Neighborhood Deprivation and Access to Fast-Food Retailing
A National Study

Jamie Pearce, PhD, Tony Blakely, PhD, Karen Witten, PhD, Phil Bartie, MSc

Background: Obesogenic environments may be an important contextual explanation for the growing obesity epidemic, including its unequal social distribution. The objective of this study was to determine whether geographic access to fast-food outlets varied by neighborhood deprivation and school socioeconomic ranking, and whether any such associations differed to those for access to healthier food outlets.

Methods: Data were collected on the location of fast-food outlets, supermarkets, and convenience stores across New Zealand. The data were geocoded and geographic information systems used to calculate travel distances from each census meshblock (i.e., neighborhood), and each school, to the closest fast-food outlet. Median travel distances are reported by a census-based index of socioeconomic deprivation for each neighborhood, and by a Ministry of Education measure of socioeconomic circumstances for each school. Analyses were repeated for outlets selling healthy food to allow comparisons.

Results: At the national level, statistically significant negative associations were found between neighborhood access to the nearest fast-food outlet and neighborhood deprivation ($p<0.001$) for both multinational fast-food outlets and locally operated outlets. The travel distances to both types of fast food outlet were at least twice as far in the least socially deprived neighborhoods compared to the most deprived neighborhoods. A similar pattern was found for outlets selling healthy food such as supermarkets and smaller food outlets ($p<0.001$). These relationships were broadly linear with travel distances tending to be shorter in more-deprived neighborhoods.

Conclusions: There is a strong association between neighborhood deprivation and geographic access to fast food outlets in New Zealand, which may contribute to the understanding of environmental causes of obesity. However, outlets potentially selling healthy food (e.g., supermarkets) are patterned by deprivation in a similar way. These findings highlight the importance of considering all aspects of the food environment (healthy and unhealthy) when developing environmental strategies to address the obesity epidemic.
(Am J Prev Med 2007;32(5):375–382) © 2007 American Journal of Preventive Medicine

Introduction

The increasing prevalence of obesity in many countries has generated considerable concern about health burdens. For example, it has been estimated that 64% of Americans are overweight (34%) or obese (30%),[1] causing somewhere between about 100,000[2] and 300,000[3] deaths per year, rivaling smoking as a public health issue.[4] The emergence of this "obesity epidemic" has been linked to a range of health outcomes including rising rates of heart disease, hypertension, various types of cancer, and non–insulin-dependent diabetes.[5] Further, a strong and growing social gradient in obesity has been noted, with higher rates among lower socioeconomic groups and for those living in areas of social disadvantage.[6–8] New Zealand is no exception to these trends, as the prevalence of obesity has doubled over the past 25 years.[9] Rates of obesity are twice as high in the most-deprived quintile of neighborhoods in New Zealand compared to the least-deprived quintile,[10] probably contributing to increasing social and geographic inequalities in health status.[11–14] While not an estimate of the independent contribution of overweight and obesity, it has been estimated that two of every five deaths in New Zealand are attributable to nutrition-related factors.[15] As a result, improving nutrition and reducing obesity are two of 13 priority objectives in the New Zealand Health Strategy.[16]

From the GeoHealth Laboratory, Department of Geography, University of Canterbury (Pearce, Bartie), Christchurch, Wellington School of Medicine and Health Sciences, University of Otago (Blakely), Wellington, and Centre for Social and Health Outcomes Research and Evaluation, Massey University (Witten), Auckland, New Zealand

Address correspondence and reprint requests to: Jamie Pearce, PhD, GeoHealth Laboratory, Department of Geography, University of Canterbury, Private Bag 4800, Christchurch 8020, New Zealand. E-mail: jamie.pearce@canterbury.ac.nz.

Explanations for increasing rates of obesity in areas of greater socioeconomic disadvantage are likely to be multifaceted and to include characteristics relating to individuals (composition) and those associated with the environment or neighborhood in which people live (context).[17,18] It has been suggested that contextual drivers may be more prevalent in deprived neighborhoods, resulting in neighborhoods that support unhealthy eating, or so-called "obeseogenic environments."[18,19] One possible contextual driver is a higher density of fast-food outlets in socially deprived neighborhoods.[20] For example, a cross-sectional analysis of the mean number of McDonald's restaurants per 1000 people in England and Wales demonstrated that there was greater outlet density in deprived neighborhoods.[21] Similarly, people living in the lowest-income communities in Melbourne, Australia, had 2.5 times the exposure to fast-food outlets than people living in the highest-income communities.[22] Other studies have focused on specific at-risk groups, particularly the young, as there is strong evidence that exposure to key risk factors early in life is a strong predictor of obesity patterns in adulthood.[23,24] Researchers have noted, for example, that fast-food outlets are often concentrated within short walking distances of primary and secondary schools.[25,26]

Although the relationship between area deprivation and the geographic access to fast-food outlets has received some attention, previous studies have often relied on definitions of neighborhoods predefined as administrative areas (often the census unit) for which data are easily available, and analyses have usually been focused on the presence or absence of an outlet in these arbitrary units.[27] Further, due to the difficulties of data collection, studies have usually been limited in scope and confined to small geographic areas such as cities rather than, for example, considering accessibility at a national level.[27] In this study, these previous limitations were addressed by adopting a geographic information systems (GIS) approach to provide a measure of location accessibility to fast food outlets in small areas throughout New Zealand. Access was calculated for both residential neighborhoods and for schools across the country. For comparison, and to examine the overall neighborhood "foodscape," access to other types of food outlets that potentially sell "healthier food" (including supermarkets and locally operated food shops) was also calculated. This is the first study in New Zealand and one of the first national studies anywhere to use GIS methods to examine accessibility to fast-food retailing by neighborhood socioeconomic status (SES).

Methods

Data on fast-food outlets were obtained from all 74 local Territorial Authorities (TAs) across New Zealand during the latter part of 2005. TAs have regulatory responsibility for safety inspections of all premises in respective regions used in the manufacture, preparation, and/or storage of food for sale. For each outlet, information was requested on the street address as well as its name. The data were verified using the online telephone directory (i.e., Yellow Pages)[28]; in cases of missing data or incomplete records, the data were supplemented with additional address information. The data were coded into two groups: multinational fast-food outlets (McDonald's, Burger King, Kentucky Fried Chicken, Pizza Hut, Subway, Domino's Pizzas, and Dunkin' Donuts), and the remaining locally operated outlets. A total of 2930 fast-food outlets in New Zealand were registered, of which 474 were multinational outlets. In addition, data on all outlets potentially selling healthier food were collected from the TAs. Healthier-food outlets included all supermarkets as well as locally operated convenience stores and service stations selling fresh food. All outlets were geocoded to provide a precise geographic coordinate of its location. Neighborhood access to outlets was linked to neighborhood and school-based measures of socioeconomic deprivation through the meshblock (i.e., neighborhood) geographic unit. Meshblocks compose the smallest unit of dissemination of census data in the New Zealand census; there are 38,350 meshblocks across the country, each representing approximately 100 people.

In the first stage of the analysis, GIS was used to calculate the distance (in meters) from each meshblock centroid to the closest fast-food facility. Each meshblock was represented by its population-weighted centroid (the center of population in the area rather than the geometric centroid), and the travel time taken to each community resource along the road network was calculated using GIS network functionality. In order to more accurately represent accessibility, it is important to use the distance between each meshblock and the location of each community resource through the road network to calculate total travel time rather than the Euclidean (straight-line) distance.[29] GIS has the advantage of not restricting the neighborhood measure of access to outlets in the immediate vicinity.[21,30] A full explanation of the adopted GIS methods is reported elsewhere.[31] The analysis was repeated independently for both multinational outlets and local vendors. The distance measure was used to calculate the median travel distances in neighborhoods stratified by neighborhood deprivation. Deprivation was measured by the 2001 New Zealand Deprivation Index (NZDep) calculated from census data on nine socioeconomic characteristics (car access, tenure, benefit receipt, unemployment, low income, telephone access, single-parent families, education, and living space).[32] All meshblocks in New Zealand were then assigned to a decile rank by this deprivation measure. In the second stage of the analysis, accessibility to fast-food restaurants was measured around each of the 2652 schools across the country. The distance from each school to the closest fast-food outlet as well as distances to multinational and local outlets were calculated. The median travel distance for schools grouped by the Ministry of Education's school socioeconomic decile rating is reported. (School decile ratings run in the reverse direction to NZDep ratings, that is, a decile-one school is located in an area of high deprivation, whereas a decile-one NZDep rating signifies a low-deprivation meshblock. For clarity in the interpretation of findings in this study, the school decile rating was reversed when reported in

the paper.) A school's decile rating reflects the socio-economic characteristics of the neighborhoods from which its pupils are drawn. The rating is based on census data pertaining to those neighborhoods on household income, occupation, household overcrowding, education, and income support in households with children.[33] Lunches are not provided in New Zealand schools. Pupils bring lunch from home, purchase food from food outlets in the vicinity of the school, or in some circumstances, from a food shop in the school.

For both sets of measures (neighborhood deprivation and school decile rating), results were also disaggregated by urban/rural status using Statistic New Zealand's New Zealand Urban–Rural Profile classification.[34] The index groups all meshblocks across the country into one of seven urban/rural categories ranging from major urban centre to highly rural areas, using the workplace address relative to the home address, which allows for economic and social ties between urban and rural areas to be incorporated into the classification. In this analysis, a dichotomous categorization was used that divided all neighborhoods into urban (highly urban, satellite urban, or independent urban) or rural (highly rural and rural areas with varying degrees of urban influence). To examine whether the results were explained by systematic differences in population density between deprived and non-deprived neighborhoods across the country, the analysis of the urban meshblocks was further stratified into areas of high, medium, and low population density. The relationship between access to fast-food outlets and neighborhood deprivation was examined separately for each population density group. In the final stage, a comparative analysis was under-taken for shops potentially selling healthy food (e.g., super-markets and convenience stores). Again the distances from each meshblock centroid and school to the nearest facility were calculated using a GIS. For each of these analyses, results were reported for deprivation/school deciles with the national median value and the one-way analysis of variance result presented.

Results

Median travel distance to the nearest fast-food outlet varied by neighborhood deprivation ($p<0.001$), with travel distance being at least twice as far (i.e., worse access) in the least-deprived compared to the most-deprived areas (Figure 1). The median distance to all types of fast-food outlets peaks in deprivation Decile 2 (1870 m), and then gradually decreases to its lowest value in Decile 9 (714 m), followed by a slight rise in decile 10 (742 m). A similar trend can be noted for both multinational and locally operated outlets with a statistically significant ($p<0.001$) negative association with decile of deprivation (better access in more-deprived neighborhoods), although in each decile the absolute travel distance to the less numerous multinational outlets is more than twice that of the locally operated outlets. When the analysis is disaggregated by urban/rural status, a similar statistically significant ($p<0.001$) pattern is noted in urban areas that numerically dominate the combined analysis (Table 1). How-
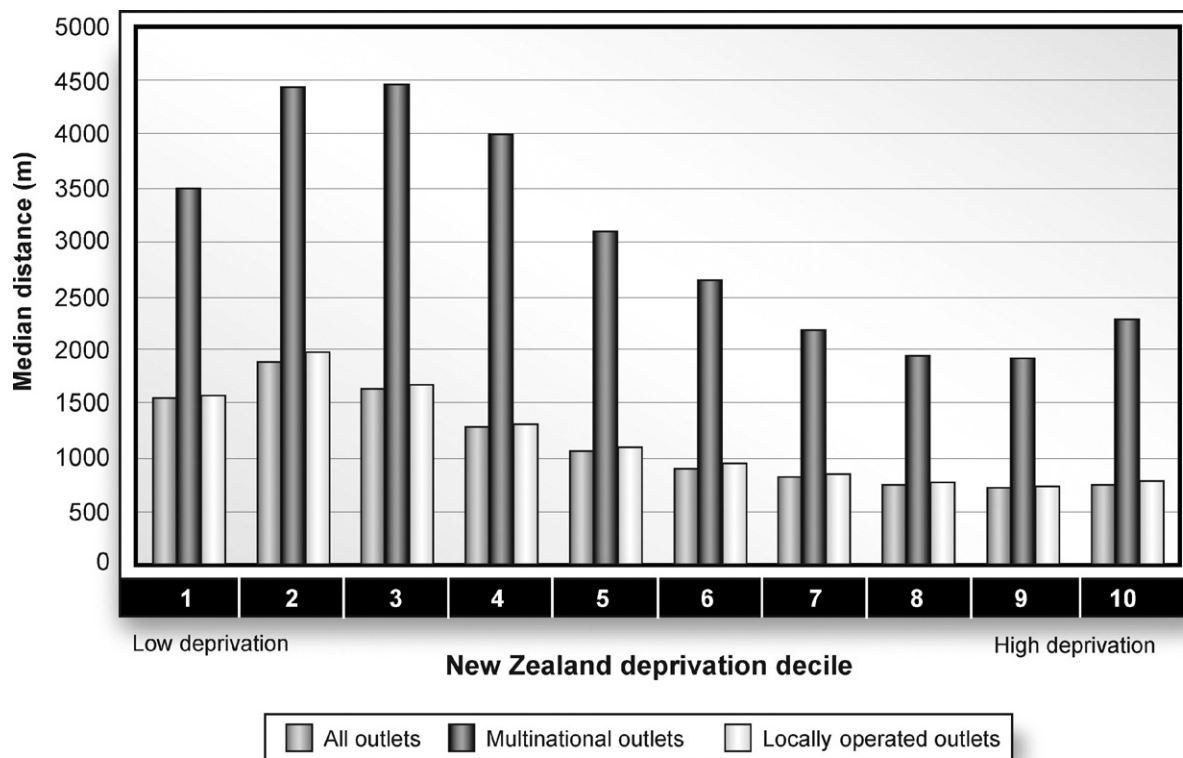
Figure 1. Median travel distance to closest fast-food outlet for New Zealand deprivation deciles. Median travel distances: all, 99 m; multinational, 2827 m; locally operated, 1025 m (analysis of variance, $p=0.000$).

Table 1. Median travel distance (meters) to closest fast-food outlet by neighborhood deprivation, stratified by urban/rural status

Decile	All fast food (n=37,760 neighborhoods)			Fast food, urban areas (n=28,992 neighborhoods)			Fast food, rural areas (n=8832 neighborhoods)		
	All	Multinational	Local	All	Multinational	Local	All	Multinational	Local
1 (low)	1545	3498	1576	1217	2726	1240	10,778	21,578	10,844
2	1870	4422	1950	1029	2564	1052	11,933	26,126	11,958
3	1629	4459	1661	982	2483	1006	11,314	27,175	11,314
4	1274	3978	1301	803	2112	821	12,300	32,958	12,321
5	1046	3076	1083	794	1965	813	13,028	32,225	13,033
6	892	2617	919	701	1797	717	12,576	33,647	12,606
7	806	2161	823	687	1739	707	14,775	38,775	14,775
8	735	1926	762	644	1590	670	10,995	36,184	11,024
9	714	1894	734	640	1622	664	16,462	35,168	16,462
10 (high)	742	2259	753	653	1870	665	21,630	43,987	21,630
Median	999	2827	1025	776	2004	795	12,594	31,310	12,617
p value (ANOVA)	**0.000***	**0.000***	**0.000***	**0.000***	**0.000***	**0.000***	**0.000***	**0.000***	**0.000***

*$p=0.000$ (bolded).
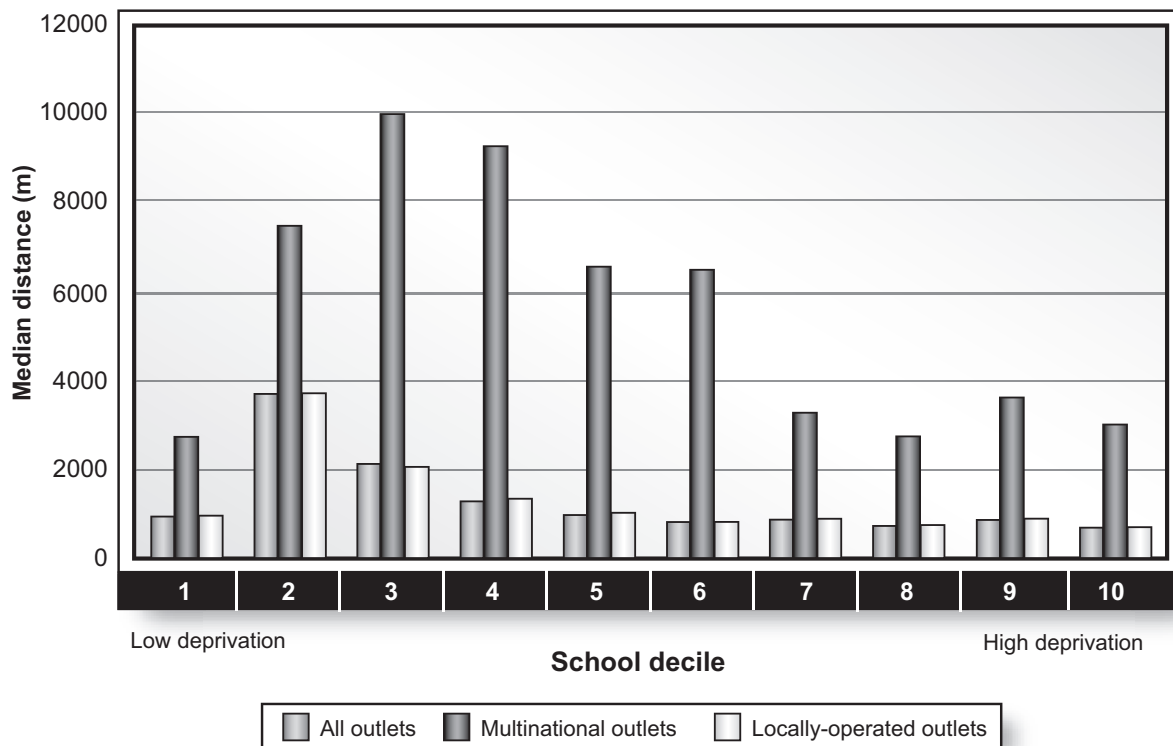ANOVA, analysis of variance.

ever, in rural areas (23% of all meshblocks) there is a statistically significant ($p<0.001$) positive pattern of access with greater distances to fast-food outlets in more-deprived areas, that is, the converse of the pattern found in urban areas. The results are not explained by systematic variations in population density between deprived and nondeprived neighborhoods. When the urban meshblocks are stratified by population density, the association between access to fast food outlets and neighborhood deprivation persists for low, medium, and high urban areas, although the strength of the relationship is stronger in low-density neighborhoods (Figure 2).

When distance is calculated to fast-food outlets from each school across the country, access similarly tends to be better around more-deprived schools (Deciles 7 to 10), for both multinational and local fast-food outlets (Figure 3). However, access to multinational fast-food
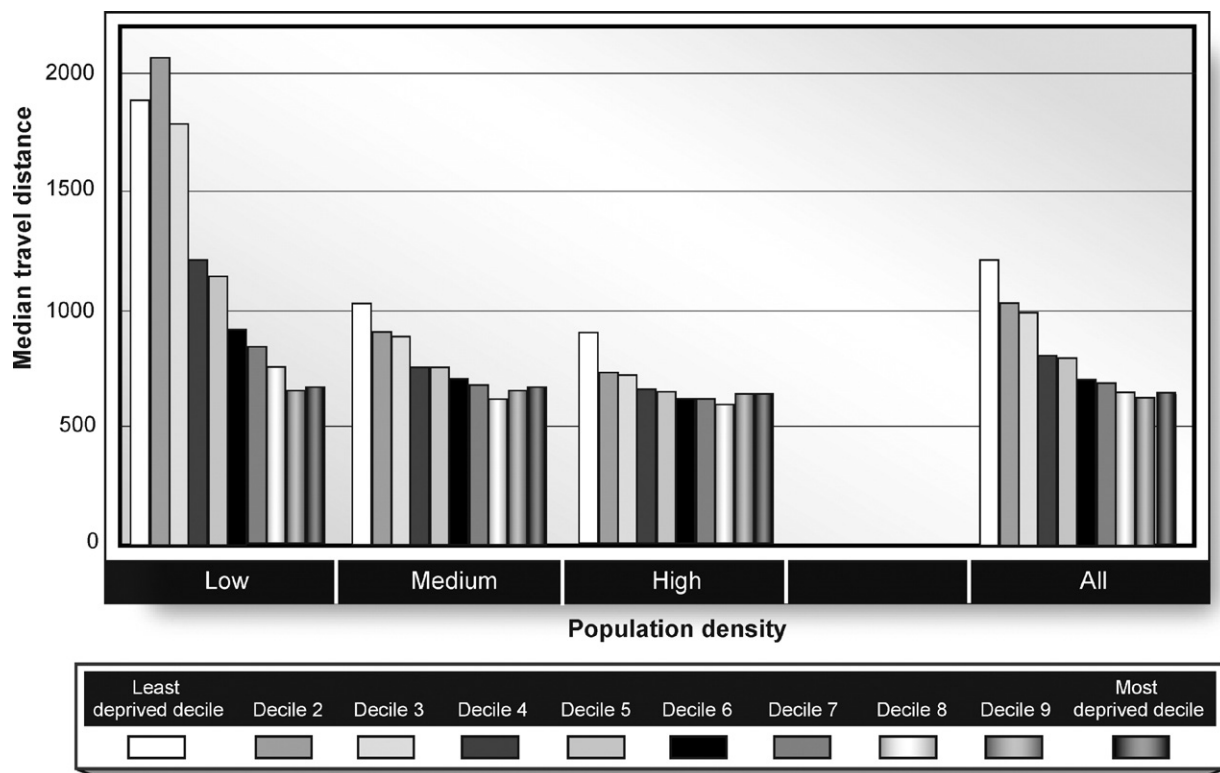
Figure 2. Median travel distance to closest fast-food outlet for New Zealand Deprivation Index (2001) deciles grouped by population density.

Figure 3. Median travel distance to closest fast-food outlet for school deciles. Median travel distances: all, 976 m; multinational, 3850 m; locally operated, 1002 m (analysis of variance, $p=0.000$).

outlets is also high in Decile 1 (lowest deprivation), but distance to the nearest outlet increases markedly in Deciles 2 and 3 followed by a gradual decrease in distances through to Decile 10 (high deprivation). The pattern for all outlets and locally operated outlets, while significant ($p<0.001$), is less pronounced with more equal median distances in Deciles 5 to 10. An examination of the pattern of access in urban and rural areas (Table 2) shows that in urban areas, travel distances tend to be slightly shorter in the more-deprived areas ($p<0.001$) for all types of outlets but that in

Decile 10 (most deprived) median travel distances to multinational fast-food outlets is considerably higher (2208 m) than in Deciles 5 to 9 (all <2000 m). In rural areas, however, median travel distances were the lowest for the schools in less-deprived neighborhoods, with distance tending to increase from Deciles 1 to 10 for all types of fast-food outlets.

The pattern of geographic access to food outlets potentially selling healthier food (supermarkets and other locally operated outlets) by neighborhood deprivation and school decile rating showed similar trends to

Table 2. Median travel distance (meters) to closest fast-food outlet by school socioeconomic decile ranking

Decile	**All fast food**			**Fast food (urban areas)**			**Fast food (rural areas)**		
	All	**Multinational**	**Local**	**All**	**Multinational**	**Local**	**All**	**Multinational**	**Local**
1 (low)	923	2744	925	747	1923	766	11,650	17,833	11,736
2	3688	7417	3688	766	2228	889	13,466	23,789	13,489
3	2061	9911	2061	593	2128	622	14,041	28,135	14,041
4	1302	9200	1308	637	2055	692	13,740	31,744	13,740
5	970	6523	981	663	1931	667	9,386	25,360	9,386
6	788	6378	804	559	1662	570	14,610	34,488	14,610
7	871	3245	890	677	1906	726	13,732	27,246	14,144
8	719	2724	720	603	1796	614	13,340	25,659	13,340
9	822	3633	872	567	1608	620	21,912	44,048	21,912
10 (high)	694	2960	713	597	2208	599	24,100	39,155	24,100
Median	976	3850	1002	637	1918	661	14,178	29,115	14,178
p value (ANOVA)	**0.000***	**0.000***	**0.000***	**0.000***	**0.000***	**0.000***	**0.000***	**0.000***	**0.000***

*$p=0.000$ (bolded).
ANOVA, analysis of variance.

Table 3. Median travel distance(meters) to closest "healthier food" outlets for New Zealand Deprivation (2001) deciles and school deciles

Decile	NZDep 2001 decile		School decile	
	Supermarkets	Other	Supermarkets	Other
1 (low)	2313	1343	1639	704
2	2772	1442	4417	1367
3	2410	1315	2660	1023
4	2129	1088	1805	761
5	1743	877	1786	678
6	1524	766	1327	603
7	1367	666	1280	573
8	1290	621	1413	559
9	1275	587	1575	508
10 (high)	1368	624	1491	544
Median	1696	834	1602	663
p value (ANOVA)	**0.000***	**0.000***	**0.000***	**0.000***

*$p=0.000$ (bolded).
ANOVA, analysis of variance; NZDep, New Zealand Deprivation Index.

those of the fast food outlets (Table 3). There was a significant negative relationship between neighborhood deprivation ($p<0.001$) and median distance to supermarkets and locally operated outlets, decreasing from 2313 m and 1343 m, respectively, in Decile 1, to 1368 m and 624 m, respectively, in Decile 10, with the highest value in Decile 2 (2772 m and 1442 m) and lowest in Decile 9 (1275 m and 587 m). Similar to the results for fast-food outlets, the results stratified by school decile rating show that there is a significant negative relationship with school decile ($p<0.001$); access to potentially healthier foods was better around the most-deprived schools with the exception of Decile 1 where the median distance was substantially lower than for Decile 2.

Discussion

Earlier studies have proposed environmental (contextual) explanations, including access to fast food outlets, for the rising rates and social gradient of obesity. The key finding of this study is that access to fast-food outlets in New Zealand is patterned by deprivation. At the national level, access to both multinational and locally operated fast-food outlets is better in more-deprived neighborhoods and around more socioeconomically disadvantaged schools, although the patterns are not linear. In isolation, these findings would support a contextual contribution to the social gradient in obesity rates. However, it was also found that geographic accessibility to other types of food outlets, particularly those selling "healthier" food including supermarkets and locally operated food shops, is patterned by deprivation in a similar way as to fast-food outlets. These findings highlight the importance of considering all aspects of the food environment when

evaluating environmental explanations for increasing obesity rates and before advocating environmental interventions.

These results are consistent with international evidence highlighting that fast-food restaurants tend to be more prevalent in more-deprived neighborhoods.[20–22,35] Studies in the United States,[35,36] United Kingdom,[21] and Australia[22] have consistently found access to fast-food restaurants to be better in more-deprived neighborhoods. The findings also support studies from a range of countries that have investigated the presence (or absence) of so-called "food deserts."[30,35,37] With the exception of a few local studies,[38,39] there is little evidence outside of North America to suggest that more-deprived neighborhoods have less geographic access to shops selling healthy food.[17,40,41] In fact, in New Zealand, the results at the national level suggest that access to supermarkets and other shops potentially selling healthy food is better in more-deprived neighborhoods.[42]

Three mechanisms might explain why access to fast-food (and healthier food) outlets is socially patterned in New Zealand. First, it can be argued that consumer demand is greater in more-deprived areas, so retailers preferentially locate in these communities. However, in many urban areas higher- and lower-SES suburbs are located in reasonable proximity to each other, so locating outlets in lower-decile suburbs will not greatly preclude access by the highly mobile and affluent residents of adjacent suburbs. (An opposing element of consumer demand is likely civic resistance to the aesthetic and other impacts of fast-food outlets in more affluent suburbs, directly influencing the location of food outlets.) A second possible explanation is that population density is associated with neighborhood deprivation,[43] which in part may explain why there is a greater density of all types of food outlets (healthy and unhealthy) in deprived neighborhoods—there are simply more customers to be served. However, it was found that the association of neighborhood deprivation with fast-food access persisted in strata of population density (Figure 2).

Third, land-use costs, neighborhood histories, and planning and control measures need to be examined. For example, lower land prices and building rental costs in lower-SES neighborhoods would also influence the location choices made by international and local proprietors. That is, there might be no deliberate or preferential targeting of unhealthy foods to lower socioeconomic neighborhoods, but rather other considerations that influence the location of both healthy and unhealthy food outlets.

Regardless of the historical mechanisms by which food-outlet locations have come to be socioeconomically patterned, in New Zealand as elsewhere there is potential for public health advocacy around land use planning to help tackle the "obesity epidemic." Mair

et al.[44] identify a number of examples of zoning restrictions on fast-food outlets and drive-through services in the U.S., although they observe that generally the rationale for the adoption of restrictions has been unrelated to obesity. Preserving and enhancing the aesthetic quality of communities, reducing congestion, and protecting the small business sector are among the justifications identified. Land-use strategies that have related to obesity-based rationales include requiring fast food outlets to locate a minimum distance from youth-oriented facilities such as schools, limiting the per capita number of fast-food restaurants in neighborhoods, especially in socially deprived neighborhoods, and limiting the proximity of fast-food restaurants to each other.[45] In the New Zealand context, zoning restrictions on fast-food outlets would need to be incorporated into the district plans of the TAs. If such changes occurred, a proposal to locate an outlet in a restricted zone would then require notified resource consent, which would provide an avenue for public health advocacy.

Location access is not the only way that fast-food outlets may contribute to an obesogenic environment. Many fast-food outlets display strong visual branding and associated food advertising. Both the increased availability and point-of-sales fast-food product marketing are potential contributors to obesogenic environment in more-deprived New Zealand neighborhoods. The 1990 Smoke Free Environments Act in New Zealand that regulated the marketing, advertising, and promotion of tobacco products may provide a lead with regard to public health action in this visual component of obesogenic neighborhood environments.

This study is limited in that it lacks data on dietary consumption or rates of obesity in deprived and non-deprived neighborhoods. The relationship between type of food outlet and products offered, and hence consumption pattern, is not fixed.[36,46–48] Further research could usefully examine the relationship between neighborhood access to fast-food outlets, fast-food consumption, and obesity in schoolchildren and general population samples. Future studies should also simultaneously examine all aspects of the food environment (healthy and unhealthy) in order to disentangle the various contextual drivers of dietary intake. Nonetheless, this study is unique in that it adopts a GIS approach that is not limited to the simple presence or absence of an outlet within each neighborhood but rather uses the distance to the closest facility either within or outside each area.

Research into dietary intake, and individual health-related behaviors more generally, has tended to emphasize individual choices and ignore the effects on personal diets from the "complex social and physical contexts in which individual behavioral decisions are made."[17] This research adds to the growing body of recent research on "environmental" or "contextual"

exposures that affect dietary intake.[49,50] Results show that geographic access to outlets selling fast food is better in more-deprived neighborhoods across New Zealand. The parallel finding that food outlets selling potentially healthier food warns against knee-jerk blaming of the fast-food industry for socioeconomic targeting. Nevertheless, and importantly, the findings still suggest potential for, and add weight to, environmental interventions to reduce nutrition-related mortality and morbidity as well as to reduce health inequalities. For example, policies in New Zealand such as the Ministry of Health's "Healthy Eating–Healthy Action" strategy should focus on environmental modification as well as individual behavioral change.[51]

References

1. Flegal KM, Carroll MD, Ogden CL, Johnson CL. Prevalence and trends in obesity among US adults, 1999–2000. JAMA 2002;288:1723–7.
2. Flegal KM, Graubard BI, Williamson DF, Gail MH. Excess deaths associated with underweight, overweight, and obesity. JAMA 2005;293:1861–7.
3. Allison DB, Fontaine KR, Manson JE, Stevens J, VanItallie TB. Annual deaths attributable to obesity in the United States. JAMA 1999;282:1530–8.
4. Sturm R, Wells KB. Does obesity contribute as much to morbidity as poverty or smoking? Public Health 2001;115:229–35.
5. Must A, Spadano J, Coakley EH, Field AE, Colditz G, Dietz WH. The disease burden associated with overweight and obesity. JAMA 1999;282:1523–9.
6. Oliver LN, Hayes MV. Neighbourhood socio-economic status and the prevalence of overweight Canadian children and youth. Can J Public Health 2005;96:415–20.
7. Mobley LR, Root ED, Finkelstein EA, Khavjou O, Farris RP, Will JC. Environment, obesity, and cardiovascular disease risk in low-income women. Am J Prev Med 2006;30:327–32.
8. Wardle J, Waller J, Jarvis MJ. Sex differences in the association of socioeconomic status with obesity. Am J Public Health 2002;92:1299–304.
9. Ministry of Health. Tracking the obesity epidemic: New Zealand 1977–2003. Wellington: Ministry of Health, 2004.
10. Ministry of Health. A Portrait of Health: Key Results of the 2002/03 New Zealand Health Survey. Wellington: Ministry of Health, 2004.
11. Blakely T, Fawcett J, Atkinson J, Tobias M, Cheung J. Decades of disparity II: socioeconomic mortality trends in New Zealand, 1981–1999. Wellington: Ministry of Health, 2005.
12. Blakely T, Tobias M, Robson B, Ajwani S, Bonne M, Woodward A. Widening ethnic mortality disparities in New Zealand 1981–99. Soc Sci Med 2005;61:2233–51.
13. Pearce J, Dorling D. Increasing geographical inequalities in health in New Zealand, 1980–2001. Int J Epidemiol 2006;35:597–603.
14. Pearce J, Dorling D, Wheeler B, Barnett R, Rigby J. Geographical inequalities in health in New Zealand, 1980–2001: the gap widens. Aust N Z J Public Health 2006;30:461–6.
15. Ministry of Health. Healthy eating—healthy action: a strategic framework. Wellington, New Zealand: Ministry of Health, 2003.
16. Ministry of Health. New Zealand health strategy. Wellington: Ministry of Health, 2000.
17. Cummins S, Macintyre S. Food environments and obesity—neighbourhood or nation? Int J Epidemiol 2006;35:100–4.
18. Egger G, Swinburn B. An "ecological" approach to the obesity pandemic. BMJ 1997;315:477–80.
19. Powell LM, Slater S, Mirtcheva D, Bao Y, Chaloupka FJ. Food store availability and neighborhood characteristics in the United States. Prev Med 2006. (In press)
20. Block JP, Scribner RA, DeSalvo KB. Fast food, race/ethnicity, and income: a geographic analysis. Am J Prev Med 2004;27:211–7.

21. Cummins SC, McKay L, MacIntyre S. McDonald's restaurants and neighborhood deprivation in Scotland and England. Am J Prev Med 2005; 29:308–10.

22. Reidpath DD, Burns C, Garrard J, Mahoney M, Townsend M. An ecological study of the relationship between social and environmental determinants of obesity. Health Place 2002;8:141–5.

23. Power C, Graham H, Due P, Hallqvist J, Joung I, Kuh D, et al. The contribution of childhood and adult socioeconomic position to adult obesity and smoking behaviour: an international comparison. Int J Epidemiol 2005;34:335–44.

24. James SA, Fowler-Brown A, Raghunathan TE, Van Hoewyk J. Life-course socioeconomic position and obesity in African American women: the Pitt County study. Am J Public Health 2006;96:554–60.

25. Austin SB, Melly SJ, Sanchez BN, Patel A, Buka S, Gortmaker SL. Clustering of fast-food restaurants around schools: a novel application of spatial statistics to the study of food environments. Am J Public Health 2005;95: 1575–81.

26. Maher A, Wilson N, Signal L. Advertising and availability of 'obesogenic' foods around New Zealand secondary schools: a pilot study. N Z Med J 2005;118:U1556.

27. Cummins S, Macintyre S, Davidson S, Ellaway A. Measuring neighbourhood social and material context: generation and interpretation of ecological data from routine and non-routine sources. Health Place 2005;11:249–60.

28. Yellow Pages. New Zealand Yellow Pages, January 2006. Available at: www.yellowpages.co.nz.

29. Witten K, Exeter D, Field A. The quality of urban environments: mapping variation in access to community resources. Urban Studies 2002;40:161–177.

30. Zenk SN, Schulz AJ, Israel BA, James SA, Bao S, Wilson ML. Neighborhood racial composition, neighborhood poverty, and the spatial accessibility of supermarkets in metropolitan Detroit. Am J Public Health 2005;95:660–7.

31. Pearce J, Witten K, Bartie P. Neighbourhoods and health: a GIS approach to measuring community resource accessibility. J Epidemiol Community Health 2006;60:389–95.

32. Salmond C, Crampton P. NZDep2001 index of deprivation. Wellington, New Zealand: Department of Public Health, Wellington School of Medicine and Health Sciences, 2002.

33. New Zealand Ministry of Education. How the decile is calculated, 2006. Available at: http://www.minedu.govt.nz.

34. Statistics New Zealand. New Zealand: an urban/rural profile. Wellington: Statistics New Zealand, 2005.

35. Lewis LB, Sloane DC, Nascimento LM, et al. African Americans' access to healthy food options in South Los Angeles restaurants. Am J Public Health 2005;95:668–73.

36. Burdette HL, Whitaker RC. Neighborhood playgrounds, fast food restaurants, and crime: relationships to overweight in low-income preschool children. Prev Med 2004;38:57–63.

37. Alwitt LF, Donley TD. Retail stores in poor urban neighborhoods. J Consumer Aff 1997;31:139–64.

38. Guy C, Clarke G, Eyre H. Food retail change and the growth of food deserts: a case study of Cardiff. Int J Retail Distrib Manag 2004;32:72–88.

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

40. Cummins S, Macintyre S. "Food deserts"—evidence and assumption in health policy making. BMJ 2002;325:436–8.

41. Winkler E, Turrell G, Patterson C. Does living in a disadvantaged area mean fewer opportunities to purchase fresh fruit and vegetables in the area? Findings from the Brisbane food study. Health Place 2006;12:306–19.

42. Pearce J, Witten K, Hiscock R, Blakely T. Are socially disadvantaged neighbourhoods deprived of health-related community resources? Int J Epidemiol 2007. (In press)

43. Auckland Regional Public Health Service. Improving health and wellbeing: a public health perspective for local authorities in the Auckland region. Auckland: Auckland Regional Public Health Service, 2006.

44. Mair J, Pierce M, Teret S. The city planner's guide to the obesity epidemic: zoning and fast food. Baltimore: Centre for Law and the Public's Health at Johns Hopkins and Georgetown Universities, 2005.

45. Ashe M, Jernigan D, Kline R, Galaz R. Land use planning and the control of alcohol, tobacco, firearms, and fast food restaurants. Am J Public Health 2003;93:1404–8.

46. Jeffery R, Baxter J, McGuire M, Linde J. Are fast food restaurants an environmental risk factor for obesity? Int J Behav Nutr Phys Activ 2006;3:2.

47. Maddock J. The relationship between obesity and the prevalence of fast food restaurants: state-level analysis. Am J Health Promot 2004;19:137–43.

48. Moore LV, Diez Roux AV. Associations of neighborhood characteristics with the location and type of food stores. Am J Public Health 2006;96: 325–31.

49. Drewnowski A. Obesity and the food environment: dietary energy density and diet costs. Am J Prev Med 2004;27(suppl 3):154–62.

50. Hill JO, Peters JC. Environmental contributions to the obesity epidemic. Science 1998;280:1371–4.

51. Ministry of Health. Healthy eating—health action. Oranga Kai—Oranga Pumau: a strategic framework 2003. Wellington, New Zealand: Ministry of Health, 2003.