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The contextual effects of neighbourhood access to supermarkets and convenience stores on individual fruit and vegetable consumption

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ABSTRACT

Background: It is often suggested that neighbourhood access to food retailers affects the dietary patterns of local residents, but this hypothesis has not been adequately researched. We examine the association between neighbourhood accessibility to supermarkets and convenience stores and individuals' consumption of fruit and vegetables in New Zealand.

Methods: Using geographical information systems, travel times from the population-weighted centroid of each neighbourhood to the closest supermarket and convenience store were calculated for 38 350 neighbourhoods. These neighbourhood measures of accessibility were appended to the 2002–3 New Zealand Health Survey of 12 529 adults.

Results: The consumption of the recommended daily intake of fruit was not associated with living in a neighbourhood with better access to supermarkets or convenience stores. Similarly, access to supermarkets was not related to vegetable intake. However, individuals in the quartile of neighbourhoods with the best access to convenience stores had 25% (OR 0.75, 95% CI 0.60% to 0.93%) lower odds of eating the recommended vegetable intake compared to individuals in the base category (worst access).

Conclusion: This study found little evidence that poor locational access to food retail provision is associated with lower fruit and vegetable consumption. However, before rejecting the commonsense notion that neighbourhood access to fruit and vegetables affects personal consumption, research that measures fruit and vegetable access more precisely and directly is required.

The relation between fruit and vegetable consumption and health is well established with higher levels of fruit and vegetable intake associated with a lower incidence of a range of health outcomes including certain types of cancer,[1 2] ischaemic stroke[3] and heart disease.[4 5] People in higher socioeconomic positions tend to consume or procure more fruit and vegetables.[6–14]

The explanations for patterns of dietary choices are related to a number of factors including awareness of the causative and preventative effects, preparation knowledge and the cost and availability of different types of food.[15–20] While there has been a considerable focus on individual factors affecting dietary choices, there has been less attention to the environmental or contextual explanations for dietary patterns,[21–23] particularly the impact of availability or neighbourhood access to shops selling healthy and nutritious food.[24] The evidence from the United States suggests that worse access to food shopping facilities has a deleterious impact on diets.[24–26] However, studies in the United Kingdom that have examined the effect of introducing new food retail developments on the fruit and vegetable consumption of those living in the local vicinity have produced mixed findings.[27–29]

This study examines the association between travel time access to supermarkets and convenience stores, and adherence to the recommended consumption of fruit and vegetables in New Zealand.

METHODS

Data on the addresses of each supermarket (larger stores selling a wide range of lower priced products) and local convenience store (locally operated smaller outlets selling a narrower range of often higher priced products) were collected from all 74 territorial authorities (TAs) across New Zealand. TAs have regulatory responsibility for the hygiene inspection of all premises in their region used in the manufacture, preparation or storage of food for sale. To allow the food outlet data to be geocoded, information was requested on the street address. There were a total of 661 supermarkets and 3681 convenience stores. Geographical access to supermarkets and convenience stores was calculated separately for all 38 350 census meshblocks (average population 100), or what we refer to as "neighbourhoods." Each neighbourhood was represented by its population-weighted centroid and the travel time taken to the nearest supermarket and convenience store along the road network was calculated using the network functionality in a geographical information system (GIS). All segments in the road system were adjusted to account for variations in speed limits, type of road surface, sinuosity and differences in the topography across the network. Full details of the GIS methods are documented elsewhere.[30]

The 2002–3 New Zealand Health Survey (NZHS) is a national survey of the health status of 12 529 adults aged 15+ (target population 2.6 million) posing a range of questions including fruit and vegetable consumption.[31] Respondents were asked two nutrition-related questions on their average daily servings of fruit and vegetables. Fruit included fresh, frozen, canned or stewed fruit but not fruit juice or dried fruit. Vegetables included fresh, frozen or canned vegetables but not vegetable juices. For each respondent, two dichotomous outcome variables were developed: consuming the recommended two servings of fruit per day, and three servings of vegetables. The

neighbourhood measures of food retail access were divided into quartiles (for confidentiality reasons) and appended to each respondent in the survey. The 12 529 respondents were distributed across 1178 meshblock neighbourhoods and there were between one and 83 respondents per neighbourhood although in most neighbourhoods the total number of respondents was less than 20.

Two-level logistic regression models with a random intercept were fitted in the multilevel software package MLWin (version 2.0) using second order penalised quasi-likelihood (PQL) estimation methods. Variables were added in four stages. Firstly, we included design variables to account for the sample stratification and oversampling of ethnic minorities. Sex and age were also included in all models. Secondly, individual-level socioeconomic variables were added. The socioeconomic variables included education (none, school, post-school), social class (professional/managerial, other non-manual, skilled manual, semi-skilled and unskilled manual), benefits receipt (recipient or not), employment status (employed or unemployed) and household income (<$25k, $25–50k, >$50k). Two potential ecological confounders (at the neighbourhood level) were added in the third and fourth stages: area deprivation measured using the 2001 New Zealand Deprivation Index (NZDep 2001)[32] divided into quintiles and the five-level 2001 Urban Area Classification (main urban area, secondary urban area, minor urban area, rural centre and rural area).[33] All neighbourhood variables were included as categorical variables to satisfy confidentiality requirements. Potential individual socioeconomic and ecological confounders were selected a priori for model building. To ensure best model fit, variables were only retained where they reached $p<0.05$ (using the Wald statistic). Potential interactions between the main effects (access to supermarkets and convenience stores) and all other socioeconomic and ecological variables were also examined.

RESULTS

We found that consumption of the recommended daily intake of fruit was not associated with neighbourhood access to supermarkets or convenience stores (table 1). Any modest association of neighbourhood supermarket and convenience store access with fruit consumption in baseline models (odds ratios (OR) of 0.93 and 0.88, respectively, for the best versus worst access quartiles) moved closer to or beyond the null in the fully adjusted models (ORs 1.06 and 0.92, respectively) and nearly all 95% confidence intervals included 1.0. Moreover, there was no convincing dose-response relation.

Similarly, the consumption of the recommended daily intake of vegetables was not associated with better access to supermarkets (models 9–12). However, there was a moderate association between access to convenience stores and vegetable consumption. Once adjusted for individual SES plus neighbourhood deprivation and rurality (model 16, table 1), the quartile of neighbourhoods with the best access to convenience stores had a 25% (OR 0.75, 95% CI 0.60% to 0.93%) lower odds of eating the recommended vegetable intake compared to neighbourhoods with the worst access. None of the interaction effects between access to convenience stores and any of the socioeconomic variables were significant.

Table 1 Odds ratios of eating recommended fruit and vegetables (95% confidence intervals) and random variance estimates predicted from access to supermarkets and food shops

	Stage 1*	Stage 2†	Stage 3‡	Stage 4§
	Baseline	**Individual SES**	**NZDep**	**Urban/rural**
Recommended fruit				
Access to supermarkets	Model 1	Model 2	Model 3	Model 4
Best (0.06–1.89 minutes)	0.93 (0.81 to 1.07)	0.95 (0.83 to 1.09)	1.02 (0.89 to 1.17)	1.06 (0.89 to 1.27)
Better (1.89–3.22 minutes)	0.96 (0.84 to 1.10)	0.97 (0.85 to 1.11)	1.02 (0.89 to 1.17)	1.05 (0.88 to 1.25)
Worse (3.23–6.54 minutes)	1.03 (0.90 to 1.18)	1.02 (0.89 to 1.17)	1.05 (0.92 to 1.21)	1.08 (0.91 to 1.29)
Worst (6.54+ minutes)	1	1	1	1
Level 2 variance (SE)	0.18 (0.02)	0.17 (0.02)	0.16 (0.02)	0.16 (0.02)
Access to convenience stores	Model 5	Model 6	Model 7	Model 8
Best (0.05–0.98 minutes)	0.88 (0.77 to 1.01)	0.90 (0.78 to 1.03)	0.96 (0.83 to 1.11)	0.92 (0.77 to 1.10)
Better (0.98–1.65 minutes)	0.83 (0.72 to 0.95)	0.84 (0.73 to 0.97)	0.89 (0.77 to 1.02)	0.85 (0.72 to 1.02)
Worse (1.65–3.89 minutes)	0.95 (0.83 to 1.09)	0.96 (0.84 to 1.10)	0.98 (0.85 to 1.12)	0.95 (0.80 to 1.12)
Worst (3.89+ minutes)	1	1	1	1
Level 2 variance (SE)	0.17 (0.02)	0.16 (0.02)	0.16 (0.02)	0.16 (0.02)
Recommended vegetables				
Access to supermarkets	Model 9	Model 10	Model 11	Model 12
Best (0.06–1.89 minutes)	0.88 (0.73 to 1.05)	0.89 (0.74 to 1.06)	0.93 (0.77 to 1.11)	0.99 (0.79 to 1.24)
Better (1.89–3.22 minutes)	0.85 (0.71 to 1.01)	0.86 (0.72 to 1.02)	0.88 (0.74 to 1.05)	0.99 (0.79 to 1.23)
Worse (3.23–6.54 minutes)	0.95 (0.80 to 1.13)	0.95 (0.80 to 1.13)	0.97 (0.81 to 1.16)	1.10 (0.89 to 1.37)
Worst (6.54+ minutes)	1	1	1	1
Level 2 variance (SE)	0.41 (0.04)	0.41 (0.04)	0.40 (0.04)	0.37 (0.04)
Access to convenience stores	Model 13	Model 14	Model 15	Model 16
Best (0.05–0.98 minutes)	0.69 (0.58 to 0.82)	0.70 (0.58 to 0.83)	0.71 (0.59 to 0.85)	0.75 (0.60 to 0.93)
Better (0.98–1.65 minutes)	0.75 (0.63 to 0.90)	0.76 (0.63 to 0.91)	0.77 (0.64 to 0.92)	0.80 (0.64 to 0.99)
Worse (1.65–3.89 minutes)	0.87 (0.73 to 1.04)	0.87 (0.73 to 1.04)	0.88 (0.74 to 1.05)	0.89 (0.72 to 1.10)
Worst (3.89+ minutes)	1	1	1	1
Level 2 variance (SE)	0.41 (0.04)	0.40 (0.04)	0.40 (0.04)	0.38 (0.04)

*Models include individual-level design, sex and age variables.
†Individual-level socioeconomic variables (education, social class, benefits receipts employment status and household income) included in models containing design, sex and age variables.
‡Neighbourhood-level deprivation included in models containing individual-level design, sex, age and socioeconomic variables.
§Neighbourhood-level urban area classification included in models containing neighbourhood-level deprivation and individual-level design, sex, age and socioeconomic variables.

What is already known on this subject

- Higher levels of fruit and vegetable intake are associated with a lower incidence of a range of health outcomes.
- Dietary intake, including the consumption of fruit and vegetables, is strongly patterned by socioeconomic circumstances with people on higher incomes, higher educational attainment and living in areas of low social deprivation tending to consume or procure more fruit and vegetables.
- Neighbourhood access to shops selling fruit and vegetables has been suggested as one explanation for the social gradient in fruit and vegetable consumption.

What this study adds

This paper adds to the understanding of contextual explanations for dietary patterns. We found little evidence that poor locational access to food retail provision is associated with lower fruit and vegetable consumption. More precise measurement of fruit and vegetable access and purchasing behaviour is required.

Policy implications

The findings of this analysis suggest that improving neighbourhood access to supermarkets and convenience stores alone may not improve fruit and vegetable consumption in New Zealand.

DISCUSSION

This study presents the results of the first national study, to our knowledge, of the effects of the neighbourhood food environment upon diet. We found no evidence for an association between neighbourhood access to supermarkets or convenience stores and the consumption of fruit, and no association of supermarket access and vegetable consumption. However, better access to convenience stores was associated with lower vegetable consumption. What might have produced this last finding? Firstly, statistical chance is possible. Secondly, convenience stores may actually be a better proxy for access to poor dietary foods, such as high fat and high sugar ready-to-eat foods and drinks. Convenience stores in New Zealand do not always provide a range of low-cost fresh food options (including vegetables). Unfortunately, we did not have sufficient resolution in our datasets to identify fresh fruit and vegetable stores separately.

This study has limitations. Firstly, we have not considered obstacles other than geographic access—for example, financial barriers. Secondly, we measure access to the nearest facility but not access to fruit and vegetables per se. As such our exposure variable is only a proxy for geographic access to fruit and vegetables, and it may be that a more specific measure would have disclosed an association in the expected direction. Thirdly, without information on shopping habits there is no validation that people actually purchase food from their closest supermarket and/or convenience store. Fourthly, other aspects of the food environment such as the availability of fast foods or homegrown fruit and vegetables that may influence food choice were not measured. Finally, the differences in travel time between each quartile are not large, suggesting that few neighbourhoods in New Zealand have substantial distances to travel to a food store.

Limitations acknowledged, our results suggest that neighbourhood access to supermarkets and convenience stores alone does not seem to be an explanation for food consumption patterns in New Zealand. These results are consistent with some UK work which found that the improved neighbourhood access to food retailing had little effect upon the diet of the local residents.[27] However, our findings do not support other UK studies[28] and those in the United States where research has tended to show that poorer access to food retail opportunities has a detrimental effect upon diet,[24 25] including fruit and vegetable consumption.[26] A more nuanced investigation of the barriers to access, to purchase and to the consumption of fruit and vegetable is needed to explain the observed social patterns of fruit and vegetable consumption in New Zealand.

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