

The influence of fast-food restaurants surrounding homes and schools on measures of child and adolescent obesity: A Knowledge Synthesis

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Summary

- Rates of childhood overweight and obesity in Canada have increased substantially over the last 30 years
- Overweight and obesity in childhood is associated with reduced social and emotional well-being and increased risk of developing cardiovascular disease and type II diabetes in adulthood
- Interventions to combat the rising level of obesity in children have largely focussed on changing behavioural factors such as healthy eating and exercise at the individual level, with limited success
- Research has shown that components of the built environment encourage increased energy consumption and sedentary behaviour
- In recent years, fast-food restaurants have come under increased scrutiny for their role in contributing to the obesity epidemic
- Evidence to date suggests that the density of fast-food restaurants surrounding children's schools and homes *may* be associated with increased BMI, but is likely not associated with food consumption patterns or food purchasing behaviour
- Currently, there is little evidence to support policy decisions that limit the number or proximity of fast-food restaurants surrounding neighbourhoods and schools
- Additional, high quality longitudinal studies are needed to measure changes in food consumption patterns and food purchasing behaviour in children as their food environment changes over time

Introduction

Childhood obesity is one of the most pressing public health concerns of the 21st century (1). Its prevalence has increased substantially, both in Canada and abroad for the better part of the last three decades (2). According to results from the 2009 and 2011 Canadian Health Measures Survey, close to one third (31.5%) of all Canadian children between the ages five and 17 are overweight or obese (3). The health effects of overweight and obesity in childhood are significant and well-established. In addition to being at increased risk for developing insulin resistance and hypertension, overweight and obese children often experience diminished social and emotional well-being (3). Overweight and obesity are known to track into adulthood, increasing the premature onset of cardiovascular disease, type II diabetes and some cancers (4, 5). Presently, more than half of all adult Canadians are overweight or obese. If current trends continue, by the year 2040, it is estimated that more than 70% of Canadians over the age of 40 will be overweight or obese (6).

Interventions to combat the rising levels of obesity have typically focussed on preventing excess weight gain in childhood and adolescence by influencing individual level factors, such as diet and physical activity through behavioural intervention and education, with limited success (7). More recently, interventions have focussed on altering the environmental conditions that lead to obesogenic environments. That is, environments that foster and encourage sedentary behaviour and increased energy consumption (8). Much of this attention concerns the role the built environment plays in encouraging unhealthy lifestyle choices. A chief component of the built environment that has come under scrutiny in recent years for its part in contributing to the obesity epidemic, is fast-food restaurants.

Interestingly, the birth and growth of the fast food industry have paralleled the rise in obesity in much of western society (9). Between 1977 and 1996, there was a 300% increase in the percentage of calories ingested from fast-food restaurants among American adolescents (9). Research has shown that children and adolescents who consume fast food have higher daily levels of sodium, fat, carbohydrates and total energy intake (10). Given that the mobility of most children and adolescents is restricted to areas within walking or biking distance of their schools and homes, it is thought that the immediate food environment is highly influential on their dietary habits. Furthermore, fast-food restaurants tend to cluster around schools, and are increasingly prevalent in communities with high numbers of ethnic minority and socially deprived residents (11). To date, studies on the relationship between neighbourhood and community environments and obesity has focussed on adults. This review will explore the availability and accessibility of fast-food restaurants to homes and schools and their association with childhood overweight and obesity.

Methods

The evidence review was conducted on English, peer-reviewed literature using the web-based academic search tools: Primo (University of Guelph), Medline (PubMed) and Google Scholar. The search terms included a combination of: “Child and Adolescent,” “Fast-food restaurants,” “Overweight and obesity,” “Childhood obesity and schools,” “Neighbourhood environments,” “Food purchasing behaviour,” and “BMI.” Given the depth of evidence, and the word limit restrictions of the review, only journal articles proceeding 2010 were included. However, after scanning reference lists for relevant journal articles, a study from 2009 was added to the literature review as it is a highly cited article and important contributor to the body of evidence. All abstracts were screened and checked for relevance, and only studies that pertained

to children between the ages of five and 18 were included. Articles which measured the built environment surrounding the school or home were selected. This included any food store or catering establishment, but precluded food provision within the school (cafeterias). Outcome data were required to include at least one measure related to overweight and obesity, including: BMI, overweight or obesity status, body weight, food purchasing behavior or dietary intake. Studies are grouped according to these outcome measures.

Results and Discussion

Fast-food restaurants, BMI and body weight

Pedro and colleagues (2013) conducted a cross-sectional study to assess the effect of fast-food restaurants on childhood obesity in students from kindergarten through grade 10 in all Arkansas Public Schools. Researchers found that the addition of a fast-food restaurant within a one mile radius from a school increased obesity levels by 1.23 percentage points (12). Similarly, Gilliland and colleagues discovered that fast-food outlets within the local school neighbourhood were associated with significantly higher BMI z-scores in 1,048 students aged 10-14 from 20 schools in London, Ontario Canada (23).

To assess the impact of fast-foods within children's neighbourhood on bodyweight, Fraser and Edwards (2010) mapped fast-food restaurants using GIS software and assessed the proximity and density of these outlets to children's residences. They determined that the distance from a youth's residence to the nearest fast-food restaurant (proximity) was not associated with obesity; however the number (density) of fast-food restaurants was associated with the likelihood of being overweight or obese (17). In a similar study, from the UK, researchers divided food outlets into three categories: BMI-healthy, BMI-unhealthy and BMI-

intermediate, based on the quality of food items offered at these establishments (18). Results indicated that children who lived in neighbourhoods with an availability of BMI-unhealthy outlets, had on average, a body weight that was 1.3kg higher and a BMI that was 0.4kg/m² larger, than children who did not have easy access to a fast-food restaurant (18).

To determine if the availability of food is a risk factor for obesity, Helen Lee (2012) used a multi-level longitudinal modeling framework to investigate children's weight transitions over time. Results suggested that the density and proximity of fast-food restaurants was not independently related to weight gain over time. In other words, children and adolescents who were either in close proximity to fast-food establishments or had a large number of them within their neighbourhood did not have an increased risk of becoming overweight or obese (20).

Although the cross-sectional studies suggest a positive relationship between the number of fast-food outlets accessible to children and their BMI and weight status, there may be other plausible explanations for these results. Since, researchers did not assess the food consumption patterns of youth, or the frequency which students purchased and ate food products from these outlets, it is possible that fast-food establishments purposefully locate near overweight consumers or that overweight consumers choose to purchase homes in locations that are in close proximity to fast-food restaurants (12). Furthermore, the proximity of fast-food restaurants to children's schools and neighbourhoods may be an indicator of other factors that are directly correlated with BMI, such as the economic development surrounding the school or neighbourhood (13).

Fast-food restaurants and food consumption patterns

To determine whether the food consumption patterns of youth differed based on their proximity to fast-food restaurants, Davis and Carpenter (2009) analyzed the California Health Kids Survey to collect data on more than 500,000 middle and high school students across California. Investigators discovered that youth who had at least one fast-food outlet within a half mile radius of their school, ate fewer servings of fruit and vegetables, consumed more soda and were more likely to be overweight and obese compared with youths who did not have a fast-food restaurant close by (13). However, no relationship existed between BMI, fast-food consumption or body weight and fast-food restaurants in radii greater than a half mile from the school (13). Perhaps any distance greater than one half mile is too far for youth to travel during a recess or lunch break, and should not be considered within the immediate school environment.

Melissa Laska and her colleagues (2010) investigated the relationship between the proximity and density of food outlets in school and home environments and dietary consumption patterns, BMI and body fat percentage. They found no significant associations between food consumption patterns, macronutrient levels, total energy intake or fast-food purchasing behaviour and the proximity or density of fast-food restaurants (22). Similarly, Ruopeng and Sturm (2012) reported no association between the consumption patterns of children and adolescents and the density of fast-food restaurants located within 0.1 and 0.5 miles of children's schools (15). In addition, researchers analyzed the density of grocery stores and food markets within 0.1 and 0.5 miles of the schools. They discovered that students in school neighbourhoods with significantly higher numbers of healthy food markets did not have improved diet quality or a reduced BMI compared to students from schools with few healthy food outlets located nearby (13).

To measure food consumption changes over time, Fraser and his colleagues (2012) assessed parent reported consumption of fast-food, fast-food density and proximity, as well as BMI, body fat percentage, obesity status and dietary patterns at age 13 and age 15, in 4827 adolescents from the former Avon Region of the UK. Results indicated that eating fast-food at age 13 was associated with a 23% increased chance of being obese at age 15 (16), providing additional evidence for the well-established longitudinal association between the consumption of fast-food and obesity (2). Higher fast-food accessibility, as measured by neighbourhood proximity and density of fast-food restaurants was positively associated with increased consumption of fast-food in two rural regions, but was negatively associated with regions in the north and south of Bristol (16). These conflicting findings suggest that there may be a spatial variation in the effect of fast-food restaurants in measures of overweight and obesity.

Important to note is that these researchers did not assess whether these consumption patterns reflected food purchased at fast-food restaurants, or food brought from home. The fact that a child has a BMI-healthy or BMI-unhealthy establishment close to home does not necessarily indicate that they eat at these locations, or that differences in their weight and BMI can attributed to the food consumed at these establishments.

Fast-food restaurants and indices of healthy eating

He and colleagues (2012) used food frequency questionnaires to assess children's diets over the previous 12 months, and the Healthy Eating Index to measure their overall diet quality. Results showed that those students who attended schools with three or more fast-food restaurants within a 1km radius had lower HEI scores than did students from schools without a fast-food

restaurant within 1km (19). The proximity of supermarkets and grocery stores was not associated with the HEI scores of children in this study sample (19).

Fast-food restaurants and food purchasing behaviour

Most studies have focussed on the association between overweight and obesity and the accessibility of fast-food restaurants, failing to investigate the actual food purchasing behaviour of individuals at these establishments. To assess whether adolescents who live or attend school near fast-food restaurants eat more frequently at these establishments, Ann Forsyth and her colleagues (2012) assessed the consumption patterns of 2724 secondary school students in Minnesota, USA. Researchers found that the boys, but not girls who lived and went to school in areas with the highest density of fast-food restaurants (11+ within 1600m) ate more frequently at these establishments than with boys who lived and went to school in neighbourhoods with fewer fast-food outlets (14). However, the results were insignificant at densities less than 11 fast food restaurants within 1600m from the school.

Socio-demographic influences on fast-food consumption

The evidence is clear: fast-food restaurants tend to cluster in neighbourhoods with a high number of socially deprived, low income and minority residents (14). Studies indicate Caucasians and Asians have significantly fewer fast-food restaurants within 1600m of their home than Native Americans, Hispanics and African-Americans, even after adjusting for SES (14). Adolescents living in neighbourhoods with a median household income lower than the national average have an average of 6.6 fast-food restaurants within 1600m of their home compared with an average of 4.8 for families in high income brackets (14). These families have the highest

risk of developing obesity and the fewest resources available to influence their immediate food environment (20).

According to Lee (2012), in their first year of formal schooling, students who lived in poor ethnic communities had significantly more fast-food establishments within walking distance than their white, affluent counterparts (20). Investigators found that children's BMI increased from kindergarten through to grade 5, but increased at a much greater rate for poor, Black and Hispanic children. Modelling revealed that it was not the accessibility of healthy food outlets, nor the inaccessibility of unhealthy food stores that was protective of weight gain over time. Researchers discovered that parent's income at the highest level and maternal education were two factors which protected against excessive weight gain in childhood (20). This result is not surprising, as increased SES has been associated with a decreased frequency of eating at fast-food restaurants (14). Perhaps interventions targeting socio-demographic characteristics may be more successful in combating childhood obesity than initiatives that improve the accessibility of healthy food outlets or that limit exposure to unhealthy establishments (20).

Limitations

Several methodological limitations were present in the studies discussed in this evidence review. Much of the research concerning the association between the presence of fast-food restaurants and the incidence of childhood obesity is cross-sectional. Since cross-sectional studies are carried out at one point in time, they cannot infer causality. They are susceptible to confounding and are unable to determine the direction of association (24). In many of the studies reviewed, measurement bias is likely. Information pertaining to the dietary habits of children and adolescents was reported by their parents, who may not provide an accurate

depiction of the fast-food items consumed by their children (16). In some cases, dietary recalls included single item questions without the use of serving size to gauge consumption patterns (14). Data that assessed youth's fast-food consumption patterns did not specify the types of foods eaten at these locations. Many fast-food outlets now offer healthy alternatives to the typical high fat, low micronutrient options (16). To determine the location of food establishments, many investigators used commercial and business listings; however some addresses did not reflect the actual locations of fast-food restaurants (15). Furthermore, there is currently no agreed upon definition of fast-food in the literature, making comparison between studies difficult (20).

Conclusions and Policy Implications

This review summarizes the evidence for the influence of fast-food restaurants on childhood and adolescent obesity. Evidence to date suggests that BMI and weight gain *may* be positively correlated with the prevalence of fast-food restaurants located near youth's schools and homes. However, there is little evidence to suggest that food consumption patterns or food purchasing behaviour is influenced by the number or location of fast-food restaurants. Inconsistencies in study findings may be attributable to methodological limitations, such as failing to account for other factors of the built environment which may influence weight gain and fast food consumption (18). There is consistent evidence that low income, high minority populations have significantly more fast-food restaurants near their homes and schools (14). However, at this point, the scientific evidence does not support policies to limit the number of fast-food restaurants surrounding children's homes and schools. High quality, longitudinal studies are required to measure changes in food consumption patterns and food purchasing behaviour of children as the food environment changes over time.

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Appendix: Article Summaries

Article Title	Methodology	Key Findings
<p>The effect of fast-food restaurants on childhood obesity: a school level analysis</p>	<p><i>Study Type:</i> cross-Sectional</p> <p><i>Participants and Setting:</i> Students from KG through grade 10 in all Public Schools in Arkansas, USA</p> <p><i>Outcome Measures:</i> BMI of students</p> <p><i>Explanatory Variables:</i> # of fast food restaurants within a one mile radius of Arkansas Public Schools</p>	<p>-The goal of this study was to determine the impact that the density of fast food restaurants have on the rates of obesity in children from Arkansas Public Schools</p> <p>- Researchers controlled for: the enrollment proportions of each even grade for which BMI data was collected, gender, race and those students who were eligible for a free or reduced lunch program.</p> <p>- Researchers concluded that the addition of a fast-food restaurant within a 1 mile radius from a school increases school obesity rates by 1.23 percentage points (statistically significant).</p>
<p>Proximity of Fast-Food Restaurants to Schools and Adolescent Obesity</p>	<p><i>Study Type:</i> cross-sectional</p> <p><i>Participants and Setting:</i> 500,000+ youth (middle school and high school students) from California, USA.</p> <p><i>Outcome Measures:</i>, Youth's weight (BMI), overweight, obesity and food consumption measures</p> <p><i>Explanatory Variables:</i> The presence and number of fast-food restaurants near schools</p>	<p>- Researchers controlled for gender, age category, grade and race/ethnicity, youth's physical activity and exercise regimen, school and contextual characteristics, including school type (middle vs high school), the proportions of students eligible for free or reduced price meals, school location types, urban vs rural locations,</p> <p>- Researchers found that fast-food restaurants within one half mile of their school consumed fewer servings of fruits and vegetables, consumed more soda and were more likely to be overweight [OR] = 1.06, [CI] = 1.02, 1.10 and obese [OR] = 1.07, [CI] = 1.02, 1.12 that youths that were not near fast-food restaurants. Black students (but no other racial minorities) had a higher association between being near a fast food restaurant and BMI compared to all students.</p> <p>- There was no statistically significant relationship between the number of fast-food restaurants within one half mile of a school and a student's BMI. Also, there was no relationship between weight, BMI or food consumption patterns for fast-food restaurants between one half mile and three quarter miles from the school.</p>

<p>Do adolescents who live or go to school near fast-food restaurants eat more frequently from fast-food restaurants?</p>	<p><i>Study Type:</i> cross-sectional</p> <p><i>Participants and Setting:</i> 2724 racially and ethnically diverse youth from 20 secondary schools in Minneapolis/St. Paul, Minnesota, USA</p> <p><i>Outcome Measures:</i> fast food consumption patterns of adolescents</p> <p><i>Explanatory Variables:</i> The presence and # of fast food restaurants within 800, 1600 and 3000m school and neighbourhood buffer zones and</p>	<p>-Social demographic characteristics were self-reported by adolescent participants, including their gender, age, race/ethnicity and measures of socioeconomic status and were controlled for.</p> <p>- The # of fast-food restaurants within a 1600m network buffer of homes was found to differ according to socio-demographic characteristics of students. Analyses showed that Whites and Asians had 1.2 to 1.7 fewer fast food restaurants near their homes than Hispanic, Native American and African American students ($p < 0.05$), even after adjusting for gender, SES and grade level. Adolescents with lower individuals-level SES were more likely than others to have a higher number of fast food restaurants within 1600m of their home.</p> <p>- Adolescents living in census tracts with lower than the sample median household income had on average 6.6 fast food restaurants within the 1600m buffer zone, which was significantly higher than neighbourhoods with higher incomes (4.8 fast food restaurants) ($p < 0.0001$).</p> <p>- Boys, but not girls from such areas with the highest numbers of fast food restaurants ate from fast food restaurants significantly more often than those who had lower numbers of fast food restaurants in their neighbourhoods.</p>
<p>School and Residential Neighbourhood Food Environment and Diet Among California Youth</p>	<p><i>Study Type:</i> cross-sectional</p> <p><i>Participants and Setting:</i> 8226 children (aged 5-11) and 5236 adolescents (aged 12-17) from California, USA.</p> <p><i>Outcome Measures:</i></p> <ul style="list-style-type: none"> - Self-reported consumption of fruits, vegetables, juice, milk, soda, high-sugar foods and fast foods among children and adolescents - BMI of children and adolescents 	<ul style="list-style-type: none"> - Parent reported (for children) and self-reported (for adolescents) height and weight were used to calculate age and gender specific BMI percentile - Researchers controlled for gender, age, race/ethnicity, household size, annual household income, parent's education and parent's BMI - ArcMap, a geospatial program captured the location of student's schools and homes. Researchers used a buffer of 0.1, 0.5, 1.0 and 1.5 miles from these locations to assess the # and density of fast-food restaurants. - No statistically significant associations were found for the consumption patterns of children and adolescents and their proximity to a fast-food restaurant at either home or at school. - Researchers found no evidence to support the hypothesis that improved access to supermarkets, or reduced exposure to fast-food restaurants or convenience stores within walking distance, improves diet quality or reduces BMI among California youth.

	<p><i>Explanatory Variables:</i></p> <ul style="list-style-type: none"> - Counts and density of fast-food businesses (distinguishing fast-food restaurants, convenience stores, small food stores, grocery stores and supermarkets within 0.1 to 0.5 miles from a youth's home and school) 	
<p>Fast Food and Obesity: A Spatial Analysis of in a large United Kingdom Population of Children Aged 13-15</p>	<p><i>Study Type:</i> longitudinal</p> <p><i>Participants and Setting:</i> 4827 adolescents who live within the former Avon Region of the United Kingdom. (Participants within the Avon Longitudinal Study of Parents and Children (ALSPAC))</p> <p><i>Outcome Measures:</i></p> <ul style="list-style-type: none"> - Parent-reported consumption of fast-food at age 13 again at age 15 - BMI SD score, body fat % and obesity status <p><i>Explanatory Variables:</i></p> <ul style="list-style-type: none"> - Fast food accessibility score (proximity and density of FF restaurants) - Fast food consumption patterns 	<ul style="list-style-type: none"> - Data on participant dietary patterns were taken from a food frequency questionnaire completed by the adolescent's mother or caretaker - Researcher developed a formula, the "cumulative opportunities measure" to generate an accessibility score that takes into consideration: the # of FF outlets within a given distance (density) and the walking distance to the nearest FF restaurant (proximity) - Fast-food consumption was associated with a 2% increase in body fat percentage - Deprivation was positively associated with being obese. Eating fast food is associated with a 23% increase in being obese - Higher fast-food accessibility, as measured by the accessibility score was positively associated with increased consumption in two rural areas, but negatively associated in regions to the North and South of Bristol. - The rural area to the southwest of the study region with the positive association is for the most part not deprived, although it is close to the deprived town of Weston Super-Mare. The area in the north of the city of Bristol with the negative association (i.e., higher access, lower consumption) is more urban and densely populated, with higher deprivation.

<p>The Association between the geography of fast food outlets and childhood obesity rates in Leeds, UK</p>	<p><i>Study Type:</i> cross-sectional</p> <p><i>Participants and Setting:</i> 33594 children between the ages of 3-14 from Leeds in West Yorkshire, UK</p> <p><i>Outcome Measures:</i></p> <ul style="list-style-type: none"> - The weight status of the child: overweight, obese or normal weight <p><i>Explanatory Variables</i></p> <ul style="list-style-type: none"> - The # of fast food outlets per area (density) and the distance to the nearest fast food outlet from a child`s home address (proximity) 	<ul style="list-style-type: none"> - A deprivation score (index of multiple deprivation) was assigned to each child by linking their home address postcode to their area of residence - Results showed that there was a significant positive correlation between the # of FF outlets and deprivation score, whereby children who lived in more deprived areas had more FF outlets in their neighbourhood. (p<0.001). - There was no significant association between the distance to the nearest FF outlet (proximity) and whether the child was obese or not. However, there was a significant association between the # of FF outlets per neighbourhood and the likelihood of being overweight or obese.
<p>Local Food Outlets, Weight Status, and Dietary Intake: Associations in Children Aged 9-10 years</p>	<p><i>Study Type:</i> cross-sectional</p> <p><i>Participants and Setting:</i> 1669 children aged 9-10 years from 90 schools within Norfolk, United Kingdom</p> <p><i>Outcome Measures:</i></p> <ul style="list-style-type: none"> -Bodyweight, BMI, waist circumference, percentage body fat - Dietary intake <p><i>Explanatory Variables:</i></p>	<ul style="list-style-type: none"> - To measure the quality of the local food environment, food outlets were classified into BMI-healthy, BMI unhealthy and BMI-intermediate categories. Supermarkets and fruit and vegetable stores were classified as BMI-healthy and takeout/fast-food outlets and convenience stores as BMI-unhealthy. Non fast food restaurants and other food shops were classified as BMI intermediate, as the available information was insufficient to place them in either of the other two categories - Results indicated that body weight was 1.3kg lower in children who had availability of BMI-healthy outlets compared to those with no availability, their BMI was 0.5kg/m squared lower, waist circumference was 1.3cm lower and percentage of body fat was 1.1% lower - For those with availability of BMI-unhealthy outlets, body weight was 1.3kg higher, BMI 0.4kg/m squared higher, waist circumference was

	<ul style="list-style-type: none"> - The # of fast food outlets per area (density) and the distance to the nearest fast food outlet from a child's home address (proximity) 	<ul style="list-style-type: none"> 1.1cm higher and percentage body fat was 1% higher. - However, there were no significant associations between the availability of BMI-healthy, unhealthy and or intermediate outlets and prevalence of overweight or obesity - Children with availability of BMI-unhealthy outlets in their neighbourhoods had diets containing more fizzy drinks ($p=0.042$), and noncarbonated "fruit" drinks ($p=0.031$). The inverse was true when children had access to BMI-healthy food outlets
Obesogenic neighbourhoods: the impact of neighbourhood restaurants and convenience stores on adolescent's food consumption patterns	<p><i>Study Type:</i> cross-sectional</p> <p><i>Participants and Setting:</i> 810 grade 7 and 8 students from 21 elementary schools in London, Ontario Canada</p> <p><i>Outcome Measures:</i></p> <ul style="list-style-type: none"> -Children's diets – as measured by the HEI <p><i>Explanatory Variables:</i></p> <ul style="list-style-type: none"> - Proximity and density of fast food restaurants and convenience stores within the proximity of a child's home 	<ul style="list-style-type: none"> - The modified Healthy Eating Index (HEI) was used to assess participant's overall diet quality - Fast-food restaurants were defined as restaurants where one orders at a counter and pays in advance for one's food - Students whose homes were further than 1km from the nearest convenience store had a higher HEI score than those who lived within 1km ($p<0.05$). Students who attended schools that were further than 1km from the nearest convenience store ($p<0.05$) and fast food outlet ($p<0.01$) had higher HEI scores than those whose schools were within 1km of such establishments. Students attending schools with three or more fast-food outlets within 1km had lower HEI scores than those with non in the school surroundings ($p<0.05$). - The distance from home to the nearest supermarket was not associated with diet quality scores among the adolescents in our study.
The role of local food availability in explaining obesity risk among young school aged children	<p><i>Study Type:</i> longitudinal</p> <p><i>Participants and Setting:</i> 11400 children in Kg through to grade 5</p> <p><i>Outcome Measures:</i></p> <ul style="list-style-type: none"> -Children's BMI change over time 	<ul style="list-style-type: none"> - On average, children's BMI percentile rankings grew over the course of the elementary school years (Kg – Gr 5), but this increase was notably higher for poor, Black and Hispanic minority children compared to their non-poor and white counterparts. - In the year that children begin formal schooling, children who reside in poor and non-white areas have greater access to fast-food establishments and convenience stores in terms of density per land area. However, less

	<p><i>Explanatory Variables:</i></p> <ul style="list-style-type: none"> - The total number of outlets per type per square mile in the tract (density per land area) - The total # of store types or restaurants per capita (density per population) and the percent of each establishment type out of all food outlets found within the neighbourhood (percent shares) 	<p>affluent and minority areas also have significantly greater access to food establishments that are not linked to obesity risk, including large-scale grocery stores and full service restaurants.</p> <ul style="list-style-type: none"> - The % of large-scale grocery stores out of all food establishments is identical across neighbourhood poverty status and racial/ethnic composition, whereas corner stores have a larger presence in poor and non-white neighbourhoods. - Results suggested that food outlet exposure holds no independent relationship to child weight gain, even in the simplest model. - All model results imply that children who experienced greater exposure to fast-food or convenience food establishments in their home neighbourhoods are no more likely to gain excess weight than their counterparts who experience less exposure. - Maternal education at the highest level was significantly protective of weight gain over time in adjusted models, as well as income at the highest levels (although not statistically significant at the 5% level).
<p>Neighbourhood food environments: are they associated with adolescent dietary intake, food purchases and weight status?</p>	<p><i>Study Type:</i> cross sectional</p> <p><i>Participants and Setting:</i> 349 adolescents from Minneapolis/St. Paul, USA</p> <p><i>Outcome Measures:</i></p> <ul style="list-style-type: none"> - BMI and %age body fat - Dietary characteristics and food consumption patterns <p><i>Explanatory Variables:</i></p> <ul style="list-style-type: none"> - Distance to the nearest food outlet (proximity) - # of food outlets within buffer zones (density) 	<ul style="list-style-type: none"> - Adjusting for gender, age and SES, adolescent's sugar sweetened beverage intake was associated with residential proximity to restaurants (including fast food), convenience stores, grocery stores and other retail facilities within the 800 and/or 1600m residential buffers. - BMI and % body fat were positively associated with the presence of a convenience store within 1600m buffer - No significant association ($p < 0.01$) between energy, dietary fat, fruit and vegetables, vegetables alone, or fast food and convenience store purchasing and GIS variables. - Adjusted models indicate that sugar-sweetened beverage (SSB) intake was negatively associated with distance from home to the nearest restaurant or grocery store, with greater distance associated with less consumption. SSB consumption was also positively associated with food outlet density across a 800 and 1600m buffer. - BMI Z score and % body fat were positively associated with the presence of a convenience store within a 1600m residential buffer.

		<ul style="list-style-type: none"> - % body fat was negatively associated with the presence of a FF restaurant within 800m, % body fats negatively associated with the presence of any restaurant within 800m. -Although many diet- and weight- related variables examined here were not consistently associated with neighbourhood food environments
The Influence of Neighborhood Food Stores on Change in Young Girls' Body Mass Index	<p><i>Study Type:</i> Longitudinal Study</p> <p><i>Participants and Setting:</i> 353 girls from four counties in the San Francisco Bay Area, USA</p> <p><i>Outcome Measures:</i></p> <ul style="list-style-type: none"> - BMI z-score change - Risk of Overweight and/or obese <p><i>Explanatory Variables:</i></p> <ul style="list-style-type: none"> - Neighbourhood food stores available per 1000 people (neighbourhood food store density) 	<ul style="list-style-type: none"> - examined the relationship between the presence of neighbourhood food stores within a girl's neighbourhood and 3 year risk of overweight/obesity and change in BMI in girls aged 6 or 7 years at baseline - After adjustment for sociodemographic characteristics, availability of convenience stores remained positively associated with girl's risk of overweight and obesity over time. - After adjusting for sociodemographic characteristics, the availability of convenience stores was associated with a 0.13 unit increase in BMI z-score over 3 years (p=0.05). The availability of other types of neighbourhood food stores was not significantly associated with girl's risk of overweight or obesity, or BMI z score - After adjusting for sociodemographic characteristics, the availability of produce vendors/farmer's markets was marginally associated with a lower risk of overweight or obesity.
Linking Childhood Obesity to the Built Environment: A Multi-level Analysis of Home and School Neighbourhood Factors Associated With Body Mass Index	<p><i>Study Type:</i> cross-sectional</p> <p><i>Participants and Setting:</i> Students (n=1,048) aged 10-14 years at 28 schools in London, ON</p> <p><i>Outcome Measures:</i></p> <ul style="list-style-type: none"> - BMI z-score <p><i>Explanatory Variables:</i></p> <ul style="list-style-type: none"> - The built environment and the school watershed within 500m and 	<ul style="list-style-type: none"> - Investigators used network buffers at 500 m and 1000 m from the school address, as well as an additional areal unit: the school "walkshed" to assess the built environment around the school. - The walkshed is the territory within a school's observed catchment area that encompasses only those students living within walking distance, as defined by the respective school boards - The presence of public recreation opportunities within a 500 m network distance of home was associated with lower BMI z-scores (p<0.05) - The presence of fast-food restaurants within the school walkshed was the only food environment variable that had a statistically significant association with higher BMI z-scores among our sample children

	1000m from children's schools	
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