The Role of the Neighborhood Fast Food Environment in Weight Status of Inner-City Children

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ABSTRACT

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In the past three decades prevalence of obesity has increased substantively in the US and has reached epidemic proportions both among adults and among children. Childhood obesity is of significant concern because it is associated with childhood morbidity, adverse social outcomes and may be associated with life-long implications. In recent years, there has been an increased interest in understanding the possible role of local food environment in shaping individual's behavior in ways that may encourage food consumption and affect weight status. This study examines whether fast food availability at the residential neighborhood may explain children's risk for obesity. Data from the Fragile Families and Child Wellbeing study, a population-based panel data of urban children and their families, were linked to locations of fast food outlets. Using both cross-sectional and longitudinal analytic techniques and numerous robustness checks, I find no discernible effect of exposure to fast food at the residential neighborhood on children's weight. Policies designed to reduce accessibility to fast food in children's residential neighborhood may not be effective in the effort to fight the childhood obesity epidemic.

Table of Contents

Index of Tables

Index of Figures

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Dedication

To my beloved parents on reaching the age of Gvurot (valor).

1. Introduction

With 17 percent of children under 18 overweight or obese and even higher rates in racial/ethnic minority and low-income populations, childhood obesity has reached epidemic proportions in the US. Childhood obesity is of significant concern because it is associated with childhood morbidity (Daniels, 2006) as well as with many psychological and social consequences (Lobstein, Baur, & Uauy, 2004); these may have life-long implications. If not addressed, the concentration of the problem in disadvantaged populations may exacerbate future socioeconomic and health disparities.

Obesity, which results from imbalance between energy intake and expenditure (Ogden et al., 2006), is associated with many risk factors at the individual, family and community levels (Davison & Birch, 2001). In recent years environmental factors are increasingly thought to play a role in influencing lifestyle and risks for developing obesity (French, Story, & Jeffery, 2001).

Characteristics of the individuals' neighborhood may affect behavioral choices related to obesity. Among others, unsafe neighborhoods, lack of recreational facilities and neglected parks have been found to be barriers to outdoor physical activity, and hence energy expenditure, by children (Glanz & Sallis, 2006). Another environmental factor, related to the energy intake side, is availability of food outlets in the neighborhood. Low-income and minority neighborhoods have fewer supermarkets that stock healthful foods and, at the same time, have more fast-food restaurants (Galvez et al., 2009). Neighborhood food environment has been linked to dietary quality and weight status in adults (Baker, Schootman, Barnidge, & Kelly, 2006; S. Kumanyika

& Grier, 2006; Morland, Wing, Diez Roux, & Poole, 2002). Less is known about the influence of the food environment on children's weight status (Galvez, et al., 2009).

Using a birth cohort from a national sample drawn from 20 large US cities, this study will explore the extent to which differential access to fast food across neighborhoods may explain variations in children's body mass index (BMI) and obesity across population sub-groups.

This study contributes to the existing literature on neighborhood effects and childhood obesity. More specifically, it addresses a gap in knowledge on the food environment role in children's weight status. This study is among the first to examine the effect of changes in food environment on changes in children's weight status and, therefore, contributes to the understanding of the possible causal role the neighborhood environment plays in the obesity epidemic. Furthermore, while most previous studies have focused on small geographic areas, this study will use a national urban sample and will advance our understanding of the effects of variations in urban planning characteristics on childhood obesity.

2. Background

2.1. Trends and Consequences of Childhood Obesity

Obesity in the US, both for adults and children, has become a pressing public health concern. Between 1980 and 2002, the prevalence of obesity has doubled among adults 20 years or older. During the same time period, the prevalence of obesity has tripled among children and adolescents. In 2008, approximately 32% of children between the ages 2 to 19 were overweight (BMI≥85^{th} percentile) and 17% were obese (BMI≥95^{th} percentile) (Ogden & Flegal, 2010). This epidemic threatens the nation's state of health, economy and future. Obesity has become one of America's leading health problems and the associated costs surpass those related to tobacco consumption (General, 2001; Sturm & Wells, 2001).

Childhood obesity is a significant concern because it is associated with childhood morbidity. Many health conditions such as type 2 diabetes, cardiovascular disease and sleep disordered breathing, once linked to obesity in adulthood, are now being diagnosed more frequently among children (Daniels, 2006). Additionally, overweight children are at elevated risk of becoming overweight adults who are at a disproportionate risk for adverse health and social outcomes (Whitaker, Wright, Pepe, Seidel, & Dietz, 1997).

Childhood obesity also carries with it many psychological and social consequences including stigma, lower likelihood of social contacts, reduced self esteem and quality of life and increased prevalence of psychiatric problems. In addition, adult women who were obese as children have lower educational attainment, higher rates of poverty and lower likelihood of marriage (Lobstein, et al., 2004).

2.2. Defining Overweight and Obesity

Various measures are used to assess body size and body composition. Body Mass Index (BMI) is the most commonly used measure because of its low cost, relative simplicity and validity (Mei et al., 2002). BMI is a widely used marker of adults and children's adiposity and therefore comparable across studies. BMI is calculated as weight in kilograms divided by height in meters squared. In children, weight varies not only by height but also by sex and age. To account for this variability children's BMI is compared with sex- and age-specific reference values which are based on the 2000 Center for Disease Control (CDC) growth charts. The CDC and the Institute of Medicine (IOM) classify children with BMI-for-age between the 85^{th} and 95^{th} percentiles as "overweight"; Children with BMI-for-age at or above the 95^{th} percentile are classified as "obese" (Ogden & Flegal, 2010).

2.3. Causes of Childhood Obesity

While the physiological mechanism leading to obesity -- excess energy intake over energy expenditure -- is well understood, less is known about the causes leading to the increase in prevalence of obesity. Many individual, familial and environmental characteristics and risk factors have been linked to childhood obesity:

2.3.1. Child Characteristics and Risk Factors

The gestational period, infancy and early childhood are recognized as important stages in the development of obesity among children (Taveras, Gillman, Kleinman, Rich-Edwards, & Rifas-Shiman, 2010). Risks for becoming overweight are affected by the in-utero fetal environment. Among others, maternal smoking during pregnancy and child's birth weight are associated with increased risk of overweight in childhood (Olson, Strawderman, & Dennison, 2009; Singhal, Fewtrell, Cole, & Lucas, 2003).

During infancy, parental choice of the feeding method has a lasting effect on the child's nutritional habits over his/her lifetime. Research suggests that breastfeeding has a protective effect against obesity and type 2 diabetes in childhood and adolescence. Children who have been breast-fed for a longer period seem to have better protection (Li et al., 2005; Lobstein, et al., 2004).

Gender differences in mechanisms leading to obesity exist already at childhood. Research suggests that girls and boys differ in fat mass, fat distribution, hormone levels, susceptibility to family and environmental factors that lead to obesity and in the benefit received from physical activity (Wisniewski & Chernausek, 2009).

Research suggests that association between obesity and sexual maturation differs among boys and girls. While among girls there is a positive association between pubertal maturation and obesity, among boys the association was found to be negative, i.e., early maturing boys have lower BMI (Wang, 2002). Age of pubertal maturation has been decreasing in recent years. Studies found a secular trend between increasing BMI and early maturation. In the US the trend appears to be stronger among Black girls as compared to White girls. Among boys, there does not appear to be an association between obesity and pubertal maturation. While some studies find an association between increased prevalence of obesity, among girls in particular, and earlier onset of puberty, others suggest that the two trends are independent (Biro, Khoury, & Morrison, 2006).

Genetics also play a role in children's susceptibility to weight gain. Studies on twins, families and adoptees indicate that much of the variance in BMI is attributable to genetic factors. Heritability is estimated to be as high as 30 to 40 percent for factors such as adipose-tissue distribution, physical activity, resting metabolic rate, food preference and changes is energy expenditure in response to overeating. Obesity is not likely to be attributable to a single gene and in most cases is probably caused by gene-environment interaction (Rosenbaum, Leibel, & Hirsch, 1997).

Child behavioral patterns such as dietary intake, physical activity and sedentary behavior are associated with increased risk for overweight (Davison & Birch, 2001). These factors which are established early in childhood are considered largely modifiable and therefore may play an important role in prevention (Klesges, Klesges, Eck, & Shelton, 1995). Increased caloric intake among pre-school children is associated with weight gain. The association is stronger for calories from fat (Klesges, et al., 1995). More recently, consumption of sugar sweetened beverages and snacks have been studied as potential culprits in the childhood obesity epidemic (Brownell et al., 2009). Snacks tend to be energy dense and their consumption increases overall energy intake. One study (Cutler, Glaeser, & Shapiro, 2003) finds that the number of daily snacks increased dramatically between 1977-1978 and 1994-1996. Anderson and Butcher (2006) found a link between availability of snack and junk food in schools and increased BMI.

Although only a weak association was found between children's physical activity and their overweight status, this link is important as even small effects of physical activity on weight may cumulate across many activities and over time. Technological changes and urban development have made lives more sedentary in general. Children spend more time in cars (being driven to school and other activities) than they used to only a generation ago. There has also been a 25% drop in play and a 50% drop in unstructured outdoor activity for children (Anderson & Butcher, 2006).

Stronger evidence was found about the effect of sedentary activities (e.g., television watching) on obesity among children. One study found that each additional hour of TV watching per day increased prevalence of obesity by 2 percent. In addition to being sedentary, watching TV may expose children to advertising of low-nutrient food which may lead, even after a brief exposure, to increased caloric consumption due to snacking (Anderson & Butcher, 2006). A recent study found a link between exposure to TV advertising for fast-food and soft drinks and their consumption among elementary school children (Andreyeva, Kelly, & Harris, 2011). This finding may be of particular importance for low-income racial and ethnic minority children who have been found to watch more TV than their counterparts in higher-income families (Borzekowski & Robinson, 2001).

2.3.2. Family Characteristics

Family structure, race, socio-economic status and culture also play a role in children's eating environment and may, as a result, affect their weight status.

Childhood obesity disproportionately affects racial, ethnic minorities and low-income communities. These disparities are present as early as preschool age. Overweight and obesity are even more prevalent among older children (6-19 years of age). Among children 6 to 11 years of age, 37.6% of Black Non-Hispanic, 42.6% of Hispanic and 34.5% of White Non-Hispanic are overweight or obese. (Ogden, Carroll, Curtin, Lamb, & Flegal, 2010). Among White children, obesity usually declines with increases in parental income and education. Among racial and ethnic minorities a different pattern emerges: for African-American and Mexican-American girls, obesity rates increase with income while there is no consistent pattern for boys (Troiano & Flegal, 1998).

Children in low-income families are at increased risk of obesity within their racial or ethnic groups (S. Kumanyika & Grier, 2006). Children in single-parent families are more likely, in comparison to children of other family structures, to be poor and also to be obese. While there are no national estimates of obesity or overweight among single-parent families, it was found that children in those families are at an increased risk for health problems (Ziol-Guest, DeLeire, & Kalil, 2006). An Australian study investigating the role of family and maternal factors in childhood obesity found that having a single-parent (mother specifically) increases the likelihood of the child being overweight or obese (Gibson et al., 2007).

Maternal employment status has also been found to have an important effect on child's weight status. Research establishes a causal relationship between maternal employment (number of hours worked per week) and child's overweight status. Surprisingly, the effect was found only among children in higher socio-economic households (Anderson, Butcher, & Levine, 2003).

Food purchasing and preparation decisions are usually done by an adult in the household, most frequently by women (Belch & Willis, 2002). The significant increase in women's labor force participation in the past thirty years and the associated decrease in leisure time has led to changes in time allocation. As a result, many women resort to purchasing inexpensive convenience and fast food away from home, rather than preparing healthful meals as at home (Chou, Grossman, & Saffer, 2002). Food purchasing decisions are also affected by family structure. Single parents (mothers or fathers) spend a greater share of their food budget on food purchases away from home and a smaller share on fruits and vegetables as compared to married families (Ziol-Guest, et al., 2006).

Barriers to consumption of healthful foods such as fresh fruit and vegetables, fish and lean meat may be contributing to the obesity epidemic among children and adolescents as well. One such barrier is limited access. Vehicle ownership is a good marker of access. While vast majority (89.7%) of US households own cars, the rates are slightly lower (87.8%) in the urban population. Moreover, low-income US households are 6 to 7 times less likely than other households to own a vehicle (Vallianatos, Shaffer, & Gottlieb, 2002), making their access to food outlets more challenging (Ver Ploeg, Breneman, & Farrigan, 2009). To overcome transportation barriers, low income families shop less frequently than the general population at supermarkets, which are often located outside of their immediate communities (on average once per month compared to 2.2 times per week among the general population) (Mikkelsen & Chehimi, 2007). A recent study (Inagami, Cohen, Brown, & Asch, 2009) that investigated whether car ownership might moderate the association between fast food density and BMI used data from the Los Angeles Family and Neighborhood Survey (L.A.FANS). Findings from this study suggest that among adults car ownership may reduce the effect of fast food availability within the neighborhood, while no car possession may exacerbate it.

2.3.3. Built Environment

The built environment consists of the neighborhoods, roads, buildings, recreational facilities and food sources in which and near which people live (Glanz & Sallis, 2006). The sharp increase in prevalence of obesity over the past three decades leads researchers to suspect the environment to be a major contributor to the obesity epidemic (Hill, Wyatt, Reed, & Peters, 2003). The built environment has been thought to affect weight status by shaping an individual's behavior in ways that encourage energy consumption and reduce energy expenditure (Glanz & Sallis, 2006; Hill, et al., 2003). Environment may have a particular importance among children since they have little control over their external environment (Carter & Dubois, 2010).

Neighborhoods' effects on health outcomes were found to be mostly indirect -- through individual proximate determinants such as diet, stress and physical activity -- rather than through exposure to harmful social and environmental conditions (direct effect) (Bond Huie, 2001). Barriers to physical activity, such as crime, presence of hazards (e.g., litter and trash) and heavy traffic, may discourage children from spending time outdoors and reduce the likelihood that they are physically active (Glanz & Sallis, 2006). The evidence on the effects of such barriers is inconclusive. While some studies find negative associations between neighborhood safety and physical activity among children (Gomez, Johnson, Selva, & Sallis, 2004; Lumeng, Appugliese, Cabral, Bradley, & Zuckerman, 2006), others do not (Burdette & Whitaker, 2004, 2005). Presence of physical disorder (e.g., garbage, broken glass) in residential neighborhood was linked with increased risk for obesity among children (Grafova, 2008). Neighborhood aesthetics and greenness, on the other hand, were found to be negatively associated with prevalence of obesity among children (Carter & Dubois, 2010).

2.3.3.1. Food Outlets

There is evidence of racial/ethnic and socio-economic disparities in access to food outlets. Neighborhoods with higher proportions of low income and Black populations tend to have lower access to supermarkets and greater access to convenience stores as compared to their higher-income and non-Black counterparts (Lovasi, Hutson, Guerra, & Neckerman, 2009). Findings regarding neighborhood characteristics and access to fast food restaurants are less conclusive. Some studies, using limited geographical areas, find higher numbers of fast-food restaurants in low-income and African-American neighborhoods (Block, Scribner, & DeSalvo, 2004; Kwate, Yau, Loh, & Williams, 2009; Wisniewski & Chernausek, 2009). Other studies find that while African-American neighborhoods have a lower overall number of restaurants (full service and fast food) they have a higher proportion of fast food restaurants as compared to predominantly White neighborhoods (Powell et al, 2007). Food outlet density tends to be higher in pedestrian-oriented environments, which are associated with higher physical activity and lower BMI (Bader, Purciel, Yousefzadeh, & Neckerman, 2010).

2.3.3.1.1. Fast Food Restaurants

Fast-food restaurants are establishments primarily engaged in the retail sale of prepared food and drinks for an on-premise or immediate consumption (US Census Bureau). According to the Census of Retail Trade, the per-capita number of fast food restaurants has doubled between 1972 to 1997 (Chou, et al., 2002). During that period there was a parallel increase in consumption of food prepared away from home (from 18% to 32% of total calories). The increase in consumption of food prepared away from home has been linked with increased women labor-force participation as well as with technological changes that made this type of food more affordable (Guthrie, Lin, & Frazao, 2002). Portion sizes of foods purchased away from home, fast-food among them, have also increased during the same time period (Young & Nestle, 2002). Portion sizes have been found to affect food intake among children as young as 5 years old (Roll, Engell, & Birch, 2000). It has been established that foods served at fast-food restaurants have more fat content and are more energy-dense than meals prepared at home (Prentice & Jebb, 2003). Consumption of fast-food was found to be associated with increased caloric intake, reduced diet quality (Bowman, Gortmaker, Ebbeling, Pereira, & Ludwig, 2004; Mancino, Todd, Guthrie, & Lin, 2010) and weight gain (Taveras et al., 2005).

Neighborhood food environment has been linked to diet quality and body size in adults (Baker, et al., 2006; S. Kumanyika & Grier, 2006; Morland, et al., 2002). Less is known about the influence of the food environment on children's body size (Galvez, et al., 2009). A number of studies examined the effect of availability of fast food near schools on children's and adolescents' food consumption and weight. It has been established that fast food restaurants are clustered within a short walking distance from schools (Austin Bryn et al., 2005; Simon, Kwan, Angelescu, Shih, & Fielding, 2008). Density of food establishments around schools was found to be higher in a socio-economically disadvantaged neighborhoods (Day & Pearce, 2011; Sturm, 2008). However, findings about the link between availability of fast food near schools and children's consumption of such foods or their weight status is ambiguous. One study (Harris et al., 2011) found no association between availability of fast food near schools and likelihood of overweight or obesity among high school children in Maine. Another study using data from Rotterdam (the Netherlands) found little evidence of an association between availability of food establishments near schools and soft drink and snack consumption among adolescents (van der Horst et al., 2008). On the other hand, studies in Ontario, Canada found an association between density of fast food outlets in school vicinity and low Healthy Eating Index (He, Tucker, Irwin, et al., 2012), as well as increased likelihood of purchasing fast food when the students were on their own or with peers (He, Tucker, Gilliland, et al., 2012). A study of middle and high school students from California (Davis & Carpenter, 2009), found that adolescents attending a school located within one-half mile of a fast food restaurant were more likely to be overweight or obese and less likely to consume fruits and vegetables.

There is no conclusive evidence of the effect of living close to fast-food restaurants on childhood obesity, as only a few studies have been undertaken and most did not control for both individual and neighborhood characteristics. For example, Glavez et al. (2009) did not find association between children's BMI-percentile and number of fast-food restaurants on the child's residential census block. A recent study (An & Sturm, 2012) found no evidence that accessibility (living within a walking distance) to food outlets affects diet quality or BMI among children and adolescents in California. A study using data from Melbourne, Australia (Crawford et al., 2008) found no evidence to support the hypothesis that exposure to fast foods in residential neighborhood is associated with increased risk for obesity among children and their parents. While focusing on a 2-kilometer radial buffer, the researchers suggest examining the relationship using different buffer sizes. Another cross-sectional study which used data from Norfolk, UK

(Jennings et al., 2011) found a positive association between availability of un-healthy food (takeout/fast food and convenience stores) establishments and weight status of 9 and 10 year old children.

Only a limited number of studies have examined the effects of changes in the neighborhoods' food environments on obesity prevalence in an effort to understand the causal role of the neighborhood food environment in the obesity epidemic. One study (Currie, DellaVigna, Moretti, & Pathania, 2010) examined the consequences of changes in supply of fast-food restaurants, as measured by the exact geographical location of the fast food restaurants, on obesity rates among 9th grade students and on weight gain of pregnant women. They found that fast-food restaurants within close proximity to schools (0.1 miles) and expectant mothers' residential addresses (0.5 miles) are associated with increased rates of obesity among children and access weight gain (>20 kilograms) among women during pregnancy. Another study (Powell, 2009) used individual fixed-effects models to examine the relationship between adolescent BMI, fast-food price and fast-food restaurants availability (measured as number of establishments per 10,000 people). It was found that fast-food prices, but not fast-food restaurants availability, have a significant effect on adolescents' BMI. A recent study (Lee, 2012) used the Early Childhood Longitudinal Study - Kindergarten Cohort (ECLS-K) to investigate the relationship between exposure to different food outlets at the residential census tract and children's BMI. Using multi-level longitudinal analytic methods it was found that differential exposure to food environment did not explain change in BMI among elementary school children.

This study adds to the limited but growing body of literature examining the role of the fast food environment on children's weight status and one of the first to investigate the causal relationship between the two. Using exact geographical location of both children's residential addresses and of fast food restaurants, a more precise geographic location than used in previous studies, I investigate the association between children's exposure to fast food and their weight status. Using the panel design of the Fragile Families and Child Wellbeing study (FFCWB) and data on business establishments from two different time points, I examine the effect of change in fast food availability on shift in children's weight over time (between age 5 and age 9). The rich dataset allows me to control for many early life factors and for physiological changes (i.e., pubertal maturation) that have been linked to obesity but have been excluded from previous studies (Carter & Dubois, 2010; Wang, 2002). While most previous studies were limited to a small geographic area, this study uses data from a national sample of urban population from 20 large US cities and controls, in addition to individual characteristics, for neighborhood socio-economic and demographic characteristics that were found to be linked with obesity.

3. Data

3.1. Data Sources

Two data sources are used for this project.

The Fragile Families and Child Wellbeing (FFCWB) survey follows a cohort of nearly 5,000 parents and their children who were born between 1998 and 2000 in twenty large US cities. Unmarried parents are systematically over-sampled, making this a highly disadvantaged group of families whose children are at an increased risk for childhood obesity. Baseline interviews were conducted with both mothers and fathers shortly after their child's birth. Follow-up interviews were conducted over the telephone when the children were one (1-), three (3-), five (5-) and nine (9-) years old. Eighty nine percent of the mothers who completed baseline interviews were re-interviewed when their children were between 12 and 18 months old; eighty six, eighty five and seventy three percent of mothers who completed baseline interviews were re-interviewed when their children were about 3-, 5- and 9-years old, respectively.

The FFCWB study was initially designed to address three areas of interest—non-marital childbearing, the role of fathers and, welfare reform—and their effects on family formation and children's wellbeing. It has since expanded to further examine the roles of social and material disadvantage (Reichman, Teitler, Garfinkel, & McLanahan, 2001).

The core FFCWB data was augmented with data from two ancillary studies. The first is an in-depth, in-home assessment during which data were collected for a sub-sample of children when they were about 3- , 5- and 9-years old. The in-home assessment provides first-hand information on the children's physical health, environment as well as the quality of parenting and parent-child interactions. The assessment includes objective measurements of children's weight and height, information about the children's activities (e.g., outdoor play time and TV watching), mothers' assessment of neighborhood safety as well as information about families' food shopping habits and expenditures. At the 5-year follow-up, about seventy four percent of mothers who were interviewed for the core FFCWB study participated in the in-home survey as well. About ninety two percent of mothers who participated in the core survey participated in the in-home assessments at year 9.

At the 5-year follow-up survey only 2,381 (58% of core survey participants) mothers completed the home visit component of the survey. The sampling strategy was changed at the 9-year follow-up survey and the in-home module was incorporated into the core survey. As a result of this, participation rates were much higher at the year 9 follow-up survey; 93% (3,391) of families who completed the primary care giver interview took part in the In-Home component of the survey.

The second ancillary study is a contextual data supplement to FFCWB study which contains tract-level information on racial composition, poverty, education and unemployment rates for residential addresses of survey participants during each of the survey waves.

Food establishments data is from InfoUSA. InfoUSA provides data and marketing services to generate sales leads and develop direct mail, email and telemarketing campaigns. As such, it is arguably more precise and comprehensive than yellow pages and business directories. Data from years 2006 and 2009 were used. These years were used because they were within the range of years data collection for each respective follow-up wave of the FFCWB study took place. The year 5 in-home assessments were conducted between the years 2000 and 2006 with the majority of the assessments (67%) occurring in 2005. The year 9 in-home assessments took place between the years 2007 and 2010 with the majority of assessment (57%) taking place in 2009.

The data are geo-coded and include information about the business's name, Standard Industrial Classification (SIC), the North American Industry Classification System (NAICS), and additional information about number of employees and sales volume for businesses in all classifications. The 2006 data file includes almost 12 million records on private and public US business establishments. The 2009 data file includes more than 12 million records. InfoUSA includes records on a variety of business categories including automobile dealers, automobile rentals, banks, books retail, churches, department store, food outlets (e.g., grocers retail, ice cream, pizza, restaurants) and more. For the purpose of this study only businesses with SIC 54 (Food Stores) and SIC 58 (Eating and Drinking Places) were used. Additional businesses were excluded if it was clear, based on their SIC, that they didn't provide fast food services (e.g., SIC 581249 - restaurants reservation; SIC 581250 - wedding rehearsal dinner; SIC 581302 - discotheques). Locations that are headquarters or subsidiary headquarters were excluded from the analyses, reducing the number of potentially relevant records to 583,191 for the data file from 2006 and 628,946 records for 2009.

3.2. Measures of Fast Food

3.2.1. Fast Food Establishments Variables

There is no consensus about the definition of fast food in the literature (Currie, et al., 2010). Using InfoUSA data three different measures of fast food were created. The first measure is based on a list of national fast food chains from Wikipedia (http://en.wikipedia.org/wiki/List_of_fast_food_restaurant_chains, accessed 02/27/12) and herein will be referred to as "national fast food chains" variable. This measure was used by Currie et al. (2010) as well in their study of the effect of increased supply of fast food restaurants on obesity rates among adolescents and pregnant women. The list consists of 151 national chains (see list in Appendix A.1). To validate that establishments on the list indeed are national fast food chains, each one of the establishments was searched for using an on-line search. The restaurants menus, mission statements, locations and additional information were reviewed. While the vast majority of the establishments were indeed fast food establishments, ten[1] of the establishments seemed better fitted into a casual dining category. All the establishments included on the Wikipedia list of national fast food chains were kept in the "national fast food chains" measure since, even if they seem to fit better into a different category, some consumers considered them to be a national fast food chain. Some potential drawbacks of using a list from Wikipedia have to be kept in mind. First, the list may change over time as it may be updated by Wikipedia contributors. Second, the list represents the perception of Wikipedia contributors and may not be accurate (i.e., may include establishments that may not necessarily be a fast food) and lastly, it may not include all the fast food chains.

[1] Establishments that seem better fitted into a casual dining category include: Cheeburger Cheeburger, Denny's Big Boy, Dickey's Barbeque Pit, Happy Joe's, Huddle House, Johnny Rockets, Lyon's, Maid-Rite and Mellow Mushroom

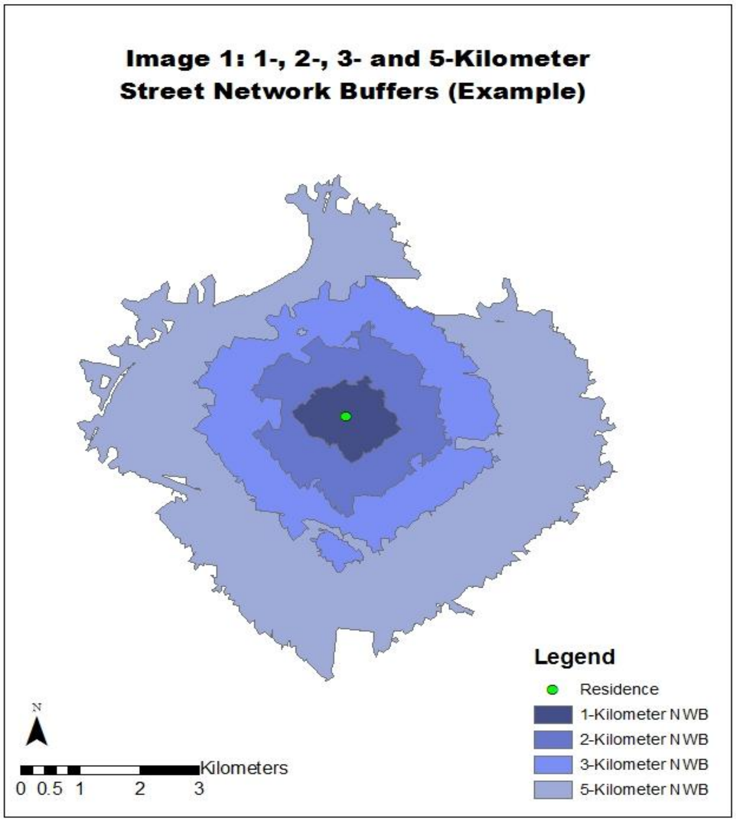
Fast food establishments were coded based on a combination of the business SIC code and the franchise code in the infoUSA data if one was available. When a franchise code was not available establishments were coded based on a combination of the SIC code and the establishment's name. Different locations of the same chain could be listed in infoUSA with different spelling (e.g., "CLUCK-U" and "CLUCK U"). This could be a result of a mistake in the information provided by the specific location's owner or a data entry mistake. In those cases, multiple possible spellings of the chain's name were used. In the 2006 and 2009 data files respectively, 105,307 and 111,716 establishments were categorized as "national fast food chains". The "national fast food chains" measure includes many national fast food chains, however, it may not be complete. First, some chains may have been left out of the list and therefore the list may not be exhaustive. Second, the list does not identify independent, small and local fast food establishments that may serve similar food. Therefore, a second, broader measure of fast food establishments was generated. This measure, herein referred to as "all fast food", includes, in addition to the establishments in the "national fast food chains" measure, establishments which names include words associated with fast food. The list of words used is: "pizza", "pizzeria", "burger", "subs", "sandwich", "hoagie", "wraps", "deli", "taco", "burrito", "wings", "chicken", "pollo", "hotdog", "hot dog", "dogs", "corndogs", "corn dog", "fried", "bagels", "falafel", "gyro", "smoothie", "juice" and "donuts". In the 2006 data 219,742 establishments were categorized as "all fast food"; In the 2009 data 243,334 establishments were categorized in this measure. A third measure of fast foods, which I call "fast food excluding ice-cream, donuts and coffee shops" or "fast food E.I.D.C", in short, builds upon the "all fast food" measure, however, ice-cream, donuts and coffee shops are excluded from the definition. There were 198,746 establishments in this measure based on the 2006 InfoUSA data. On the 2009 data file, there were 213,311 establishments in this measure.

To check the validity of the broad definition, two random samples of 50 establishments each were taken. The first sample included establishments coded as a fast food. The second sample included 50 establishments coded as a non-fast food. Using Google Street View (GSV) each of the establishments was located and inspected to evaluate whether it sells fast food or not. When possible, the decision on whether a specific location was a fast food establishment was made based on the information obtained from GSV. For some locations the information obtained from GSV was insufficient (e.g., obstructed view, no street view of the location, impossible to determine based on the outdoors). In those cases further information was searched for using yelp.com, urbanspoon.com and other business listings. Based on the inspection it was determined whether the coding of each location (as a fast food establishment or not) was accurate. Twenty percent of the local fast food establishments (not part of a national chain) were found to be coded as a fast food when they were actually not (false positive). Sixteen percent of the establishments were found to be coded as a non-fast food when they were a fast food (false negative).

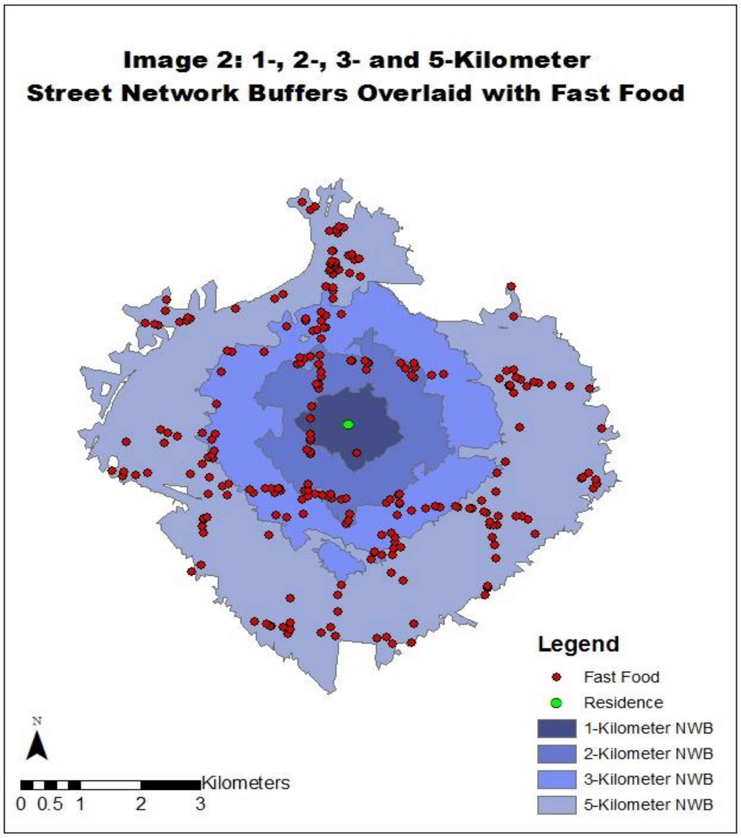
3.2.2. Geocoding Fast Food Establishments

Goecoded mothers' residential addresses at the year 5 and year 9 follow-up interviews were used. Addresses of 4,095 of the mothers at the 5-year follow-up were successfully geocoded. At the 9-year follow-up, 3,539 mothers’ addresses were successfully geocoded.

Measures of accessibility to fast food outlets were generated using ArcGIS 10.0. Geo-coded mothers' residential addresses from the time of the 5- and 9- year surveys were used to create street network buffers at distances of approximately 1-, 2-, 3- and 5- kilometers around mothers' homes. A 1-kilometer distance which is about a 10-15 minute walk, is considered "walkable" and has often been used as a measure of access in urban areas (Ver Ploeg, et al., 2009). However, this may not always be appropriate. There may be variation in accessibility across urban design. While some metropolitan areas, which are high-densely populated, may offer many fast food options within a "walkable" distance (e.g., New York City), other areas may offer residents less or no options within a 1-kilometer distance. To measure availability of fast food beyond a "walkable" distance, additional indicators for fast food availability within 2-, 3- and 5-kilometer were generated. Image 1 provides an example of the 4-street network buffers for one of the FFCWB study participants.



Water layers were erased from each buffer to find the net land area in which individuals could travel and also where fast food establishments could be located. Geo-coded food establishments' data were overlaid on the street network buffers to create the measures of access to fast food establishments. Image 2 provides an example of the street network buffers overlaid with fast food establishments.



Density, calculated as the number fast food establishments per land area, was generated for each of the fast food establishments measures described above at 1-, 2-, 3- and 5- kilometer network buffers around mothers' residential addresses.

3.3. Outcome Variables

Children's height and weight at approximately age 5 (mean age = 63.3 months) and age 9 (mean age = 111.5 months) were measured during the home visit by interviewers who were trained to use the CDC height and weight guidelines. Height, in centimeters, was measured using a "stadiomater" (a large plastic standing ruler). At age 5 an effort was made to weigh the children by themselves. When the efforts were unsuccessful, the child and mother were weighed together and then mother's weight was subtracted from the total. Valid height and weight measures were available for 2,174 of the children who participated in the year 5 follow-up and 3,293 of the children who participated in the year 9 follow-up. Age and gender-specific body mass index (BMI) were calculated using the Center for Disease Control (CDC) SAS macro (Kuczmarski et al., 2002; Must & Anderson, 2006). Based on the CDC classification (Ogden & Flegal, 2010) children with BMI below the 85th percentile were categorized as normal weight, children with BMI between the 85th and the 95th percentiles as overweight and those at or above the 95th percentile were categorized as obese.

The two outcomes of interest are BMI z-score and obesity at each of the respective survey waves:

3.3.1. BMI z-score

BMI z-score is a continuous measure of relative weight adjusted for age and sex based on the CDC 2000 growth charts (Kuczmarski, et al., 2002) and is standardized relative to an external (i.e., the US) reference. At the 5 year follow-up survey BMI z-scores ranged from (-4.16) to

(4.74) with a mean of 0.60 (SD = 1.15). BMI z-scores at the 9 year follow-up interview ranged from (-5.2) to (2.78) with a mean of 0.74 (SD = 1.11).

3.3.2. Obesity

The obesity measure is an indicator variable for whether the child's BMI is at or above the 95th percentile for age and sex as opposed to normal weight. Two alternative measures, the first comparing obese children to children who are normal or overweight and the second comparing children who are obese or overweight to those who are in the normal weight category, were used as a sensitivity analyses. At the 5 year follow-up 17.4% of the children who participated in survey were obese. At the 9-year follow-up survey 25.0% of children were obese.

3.4. Confounding Covariates

Since both residential location and child's weight status are associated with socioeconomic status, an extensive set of demographic and socio-economic covariates are included in the models. Demographic characteristics include the child's gender and age, in months, at the time of assessment, race/ethnicity based on the mother's report of her own race/ethnicity at baseline and whether the mother was born within the US. Socio-economic characteristics include maternal educational attainment as well as contemporaneous measures of income as measured by income-to-poverty ratios, employment status and car ownership. Indicator variables for mother's relationship status with the child's biological father at the time of the respective survey are also included. Breastfeeding has been found to have a protective effect against obesity (Li, et al., 2005; Lobstein, et al., 2004), therefore, an indicator variable for whether the child has been ever breastfed is included in the model. Maternal smoking during pregnancy is associated with increased risk of overweight in childhood (Olson, et al., 2009), therefore, a control for whether the mother smoked during her pregnancy is included.

By age 9 some children experience first signs of puberty, therefore, a measure of pubertal development is included in the year 9 models. The pubertal development scale (Petersen, Crockett, Richards, & Andrew, 1988) consists of 5 questions about physical development and asks the primary care giver to what degree each specific change has occurred in the child. The scale is gender specific. Questions about growth spurt, growth of underarm or pubic hair and pimply skin, are asked about both boys and girls. In addition, gender specific questions include questions about breast development and menstruation for girls as well as questions about facial hair and deepening of the voice for boys. Response categories for each question range from 1 (No) to 4 (development completed). The pubertal development is calculated as the mean of items with complete data. Pubertal development scores in the sample range from 1 to 3.2.

Sedentary behavior was linked to increased prevalence of obesity (Anderson & Butcher, 2006). The Council on Communication and Media of the American Academy of Pediatrics' recommendation is that children spend less than 2 hours of non-educational screen time per day (Strasburger et al., 2011). An indicator for whether the child is engaged in more than 2 hours of sedentary behavior per weekday (watching television or, using a computer to chat with friends, to play computer games or for school work) is included in the model.

3.5. Neighborhood Socioeconomic Contextual Covariates

Studies using US Census data have found that residents of low-income and minority neighborhoods are disproportionately affected by poor availability of healthful food stores and by larger availability of restaurants, in particular fast-food restaurants (Larson, Story, & Nelson, 2009). A recent study found that children in predominantly Black neighborhoods are at increased risk for obesity. Contrary to the expected, it was found children in neighborhoods with highest proportions of foreign born experience reduced risk for obesity (Kimbro & Denney, 2012). Neighborhood socioeconomic variables are included as potential confounders. Neighborhood poverty (percent of population living below the federal poverty line), neighborhood racial/ethnic composition (percent of population Black, percent of population Hispanic Not-Black), percent of population foreign born and population density (residents per square mile) were constructed using data from the 2000 US census, summary file 3 (SF3) at the census tract level.

4. Analytic Strategy

4.1. Cross-Sectional Analytic Strategy

A series of regression models are used to examine the association between children's weight status and fast food availability in their residential neighborhood. Ordinary Least Square (OLS) regression models are used for BMI z-score and logistic regression models are used for obesity.

Model 1 examines the bivariate relationship between density of fast food establishments and children's weight status. Model 2 adjusts, in addition, for demographic and socio-economic characteristics of children and their families. Built environment planning and population density varies widely across the twenty cities in the FFCWB study which represents cities with population of 200,000 or more. For example, population density per square mile of land use in New York City is 26,402.9 while in San Antonio, Texas it is 2,808.5 (US Census). Research found statistically significant associations between built environment and travel behavior (Ewing & Cervero, 2010). Residents of spawning counties are likely to walk less and to have poorer health outcomes when compared to residents of compact counties (Ewing, Schmid, Killingsworth, Zlot, & Raudenbush, 2003). Urbanized areas with high population density encourage walking and are also more likely to have large number food stores and restaurants as compared to less densely populated areas (Rundle et al., 2009). Many survey participants moved (sometime multiple times) since the baseline survey. To account for variation in built environment planning across cities, indicator variables for residential Consolidated Metropolitan Statistical Area (CMSA) at the time of interview are added in Model 3. Consolidated Metropolitan Statistical Area is a metropolitan area that has a population of one million or more (US Census.) An indicator variable is included for study participants who live in a metropolitan area with population of less than one million, or in a rural area. In Model 4, neighborhood socioeconomic contextual covariates, which are associated with both availability of food establishments and with children's weight status, are added. All models were clustered at the residential census tract and robust standard error were used.

The association between density of fast food establishments and the two measures of children's weight status is estimated for each one of the three fast food measures. For each of the fast food measures the association between density of the establishments at a walkable distance of 1-kilometer network buffer is examined. Additional analyses were conducted to examine the association between density of establishments at 2-, 3- and 5-kilometer network buffers and child's weight status.

Variability in access to food outlets across different built environment characteristics may affect food consumption and, therefore, children's weight status. Mode of transportation is an important measure of access. In high densely-populated areas people are more likely to walk to their destination than to use motorized modes of transportation. Pedestrian-oriented neighborhoods which tend to have higher density of food establishments (Bader, et al., 2010) may experience higher exposure to fast food. Use of motorized transportation, on the other hand, may help overcome barriers to healthier food options which may be available at a farther distance. Therefore, it would be expected that in high-densely populated neighborhoods there will be a stronger association between fast food density and weight status.

Research suggests that the threshold at which people shift transportation mode for shopping from car to public transit or walking is 13 residents per acre (Frank & Pivo, 1994). This translates into 8,320 residents per square mile. To assess whether variability in food access across urban design characteristics may be associated with children's weight status, models were estimated separately for children who live in census tracts with population density of 8,320 people per square mile or more and for children who live in a less densely populated census tracts (<8,320 people per square mile.)

Vehicle ownership is another important marker of access. Studies have found a stronger association between neighborhood characteristics and health outcomes among individuals who do not own a car (Inagami, et al., 2009; Inagami, Cohen, & Finch, 2007). Car possession (owning/leasing) may reduce barriers to healthier food establishments (e.g., supermarkets) which may be located farther away from home. Families which do not possess a car may rely more heavily on near-by foods establishments which may offer a less healthy fair fast food among them. While vast majority (89.7%) of US households own cars, the rates are slightly lower (87.8%) in the urban population. Moreover, low-income US households are 6 to 7 times less likely than other households to own a vehicle (Vallianatos, et al., 2002), making their access to food outlets more challenging (Ver Ploeg, et al., 2009). Among families in the Fragile Families survey, the rates of car ownership are lower than in the US population. At the year 9 follow-up interview, only 77.8% of survey participants report that they own or lease a car. As another test of variability in accessibility to food establishments and children weight status models stratified by vehicle possession were estimated as well.

4.2. Change Models Analytic Strategy

To date, most studies examining the relationship between availability of food outlets and children's weight status use cross-sectional data. Only a limited number of studies, e.g., Currie at al. (2010), Powell (2009) and Lee (2012) use panel data to examine whether a causal relationship exists between the two. Using the longitudinal design of the FFCWB study, which includes a rich set of covariates and detailed spatial information, I examine whether changes in the food environment in children's residential neighborhoods during the 4-year time interval between the 5- and 9-year follow-up interviews is associated with change in their weight status as measured by BMI, which was found to be the most appropriate measure for studying adiposity change among children (Cole, Faith, Pietrobelli, & Heo, 2005).

Investigating the effect of change in exposure to fast food on change in BMI during the same time period allows me to better understand the possible temporal relationship between the two. Two estimation strategies, gain scores models and individual fixed effects models, are used to examine the temporal relationship between exposure to fast food and children's weight status.

OLS regression models are used to estimate the change in BMI (gain score) during the four years interval between the two surveys. Gain score is calculated by subtracting BMI at age 5 from BMI at age 9. Model 1 examines the relationship between change in density of fast food outlets at a 1-kilometer network buffer and change in children's BMI. In addition to change in density of fast food, the model includes controls for child's BMI at age 5, child's age at the time of the 5-year assessment, the number of months between assessments and whether the child moved at least once during the 4-years time interval of interest. Including a variable for the child's BMI at age 5, prior to the change in exposure, increases the likelihood that the observed change in BMI is due to change in exposure to fast food (Gellman & Hill, 2007). Model 2 examines whether the relationship between change in density of fast food and change in children's BMI are affected when changes in neighborhood contextual characteristics are taken into account (i.e., percent population Black, Hispanic, foreign born, living below the federal poverty line and population density). Changes in residential neighborhood socio-demographic characteristics may be either due to residential move of survey participants or changes in the neighborhood itself due to changes in residential and business composition (e.g., gentrification). Model 3 adjusts, in addition, for children’s and families’ time-invariant characteristics (i.e., race/ethnicity, whether the mother is US born, maternal educational attainment, whether the child was ever breastfed and maternal smoking during pregnancy). In Model 4 children's and families’ time-variant characteristics are added, including sedentary behavior, parents’ relationship status, income, employment status and car ownership, all measured at age 5. Pubertal maturation, measured at age 9, is also included in the model. All models were clustered at the residential census tract and robust standard error were used.

Individual fixed effects models allow estimation of the "treatment effect" - the change in the outcome variable (Greene, 2008). Use of individual fixed effects models eliminates the influence of unobserved time-invariant heterogeneity across children. It is possible that unmeasured changes in circumstances during the four years' interval between the two survey waves may have caused both change in exposure to fast food and a change in child's BMI or that some unmeasured differences between children may account for the change in child weight status. Using individual fixed effects models to control for change in exposure to fast food between age

5 and age 9 and for other time-variant and time-invariant characteristics accounts for these possibilities. Although fixed effects estimates may also suffer from omitted variable bias, the focus on within-individual changes eliminates bias from unobservable heterogeneity. Model 1 examines the bivariate relationship between change in density of fast food establishments at the residential neighborhood between age 5 and age 9 and change in children's BMI. Model 2 examines whether the relationship between change in density of fast food and change in children's BMI is affected when changes in neighborhood contextual characteristics are taken into account. In Model 3 children's and families' time-variant characteristics are added.

5. Results

Height and weight measures were available for 3,348 children who participated in the 9-year follow-up survey. Of those, 110 cases were excluded from the sample because their residential address could not be successfully geocoded. Additional 196 cases were excluded because they did not live with their mothers all or most of the time. Cases with implausible height or weight measures (20 and 15 cases, respectively) and those with implausible BMI values (18 cases) were also excluded from the sample. Finally, 316 cases missing data on any other model covariates (i.e., age, gender, race/ethnicity, maternal nativity status, parental relationship status, household income, maternal educational attainment, maternal employment, car ownership, breastfeeding, maternal smoking at pregnancy, pubertal development or sedentary behavior) were also excluded from the model, resulting in an analytic dataset of 2,673 children.

Majority of children in the sample have at least one fast food establishment within 1-kilometer network buffer of their residence. When the broadest definition of fast food ("All fast food") is used 61% of children have at least one establishment within a walkable distance. When the "National Fast Food Chain", which is the narrowest definition, is used 44% of children have at least one establishment within a 1-kilometer network buffer about their house. Ninety four and ninety two percent, respectively, have at least one fast food establishment within a 5-kilometer network buffer.

Of the children in the analytic sample 53.5% live in one of 17 CMSAs represented in the data, while 46.5% of children live in a sub-urban or rural area which is not classified as a CMSA. The 2,673 children in the sample live in 2,222 different census tracts. The number of children in each tract ranges from 1 to 8. The vast majority of census tracts in the sample (1,726) include only one child.

5.1. Sample Description

Table 1 describes the demographic and socio-economic characteristics of children and of their residential census tract at the time of 9-year follow-up interview. Obese children are compared to children who have normal weight. Results suggest that obese children are more likely to be of Hispanic ethnicity, to be further along in the pubertal maturation process (i.e., score higher on the pubertal development scale) and to be more sedentary. Obese children are less likely to have been breastfed. Families of children who are obese at age 9 are disproportionately disadvantaged as compared to families of children with normal weight. Mothers in these families are less likely to be married to the child's biological father by the time of the 9-year follow-up interview, they have lower educational attainment and are more likely to be foreign born. These families are also more likely to be poor or near poor. Obese children live in neighborhoods where population density is higher, higher proportion of the population live below the federal poverty line and higher percent of the population is Black, Hispanic and foreign born.

Characteristics of children who live in high density census tracts (≥8,320 people per square mile) are compared to those who live in low density census tracts (<8,320 people per square mile) in Table 2. Children in high density census tracts have, on average, higher BMI z-score and are more likely to be obese as compared to those in low density tracts. Children in high density tracts are also more advanced in their pubertal maturation and are more likely to be sedentary than their counterparts in low density tracts. Families in high density tracts are more likely to have a mother who is of Black Non-Hispanic or Hispanic race/ethnicity and is foreign born. Mothers of families in high density tracts have lower educational attainment, are less likely to be employed and are less likely to be married to their child's father by the time their child is 9 years old. There are also differences in neighborhood socio-economic characteristics between high and low-density tracts. In high density tracts higher percentage of the population lives below the poverty line, is foreign born and is of racial/ethnic minority.

Table 3 describes density of fast food establishments near residential addresses of children at the time of the year 9 follow-up interview and compares between its availability for obese and normal weight children. Density of all three measures of fast food is slightly higher for obese children as compared to children with normal weight across the four network buffers. However, the differences between the two groups are not statistically significant. In Table 4 density of fast food establishments in high population density census tracts (≥8,320 people per square mile) are compared to density of fast food establishments in low population density tracts. Densities of fast foods are statistically significantly higher ($p<0.001$) for all 3 fast food measures for all network buffer sizes in high density census tracts.

5.2. Cross-Sectional Analyses Results

Multivariate analyses were performed to isolate the effects of fast food availability on children's adiposity. Results presented in this section focus on the "fast food E.I.D.C" measure. Analyses using the two additional measures of fast food, "national fast food" and "all fast food", are treated as sensitivity analyses and results from most of those models are presented in the Appendix.

Results from the full sample of 9-year old children are presented first, followed by results from models examining whether accessibility may moderate the association between fast food and weight.

Table 5 presents coefficients from ordinary least square (OLS) regression models estimating the association between density of the "fast food E.I.D.C" measure at a 1-kilometer network buffer about children's residential addresses at the time of the 9-year follow-up interview and their BMI z-score. Ninety five percent confidence intervals are presented in brackets. Model 1 represents the bivariate association between "fast food E.I.D.C" and children's BMI z-scores. Model 2 controls for individual demographic and socio-economic characteristics of the children in addition to density of "fast food E.I.D.C". Model 3 controls for the Consolidated Metropolitan Statistical Area (CMSA) of children's residence at age 9 in addition to all the covariates in Model 2. In Model 4 neighborhood socio-economic contextual covariates are added. Results from all four models suggest that densities of fast food establishments within a 1-kilometer network buffer of children's residential address are not statistically significantly associated with 9-year old children's BMI z-score. The associations are very small in magnitude and while they are positive in the first three models, once neighborhood socio-economic contextual covariates are added in Model 4, the coefficient for fast food restaurants density changes direction and becomes negative.

Results also suggest that boys have higher BMI z-scores as compared to girls. Pubertal maturation is statistically significantly and positively associated with BMI z-score among 9-year old children. The association between gender and BMI z-score are opposite of the expected direction (Wang, 2002). Results from models that include an interaction between gender and pubertal maturation (results not shown) suggest that the positive association between gender and BMI z-score is limited to boys who did not start their pubertal maturation process yet. The counter-intuitive results in the analyses presented suggest that at age 9 most children in the sample have not started puberty yet. The gender-pubertal maturation interaction does not moderate the association between BMI z-score and fast food.

Being of Hispanic ethnicity and living in a near poor household (100-199% of the federal poverty line) are also statistically significant and positively associated with higher BMI z-score in this population. Consistent with previous research (Arenz, Ruckerl, Koletzko, & Von Kries, 2004; Armstrong & Reilly, 2002), being breastfed as an infant has a negative association with children's BMI z-score; therefore, may have a protective effect against obesity. However, the association is statistically significant only in some of the models. Maternal educational attainment has an inverse, but statistically insignificant, association with child's BMI z-score in this sample. Other studies (e.g., Lee, 2012) found similar but statistically significant associations between these variables. The insignificant associations in the current study may possibly be explained by the limited amount of variation in educational attainment among mothers in the FFCWB survey (over 60% of mothers have high school education or less). It is noteworthy that there is variation across CMSA (results not shown). Coefficients for two (of the 17) CMSA indicators are positive and statistically significantly associated with children's BMI z-scores when controlling for neighborhood contextual variables (Model 4). This suggests that residents of these metropolitan areas are at increased risk for overweight or obesity. Living in an area that is not classified as a CMSA (i.e., sub-urban or rural) is not statistically significantly associated with BMI z-score in this sample.

While a 1-kilometer network buffer represents convenience (as measured by proximity), families may travel beyond this distance for shopping, in general, and for fast food in particular. Table 6 presents coefficients from the maximally adjusted regression model across the 4 network buffers about children's residence. For convenience, the first column presents results from Model 4 in Table 5 (1-km network buffer). The following columns represent results from models using 2-, 3- and 5-kilometer network buffers, respectively.

The coefficients for the density of fast food variables in all four models are negative, suggesting an inverse association with children's BMI z-score. However, none of the coefficients reaches a statistical significance level of 5%. Overall, the results suggest that exposure to fast food is not associated with higher BMI z-score among 9 year old children.

Table 7 summarizes results from 32 different OLS regression models estimating the association between fast food density in residential neighborhoods and BMI z-scores of 9-year old children in the Fragile Families study. Each coefficient in the table represents results from one regression model. Coefficients for the "all fast food" measure are presented in the top panel and coefficients for the "national fast food chain" measure are presented in the bottom panel. Results in column 1 are from unadjusted models estimating the associations between density of fast food restaurants and BMI z-scores. Results in column 2 are for models adjusting for individual demographic and socio-economic characteristics of children and their families in addition to density of fast food measures. Results in column 3 are from models adjusting for residential CMSA in addition to all the covariates in Model 2. Results in column 4 are from models that adjust for neighborhood socio-economic contextual covariates as well. Within each panel, each row represents density of fast food establishments within a specific network buffer, i.e., 1-, 2-, 3- and 5- kilometer.

All the coefficients in Table 7 are small in magnitude and none reach statistical significance at the 5% level. It is noteworthy that coefficients in the bivariate models are positive. However, once additional covariates are added, many of the associations become negative. These results suggest that exposure to fast food in residential neighborhood may not be associated children's BMI z-score.

Table 8 presents odds ratios and 95% confidence intervals from logistic regression models examining the association between density of "fast food E.I.D.C" at a 1-kilometer network buffer about children's residential address at the time of the 9-year follow-up interview and probability of obesity (vs. normal weight). As previously mentioned, the "fast food E.I.D.C" measure includes the national fast food restaurants chains from the Wikipedia list (see Appendix A.1) as well as local and national fast food restaurants identified using a word search but excludes establishments that are coffee shops, donuts shops or ice cream parlors. The table follows the same format as Table 5 above. The association between density of "fast food E.I.D.C" and probability of obesity is positive but not statistically significant in the bivariate model. Once other covariates are added to the model, the association becomes *negative* (though very small in magnitude) and remains statistically insignificant. Overall, results in the table suggest no association between "fast food E.I.D.C" and probability of obesity among the children in the sample.

Results also suggest that children who are further along in their pubertal maturation process (higher score on the puberty developmental scale) are more likely to be obese as compared to their counterparts, children who are less advanced in their pubertal maturation. A one unit increase in pubertal development score (range from 1 to 3.2) is associated with approximately 5 times increase in the odds of being obese. Results from models including an interaction between gender and pubertal maturation (not shown) suggest that boys who start puberty are less likely to be obese as compared to boys who did not start this process yet and to girls. Children who engage in sedentary activities, measured as watching television or using a computer for more than 2 hours per weekday, are more likely to be obese than children who perform such activities for 2 hours or less per weekday. Hispanic children are more likely than their counterparts, White Non-Hispanic, Black Non-Hispanic and those in the other race group to be obese. Additionally, children of mothers who were born within the US are less likely to be obese than their counterparts whose mothers were born outside of the US.

Higher maternal educational attainment (college or more), higher household income (above 200% of federal poverty line) and being breastfed appear to be negatively associated with odds of obesity at age 9. However, none of these associations reach a statistical significance at the 5% level. Results for Model 4 suggest a positive association between living in a census tract where a higher share of the population is below the federal poverty line, is foreign born or is of racial/ethnic minority (Black or Hispanic) and probability of obesity at year 9; however, results do not reach statistical significance at the 5% level. Prior research found evidence among adults (Boardman, Saint Onge, Rogers, & Denney, 2005) and children (Carter & Dubois, 2010; Kimbro & Denney, 2012; Lee, 2012) that residing in a disadvantaged neighborhood is associated with increased risk for obesity. The consistent trends found, using data from the Fragile Families and Child Wellbeing study, lend credence to the null findings on the effects of proximity to fast food establishments.

Table A.2 in the Appendix presents odds ratios from 48 different logistic regression models estimating the association between each of the three different measures of fast food density in residential neighborhoods and probability of obesity across the four network buffers; 95% confidence intervals are presented in brackets. None of the associations in the table reach a statistically significant level, suggesting that exposure to fast food at the residential neighborhood, regardless of measure used and area of exposure, may not be associated with obesity among young children.

In highly-dense population neighborhoods accessibility of fast food and other retail establishments may be easier, both because such neighborhoods tend be dense in retail establishments and because people tend to use non-motorized forms of transportations. The higher exposure may encourage consumption, which may in turn affect weight status. As previously mentioned, the threshold beyond which people shift from a motorized to non-motorized mode of transportation was found to be 8,320 people per square mile.

Table 9 presents coefficients from OLS regression models estimating the association between density of "fast food E.I.D.C" and BMI z-score separately for children in high and low population density census tracts. Opposite of the expected, there is a positive and statistically significant association between fast food density and children's BMI z-scores in low population density census tracts. In high population density census tracts no statistically significant association is observed. A possible explanation is that highly dense populated neighborhoods are likely located in urban centers which are highly commercialized and offer a wide variety of food establishments; therefore, density of fast food may not play a key role. In low population density tracts on the other hand, there is a much smaller selection of food establishments; therefore, in those neighborhoods fast food restaurants may serve as destinations for residents who may frequent such establishments. Another possible explanation of these unexpected findings is that in highly dense populated ("walkable") neighborhoods food stores and restaurants may serve as destinations (Lovasi, et al., 2009) and offer more opportunities for physical activity (e.g., walking) while in less densely populated neighborhoods people tend to drive and, therefore, have less opportunities for physical activity.

Further analyses using alternative measures of fast food (Appendix A.3 and A.4) suggest similar trends -- positive and statistically (or marginally) significant associations between density of fast food and BMI z-scores at a 1-kilometer network buffer about residence in low population density neighborhoods, but no statistically significant association in high density neighborhoods. The associations between BMI z-scores and fast food in low population density neighborhoods are limited to a 1-kilometer network buffer. No statistically significant associations are observed at larger buffers.

Odds ratios from models estimating the associations between density of fast food and probability of obesity in low and high densely populated census tracts are presented in Appendix A.5 and A.6, respectively. Of the 48 odds ratios presented in Appendix A.5 only one (2% which is within the 5% range of an occurrence by chance) reach a significance level of 5%,. Results in Appendix A.6 also show no evidence of a statistically significant association between exposure to fast food, regardless of measure of fast food used and buffer size, and probability of obesity among 9-year old children. In a high densely populated census tract, percent of population which is Black Non-Hispanic is positively and significantly associated with probability of obesity. As previously shown, residents of high densely-populated census tracts are much more likely to be of racial/ethnic minority than their counterparts of low densely-populated areas. This finding may support the cultural argument for obesity risk among Black children (Kimbro & Denney, 2012; S. Kumanyika, 1998). Other neighborhood characteristics (i.e., percent of residents below poverty line, percent foreign born and percent Hispanic) are also positively associated with probability of obesity; however, the odds ratios do not reach statistical significance.

Another important measure of accessibility is car ownership. Families who do not own or lease a car may have to rely more heavily on consumption of less healthy food options in their neighborhoods which may be easily accessed. Therefore, it would be expected that among families who do not possess a car there would be a larger effect of exposure to fast food in close proximity (e.g., 1-kilometer network buffer) as compared to fast food at a larger distance. Among families who have car availability the effect of fast food is not expected to be limited to a "walkable" distance.

Results from models stratified by car ownership are presented in Tables 10 and 11. Table 10 includes coefficients from 48 OLS regression models estimating the association between BMI z-scores and fast food density among children in families who own or lease a car. Statistically significant and positive associations are observed in the bivariate models. However, once individual demographic and socio-economic characteristics are added to the model, the coefficients decrease substantially in magnitude and are no longer statistically significant.

No statistically significant associations are observed between BMI z-scores and density of fast food among children in families which do not own or lease a car (Table 11). Interestingly, all the coefficients in the table are *negative*. It is important to note that a relatively small number of children (593 or 22% of the analytic sample) live in families that have no car and therefore, these analyses may not have enough statistical power to detect an effect. However, it is interesting to compare differences in magnitude of the associations across car ownership.

Similar patterns are observed in Tables A.7 and A.8 in the Appendix which present odds ratios from models estimating the association between density of fast food establishments and probability of obesity among children in families which own or lease a car and families who do not, respectively. This suggests that accessibility may not play a key role in the relationship between fast food and children's weight status in this sample.

5.3. Sensitivity Analyses

First, models were estimated using alternate measures of obesity. Obesity was re-characterized as obese (BMI ≥ 95th percentile) versus normal weight or overweight (BMI <95th percentile) and also as overweight or obese (BMI ≥ 85th percentile) versus normal weight (BMI <85th percentile). Regardless of the obesity measure used (results are shown in Table A.9 and Table A.10 in the Appendix) there was no significant association between density of fast food restaurants and children's weight status.

The built-environment design in suburban and rural areas that are less densely populated may be different from that of urban areas which are densely populated and offer its residents a high mix of retail and services at a close proximity. Fast food in urban areas may be more accessible to residents because of the higher density and more variety of businesses in such areas as compared to sub-urban or rural areas. The higher exposure in urban areas may encourage consumption and therefore, access to fast food may have a larger effect among children residing in such areas. To examine this, models were estimated only for residents of Consolidated Metropolitan Statistical Area (a metropolitan area that has a population of one million or more). 1,243 children who live in a sub-urban or rural area that is not classified as CMSA were excluded from the sample, leaving an analytic sample of 1,430. In all models (Tables A.11 and A.12 in the Appendix) the associations between density of fast food and children's weight status (BMI z-score or obesity) remain statistically insignificant.

A change in exposure to fast food within the neighborhood may affect consumption behavior. A change in exposure to fast food may occur either because new restaurants opened in the neighborhood, or because the child's family moved to a new location which may offer either fewer or more restaurants in its vicinity. By estimating the associations between fast food restaurants and weight status separately for children who experienced a residential move during the 4-year time interval between the two follow-up interviews and those who did not, I can examine whether the change in the neighborhood or the move to a new location may have a stronger effect. Children who experienced at least one residential move during the 4-year interval are considered "movers". Results in Table A.13 and A.14 are from models examining the association between density of fast food establishments and BMI z-score among non-movers and movers, respectively. Tables A.15 and A.16 show results from models examining the associations between fast food density and probability of obesity among non-movers and movers, respectively. In all models, for children who moved during this 4-years interval as well as for those who did not, the associations between density of fast food and weight status did not reach statistical significance.

Some research suggests that the threshold above which people tend to substitute motorized for non-motorized transportation is a density of 3,500 people per square mile (Lopez, 2004). Stratified analyses were conducted for census tracts with high (≥3,500 people per square mile) and low (<3,500 people per square mile) population density. In high population density census tracts (Table A.17) all the association between density of fast food and children's BMI z-scores are negative (opposite of the expected direction) though none is statistically significant at the 5% level. No statistically significant associations are observed in low population density census tracts (Table A.18) as well. Similar patterns are observed for the association between fast food density and probability of obesity in Tables A.19 and A.20.

To investigate the possibility of non-linear associations between availability of fast food restaurants and child weight status, models were estimated with indicators for availability of at least one fast food outlet within 1-, 2-, 3- and 5-kilometer network buffers of the child's residence. The indicators are not mutually exclusive and were all entered to the model at once. Therefore, the coefficient for fast food within a 1-kilometer network buffer should be interpreted as the difference in effect of having a fast food restaurant within a 1-kilometer buffer and the effect of having a fast food within a 2-kilometer buffer. Results (not shown) suggest no statistically significant association between availability of fast food and weight status (measured by BMI z-score as well as obesity).

It is possible that exposure to fast food affects children differently at different times during their childhood. At a young age children are supervised closely by their parents in all aspects of life, including their diet. However, as they get older, they gain independence and make more unsupervised decisions. It is possible, therefore, that exposure to fast food would affect 5-year old children differently than 9-year olds. Analyses of the association between fast food availability and weight status (BMI z-score and obesity) was conducted for 5 year old children who participated in the 5-year follow-up interview as well. Results (not shown) suggest no statistically significant associations between density of fast food and children's weight status at age 5.

5.4. Change Models Analyses Results

Overall, 2,087 children were followed-up at both the 5- and 9-year In-Home surveys. Weight and height information was available for 1,858 of these children at both waves. Of those, only 1,726 children who were reported to live with their mother "all or most of the time" at both waves were kept in the sample. Children with implausible height, weight or BMI information (N=18) were excluded from the sample. Additional 13 cases which experienced a change of more than 80 percentage points (increase or decrease) in BMI percentile during the 4-year interval between the two survey waves, were also excluded from the sample. Cases missing on other model covariates, (e.g., gender, race/ethnicity, pubertal development, sedentary behavior, maternal educational attainment), were excluded from the sample as well, leaving an analytic sample of 1,583 children.

The change in sampling strategy between the 5- and 9- year surveys may lead to a sample selection problem. Table 12 describes characteristics of children and families who were surveyed at both the 5- and 9-year follow-up interviews and compares them to those who were followed-up at the 9-year survey only. On average, between age 5 and age 9 children experienced an upward shift in BMI (from 16.63 to 19.24), an increase of 0.09 units in mean BMI z-score (from 0.61 to 0.70) and an increase of 2.4 points in their BMI percentile. Prevalence of obesity has increased from 16.7% to 22.9% during this 4-year time interval. During this time period families experienced economic changes as well. A smaller proportion of families live below the federal poverty line at year 9 as compared to year 5. There is an increase in proportion of mothers who are employed and a larger proportion own or lease a car. On the other hand a smaller proportion of parents are still married and a larger proportion of the children live in a family in which the biological parents are not in a married or cohabiting relationship.

More than half the children in the sample (56%) experienced a residential move during the four years interval between the 5-year and the 9-year follow-up interviews. During these four years children experienced changes in the characteristics of their residential neighborhoods as well. On average, at the 9-year follow-up children live in neighborhoods that are less socio-economically disadvantaged as compared to their residential neighborhoods as age 5. Neighborhoods at the 9-year follow-up have lower proportion of the population who lives below the federal poverty line, lower proportions of racial/ethnic minorities (Non-Hispanic Black and Hispanic) and lower population density as compared to their residential neighborhoods at age 5.

The third column in Table 12 describes the characteristics of children and families who were followed-up at the 9-year survey only and compares them to children who were followed-up at both waves. Children who were followed-up only at the 9-year survey have higher BMI and are more likely to be obese as compared to children who were interviewed at both waves. Those who were interviewed at year 9 only appear to be less disadvantaged as compared to children who were followed-up in both waves: they are older, more likely to have been breastfed in infancy and are more likely to live with both biological parents, in a household with an owned or leased car. Those children are also less likely to be of Black Non-Hispanic race/ethnicity, less likely to have a US born mother and less likely to be sedentary. Children who were followed-up at the 9-year survey only live in neighborhoods with different characteristics as compared to children who were followed-up in both waves: they are more likely to live in neighborhoods where a lower percentage the residents live below the federal poverty line and lower percentage of the population is Black. They are also more likely to live in neighborhoods where higher percentage of the population is foreign born and of Hispanic origin.

Table 13 presents densities (number of establishments per square kilometer) of each of the fast food restaurants measures at the 1-, 2-, 3- and 5- kilometer network buffers about children's residential addresses at the time of the 5- and 9- year follow-up interviews for children who were interviewed at both waves. Changes in densities are presented in the table as well. On average, children who participated in both surveys experienced an increase in density of fast food establishments about their homes during the 4-years time interval between surveys.

Table 14 presents results from OLS regression models examining the association between change in density of the "fast food E.I.D.C" measure at a 1-kilometer network buffer about residential address and change in BMI during the 4-year interval between the 5- and 9- year follow-up interviews (gain scores models). Model 1 includes only controls for change in fast food density at the 1-kilometer network buffer, for child's BMI at age 5, for child's age, in months, at the time of the 5-year assessment, for the number of months between the year 5 and year 9 assessments and includes an indicator for any residential moves between the survey waves. Model 2 controls, in addition, for changes in residential neighborhood socio-demographic composition. Child and family time in-varying characteristics are added in Model 3. In model 4 child and family time-varying characteristics are added as well. Including covariates that were measured prior to the period in which a change in density of food outlet may have occurred, assures that remaining relationship between fast food density and BMI is unlikely to be confounded by these observed characteristics. Results suggest no statistically significant association between change in density of fast food restaurants and weight gain among children even in the simplest model (Model 1). The coefficients for the associations between change in density of fast food establishments and change in BMI are small in magnitude, *negative* and do not reach a statistical significant level.

The addition of neighborhood socio-economic characteristics in Model 2 does not change the magnitude of the coefficient for the association between changes in fast food establishments and change in BMI substantially. Change in percent of neighborhood (census tract) residents who live below the federal poverty line is positively associated with change children's BMI. However, the association is not statistically significant. Changes in all other neighborhood contextual variables (i.e., percent of population Black Non-Hispanic, percent of population Hispanic, percent foreign born and population density) are inversely associated with change in children's BMI, though, for the most part, these associations do not reach a statistically significant level. In models 1 through 3 in Table 14, child's BMI at age 5 is statistically significantly and positively associated with change in BMI over the 4 years time period, suggesting that children who were heavier at the beginning of the period gained more weight. These findings are consistent with trends observed in previous research (Flegal & Troiano, 2000; Jolliffe, 2004). Once time-varying variables are added in Model 4, the coefficient for child's BMI at age 5 is no longer statistically significant but remains positive and large in magnitude. Among the individual characteristics, being a male is negatively associated with change in BMI; pubertal maturation, number of months between assessments and maternal employment are positively associated with change in BMI. Being of White Non-Hispanic or Black Non-Hispanic race/ethnicity is inversely associated with a change in BMI as compared to children of Hispanic ethnicity, though the associations are only marginally statistically significant ($0.05 < p < 0.1$).

Table 15 presents coefficients from 48 regression models estimating the effect of change in exposure to fast food between the 5- and 9-year follow-up surveys on change in children's BMI during the same time period. Model 1 in the first column presents results from models adjusting only for change in density of fast food, child's BMI at year 5, the child's age at the time of the year 5 assessment, number of months between surveys and whether the child had moved at least once between waves. Model 2 adjusts, in addition, for changes in neighborhood socio-economic composition during the 4-year time period of interest. Child and family time in-varying variables are added in Model 3. Model 4 includes child and family time-varying characteristics in addition to all the covariates in Model 3.

Results for all three measures of fast food (i.e., fast food E.I.D.C., all fast food and national fast food) and across the four different network buffers used (i.e., 1-, 2- 3- and 5-kilometer) show no evidence of a causal relationship between density of fast food and children's BMI. None of the coefficients presented in Table 16 reach a statistical significant level and most are *negative* (opposite of the expected direction).

Table 16 presents results from individual fixed-effects models that focus on within-child changes. Results in Model 1 which adjust only for the density of "fast food E.I.D.C." at a 1-kilometer network buffer suggest a positive and statistically significant association between density of fast food and child's BMI. The association remains positive and statistically significant when neighborhood contextual covariates are added in Model 2. Moreover, results in Model 2 suggest an inverse relationship between neighborhood race/ethnic composition and child's BMI. However, when individual time-varying characteristics are added in Model 3 the coefficient for the density of fast food variable decreases substantively in magnitude, changes sign and becomes statistically insignificant as do all the neighborhood contextual variables. Among the individual time-varying characteristics only pubertal maturation has a strong and statistically significant association with BMI. This suggests that exposure to fast food may not play a small role in children's weight status; individual characteristics may have a more important role.

6. Discussion

6.1. Summary of Findings

This is among the first studies to investigate the effect of fast food exposure on weight status among children and to explore the possible temporal relationship between the two. Using a population-based data from a national urban birth cohort study, implementing both cross-sectional and longitudinal analytic techniques and numerous robustness checks, I find, in general, no discernible effect of exposure to fast food at the residential neighborhood on children's weight status measured both, by BMI z-score and as an indicator for obesity. Results from this analysis are consistent with a recent studies that find no effect of proximity to fast food in particular on children's dietary intake (An & Sturm, 2012) or risk for obesity (Burdette & Whitaker, 2004; Crawford, et al., 2008; Lee, 2012; Powell, 2009; Sturm & Datar, 2005). Only a small number of studies, e.g., Currie, et al. (2010) find a causal relationship between proximity of fast food and children's adiposity. However, they use aggregate data of 9th grade high school students in California and examine the effect of proximity of fast food restaurants to schools on prevalence of obesity.

This study finds that high population density neighborhoods, which tend to be highly disadvantaged (e.g., high percent of the population live below the federal poverty line and high percent of racial/ethnic minority), have higher concentration of fast foods. However, despite the higher exposure, this study does not find evidence of an association between fast food and residing children's weight status in high population density neighborhoods. Of all the analyses conducted for this study, the only statistically significant association between fast food density and children's BMI z-score is observed at the smallest network buffer (1-kilometer) among children who reside in low population density census tract. Previous studies found that residents of high-sprawl environments may be less likely to engage in physical and more likely to be obese (Lovasi, et al., 2009).

This study does not find evidence that family's car possession may moderate the association between fast food and children's weight status. The only other study that I am aware of to examine whether car ownership may moderate the effect of neighborhood's fast food (Inagami, et al., 2009) found that car ownership may reduce the effect of neighborhood's fast food on risk for obesity. However, their study used a sample of adults from one US city (Los Angeles) only.

6.2. Strength and Limitations

Using the panel design of the FFCWB study, which includes detailed geographic information of both residential addresses and of fast food establishments, allows me to examine the possible temporal relationship between exposure to fast food in residential neighborhood and children's weight status. Though the use of fixed-effects models that focus on changes in within-child BMI reduce the risk for unobservable heterogeneity, biased results may still emerge; unobserved changes in family or child circumstances may increase both the likelihood of change of residential neighborhood and of child's weight status. Fixed-effects estimates that do not reflect these changes will misstate the effects of fast food density on child weight.

The data are extremely rich and include objective measures of height and weight, detailed socio-demographic data of children and their families and contextual neighborhood characteristics. Additionally, the rich dataset allows the inclusion of indicators for early life factors (e.g., breastfeeding, maternal smoking during pregnancy) and physiological maturations which have been linked with obesity, but were not adjusted for in previous studies. Indicators for residential mobility, which were excluded from most previous analyses are included in this analysis as well (Carter & Dubois, 2010; Jeffery, Baxter, McGuire, & Linde, 2006). The use of three alternative specifications of fast food and four different buffer sizes tests the results' sensitivity to specification and strengthen confidence in the findings. While most studies use aggregate measure of exposure to fast food (Jeffery, et al., 2006) this study uses street network buffers about individual residential address, a more precise measure of individual exposure.

A few limitations of the study should be mentioned as well. Fast food establishment location is based on longitude and latitude information provided by InfoUSA. Inaccuracies in geocoded information may limit the accuracy of the analysis and bias the results. Although three definitions of fast food establishments were used results may be sensitive to the definition used which may yield different results if another algorithm is used. Additionally, business establishments' data are available only for two years (2006 and 2009) and are used respectively for each one of the survey waves. The food industry is known for having a large turn-over, with many restaurants closing and new opening every year. Therefore, a better alignment of the business data with year of interview data may improve the estimates. While the study includes a rich set of confounding variables some confounding variables may have been unmeasured. Despite the population-based nature of the FFCWB data, sampling weights were not available for these analyses and, therefore, generalizability of the findings may be limited. Using a national sample from multiple geographical areas may conceal accessibility patterns in local areas.

Children spend a large portion of the day at school. Evidence suggests that fast food outlets are clustered around schools (Austin Bryn, et al., 2005; Simon, et al., 2008). Children may be exposed to fast food on their way to or from school. Findings regarding the association between availability of fast food in school vicinity and children's diet and weight status are inconclusive (Currie, et al., 2010; Davis & Carpenter, 2009; Harris, et al., 2011; He, Tucker, Irwin, et al., 2012; van der Horst, et al., 2008). The current study focuses on the effects of exposure of pre-adolescent children to fast food in residential neighborhood on their weight status. At this age children have limited personal autonomy and are likely to be supervised by an adult. However, it is important to consider possible exposure in other environments (e.g., near school). Future research should further investigate the possible effect of fast food in school vicinity or other activity centers on children's adiposity.

Recent studies find that most disadvantaged and minority neighborhoods are faced with ease rather than lack of access to food (Lee, 2012). Focusing solely on fast food without taking into account other food establishments may bias the results. Similar to other food availability studies, consumption of fast food, which has been linked with increased energy intake (Bowman, et al., 2004) is not measured. The current study does not find an effect of density of fast food establishments in residential neighborhood on weight status of children. However, it does not evaluate other health outcomes such as cardio-vascular disease and diabetes which have been linked to poor diets associated with fast food (Bowman, et al., 2004).

It is possible that factors other than exposure, e.g., food price or personal choice, may play a more important role. Future research should be focused at understanding possible interaction between fast food exposure and consumption.

6.3. *Policy Implications*

As noted in the background section, childhood obesity has become a serious public health concern. The concentration of childhood obesity among disadvantaged populations is likely to continue into adulthood and, therefore, perpetuate differences in health outcomes over the life course. If not addressed, the high rates of obesity and associated consequences may burden the nation's health, economic and welfare systems. Preventing childhood obesity may also play an important role in reducing future socioeconomic, racial and ethnic health disparities.

In recent years the neighborhood food environment has emerged as a potential culprit in the obesity epidemic. Though the empirical evidence of this relationship is relatively limited, recent policy proposals include the use of zoning laws to restrict fast food in an effort to curb the epidemic (Mair, Pierce, & Teret, 2005). In some areas, policy makers have taken action to limit availability of fast food. In Los Angeles, for example, the City Council banned opening of new fast food restaurants in a disadvantaged area of the city (Council, 2008; Sturm & Cohen, 2009).

This research finds no evidence to the support the hypothesis that density or proximity to fast food restaurants may affect weight status of pre-adolescent children. Therefore, policy directed towards banning of fast food establishments in certain areas may be misguided. This is not to say that fast food and other food establishments should be left unaccounted for. It has been established that food served at fast food restaurants is of low nutritional value (Bowman, et al., 2004). Findings from this and other studies suggest that individual characteristics may play a key role in the obesity epidemic. Therefore, policy makers’ efforts may be better directed at providing the public with information needed to make informed choices for a better lifestyle. Requiring fast food restaurants to post nutritional values of their meals offering is a step in the right direction. However, it may be insufficient on its own. A recent poll suggests people's perception of their and their children's weight are inaccurate. Furthermore, the poll suggests that most Americans are not aware of the link between obesity and other health outcomes. (Tompson et al., 2013). Providing the public information about adequate caloric intake and physical activity regimes may help people make better life style choices for them and their families and improve weight status across environmental influences.

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Table 1. Child, Family and Neighborhood Characteristics - Fragile Families Year 9

	Full Sample	Obese	Normal Weight
	(N=2,673)	(N=669)	(N=1,557)
Child Characteristics			
BMI z-score (Mean)	0.74 (1.11)	2.10*** (0.28)	-0.01 (0.78)
Obese	25.0	100	0
Gender (Male)	52.1	49.8	53.8
Age at Time of Assessment (Mean; Months)	111.5 (4.7)	111.7 (5.1)	111.4 (4.6)
Pubertal Development Score (Mean)	1.46 (0.35)	1.58*** (0.38)	1.39 (0.32)
> 2hrs Sedentary Behavior per Weekday	38.9	42.6**	36.5
Ever Breastfed	58.1	54.7*	60.3
Socio-Demographic Characteristics			
Race/Ethnicity			
White Non-Hispanic	21.3	13.6***	24.7
Black Non-Hispanic	49.3	50.5	48.3
Hispanic	26.1	33.3	23.2
Other Race	3.4	2.5	3.9
Mother is a US Born	85.6	82.7**	87.0
Maternal Education			
Less than High School	31.0	34.2***	29.7
High School	32.1	34.1	30.7
Some College	25.7	25.4	26.1
College or more	11.2	6.0	13.6
Household Income - Yr 9			
Below Federal Poverty Line	36.2	38.6***	36.0
100-199% of Poverty Line	29.5	32.9	27.2
200-299% of Poverty Line	13.9	13.9	13.9
300% or more of Poverty Line	20.4	14.6	22.9
Parental Relationship Status - Yr 9			
Married	31.5	26.0***	33.7
Cohabiting	9.8	12.1	8.7
Not-Married Not-Cohabiting	58.6	61.9	57.6
Mother Employment Status - Yr 9	64.0	64.0	63.8
Mother Own/Lease Car - Yr 9	77.8	76.1	78.5
Smoked During Pregnancy	17.5	17.3	17.6
Neighborhood Contextual Variables			
Percent Poverty	18.2 (13.8)	19.9*** (13.4)	17.2 (13.8)
Percent Foreign Born	11.8	13.3 **	11.3

	(13.6)	(14.9)	(13.2)
Percent Non-Hispanic Black	34.9	37.1*	33.6
	(35.8)	(35.7)	(35.7)
Percent Hispanic	18.1	20.9***	16.5
	(24.5)	(25.7)	(23.3)
Population Density (10,000 people/square mile)	1.05	1.23*	1.02
	(1.90)	(2.28)	(1.84)

Unless otherwise specified, results are presented in percentages and standard deviations are presented in parentheses

* p<0.05, ** p<0.01, *** p<0.001, in comparison of obese and normal weight children.

Table 2. Child, Family and Neighborhood Characteristics in High (≥8,320 people per square mile) and Low (<8,320 people per square mile) Population Density Census Tracts

	Full Sample	High Population Density	Low Population Density
	(N=2,673)	(N=922)	(N=1,751)
Child Characteristics			
BMI z-score (Mean)	0.74 (1.11)	0.84*** (1.07)	0.69 (1.13)
Obese	25.0	28.2*	23.4
Gender (Male)	52.1	50.4	53.0
Age at Time of Assessment (Months)	111.5 (4.7)	111.6 (4.9)	111.5 (4.6)
Pubertal Development Score (Mean)	1.46 (0.35)	1.50*** (0.37)	1.44 (0.34)
> 2hrs Sedentary Behavior per Weekday	38.9	43.6***	36.5
Ever Breastfed	58.1	56.1	59.2
Socio-Demographic Characteristics			
Race/Ethnicity			
White Non-Hispanic	21.3	6.0***	29.4
Black Non-Hispanic	49.3	61.4	42.9
Hispanic	26.1	30.0	24.0
Other Race	3.4	2.6	3.8
Mother is a US Born	85.6	78.5***	89.4
Maternal Education			
Less than High School	31.0	38.7***	27.0
High School	32.1	33.3	31.5
Some College	25.7	22.5	27.3
College or more	11.2	5.5	14.2
Household Income - Yr 9			
Below Federal Poverty Line	36.2	44.0***	32.1
100-199% of Poverty Line	29.5	31.0	28.7
200-299% of Poverty Line	13.9	13.2	14.3
300% or more of Poverty Line	20.4	11.8	24.9
Parental Relationship Status - Yr 9			
Married	31.5	24.7***	35.1
Cohabiting	9.8	13.7	7.8
Not-Married Not-Cohabiting	58.6	61.6	57.1
Mother Employment Status - Yr 9	64.0	60.3**	65.9
Mother Own/Lease Car - Yr 9	77.8	64.4***	84.9
Smoked During Pregnancy	17.5	18.4	17.0
Neighborhood Contextual Variables			

Percent Poverty	18.2	25.8***	14.2
	(13.8)	(13.6)	(12.1)
Percent Foreign Born	11.8	18.8***	8.1
	(13.6)	(17.7)	(8.9)
Percent Non-Hispanic Black	34.9	51.7***	26.0
	(35.8)	(37.1)	(31.8)
Percent Hispanic	18.1	21.0***	16.5
	(24.5)	(24.5)	(24.3)
Population Density (10,000	1.05	1.23*	1.02
people/square mile)	(1.90)	(2.28)	(1.84)

Unless otherwise specified, results are presented in percentages and standard deviations are presented in parentheses

* $p<0.05$, ** $p<0.01$, *** $p<0.001$, in comparison of children in high (≥8,320 per square mile) and low population density (<8,320 per square mile) census tracts.

Table 3. Density of Fast Food Restaurants about Residential Addresses, Full Sample and Stratified by Obese and Normal Weight

	Full Sample	Obese	Normal Weight
	(N=2,673)	(N=669)	(N=1,557)
"Fast food E.I.D.C"			
within 1km network buffer	2.67	2.93	2.63
	(4.97)	(5.14)	(5.12)
within 2km network buffer	2.53	2.70	2.54
	(4.01)	(4.23)	(4.10)
within 3km network buffer	2.44	2.64	2.45
	(3.88)	(4.27)	(3.98)
within 5km network buffer	2.31	2.53	2.32
	(3.79)	(4.04)	(3.97)
"All Fast Food"			
within 1km network buffer	2.96	3.23	2.93
	(5.61)	(5.72)	(5.77)
within 2km network buffer	2.84	3.03	2.86
	(4.59)	(4.85)	(4.70)
within 3km network buffer	2.76	2.98	2.78
	(4.50)	(4.98)	(4.62)
within 5km network buffer	2.64	2.88	2.65
	(4.43)	(4.71)	(4.63)
"National Fast Food Chains"			
within 1km network buffer	0.92	0.99	0.89
	(1.60)	(1.62)	(1.62)
within 2km network buffer	0.95	0.99	0.94
	(1.13)	(1.15)	(1.15)
within 3km network buffer	0.92	0.98	0.92
	(1.05)	(1.18)	(1.06)
within 5km network buffer	0.89	0.95	0.88
	(1.04)	(1.08)	(1.10)

Unless otherwise specified, results are presented as means and standard deviations are presented in parentheses

* $p<0.05$, ** $p<0.01$, *** $p<0.001$, in comparison of obese and normal weight children.

Table 4. Density of Fast Food Restaurants, Full Sample and Stratified by High (≥8,320 people per square mile) and Low (<8,320 people per square mile) Population Density

	Full Sample	High Population Density	Low Population Density
	(N=2,673)	(N=922)	(N=1,751)
"Fast food E.I.D.C"			
within 1km network buffer	2.67	5.29***	1.28
	(4.97)	(7.23)	(2.17)
within 2km network buffer	2.53	4.84***	1.30
	(4.01)	(5.87)	(1.43)
within 3km network buffer	2.44	4.76***	1.21
	(3.88)	(5.74)	(1.11)
within 5km network buffer	2.31	4.57***	1.12
	(3.79)	(5.68)	(0.95)
"All Fast Food"			
within 1km network buffer	2.96	5.90***	1.41
	(5.61)	(8.17)	(2.43)
within 2km network buffer	2.84	5.48***	1.44
	(4.59)	(6.75)	(1.62)
within 3km network buffer	2.76	5.44***	1.35
	(4.50)	(6.68)	(1.28)
within 5km network buffer	2.64	5.26***	1.26
	(4.43)	(6.64)	(1.12)
"National Fast Food Chains"			
within 1km network buffer	0.92	1.45***	0.64
	(1.60)	(1.92)	(1.33)
within 2km network buffer	0.95	1.44***	0.68
	(1.13)	(1.46)	(0.79)
within 3km network buffer	0.92	1.47***	0.63
	(1.05)	(1.47)	(0.55)
within 5km network buffer	0.89	1.46***	0.59
	(1.04)	(1.52)	(0.42)

Unless otherwise specified, results are presented as means and standard deviations are presented in parentheses

* $p<0.05$, ** $p<0.01$, *** $p<0.001$, in comparison high (≥8,320 per square mile) and low population density (<8,320 per square mile) census tracts.

Table 5. Coefficients from OLS Regression Models Estimating the Association between Density of "Fast food E.I.D.C" at 1-Kilometer Network Buffer and Year 9 BMI z-score

	Model 1	Model 2	Model 3	Model 4
Fast food E.I.D.C	0.005 [-0.003,0.014]	0.000 [-0.008,0.008]	0.000 [-0.009,0.010]	-0.002 [-0.015,0.011]
Child Characteristics				
Gender (Male)		0.166*** [0.079,0.253]	0.168*** [0.081,0.255]	0.169*** [0.081,0.256]
Age at Time of Assessment (Months)		-0.002 [-0.011,0.007]	-0.004 [-0.013,0.006]	-0.004 [-0.013,0.006]
Pubertal Development Score		0.814*** [0.697,0.931]	0.825*** [0.707,0.943]	0.822*** [0.704,0.940]
> 2hrs Sedentary Behavior		0.073 [-0.011,0.158]	0.078 [-0.007,0.162]	0.073 [-0.012,0.157]
Ever Breastfed		-0.082 [-0.171,0.007]	-0.090* [-0.180,-0.001]	-0.087 [-0.177,0.003]
Socio-Demographic Characteristics				
Race/Ethnicity				
White-Non Hispanic		-0.310*** [-0.455,-0.165]	-0.290*** [-0.437,-0.143]	-0.254** [-0.417,-0.092]
Black-Non Hispanic		-0.211*** [-0.325,-0.097]	-0.190** [-0.308,-0.072]	-0.182* [-0.325,-0.039]
Other Race		-0.298* [-0.549,-0.047]	-0.299* [-0.557,-0.040]	-0.277* [-0.546,-0.009]
Mother is a US born		-0.089 [-0.231,0.053]	-0.078 [-0.225,0.070]	-0.084 [-0.235,0.066]
Maternal Education				
High School		0.055 [-0.046,0.156]	0.063 [-0.038,0.165]	0.069 [-0.034,0.171]
Some College		-0.040 [-0.164,0.083]	-0.030 [-0.155,0.095]	-0.022 [-0.147,0.104]
College or Higher		-0.126 [-0.306,0.054]	-0.125 [-0.305,0.056]	-0.109 [-0.290,0.072]
Household Income				
100-199% of Poverty Line		0.112* [0.006,0.219]	0.113* [0.006,0.221]	0.117* [0.010,0.225]
200-299% of Poverty Line		0.012 [-0.129,0.152]	0.004 [-0.136,0.145]	0.020 [-0.121,0.162]
300% or More of		0.007	0.006	0.026

Poverty Line				
		[-0.138,0.152]	[-0.140,0.152]	[-0.121,0.174]
Parents Relationship Status				
Cohabiting - Yr 9		0.029	0.017	0.011
		[-0.136,0.193]	[-0.148,0.182]	[-0.154,0.176]
Not Married Not Cohabiting - Yr 9		-0.006	-0.007	-0.010
		[-0.113,0.101]	[-0.114,0.101]	[-0.117,0.098]
Mother Employment Status - Yr 9		0.028	0.030	0.030
		[-0.064,0.119]	[-0.062,0.122]	[-0.063,0.122]
Mother Own/Lease Car - Yr 9		0.003	0.005	0.015
		[-0.110,0.117]	[-0.110,0.120]	[-0.100,0.131]
Mother smoked cigarettes during pregnancy		0.019	0.013	0.013
		[-0.091,0.130]	[-0.099,0.124]	[-0.099,0.125]
Neighborhood Contextual Variables				
Percent Poverty				0.251
				[-0.198,0.701]
Percent Foreign Born				0.022
				[-0.524,0.567]
Percent Non-Hispanic Black				0.023
				[-0.176,0.222]
Percent Hispanic				0.051
				[-0.241,0.343]
Population Density (10,000 people/square mile)				0.007
				[-0.032,0.046]
R-squared	0.001	0.089	0.093	0.094
N	2673	2673	2673	2673

* p<0.05, ** p<0.01, *** p<0.001

Table 6. Coefficients from OLS Regression Models Estimating the Association between Density of "Fast food E.I.D.C" at 1-, 2-, 3- and 5-Kilometer Network Buffer and Year 9 BMI z-score

	1-KM Network Buffer	**2-KM Network Buffer**	**3-KM Network Buffer**	**5-KM Network Buffer**
Fast Food Density at 1-KM Buffer	-0.002			
	[-0.015,0.011]			
Fast Food Density at 2-KM Buffer		-0.011		
		[-0.028,0.005]		
Fast Food Density at 3-KM Buffer			-0.018	
			[-0.036,0.001]	
Fast Food Density at 5-KM Buffer				-0.014
				[-0.032,0.005]
Child Characteristics				
Gender (Male)	0.169***	0.168***	0.169***	0.169***
	[0.081,0.256]	[0.081,0.256]	[0.081,0.256]	[0.082,0.257]
Age at Time of Assessment (Months)	-0.004	-0.004	-0.004	-0.004
	[-0.013,0.006]	[-0.013,0.006]	[-0.013,0.006]	[-0.013,0.006]
Pubertal Development Score	0.822***	0.822***	0.822***	0.822***
	[0.704,0.940]	[0.704,0.940]	[0.704,0.940]	[0.704,0.940]
> 2hrs Sedentary Behavior	0.073	0.072	0.071	0.072
	[-0.012,0.157]	[-0.013,0.157]	[-0.014,0.156]	[-0.013,0.157]
Ever Breastfed	-0.087	-0.086	-0.087	-0.088
	[-0.177,0.003]	[-0.176,0.004]	[-0.177,0.003]	[-0.178,0.002]
Socio-Demographic Characteristics				
Race/Ethnicity				
White-Non Hispanic	-0.254**	-0.256**	-0.257**	-0.256**
	[-0.417,-0.092]	[-0.418,-0.094]	[-0.419,-0.094]	[-0.418,-0.093]
Black-Non Hispanic	-0.182*	-0.179*	-0.177*	-0.179*
	[-0.325,-0.039]	[-0.322,-0.036]	[-0.320,-0.034]	[-0.322,-0.036]
Other Race	-0.277*	-0.281*	-0.282*	-0.278*
	[-0.546,-0.009]	[-0.550,-0.012]	[-0.550,-0.013]	[-0.546,-0.010]
Mother is a US born	-0.084	-0.087	-0.087	-0.085
	[-0.235,0.066]	[-0.238,0.064]	[-0.237,0.064]	[-0.236,0.065]
Maternal Education				
High School	0.069	0.067	0.067	0.067
	[-0.034,0.171]	[-0.035,0.170]	[-0.035,0.169]	[-0.035,0.169]
Some College	-0.022	-0.022	-0.021	-0.021
	[-0.147,0.104]	[-0.148,0.103]	[-0.146,0.104]	[-0.147,0.104]
College or Higher	-0.109	-0.108	-0.106	-0.106

	[-0.290,0.072]	[-0.289,0.073]	[-0.287,0.074]	[-0.287,0.075]
Household Income				
100-199% of Poverty Line	0.117*	0.119*	0.119*	0.118*
	[0.010,0.225]	[0.011,0.226]	[0.011,0.226]	[0.011,0.226]
200-299% of Poverty Line	0.020	0.020	0.019	0.019
	[-0.121,0.162]	[-0.122,0.162]	[-0.122,0.161]	[-0.123,0.161]
300% or More of Poverty Line	0.026	0.027	0.028	0.029
	[-0.121,0.174]	[-0.120,0.175]	[-0.120,0.176]	[-0.119,0.177]
Parents Relationship Status				
Cohabiting	0.011	0.012	0.011	0.010
	[-0.154,0.176]	[-0.153,0.177]	[-0.154,0.176]	[-0.155,0.175]
Not Married Not Cohabiting	-0.010	-0.008	-0.009	-0.009
	[-0.117,0.098]	[-0.116,0.099]	[-0.116,0.099]	[-0.117,0.098]
Mother Employment Status - Yr 9	0.030	0.031	0.031	0.030
	[-0.063,0.122]	[-0.061,0.123]	[-0.061,0.123]	[-0.062,0.122]
Mother Own/Lease Car - Yr 9	0.015	0.013	0.011	0.012
	[-0.100,0.131]	[-0.103,0.128]	[-0.104,0.126]	[-0.103,0.128]
Mother smoked cigarettes during pregnancy	0.013	0.014	0.016	0.014
	[-0.099,0.125]	[-0.098,0.126]	[-0.096,0.128]	[-0.098,0.126]
Neighborhood Contextual Variables				
Percent Poverty	0.251	0.270	0.287	0.275
	[-0.198,0.701]	[-0.180,0.719]	[-0.161,0.736]	[-0.176,0.726]
Percent Foreign Born	0.022	0.003	-0.027	-0.026
	[-0.524,0.567]	[-0.543,0.548]	[-0.574,0.521]	[-0.575,0.524]
Percent Non-Hispanic Black	0.023	0.008	-0.000	0.011
	[-0.176,0.222]	[-0.190,0.206]	[-0.198,0.198]	[-0.186,0.208]
Percent Hispanic	0.051	0.050	0.053	0.052
	[-0.241,0.343]	[-0.242,0.342]	[-0.239,0.345]	[-0.241,0.344]
Population Density (10,000 people/square mile)	0.007	0.018	0.027	0.022
	[-0.032,0.046]	[-0.020,0.057]	[-0.012,0.066]	[-0.019,0.062]
R-squared	0.079	0.080	0.081	0.080
N	2673	2673	2673	2673

* p<0.05, ** p<0.01, *** p<0.001

Table 7. Coefficients from OLS Regression Models Estimating the Associations between Density of Fast Food and Year 9 BMI z-score

	Bivariate Associations	P-value	Model 1 + Individual Characteristics	P-value	Model 2 + CMSA FE	P-value	Model 3 + Neigh. Composition	P-value
All Fast Food								
1-km Network Buffer	0.004	0.257	-0.000	0.922	-0.000	0.948	-0.003	0.568
	[-0.003, 0.011]		[-0.007,0.007]		[-0.009,0.008]		[-0.015,0.008]	
2-km Network Buffer	0.004	0.346	-0.002	0.648	-0.004	0.530	-0.011	0.142
	[-0.005, 0.013]		[-0.011,0.007]		[-0.014,0.007]		[-0.025,0.004]	
3-km Network Buffer	0.004	0.407	-0.003	0.542	-0.005	0.383	-0.015	0.060
	[-0.005, 0.014]		[-0.012,0.006]		[-0.017,0.006]		[-0.030,0.001]	
5-km Network Buffer	0.005	0.333	-0.002	0.734	-0.003	0.596	-0.011	0.152
	[-0.005, 0.014]		[-0.010,0.007]		[-0.014,0.008]		[-0.026,0.004]	
National Fast Food Chain								
1-km Network Buffer	0.019	0.155	0.004	0.739	0.005	0.702	0.003	0.844
	[-0.007, 0.045]		[-0.021,0.029]		[-0.022,0.032]		[-0.026,0.032]	
2-km Network Buffer	0.019	0.310	-0.008	0.649	-0.013	0.530	-0.024	0.307
	[-0.018, 0.055]		[-0.044,0.027]		[-0.053,0.028]		[-0.069,0.022]	
3-km Network Buffer	0.016	0.435	-0.018	0.382	-0.027	0.244	-0.049	0.070
	[-0.024, 0.057]		[-0.057,0.022]		[-0.073,0.019]		[-0.102,0.004]	
5-km Network Buffer	0.025	0.229	-0.006	0.768	-0.011	0.592	-0.031	0.235
	[-0.016, 0.066]		[-0.042,0.031]		[-0.053,0.031]		[-0.082,0.020]	

* p<0.05, ** p<0.01, *** p<0.001

Table 8. Odd Ratios from Logistic Regression Models Estimating the Association between Density of "Fast food E.I.D.C" at 1-Kilometer Network Buffer and Year 9 Obesity

	Model 1	Model 2	Model 3	Model 4
Fast food E.I.D.C	1.011	0.995	0.993	0.989
	[0.994,1.028]	[0.976,1.014]	[0.970,1.017]	[0.960,1.019]
Child Characteristics				
Gender (Male)		1.173	1.191	1.195
		[0.962,1.432]	[0.975,1.455]	[0.978,1.462]
Age at Time of Assessment (Months)		0.992	0.990	0.989
		[0.971,1.013]	[0.968,1.012]	[0.968,1.012]
Pubertal Development Score		4.949***	5.046***	5.034***
		[3.672,6.672]	[3.730,6.826]	[3.718,6.815]
> 2hrs Sedentary Behavior		1.248*	1.260*	1.246*
		[1.026,1.517]	[1.034,1.535]	[1.022,1.518]
Ever Breastfed		0.836	0.822	0.826
		[0.676,1.034]	[0.663,1.019]	[0.666,1.026]
Socio-Demographic Characteristics				
White-Non Hispanic		0.538***	0.558***	0.610*
		[0.385,0.750]	[0.397,0.784]	[0.418,0.889]
Black-Non Hispanic		0.578***	0.599***	0.613**
		[0.450,0.743]	[0.460,0.782]	[0.441,0.852]
Other Race		0.478*	0.509*	0.530
		[0.255,0.897]	[0.267,0.969]	[0.274,1.025]
Mother is a US born		0.694*	0.717*	0.714*
		[0.507,0.952]	[0.518,0.992]	[0.514,0.993]
Maternal Education				
High School		1.058	1.074	1.081
		[0.832,1.344]	[0.843,1.368]	[0.848,1.377]
Some College		1.056	1.076	1.090
		[0.799,1.397]	[0.811,1.428]	[0.821,1.448]
College or Higher		0.738	0.739	0.760
Household Income				
		[0.465,1.173]	[0.463,1.179]	[0.476,1.212]
100-199% of Poverty Line		1.105	1.113	1.119
		[0.866,1.409]	[0.870,1.425]	[0.873,1.433]
200-299% of Poverty Line		0.893	0.870	0.893
		[0.646,1.235]	[0.629,1.203]	[0.644,1.237]
300% or More of Poverty Line		0.858	0.852	0.884
		[0.605,1.218]	[0.599,1.212]	[0.619,1.263]
Parents Relationship Status at Year 9				
Cohabiting		1.257	1.246	1.233
		[0.874,1.806]	[0.865,1.796]	[0.855,1.778]
Not Married Not Cohabiting		1.131	1.127	1.120
		[0.874,1.463]	[0.870,1.459]	[0.865,1.451]
Mother Employment Status -Yr 9		1.093	1.094	1.095

		[0.881,1.356]	[0.880,1.360]	[0.881,1.361]
Mother Own/Lease Car - Yr 9		0.938	0.953	0.972
		[0.722,1.219]	[0.731,1.242]	[0.745,1.269]
Mother smoked cigarettes during pregnancy		0.987	0.970	0.974
		[0.754,1.291]	[0.740,1.271]	[0.742,1.278]
Neighborhood Contextual Variables				
Percent Poverty				1.396
				[0.523,3.722]
Percent Foreign Born				1.250
				[0.365,4.274]
Percent Non-Hispanic Black				1.114
				[0.709,1.751]
Percent Hispanic				1.169
				[0.599,2.281]
Population Density (10,000 people/square mile)				1.005
				[0.920,1.098]
N	2226	2226	2212	2212

* p<0.05, ** p<0.01, *** p<0.001

Table 9. Coefficients from OLS Regression Models Estimating the Association between Density of "Fast food E.I.D.C" at 1-Kilometer Network Buffer and Year 9 BMI z-score in High and Low Population Density Census Tracts

	High Density Population Density (≥8,320 people/square mile)	Low Density Population Density (<8,320 people/square mile)
Fast food E.I.D.C	-0.006	0.024*
	[-0.019,0.006]	[0.000,0.047]
Child Characteristics		
Gender (Male)	0.256***	0.128*
	[0.110,0.402]	[0.017,0.238]
Age at Time of Assessment (Months)	-0.008	-0.002
	[-0.022,0.007]	[-0.014,0.011]
Pubertal Development Score	0.873***	0.807***
	[0.677,1.069]	[0.657,0.957]
> 2hrs Sedentary Behavior	0.154*	0.04
	[0.013,0.295]	[-0.067,0.148]
Ever Breastfed	-0.026	-0.128*
	[-0.170,0.118]	[-0.246,-0.010]
Socio-Demographic Characteristics		
Race/Ethnicity		
White-Non Hispanic	0.024	-0.280**
	[-0.317,0.364]	[-0.475,-0.085]
Black-Non Hispanic	-0.094	-0.229*
	[-0.323,0.136]	[-0.414,-0.044]
Other Race	-0.302	-0.299
	[-0.758,0.154]	[-0.629,0.031]
Mother is a US born	-0.178	-0.06
	[-0.409,0.053]	[-0.262,0.142]
Maternal Education		
High School	0.091	0.044
	[-0.066,0.248]	[-0.091,0.178]
Some College	0.016	-0.054
	[-0.198,0.231]	[-0.210,0.103]
College or Higher	-0.068	-0.126
	[-0.441,0.304]	[-0.342,0.090]
Household Income		
100-199% of Poverty Line	0.167	0.086
	[-0.011,0.346]	[-0.053,0.225]
200-299% of Poverty Line	-0.034	0.069
	[-0.264,0.195]	[-0.114,0.251]
300% or More of Poverty Line	0.111	0.035
	[-0.162,0.384]	[-0.148,0.218]
Parents Relationship Status		
Cohabiting - Yr 9	0.019	-0.012
	[-0.233,0.271]	[-0.240,0.216]

Not Married Not Cohabiting - Yr 9	-0.028	-0.012
	[-0.222,0.166]	[-0.144,0.119]
Mother Employment Status -Yr 9	0.082	-0.004
	[-0.079,0.243]	[-0.118,0.110]
Mother Own/Lease Car - Yr 9	0.014	-0.031
	[-0.160,0.187]	[-0.192,0.130]
Mother smoked cigarettes during pregnancy	0.02	0.001
	[-0.164,0.204]	[-0.143,0.146]
Neighborhood Contextual Variables		
Percent Poverty	0.456	0.216
	[-0.211,1.123]	[-0.420,0.851]
Percent Foreign Born	0.305	0.27
	[-0.477,1.088]	[-0.598,1.139]
Percent Non-Hispanic Black	0.037	0.015
	[-0.291,0.365]	[-0.246,0.276]
Percent Hispanic	-0.201	0.1
	[-0.734,0.331]	[-0.264,0.465]
R-squared	0.072	0.076
N	922	1751

* p<0.05, ** p<0.01, *** p<0.001

Table 10. Coefficients from OLS Regression Models Estimating the Associations between Density of Fast Food and Year 9 BMI z-score in Families who Own or Lease a Car

	Bivariate Associations	P-value	Model 1 + Individual Characteristics	P-value	Model 2 + CMSA FE	P-value	Model 3 + Neigh. Composition	P-value
Fast food E.I.D.C								
1-km Network Buffer	0.014	0.012	0.007	0.230	0.009	0.183	0.007	0.425
	[0.003,0.025]		[-0.004,0.018]		[-0.004,0.023]		[-0.010,0.024]	
2-km Network Buffer	0.017	0.018	0.007	0.340	0.008	0.341	0.002	0.881
	[0.003,0.031]		[-0.007,0.020]		[-0.009,0.025]		[-0.020,0.023]	
3-km Network Buffer	0.019	0.017	0.007	0.331	0.009	0.336	-0.000	0.985
	[0.003,0.034]		[-0.007,0.021]		[-0.009,0.026]		[-0.023,0.023]	
5-km Network Buffer	0.021	0.015	0.009	0.215	0.012	0.202	0.006	0.645
	[0.004,0.038]		[-0.005,0.024]		[-0.006,0.030]		[-0.020,0.032]	
All Fast Food								
1-km Network Buffer	0.013	0.011	0.006	0.224	0.008	0.183	0.006	0.424
	[0.003,0.022]		[-0.004,0.016]		[-0.004,0.020]		[-0.009,0.021]	
2-km Network Buffer	0.014	0.021	0.006	0.352	0.007	0.372	0.001	0.914
	[0.002,0.026]		[-0.006,0.017]		[-0.008,0.021]		[-0.017,0.019]	
3-km Network Buffer	0.016	0.020	0.006	0.353	0.007	0.378	-0.001	0.931
	[0.002,0.029]		[-0.006,0.019]		[-0.008,0.022]		[-0.020,0.019]	
5-km Network Buffer	0.017	0.021	0.007	0.244	0.009	0.246	0.004	0.735
	[0.003,0.032]		[-0.005,0.020]		[-0.006,0.025]		[-0.017,0.025]	
National Fast Food Chains								
1-km Network Buffer	0.033	0.039	0.016	0.288	0.017	0.307	0.013	0.456
	[0.002,0.064]		[-0.014,0.047]		[-0.016,0.049]		[-0.021,0.047]	
2-km Network Buffer	0.047	0.048	0.0154	0.530	0.009	0.718	-0.003	0.910
	[0.000,0.094]		[-0.031,0.060]		[-0.042,0.060]		[-0.058,0.052]	
3-km Network Buffer	0.056	0.043	0.009	0.748	-0.000	0.989	-0.029	0.386
	[0.002,0.110]		[-0.044,0.061]		[-0.060,0.059]		[-0.096,0.037]	
5-km Network Buffer	0.071	0.034	0.026	0.339	0.022	0.474	-0.002	0.949
	[0.005,0.137]		[-0.027,0.078]		[-0.037,0.080]		[-0.072,0.068]	

* p<0.05, ** p<0.01, *** p<0.001

Table 11. Coefficients from OLS Regression Models Estimating the Associations between Density of Fast Food and Year 9 BMI z-score in Families who Do Not Own or Lease a Car

	Bivariate Associations	P-value	Model 1 + Individual Characteristics	P-value	Model 2 + CMSA FE	P-value	Model 3 + Neigh. Composition	P-value
Fast food E.I.D.C								
1-km Network Buffer	-0.005	0.471	-0.005	0.471	-0.004	0.623	-0.008	0.536
	[-0.018,0.008]		[-0.019,0.009]		[-0.022,0.013]		[-0.032,0.016]	
2-km Network Buffer	-0.007	0.371	-0.009	0.306	-0.011	0.342	-0.019	0.227
	[-0.023,0.009]		[-0.026,0.008]		[-0.033,0.011]		[-0.050,0.012]	
3-km Network Buffer	-0.010	0.270	-0.011	0.222	-0.015	0.201	-0.027	0.122
	[-0.027,0.007]		[-0.029,0.007]		[-0.038,0.008]		[-0.061,0.007]	
5-km Network Buffer	-0.009	0.285	-0.009	0.297	-0.012	0.291	0.023	0.168
	[-0.026,0.008]		[-0.027,0.008]		[-0.034,0.010]		[-0.055,0.010]	
All Fast Food								
1-km Network Buffer	-0.005	0.370	-0.006	0.378	-0.005	0.496	-0.009	0.390
	[-0.016,0.006]		[-0.018,0.007]		[-0.021,0.010]		[-0.031,0.012]	
2-km Network Buffer	-0.007	0.309	-0.008	0.274	-0.010	0.310	-0.017	0.203
	[-0.021,0.007]		[-0.023,0.007]		[-0.029,0.009]		[-0.043,0.009]	
3-km Network Buffer	-0.009	0.240	-0.010	0.216	-0.013	0.210	-0.022	0.139
	[-0.023,0.006]		[-0.025,0.006]		[0.032,0.007]		[-0.050,0.007]	
5-km Network Buffer	-0.008	0.286	-0.008	0.313	-0.009	0.332	-0.017	0.205
	[-0.022,0.007]		[-0.023,0.007]		[-0.028,0.009]		[-0.044,0.010]	
National Fast Food Chains								
1-km Network Buffer	-0.012	0.623	-0.013	0.615	-0.005	0.850	-0.008	0.798
	[-0.059,0.035]		[-0.062,0.036]		[-0.061,0.051]		[-0.073,0.056]	
2-km Network Buffer	-0.033	0.284	-0.032	0.332	-0.028	0.477	-0.038	0.408
	[-0.094,0.027]		[-0.098,0.033]		[-0.107,0.050]		[-0.128,0.052]	
3-km Network Buffer	-0.040	0.225	-0.039	0.259	-0.039	0.327	-0.053	0.266
	[-0.105,0.025]		[-0.106,0.029]		[-0.118,0.039]		[-0.146,0.040]	
5-km Network Buffer	-0.033	0.302	-0.027	0.414	-0.024	0.506	-0.040	0.382
	[-0.094,0.029]		[-0.091,0.037]		[-0.097,0.048]		[-0.129,0.050]	

* p<0.05, ** p<0.01, *** p<0.001

Table 12. Descriptive Statistics of Children Who Were Interviewed at Both Year 5 and Year 9 Follow-Up Interviews

	Year 5	**Year 9**	**Year 9 Only**
	(N=1,583)	(N=1,583[a])	(N=1,076[a])
Time In-Varying Characteristics			
Child Early Life Characteristics			
Gender (Male)	51.4		53.7
Ever Breastfed	55.7		63.2***
Mother Smoked During Pregnancy	18.4		15.4*
Socio-Demographic Characteristics			
Race/Ethnicity			
White Non-Hispanic	21.7		21.7**
Black Non-Hispanic	51.8		46.6
Hispanic	23.3		29.0
Other Race	3.2		3.7
Mother is a US Born	88.3		83.1***
Maternal Education			
Less than High School	31.0		30.2
High School	32.9		31.2
Some College	25.3		25.8
College or more	10.8		12.8
Time-Varying Characteristics			
Child Characteristics			
BMI (Mean)	16.62	19.22	19.59*
	(2.32)	(4.19)	(4.31)
BMI z-score (Mean)	0.61	0.70	0.75
	(1.11)	(1.11)	(1.13)
BMI percentile	66.34	68.66	69.7
	(28.20)	(28.4)	(28.6)
Obese	16.7	22.9	26.6*
Age at Time of Assessment (Months)	63.6	110.4	113.1 ***
	(2.9)	(3.9)	(5.3)
No. of Months between Yr 5 and Yr 9 Assessments	NA	46.9	
		(4.5)	
Pubertal Development Score (Mean)	NA	1.45	1.46
		(0.36)	(0.35)
> 2hrs Sedentary Behavior per Weekday	43.4	40.9	36.8*
Moved at Least Once between Yr 5 and Yr 9	N/A	55.8	59.6*
Socio-Demographic Characteristics			

Household Income			
Below Federal Poverty Line	42.4	37.8	34.2
100-199% of Poverty Line	24.3	29.4	29.7
200-299% of Poverty Line	14.6	13.6	13.7
300% or more of Poverty Line	18.7	19.2	22.4
Parental Relationship Status			
Married	31.3	30.7	34.2
Cohabiting	13.6	10.7	8.8
Not-Married Not-Cohabiting	55.0	58.6	57.0
Mother Employment Status	61.4	62.8	65.9
Mother Own/Lease Car	66.9	75.6	80.6**
Neighborhood Contextual Variables			
Percent Poverty	20.3	18.7	17.1**
	(14.5)	(14.2)	(12.9)
Percent Foreign Born	10.4	10.5	13.2***
	(13.2)	(13.3)	(13.6)
Percent Non-Hispanic Black	41.3	38.0	30.9***
	(38.1)	(37.5)	(33.4)
Percent Hispanic	16.8	16.3	19.9***
	(24.8)	(24.2)	(24.1)
Population Density (10,000 people/square mile)	1.12	1.05	1.02
	(1.85)	(1.83)	(1.84)

* p<0.05, ** p<0.01, *** p<0.001, in comparison between children who were interviewed at both survey waves and those interviewed at year 9 only.

[a] - Number of observation may vary due to missing answers.

Table 13. Density of Fast Food Establishments at Residential Neighborhood at Year 5, Year 9 and Change Between the Two Survey Waves

	Year 5	Year 9	Change
	(N=1,583)	(N=1,583)	(N=1,583)
"Fast Food E.I.D.C"			
within 1km network buffer	2.49	2.73	0.24
	(4.27)	(5.02)	(2.68)
within 2km network buffer	2.48	2.57	0.09
	(3.67)	(4.10)	(1.90)
within 3km network buffer	2.39	2.45	0.05
	(3.43)	(3.87)	(1.67)
within 5km network buffer	2.27	2.31	0.03
	(3.17)	(3.59)	(1.39)
"All Fast Food"			
within 1km network buffer	2.71	3.02	0.31
	(4.72)	(5.67)	(2.96)
within 2km network buffer	2.70	2.87	0.17
	(4.08)	(4.73)	(2.17)
within 3km network buffer	2.63	2.76	0.13
	(3.88)	(4.53)	(1.98)
within 5km network buffer	2.51	2.62	0.11
	(3.57)	(4.17)	(1.64)
"National Fast Food Chains"			
within 1km network buffer	0.87	0.94	0.07
	(1.44)	(1.64)	(1.51)
within 2km network buffer	0.93	0.97	0.04
	(1.09)	(1.20)	(0.92)
within 3km network buffer	0.91	0.93	0.02
	(0.94)	(1.10)	(0.70)
within 5km network buffer	0.87	0.89	0.02
	(0.78)	(0.96)	(0.51)

Table 14. Coefficients from OLS Regression Models Estimating the Association between Change in Density of "Fast Food E.I.D.C" at 1-Kilometer Network Buffer and Change in BMI between Year 5 and Year 9

	Model 1	Model 2	Model 3	Model 4
Change in Density of Fast Food	-0.011	-0.006	-0.012	-0.010
	[-0.059,0.037]	[-0.059,0.046]	[-0.065,0.042]	[-0.063,0.044]
Change in Neighborhood Socio-Economic Contextual Variable				
Percent Poverty		0.673	0.727	0.647
		[-0.783,2.128]	[-0.720,2.174]	[-0.775,2.069]
Percent Foreign Born		-0.076	-0.159	-0.218
		[-2.287,2.136]	[-2.432,2.114]	[-2.492,2.057]
Percent Black		-0.193	-0.180	-0.216
		[-0.860,0.473]	[-0.849,0.488]	[-0.870,0.438]
Percent Hispanic		-1.227	-1.354*	-1.184
		[-2.561,0.108]	[-2.701,-0.007]	[-2.566,0.199]
Population Density		-0.000	-0.000	-0.000
		[-0.000,0.000]	[-0.000,0.000]	[-0.000,0.000]
Child and Family Time In-varying Characteristics				
Gender (Male)			-0.569***	-0.296*
			[-0.856,-0.282]	[-0.584,-0.008]
Ever Breastfed			-0.184	-0.165
			[-0.504,0.135]	[-0.494,0.163]
Race/Ethnicity				
White-Non Hispanic			-0.679*	-0.546
			[-1.325,-0.033]	[-1.150,0.058]
Black-Non Hispanic			-0.180	-0.374
			[-0.597,0.236]	[-0.800,0.051]
Other Race			0.017	0.057
			[-0.739,0.773]	[-0.699,0.813]
Mother is a US born			0.288	0.165
			[-0.228,0.805]	[-0.366,0.696]
Maternal Education				
High School			0.191	0.208
			[-0.208,0.589]	[-0.201,0.618]
Some College			-0.350	-0.277
			[-0.782,0.082]	[-0.749,0.196]
College or Higher			-0.462	-0.225
			[-1.084,0.161]	[-0.994,0.544]
Mother Smoked Cigarettes During Pregnancy			-0.040	-0.093
			[-0.446,0.366]	[-0.514,0.328]

Child and Family Time-Varying Characteristics				
Pubertal Development Score				1.457***
				[1.024,1.889]
> 2hrs Sedentary Behavior per Weekday				0.097
				[-0.209,0.404]
Household Income -				
100-199% of Poverty Line				0.135
				[-0.247,0.517]
200-299% of Poverty Line				-0.119
				[-0.601,0.364]
300% or More of Poverty Line				-0.344
				[-0.901,0.214]
Parents Relationship Status at Year 9				
Cohabiting				0.015
				[-0.531,0.561]
Not Married Not Cohabiting				0.094
				[-0.342,0.530]
Mother Employment Status -Yr 5				0.324*
				[0.005,0.644]
Mother Own/Lease Car - Yr 5				-0.016
				[-0.384,0.351]
Other Controls				
BMI at Yr 5	0.271*	0.269*	0.260*	0.223
	[0.042,0.500]	[0.039,0.499]	[0.029,0.490]	[-0.008,0.454]
Age at Time of Yr 5 Assessment (Months)	0.045	0.043	0.039	0.027
	[-0.016,0.106]	[-0.018,0.104]	[-0.021,0.098]	[-0.032,0.087]
No. of Months between Yr 5 and Y9 Assessment	0.071***	0.070**	0.062**	0.046*
	[0.030,0.113]	[0.028,0.112]	[0.021,0.103]	[0.007,0.086]
At Least One Residential Move Between Y5 & Y9	0.044	0.036	-0.100	-0.139
	[-0.255,0.343]	[-0.265,0.336]	[-0.423,0.224]	[-0.452,0.174]
R-squared	0.050	0.049	0.070	0.095
N	1583	1583	1583	1583

* p<0.05, ** p<0.01, *** p<0.001

Table 15. Coefficients from OLS Regression Models Estimating the Associations between Change in Density of Fast Food and Change in BMI between Year 5 and Year 9

	Model 1	P-value	Model 1 + Neigh Contextual Change	P-value	Model 2 + Time In-varying Covariates	P-value	Model 3 + Time Varying Covariates	P-value
Fast food E.I.D.C								
1-km Network Buffer	-0.011	0.666	-0.006	0.810	-0.012	0.671	-0.010	0.726
	[-0.059,0.037]		[-0.019,0.009]		[-0.065,0.042]		[-0.063,0.044]	
2-km Network Buffer	-0.000	0.994	0.009	0.812	-0.001	0.981	-0.002	0.965
	[-0.070,0.069]		[-0.068,0.087]		[-0.077,0.076]		[-0.077,0.074]	
3-km Network Buffer	-0.005	0.894	0.005	0.908	-0.004	0.922	-0.003	0.944
	[-0.077,0.067]		[-0.079,0.089]		[-0.086,0.078]		[-0.086,0.080]	
5-km Network Buffer	-0.013	0.773	-0.003	0.958	-0.006	0.951	-0.017	0.754
	[-0.100,0.074]		[-0.110,0.104]		[-0.110,0.099]		[-0.125,0.091]	
All Fast Food								
1-km Network Buffer	-0.018	0.399	-0.015	0.525	-0.020	0.408	-0.019	0.446
	[-0.061,0.024]		[-0.062,0.032]		[-0.068,0.028]		[-0.06,0.030]	
2-km Network Buffer	-0.009	0.777	-0.001	0.966	-0.011	0.736	-0.012	0.728
	[-0.068,0.051]		[-0.069,0.066]		[-0.078,0.055]		[-0.078,0.055]	
3-km Network Buffer	-0.013	0.672	-0.007	0.845	-0.015	0.659	-0.015	0.666
	[-0.071,0.046]		[-0.076,0.062]		[-0.082,0.052]		[-0.084,0.053]	
5-km Network Buffer	-0.018	0.634	-0.012	0.795	-0.016	0.724	-0.026	0.569
	[-0.090,0.055]		[-0.102,0.078]		[-0.103,0.071]		[-0.116,0.064]	
National Fast Food Chains								
1-km Network Buffer	-0.033	0.477	-0.029	0.534	-0.045	0.350	-0.033	0.494
	[-0.123,0.058]		[-0.122,0.063]		[-0.138,0.049]		[-0.128,0.062]	
2-km Network Buffer	0.050	0.502	0.067	0.392	0.022	0.782	0.031	0.696
	[-0.097,0.198]		[-0.086,0.220]		[-0.133,0.177]		[-0.124,0.185]	
3-km Network Buffer	0.014	0.885	0.029	0.777	0.017	0.862	-0.006	0.951
	[-0.172,0.199]		[-0.170,0.227]		[-0.212,0.178]		[-0.205,0.192]	
5-km Network Buffer	-0.073	0.553	-0.357	0.605	-0.123	0.372	-0.156	0.280
	[-0.314,0.168]		[-0.357,0.208]		[-0.394,0.147]		[-0.439,0.127]	

* p<0.05, ** p<0.01, *** p<0.001

Table 16. Coefficients from Individual Fixed Effects Models Estimating the Associations between Density of "Fast Food E.I.D.C." and BMI

	Model 1	Model 2	Model 3
Density of Fast Food	0.080*	0.104**	-0.000
	[0.017,0.144]	[0.038,0.170]	[-0.054,0.054]
Neighborhood Socio-Economic Contextual Variable			
Percent Poverty		-0.929	0.247
		[-2.801,0.943]	[-1.152,1.645]
Percent Foreign Born		-0.839	0.170
		[-3.646,1.968]	[-2.186,2.527]
Percent Black		-1.396**	-0.052
		[-2.225,0.566]	[-0.707,0.602]
Percent Hispanic		-2.372*	-1.286
		[-4.252,-0.491]	[-2.708, 0.136]
Population Density		-0.000	-0.000
		[-0.000,0.000]	[-0.000,0.000]
Child and Family Time-Variant Characteristics			
Child's Age			0.001
			[-0.011,0.014]
Pubertal Development Score			1.769***
			[1.376,2.161]
Any Residential Move Between Y5 & Y9			0.000
			[-0.291,0.292]
> 2hrs Sedentary Behavior per Weekday			-0.057
			[-0.269,0.156]
Household Income -			
100-199% of Poverty Line			-0.027
			[-0.339,0.284]
200-299% of Poverty Line			0.015
			[-0.405,0.436]
300% or More of Poverty Line			-0.008
			[-0.487,0.472]
Parents Relationship Status at Year 9			
Cohabiting			-0.159
			[-0.643,0.324]
Not Married Not Cohabiting			-0.253
			[-0.711,0.205]
Mother Employment Status			-0.257
			[-0.558,0.044]
Mother Own/Lease Car			0.047
			[-0.278,0.372]
N	1695	1695	1693

* p<0.05, ** p<0.01, *** p<0.001

Appendix

A.1. Wikipedia List of Fast Food Restaurants

- A&W Restaurants
- Amigos/Kings Classic
- Andy's Frozen Custard
- Arby's
- Arctic Circle Restaurants
- Arthur Treacher's
- Baker's Drive-Thru
- Baskin-Robbins
- Bess Eaton
- Big Apple Bagels
- Big Boy Restaurants
- Biscuitville
- Blake's Lotaburger
- Blimpie
- Bojangles' Famous Chicken 'n Biscuits
- Brooklyn Ice Cream Factory
- Burger King
- Braum's
- Brown's Chicken & Pasta
- Burger Street
- Burgerville
- Cafe Rio
- California Tortilla
- Captain D's
- Carl's Jr.
- Checkers (also called Rally's)
- Cheeburger Cheeburger
- Chick-fil-A
- Chinese Gourmet Express
- Church's Chicken
- CiCi's Pizza
- Cluck-U Chicken
- Cook Out
- Cousins Subs
- Crown Burgers
- Dairy Queen
- Del Taco
- Denny's
- Dick's Drive-In
- Dickey's Barbecue Pit
- Dog n Suds
- Duchess
- Dunkin' Donuts
- Einstein Bros. Bagels
- El Pollo Loco
- Erbert & Gerbert's
- Fatburger
- Firehouse Subs
- Fosters Freeze
- Freddy's Frozen Custard
- Gold Star Chili
- Golden Chick
- Golden Spoon
- Good Times Burgers & Frozen Custard
- Grandy's
- Gray's Papaya
- Great Steak
- Green Burrito
- Griff's Hamburgers
- Halo Burger
- Happi House
- Happy Joe's
- Hardee's
- Harold's Chicken Shack
- Hogi Yogi
- Honey Dew Donuts
- Hot Dog on a Stick
- Hot 'n Now
- Huddle House
- In-N-Out Burger
- Ivar's
- Jack in the Box
- Jack's
- Jersey Mike's Subs
- Jimboy's Tacos
- Johnny Rockets
- Juan Pollo
- KFC
- Kopp's Frozen Custard
- Krispy Kreme
- Krystal
- LaMar's Donuts
- Larry's Giant Subs
- Lenny's Sub Shop
- Long John Silver's
- Lyon's
- Maid-Rite
- Manchu Wok
- McDonald's
- Mellow Mushroom
- Mighty Taco
- Milio's Sandwiches
- Milo's Hamburgers
- Mr. Hero
- Mrs. Winner's Chicken & Biscuits
- Nathan's Famous
- Nedick's
- Nu-Way Weiners
- Nu Way Cafe
- Orange Julius
- The Original Hamburger Stand

- Original Tommy's
- Pal's
- Pioneer Chicken
- Popeyes Chicken & Biscuits
- Portillo's Restaurants
- Port of Subs
- Quiznos
- Raising Cane's Chicken Fingers
- Rally's
- Ranch1
- Red Burrito
- Roy Rogers Restaurants
- Runza
- Saladworks
- Schlotzsky's
- Sheetz
- Skippers Seafood & Chowder House
- Smoothie King
- Sneaky Pete's
- Sonic Drive-In
- Spangles
- Steak Escape
- Steak 'n Shake
- Submarina
- Subway
- Taco Bell
- Taco Bueno
- Taco Cabana
- Taco del Mar
- Taco Mayo
- Taco Tico
- Taco Time
- Ted's Hot Dogs
- Texadelphia
- The Hat
- The Whole Donut
- Togo's
- Tudor's Biscuit World
- The Varsity
- Wendy's
- Wetzel's Pretzels
- Whataburger
- White Castle
- Wienerschnitzel
- Winchell's Donuts
- WingStreet
- Winstead's
- Wing Zone
- Woody's Chicago Style
- Yum-Yum Donuts

Table A.2. Odds Ratios from Logistic Regression Models Estimating the Associations between Density of Fast Food and Obesity at Year 9

	Bivariate Associations	P-value	Model 1 + Individual Characteristics	P-value	Model 2 + CMSA FE	P-value	Model 3 + Neigh. Composition	P-value
Fast food E.I.D.C								
1-km Network Buffer	1.011	0.223	0.995	0.577	0.993	0.577	0.989	0.477
	[0.994, 1.028]		[0.976 - 1.014]		[0.970 - 1.017]		[0.960 - 1.019]	
2-km Network Buffer	1.009	0.403	0.987	0.294	0.979	0.214	0.960	0.092
	[0.988, 1.031]		[0.962 - 1.012]		[0.946 - 1.012]		[0.915 - 1.007]	
3-km Network Buffer	1.011	0.314	0.989	0.394	0.982	0.310	0.963	0.179
	[0.990, 1.033]		[0.964 - 1.015]		[0.949 - 1.017]		[0.912 - 1.017]	
5-km Network Buffer	1.013	0.262	0.992	0.541	0.988	0.466	0.975	0.328
	[0.991, 1.035]		[0.967 - 1.017]		[0.956 - 1.021]		[0.925 - 1.026]	
All Fast Food								
1-km Network Buffer	1.009	0.258	0.995	0.527	0.993	0.511	0.989	0.411
	[0.004, 1.024]		[0.978 - 1.012]		[0.972 - 1.014]		[0.963 - 1.016]	
2-km Network Buffer	1.007	0.446	0.988	0.283	0.981	0.206	0.965	0.099
	[0.989, 1.026]		[0.966 - 1.010]		[0.952 - 1.011]		[0.925 - 1.007]	
3-km Network Buffer	1.009	0.346	0.990	0.389	0.984	0.310	0.969	0.203
	[0.990, 1.028]		[0.968 - 1.013]		[0.955 - 1.015]		[0.924 - 1.017]	
5-km Network Buffer	1.010	0.288	0.993	0.529	0.989	0.451	0.978	0.335
	[0.001, 1.029]		[0.972 - 1.015]		[0.961 - 1.018]		[0.936 - 1.023]	
National Fast Food Chains								
1-km Network Buffer	1.037	0.172	0.996	0.900	1.001	0.991	1.001	0.973
	[0.984, 1.094]		[0.940 - 1.056]		[0.939 - 1.066]		[0.934 - 1.073]	
2-km Network Buffer	1.037	0.338	0.960	0.369	0.952	0.345	0.940	0.297
	[0.962, 1.118]		[0.878 - 1.050]		[0.859 - 1.055]		[0.837 - 1.056]	
3-km Network Buffer	1.050	0.217	0.966	0.480	0.953	0.419	0.933	0.357
	[0.972, 1.135]		[0.877 - 1.063]		[0.849 - 1.071]		[0.806 - 1.081]	
5-km Network Buffer	1.054	0.191	0.978	0.642	0.968	0.558	0.951	0.492
	[0.974, 1.139]		[0.892 - 1.073]		[0.868 - 1.080]		[0.823 - 1.099]	

* p<0.05, ** p<0.01, *** p<0.001

Table A.3. Coefficients from OLS Regression Models Estimating the Association between Density of Fast Food and BMI z-score among 9-Year Old Children in Low Density Census Tracts (<8,320 per square mile)

	Bivariate Associations	P-value	Model 1 + Individual Characteristics	P-value	Model 2 + CMSA FE	P-value	Model 3 + Neigh. Composition	P-value
Fast food E.I.D.C								
1-km Network Buffer	0.030	0.012	0.024	0.038	0.024	0.042	0.024	0.046
	[0.007, 0.053]		[0.001, 0.046]		[0.001,0.048]		[0.000,0.047]	
2-km Network Buffer	0.028	0.126	0.014	0.437	0.012	0.527	0.008	0.690
	[-0.008, 0.064]		[-0.021,0.048]		[-0.026,0.050]		[-0.030,0.046]	
3-km Network Buffer	0.032	0.185	0.005	0.813	0.001	0.957	-0.007	0.775
	[-0.015, 0.079]		[-0.038,0.049]		[-0.047,0.050]		[-0.056,0.042]	
5-km Network Buffer	0.028	0.357	-0.004	0.886	-0.012	0.677	-0.024	0.430
	[-0.032, 0.089]		[-0.058,0.050]		[-0.071,0.046]		[-0.083,0.035]	
All Fast Food								
1-km Network Buffer	0.025	0.014	0.020	0.048	0.020	0.054	0.020	0.058
	[0.005, 0.046]		[0.000,0.039]		[-0.000,0.041]		[-0.001,0.040]	
2-km Network Buffer	0.022	0.161	0.102	0.505	0.009	0.618	0.005	0.783
	[-0.009, 0.054]		[-0.020,0.040]		[-0.025,0.042]		[-0.029,0.039]	
3-km Network Buffer	0.025	0.235	0.003	0.891	-0.002	0.929	-0.009	0.672
	[-0.016, 0.065]		[-0.035, 0.040]		[-0.045,0.049]		[-0.053,0.034]	
5-km Network Buffer	0.019	0.483	-0.006	0.789	-0.016	0.551	-0.026	0.341
	[-0.034, 0.072]		[-0.054,0.041]		[-0.069,0.037]		[-0.078,0.027]	
National Fast Food Chain								
1-km Network Buffer	0.050	0.010	0.034	0.076	0.035	0.079	0.034	0.086
	[0.012, 0.087]		[-0.004, 0.072]		[-0.004,0.074]		[-0.005,0.073]	
2-km Network Buffer	0.059	0.085	0.018	0.606	0.011	0.755	0.004	0.902
	[-0.008, 0.126]		[-0.049,0.084]		[-0.059,0.081]		[0.067,0.076]	
3-km Network Buffer	0.064	0.214	-0.018	0.717	-0.035	0.505	-0.051	0.339
	[-0.037, 0.164]		[-0.115,0.079]		[-0.137,0.068]		[-0.157,0.054]	
5-km Network Buffer	0.096	0.255	-0.017	0.818	-0.046	0.547	-0.071	0.360
	[-0.069, 0.260]		[-0.160,0.127]		[-0.196,0.104]		[-0.222,0.081]	

* p<0.05, ** p<0.01, *** p<0.001

Table A.4. Coefficients from OLS Regression Models Estimating the Association between Density of Fast Food and BMI z-score among 9-Year Old Children in High Density Census Tracts (≥8,320 per square mile)

	Bivariate Associations	P-value	Model 1 + Individual Characteristics	P-value	Model 2 + CMSA FE	P-value	Model 3 + Neigh. Composition	P-value
Fast food E.I.D.C								
1-km Network Buffer	-0.005	0.305	-0.006	0.231	-0.006	0.301	-0.006	0.305
	[-0.015, 0.005]		[-0.016, 0.004]		[-0.018,0.005]		[-0.019,0.006]	
2-km Network Buffer	-0.006	0.368	-0.007	0.273	-0.007	0.303	-0.008	0.302
	[-0.017, 0.007]		[-0.018,0.005]		[-0.022,0.007]		[-0.023,0.007]	
3-km Network Buffer	-0.006	0.368	-0.007	0.283	-0.008	0.284	-0.009	0.274
	[-0.019, 0.007]		[-0.019,0.006]		[-0.022,0.007]		[-0.024,0.007]	
5-km Network Buffer	-0.004	0.502	-0.004	0.470	-0.004	0.538	-0.005	0.529
	[-0.017, 0.008]		[-0.016,0.008]		[-0.018,0.010]		[-0.020,0.010]	
All Fast Food								
1-km Network Buffer	-0.005	0.252	-0.006	0.187	-0.006	0.247	-0.006	0.246
	[-0.014, 0.004]		[-0.014,0.003]		[-0.016,0.004]		[-0.017,0.004]	
2-km Network Buffer	-0.005	0.317	-0.006	0.241	-0.007	0.274	-0.007	0.274
	[-0.016, 0.005]		[-0.016,0.004]		[-0.019,0.005]		[-0.020,0.006]	
3-km Network Buffer	-0.005	0.337	-0.006	0.261	-0.007	0.269	-0.008	0.263
	[-0.016, 0.006]		[-0.017,0.005]		[-0.019,0.005]		[-0.021,0.006]	
5-km Network Buffer	-0.004	0.492	-0.004	0.466	-0.004	0.552	-0.004	0.549
	[-0.014, 0.007]		[-0.014,0.006]		[-0.015,0.008]		[-0.016,0.009]	
National Fast Food Chain								
1-km Network Buffer	-0.028	0.128	-0.029	0.113	-0.025	0.228	-0.026	0.213
	[-0.065, 0.008]		[-0.065, 0.007]		[-0.065,0.016]		[-0.067,0.015]	
2-km Network Buffer	-0.035	0.141	-0.033	0.160	-0.032	0.239	-0.034	0.234
	[-0.082, 0.012]		[-0.079,0.013]		[-0.085,0.021]		[-0.089,0.022]	
3-km Network Buffer	-0.031	0.237	-0.030	0.214	-0.031	0.252	-0.032	0.255
	[-0.083, 0.020]		[-0.078,0.018]		[-0.083,0.022]		[-0.088,0.023]	
5-km Network Buffer	-0.016	0.472	-0.015	0.483	-0.012	0.602	-0.012	0.622
	[-0.061, 0.028]		[-0.056,0.027]		[-0.056,0.033]		[-0.057,0.034]	

* p<0.05, ** p<0.01, *** p<0.001

Table A.5. Odds Ratios from Logistic Regression Models Estimating the Associations between Density of Fast Food and Probability of Obesity among 9-Year Old Children in Low Population Density Census Tracts (<8,320 People per Square Mile)

	Bivariate Associations	P-value	Model 1 + Individual Characteristic s	P-value	Model 2 + CMSA FE	P-value	Model 3 + Neigh. Composition	P-value
Fast food E.I.D.C								
1-km Network Buffer	1.045	0.088	1.034	0.216	1.028	0.322	1.026	0.351
	[0.993,1.100]		[0.980,1.091]		[0.973,1.087]		[0.977,1.150]	
2-km Network Buffer	1.010	0.802	0.973	0.550	0.956	0.366	0.945	0.261
	[0.935,1.090]		[0.888,1.066]		[0.867,1.054]		[0.855,1.043]	
3-km Network Buffer	1.013	0.788	0.950	0.374	0.919	0.162	0.897	0.084
	[0.923,1.112]		[0.849,1.064]		[0.817,1.034]		[0.793,1.015]	
5-km Network Buffer	1.050	0.395	0.992	0.902	0.957	0.484	0.933	0.289
	[0.938,1.175]		[0.877,1.123]		[0.847,1.082]		[0.820,1.061]	
All Fast Food								
1-km Network Buffer	1.040	0.086	1.029	0.231	1.023	0.357	1.022	0.392
	[0.994, 1.089]		[0.982,1.079]		[0.947,1.075]		[0.973,1.073]	
2-km Network Buffer	1.007	0.845	0.974	0.522	0.957	0.322	0.947	0.223
	[0.941, 1.077]		[0.899,1.055]		[0.877,1.044]		[0.867,1.034]	
3-km Network Buffer	1.008	0.846	0.955	0.361	0.923	0.133	0.902	0.066
	[0.928, 1.095]		[0.865,1.054]		[0.831,1.025]		[0.808,1.001]	
5-km Network Buffer	1.036	0.475	0.989	0.838	0.954	0.386	0.932	0.223
	[0.941, 1.140]		[0.889,1.100]		[0.857,1.061]		[0.832,1.044]	
National Fast Food Chain								
1-km Network Buffer	1.087	0.040	1.062	0.179	1.057	0.225	1.056	0.235
	[1.004,1.177]		[0.973,1.159]		[0.966,1.157]		[0.965,1.156]	
2-km Network Buffer	1.085	0.260	0.986	0.867	0.980	0.810	0.967	0.701
	[0.941,1.251]		[0.841,1.157]		[0.829,1.157]		[0.814,1.148]	
3-km Network Buffer	1.127	0.248	0.940	0.586	0.910	0.418	0.876	0.275
	[0.920,1.381]		[0.753,1.174]		[0.724,1.144]		[0.690,1.111]	
5-km Network Buffer	1.290	0.085	1.049	0.743	0.993	0.963	0.950	0.737
	[0.965,1.725]		[0.790,1.392]		[0.746,1.323]		[0.706,1.279]	

* $p<0.05$, ** $p<0.01$, *** $p<0.001$

Table A.6. Odds Ratios from Logistic Regression Models Estimating the Associations between Density of Fast Food and Probability of Obesity among 9-Year Old Children in High Population Density Census Tracts (≥8,320 People per Square Mile)

	Bivariate Associations	P-value	Model 1 + Individual Characteristics	P-value	Model 2 + CMSA FE	P-value	Model 3 + Neigh. Composition	P-value
Fast food E.I.D.C								
1-km Network Buffer	0.995	0.673	0.989	0.378	0.989	0.436	0.987	0.414
	[0.975, 1.017]		[0.965,1.013]		[0.960,1.018]		[0.956,1.019]	
2-km Network Buffer	0.995	0.707	0.988	0.425	0.986	0.431	0.984	0.460
	[0.969, 1.021]		[0.960,1.017]		[0.951,1.021]		[0.944,1.026]	
3-km Network Buffer	0.997	0.838	0.982	0.576	0.992	0.632	0.991	0.674
	[0.972, 1.024]		[0.964,1.020]		[0.959,1.026]		[0.952,1.032]	
5-km Network Buffer	0.997	0.848	0.994	0.655	0.994	0.731	0.994	0.763
	[0.972, 1.023]		[0.966,1.022]		[0.961,1.028]		[0.955,1.034]	
All Fast Food								
1-km Network Buffer	0.995	0.599	0.989	0.331	0.988	0.373	0.987	0.366
	[0.977, 1.014]		[0.968,1.010]		[0.963,1.014]		[0.959,1.016]	
2-km Network Buffer	0.995	0.661	0.989	0.405	0.987	0.406	0.986	0.462
	[0.972, 1.018]		[0.965,1.015]		[0.945,1.006]		[0.951,1.023]	
3-km Network Buffer	0.997	0.803	0.993	0.449	0.992	0.604	0.993	0.679
	[0.975, 1.020]		[0.969,1.017]		[0.964,1.021]		[0.959,1.028]	
5-km Network Buffer	0.996	0.825	0.994	0.642	0.995	0.708	0.995	0.770
	[0.976, 1.020]		[0.970,1.019]		[0.967,1.023]		[0.962,1.029]	
National Fast Food Chain								
1-km Network Buffer	0.966	0.380	0.946	0.242	0.951	0.332	0.946	0.312
	[0.894, 1.044]		[0.863,1.038]		[0.859,1.052]		[0.850,1.053]	
2-km Network Buffer	0.963	0.486	0.948	0.385	0.943	0.383	0.951	0.507
	[0.866, 1.071]		[0.842,1.069]		[0.826,1.076]		[0.820,1.103]	
3-km Network Buffer	0.985	0.782	0.973	0.623	0.973	0.647	0.985	0.823
	[0.888, 1.094]		[0.875,1.083]		[0.867,1.093]		[0.861,1.127]	
5-km Network Buffer	0.983	0.724	0.972	0.591	0.971	0.615	0.982	0.784
	[0.892, 1.083]		[0.875,1.079]		[0.867,1.088]		[0.861,1.120]	

* p<0.05, ** p<0.01, *** p<0.001

Table A.7. Odds Ratios from Logistic Regression Models Estimating the Associations between Density of Fast Food and Probability of Obesity among 9-Year Old Children in Families Who Own or Lease a Car

	Bivariate Associations	P-value	Model 1 + Individual Characteristics	P-value	Model 2 + CMSA FE	P-value	Model 3 + Neigh. Composition	P-value
Fast food E.I.D.C								
1-km Network Buffer	1.025	0.055	1.003	0.815	1.006	0.713	1.012	0.585
	[0.999,1.052]		[0.976,1.031]		[0.973,1.040]		[0.970,1.056]	
2-km Network Buffer	1.019	0.237	0.990	0.575	0.983	0.491	0.971	0.372
	[0.987,1.053]		[0.955,1.026]		[0.937,1.032]		[0.910,1.036]	
3-km Network Buffer	1.023	0.173	0.992	0.667	0.986	0.569	0.972	0.421
	[0.990,1.057]		[0.957,1.028]		[0.940,1.035]		[0.907,1.042]	
5-km Network Buffer	1.027	0.134	0.997	0.862	0.993	0.777	0.987	0.704
	[0.992,1.064]		[0.961,1.034]		[0.949,1.040]		[0.924,1.055]	
All Fast Food								
1-km Network Buffer	1.023	0.049	1.004	0.768	1.006	0.670	1.012	0.527
	[1.000,1.046]		[0.979,1.029]		[0.977,1.037]		[0.975,1.052]	
2-km Network Buffer	1.017	0.234	0.992	0.614	0.986	0.525	0.978	0.425
	[0.989,1.046]		[0.961,1.024]		[0.945,1.029]		[0.925,1.034]	
3-km Network Buffer	1.019	0.180	0.994	0.681	0.988	0.576	0.977	0.452
	[0.991,1.048]		[0.963,1.025]		[0.947,1.031]		[0.920,1.038]	
5-km Network Buffer	1.022	0.154	0.997	0.831	0.993	0.722	0.987	0.644
	[0.992,1.053]		[0.966,1.028]		[0.954,1.033]		[0.932,1.044]	
National Fast Food Chains								
1-km Network Buffer	1.065	0.063	1.023	0.540	1.030	0.446	1.036	0.400
	[0.995,1.139]		[0.951,1.101]		[0.954,1.113]		[0.955,1.124]	
2-km Network Buffer	1.073	0.172	0.982	0.761	0.976	0.716	0.972	0.695
	[0.970,1.187]		[0.876,1.102]		[0.859,1.110]		[0.845,1.119]	
3-km Network Buffer	1.102	0.097	0.981	0.770	0.965	0.644	0.949	0.571
	[0.983,1.235]		[0.865,1.114]		[0.829,1.123]		[0.790,1.139]	
5-km Network Buffer	1.113	0.124	0.995	0.944	0.980	0.784	0.970	0.741
	[0.971,1.275]		[0.878,1.129]		[0.846,1.135]		[0.807,1.165]	

* $p<0.05$, ** $p<0.01$, *** $p<0.001$

Table A.8. Odds Ratios from Logistic Regression Models Estimating the Associations between Density of Fast Food and Probability of Obesity among 9-Year Old Children in Families Who Do Not Own or Lease a Car

	Bivariate Associations	P-value	Model 1 + Individual Characteristics	P-value	Model 2 + CMSA FE	P-value	Model 3 + Neigh. Composition	P-value
Fast food E.I.D.C								
1-km Network Buffer	0.993	0.607	0.982	0.296	0.978	0.319	0.961	0.165
	[0.969,1.019]		[0.948,1.016]		[0.936,1.022]		[0.908,1.017]	
2-km Network Buffer	0.994	0.726	0.978	0.331	0.973	0.366	0.953	0.236
	[0.963,1.027]		[0.936,1.022]		[0.918,1.032]		[0.881,1.032]	
3-km Network Buffer	0.995	0.767	0.982	0.409	0.979	0.482	0.964	0.397
	[0.962,1.029]		[0.939,1.026]		[0.924,1.038]		[0.886,1.049]	
5-km Network Buffer	0.995	0.764	0.985	0.502	0.986	0.624	0.974	0.517
	[0.923,1.028]		[0.943,1.029]		[0.931,1.044]		[0.900,1.054]	
All Fast Food								
1-km Network Buffer	0.993	0.503	0.981	0.230	0.976	0.235	0.957	0.108
	[0.971,1.015]		[0.950,1.012]		[0.938,1.016]		[0.908,1.010]	
2-km Network Buffer	0.994	0.647	0.979	0.293	0.974	0.324	0.956	0.230
	[0.966,1.022]		[0.942,1.018]		[0.925,1.026]		[0.889,1.029]	
3-km Network Buffer	0.995	0.721	0.984	0.398	0.982	0.482	0.970	0.419
	[0.996,1.024]		[0.947,1.022]		[0.934,1.033]		[0.903,1.044]	
5-km Network Buffer	0.996	0.756	0.987	0.512	0.989	0.653	0.981	0.561
	[0.968,1.024]		[0.951,1.025]		[0.942,1.038]		[0.919,1.047]	
National Fast Food Chains								
1-km Network Buffer	0.980	0.662	0.935	0.320	0.935	0.373	0.920	0.334
	[0.897,1.072]		[0.818,1.068]		[0.806,1.084]		[0.776,1.090]	
2-km Network Buffer	0.969	0.619	0.920	0.370	0.922	0.449	0.907	0.422
	[0.855,1.098]		[0.767,1.104]		[0.746,1.138]		[0.714,1.152]	
3-km Network Buffer	0.975	0.711	0.938	0.474	0.945	0.586	0.934	0.573
	[0.852,1.115]		[0.787,1.117]		[0.771,1.158]		[0.736,1.185]	
5-km Network Buffer	0.979	0.743	0.957	0.605	0.973	0.775	0.962	0.737
	[0.863,1.111]		[0.808,1.132]		[0.803,1.177]		[0.769,1.204]	

* p<0.05, ** p<0.01, *** p<0.001

Table A.9. Odds Ratios from Logistic Regression Models Estimating the Associations between Density of Fast Food and Probability of Obesity vs. Overweight or Normal Weight at Year 9

	Bivariate Associations	P-value	Model 1 + Individual Characteristics	P-value	Model 2 + CMSA FE	P-value	Model 3 + Neigh. Composition	P-value
Fast food E.I.D.C								
1-km Network Buffer	1.013	0.123	1.001	0.906	0.996	0.724	0.988	0.416
	[0.996, 1.030]		[0.983 - 1.020]		[0.974 - 1.019]		[0.960 - 1.017]	
2-km Network Buffer	1.014	0.198	0.997	0.812	0.985	0.372	0.963	0.116
	[0.993, 1.036]		[0.976 - 1.021]		[0.954 - 1.018]		[0.920 - 1.009]	
3-km Network Buffer	1.017	0.127	1.000	0.995	0.990	0.542	0.969	0.247
	[0.995, 1.039]		[0.976 - 1.025]		[0.957 - 1.023]		[0.918 - 1.022]	
5-km Network Buffer	1.018	0.099	1.003	0.790	0.995	0.752	0.980	0.430
	[0.997, 1.041]		[0.979 - 1.028]		[0.964 - 1.027]		[0.932 - 1.030]	
All Fast Food								
1-km Network Buffer	1.011	0.151	1.000	0.975	0.995	0.632	0.987	0.334
	[0.996, 1.026]		[0.984 - 1.017]		[0.975 - 1.015]		[0.962 - 1.013]	
2-km Network Buffer	1.011	0.227	0.997	0.784	0.987	0.351	0.968	0.121
	[0.993, 1.030]		[0.976 - 1.018]		[0.959 - 1.015]		[0.928 - 1.009]	
3-km Network Buffer	1.014	0.143	1.000	0.983	0.991	0.526	0.974	0.266
	[0.995, 1.033]		[0.979 - 1.021]		[0.962 - 1.020]		[0.929 - 1.021]	
5-km Network Buffer	1.015	0.113	1.002	0.816	0.995	0.719	0.983	0.426
	[0.996, 1.034]		[0.982 - 1.023]		[0.968 - 1.023]		[0.941 - 1.026]	
National Fast Food Chain								
1-km Network Buffer	1.035	0.194	0.999	0.983	0.992	0.790	0.986	0.666
	[0.983, 1.089]		[0.945 - 1.057]		[0.934 - 1.053]		[0.923 - 1.053]	
2-km Network Buffer	1.050	0.188	0.988	0.790	0.965	0.481	0.945	0.331
	[0.976, 1.130]		[0.908 - 1.076]		[0.875 - 1.065]		[0.844 - 1.057]	
3-km Network Buffer	1.069	0.084	1.000	1.000	0.972	0.621	0.945	0.444
	[0.991, 1.154]		[0.913 - 1.095]		[0.867 - 1.089]		[0.818 - 1.092]	
5-km Network Buffer	1.071	0.078	1.012	0.786	0.985	0.779	0.959	0.565
	[0.992, 1.157]		[0.928 - 1.104]		[0.886 - 1.095]		[0.831 - 1.106]	

* p<0.05, ** p<0.01, *** p<0.001

Table A.10. Odds Ratios from Logistic Regression Models Estimating the Associations between Density of Fast Food and Probability of Overweight or Obesity vs. Normal Weight at Year 9

	Bivariate Associations	P-value	Model 1 + Individual Characteristics	P-value	Model 2 + CMSA FE	P-value	Model 3 + Neigh. Composition	P-value
Fast food E.I.D.C								
1-km Network Buffer	1.003	0.704	0.992	0.318	0.995	0.658	0.997	0.829
	[0.989, 1.018]		[0.975 - 1.008]		[0.975 - 1.016]		[0.970 - 1.024]	
2-km Network Buffer	0.998	0.827	0.981	0.081	0.979	0.153	0.967	0.106
	[0.979, 1.017]		[0.959 - 1.002]		[0.951 - 1.008]		[0.929 - 1.007]	
3-km Network Buffer	0.998	0.854	0.980	0.080	0.978	0.143	0.961	0.087
	[0.978, 1.018]		[0.958 - 1.002]		[0.950 - 1.007]		[0.919 - 1.006]	
5-km Network Buffer	0.999	0.933	0.982	0.120	0.982	0.216	0.968	0.158
	[0.979, 1.019]		[0.961 - 1.005]		[0.954 - 1.011]		[0.926 - 1.013]	
All Fast Food								
1-km Network Buffer	1.002	0.744	0.992	0.302	0.996	0.631	0.997	0.808
	[0.999, 1.016]		[0.978 - 1.007]		[0.978 - 1.014]		[0.973 - 1.021]	
2-km Network Buffer	0.998	0.783	0.983	0.081	0.982	0.152	0.972	0.116
	[0.981, 1.014]		[0.964 - 1.002]		[0.957 - 1.007]		[0.938 - 1.007]	
3-km Network Buffer	0.998	0.809	0.983	0.073	0.981	0.141	0.968	0.100
	[0.981, 1.015]		[0.964 - 1.002]		[0.956 - 1.006]		[0.930 - 1.006]	
5-km Network Buffer	0.999	0.898	0.985	0.120	0.984	0.212	0.974	0.170
	[0.982, 1.016]		[0.966 - 1.004]		[0.960 - 1.009]		[0.938 - 1.011]	
National Fast Food Chain								
1-km Network Buffer	1.029	0.223	1.004	0.873	1.019	0.507	1.028	0.370
	[0.983, 1.079]		[0.955 - 1.055]		[0.965 - 1.075]		[0.968 - 1.091]	
2-km Network Buffer	1.003	0.941	0.946	0.154	0.952	0.262	0.949	0.289
	[0.938, 1.072]		[0.877 - 1.021]		[0.874 - 1.037]		[0.861 - 1.045]	
3-km Network Buffer	1.004	0.911	0.935	0.125	0.938	0.202	0.922	0.192
	[0.934, 1.080]		[0.859 - 1.019]		[0.850 - 1.035]		[0.817 - 1.041]	
5-km Network Buffer	1.010	0.939	0.947	0.197	0.951	0.301	0.936	0.296
	[0.939, 1.086]		[0.871 - 1.029]		[0.864 - 1.046]		[0.827 - 1.060]	

* p<0.05, ** p<0.01, *** p<0.001

Table A.11. Coefficients from OLS Regression Models Estimating the Associations between Density of Fast Food and BMI z-score among 9-Year Old Children Residing in a Consolidated Metropolitan Statistical Area

	Bivariate Associations	P-value	Model 1 + Individual Characteristics	P-value	Model 2 + CMSA FE	P-value	Model 3 + Neigh. Composition	P-value
Fast food E.I.D.C								
1-km Network Buffer	0.003	0.507	-0.002	0.618	-0.002	0.773	-0.007	0.314
	[-0.006, 0.012]		[-0.011,0.007]		[-0.012,0.009]		[-0.021,0.007]	
2-km Network Buffer	0.004	0.488	-0.003	0.587	-0.003	0.647	-0.013	0.152
	[-0.007, 0.015]		[-0.014,0.008]		[-0.016,0.010]		[-0.030,0.005]	
3-km Network Buffer	0.003	0.577	-0.003	0.556	-0.004	0.558	-0.016	0.095
	[-0.009, 0.015]		[-0.015,0.008]		[-0.018,0.010]		[-0.035,0.003]	
5-km Network Buffer	0.004	0.536	-0.002	0.688	-0.002	0.724	-0.013	0.167
	[-0.008, 0.016]		[-0.013,0.009]		[-0.016,0.011]		[-0.032,0.006]	
All Fast Food								
1-km Network Buffer	0.002	0.585	-0.002	0.551	-0.002	0.682	-0.007	0.243
	[-0.006, 0.010]		[-0.010,0.005]		[-0.011,0.007]		[-0.019,0.005]	
2-km Network Buffer	0.003	0.548	-0.003	0.557	-0.003	0.599	-0.011	0.136
	[-0.007, 0.013]		[-0.012,0.007]		[-0.014,0.008]		[-0.026,0.004]	
3-km Network Buffer	0.003	0.623	-0.003	0.539	-0.004	0.532	-0.013	0.097
	[-0.008, 0.013]		[-0.013,0.007]		[-0.015,0.008]		[-0.029,0.002]	
5-km Network Buffer	0.003	0.553	-0.002	0.697	-0.002	0.713	-0.010	0.188
	[-0.007, 0.013]		[-0.011,0.008]		[-0.013,0.009]		[-0.026,0.005]	
National Fast Food Chain								
1-km Network Buffer	0.006	0.717	-0.011	0.476	-0.010	0.541	-0.019	0.300
	[-0.025, 0.037]		[-0.041,0.019]		[-0.043,0.023]		[-0.056,0.017]	
2-km Network Buffer	0.012	0.577	-0.013	0.535	-0.018	0.445	-0.039	0.147
	[-0.030, 0.054]		[-0.055,0.028]		[-0.065,0.028]		[-0.092,0.014]	
3-km Network Buffer	0.012	0.594	-0.011	0.611	-0.017	0.491	-0.041	0.156
	[-0.033, 0.058]		[-0.055,0.032]		[-0.065,0.031]		[-0.098,0.016]	
5-km Network Buffer	0.018	0.421	-0.002	0.915	-0.005	0.831	-0.027	0.328
	[-0.026, 0.062]		[-0.042,0.037]		[-0.048,0.038]		[-0.080,0.027]	

* p<0.05, ** p<0.01, *** p<0.001

Table A.12. Odds Ratios from Logistic Regression Models Estimating the Associations between Density of Fast Food and Probability of Obesity among 9-Year Old Children Residing in a Consolidated Metropolitan Statistical Area

	Bivariate Associations	P-value	Model 1 + Individual Characteristics	P-value	Model 2 + CMSA FE	P-value	Model 3 + Neigh. Composition	P-value
Fast food E.I.D.C								
1-km Network Buffer	1.008	0.403	0.991	0.441	0.990	0.446	0.979	0.222
	[0.989,1.027]		[0.970,1.013]		[0.965,1.016]		[0.945,1.013]	
2-km Network Buffer	1.007	0.550	0.986	0.317	0.980	0.249	0.955	0.080
	[0.984,1.031]		[0.959,1.014]		[0.947,1.014]		[0.906,1.006]	
3-km Network Buffer	1.010	0.415	0.991	0.524	0.988	0.455	0.968	0.240
	[0.987,1.033]		[0.965,1.018]		[0.956,1.020]		[0.916,1.022]	
5-km Network Buffer	1.010	0.386	0.994	0.651	0.990	0.597	0.976	0.356
	[0.987,1.034]		[0.968,1.021]		[0.960,1.024]		[0.926,1.028]	
All Fast Food								
1-km Network Buffer	1.007	0.436	0.992	0.419	0.991	0.411	0.981	0.209
	[0.990,1.023]		[0.973,1.011]		[0.968,1.013]		[0.951,1.011]	
2-km Network Buffer	1.006	0.584	0.988	0.313	0.982	0.242	0.962	0.096
	[0.986,1.026]		[0.964,1.012]		[0.953,1.012]		[0.919,1.007]	
3-km Network Buffer	1.008	0.436	0.993	0.528	0.989	0.451	0.974	0.270
	[0.988,1.028]		[0.970,1.016]		[0.962,1.017]		[0.930,1.020]	
5-km Network Buffer	1.008	0.404	0.995	0.655	0.993	0.590	0.980	0.379
	[0.989,1.029]		[0.972,1.018]		[0.966,1.020]		[0.938,1.024]	
National Fast Food Chain								
1-km Network Buffer	1.018	0.580	0.966	0.366	0.966	0.390	0.953	0.303
	[0.955,1.086]		[0.897,1.041]		[0.893,1.045]		[0.871,1.044]	
2-km Network Buffer	1.012	0.791	0.930	0.208	0.910	0.148	0.872	0.088
	[0.926,1.106]		[0.831,1.041]		[0.801,1.034]		[0.745,1.021]	
3-km Network Buffer	1.040	0.373	0.977	0.651	0.963	0.517	0.936	0.419
	[0.954,1.133]		[0.884,1.080]		[0.860,1.079]		[0.799,1.098]	
5-km Network Buffer	1.041	0.343	0.988	0.797	0.976	0.646	0.950	0.509
	[0.958,1.131]		[0.899,1.085]		[0.879,1.083]		[0.818,1.105]	

* p<0.05, ** p<0.01, *** p<0.001

Table A.13. Coefficients from OLS Regression Models Estimating the Associations between Density of Fast Food and BMI z-score among 9-Year Old Children Who Did Not Experience a Residential Move between Year 5 and Year 9

	Bivariate Associations	P-value	Model 1 + Individual Characteristics	P-value	Model 2 + CMSA FE	P-value	Model 3 + Neigh. Composition	P-value
Fast food E.I.D.C								
1-km Network Buffer	0.007	0.287	-0.004	0.570	-0.005	0.571	-0.016	0.152
	[-0.006, 0.020]		[-0.016 - 0.009]		[-0.021 - 0.011]		[-0.037 - 0.006]	
2-km Network Buffer	0.011	0.190	-0.003	0.676	-0.005	0.675	-0.019	0.182
	[-0.005, 0.026]		[-0.019 - 0.012]		[-0.026 - 0.017]		[-0.046 - 0.009]	
3-km Network Buffer	0.009	0.283	-0.005	0.511	-0.008	0.471	-0.026	0.103
	[-0.007, 0.025]		[-0.022 - 0.011]		[-0.030 - 0.014]		[-0.058 - 0.005]	
5-km Network Buffer	0.009	0.258	-0.005	0.577	-0.007	0.516	-0.023	0.145
	[-0.007, 0.025]		[-0.021 - 0.011]		[-0.029 - 0.014]		[-0.055 - 0.008]	
All Fast Food								
1-km Network Buffer	0.006	0.312	-0.003	0.556	-0.004	0.553	-0.014	0.127
	[-0.006, 0.018]		[-0.015 - 0.008]		[-0.018 - 0.010]		[-0.033 - 0.004]	
2-km Network Buffer	0.009	0.220	-0.003	0.649	-0.004	0.649	-0.016	0.177
	[-0.005, 0.022]		[-0.017 - 0.011]		[-0.023 - 0.014]		[-0.039 - 0.007]	
3-km Network Buffer	0.007	0.317	-0.005	0.506	-0.007	0.476	-0.021	0.120
	[-0.007, 0.021]		[-0.019 - 0.009]		[-0.026 - 0.012]		[-0.047 - 0.005]	
5-km Network Buffer	0.008	0.262	-0.004	0.583	-0.006	0.551	-0.018	0.177
	[-0.006, 0.022]		[-0.018 - 0.010]		[-0.024 - 0.013]		[-0.044 - 0.008]	
National Fast Food Chain								
1-km Network Buffer	0.027	0.223	-0.006	0.789	-0.002	0.923	-0.013	0.604
	[-0.016, 0.069]		[-0.047 - 0.035]		[-0.048 - 0.043]		[-0.063 - 0.037]	
2-km Network Buffer	0.036	0.212	-0.014	0.622	-0.014	0.675	-0.032	0.377
	[-0.021, 0.093]		[-0.071 - 0.043]		[-0.082 - 0.053]		[-0.104 - 0.039]	
3-km Network Buffer	0.027	0.364	-0.029	0.370	-0.035	0.373	-0.064	0.145
	[-0.031, 0.086]		[-0.093 - 0.035]		[-0.112 - 0.042]		[-0.150 - 0.022]	
5-km Network Buffer	0.040	0.207	-0.016	0.601	-0.021	0.585	-0.050	0.278
	[-0.022, 0.101]		[-0.078 - 0.045]		[-0.096 - 0.054]		[-0.140 - 0.040]	

* p<0.05, ** p<0.01, *** p<0.001

Table A.14. Coefficients from OLS Regression Models Estimating the Associations between Density of Fast Food and BMI z-score among 9-Year Old Children Who Experienced a Residential Move between Year 5 and Year 9

	Bivariate Associations	P-value	Model 1 + Individual Characteristics	P-value	Model 2 + CMSA FE	P-value	Model 3 + Neigh. Composition	P-value
Fast food E.I.D.C								
1-km Network Buffer	0.005	0.391	0.004	0.532	0.004	0.542	0.005	0.605
	[-0.006, 0.016]		[-0.008 - 0.016]		[-0.010 - 0.018]		[-0.013 - 0.023]	
2-km Network Buffer	0.002	0.766	0.000	0.998	-0.002	0.800	-0.008	0.479
	[-0.012, 0.016]		[-0.014 - 0.014]		[-0.019 - 0.015]		[-0.031 - 0.015]	
3-km Network Buffer	0.003	0.686	0.001	0.945	-0.002	0.847	-0.011	0.390
	[-0.012, 0.019]		[-0.015 - 0.016]		[-0.021 - 0.017]		[-0.035 - 0.014]	
5-km Network Buffer	0.004	0.608	0.003	0.755	0.002	0.868	-0.005	0.719
	[-0.012, 0.020]		[-0.013 - 0.018]		[-0.017 - 0.020]		[-0.030 - 0.021]	
All Fast Food								
1-km Network Buffer	0.004	0.472	0.002	0.634	0.002	0.687	0.002	0.771
	[-0.006, 0.013]		[-0.008 - 0.013]		[-0.009 - 0.014]		[-0.013 - 0.018]	
2-km Network Buffer	0.001	0.850	-0.001	0.916	-0.003	0.678	-0.009	0.375
	[-0.011, 0.013]		[-0.013 - 0.012]		[-0.018 - 0.012]		[-0.028 - 0.011]	
3-km Network Buffer	0.002	0.743	-0.001	0.986	-0.003	0.751	-0.010	0.316
	[-0.011, 0.015]		[-0.013 - 0.013]		[-0.019 - 0.013]		[-0.031 - 0.010]	
5-km Network Buffer	0.003	0.665	0.001	0.830	0.000	0.964	-0.005	0.615
	[-0.011, 0.017]		[-0.012 - 0.015]		[-0.015 - 0.016]		[-0.026 - 0.015]	
National Fast Food Chain								
1-km Network Buffer	0.014	0.413	0.009	0.601	0.007	0.687	0.006	0.735
	[-0.019, 0.047]		[-0.024 - 0.042]		[-0.028 - 0.042]		[-0.031 - 0.044]	
2-km Network Buffer	0.055	0.823	-0.005	0.833	-0.016	0.562	-0.027	0.388
	[-0.043, 0.055]		[-0.055 - 0.044]		[-0.070 - 0.038]		[-0.088 - 0.034]	
3-km Network Buffer	0.009	0.752	-0.005	0.853	-0.020	0.530	-0.043	0.241
	[-0.047, 0.065]		[-0.061 - 0.050]		[-0.082 - 0.042]		[-0.114 - 0.029]	
5-km Network Buffer	0.016	0.563	0.006	0.824	-0.001	0.972	-0.018	0.579
	[-0.038, 0.069]		[-0.044 - 0.056]		[-0.055 - 0.053]		[-0.084 - 0.047]	

* p<0.05, ** p<0.01, *** p<0.001

Table A.15. Odds Ratios from Logistic Regression Models Estimating the Associations between Density of Fast Food and Probability of Obesity among 9-Year Old Children Who Did Not Experience a Residential Move between Year 5 and Year 9

	Bivariate Associations	P-value	Model 1 + Individual Characteristics	P-value	Model 2 + CMSA FE	P-value	Model 3 + Neigh. Composition	P-value
Fast food E.I.D.C								
1-km Network Buffer	1.016	0.169	0.990	0.476	0.986	0.448	0.974	0.284
	[0.993,1.039]		[0.965,1.017]		[0.950,1.023]		[0.928,1.022]	
2-km Network Buffer	1.020	0.157	0.988	0.505	0.980	0.456	0.961	0.302
	[0.992,1.048]		[0.955,1.023]		[0.929,1.034]		[0.890,1.037]	
3-km Network Buffer	1.020	0.151	0.989	0.549	0.982	0.426	0.964	0.397
	[0.993,1.048]		[0.955,1.025]		[0.929,1.038]		[0.885,1.050]	
5-km Network Buffer	1.021	0.136	0.991	0.622	0.985	0.588	0.970	0.467
	[0.993,1.050]		[0.956,1.027]		[0.933,1.040]		[0.893,1.053]	
All Fast Food								
1-km Network Buffer	1.013	0.194	0.991	0.464	0.986	0.423	0.975	0.250
	[0.993,1.033]		[0.968,1.015]		[0.954,1.020]		[0.934,1.018]	
2-km Network Buffer	1.017	0.174	0.990	0.515	0.982	0.468	0.967	0.328
	[0.993,1.041]		[0.960,1.021]		[0.937,1.031]		[0.905,1.034]	
3-km Network Buffer	1.017	0.161	0.991	0.581	0.986	0.565	0.973	0.449
	[0.993,1.041]		[0.961,1.022]		[0.940,1.034]		[0.906,1.044]	
5-km Network Buffer	1.018	0.134	0.993	0.667	0.989	0.635	0.978	0.523
	[0.994,1.063]		[0.963,1.024]		[0.944,1.036]		[0.914,1.047]	
National Fast Food Chain								
1-km Network Buffer	1.054	0.201	0.974	0.383	0.979	0.711	0.970	0.632
	[0.972,1.143]		[0.886,1.071]		[0.893,1.045]		[0.857,1.098]	
2-km Network Buffer	1.073	0.181	0.956	0.521	0.943	0.514	0.928	0.438
	[0.968,1.191]		[0.833,1.097]		[0.791,1.124]		[0.767,1.122]	
3-km Network Buffer	1.087	0.096	0.972	0.694	0.966	0.708	0.951	0.636
	[0.985,1.200]		[0.845,1.118]		[0.805,1.159]		[0.772,1.171]	
5-km Network Buffer	1.099	0.075	0.987	0.847	0.979	0.815	0.964	0.738
	[0.990,1.220]		[0.860,1.132]		[0.820,1.169]		[0.779,1.193]	

* p<0.05, ** p<0.01, *** p<0.001

Table A.16. Odds Ratios from Logistic Regression Models Estimating the Associations between Density of Fast Food and Probability of Obesity among 9-Year Old Children Who Experienced a Residential move between Year 5 and Year 9

	Bivariate Associations	P-value	Model 1 + Individual Characteristics	P-value	Model 2 + CMSA FE	P-value	Model 3 + Neigh. Composition	P-value
Fast food E.I.D.C								
1-km Network Buffer	1.006	0.670	0.997	0.854	0.999	0.943	0.999	0.974
	[0.980,1.031]		[0.969,1.027]		[0.967,1.032]		[0.958,1.042]	
2-km Network Buffer	0.997	0.837	0.983	0.392	0.977	0.341	0.959	0.188
	[0.965,1.029]		[0.945,1.023]		[0.933,1.024]		[0.901,1.021]	
3-km Network Buffer	1.000	0.993	0.986	0.500	0.982	0.459	0.962	0.271
	[0.967,1.034]		[0.947,1.027]		[0.936,1.030]		[0.898,1.031]	
5-km Network Buffer	1.002	0.889	0.991	0.635	0.989	0.609	0.975	0.426
	[0.970,1.035]		[0.953,1.030]		[0.947,1.033]		[0.915,1.038]	
All Fast Food								
1-km Network Buffer	1.004	0.712	0.997	0.801	0.998	0.869	0.998	0.902
	[0.982,1.027]		[0.971,1.023]		[0.969,1.027]		[0.961,1.036]	
2-km Network Buffer	0.996	0.786	0.984	0.355	0.978	0.298	0.962	0.328
	[0.968,1.025]		[0.950,1.019]		[0.938,1.020]		[0.910,1.016]	
3-km Network Buffer	0.999	0.948	0.986	0.449	0.982	0.396	0.963	0.230
	[0.971,1.028]		[0.952,1.022]		[0.942,1.024]		[0.906,1.023]	
5-km Network Buffer	1.000	0.976	0.990	0.552	0.987	0.506	0.974	0.329
	[0.976,1.028]		[0.958,1.023]		[0.951,1.025]		[0.923,1.027]	
National Fast Food Chain								
1-km Network Buffer	1.025	0.494	1.007	0.859	1.013	0.763	1.016	0.735
	[0.956,1.101]		[0.930,1.091]		[0.932,1.001]		[0.928,1.111]	
2-km Network Buffer	1.002	0.966	0.954	0.473	0.956	0.514	0.943	0.461
	[0.900,1.116]		[0.841,1.084]		[0.834,1.095]		[0.806,1.103]	
3-km Network Buffer	1.003	0.955	0.946	0.447	0.939	0.426	0.907	0.323
	[0.891,1.130]		[0.820,1.091]		[0.803,1.097]		[0.747,1.101]	
5-km Network Buffer	1.005	0.925	0.961	0.530	0.955	0.495	0.923	0.381
	[0.904,1.117]		[0.848,1.089]		[0.837,1.090]		[0.773,1.103]	

* p<0.05, ** p<0.01, *** p<0.001

Table A.17. Coefficients from OLS Regression Models Estimating the Associations between Density of Fast Food and BMI z-score among 9-Year Old Children in High Population Density Census Tracts (≥3500 people per square mile)

	Bivariate Associations	P-value	Model 1 + Individual Characteristics	P-value	Model 2 + CMSA FE	P-value	Model 3 + Neigh. Composition	P-value
Fast food E.I.D.C								
1-km Network Buffer	-0.003	0.538	-0.005	0.297	-0.006	0.278	-0.006	0.267
	[-0.012, 0.006]		[-0.013, 0.004]		[-0.016,0.005]		[-0.017,0.005]	
2-km Network Buffer	-0.004	0.518	-0.006	0.245	-0.009	0.173	-0.010	0.158
	[-0.015, 0.007]		[-0.017,0.004]		[-0.022,0.004]		[-0.023,0.004]	
3-km Network Buffer	-0.004	0.468	-0.007	0.208	-0.011	0.117	-0.012	0.109
	[-0.016, 0.007]		[-0.018,0.004]		[-0.025,0.003]		[-0.026,0.003]	
5-km Network Buffer	-0.003	0.605	-0.005	0.329	-0.008	0.231	-0.008	0.236
	[-0.015, 0.009]		[-0.017,0.006]		[-0.021,0.005]		[-0.022,0.005]	
All Fast Food								
1-km Network Buffer	-0.003	0.477	-0.004	0.260	-0.005	0.244	-0.006	0.228
	[-0.011, 0.005]		[-0.012,0.003]		[-0.015,0.004]		[-0.015,0.004]	
2-km Network Buffer	-0.004	0.453	-0.006	0.216	-0.008	0.153	-0.009	0.135
	[-0.013, 0.006]		[-0.015,0.003]		[-0.020,0.003]		[-0.020,0.003]	
3-km Network Buffer	-0.004	0.434	-0.006	0.192	-0.010	0.114	-0.010	0.104
	[0.014, 0.006]		[-0.160,0.003]		[-0.021,0.002]		[-0.022,0.002]	
5-km Network Buffer	-0.003	0.582	-0.005	0.318	-0.007	0.234	-0.007	0.236
	[-0.013, 0.007]		[-0.014,0.005]		[-0.018,0.004]		[-0.018,0.004]	
National Fast Food Chains								
1-km Network Buffer	-0.014	0.373	-0.016	0.278	-0.014	0.385	-0.015	0.370
	[-0.045, 0.017]		[-0.046, 0.013]		[-0.046,0.018]		[-0.047,0.018]	
2-km Network Buffer	-0.024	0.262	-0.029	0.151	-0.030	0.187	-0.032	0.163
	[-0.065, 0.018]		[-0.068,0.011]		[-0.076,0.015]		[-0.077,0.013]	
3-km Network Buffer	-0.024	0.322	-0.032	0.150	-0.038	0.133	-0.039	0.118
	[-0.070, 0.023]		[-0.075,0.016]		[-0.087,0.012]		[-0.089,0.010]	
5-km Network Buffer	-0.013	0.577	-0.021	0.305	-0.024	0.288	-0.024	0.281
	[-0.056, 0.030]		[-0.060,0.019]		[-0.067,0.020]		[-0.067,0.020]	

* p<0.05, ** p<0.01, *** p<0.001

Table A.18. Coefficients from OLS -Regression Models Estimating the Associations between Density of Fast Food and BMI z-score among 9-Year Old Children in Low Population Density Census Tracts (<3500 people per square mile)

	Bivariate Associations	P-value	Model 1 + Individual Characteristics	P-value	Model 2 + CMSA FE	P-value	Model 3 + Neigh. Composition	P-value
Fast food E.I.D.C								
1-km Network Buffer	0.027	0.109	0.016	0.333	0.019	0.251	0.020	0.218
	[-0.006, 0.060]		[0.016, 0.048]		[-0.013,0.051]		[-0.012,0.053]	
2-km Network Buffer	0.013	0.645	-0.006	0.826	0.000	0.994	-0.004	0.902
	[-0.041, 0.066]		[-0.059,0.047]		[-0.055,0.055]		[-0.060,0.053]	
3-km Network Buffer	0.008	0.827	-0.022	0.541	-0.008	0.827	-0.018	0.651
	[-0.063, 0.079]		[-0.093,0.049]		[-0.082,0.065]		[-0.095,0.059]	
5-km Network Buffer	-0.020	0.643	-0.056	0.175	-0.050	0.245	-0.064	0.178
	[-0.106, 0.065]		[-0.138,0.025]		[-0.135,0.035]		[-0.157,0.029]	
All Fast Food								
1-km Network Buffer	0.022	0.141	0.010	0.479	0.013	0.385	0.014	0.338
	[-0.007, 0.051]		[-0.018,0.038]		[-0.016,0.041]		[-0.015,0.043]	
2-km Network Buffer	0.008	0.748	-0.009	0.699	-0.004	0.867	-0.007	0.784
	[-0.040, 0.006]		[-0.055,0.037]		[-0.053,0.045]		[-0.057,0.043]	
3-km Network Buffer	0.001	0.975	-0.024	0.436	-0.013	0.697	-0.021	0.548
	[-0.061, 0.063]		[-0.086, 0.037]		[-0.078,0.052]		[-0.089,0.047]	
5-km Network Buffer	-0.023	0.545	-0.052	0.147	-0.050	0.194	-0.061	0.151
	[-0.097, 0.051]		[-0.123,0.018]		[-0.125,0.025]		[-0.145,0.022]	
National Fast Food Chains								
1-km Network Buffer	0.054	0.037	0.032	0.255	0.033	0.232	0.035	0.204
	[0.003, 0.105]		[-0.020, 0.086]		[-0.021,0.086]		[-0.019,0.089]	
2-km Network Buffer	0.043	0.362	0.007	0.875	0.002	0.970	-0.004	0.926
	[-0.049, 0.134]		[-0.082,0.097]		[-0.092,0.096]		[-0.102,0.093]	
3-km Network Buffer	0.004	0.948	-0.053	0.440	-0.056	0.424	-0.074	0.318
	[-0.130, 0.139]		[-0.187,0.081]		[-0.195,0.082]		[-0.219,0.071]	
5-km Network Buffer	0.013	0.900	-0.076	0.431	-0.105	0.285	-0.133	0.193
	[-0.185, 0.210]		[-0.264,0.113]		[-0.298,0.088]		[-0.332,0.067]	

* p<0.05, ** p<0.01, *** p<0.001

Table A.19. Odds Ratios from Logistic Regression Models Estimating the Associations between Density of Fast Food and Probability of Obesity among 9-Year Old Children in High Population Density Census Tracts (≥3500 people per square mile)

	Bivariate Associations	P-value	Model 1 + Individual Characteristics	P-value	Model 2 + CMSA FE	P-value	Model 3 + Neigh. Composition	P-value
Fast food E.I.D.C								
1-km Network Buffer	0.999	0.932	0.990	0.359	0.983	0.200	0.984	0.242
	[0.980, 1.018]		[0.969,1.011]		[0.957,1.009]		[0.957,1.011]	
2-km Network Buffer	0.997	0.836	0.986	0.286	0.972	0.117	0.972	0.141
	[0.974, 1.022]		[0.960,1.012]		[0.938,1.007]		[0.936,1.009]	
3-km Network Buffer	1.000	0.978	0.989	0.410	0.977	0.195	0.978	0.241
	[0.976, 1.024]		[0.964,1.015]		[0.943,1.012]		[0.943,1.015]	
5-km Network Buffer	1.000	0.961	0.991	0.503	0.981	0.265	0.983	0.334
	[0.977, 1.025]		[0.965,1.017]		[0.948,1.015]		[0.949,1.018]	
All Fast Food								
1-km Network Buffer	0.999	0.887	0.991	0.338	0.984	0.183	0.985	0.221
	[0.982, 1.016]		[0.972,1.010]		[0.961,1.008]		[0.961,1.009]	
2-km Network Buffer	0.997	0.798	0.987	0.276	0.975	0.117	0.975	0.140
	[0.977, 1.018]		[0.965,1.010]		[0.945,1.006]		[0.944,1.008]	
3-km Network Buffer	0.999	0.954	0.990	0.403	0.980	0.200	0.981	0.244
	[0.979, 1.020]		[0.968,1.013]		[0.951,1.010]		[0.951,1.013]	
5-km Network Buffer	1.000	0.989	0.992	0.492	0.983	0.265	0.985	0.330
	[0.980, 1.021]		[0.970,1.015]		[0.955,1.013]		[0.956,1.015]	
National Fast Food Chains								
1-km Network Buffer	0.994	0.865	0.974	0.476	0.971	0.471	0.975	0.528
	[0.932, 1.061]		[0.906,1.047]		[0.898,1.051]		[0.900,1.056]	
2-km Network Buffer	0.990	0.828	0.955	0.364	0.938	0.276	0.942	0.313
	[0.905, 1.083]		[0.863,1.055]		[0.837,1.052]		[0.839,1.058]	
3-km Network Buffer	1.006	0.902	0.973	0.580	0.953	0.407	0.958	0.469
	[0.918, 1.101]		[0.883,1.072]		[0.850,1.068]		[0.855,1.075]	
5-km Network Buffer	1.001	0.971	0.971	0.547	0.949	0.370	0.956	0.433
	[0.918, 1.093]		[0.881,1.069]		[0.848,1.064]		[0.854,1.070]	

* p<0.05, ** p<0.01, *** p<0.001

Table A.20. Odds Ratios from Logistic Regression Models Estimating the Associations between Density of Fast Food and Probability of Obesity among 9-Year Old Children in Low Population Density Census Tracts (<3500 people per square mile)

	Bivariate Associations	P-value	Model 1 + Individual Characteristics	P-value	Model 2 + CMSA FE	P-value	Model 3 + Neigh. Composition	P-value
Fast food E.I.D.C								
1-km Network Buffer	1.040	0.270	1.029	0.438	1.055	0.191	1.060	0.160
	[0.970,1.114]		[0.958,1.106]		[0.974,1.143]		[0.977,1.150]	
2-km Network Buffer	0.972	0.642	0.936	0.334	0.958	0.593	0.945	0.512
	[0.862,1.096]		[0.819,1.070]		[0.819,1.121]		[0.799,1.118]	
3-km Network Buffer	0.928	0.355	0.857	0.105	0.886	0.282	0.844	0.158
	[0.791,1.088]		[0.712,1.032]		[0.711,1.105]		[0.666,1.068]	
5-km Network Buffer	0.941	0.523	0.881	0.234	0.928	0.583	0.843	0.228
	[0.780,1.134]		[0.716,1.085]		[0.712,1.210]		[0.638,1.113]	
All Fast Food								
1-km Network Buffer	1.031	0.326	1.018	0.577	1.040	0.295	1.044	0.255
	[0.970, 1.097]		[0.956,1.084]		[0.966,1.119]		[0.969,1.125]	
2-km Network Buffer	0.967	0.541	0.934	0.263	0.951	0.493	0.940	0.431
	[0.868, 1.077]		[0.830,1.052]		[0.824,1.098]		[0.807,1.096]	
3-km Network Buffer	0.919	0.263	0.860	0.083	0.880	0.215	0.841	0.117
	[0.793, 1.065]		[0.723,1.018]		[0.718,1.077]		[0.678,1.044]	
5-km Network Buffer	0.929	0.415	0.881	0.203	0.911	0.448	0.836	0.164
	[0.778, 1.109]		[0.725,1.071]		[0.715,1.160]		[0.645,1.076]	
National Fast Food Chains								
1-km Network Buffer	1.078	0.166	1.046	0.435	1.063	0.339	1.075	0.265
	[0.969,1.198]		[0.934,1.172]		[0.937,1.205]		[0.947,1.221]	
2-km Network Buffer	1.011	0.911	0.941	0.589	0.948	0.654	0.936	0.601
	[0.828,1.234]		[0.756,1.172]		[0.748,1.200]		[0.730,1.200]	
3-km Network Buffer	0.939	0.673	0.808	0.208	0.822	0.281	0.778	0.188
	[0.703,1.255]		[0.580,1.126]		[0.576,1.173]		[0.535,1.131]	
5-km Network Buffer	1.060	0.781	0.907	0.658	0.933	0.773	0.833	0.472
	[0.702,1.601]		[0.588,1.399]		[0.582,1.496]		[0.505,1.372]	

* p<0.05, ** p<0.01, *** p<0.001