ELSEVIER

Health & Place 14 (2008) 740–754

HEALTH & PLACE

www.elsevier.com/locate/healthplace

The association between neighborhood socioeconomic status and exposure to supermarkets and fast food outlets

Karen E. Smoyer-Tomic[a,*], John C. Spence[b], Kim D. Raine[c], Carl Amrhein[d], Nairne Cameron[d], Vladimir Yasenovskiy[d], Nicoleta Cutumisu[b], Eric Hemphill[c], Julia Healy[d]

[a]*Department of Geography, University of Delaware, 216 Pearson Hall, Newark, DE 19716, USA*
[b]*Sedentary Living Lab, Faculty of Physical Education and Recreation, University of Alberta, Edmonton, Alberta, Canada*
[c]*Centre for Health Promotion Studies, School of Public Health, University of Alberta, Edmonton, Alberta, Canada*
[d]*Faculty of Science, Department of Earth and Atmospheric Sciences, University of Alberta, Edmonton, Alberta, Canada*

Received 31 August 2007; received in revised form 22 November 2007; accepted 4 December 2007

Abstract

This study examines whether exposure to supermarkets and fast food outlets varies with neighborhood-level socioeconomic status in Edmonton, Canada. Only market area and fast food proximity predicted supermarket exposure. For fast food outlets, the odds of exposure were greater in areas with more Aboriginals, renters, lone parents, low-income households, and public transportation commuters; and lower in those with higher median income and dwelling value. Low wealth, renter-occupied, and lone parent neighborhoods had greater exposure to fast food outlets, which was not offset by better supermarket access. The implications are troubling for fast food consumption among lone parent families in light of growing obesity rates among children.

Keywords: Supermarket; Fast food; Accessibility; Edmonton; Canada

Introduction

Obesity prevalence has risen significantly since the 1970s in Canada, and with it the risk of developing cardiovascular diseases, diabetes, physical disabilities, and other health conditions (Katzmarzyk, 2002). From 1978 to 2004 measured age-adjusted obesity rates for adults increased from 14% to 23% (Statistics Canada, 2005), and childhood obesity has tripled over the last 25 years. As of 2004, 26% of Canadian children and adolescents aged 2–17 years were overweight or obese (Shields, 2006).

Physical inactivity and food consumption are two major behavioral factors in obesity. However, individual behaviors are embedded within environmental contexts. Increasingly, researchers are examining ecological determinants of individual behaviors in the causal pathway for obesity (Swinburn et al., 1999). For example, accessibility and availability of food services reflect an important component of the built environment that plays a role in individual food choices (Cheadle et al., 1991;

*Corresponding author. Tel.: +1 302 831 6581; fax: +1 302 831 6654.
E-mail address: ktomic@udel.edu (K.E. Smoyer-Tomic).

1353-8292/$ - see front matter © 2007 Elsevier Ltd. All rights reserved.
doi:10.1016/j.healthplace.2007.12.001

Morland et al., 2002; Nielsen et al., 2002; Wrigley et al., 2003). People in Canada and the United States are increasingly eating more meals outside the home, and they are consuming more energy-dense foods and beverages (Harnack et al., 2000; Nielsen et al., 2002; Nielsen and Popkin, 2004; Statistics Canada, 2003). Regular and frequent fast food consumption over time has adverse health implications. Over a 15-year period fast food consumption had a strong positive association with weight gain and insulin resistance in the CARDIA study (Pereira et al., 2005).

An emerging body of research is linking negative health consequences to food retail accessibility. These include higher obesity, overweight, and hypertension rates among residents living in a census tract without a supermarket (Morland et al., 2006) or in zipcodes with more fast food outlets (Lewis et al., 2005). Other work has shown positive associations between the number (Chou et al., 2004) and density of restaurants, including fast food outlets (Maddock, 2004) and state-level obesity rates in the United States, and higher rates of mortality and acute coronary syndrome hospital admissions in Ontario (Canada) health regions with more fast food outlets (Alter and Eny, 2005). Furthermore, access to supermarkets (a source of affordable, healthy food) and fast food restaurants (a source of affordable, energy-dense foods) may influence food consumption trends for disadvantaged groups that have fewer resources than more affluent groups for traveling outside of the local area to purchase food (Kumanyika and Grier, 2006). It may be difficult to change eating behaviors to be more consistent with healthy eating guidelines, particularly in high-risk populations, if inexpensive, energy-dense, low nutritional foods are more accessible (and affordable) than those that are nutritious (Drewnowski and Specter, 2004).

Socioeconomic status and food retail accessibility

Researchers have identified poor supermarket access for low-income, inner-city, and predominantly African American or Hispanic neighborhoods within US urban areas, especially compared to more affluent suburban and primarily white residential areas (Cotterill and Franklin, 1995; Curtis and McClellan, 1995; Kolodinsky and Cranwell, 2000; Weinberg, 2000; Eisenhauer, 2001; Morland et al., 2002, 2006; Zenk et al., 2005). Several UK studies have also noted unsupportive local food environments in socially deprived areas, although in the UK these have tended to encompass suburban local authority housing estates rather than occurring primarily in inner cities as in the US (Sooman et al., 1993; Donkin et al., 2000; Clarke et al., 2002; Wrigley, 2002). Canadian research on supermarket accessibility is still in its early stages, but the literature has shown relatively good access to supermarkets for low socioeconomic status (SES) and inner-city neighborhoods (Smoyer-Tomic et al., 2006; Apparicio et al., 2007).

Research from the US suggests that low-income and predominantly African American neighborhoods have greater exposure to fast food outlets than higher income and predominantly white areas (Block et al., 2004; Lewis et al., 2005). These findings support a study from Melbourne, Australia that found 2.5 times more fast food restaurants in the lowest income areas than in the highest (Reidpath et al., 2002) and from Scotland and England showing a linear increase between neighborhood deprivation and mean number of McDonald's fast food outlets (Cummins et al., 2005).

Limited research has explored the comparative accessibility to supermarkets and fast food outlets. A national study of New Zealand found a strong relation between neighborhood deprivation and travel distance to fast food outlets, but also a similar pattern for supermarket access (Pearce et al., 2007). In a study of selected US locations, Morland et al. (2002) found the number of fast food restaurants and bars decreased as the wealth of the neighborhood increased, and that predominantly white residential areas were four times more likely to have a supermarket near them than predominantly African-American areas. In areas lacking a supermarket, fast food, if readily available, may fill in this food gap (Kumanyika and Grier, 2006; Regan et al., 2006). Residents of areas with proximate fast food outlets may have higher fast food consumption than those in areas without a fast food outlet nearby (Jekanowski et al., 2001).

Past work in Edmonton, Alberta, Canada, has found higher fast food exposure for neighborhoods with greater percentages of unemployed, low-income, and renting populations (Hemphill et al., in press). For supermarket exposure, Edmonton findings were similar to those from the UK (Clarke et al., 2002) and New Zealand (Pearce et al., 2007). Edmonton neighborhoods with the highest supermarket accessibility had higher percentages of

households lacking a vehicle, with low income, and with a member over 64 years than those with the lowest accessibility. Still, supermarket access was limited in a handful of low-income neighborhoods with low vehicle ownership rates (Smoyer-Tomic et al., 2006). To learn whether exposure to fast food outlets and supermarkets differs in relation to neighborhood conditions, this paper examines relationships among supermarket and fast food outlet exposure, and neighborhood deprivation indicators in Edmonton, Alberta, for 2004.

Data and methods

The study area was the City of Edmonton, in Alberta, Canada, whose boundaries contain just over 660,000 people living within 683 km^2 (Statistics Canada, 2002). Neighborhood boundary files from the City of Edmonton and all other road network and census data were obtained from Statistics Canada. Retained for analysis were 215 residential neighborhoods with populations over 275, which had non-suppressed data. Location data for all commercial food services in Edmonton for 2004 were supplied by Capital Health Region, Health Inspection Division. From the food service dataset, we selected supermarkets and fast food outlets. Supermarkets were defined as stores stocking fresh meat, wheat-based Western style bread, fruits, vegetables, and dairy milk, and had no required membership (free access). Specialty food (e.g., ethnic, organic, or upscale/gourmet) and convenience stores were excluded from the analysis. Fast food outlets were defined as restaurants with walk-up counter service selling predominantly pre-processed and prepared to order foods. Concession stands, sit-down restaurants, school cafeterias, cafes, and coffee shops were excluded from the analysis. This study differs from other similar analyses in that it includes all sources of fast food in the study area, rather than a select group (i.e., popular chain restaurants; see Reidpath et al., 2002; Block et al., 2004; Maddock, 2004; Cummins et al., 2005).

We included in the analysis 761 fast food outlets and 61 supermarkets. Each location was first determined using GeoPinPoint software (DMTI, Spatial Inc, Markham, Ontario, Version 5.4), then manually checked and corrected as needed. To determine neighborhood-level exposure to each facility type, we used Arcview (ESRI, Redlands, CA, Version 9.1) and its Network Analyst extension to calculate the number of fast food and supermarkets within a street network distance of 500, 800, 1000, and 1500 m from the geometric center of each census block in each of the 215 study neighborhoods. These distances correspond with those used in related literature (Apparicio et al., 2007; Block et al., 2004; Dowler, 2002). Counts were then weighted by census block population to identify the population-weighted mean number of each facility type within the four different radii for each neighborhood. We also used a similar procedure to calculate weighted mean minimum distance to the nearest fast food outlet and nearest supermarket for each neighborhood. These methods minimize aggregation error and better estimate average distance from each neighborhood to a facility than would arise from using the geometric center of the neighborhood (Hillsman and Rhoda, 1978; Current and Schilling, 1987; Hodgson et al., 1997). Based on the number and distribution of supermarkets and fast food outlets in Edmonton using the four network distances above, we selected distances that classified approximately 50% of the neighborhoods into those with and without exposure to each facility type to facilitate statistical analysis. Thus supermarket exposure was defined as any census block in the neighborhood having a supermarket within 800 m; fast food exposure was indicated by whether or not any census block in the neighborhood had a fast food restaurant within 500 m.

Data analysis

Using neighborhood-level variables from the 2001 Canadian census (Statistics Canada, 2001a, 2002), we evaluated differences between neighborhoods with and without an accessible supermarket (within 800 m) and fast food outlet (within 500 m) for several types of variables: race/ethnicity (Aboriginal, visible minority, recent immigrant); SES (low-income, median income, unemployment, no high school diploma); age and family status (lone parent, seniors); housing tenure (renters, average dwelling value); and urbanization (public transportation users, number of census blocks, population density, population size, neighborhood geographical area). Descriptive statistics for each of these variables for neighborhoods with and without an accessible supermarket or fast food were examined and tested for statistically significant differences using the Mann–Whitney two sample statistic (Stata

Corporation, College Station, TX, 9.2 Special Edition).

We ran logit models (Stata Corporation, 9.2 Special Edition) to examine whether neighborhoods in the lowest tercile for the variables above had differential exposure to fast food and supermarkets than those in higher terciles. Dummy variables were created for food outlet exposure. We also examined the effects of neighborhood median family income on each of the census indicator models. Since neighborhoods differ in population size and area, we used the number of census blocks in each neighborhood (a function of density and geographic size) as a control for market area. All models also controlled for the presence of the other food outlet type by including a dummy variable indicating whether a fast food restaurant was located within a mean distance of 500 m from any census block in the neighborhood for supermarket models; and whether a supermarket was located within 800 m from any census block in the neighborhood for fast food models. Results are reported for indicator variables with p-values $\leqslant 0.10$ in Tables 2 and 3, with the lowest tercile as the comparison with odds ratios (OR) equal to 1. Model goodness of fit was evaluated using Bayesian Information Criterion [BIC] (Raftery, 1995).

Results

Descriptive statistics

There are almost 12.5 times more fast food outlets than supermarkets in Edmonton. The mean street network distance to the nearest fast food outlet was 1139 m, 581 m closer than the mean distance to the nearest supermarket of 1720 m (Table 1). Almost two-thirds of the city's neighborhoods had at least one fast food outlet within 500 m (nearly 20% had more than one fast food outlet within 500 m), compared to one-third of the city's neighborhoods (31.7%) with a supermarket within 500 m (data not shown). Only a scant 12% of Edmonton's neighborhoods had no fast food within 1500 m, while more than twice as many had no supermarket within 1500 m. Fast food is readily accessible—within walking distance for many areas—while getting to a supermarket requires traveling more than 1000 m (and thus likely requires vehicular transport) for 101 (45.7%) of Edmonton's residential neighborhoods.

Statistical models

The base models show that both the number of census blocks and the economic indicator (fast food outlet within 500 m for supermarket models and supermarket outlet within 800 m for fast food models) predict supermarket as well as fast food exposure. The odds of supermarket exposure within 800 m was 2.5% higher for each additional census block within the neighborhood and 3.13 times higher when a fast food outlet was located within 500 m of one or more census blocks within the neighborhood (Table 2). The odds of a fast food outlet within 500 m was 10.3% higher for each additional census block and 2.76 times higher when a supermarket was located within 800 m of one or more census blocks within the neighborhood (Table 3).

Race/ethnicity

Neighborhoods with a supermarket within 800 m or a fast food outlet within 500 m had more Aboriginal residents than those areas without, although the difference was only statistically significant for fast food outlets (Table 1). In the logit models, neighborhoods in the highest tercile of Aboriginal residents were 2.68 times more likely to have a fast food outlet within 500 m than the lowest tercile (Table 3, Model 1a). Once median income was included into the model, however, Aboriginal concentrations lost significance to median income (Table 3, Model 1b). Visible minority (Table 2, Model 1; Table 3, Models 2a, 2b) and recent immigrant (not shown) were not significant in any of the models.

Socioeconomic status

Neighborhoods with a supermarket within 800 m tended to be of lower SES than those without a supermarket, but the differences were statistically significant only for unemployment rate (Table 1). For fast food accessibility, all of the SES variables examined had statistically significant differences, with lower SES indicators in areas with a nearby fast food outlet (Table 1).

In the supermarket exposure logit models, none of the SES variables were significant (Table 2). However, the odds of encountering a fast food outlet within 500 m for neighborhoods in the lowest income tercile were 2.39 (Table 3, Model 3). Neighborhoods with median income in the highest

Table 1
Mean and standard deviation (in parentheses) of neighborhood characteristics by supermarket and fast food accessibility categories

Census variable	Supermarket within 800 m[a]		All neighborhoods	Fast food outlet within 500 m[a]	
	No	Yes		No	Yes
Number of neighborhoods	120	95	215	75	140
Minimum distance to supermarket (m)	2290.82**	999.63**	1720.30	2338.21**	1389.27**
	(1355.11)	(278.56)	(1211.73)	(1659.00)	(692.03)
Minimum distance to fast food (m)	1436.63**	763.14**	1139.04	2031.38**	661.01**
	(1436.63)	(451.94)	(1072.04)	(1407.79)	(233.43)
Number supermarkets within 1000 m	0.04**	0.64**	0.30	0.13**	0.40**
	(0.14)	(0.43)	(0.42)	(0.25)	(0.47)
Number fast food outlets within 1000 m	1.75**	5.37**	3.35	0.55**	4.84**
	(2.41)	(6.42)	(4.96)	(0.93)	(5.56)
% Aboriginal	3.85	4.75	4.24	2.80**	5.02**
	(3.26)	(4.01)	(3.63)	(2.38)	(3.94)
% Visible minority	19.16	16.81	18.12	18.59	17.87
	(11.44)	(9.92)	(10.84)	(12.12)	(10.12)
% Immigrated within 5 years	2.61	2.72	2.66	2.59	2.70
	(2.18)	(2.38)	(2.26)	(2.76)	(1.96)
% Below low-income cutoff	13.64	15.84	14.64	11.48**	16.19**
	(8.51)	(9.80)	(9.16)	(8.51)	(9.10)
Median family income ($Canadian)	64,217	57,318	61,169	71,159**	55,817**
	(24,313)	(16,594)	(21,481)	(25,972)	(16,389)
% Unemployed	5.39*	6.13*	5.73	5.27*	5.96*
	(2.14)	(2.33)	(2.25)	(2.19)	(2.25)
% No high school diploma	17.94	18.88	18.35	16.37**	19.41**
	(7.30)	(7.10)	(7.21)	(7.56)	(6.80)
% of lone parent households	17.00	18.61	17.71	13.75**	19.81**
	(8.03)	(7.88)	(7.99)	(7.93)	(7.20)
% Over 64 years (seniors)	10.71	12.40	11.46	10.41*	12.02*
	(6.70)	(6.77)	(6.77)	(7.15)	(6.51)
% Renters	28.67*	35.21*	31.56	19.88**	37.82**
	(23.52)	(24.45)	(24.10)	(20.32)	(23.70)
Average dwelling value ($Canadian)	152,921	137,028	145,907	168,049**	133,874**
	(59,796)	(37,724)	(51,740)	(61,773)	(40,830)
% Using public transportation	9.96	11.15	10.49	8.40**	11.61**
	(5.91)	(4.88)	(5.50)	(6.31)	(4.66)
Population density (per km^2)	1436.63*	3025.84*	2783.18	2379.27**	2999.56**
	(1275.61)	(1139.80)	(1233.82)	(1371.49)	(1098.70)
Total population	2738.88**	3434.84**	3046.40	2303.33**	3444.46**
	(1662.24)	(1899.84)	(1800.53)	(1536.83)	(1810.03)
Number of census blocks	17.00**	25.81**	20.89	11.77**	25.77**
	(14.37)	(16.29)	(15.83)	(9.56)	(16.37)
Area (km^2)	2.84	1.15	2.09	3.85	1.15
	(7.95)	(0.41)	(5.99)	(9.93)	(0.40)

Asterisk indicates statistically significant difference between category types using Mann–Whitney test. *$p<.05$, **$p<.01$.

[a]Supermarket (fast food outlet) within 800 m (500 m) categories: 'No' = no census blocks in neighborhood have supermarket (fast food outlet) within 800 m (500 m); 'Yes' = at least one census block in neighborhood has supermarket (fast food outlet) within 800 m (500 m).

tercile were 74% less likely to have a proximate fast food outlet than lowest tercile (Table 3, Model 4).

Age and family status

The percentages of residents over 64 years and of lone parent households were higher in neighborhoods with a supermarket within 800 m or with a fast food outlet within 500 m, but the differences were statistically significant only for fast food outlets (Table 1). In the logit models, the middle tercile of lone parent neighborhoods was 2.32 times more likely to encounter a fast food outlet within 500 m, and the highest tercile, 5.17 times more likely, than the lowest tercile (Table 3, Model 5a).

Table 2
Logit models for one or more supermarkets being within 800 m of one or more census blocks in a neighborhood

Variables[a]	Odds ratio	SE	z	$p>\|z\|$	95% CI	
Base model					$BIC^b = -871.8$	
Census blocks	1.025	0.011	2.31	0.021	1.004	1.046
ff500m	3.130	1.100	3.26	0.001	1.575	6.218
Model 1	*Visible minority and median income*				$BIC = -854.9$	
Census blocks	1.025	0.112	2.25	0.025	1.003	1.047
ff500m	3.017	1.104	3.02	0.003	1.473	6.181
mi3vismin	1.225	0.452	0.55	0.582	0.595	2.523
hg3vismin	0.727	0.272	−0.85	0.395	0.349	1.155
mi3medinc	1.871	0.688	1.70	0.089	0.910	3.847
hg3medinc	1.245	0.492	0.56	0.578	0.575	2.699
Model 2	*Unemployment and median income*				$BIC = -853.8$	
Census blocks	1.024	0.011	2.10	0.035	1.002	1.046
ff500m	3.169	1.171	3.12	0.002	1.537	6.537
mi3unemp	1.169	0.438	0.42	0.676	0.561	2.435
hg3unemp	1.497	0.615	0.98	0.326	0.669	3.349
mi3medinc	1.963	0.771	1.72	0.086	0.909	4.238
hg3medinc	1.361	0.575	0.73	0.467	0.594	3.117
Model 3	*Total population*				$BIC = -864.2$	
Census blocks	1.022	0.011	1.94	0.052	0.999	1.044
ff500m	2.839	1.015	2.92	0.004	1.409	5.722
mi3tpop	1.958	0.754	1.75	0.081	0.921	4.164
hi3tpop	1.352	0.541	0.75	0.452	0.617	2.962

SE, standard error. CI, confidence interval.
ff500m, at least one census block in neighborhood has a fast food outlet within 500 m.
'mi3' indicates middle tercile of variable, 'hi3' indicates highest tercile of variable.
vismin, % visible minority residents in neighborhood.
medinc, median family income ($ Canadian).
tpop, total population of neighborhood.
unemp, % unemployed residents over 15 in neighborhood.
[a]Results are reported for indicator variables with p-values $\leqslant 0.10$ with the lowest tercile as the reference category with odds ratios (OR) equal to 1.
[b]BIC, Bayesian Information Criteria. Lower BIC values indicate better model fit.

This is one of the best fitting fast food outlet models, as indicated by its low BIC value. When median income is added to the model, the fit is not as good (BIC increases), but the lone parent upper tercile retains significance. The odds of a fast food outlet within 500 m for the highest lone parent tercile drop to 3.32 compared to the lowest tercile, and the middle lone parent tercile OR decreases, with the 95% confidence interval (CI) broadening to include 1.0 (Table 3, Model 5b). Unlike the Aboriginal models (Model 1b), median income was not significant when it was added to the lone parent models. To explore this relationship in more detail, we included low income in the lone parent model (not shown). The OR for both lone parent terciles increased compared to the lone parent model without any income variables: 2.87 (95% CI = 1.07, 7.74) for the middle and 6.25 (95% CI = 2.05, 19.11) for the highest tercile. Low income was not significant, and in fact the OR point estimates dropped below 1.0. Higher exposure to fast food outlets for neighborhoods with higher concentrations of lone parent families was independent of both median income levels and percentage of low-income households.

Housing

The percentage of renters was higher, and average dwelling value lower, in areas with a supermarket within 800 m as well as those with a fast food within 500 m than in areas without these facilities. However, the difference in dwelling value was not significant between supermarket accessibility areas (Table 1). The odds of fast food exposure increased

Table 3
Logit models for one or more fast food outlets being within 500 m of one or more census blocks in a neighborhood

Variables[a]	Odds ratio	Std. error	z	$p>\|z\|$	95% CI	
Base model					$BIC^b = -924.0$	
Census blocks	1.103	0.022	5.00	0.000	1.061	1.146
sm800m	2.756	0.984	2.84	0.005	1.369	5.550
Model 1*a*	*Aboriginal residents*				$BIC = -918.5$	
Census blocks	1.094	0.022	4.50	0.000	1.052	1.138
sm800m	2.667	0.967	2.70	0.007	1.310	5.429
mi3abor	1.436	0.565	0.92	0.358	0.664	3.105
hi3abor	2.677	1.166	2.26	0.024	1.140	6.285
Model 1*b*	*Aboriginal residents and median income*				$BIC = -915.5$	
Census blocks	1.099	0.023	4.54	0.000	1.055	1.144
sm800m	2.560	0.951	2.53	0.011	1.236	5.303
mi3abor	0.904	0.399	−0.23	0.820	0.381	2.147
hg3abor	1.164	0.631	0.28	0.780	0.402	3.370
mi3medinc	0.833	0.386	−0.39	0.694	0.336	2.065
hg3medinc	0.280	0.145	−2.46	0.014	0.101	0.773
Model 2*a*	*Visible minority*				$BIC = -916.1$	
Census blocks	1.107	0.022	5.07	0.000	1.065	1.152
sm800m	2.638	0.951	2.69	0.007	1.302	5.346
mi3vismin	2.071	0.903	1.67	0.095	0.881	4.868
hg3vismin	1.515	0.620	1.02	0.310	0.679	3.378
Model 2*b*	*Visible minority and median income*				$BIC = -917.3$	
Census blocks	1.104	0.023	4.74	0.000	1.060	1.150
sm800m	2.517	0.941	2.47	0.014	1.209	5.237
mi3vismin	1.853	0.835	1.37	0.171	0.767	4.480
hg3vismin	1.595	0.681	1.09	0.275	0.690	3.685
mi3medinc	0.814	0.371	−0.45	0.651	0.333	1.987
hg3medinc	0.267	0.117	−3.02	0.003	0.113	0.629
Model 3	*Low income*				$BIC = -918.0$	
Census blocks	1.103	0.022	4.90	0.000	1.061	1.148
sm800m	2.826	1.024	2.87	0.004	1.389	5.749
mi3lowinc	1.471	0.618	0.92	0.358	0.646	3.353
hg3lowinc	2.393	0.970	2.15	0.031	1.081	5.297
Model 4	*Median income*				$BIC = -925.9$	
Census blocks	1.099	0.022	4.65	0.000	1.056	1.144
sm800m	2.598	0.962	2.58	0.010	1.257	5.369
mi3medinc	0.782	0.347	−0.55	0.580	0.327	1.868
hg3medinc	0.257	0.110	−3.17	0.002	0.111	0.595
Model 5*a*	*Lone parent*				$BIC = -928.3$	
Census blocks	1.093	0.022	4.31	0.000	1.050	1.138
sm800m	2.777	1.047	2.71	0.007	1.326	5.813
mi3lonpar	2.321	0.952	2.05	0.040	1.039	5.186
hg3lonpar	5.172	2.291	3.71	0.000	2.171	12.321
Model 5*b*	*Lone parent and median income*				$BIC = -919.5$	
Census blocks	1.095	0.023	4.35	0.000	1.051	1.140
sm800m	2.608	0.995	2.51	0.012	1.235	5.508
mi3lonpar	1.555	0.776	0.89	0.376	0.585	4.135
hg3lonpar	3.319	1.955	2.04	0.042	1.047	10.527
mi3medinc	1.100	0.555	0.19	0.850	0.410	2.957
hg3medinc	0.553	0.319	−1.03	0.304	0.179	1.712
Model 6*a*	*Renters*				$BIC = -928.7$	
Census blocks	1.095	0.023	4.36	0.000	1.051	1.141
sm800m	2.618	0.977	2.58	0.010	1.259	5.442
mi3rent	2.556	1.041	2.30	0.021	1.151	5.679
hg3rent	5.313	2.384	3.72	0.000	2.205	12.804
Model 6*b*	*Renters and median income*				$BIC = -920.3$	
Census blocks	1.096	0.023	4.36	0.000	1.052	1.142
sm800m	2.544	0.963	2.47	0.014	1.211	5.343

Table 3 (*continued*)

Variables[a]	Odds ratio	Std. error	z	$p>\|z\|$	95% CI	
mi3rent	1.863	0.879	1.32	0.187	0.739	4.700
hg3rent	3.364	1.849	2.21	0.027	1.146	9.878
mi3medinc	0.945	0.479	−0.11	0.911	0.350	2.554
hg3medinc	0.500	0.266	−1.30	0.193	0.176	1.421
Model 7a	*Average dwelling value*				$BIC = -923.8$	
Census blocks	1.097	0.023	4.44	0.000	1.053	1.142
sm800m	2.642	0.973	2.64	0.008	1.284	5.438
mi3avdwval	0.435	0.197	−1.83	0.067	0.178	1.059
hg3avdwval	0.251	0.110	−3.15	0.002	0.107	0.593
Model 7b	*Average dwelling value and median income*				$BIC = -916.9$	
Census blocks	1.100	0.023	4.50	0.000	1.056	1.147
sm800m	2.613	0.973	2.58	0.010	1.260	5.420
mi3avdwval	0.527	0.266	−1.27	0.205	0.196	1.418
hg3avdwval	0.556	0.343	−0.95	0.342	0.166	1.866
mi3medinc	0.989	0.478	−0.02	0.982	0.384	2.552
hg3medinc	0.373	0.223	−1.65	0.098	0.116	1.201
Model 8a	*Public transit*				$BIC = -921.7$	
Census blocks	1.096	0.022	4.58	0.000	1.054	1.139
sm800m	2.780	1.022	2.78	0.005	1.353	5.714
mi3pubtran	2.089	0.838	1.84	0.066	0.952	4.585
hg3pubtran	3.303	1.427	2.77	0.006	1.416	7.701
Model 8b	*Public transit and median income*				$BIC = -916.7$	
Census blocks	1.096	0.022	4.51	0.000	1.053	1.141
sm800m	2.626	0.982	2.58	0.010	1.261	5.466
mi3pubtran	1.490	0.641	0.93	0.354	0.641	3.464
hg3pubtran	1.810	0.918	1.17	0.243	0.669	4.894
mi3medinc	0.836	0.381	−0.39	0.694	0.342	2.042
hg3medinc	0.343	0.169	−2.18	0.030	0.131	0.899
Model 9a	*Total population*				$BIC = -917.5$	
Census blocks	1.089	0.022	4.24	0.000	1.047	1.133
sm800m	2.595	0.942	2.63	0.009	1.274	5.284
mi3tpop	2.110	0.873	1.80	0.071	0.938	4.750
hi3tpop	2.062	0.877	1.70	0.089	0.896	4.746
Model 9b	*Total population and median income*				$BIC = -918.1$	
Census blocks	1.089	0.023	4.08	0.000	1.046	1.134
sm800m	2.480	0.932	2.42	0.016	1.187	5.182
mi3tpop	2.031	0.886	1.63	0.104	0.864	4.773
hi3tpop	1.746	0.778	1.25	0.211	0.729	4.184
mi3medinc	0.683	0.313	−0.83	0.406	0.278	1.678
hg3medinc	0.256	0.111	−3.13	0.002	0.109	0.601

SE, standard error. CI, confidence interval.
sm800m, at least one census block in neighborhood has a supermarket within 800 m.
'mi3' indicates middle tercile of variable, 'hi3' indicates highest tercile of variable.
vismin, % visible minority residents in neighborhood.
medinc, median family income ($ Canadian).
vismin, % visible minority residents in neighborhood.
lowinc, % residents below low-income cut-off in neighborhood.
lonpar, % lone parent families.
rent, % renting households in neighborhood.
avdwval, average dwelling value ($ Canadian).
pubtran, % public transportation commuters in neighborhood.
tpop, total population of neighborhood.

[a]Results are reported for indicator variables with p-values $\leqslant 0.10$ with the lowest tercile as the reference category with odds ratios (OR) equal to 1.

[b]BIC, Bayesian Information Criteria. Lower BIC values indicate better model fit.

across terciles of renters, with OR = 2.56 for the middle tercile and OR = 5.31 for the highest tercile (Table 3, Model 6a). As indicated by the smallest BIC measure (−928.7), the renters model was the best fitting model for fast food exposure, followed by the lone parents model. And, similar to the lone parent model, the percentage of renters was a better predictor of fast food exposure than income, and retained statistical significance when median income was included in the model (Model 6b). For average dwelling value, the highest tercile had 74.9% lower odds of fast food within 500 m than the lowest tercile (Table 3, Model 7a). The effect of dwelling value, however, was not independent of median income, and lost significance when income was added to the model (Model 7b).

Urbanization

The percentage of residents using public transportation for commuting to work was higher in neighborhoods with a fast food outlet within 500 m than for those without (Table 1). Total population, the number of census blocks, and population density were all statistically significantly higher for those areas with an accessible supermarket or fast food outlet. Although mean density was slightly higher in areas with a proximate supermarket and fast food outlet than for the city as a whole, neighborhoods without close access to these facilities had notably lower population densities. In areas without a fast food outlet within 500 m population density was 85% of the city-wide mean, while in those without a supermarket within 800 m, density was markedly lower at 51.5% of the city mean (Table 1). Thus low population density was a better indicator of limited supermarket exposure than of limited fast food exposure.

In the logit models, the only urbanization variable associated with supermarket exposure was census blocks, which were used in the base models. In the fast food models, the odds of exposure increased across terciles of public transportation commuters, with OR point estimates of 2.09 for the middle and 3.3 for the highest tercile (Table 3, Model 8a). When median income was included, public transportation lost significance (Model 8b).

Differential distribution of supermarkets and fast food outlets

Neighborhoods without a supermarket had larger populations than those without a fast food outlet, but notably lower population densities (Table 1). And, the role of market area as measured by the number of census blocks was higher for fast food outlets (OR = 1.103) than for supermarkets (OR = 1.025). Even though supermarkets require larger land parcels to support their retail and parking needs, low population density appears to be more of a deterrent to the siting of a supermarket than a fast food outlet, reflecting the larger consumer base needed to support a supermarket than a fast food outlet. Neighborhoods with sufficient consumer base to support a supermarket were highly favorable for fast food retail activity.

Neighborhood socioeconomic variables were greater predictors of the odds of exposure to a fast food outlet than to a supermarket in Edmonton. Fast food outlet exposure, much more so than supermarket exposure, was higher in deprived areas. Mean rates of unemployment and renting households were statistically higher in neighborhoods with at least one census block with a supermarket within 800 m than for those without. Population density and total population were also higher in areas with a proximate supermarket than without one. However, after controlling for the number of census blocks per neighborhood and proximity to a fast food outlet, none of the socioeconomic, ethnicity, or urbanization variables affected the odds of encountering a supermarket within 800 m of a residential neighborhood in Edmonton. For fast food outlets, however, nearly all of the variables evaluated, with the exception of percentage of visible minorities and of recent immigrants, indicated deprived neighborhoods had higher odds of exposure to a fast food outlet within 500 m of one or more census blocks. Neighborhoods with lower SES as well as those with higher percentages of Aboriginal, lone parent, or elderly residents were more likely to have a proximate fast food outlet than were higher SES neighborhoods. After controlling for number of census blocks and supermarket proximity, a range of census variables, including median income, dwelling value, percentage of renters, and percentage of public transportation commuters, remained significant predictors of the odds of exposure to a fast food outlet.

The role of wealth, as measured by median income and housing value, was different in supermarket than in fast food outlet location in Edmonton. In the 120 neighborhoods without a proximate supermarket, the average median income was $64,217 and the average dwelling value was

$152,921. These values were not significantly different than the city-wide means. For those 75 neighborhoods without a proximate fast food outlet, however, average median income was $71,159 and average dwelling value was $168,049, both notably higher than for the city as a whole (Table 1). Thus fast food outlets were less likely to locate in higher wealth areas than supermarkets were.

To explore the role of SES variables in the differential distribution of supermarkets and fast food outlets in more detail, we performed a stratified analysis of economically developed areas comparing differences in median income, percentage of lone parents, and percentage of renters for neighborhoods with and without a supermarket or fast food outlet. We used exposure to two or more fast food outlets within 500 m of at least one census block, or one or more supermarket within 800 m of at least one census block, as a rough proxy for economic development in the stratified analysis. The presence of these food outlet types indicates the area is being used for retail, and thus is more favorable for additional food retail activity (e.g., Town Centres in Edmonton often include a supermarket, fast food and full service restaurants, small shops, and services such as a dry cleaner, movie rental, or liquor store). First, we analyzed the subset of neighborhoods with exposure to a supermarket, and compared differences in the three SES variables for neighborhoods with and without exposure to a fast food outlet. We did the same thing for those neighborhoods exposed to two or more fast food outlets, comparing neighborhoods with and without a proximate supermarket. For neighborhoods with a supermarket, median income was lower and the percentages of lone parents and renters were higher in neighborhoods with exposure to a fast food outlet than those without one (Fig. 1a). For neighborhoods with two or more fast food outlets, those with a supermarket had slightly higher SES, including significantly ($p < .05$) lower percentage of renters than those without a supermarket (Fig. 1b). Thus in neighborhoods with retail activity, low SES neighborhoods were less likely to have a supermarket but more likely to have a fast food outlet.

Discussion

Our results show that, although the locations of supermarkets and fast food outlets in Edmonton are related (with each facility type predicting the odds of the location of the other), their distribution differs with respect to neighborhood-level sociodemographic factors. SES does not appear to be an independent factor in Edmonton's distribution of supermarkets—that is, supermarkets are not systematically absent from low SES neighborhoods. This finding is similar to those from New Zealand (Pearce et al., 2007) and some UK studies (Clarke et al., 2002; Cummins and MacIntyre, 1999). In comparison, US research from a range of locales has shown that low SES neighborhoods, particularly those in the inner city, have lower supermarket accessibility than those with higher SES (Cotterill and Franklin, 1995; Curtis and McClellan, 1995; Eisenhauer, 2001; Morland et al., 2002). Although we did not find evidence of city-wide socioeconomic inequity in the distribution of supermarkets in Edmonton, the stratified analysis revealed some similarities to US findings, albeit to a lesser degree. Among neighborhoods with retail activity, those with lower median income and higher rates of lone parents and renters were less likely to have a supermarket than higher SES areas.

Despite increasing globalization and convergence of supermarket industry trends, the international variations found between neighborhood-level SES and supermarket accessibility suggest that different sociodemographic, market, and legislative processes underlie the differential distribution of supermarkets within various countries. In comparison, studies of SES and fast food outlets from different countries have all found greater exposure to fast food outlets in lower SES areas (Reidpath et al., 2002; Morland et al., 2002; Block et al., 2004; Cummins et al., 2005; Lewis et al., 2005; Pearce et al., 2007; Hemphill et al., in press).

The differential distribution of supermarkets and fast food outlets with regard to neighborhood-level SES is to be expected to some extent in that the processes affecting the site selection and ongoing operation of a supermarket differ from those for a fast food outlet. The retail history of these two food outlet types also is quite different. Fast food retailers target children and youth in their advertising, and they select restaurant locations that are accessible and proximate to their target demographic (Austin et al., 2005). Deprived areas, where retail services (including supermarkets) are scarce, may be particularly attractive for fast food outlets to operate because of lower rents, a less competitive retail climate, and often less restrictive land use regulations (Kwate, 2008). While the total number of fast food outlets has increased over time, the

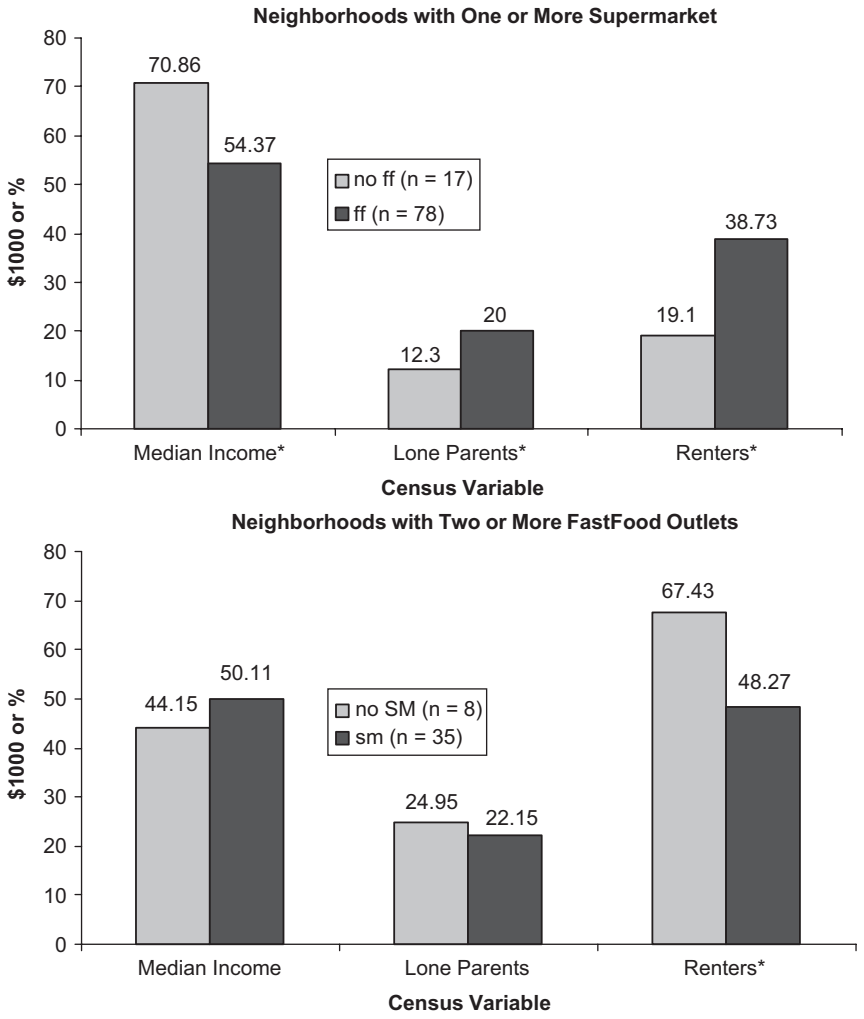

Fig. 1. (a) Socioeconomic characteristics of neighborhoods by fast food outlet exposure for neighborhoods with one or more supermarket within 800 m of at least one census block. (b) Socioeconomic characteristics of neighborhoods by supermarket exposure for neighborhoods with two or more fast food outlets within 500 m of at least one census block. *Notes*: no ff = zero fast food outlets within 500 m of any census block in neighborhood. ff = one or more fast food outlets within 500 m of any census block in neighborhood. no sm = zero supermarkets within 800 m of any census block in neighborhood. sm = one or more supermarket within 800 m of any census block in neighborhood. *$p<0.05$ between fast food (supermarket) categories using Wilcoxon rank sum test of difference.

number of grocery stores and supermarkets has decreased due to pervasive restructuring within the supermarket industry dating back to the 1950s (Guy, 1996a,b; Wrigley, 1998, 2002), including leveraged buyouts and firm mergers in the 1980s (Cotterill, 1992; Wrigley, 1999), and industry-wide differences between urban and suburban sites in insurance, financing, and wholesale prices (MacDonald and Nelson, 1991; Alwitt and Donley, 1997). Supermarkets have evolved from small grocery stores (30,000 ft^2 or less) providing essential food items to larger facilities offering an increasing array of services and non-food items. These industry-wide trends made many older stores in mature urban neighborhoods unprofitable, resulting in their closure. The result has been fewer but larger stores, which require larger land parcels and a greater consumer base (Cotterill, 1992). Suburban locations with their cheaper and more readily available land, have become increasingly appealing for new superstore, combination store, and warehouse store formats (with newer combination stores averaging over 58,000 ft^2) (Cotterill, 1992; Eisenhauer, 2001). Although many older and smaller urban supermarkets closed in Edmonton, there have been a handful of new supermarket

openings since the late 1990s in mature neighborhoods corresponding with Business Revitalization Zone economic development efforts.

As with any cross-sectional study, this study presents a single time-slice of food retail locations in relation to neighborhood-level housing and socio-demographic patterns. Spatial analysis of supermarket and fast food outlets, as with any measure of retail activity, is constrained in that the location of the variable of interest is not independent of the history of the spatial economy that has preceded it. Thus we cannot from this study directly infer whether or not fast food outlets deliberately located in low SES neighborhoods, or if their location there is a consequence of economic development. However, comparison of variables predictive of the odds of supermarket or fast food outlet exposure suggest that different factors affect the distribution of the two retail types in Edmonton, as has been suggested in other research. Low land rents make certain neighborhoods more affordable, resulting in greater concentrations of low SES populations. These areas would also be expected to have lower commercial land rents as well, and the distribution of fast food outlets in Edmonton shows that fast food retailers are operating in these areas. Market forces and trends in economic development, whether deliberate or unintended, are not conducive to supportive local food environments for vulnerable populations.

Fast food outlet exposure and vulnerable populations

Regardless of the reasons for the distribution of fast food outlets in Edmonton, persons living in Edmonton's lowest income neighborhoods are 2.3 times more likely to have a fast food outlet within a 5–10-min walk than those in the most affluent neighborhoods. Vulnerable populations including Aboriginals and lone parents living in low-income neighborhoods have fewer resources for reaching food retail outlets outside of the neighborhood.

Although fast food outlet exposure was higher in neighborhoods with higher percentages of Aboriginal residents, the variable lost statistical significance when median income was included, suggesting that income, rather than Aboriginal ethnicity is the more robust indicator of fast food exposure. Still, Aboriginal residents in Edmonton are vulnerable as they have lower average incomes and rates of employment and are more likely to reside in low-income neighborhoods than non-Aboriginals (Statistics Canada, 2001a). For example, in Alberta, off-reserve Aboriginal median income for individuals 15 and older was $11,742 compared to $21,879 for Alberta's non-Aboriginal population (Statistics Canada, 2001b). In Edmonton's low-income neighborhoods, greater exposure to fast food outlets, as well as higher exposure to low-cost, energy-dense foods from other sources, including food banks, may be a contributing factor to the higher prevalence of obesity among Canada's Aboriginal populations (Belanger-Ducharme and Tremblay, 2005).

Of particular interest is the elevated OR of fast food exposure for neighborhoods with high proportions of lone parents, even after controlling for income. The relationship appears linked to rental neighborhoods, as suggested by the strength of that variable in the fast food models. Lone parent families have lower median incomes than two-parent families, with median income for couple families of $62,663 compared to $31,950 for lone parents in Edmonton in 2000 (Statistics Canada, 2001b), offering fewer opportunities for home ownership and greatly constraining food budgets. Lone parent families are more likely to reside in high-rental areas, where the odds of fast food exposure are more than five times higher than in low rental areas. The implications for this high exposure to fast food, which is not offset by higher exposure to supermarkets, are that lone parent households have ample opportunity to purchase energy-dense, nutrient-low, prepared meals.

Research from Los Angeles has shown that in low-income neighborhoods with higher proportions of African American residents, restaurants and fast food outlets had fewer healthy food options available in terms of selection and preparation, and that unhealthy food options were strongly promoted (Lewis et al., 2005). In addition, lower prices per energy value for processed foods than healthier foods may encourage their purchase and consumption (Drewnowski and Specter, 2004). Thus not only is there higher exposure to fast food in low income than more affluent neighborhoods, but there is evidence from other locales suggesting that price along with food marketing in poor communities promotes consumption of less nutritious food options. Added to high exposure to fast food outlets are lower median income and time constraints as lone parents face the challenges of generating household income and caring for children without the benefit of a second partner. The literature has shown obesity is higher in areas where

fast food outlets are more prevalent (Chou et al., 2004; Morland et al., 2006), and among lower SES groups (French et al., 2000). Thus, higher neighborhood exposure to fast food in areas with large lone parent family populations poses a risk for higher fast food consumption among low-income children and adolescents, and may be one factor in higher overweight and obesity rates found among low-income households (Blomquist and Bergstrom, 2007; Janssen et al., 2006; Oliver and Hayes, 2005; Phipps et al., 2006).

Our findings suggest that wealth and political power can 'buy' some degree of isolation from commercial activity, particularly from those uses that may be seen as undesirable. Similar to previous research in Edmonton (Hemphill et al., in press), our findings suggest that fast food outlets are a nuisance that can be avoided through residence in higher SES neighborhoods. Indeed, there have been protests over the opening of new fast food outlets in Edmonton (Barlow, 2002a, b) and elsewhere (National Post, 2000; Kitchener Record, 2002; Cambridge Reporter, 2002). In the United States, some towns have banned fast food outlets for aesthetic or traffic safety reasons (Mair et al., 2005), and more recently city councilors from New York's Bronx (Fernandez, 2006) and South Los Angeles (Wagenseller, 2007) have proposed limiting fast food restaurants in their districts as a way to counter growing obesity rates among low SES populations. Vulnerable populations in deprived neighborhoods may lack the social capital and political clout to form effective community coalitions to protest unwanted food retail operations or advocate for affordable, healthy food outlets in their communities. Thus social and political advocacy in support of these populations is needed to change the local food environment.

Conclusions

We found that in Edmonton, predominantly low wealth, renter-occupied, and lone parent neighborhoods have greater exposure to fast food outlets, which is not offset by better supermarket access. In Alberta, as in all of Canada, the public treasury covers the costs of health care. The levels of obesity beginning to appear in children and youth (Shields, 2006) have clear negative implications over the long run for the health care sector (Hampl et al., 2007). Since certain vulnerable populations may be exposed to unhealthy food near their residence, public policy debate on regulations to protect these populations, as well as to minimize long-term health care costs is warranted. Perhaps zoning bylaws should be considered to regulate the ability of fast food stores to cluster in low-income, single-parent neighborhoods, or to encourage a greater range of healthy, affordable food choices in fast food outlets. Such zoning bylaws would replicate regulations that have been enacted for public health reasons in other areas, such as requiring bars or even fast food outlets to be located a minimum distance from schools (Ashe et al., 2003).

Acknowledgments

The funding from this paper was provided by the Social Sciences and Humanities Research Council of Canada, GEOide, and Canadian Institutes for Health Research. We also thank Michael Haan, (statistical consultant), Sirina Hamilton (undergraduate research assistant) for their assistance with the research, and the anonymous reviewers for their insightful comments on this manuscript.

References

Alter, D.A., Eny, K., 2005. The relationship between the supply of fast-food chains and cardiovascular outcomes. Canadian Journal of Public Health 96 (3), 173–177.

Alwitt, L.F., Donley, T.D., 1997. Retail stores in poor urban neighborhoods. Journal of Consumer Affairs 31, 139–164.

Apparicio, P., Cloutier, M., Shearmur, R., 2007. The case of Montreal's missing food deserts: evaluation of accessibility to food supermarkets. International Journal of Health Geographics 6 Accessed 15 August 2007 from 〈http://www.ij-healthgeographics.com/content/6/1/4〉.

Ashe, M., Jernigan, D., Kline, R., Galaz, R., 2003. Land use planning and the control of alcohol, tobacco, firearms, and fast food restaurants. American Journal of Public Health 93, 1404–1408.

Austin, S.B., Melly, S.J., Sanchez, B.N., Patel, A., Buka, S., Gortmaker, S.L., 2005. Clustering of fast-food restaurants around schools: a novel approach of spatial statistics to the study of food environments. American Journal of Public Health 95, 1575–1581.

Barlow, E., 2002a. New McDonald's stirs resistance: anonymous handbills invite Garneau residents to 'unwelcoming' party. [Final Edition]. Edmonton Journal 5 August, B15.

Barlow, E., 2002b. New McDonald's outlet 'garish,' Coun. Phair says [Final Edition]. Edmonton Journal 6 August, B5.

Belanger-Ducharme, F., Tremblay, A., 2005. Prevalence of obesity in Canada. Obesity Reviews 6, 183–186.

Block, J.P., Scribner, R.A., DeSalvo, K.B., 2004. Fast food, race/ethnicity, and income. American Journal of Preventive Medicine 27 (3), 211–217.

Blomquist, H.K., Bergstrom, E., 2007. Obesity in 4-year-old children more prevalent in girls and in municipalities with a low socioeconomic level. Acta Paediatrica 96, 113–116.

Cambridge Reporter, 2002. Get your teeth into McDonald's protest: [Final Edition]. Cambridge, Ontario, 30 July, p. A4.

Cheadle, A., Psaty, B.M., Curry, S., Wagner, E., Diehr, P., Koepsell, T., Kristal, A., 1991. Community-level comparisons between the grocery store environment and individual dietary practices. Preventative Medicine 20 (2), 250–261.

Chou, S.Y., Grossman, M., Saffer, H., 2004. An economic analysis of adult obesity: results from the behavioral risk factor surveillance system. Journal of Health Economics 23, 565–587.

Clarke, G., Eyre, H., Guy, C., 2002. Deriving indicators of access to food retail provision in British Cities: studies of Cardiff, Leeds and Bradford. Urban Studies 39, 2041–2060.

Cotterill, R.W., 1992. The changing structure and performance of the food distribution system. Implications for low income urban consumers. Food Marketing Policy Issue Paper 1. Department of Agricultural and Food Resource Economics, University of Connecticut, 36pp.

Cotterill, R.W., Franklin, A.W., 1995. The urban grocery store gap. Food Marketing Issue Paper 8. Food Marketing Policy Center, University of Connecticut, 82pp.

Cummins, S., MacIntyre, S., 1999. The location of food stores in urban areas: a case study in Glasgow. British Food Journal 101 (7), 545–553.

Cummins, S.C.J., McKay, L., MacIntyre, S., 2005. McDonald's restaurants and neighborhood deprivation in Scotland and England. American Journal of Preventive Medicine 29 (4), 308–310.

Current, J.R., Schilling, D.A., 1987. Elimination of source A and B errors in *p*-median location problems. Geographic Analysis 19, 95–110.

Curtis, K.A., McClellan, S., 1995. Falling through the safety net: poverty, food assistance and shopping constraints in an American city. Urban Anthropology and Studies of Cultural Systems and World Economic Developments 24, 93–135.

Donkin, A.J.M., Dowler, E.A., Stevenson, S.J., Turner, S.A., 2000. Mapping access to food in a deprived area: the development of price and availability indices. Public Health Nutrition 3, 31–38.

Dowler, E., 2002. Food and poverty in Britain: rights and responsibilities. Social Policy and Administration 36 (6), 698–717.

Drewnowski, A., Specter, S.E., 2004. Poverty and obesity: the role of energy density and energy costs. American Journal of Clinical Nutrition 79, 6–16.

Eisenhauer, E., 2001. In poor health: supermarket redlining and urban nutrition. GeoJournal 53, 125–133.

Fernandez, M., 2006. A Proposal to Fight Obesity by Limiting the City's Fast-Food Restaurants. New York Times, late edition (East Coast), 24 September, p. 1.37.

French, S.A., Harnack, L., Jeffery, R.W., 2000. Fast food restaurant use among women in the pound of prevention study: dietary, behavioural and demographic correlates. International Journal of Obesity 24, 1353–1359.

Hampl, S.E., Carroll, C.A., Simon, S.D., Sharma, V., 2007. Resource utilization and expenditures for overweight and obese children. Archives of Pediatric and Adolescent Medicine 161, 11–14.

Harnack, L.J., Jefferey, R.W., Boutell, K.N., 2000. Temporal trends in energy intake in the United States: an ecologic perspective. American Journal of Clinical Nutrition 71, 1478–1484.

Hemphill, E., Raine, K., Spence, J.C., Smoyer-Tomic, K.E., in press. Exploring obesogenic food environments in Edmonton, Canada: Are socioeconomic factors related to fast-food access? American Journal of Health Promotion.

Hillsman, E.L., Rhoda, R., 1978. Errors in measuring distances from populations to service centers. Annals of Regional Science 7, 74–88.

Hodgson, M.J., Shmulevitz, F., Körkel, M., 1997. Aggregation error effects on the discrete-space *p*-median model: the case of Edmonton, Canada. The Canadian Geographer 41, 415–428.

Guy, C.M., 1996a. Corporate strategies in food retailing and their local impacts: a case study of Cardiff. Environment and Planning A 28, 1575–1602.

Guy, C.M., 1996b. Grocery store saturation in the UK—the continuing debate. International Journal of Retail & Distribution Management 24 (6), 3–10.

Janssen, I., Boyce, W.F., Simpson, K., Pickett, W., 2006. Influence of individual- and area-level measures of socioeconomic status on obesity, unhealthy eating, and physical inactivity in Canadian adolescents. American Journal of Clinical Nutrition 83, 139–145.

Jekanowski, M.D., Binkley, J.K., Eales, J., 2001. Convenience, accessibility, and demand for fast food. Journal of Agriculture and Resource Economics 26, 58–74.

Katzmarzyk, P.T., 2002. The Canadian obesity epidemic, 1985–1998. Canadian Medical Association Journal 166 (8), 1039–1040.

Kitchener Record, 2002. Teen activists take on fast-food giant; but others not upset by arrival of McDonald's: [Final Edition] by McArthur, G. Kitchener, Ontario, 29 July, p. B1.

Kolodinsky, J., Cranwell, M., 2000. The poor pay more? Now they don't even have a store to choose from: bringing a supermarket back to the city. Consumer Interests Annual 46, accessed 19 June 2004 from 〈www.consumerinterests.org/public/articles/poor.pdf〉.

Kumanyika, S., Grier, S., 2006. Targeting interventions for ethnic minority and low-income populations. Future Child 16, 187–207.

Kwate, N.O.A., 2008. Fried chicken and fresh apples: racial segregation as a fundamental cause of fast food density in black neighborhoods. Health & Place 14, 32–44.

Lewis, L.B., Sloane, D.C., Nascimento, L.M., Diamant, A.L., Guinyard, J.J., Flynn, G., Yancey, A.K., 2005. African Americans' access to healthy food options in South Los Angeles restaurants. American Journal of Public Health 95, 668–673.

MacDonald, J.M., Nelson Jr., P.E., 1991. Do the poor still pay more? Food price variations in large metropolitan areas. Journal of Urban Economics 30, 344–359.

Maddock, J., 2004. The relationship between obesity and the prevalence of fast food restaurants: state-level analysis. American Journal of Health Promotion 19, 137–143.

Mair, J.S., Pierce, M.W., Teret, S.P., 2005. The city planner's guide to the obesity epidemic: Zoning and fast food. Report, The Center for Law and the Public's Health. Johns Hopkins and Georgetown Universities. 9pp. Accessed 20 November 2007 from 〈http://www.publichealthlaw.net/Research/Affprojects.htm#Zoning〉.

Morland, K., Wing, S., Diez-Roux, A., Poole, C., 2002. Neighborhood characteristics associated with the location of food stores and food service places. American Journal of Preventive Medicine 22, 23–29.

Morland, K., Diez Roux, A., Wing, S., 2006. supermarkets, other food stores, and obesity: the atherosclerosis risk in communities study. American Journal of Preventive Medicine 30, 333–339.

National Post, 2000. McDonald's may be fine for Banff, but up the road in Jasper it's a different story, national edition. Don Mills, Ontario, February 29, 2000, p. A8

Nielsen, S.J., Popkin, B.M., 2004. Changes in beverage intake between 1977 and 2001. American Journal of Preventative Medicine 27, 205–210.

Nielsen, S.J., Siega-Riz, A.M., Popkin, B.M., 2002. Trends in food locations and sources among adolescents and young adults. Preventive Medicine 35, 107–113.

Oliver, L.N., Hayes, M.V., 2005. Neighbourhood socio-economic status and the prevalence of overweight Canadian children and youth. Canadian Journal of Public Health 96, 415–420.

Pearce, J., Blakely, T., Witten, K., Bartie, P., 2007. Neighborhood deprivation and access to fast-food retailing: a national study. American Journal of Preventive Medicine 32, 375–382.

Pereira, M.A., Kartashov, A.I., Ebbeling, C.B., Van Horn, L., Slattery, M.L., Jacobs Jr., D.R., Ludwig, D.S., 2005. Fast-food habits, weight gain, and insulin resistance (the CARDIA study): 15-year prospective analysis. Lancet 365, 36–42.

Phipps, S.A., Burton, P.S., Osberg, L.S., Lethbridge, L.N., 2006. Poverty and the extent of child obesity in Canada, Norway and the United States. Obesity Reviews 7, 5–12.

Raftery, A., 1995. Bayesian model selection in social research. Sociological Methodology 25, 111–163.

Regan, G., Lee, R.E., Booth, K., Reese-Smith, J., 2006. Obesogenic influences in public housing: a mixed-method analysis. American Journal of Health Promotion 20, 282–290.

Reidpath, D.D., Burns, C., Garrard, J., Mahoney, M., Townsend, M., 2002. An ecological study of the relationship between social and environmental determinants of obesity. Health and Place 8, 141–145.

Shields, M., 2006. Overweight and obesity among children and youth. Health Reports 17, 27–42.

Smoyer-Tomic, K.E., Spence, J.C., Amrhein, C., 2006. Food deserts in the prairies? Supermarket accessibility and neighborhood need in Edmonton, Canada. The Professional Geographer 58, 307–326.

Sooman, A.S., MacIntyre, S., Anderson, A. (Eds.), 1993. Scotland's health—a more difficult challenge for some? The price and availability of healthy foods in socially contrasting localities in the West of Scotland, Health Bulletin (Edin) 51, 276–284.

Statistics Canada, 2001a. Community Profiles. Edmonton, city. Accessed 10 June 2006 from 〈http://www12.statcan.ca/english/profil01/CP01/Index.cfm?Lang=E〉.

Statistics Canada, 2001b. Employment Income Groups (22) in Constant (2000) Dollars, Sex (3) and Aboriginal Groups (11) for Population 15 Years and Over, for Canada, Provinces and Territories, 1995 and 2000—20% Sample Data. 97F0019XCB2001048.

Statistics Canada, 2002. A national overview: population and dwelling counts. Statistics Canada, Census Operations Division, Geography Division, Ottawa, ON.

Statistics Canada, 2003. Food Statistics 2001. Accessed February 7, 2003 from 〈http://www.statcan.ca/english/freepub/21-020-XIE/free.htm〉.

Statistics Canada, 2005. Canadian Community Health Survey: obesity among children and adults, The Daily, July 6, 2005. Accessed June 8, 2006 from 〈http://www.statcan.ca/Daily/English/050706/d050706a.htm〉.

Swinburn, B., Egger, G., Raza, F., 1999. Dissecting obesogenic environments: the development and application of a framework for identifying and prioritizing environmental interventions for obesity. Preventive Medicine 29, 563–570.

Wagenseller, LT., 2007. Zone my love handles away, L.A. Los Angeles Times. Accessed 25 September, 2007 from 〈http://www.latimes.com/news/opinion/la-oe-wagen21sep21,0,3097447.story?coll=la〉.

Weinberg, Z., 2000. No place to shop: food access lacking in the inner city. Race, Poverty, and Environment (Winter), 22–24.

Wrigley, N., 1998. Understanding store development programmes in post-property-crisis UK food retailing. Environment and Planning A 30, 15–35.

Wrigley, N., 1999. Market rules and spatial outcomes: insights from the corporate restructuring of US food retailing. Geographic Analysis 31, 288–309.

Wrigley, N., 2002. 'Food deserts' in British cities: policy context and research priorities. Urban Studies 39, 2029–2040.

Wrigley, N., Warm, D.L., Margetts, B.M., 2003. Deprivation, diet and food retail access: findings from the Leeds 'food deserts' study. Environment and Planning A 35, 151–188.

Zenk, S.N., Schultz, A.J., Israel, B.A., James, S.A., Bao, S., Wilson, M.L., 2005. Neighborhood racial composition, neighborhood poverty, and the spatial accessibility of supermarkets in metropolitan Detroit. American Journal of Public Health 95, 660–667.