beverages (SSBs) (i.e., fruit drinks; sports drinks; flavored waters; regular soda or pop; energy drinks; smoothies, lattes). The total weekly consumption for each of these four groups was then divided by seven to obtain the average daily consumption of fruits and vegetables, sweets, salty snacks, and SSBs. The primary dependent variables are the four daily consumption variables at follow-up. The treatment of the outcomes as continuous variables and the testing of multiple dependent variables were effectively pre-specified before analysis by choosing the BSQ instrument and its dietary subscales (Prados et al., 2023; Richardson et al., 2020; Shier et al., 2016).

2.1.2. Proximity to new supermarket

Two measures were created to assess proximity to the new supermarket. First, a binary treatment variable categorized residents into a treatment group (Jordan Downs) or comparison group (Nickerson Gardens, Imperial Courts, or other location) based on their address at follow-up. Second, a three-category measure was constructed to assess proximity to the supermarket within Jordan Downs. For children residing in Jordan Downs, addresses were geocoded and classified into two categories: households that were "close" to the supermarket (hereafter, JD-close) and households that were far from the supermarket (hereafter, JD-far) (Fig. 1). The JD-close and JD-far categories were naturally defined due to construction-related fencing, diversions, accessible roadways at the time of the survey, and approximate time it would take to walk to the retail plaza (Fig. 1). JD-close households were within 0.4 miles walking distance to the new supermarket (mean = 0.2 miles) and JD-far households were 0.5 to 0.9 miles walking distance from the supermarket (mean = 0.7 miles). Children residing in Nickerson Gardens, Imperial Courts, or that had moved away from any of the sites were coded as the third category, the comparison group, which were at least 1.5 miles (mean = 2 miles) from the new supermarket. Given that 0.5-miles is considered a walkable distance to a store (Ver Ploeg et al., 2009a), JD-close residents would have been within walking distance to the supermarket, whereas JD-far residents would have had less walkable access, and the comparison group would not have walkable access. This three-category measure of proximity to the supermarket is arguably exogenous to child dietary outcomes because home address and redevelopment construction were determined by the Housing Authority and developers.

A. Jordan Downs site prior to the redevelopment (Fall 2017)



B. Jordan Downs site after opening of the retail plaza (Fall 2020)

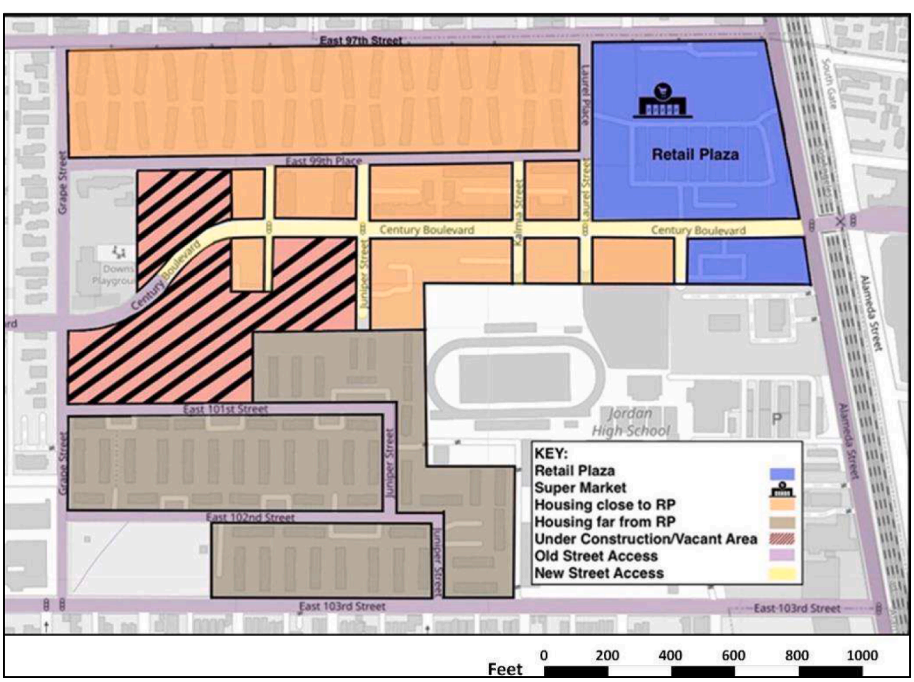


Fig. 1. Jordan Downs housing at baseline and after supermarket opening. A. Jordan Downs site prior to the redevelopment (Fall 2017). B. Jordan Downs site after opening of the retail plaza (Fall 2020).

2.1.3. Barriers to eating healthy

At baseline, one primary adult in the household was asked to rate how often (never; rarely, sometimes; often; very often or always) factors such as lack of access to fresh fruits and vegetables and the cost of healthy meals, were barriers to eating healthy. To identify households that may be uniquely vulnerable to the effects of living in a food desert and may be more impacted by the opening of a nearby supermarket, we created one binary indicator for whether the household reported an access or cost barrier to eating healthy at baseline if they reported either as barrier "Often" or "Very often or always". Access and cost barriers could not be examined separately due to insufficient sample sizes. In addition, we also consider lack of access to a vehicle as a potential barrier to eating healthy. At baseline, the primary adult household was asked, "Do you have access to a car, van, or truck when you need one?" (yes/no).

2.1.4. Covariates

Child-level covariates included the child's self-reported gender (male/female), ethnicity (Hispanic/non-Hispanic), child's age at the time of completing the survey (9–12 years old/13 years old or older), and baseline dietary outcomes (daily consumption of fruits and vegetables, sweets, salty snacks, and SSBs). Household-level covariates included household income ($9,999 or less; $10,000-$19,999; $20,000 or more), and highest level of education among adults in the household (less than high school; high school; more than high school).

2.2. Statistical analyses

We estimated analysis of covariance (ANCOVA) models to examine the impact of the new supermarket on the dietary outcomes of child residents (Huitema, 2011). These models regress the dietary outcome at follow-up on the binary treatment variable, controlling for dietary outcome at baseline and covariates. This approach is fairly standard in pre/post treatment/control study designs, and is equivalent to one that regresses change in dietary outcome from baseline to follow-up on the treatment variable, baseline dietary outcome, and covariates (Lüdtke and Robitzsch, 2023). The coefficients on the treatment variable(s) should be interpreted as changes or improvements in dietary outcomes, thus the models examined whether children in the treatment group (Jordan Downs) had greater improvements in dietary outcomes compared to children in the comparison group. We estimated a series of three multivariable linear regression models for each of the four dietary outcomes. Model 1 adjusted for child and household-level covariates. Models 2 and 3 added the interaction between proximity to the new supermarket and having an access or cost barrier to healthy eating (Model 2) and lack of access to a vehicle (Model 3). All models accounted for clustering at the household level to account for multiple participants per household (256 child participants lived in 164 households). For Models 2 and 3, pairwise comparisons of marginal linear predictions for each treatment group by barrier are reported in the results, and linear regression coefficients are reported in the Appendix. To leverage the plausibly exogenous variation in children's proximity to the supermarket within Jordan Downs, and to explore whether living closer to the new supermarket had a greater impact on children's dietary outcomes, the three models were also run using the three-category measure of proximity to the grocery store.

We conducted sensitivity analyses dropping children who reported consuming one item more than 10 times per day (e.g., salty snacks more than 10 times a day, which resulted in dropping a maximum of 17 observations). As removing these outliers did not alter our findings, we report the results using the full sample. We also conducted sensitivity analyses using change in dietary outcomes as the outcome measures, which were more normally distributed than follow-up dietary outcomes, and results did not differ. All results from the sensitivity analyses are available upon request. All analyses were conducted using Stata 18.0 (StataCorp, College Station, TX).

3. Results

Table 1 presents summary statistics of the analysis sample, overall and by the three proximity groups (i.e., comparison group, JD-far, JD-close). Half (50.0 %) of the sample of children are female and over three-quarters (78.5 %) are Hispanic. Slightly over one-third (35.2 %) live in homes with a household income of $9,999 or less, and 15.6 % live in households where adults' highest education is less than a high school degree. Almost one-third of children (32.4 %) live in a household with an access or cost barrier to healthy eating, and 16.4 % live in a household without access to a vehicle. Across the three proximity groups, child participants are similar in terms of age, gender, household income, household education, and importantly, baseline consumption of fruits and vegetables, sweets, salty snacks, and SSBs. Although there are some differences across proximity groups in terms of ethnicity and having an access or cost barrier to eating healthy at baseline, these differences do not appear to have any systematic pattern.

Estimates from the ANCOVA models with the binary treatment measure without interactions with barriers are reported in Table 2 (Panel A). After controlling for age, ethnicity, gender, household income, and baseline dietary outcomes, living at Jordan Downs was not significantly associated with daily consumption of fruit and vegetables, sweets, salty snacks, or SSBs at follow-up, compared to living elsewhere. There were similar results for the model with the three-category proximity measure (Table 2 Panel B)—both JD-far and JD-close were not significantly associated with improved dietary outcomes compared to the comparison group.

Differences in marginal linear predictions from models with interactions between the binary treatment measure and access or cost barrier and no access to vehicle are reported in Table 3. There were no significant interactions between proximity to supermarket and having an access or cost barrier, but there was an interaction between proximity and lack of vehicle access. We find that among children in households with no access to a vehicle, those who lived at Jordan Downs consumed fruits and vegetables 1.589 additional times per day (95 % CI: 0.474, 2.704) (Table 3), compared to children in the comparison group. Notably, among children in households with access to a vehicle, living at Jordan Downs was not associated with changes in fruit and vegetable consumption. Linear regression coefficient estimates from these models are reported in Table A.1.

Table 4 reports estimates of differences in marginal linear predictions from the interaction models using the three-category proximity measure. Again, there were no significant interactions between having an access or cost barrier with proximity to the supermarket, but there was an interaction with lack of vehicle access. Compared to the comparison group, fruit and vegetable consumption was significantly higher among residents in both the JD-far (1.692; 95 % CI: 0.124, 3.259) and JD-close (1.525; 95 % CI: 0.265, 2.785) groups if they had no household access to a vehicle at baseline. Linear regression coefficient estimates from these models are reported in Table A.2.

4. Discussion

Using a rigorous study design that combines longitudinal data and quasi-experimental exposure to a new supermarket, the present study found that, overall, children in Jordan Downs did not experience differential changes in dietary outcomes compared to those in the comparison group. Moreover, proximity to the new supermarket within Jordan Downs was also unrelated to diet. However, there was one exception to these findings. Echoing conclusions from prior studies, we find that, for children in households with no access to a vehicle, fruit and vegetable consumption increased by more than 1.5 times per day for children at Jordan Downs (both JD-close and JD-far) compared to those in the comparison group, a change with very meaningful clinical implications (Blackburn, 1995; Zeng et al., 2019). This finding, which may be interpreted with caution due to the testing of multiple outcomes, may

Table 1
Baseline characteristics and dietary behaviors of children living in a public housing community in Los Angeles, CA in 2019.

		Location at Follow-Up			
	Overall N (%)	Comparison N (%)	JD-farN (%)	JD-closeN (%)	
Age					
9–12 years	107 (41.8)	44 (48.9)	27 (34.6)	36 (40.9)	p = 0.170
13 + years	149 (58.2)	46 (51.1)	51 (65.4)	52 (59.1)	
Gender					
Male	128 (50.0)	48 (53.3)	39 (50.0)	41 (46.6)	p = 0.667
Female	128 (50.0)	42 (46.7)	39 (50.0)	47 (53.4)	
Ethnicity					
Non-Hispanic	55 (21.5)	28 (31.1)	3 (3.8)	24 (27.3)	p = 0.000
Hispanic	201 (78.5)	62 (68.9)	75 (96.2)	64 (72.7)	
Household income					
$9,999 or less	90 (35.2)	27 (30.0)	31 (39.7)	32 (36.4)	p = 0.742
$10,000-$19,999	76 (29.7)	30 (33.3)	21 (26.9)	25 (28.4)	
$20,000 or more	90 (35.2)	33 (36.7)	26 (33.3)	31 (35.2)	
Highest education among adults within household					
Less than high school	40 (15.6)	13 (14.4)	15 (19.2)	12 (13.6)	p = 0.676
High school	88 (34.4)	31 (34.4)	29 (37.2)	28 (31.8)	
More than high school	128 (50.0)	46 (51.1)	34 (43.6)	48 (54.5)	
Access/cost barrier to healthy eating					
No	173 (67.6)	57 (73.1)	49 (55.7)	67 (74.4)	p = 0.009
Yes	83 (32.4)	21 (26.9)	39 (44.3)	23 (25.6)	
Access to vehicle					
Yes	214 (83.6)	76 (84.4)	66 (84.6)	72 (81.8)	p = 0.857
No	42 (16.4)	14 (15.6)	12 (15.4)	16 (18.2)	
Consumption of fruits or vegetables (times/day), Mean (SD)	2.217 (2.106)	2.459 (2.278)	1.925 (1.862)	2.232 (2.119)	p = 0.263
Consumption of sweets (times/day), Mean (SD)	2.332 (2.806)	2.786 (3.590)	2.222 (2.571)	1.972 (1.941)	p = 0.146
Consumption of salty snacks (times/day), Mean (SD)	1.314 (1.750)	1.492 (2.129)	1.299 (1.589)	1.148 (1.437)	p = 0.429
Consumption of sugar-sweetened beverages (times/day), Mean (SD)	2.678 (3.112)	2.568 (3.492)	2.808 (3.248)	2.677 (2.551)	p = 0.884
Total	256 (100.0)	90 (35.2)	78 (30.5)	88 (34.4)	

be driven by the predominantly Hispanic sample, since research suggests Hispanic individuals, especially Hispanic immigrants, are more inclined to have higher consumption of fruits and vegetables (Colón-Ramos et al., 2009; Pérez-Escamilla, 2011).

These results are in line with the extensive literature demonstrating the importance of transportation in determining where and how people shop for groceries (Miller et al., 2022; Ver Ploeg et al., 2009a). Studies have suggested that individuals travel outside their neighborhood for food, and plan food shopping around their school or work (Clifton, 2004; Horn et al., 2021; Shannon, 2016). However, families without access to a vehicle may be more constrained to their immediate food environment (D'Angelo et al., 2011; Ver Ploeg et al., 2009a; Zachary et al., 2013) and rely more heavily on public transportation. While Jordan Downs is well-served by public buses, the nearest supermarket was a short bus ride plus a ½ mile walk (total) away, making it challenging for frequent and/or larger grocery shopping needs. These families would have to make infrequent trips outside of their neighborhood for food, which could explain why this study found changes in consumption of perishable food groups (fruits and vegetables), but not non-perishable foods (sweets, salty snacks, and SSBs) that could be stocked for longer periods (Cannuscio et al., 2014; MacNell et al., 2017; Zachary et al., 2013). In comparison, low-income households who have access to a vehicle may be more motivated by prices rather than proximity when determining where to shop for groceries (Hillier et al., 2011; Zachary et al., 2013). This may explain why families living in Jordan Downs with access to a vehicle were not affected by the new supermarket.

The null effects reported in this study for most residents may be driven by the complexity of the food environment. Food environments are dynamic systems, and introducing a new supermarket has important implications for supply and demand chains, including food prices and availability at surrounding food outlets. Some have found that a new supermarket may not actually increase the overall availability of fruit and vegetables in a community because smaller stores stop carrying these items when they cannot compete with the supermarket's prices of fresh produce (Ghosh-Dastidar et al., 2017). Additionally, one supermarket may be "swamped" by a greater number of smaller, less healthy food outlets (Rose et al., 2009). Indeed, there were 3 dollar stores and 28 convenience stores, mini marts, and small grocers in the Watts neighborhood. However, our other work with this data has indicated that these stores are not primary food shopping locations for Jordan Downs households (Shier et al., 2022).

These results suggest that supermarket introductions alone may not significantly improve diets for most children living in public housing communities. As many low-income families may prioritize price over proximity, affordability is an important factor that must be considered (Hillier et al., 2011; Zachary et al., 2013). Some interventions with low-income families have been more successful when pairing financial incentives (e.g., coupons, and low prices for fruits and vegetables) with new food stores (Gorham et al., 2015; Polacsek et al., 2018). In order to increase the overall neighborhood availability of healthy foods, interventions may also consider reducing the sales of unhealthy foods targeted towards children (Harris et al., 2020) and supporting local neighborhood stores to maintain or increase their healthy options once a new supermarket opens.

The study's limitations include self-report of dietary outcomes, limited food groups assessed, transportation being only assessed at baseline, and inability to examine access and cost barriers separately due to the sample size. Also, follow-up dietary outcomes were collected during the first year of the COVID-19 pandemic from a sample of children living in public housing developments in Watts and therefore may not generalize to other time periods or settings. Notably, these neighborhoods experienced extensive social distancing procedures during this period, and the closures of schools, gyms, and other establishments. However, supermarkets and small grocers generally remained open, and there were no major differences, to our knowledge, in business closures between the treatment and comparison sites.

Table 2
Linear regression results assessing the relationship between proximity to the new supermarket and dietary outcomes of children living in a public housing community in 2020–2021 (Model 1).

	Consumption (Times/day)			
	Fruits or vegetables	Sweets	Salty snacks	Sugar-sweetened beverages
Panel A. Binary treatment measure				
Jordan Downs (Ref: comparison group)	−0.081 (-0.594—0.431)	−0.130 (-0.646—0.385)	0.043 (-0.306—0.391)	0.093 (-0.543—0.729)
R-squared	0.149	0.146	0.267	0.196
Panel B. Three-category proximity measure				
JD-far (Ref: comparison group)	−0.047 (-0.616—0.522)	0.006 (-0.611—0.623)	0.115 (-0.334—0.565)	0.070 (-0.638—0.778)
JD-close (Ref: comparison group)	−0.107 (-0.711—0.498)	−0.236 (-0.824—0.353)	−0.014 (-0.400—0.373)	0.111 (-0.639—0.860)
R-squared	0.149	0.148	0.268	0.196
Observations	255	252	251	254
Mean of dependent variable	2.252	2.022	1.334	2.323

Models control for age, ethnicity, gender, household income, highest education of adults in household, and consumption of food group at baseline.
Robust 95% Confidence Interval in parentheses.
*** p < 0.001, ** p < 0.01, * p < 0.05.

Table 3
Differences in marginal linear predictions of daily consumption between children in treatment group (Jordan Downs) and comparison group, by household reported barriers to healthy eating.

Difference	Consumption (times/day)[a]			
	Fruits or vegetables	Sweets	Salty snacks	Sugar-sweetened beverages
Households without access/cost barrier				
Treatment vs. comparison	−0.088 (-0.695, 0.519)	0.097 (-0.547, 0.721)	0.320 (-0.114, 0.753)	0.461 (-0.317, 1.238)
Households with access/cost barrier				
Treatment vs. comparison	−0.039 (-0.991, 0.913)	−0.541 (-1.410, 0.325)	−0.496 (-1.089, 0.096)	−0.556 (-1.986, 0.874)
Households with access to vehicle				
Treatment vs. comparison	−0.382 (-0.921, 0.157)	−0.303 (-0.878, 0.271)	0.001 (-0.365, 0.367)	0.109 (-0.567, 0.784)
Households with no access to vehicle				
Treatment vs. comparison	1.589 (0.474, 2.704)**	0.827 (-0.591, 2.244)	0.250 (-0.885, 1.386)	0.095 (-1.451, 1.641)

Robust 95% Confidence Interval in parentheses.
[a]Estimates represent the difference in daily consumption between groups.
*** p < 0.001, ** p < 0.01, * p < 0.05.

4.1. Conclusion

Introducing a supermarket into a low-income, predominantly racial and ethnic minority community was largely not associated with improvements in children's dietary outcomes, except in families without access to private transportation. These findings suggest that supermarket introductions alone may not improve residents' dietary outcomes in such communities.

4.2. Funding statement

The authors have no financial disclosures or conflicts of interest. This research was supported by the National Cancer Institute (R01CA228058) and the Eunice Kennedy Shriver National Center for Child Health and Human Development (R01HD096293). All opinions are those of the authors and not of the funding agency.

Table 4
Differences in marginal linear predictions of daily consumption between children in JD-Close, JD-Far, and comparison group, by household reported barriers to healthy eating.

Difference	Consumption (times/day) [a]			
	Fruits or vegetables	Sweets	Salty snacks	Sugar-sweetened beverages
Households without access/cost barrier				
JD-far vs. comparison	−0.074 (-0.710, 0.561)	0.171 (-0.583, 0.924)	0.358 (-0.220, 0.937)	0.346 (-0.477, 1.169)
JD-close vs. comparison	−0.096 (-0.861, 0.668)	0.008 (-0.758, 0.775)	0.280 (-0.198, 0.757)	0.580 (-0.481, 1.641)
Households with access/cost barrier				
JD-far vs. comparison	0.040 (-1.180, 1.260)	−0.385 (-1.410, 0.641)	−0.464 (-1.061, 0.133)	−0.544 (-2.041, 0.952)
JD-close vs. comparison	−0.081 (-1.117, 0.956)	−0.624 (-1.565, 0.317)	−0.513 (-1.184, 0.158)	−0.566 (-2.077, 0.945)
Households with access to vehicle				
JD-far vs. comparison	−0.345 (-0.925, 0.235)	−0.138 (-0.863, 0.588)	0.048 (-0.453, 0.548)	0.126 (-0.651, 0.904)
JD-close vs. comparison	−0.409 (-1.053, 0.234)	−0.436 (-1.056, 0.184)	−0.036 (-0.420, 0.348)	0.092 (-0.696, 0.881)
Households with no access to vehicle				
JD-far vs. comparison	1.692 (0.124, 3.259)*	0.814 (-0.593, 2.222)	0.482 (-0.776, 1.741)	−0.156 (-1.720, 1.408)
JD-close vs. comparison	1.525 (0.265, 2.785)*	0.832 (-0.895, 2.559)	0.098 (-1.247, 1.444)	0.270 (-1.755, 2.295)

[a] Estimates represent the difference in daily consumption between groups.
95% Confidence Interval in parentheses.
*** p < 0.001, ** p < 0.01, * p < 0.05.

CRediT authorship contribution statement

Sydney Miller: Writing – review & editing, Writing – original draft, Formal analysis, Conceptualization. **Victoria Shier:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Elizabeth Wong:** Writing – review & editing, Formal analysis. **Ashlesha Datar:** Writing – review & editing, Supervision, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Acknowledgements

We acknowledge the generous support of the Housing Authority of the City of Los Angeles (HACLA) for conducting this study. The authors thank the Community Coaches and residents at the study sites for their participation and support for this study. The authors also thank Angelica Hernandez, Marai Hernandez, and Jose Scott Jr for their excellent research assistance, and Dr. Ying Liu for her assistance with data management.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2024.102664.

References

Adam, A., Jensen, J.D., 2016. What is the effectiveness of obesity related interventions at retail grocery stores and supermarkets?—a systematic review. BMC Public Health 16, 1–18.

Blackburn, G., 1995. Effect of degree of weight loss on health benefits. Obes. Res. 3 https://doi.org/10.1002/j.1550-8528.1995.tb00466.x.

Bowen, D.J., Quintiliani, L.M., Bhosrekar, S.G., Goodman, R., Smith, E., 2018. Changing the housing environment to reduce obesity in public housing residents: a cluster randomized trial. BMC Public Health 18, 1–9.

Cannuscio, C.C., Hillier, A., Karpyn, A., Glanz, K., 2014. The social dynamics of healthy food shopping and store choice in an urban environment. Soc. Sci. Med. 122, 13–20. https://doi.org/10.1016/j.socscimed.2014.10.005.

Caspi, C.E., Kawachi, I., Subramanian, S.V., Adamkiewicz, G., Sorensen, G., 2012a. The relationship between diet and perceived and objective access to supermarkets among low-income housing residents. Soc. Sci. Med. 75, 1254–1262. https://doi.org/10.1016/j.socscimed.2012.05.014.

Caspi, C.E., Sorensen, G., Subramanian, S.V., Kawachi, I., 2012b. The local food environment and diet: a systematic review. Health Place 18, 1172–1187.

Center for Disease Control, 2020. Why It Matters | Nutrition. accessed 11.6.20. https://www.cdc.gov/nutrition/about-nutrition/why-it-matters.html.

Chambers, E.C., Rehm, C.D., 2019. Brief report: characterizing the burden of cardiometabolic disease among public housing residents served by an urban hospital system. Ethn. Dis. 29, 463.

Clifton, K.J., 2004. Mobility strategies and food shopping for low-income families: a case study. J. Plan. Educ. Res. 23 (4), 402–413.

Colón-Ramos, U., Thompson, F.E., Yaroch, A.L., Moser, R.P., McNeel, T.S., Dodd, K.W., Atienza, A.A., Sugerman, S.B., Nebeling, L., 2009. Differences in fruit and vegetable intake among Hispanic subgroups in California: results from the 2005 California Health Interview Survey. J. Am. Diet. Assoc. 109, 1878–1885.

D'Angelo, H., Suratkar, S., Song, H.-J., Stauffer, E., Gittelsohn, J., 2011. Access to food source and food source use are associated with healthy and unhealthy food-purchasing behaviours among low-income African-American adults in Baltimore City. Public Health Nutr. 14, 1632–1639. https://doi.org/10.1017/S1368980011000498.

Datar, A., Shier, V., Braboy, A., Jimenez-Ortiz, M., Hernandez, A., King, S.E., Liu, Y., 2022. Assessing impacts of redeveloping public housing communities on obesity in low-income minority residents: Rationale, study design, and baseline data from the Watts Neighborhood Health Study. Contemp. Clin. Trials Commun. 25, 100879.

Dietz, W.H., 1998. Health consequences of obesity in youth: childhood predictors of adult disease. Pediatrics 101, 518–525.

Digenis-Bury, E.C., Brooks, D.R., Chen, L., Ostrem, M., Horsburgh, C.R., 2008. Use of a population-based survey to describe the health of boston public housing residents. Am. J. Public Health 98, 85–91. https://doi.org/10.2105/AJPH.2006.094912.

Dubowitz, T., Ghosh-Dastidar, M., Cohen, D.A., Beckman, R., Steiner, E.D., Hunter, G.P., Flórez, K.R., Huang, C., Vaughan, C.A., Sloan, J.C., Zenk, S.N., Cummins, S., Collins, R.L., 2015. Diet and perceptions change with supermarket introduction in a food desert, but not because of supermarket use. Health Aff. (millwood) 34, 1858–1868. https://doi.org/10.1377/hlthaff.2015.0667.

Elbel, B., Moran, A., Dixon, L.B., Kiszko, K., Cantor, J., Abrams, C., Mijanovich, T., 2015. Assessment of a government-subsidized supermarket in a high-need area on household food availability and children's dietary intakes. Public Health Nutr. 18, 2881–2890. https://doi.org/10.1017/S1368980015000282.

Fryar, C.D., Carroll, M.D., Ogden, C.L., 2018. Prevalence of overweight, obesity, and severe obesity among children and adolescents aged 2–19 years: United States, 1963–1965 through 2015–2016.

Gans, K.M., Gorham, G., Risica, P.M., Dulin-Keita, A., Dionne, L., Gao, T., Peters, S., Principato, L., 2016. A multi-level intervention in subsidized housing sites to increase fruit and vegetable access and intake: rationale, design and methods of the 'Live Well, Viva Bien' cluster randomized trial. BMC Public Health 16, 521. https://doi.org/10.1186/s12889-016-3141-7.

Ghosh-Dastidar, B., Cohen, D., Hunter, G., Zenk, S.N., Huang, C., Beckman, R., Dubowitz, T., 2014. Distance to store, food prices, and obesity in urban food deserts. Am. J. Prev. Med. 47, 587–595. https://doi.org/10.1016/j.amepre.2014.07.005.

Ghosh-Dastidar, M., Hunter, G., Collins, R.L., Zenk, S.N., Cummins, S., Beckman, R., Nugroho, A.K., Sloan, J.C., Wagner, L., Dubowitz, T., 2017. Does opening a supermarket in a food desert change the food environment? Health Place 46, 249–256. https://doi.org/10.1016/j.healthplace.2017.06.002.

Gorham, G., Dulin-Keita, A., Risica, P.M., Mello, J., Papandonatos, G., Nunn, A., Gorham, S., Roberson, M., Gans, K.M., 2015. Effectiveness of fresh to you, a discount fresh fruit and vegetable market in low-income neighborhoods, on children's fruit and vegetable consumption, Rhode Island, 2010–2011. Prev. Chronic. Dis. 12, 140583 https://doi.org/10.5888/pcd12.140583.

Harris, L., 2020. Marketing to children in supermarkets: an opportunity for public policy to improve children's diets. Int. J. Environ. Res. Public. Health 17, 1284. https://doi.org/10.3390/ijerph17041284.

Hendrickson, D., Smith, C., Eikenberry, N., 2006. Fruit and vegetable access in four low-income food deserts communities in Minnesota. Agric. Hum. Values 23, 371–383.

Hillier, A., Cannuscio, C.C., Karpyn, A., McLaughlin, J., Chilton, M., Glanz, K., 2011. How far do low-income parents travel to shop for food? empirical evidence from two urban neighborhoods. Urban Geogr. 32, 712–729. https://doi.org/10.2747/0272-3638.32.5.712.

Horn, A.L., Bell, B.M., Bueno, B.G.B., Bahrami, M., Bozkaya, B., Cui, Y., Wilson, J.P., Pentland, A., Moro, E., de la Haye, K., 2021. Investigating Mobility-Based Fast Food Outlet Visits as Indicators of Dietary Intake and Diet-Related Disease. https://doi.org/10.1101/2021.10.28.21265634.

Huitema, B., 2011. The analysis of covariance and alternatives: Statistical methods for experiments, quasi-experiments, and single-case studies. John Wiley & Sons.

James, P., Seward, M.W., James O'Malley, A., Subramanian, S., Block, J.P., 2017. Changes in the food environment over time: examining 40 years of data in the Framingham Heart Study. Int. J. Behav. Nutr. Phys. Act. 14, 84. https://doi.org/10.1186/s12966-017-0537-4.

Jewell, M.P., Lai, E.S., Thompson, J., Fox, M., Kuo, T., 2019. Higher pricing of fresh produce is more likely in SNAP-Ed eligible neighborhoods when adjacent non-program eligible neighborhoods are mixed income. Prev. Med. Rep. 14, 100817 https://doi.org/10.1016/j.pmedr.2019.01.021.

Juul, F., Martinez-Steele, E., Parekh, N., Monteiro, C.A., Chang, V.W., 2018. Ultra-processed food consumption and excess weight among US adults. Br. J. Nutr. 120, 90–100. https://doi.org/10.1017/S0007114518001046.

Lüdtke, O., Robitzsch, A., 2023. ANCOVA versus change score for the analysis of two-wave data. J. Exp. Educ. 1–33 https://doi.org/10.1080/00220973.2023.2246187.

MacNell, L., Elliott, S., Hardison-Moody, A., Bowen, S., 2017. Black and Latino urban food desert residents' perceptions of their food environment and factors that influence food shopping decisions. J. Hunger Environ. Nutr. 12, 375–393.

Malik, V.S., Willett, W.C., Hu, F.B., 2013. Global obesity: trends, risk factors and policy implications. Nat. Rev. Endocrinol. 9, 13–27. https://doi.org/10.1038/nrendo.2012.199.

Manjarrez, C.A., Popkin, S.J., Guernsey, E., 2007. Poor health: adding insult to injury for HOPE VI families. Citeseer.

Miller, S., Shirazipour, C.H., Holmes, A.F., Salvy, S.-J., de la Haye, K., 2022. Diet and physical activity behaviors of families receiving maternal and child health services: the perspective of the home visitor. J. Healthy Eat. Act. Living 2, 9.

Morland, K.B., Evenson, K.R., 2009. Obesity prevalence and the local food environment. Health Place 15, 491–495.

Morland, K., Wing, S., Roux, A.D., 2002. The contextual effect of the local food environment on residents' diets: the atherosclerosis risk in communities study. Am. J. Public Health 92, 1761–1768.

Neuhouser, M.L., Lilley, S., Lund, A., Johnson, D.B., 2009. Development and validation of a beverage and snack questionnaire for use in evaluation of school nutrition policies. J. Am. Diet. Assoc. 109, 1587–1592.

Pérez-Escamilla, R., 2011. Acculturation, nutrition, and health disparities in Latinos. Am. J. Clin. Nutr. 93, 1163S–S1167.

Polacsek, M., Moran, A., Thorndike, A.N., Boulos, R., Franckle, R.L., Greene, J.C., Blue, D.J., Block, J.P., Rimm, E.B., 2018. A supermarket double-dollar incentive program increases purchases of fresh fruits and vegetables among low-income

families with children: the healthy double study. J. Nutr. Educ. Behav. 50, 217–228. e1. https://doi.org/10.1016/j.jneb.2017.09.013.
Prados, M.J., Nicosia, N., Datar, A., 2023. Impact of built, social, and economic environments on adolescent obesity and related health behaviors. Obesity 31, 1085–1094. https://doi.org/10.1002/oby.23682.
Richardson, A.S., Nicosia, N., Ghosh-Dastidar, M.B., Datar, A., 2020. School food and beverage availability and children's diet, purchasing, and obesity: evidence from a natural experiment. J. Adolesc. Health 67, 804–813.
Rogers, C., Johnson, J., Nueslein, B., Edmunds, D., Valdez, R.S., 2018. "I love fruit but i can't afford it": using participatory action research to develop community-based initiatives to mitigate challenges to chronic disease management in an african american community living in public housing. J. Racial Ethn. Health Disparities 5, 1315–1327.
Rose, D., Bodor, J.N., Swalm, C.M., Rice, J.C., Farley, T.A., Hutchinson, P.L., 2009. Deserts in New Orleans? Illustrations of urban food access and implications for policy. Ann Arbor MI Univ Mich. Natl. Poverty CenterUSDA Econ. Res. Serv. Res.
Scammell, M.K., Torres, S., Wayman, J., Greenwood, N., Thomas, G., Kozlowski, L., Bowen, D., 2015. Balancing act: approaches to healthy eating and physical activity among boston public housing residents. J. Prev. Interv. Community 43, 109–122. https://doi.org/10.1080/10852352.2014.973271.
Shannon, J., 2016. Beyond the supermarket solution: linking food deserts, neighborhood context, and everyday mobility. Ann. Am. Assoc. Geogr. 106, 186–202. https://doi.org/10.1080/00045608.2015.1095059.
Shier, V., Nicosia, N., Datar, A., 2016. Neighborhood and home food environment and children's diet and obesity: evidence from military personnel's installation assignment. Soc. Sci. Med. 158, 122–131.
Shier, V., Miller, S., Datar, A., 2022. Heterogeneity in grocery shopping patterns among low-income minority women in public housing. BMC Public Health 22, 1612. https://doi.org/10.1186/s12889-022-14003-0.
Singh, A.S., Mulder, C., Twisk, J.W.R., Van Mechelen, W., Chinapaw, M.J.M., 2008. Tracking of childhood overweight into adulthood: a systematic review of the literature. Obes. Rev. 9, 474–488. https://doi.org/10.1111/j.1467-789X.2008.00475.x.
United States Department of Agriculture (USDA), 2019. Dietary Guidelines for Americans. accessed 5.6.21. https://www.fns.usda.gov/cnpp/dietary-guidelines-americans.
Ver Ploeg, M., Breneman, V., Farrigan, T., Hamrick, K., Hopkins, D., Kaufman, P., Lin, B.-H., Nord, M., Smith, T.A., Williams, R., 2009. Access to affordable and nutritious food: measuring and understanding food deserts and their consequences: report to congress.
ver Ploeg, M., Breneman, V., Farrigan, T., Hamrick, K., Hopkins, D., Kaufman, P., Lin, B.-H., Nord, M., Smith, T.A., Williams, R., Kinnison, K., Olander, C., Singh, A., Tuckermanty, E. (Eds.), 2009. Access to affordable and nutritious food: measuring and understanding food deserts and their consequences: Report to Congress, Administrative Publication Number 036. https://doi.org/10.22004/ag.econ.292130.
Ver Ploeg, M., Mancino, L., Todd, J.E., Clay, D.M. and Scharadin, B., 2015. Where do Americans usually shop for food and how do they travel to get there? Initial findings from the National Household Food Acquisition and Purchase Survey (No. 1476-2017-3882).
Ver Ploeg, M., Mancino, L., Todd, J.E., Clay, D.M., Scharadin, B., 2015. Where Do Americans Usually Shop for Food and How Do They Travel To Get There? Initial Findings from the National Household Food Acquisition and Purchase Survey [WWW Document]. AgEcon Search. https://doi.org/10.22004/ag.econ.262116.
Walker, R.E., Keane, C.R., Burke, J.G., 2010. Disparities and access to healthy food in the United States: a review of food deserts literature. Health Place 16, 876–884.
Zachary, D.A., Palmer, A.M., Beckham, S.W., Surkan, P.J., 2013. A framework for understanding grocery purchasing in a low-income urban environment. Qual. Health Res. 23, 665–678.
Zeng, D., Thomsen, M.R., Nayga, R.M., Bennett, J.L., 2019. Supermarket access and childhood bodyweight: Evidence from store openings and closings. Econ. Hum. Biol. 33, 78–88. https://doi.org/10.1016/j.ehb.2019.01.004.