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ORIGINAL ARTICLE

Association between fast food purchasing and the local food environment

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OBJECTIVE: In this study, an instrument was created to measure the healthy and unhealthy characteristics of food environments and investigate associations between the whole of the food environment and fast food consumption.
DESIGN AND SUBJECTS: In consultation with other academic researchers in this field, food stores were categorised to either healthy or unhealthy and weighted (between +10 and −10) by their likely contribution to healthy/unhealthy eating practices. A healthy and unhealthy food environment score (FES) was created using these weightings. Using a cross-sectional study design, multilevel multinomial regression was used to estimate the effects of the whole food environment on the fast food purchasing habits of 2547 individuals.
RESULTS: Respondents in areas with the highest tertile of the healthy FES had a lower likelihood of purchasing fast food both infrequently and frequently compared with respondents who never purchased, however only infrequent purchasing remained significant when simultaneously modelled with the unhealthy FES (odds ratio (OR) 0.52; 95% confidence interval (CI) 0.32–0.83). Although a lower likelihood of frequent fast food purchasing was also associated with living in the highest tertile of the unhealthy FES, no association remained once the healthy FES was included in the models. In our binary models, respondents living in areas with a higher unhealthy FES than healthy FES were more likely to purchase fast food infrequently (OR 1.35; 95% CI 1.00–1.82) however no association was found for frequent purchasing.
CONCLUSION: Our study provides some evidence to suggest that healthier food environments may discourage fast food purchasing.

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Keywords: food environment; fast food; eating behaviours; multilevel study; area-level disadvantage

INTRODUCTION

Eating behaviours consistent with recommended dietary guidelines are important for good health.[1,2] Individuals who do not regularly consume a healthy diet may be at greater risk of numerous adverse health outcomes.[3] Specifically, frequent fast food consumption is linked to a higher incidence of obesity and diabetes.[4–6]

In recent times, neighbourhood environments have been posited as a potential influence on eating behaviours, although to date evidence is equivocal and there remains no consistent way to measure environmental risk factors. Recent reviews have demonstrated most studies investigating neighbourhood access to food stores have only considered a single or limited range of food store types in their exposure measures.[7,8] For instance, chain supermarkets and greengrocers are typically used as proxies for access to healthy food, whereas convenience stores and fast food outlets are used as proxies for unhealthy food access. Further, it is often the case that healthy and unhealthy stores are not considered simultaneously and therefore presents an incomplete picture of the food environment. It is plausible that consumption of certain foods (for example, fast food) will be influenced not only by access to the stores selling that product (for example, fast food restaurants) but also by the access to alternative food sources.

Research regarding the role of the total food environment on food-related behaviours has received little attention. Using BMI as an outcome, a recent study from the United States investigated 14 food store types, which were subsequently classified as one of either BMI healthy, BMI intermediate or BMI unhealthy.[9] Their analysis of New York neighbourhoods revealed residents of areas with a higher density of BMI-healthy stores (supermarkets, fruit and vegetable stores, natural/health food stores) had lower mean BMIs and a lower prevalence of overweight and obesity. Another US study investigated associations between obesity and 11 types of food stores and food service places.[10] After adjustment for individual factors, a lower prevalence of obesity was observed among those with access to a chain supermarket, limited service restaurants and specialty food restaurants and higher prevalence among those with access to grocery stores and franchised fast food outlets.

This present study investigates the association between fast food consumption and exposure to a variety of food store types using data from 2547 individuals from within 49 small areas in Melbourne, Australia. Indices of healthy and unhealthy food environments were created by weighting each store type based on the potential contribution to healthy and unhealthy eating behaviours.

SUBJECTS AND METHODS

Sampling

Analysis was undertaken on data collected in 2003 as part of the multilevel Victorian Lifestyle and Neighbourhoods Environment Study (VicLANES)

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(approved by the La Trobe University Human Ethics Committee). VicLANES was conducted within a single metropolitan context, Melbourne, Australia with full sampling methods previously described.[11,12] Briefly, we randomly selected fifty Census Collector Districts (CCDs) (average size of about 220 dwellings in urban areas[13]) from the least ($n = 17$ CCDs) (mean proportion of low-income households 7.0%, range 3.5–8.5%), mid ($n = 16$) (mean 15.3%, range 14.4–16.7%) and most disadvantaged ($n = 17$) (mean 31.4%, range 24.1–59.6%) septiles. Households were sampled from these fifty CCDs and a Food Purchasing survey was mailed to 3995 randomly selected households. The survey was to be completed by the person who undertook the majority of food shopping for that household. A total of 2564 valid responses were received (64% response rate) and final analysis took place on 49 out of the 50 VicLANES CCDs (2547 participants). The area we excluded contained the Melbourne central business district in its buffer and was biased due to the high number of stores ($n = 841$ stores) in this area that exist to predominantly cater for non-residents.

Dependent variable

The outcome was fast food purchased for consumption at home from Australia's five leading fast food chains at the time of the survey: Red Rooster, McDonalds, Kentucky Fried Chicken, Hungry Jacks and Pizza Hut. Frequency of consumption from each chain was recorded in categories (not at all, 1 time, 2–3 times, 4–6 times, 7–10 times or 11+ times) and summed (using the midpoints for each category with a range and 11 for the '11+ times' category) to determine total consumption. The final outcome was recategorised to: 1) never eaten over the past month; 2) eaten one to three times over the last month (infrequent); 3) eaten four or more times over the last month (frequent).

Food environment data collection

Food environment data was collected during the same time period as the individual surveys. Trained fieldwork auditors collected information on the location and type of all food outlets that sell products that can be consumed off-site (for example, at home) within a 2-km Euclidean distance buffer around the geometric centroid[14] of the sampled CCDs. During data collection, store types were classified under 1 of 17 different categories and stores selling products solely for on-site consumption (for example, eat-in only restaurants) were not included. The fieldwork data resulted in the collection of the address and store type for 5062 food outlets in the buffers surrounding the 50 areas (4221 in the 49 included CCDs).

Creation of the food environment score (FES)

A FES was calculated for each of the 49 areas by weighting stores from more to less healthy on a scale of +10 (healthiest) to −10 (unhealthiest) and summing these weights. The weighting for each store type were created through consultation with eight academic researchers (based in Australia and internationally) who were invited to participate via email. These participants were identified as being key researchers (post-PhD) in the food environment field and were identified using a combination of literature reviews on relevant topics, internet searches and our knowledge of the field.

The researchers were asked to rate stores from +10 (shop type that may encourage healthy dietary behaviour among local residents) to −10 (shop type that may encourage unhealthy dietary behaviours among local residents). The key reasons for using negative and positive numbers was that this would differentiate between stores considered either healthy or unhealthy and we would be able to distinguish if there were areas with more unhealthy rather than healthy options. When scoring, the researchers were asked to keep in mind factors such as: (1) the proportion of healthy vs unhealthy food items that the store type may have available; (2) likely opening hours (as a reflection of accessibility); (3) whether the shop type may have drive-through or home delivery (takeaway or groceries); (4) the potential health benefits/risks of having this store type in the community.

Based on the initial scores received, a set of summary statistics for each store type were created and the researchers were given the option to change any of their original scores. Three participants altered their scores slightly at this stage. Given the expertise of the researchers, we are confident that the use of this methodology was a robust approach to devising the weighting that should be applied to the stores. Final scores are presented in Table 1.

Calculating the FES for areas. The mean scores for each store type were then used for to create variables related to healthy and unhealthy food

Table.1. Description of food stores and the food environment score allocated to each store type

Final score (mean, (s.d.))	*Store type*
Healthy food stores	
8.8 (2.1)	*Fruit and vegetable market* These may be large or small local markets selling fresh fruit and vegetables. May only be open a few days a week.
8.8 (2.1)	*Fruit and vegetable store* A greengrocer store that sells fresh fruit and vegetables. More likely every day of the week and for longer hours than a market.
8.5 (1.8)	*Fish* Sells fresh fish and other seafood products.
6.3 (2.9)	*Supermarket—large chain* A supermarket with six or more checkouts. Sells fresh fruit and vegetables. Has long opening hours.
6.0 (3.0)	*Poultry* Sells fresh poultry items only.
5.4 (3.2)	*Butcher* Conventional butcher selling meat products only.
5.3 (2.5)	*Ethnic* Generally cater to a specific ethnic group and may vary in the type of products sold e.g. Asian groceries or Indian spice store.
5.0 (2.5)	*Bakery—bread only* A bakery that sells bread items only
4.9 (2.7)	*Supermarket—mid* A mid-sized/ possibly independent supermarket that has between three and five checkouts. Sells fresh fruit and vegetables. May have reduced opening hours.
4.4 (2.4)	*Deli* Sells conventional deli items.
4.3 (3.3)	*Health* Specialises in health food products.
4.3 (2.9)	*Convenience food store (fresh)—small* A smaller milkbar style store with two or fewer checkouts. Stocks fresh fruit and vegetables.
3.3 (3.5)	*Supermarket—discount* A supermarket selling cheaper, discount items e.g. Not Quite Right
0.8 (1.9)	*Bakery—mixed* A bakery that sells bread as well as cake, pastries etc.
Unhealthy food stores	
−1.1 (4.1)	*Convenience food store (non-fresh)—small* A smaller milkbar style store with two or fewer checkouts. Does not sell fresh fruit and vegetables.
−1.1 (2.3)	*Takeaway—food court* Any takeaway food outlet located within a food court. This is categorised separately, as their location inside a major shopping centre or similar would mean that it is less likely to be accessed by local residents when purchasing food products for home consumption.
−1.6 (2.4)	*Takeaway—other* Other takeaway outlets such as roast chicken, Asian/Indian takeaway or cafes where food is purchased for home consumption.
−5.0 (0.9)	*Takeaway—minor* Smaller takeaway food outlets that are still prominent within the community—includes Subway well as other pizza and fish and chip stores.
−5.0 (3.6)	*Other* Miscellaneous food stores (e.g. lollies, ice-cream).
−8.3 (1.6)	*Takeaway—major* Major franchised fast food stores not located within a food court (Red Rooster; McDonald's; KFC; Hungry Jacks/Burger King; Pizza Hut).

access. The steps involved in calculating the final healthy and unhealthy FES for areas were:

(1) Categorise stores as either healthy (positive score) (for example, supermarket—large chain) or unhealthy (negative score) (for example, takeaway—major).
(2) For each shop category, the number of stores within a buffer were multiplied by the score it was allocated. For example, if two large supermarkets were within the buffer, then these would contribute 12.6 to the healthy FES (2×6.3).
(3) The multiplied values for each of the healthy stores were added together to create the healthy FES. The same process was applied to unhealthy stores to create the unhealthy FES and these negative values were transformed to positive values for the analysis of the unhealthy food scores.

Categorical (tertiles) variables were created for these scores because the distributions were positively skewed (Table 2). These tertiles indicated whether people had access to the highest, mid or least healthy and unhealthy food alternatives as determined by the FES. We also created binary measure, which indicated whether an area had higher unhealthy FES than healthy FES.

Confounders

A number of potential confounders were adjusted for. These included age (18–24; 25–34; 35–44; 45–54; 55–64; 65 years or over); country of birth (Australia; overseas); the education (bachelor degree or higher; diploma; vocational; no post-school qualifications) and occupation (professional; white-collar; blue-collar; not in labour force) of the main household food shopper; household composition (single adult male—no children; single female adult—no children; single adult—with children; two or more adults—no children; two or more adults—with children), household income (A$78 000 or more; $52 000–$77 999; $36 400–$51 999; $20 800–$36 399; $20 799 or less) and area-level disadvantage (described above in sampling).

Statistical analysis

Data imputation. Ten data sets were generated with imputed values for missing individual-level items (including income (35% missing)). By undertaking the imputation multiple times, confidence in the precision of estimates has been increased. Data were estimated under the Missing At Random (MAR) assumption[15] using the user-written command Imputation by Chained Equations (ICE) (P Royston) in Stata 10.1.[16] Further details of this approach are published elsewhere.[17]

Descriptive analysis. Cross-tabulations with chi-square tests were used to assess whether those living in each of the healthy and unhealthy FES tertiles differed significantly by fast food purchasing frequency. All descriptive analyses were conducted within Stata 10.1.[16]

Multilevel analysis. Multilevel multinomial regression was used to estimate the effects of the food environment on fast food purchasing across the ten imputed data sets. This was undertaken in Stata 10.1 using the GLLAMM function prefixed by the user-written 'mim' command (created by JC Galati, P Royston, and JB Carlin) which allowed for analysis to be undertaken across multiple data sets.

Analytical models were fitted to determine associations between household fast food purchasing and the local food environment using the following exposures: (1) healthy FES; (2) unhealthy FES; (3) healthy and unhealthy FES simultaneously; (4) binary measure to indicate areas that had a higher unhealthy FES than healthy FES. We included both the healthy and unhealthy FES simultaneously so that the effect of the healthy FES could be determined controlling for the unhealthy FES and vice versa. Results are presented as the odds of purchasing either infrequently or frequently compared with the base category of never purchased. These reported results are for models that include all potential confounders.

Table 2. Descriptive statistics of the food environment score

	Median	*IQR*	*Minimum*	*Maximum*
Tertiles of healthy food environment score				
Lowest	60.3	42–68	19.5	75.7
Mid	112.3	94–123	84.0	187.7
Highest	256.9	236–309	201.7	355.2
Tertiles of unhealthy food environment score				
Lowest	54.5	37–74	29.1	85.2
Mid	139.4	107–145	85.5	156.0
Highest	184.5	164–204	158.5	261.9

RESULTS

Descriptive

Food environment score. The mean FES score for each store type is provided in Table 1. The participants that assisted with rating the stores scored fruit and vegetable markets (+8.8), fruit and vegetable stores (+8.8) and stores selling fresh fish and seafood (+8.5) as healthier than large chain supermarkets. Mid-size (+4.9), small (convenience) (+4.3) and discount supermarkets (+3.3) all scored lower but were all still considered healthy. Convenience stores (−1.1) that did not stock any fresh produce were considered unhealthy. All takeaway store types were scored as unhealthy with major franchised fast food (−8.3) considered the unhealthiest.

FES tertiles and fast food purchasing frequency. A higher percentage of respondents living in the highest healthy FES tertile or the unhealthy FES tertile reported never purchasing fast food (64% and 59%, respectively) (Table 3). For both the healthy and unhealthy FES, the highest percentage of those reporting frequent fast food purchases lived in the mid tertiles (12% and 11%, respectively). A higher percentage of those living in areas with a higher healthy than unhealthy FES reported never purchasing fast food (59%), whereas infrequent purchasing was more common in area with a higher unhealthy FES (37%).

Multilevel multinomial regression

Respondents living in areas exposed to the highest tertile of the healthy FES had a lower likelihood of purchasing fast food both

Table 3. Frequency of respondents in each exposure category by fast food purchasing frequency

	Never	*Infrequent*	*Frequent*	P
	<1 per month	*1–3 per month*	*4+ per month*	
	n. 1422	*n. 872*	*n. 253*	
	%	*%*	*%*	
	55.8	34.2	9.9	
Tertiles of healthy FES				
Lowest	52.1	37.4	10.5	
Mid	52.3	35.5	12.2	
Highest	63.7	29.2	7.1	<0.001
Tertiles of unhealthy FES				
Lowest	56.4	33.9	9.7	
Mid	52.3	36.5	11.2	
Highest	59.4	31.9	8.7	0.059
Binary measure of FES				
Higher healthy FES	59.0	31.6	9.4	
Higher unhealthy FES	52.5	37.0	10.5	0.004

Abbreviation: FES, food environment score.

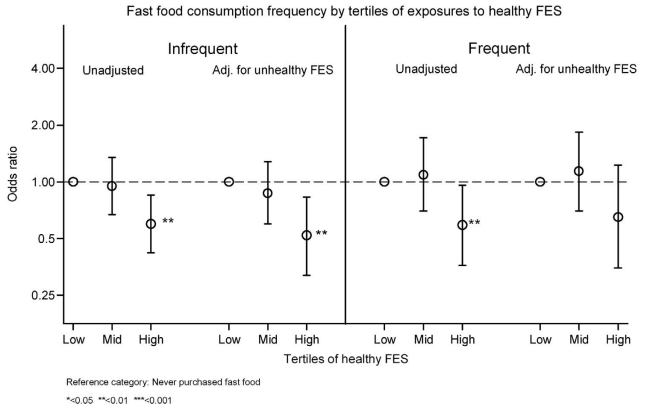

Figure 1. Multilevel multinomial regression of association between fast food purchasing frequency and the healthy FES.

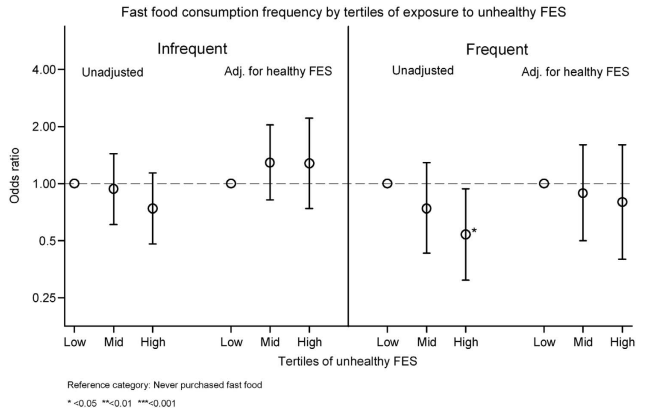

Figure 2. Multilevel multinomial regression of association between fast food purchasing frequency and the unhealthy FES.

Table 4. Multilevel multinomial regression of association between fast food purchasing frequency and living in an area with a higher unhealthy than healthy food environment score

	Infrequent fast food purchasing		*Frequent fast food purchasing*	
	OR	*(95% CI)*	*OR*	*(95% CI)*
Higher healthy FES	1.00	—	1.00	—
Higher unhealthy FES	1.35	(1.00, 1.82)*	1.04	(0.71, 1.52)

Abbreviations: CI, confidence interval; FES, food environment score; OR, odds ratio. Reference group: never eat fast food. Adjusted for age, country of birth, household composition, education, occupation, household income and area-level disadvantage. *$P \leqslant 0.05$ level.

infrequently (odds ratio (OR) 0.60; 95% confidence interval (CI) 0.42–0.85) and frequently (OR 0.59; 95% CI 0.36–0.96) compared with respondents who never purchased fast food (Figure 1). When the unhealthy FES was added to the model, the odds for infrequent purchasing further decreased (OR 0.52; 95% CI 0.32–0.83), whereas the association for frequent purchasing was no longer statistically significant.

Those living in areas with the highest tertile of unhealthy FES had half the odds of purchasing fast food frequently (OR 0.54; 95% CI 0.31–0.94) (Figure 2). When the healthy FES was included in models, the relationship was attenuated and no evidence remained to support an association. No significant effects were reported for infrequent purchasing.

Respondents living in areas with a higher unhealthy FES than healthy FES were more likely to purchase fast food infrequently (OR 1.35; 95% CI 1.00–1.82), however no association was found for frequent purchasing (Table 4).

DISCUSSION

Our study provides some evidence to support an association between the food environment and fast food purchasing. In areas that that were in the highest tertile of the healthy FES, both infrequent and frequent fast food purchasing was less likely though this was only the case for infrequent purchasing after including the unhealthy FES in the analytical models. Surprisingly, frequent purchase of fast food was also less likely in those areas that were in the highest tertile of the unhealthy food scores, however this relationship did not remain significant after adjustment for the healthy FES. It is possible that because 73% of those in the highest healthy FES tertile also lived in the highest unhealthy FES tertile that it was difficult to distinguish the independent effect of the healthy and unhealthy FES. However, we did find that those living in areas that had a higher unhealthy FES than healthy FES were more likely to purchase fast food infrequently (compared with never), although there was no evidence to support an association for frequent purchasing.

The novel approach we used to create the FES allowed us to weight all food stores by their potential contribution to either healthy or unhealthy dietary behaviours rather than providing a simple count of stores. This is an important distinction as, for example, smaller grocers are unlikely to have the equivocal positive influences on food purchasing behaviours as large chain supermarkets. Some researchers commented on the rationale for the weightings they used. For example, it was commented on by one participant that supermarkets were not considered the healthiest food stores to have access to because of the large amount of unhealthy food items they also stocked (for example, crisps, confectionery, soft drinks). This is an important consideration to make, as large supermarkets are often only recognised for stocking large amounts of fresh produce and other healthy foods such as low-fat alternatives and have longer opening hours than other store types thus making them more accessible to people with time constraints. Recent evidence on the high amounts of unhealthy snack food items present in Melbourne supermarkets supports this approach.[18]

Fast food purchasing as a function of the whole food environment is a largely unexplored topic and few examples exist of studies that have attempted to include multiple food store types, irrespective of the behavioural or health outcome of interest. Our classification of stores is largely consistent with a prior study conducted by Rundle *et al.*[9] In their study, they classified both supermarkets and fruit and vegetable stores as healthy food stores, whereas fast food outlets and convenience stores (our equivalent being 'convenience food store non-fresh') were considered unhealthy. Importantly, they also categorised a multitude of other food store types in their exposure measure (natural/health food stores, other (non-fast-food) restaurants, medium-sized grocery stores, fish markets, specialty food stores, pizza restaurants, bodegas, bakeries, candy and nut store, meat markets), although no weightings were applied.

The presence of healthy food outlets[9] and chain supermarkets[10] were previously found to be associated with a lower BMI and lower prevalence of obesity. Although those studies did not explore dietary outcomes, the findings suggest improving healthy food access may be as important as limiting unhealthy options. Additionally, prior research has also shown that having greater access to unhealthy food stores in the form of fast food outlets and convenience stores was associated with a lower consumption

of fruits and vegetables among children.[19] In this instance, the environment creates more opportunity to engage in unhealthy eating behaviours and therefore consumption of fruits and vegetable may suffer as a result. Although it is plausible to also suggest that when people are given healthy alternatives they may be more willing to make the healthier choice or that the opportunities to purchase healthy foods may mean a lower reliance on the convenience that unhealthy fast foods offer, our study provides only limited evidence to support this.

A major strength of this analysis is the inclusion of a comprehensive list of both healthy and unhealthy food stores to represent the full range of food choices available to local residents. Importantly, we also created a system whereby stores were weighted by their potential contribution to healthy and unhealthy dietary behaviours (based on the opinions of experts in the field) and not simply counted. This means of representation is more indicative of the true amount of healthy and unhealthy foods they have access to than a measure that simply considers the presence of either a fruit and vegetable store or a bakery as providing an equal contribution to food choices. Furthermore, we were able to differentiate between larger and smaller supermarkets based on the number of cash registers within a store; a method that has been used by others to define store size.[20] However, we acknowledge that the analysis contained some limitations that must be considered. First, although our approach to creating the scores based on the ratings of experts is a novel approach, the number of researchers involved in this process was small. Second, a more objective score could be created using within-store audits. Third, the current scoring method does not provide any flexibility to provide different scores to stores within the same category (that is, all large supermarkets are scored the same despite previous evidence demonstrating differences within supermarket environments).[18,21,22] Our outcome measure only included fast food consumed at home, which is likely to be an underestimate of total consumption. The fact that we only explored the food environment around home underestimates exposure to the range of environments an individual would interact with. Although we do not capture all consumption and exposures, prior research has shown that over a week, 62% participants in a US study reported eating fast food within 1 mile of their home within a week,[23] thus it is plausible our measure captures a reasonable proportion of total fast food consumption and food store exposures. Further, given our outcome measure is based on fast food consumed at home, we believe this increases the likelihood that it was purchased nearby to their household location.

Future studies could explore how the role of food environment, as measured by the FES, impacts on a wider range of dietary outcomes, such as fruit and vegetable consumption, or on the consumption of more nutritious low-fat/high-fibre alternatives of core food products, such as bread and milk, compared with the regular options. It is also important to note that the choice of stores used for this Melbourne-based study may not be applicable to other contexts. This may have contributed to the large s.d. for some store types where researchers from different nations viewed the role of these stores differently. Further research is needed to quantify the potential dietary impact of different store types and this approach would benefit from objective measures on the within-store environment.

CONCLUSION

This study benefited from the inclusion of a wide range of both healthy and unhealthy food stores as predictors and the weighting of stores based on a score created with the input of leading researchers. Although the present study provides only limited evidence of the potential positive effect of healthy food store access in reducing fast food purchasing frequency, scope is provided for future research to explore this topic in more detail. Generating such evidence will assist planners who may want to consider placing a larger emphasis on healthy food access as an alternate approach to reducing the likelihood of high unhealthy food consumption rather than simply concentrating on reducing access to unhealthy stores.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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DISCLAIMER

This paper was undertaken independently of any influence by the funding sources.

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