

## **A Conceptual Framework for the Development of Public Health-oriented Environment with Focus on Childhood Obesity.**

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### **Abstract**

There is a worldwide concern about increasing non-communicable diseases such as cancer, heart disease, diabetes, asthma and depression related to obesity in urban population. The built environment has an important role to support human health. Characteristics of the built environment can be modified to influence and facilitate or hinder public health. The rapid development of major towns and cities in developing countries producing urban sprawl, lower densities, environmental pollution, inconvenience and unsafe public spaces as well as transportation infrastructure that encourages car ridership over active transportation has altered the built environment in ways which effect health negatively. Urbanization in developing and less developed countries, therefore, is linked to rising obesity and incidence of metabolic syndrome. For instance the Malaysian Ministry of Health states that just over a quarter of Malaysian school children were obese and overweight and have the tendency to become obese adults. This research will outline and identify the significant variables concerning the built environment and childhood obesity by examining previous literature studies. There are three major aspects where urban planning and design can most effectively influence childhood obesity, namely, physical activity, community interaction and healthy eating. These three aspects address the principle risk factors for contemporary non-communicable diseases. Hence, the current research will focus on the three mentioned aspects as the keywords to extract the relative factors and indicators associated to built environment and childhood obesity. As the final outcome this research will construct a conceptual framework to serve as a basis for developing a public health-oriented built environment with focus on childhood obesity.

**Keywords:** Non-communicable Diseases, Urban Health, Childhood Obesity, Built-environment, Developing Countries

## **Introduction**

Obesity is a result from a complex interaction between nutrition consumption, physical activity and the environment (Biro & Wien 2010). The built environment includes urban design factors, land use, transportation infrastructure as well as the availability of space for recreation (Handy et al. 2002). These various components can facilitate or hinder physical activity in all age groups including children, adolescents, adults and the elderly (Sallis et al. 2006).

The increase in childhood obesity over the past few decades is considered a serious public health concern (Ogden et al. 2012). Although there are genetics factors that may play a role in childhood obesity, no dominant genes have been discovered whose presence is necessary or sufficient to cause obesity (Booth et al. 2005). However, there is an increase interest among researchers in identifying the relationship between the characteristics of the built environment and obesity due to the fact that there have been changes in the epidemiology of disease in the conceptualizations of health, from the treatment of illness in the individual, to disease prevention and health promotion in populations (Wolch et al. 2011). This has resulted in increased focus on the implications of environments on collective well-being (Wolch et al. 2011) and on the interdependence of environments and individual behaviour (Sallis & Glanz 2006). Currently, there is extensive awareness of the significance of built environment in promoting good health and well-being.

Most of the modern cities that we live in today are design to support the automobile industry, urban sprawl and intensification of land use segregation which reduces daily physical activity, increased in fast food availability, and lack of social interaction (Handy et al. 2002). Consequently, there has been an increased interest amongst health professionals, policy makers as well as urban planners in recognizing the importance of the built environment in directly affecting and supporting public health (Foster et al. 2010).

Even though the relationship between health and the built environment has been an established focus group, there still remains an on-going process to conceptualize this relationship. Especially in terms of the built environment professionals as they increasingly focus on the health and well being issues. Examining the influence of the built environment on childhood obesity is challenging for several reasons. First of all, overweight status in children is caused by energy imbalance in which caloric intake is more than energy expenditure (Casey et al. 2014). The built environment may influence both energy intake and energy expenditure by facilitating or hindering physical activity (Ding & Gebel 2012).

Both energy intake and expenditure are influence by a number of factors. For instance, a higher level of physical activity is associated with better sidewalks to encourage walking and cycling, higher quality and easier access to recreational facilities, greater housing density, and higher neighbourhood walkability (Rahman et al. 2011). It could be challenging to access correctly the effects of a certain built environment factor without taking into consideration of other built environment, social and community as well as economic factors, as these aspects occur simultaneously.

To carefully investigate the relationship between the built environment and childhood obesity, three aspects of the built environment has been taken into consideration based on their significance of which they support health and mitigate childhood obesity. The purpose of this research is to provide a conceptual framework of the relationship between the built environment and childhood obesity. We have adapted these three aspects from Kent & Thompson, 2014 which was based on their three domains of urban planning for health and well-being.

The framework is based on three aspects where the built environment can support health in children and mitigate childhood obesity:

- Physical activity
- Community and social interaction
- Healthy eating (nutrition)

The first part of this paper is to briefly describe and explain the three aspects of the built environment that supports children's health and provide a rationale for their specific recognition, and outlines the methods used to determine and organise the literature review. The second part of this paper is to set these three aspects in line and present a description review of existing research concerning on specific methods where the built environment influences each aspect.

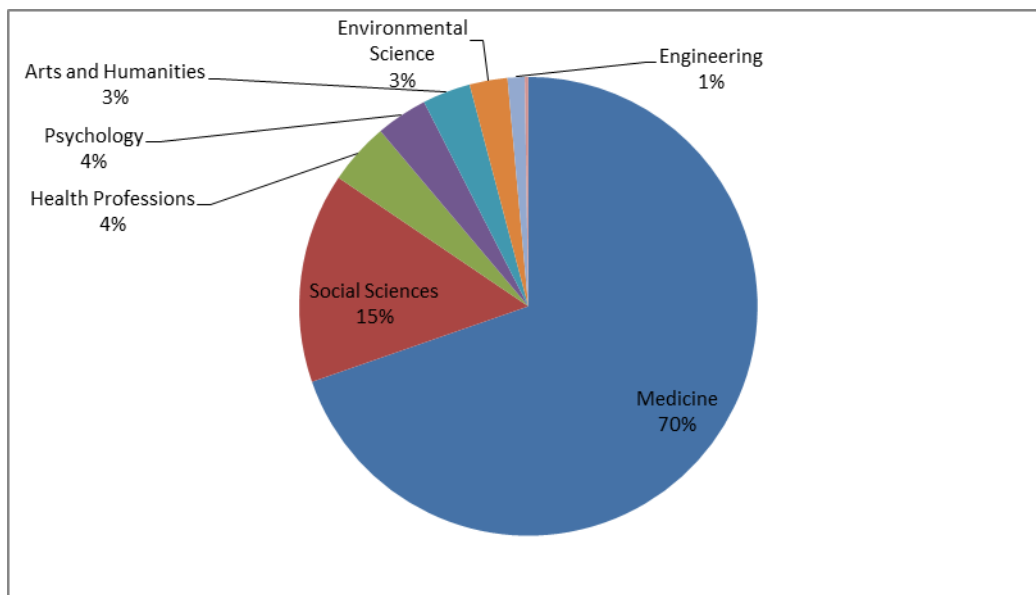
### **Literature Review Methodology**

The methodology adopted for this study is focused on thematic review that supports healthy built environment with focus on childhood health and obesity. Searches using PubMed, Web of Science, Bio Med Central, Science Direct and Scopus were conducted to identify articles and journals examining relationship between the built environment and childhood health. The searches included subject keywords such as "obesity", "overweight", "obesogenic", "childhood obesity", "childhood health", "built environment", "physical activity", "healthy eating", "social interaction", "neighbourhood", "parks", "green spaces", "healthy cities", "food environments", "food retail" and "fast food access".

The search was filtered to studies published in English concerning human subjects examining at least one built environment factor and its association with childhood health related outcome. The initial search returns 15,271 papers. We excluded those with duplicated papers from all of the database sources. The searched query was then restricted to the relevant scientific field of study concerning human health and the built environment such as medicine, social science, health professions, psychology, arts and humanities, environmental science and engineering, other scientific field of study were excluded. As a result, a total of 331 related documents remained for inclusion.

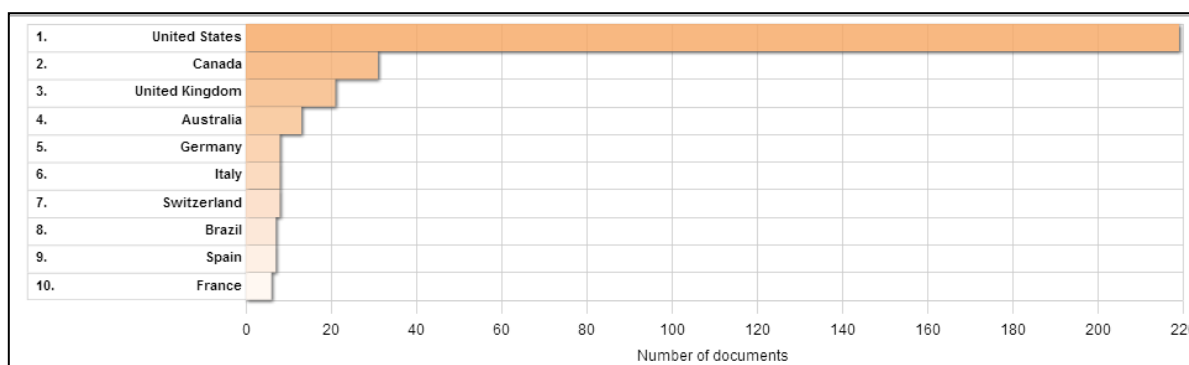
There was a large number of literature on health related to childhood obesity, with a total number of 287 documents, which is about 70 percent. The second highest subject area is

on social science, which covers about 15 percent of the query result of about 61 documents. Health professions place in third with a total number of 18 documents which covers about 4 percent of the total query result. See figure 1.



**Figure 1:** Percentage of Paper Based Field of Study

The number of publications according to country was also analysed. Based on the query results, the most number of publications came from the United States with a total number of 219 documents, this was mainly due to the fact that the US has had obesity pandemic for quite some time now. The least number of documents came from France, with a total of 6 documents. Canada came in second with a total of 31 documents, while the United Kingdom came in third with a total of 21 documents respectively.



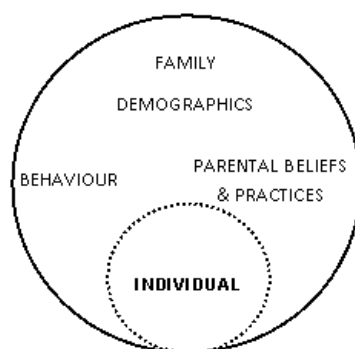
**Figure 2:** Number of Documents According to Country

Having identified the latest research, the searched results were then categorised under the three aspects of the research which is physical activity, social and community interaction and healthy eating. In total, there were 306 documented results that were related to the way

the built environment shapes the physical activity in children. The way the built environment influences community interaction in children screened a total of 48 documented results, while in relation with healthy eating aspect, a total of 141 related documents.

### **The Built Environment and Physical Activity in Childhood Obesity**

As childhood obesity has reached epidemic proportions, it is critical to devise interventions that target the root causes of obesity and its risk factors. One main components of childhood obesity is physical inactivity, and it is becoming increasingly evident that the built environment can determine the level of exposure to these risk factors (Rahman et al. 2011). Through a multidisciplinary literature review, we investigated the association between various built environment attributes and physical activity regarding childhood health. However, before we look into the built environment aspect, there are individual factors that can contribute to childhood obesity. For instance, family demographics, parental beliefs and practices, and the child's behaviour itself have all evidenced associations with contributions that can lead to early obesity and with child obesity itself (Gable & Lutz 2000). Gable and Lutz (2000), considers obesity as a characteristic of individual development that is embedded in a system of interacting elements which make both direct and indirect contributions to children's health. They propose that children's obesity risk and actual obesity depend on a number of factors, many of which originate with parents and subsequently influence children. Figure 3, shows contributions that can directly or indirectly affect childhood obesity at an individual level.



**Figure 3:** The contributions of childhood obesity at an individual level

Although there are contributions of childhood obesity at an individual level, the built environment also plays a vital role in shaping childhood health. Characteristics of the built environment that influence physical activity differ depending on various population groups such as children, adolescence, adults, as well as senior citizens. Physical activity also varies in terms of purpose such as for recreational or leisure, walking or bicycling to place of work or education. It also differs in terms of the location and context of the urban environment for example the inner city, suburban, regional and rural areas (Williams et al. 2012). The form of

the built environment, incorporating residential and commercial density, land use mix, connectivity and accessibility, influences on what we do and how we move within that environment (Handy et al. 2002). In particular, the physical activity in childhood requires a more in depth view of the built environment due to the fact that their level of physical activity is somewhat limited compared to adults. Based on the various literatures concerning the field of childhood health and obesity, we found that built environment features that encourage active transport such as walkability/cycling, mixed land use, and accessible destinations, increases children physical activity.

Researchers and policymakers now recognise the prominent part the built environment play in shaping individual physical activity levels and population health (Sandy et al. 2013). According to Oakes, Forsyth, and Schmitz (2007), research in the built environment and physical activity has identified four key built and neighbourhood environment factors thought to affect active transport, these are:

### **Street pattern, connectivity and accessibility**

This affects the directness of travel behaviour by making travel more or less efficient. The number of alternative choices of routes may affect people's interest and safety (Oakes et al. 2007). Accessibility is very important and plays a vital role in supporting physical activity amongst children. Accessibility in this context here refers to the degree to which the built environment component is available to as many people as possible in this particular case the children. Accessibility can be viewed as the "ability to access" and benefit from the built environment. It is generally measured as the distance between origin and destination.

As that being said, there is a degree or limitation to as how long and far children can travel. Young children cannot travel for long distances by themselves because they cannot drive, there are no safe and practical transit options for children, and the safety risk from travel by non-motorized means is high. In a world built and design around automobile, children are at a disadvantage. They are completely reliant towards their parents for transportation to various destinations or they are limited to a highly restricted spatial realm consisting of small number of destinations that are readily and safely accessible by non-motorised means. In the United States, children do not walk or ride their bicycles nearly as much as they used to. Walking or bicycling to school, a phenomenon that used to be a ritual for them is now a rare occurrence. A study done by National Safe Kids Campaign 2002, states that only around 10 percent of school children walk or ride their bicycles to school.

While there is a clear empirical link between the physical environment and adult's physical activity (Brownson et al. 2009), there has been much less research with children and how the built and the neighbourhood environment may affect their physical activity and active transport levels. According to Davison & Lawson, 2006 one cannot assume that associations between the physical environment and physical activity among adults are applicable to children. Children's physical activity consists generally of short intermittent bouts resulting from unstructured play rather than organised sports (Bringolf-Isler et al.

2010). Children play anywhere and everywhere, often venturing to places where their environmental needs have seldom been recognised (Matthews & Limb 1999). According to Sallis, Floyd, Rodríguez, & Saelens, 2012 the most studied locations for child physical activity are the school, neighbourhood streets and parks.

Research has found that a young person's levels of active transport and physical activity is affected by a wide range of built environment factors such as the lack of street connectivity, lack of or poorly designed footpaths and cycle lanes (Panter et al. 2008) and distance to facilities or school (Koohsari et al. 2013). Studies have found that a higher level of physical activity is associated with better sidewalks, higher quality recreational facilities, easier access to recreational facilities (Foster & Giles-Corti 2008).

### **Residential density**

Density is thought to be important because higher densities tend to create a critical mass of people that may contribute to more people to be seen out walking that, in turn, creates a sense of safety (Oakes et al. 2007). Higher residential densities can lead to shorter distances between origin and destinations. Shorter distances tend to encourage the use of active transport.

Research has found that greater housing density encourages higher neighbourhood walkability (Lee et al. 2007). Panter & Jones, (2008) reviewed twenty four studies that examined the associations between the environment (perceived or objectively measured) and active travel among youth aged 5 - 18 years. Results from this review found that youth travel is positively associated with social interactions, facilities to assist active travel and urban form in the neighbourhood as well as shorter route length and road safety.

Apart from affecting physical activity levels, research suggests that poorly built neighbourhood environments may affect the obesity levels in children and young people. According to Grafova (2008), recent evidence suggests that the built environment may influence children's weight, for example, children living in sprawling and dispersed counties are more likely to be overweight than children living in areas with more compact development. Specifically, Grafova, (2008) examined the relationship between overweight status of children aged between 5 and 18 and eight built environment factors reflecting population density, street connectivity, urban design, neighbourhood physical disorder and food environment. Both the weight and height of the participants were measured and their body mass index was calculated as weight in kilograms. The Interviewer's observations on neighbourhood physical disorder, such as the condition and upkeep of the buildings and street surface on the block were analysed. Results of this study found that living in a neighbourhood with higher convenience store density is associated with a higher probability of being overweight children and adolescents. Living in a neighbourhood where no physical disorder such as the condition and upkeep of buildings and street surface, is associated with a decreased likelihood of being overweight.

### **Mixed land uses and the presence of destinations**

According to Frank and Pivo (1994), mixed use developments are those with a variety of offices, shops, restaurants, banks, and other activities intermingled amongst one another. The availability and close proximity of recreational facilities, such as swimming pools and playing pitches, as well as walking and cycling trails has a positive relationship with physical activity, though the evidence is mixed (Yang & French 2013). According to Nelson et al. (2008) a lack of available facilities are frequently suggested to be a barrier to physical activity participation.

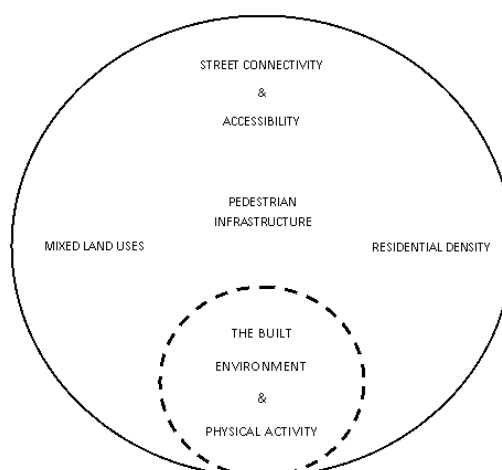
Most children and adolescents have considerable amount of time for recreation but they are not able to drive and are subject to restrictions placed on them by adults (Deforche et al. 2010). Specifically, Deforche et al., 2010 found that lack of traffic danger and better access to recreational facilities is associated with more leisure-time sports and active transport. Children with positive perceptions of certain environmental characteristics such as the presence of places they like to use frequently near their home were more likely to be more physically active (Santos et al. 2009). The availability of recreational facilities may be also more highly correlated with physical activity participation among females than males (Brownson et al. 2001).

### **Pedestrian infrastructure and design related to the issues of comfort, safety and interest.**

Walking occurs primarily in neighbourhood streets and public facilities, and the character of such places influences the degree to which they are safe, comfortable and attractive for walking (Saelens & Handy 2010). According to Chin, Van Niel, Giles-Corti, & Knuiman, (2008) neighbourhoods that are designed using traditional grid networks with proper pedestrian facilities can help to increase walking by reducing the distances to facilities by providing multiple routes.

Sugiyama, Leslie, Giles-Corti, & Owen, 2009 found that access to outdoor recreational facilities (parks and sports facilities) and access to places of interest (cafe and local shops) were significantly associated with neighbourhood street use. Facilities such as bikeways and walking trails are also positively correlated with levels of physical activity (Booth et al. 2005). When recreational facilities are available close by youths may be more likely to utilize them (Trilk et al. 2011). Previous research demonstrates that people's perceptions of their accessibility to facilities may be influenced by the convenience of location, cost, transportation and preferred type of physical activity (Panter & Jones 2008).





**Figure 4:** The built environment and physical activity that supports children's health

### **The Neighbourhood and Community Interaction Amongst Children**

The neighbourhood is an important setting for outdoor play in children and young people. According to Carver, Timperio, & Crawford, (2008) there is evidence to suggest that the time children spent outdoors is a strong determinant of overall children's health. Perceptions of the neighbourhood environment are also important determinants (Alton et al. 2007) particularly a fear and dislike of local environments (Lorenc et al. 2008) and parents perceptions of the local environment (Bringolf-Isler et al. 2010). A sense of community and belonging within the places where people live, work, and travel, is an influential determinant of mental and physical health (Dahl & Malmberg-Heimonen 2010).

A sense of belonging fosters perceptions of security, confidence, and comfort that encourage people to be physically active in their neighbourhoods, as well as socially connected to others.

### **Children's perceptions towards the neighbourhood**

Alton et al. (2007) is one of the few studies that is focused on how perceptions of the neighbourhood affects walking rather than general physical activity. The overall aim of this study was to examine the relationship between frequency of walking trips, perceptions of the local environment and individual travel preferences in children. Using six primary schools in Birmingham UK, Alton et al. surveyed 473 children about 1) socio-demographic information 2) walking frequency in the past seven days and 3) children's perceptions of the local environment. Questionnaires were handed out to 579 children and 473 were given permission from their parents to participate. Results from this study found that 41.9% of children surveyed were high walkers. High walkers were children who walked more than the mean number of walking trips which was 20.1 in seven days. The most common place they walked to was the local shops. A third of participants surveyed rated their neighbourhoods as having heavy traffic and dangerous roads. When asked what their preferred method of

travelling to school was 36.4% said walking, 33.8% said cycling, 26% said the car while only 3.4% said that they preferred to take the bus. A limitation of this study is that it is subject to recall and self-report biases.

Similarly, Santos et al. (2009) looked into associations between perceived attributes of the neighbourhood environment and adolescent's physical activity. This study was conducted in Ílhavo Portugal. Their population sample was students from all public schools in the area, three middle schools aged between 12 and 18 years and two high schools aged between 12 and 21 years. Participant's physical activity levels were measured using a self report questionnaire. Their neighbourhood environment perceptions were assessed using the Environmental Module of the International Physical Activity Prevalence study. Results from this study found that compared to boys physical activity levels, girls were classed as low active. In relation to their neighbourhood environment adolescent girls who perceive their neighbourhoods to have free or low cost recreational facilities and boys who perceive people being active in their social environment were more likely to be in the active group. Strengths of this study include the gender difference comparison but a limitation of this study is that they only focused on one area which according to Santos et al. (2009) may not represent Portugal as a whole so results may differ in different areas of the country.

Page, Cooper, Griew, Davis, & Hillsdon, (2009) investigated whether independent mobility in boys and girls was related to objectively measured physical activity. They recruited 1307 children from 23 public primary schools within a large UK city. Participants completed a computerised self-report physical activity questionnaire and wore an accelerometer for seven days during waking hours. Results of this study found that parents were more likely to let their children visit local destinations unsupervised, such as friend's houses, parks, local shops and schools, than facilities that were further away (Page et al. 2009). They also found that children who reported being allowed to visit destinations unsupervised had higher levels of weekday physical activity. The main limitation of this study was the reliance on self-reported independent mobility (Page et al. 2009).

### **Parent's perceptions towards the neighbourhood**

Compared with previous generations research has found that children spend less time playing outdoors and that the sight of children running errands in the neighbourhood, meeting friends, or playing informally has become an increasingly uncommon sight (Carver, A. Timperio, et al. 2008). Reasons for this may be due to parents chauffeuring their children to and from school and other places such as structured activities limiting the amount of time that children get to spend outdoors (Carver, A. Timperio, et al. 2008).

Karsten, (2005) distinguishes different patterns in the relationship children have with their neighbourhood. Participants in her study were "former children", that is adults who were brought up in a particular street and "older neighbours", that is persons who have a long history of living in a particular street and who knew about different periods in the past and

present situation. Children and their parents currently living in the neighbourhoods were also interviewed. All were interviewed and asked questions about their neighbourhood. Through her research, Karsten was able to identify three types of children: “inside children”, “outside children” and “backseat children”. Inside children can be defined as children who rarely play outside or if they do go outside it is only for short periods at a time. They play indoors and do not participate in many other activities. Outdoor children are children who play outside all the time, and Backseat children are escorted to adult organised activities such as sports lessons, or music lessons. Karsten, (2005) found that children’s time space behaviour in the 1950’s and 1960’s can be roughly characterised by one type namely outdoor children, this differs greatly from children of today. Many other factors that may contribute to this lack of children playing in the neighbourhood include road safety, having no safe places to play and “stranger danger” (Page et al. 2009).

### **Road safety**

Many studies have found neighbourhood safety such as crime and traffic safety such as speeding cars as the most common barriers to active transport and children’s health (Collins & Kearns 2001). According to Mullan (2003) safety fears about road safety can result in a reduction in play, cycling and walking activities among children and young people.

The marginalisation of children and young people within cities and in urban planning means that parks, streets and pedestrian areas have become sources of danger to the very groups which most need to access them (Davis and Jones, 1997). Within the local environment sources of dangers that children may remain vulnerable to include air pollutions, traffic danger and stranger danger (Matthews and Limb 1999). According to Carver, Timperio, et al. (2008) perceived safety is also associated with factors in the physical environment, such as, inadequate street lighting, poorly maintained footpaths, dangerous traffic and unattended dogs. The absence of walkable public places such as streets, squares and parks, means that people of diverse ages, races and beliefs are unlikely to meet and talk (Nelson et al. 2008).

Recent studies have shown that elementary school students who walk/bike to school may obtain more daily physical activity than those using motorized commuting modes (Southward et al. 2012) are more likely to engage in physical activity outside school and are more likely to walk/bike to other non-school destinations (Goodman et al. 2011). Despite its potential health benefits, rates of active commuting to school (e.g. walking and bicycling) have plummeted over the last four decades in the U.S. In 2009, only 12.7% of elementary and middle school students walked or biked to school compared with 47.7% in 1969 (McDonald et al. 2011). Several reasons for this sharp drop in active commuting to school (ACS) have been identified by parents with school aged children (5-18 years old), including distance (62%), traffic-related danger (30.4%), weather (18.6%), crime (11.7%), and school policy (6.0%) (Beck & Greenspan 2008). For walking to school (WTS), two of the most frequently reported barriers are long distance and safety concerns (Alton et al. 2007).

Based on Oluyomi et al. (2014), they found that, 18% of parents reported that their child walked to school on most days of the week. For traffic safety, students were more likely to walk to school if their parent reported favourable perceptions about the following items in the home neighbourhood environment such as higher sidewalk availability, well maintained sidewalks and safe road crossings. For the route to school, the odds of WTS were higher for those who reported "no problem" with each one of the following: traffic speed, amount of traffic, sidewalks/pathways, intersection/crossing safety, and crossing guards, when compared to those that reported "always a problem". For personal safety in the en-route to school environment, the odds of WTS were lower when parents reported concerns about: stray or dangerous animals and availability of others with whom to walk.

Their findings offered insights into the specific issues that drive safety concerns for elementary school children's WTS behaviours. The observed associations between more favourable perceptions of safety and WTS provide further justification for practical intervention strategies to reduce WTS barriers that can potentially bring long-term physical activity and health benefits to school-aged children (Oluyomi et al. 2014).

### **Stranger danger**

According to Thomson (2009) children are discouraged from speaking with adults who are seen as strangers. Hillman (2006) defines strangers as adults not known to children. This discouragement results in a disconnection from our neighbourhoods, which in turn results in fewer familiar faces and interactions between people who live nearby. Parents who are actively engaged with their neighbours and their community were more likely to associate the benefits of giving their child independence with their growth and maturity.

There are multiple manifestations of "stranger danger" such as unwelcome approaches by strangers, abduction, assault, molestation and even murder (Carver et al. 2010). Hillman found that parents are increasingly worried about the "outside world" as it can be seen as a place where children are likely to be injured by a motor vehicle, or harmed by a bully or stranger. Due to this parents are restricting the amount of time that their children can spend outdoors. Lee and Rowe (1994), found that being approached by a stranger was ranked third (behind smoking and bullying) as a potential risk perceived by 10-12 year old children on their way to school. This shows that parents and children may have different views when it comes to stranger danger. Although, a child is more likely to be assaulted by a family member or acquaintance random assault by a stranger is feared more (Carver, A. Timperio, et al. 2008).

One of the most common fears to limit the amount of active transport in children and young people is "stranger danger" (Timperio 2004) but safety worries about where children are active can also affect their active transport levels. According to Matthews & Limb (1999), several studies reveal that children who are old enough to go outside their home

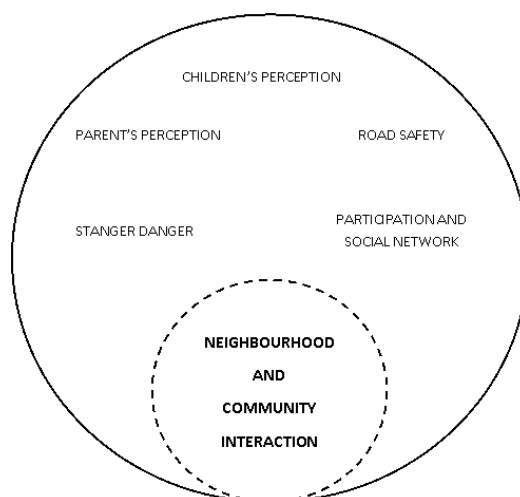
unaccompanied spend a lot of time on the pavements, streets and other areas of their immediate neighbourhood. Children use these different types of settings as meeting places where they can hang out and relax with friends. These meeting places can be viewed as problem areas due to vandalism and younger children being afraid to use parks due to older children hanging around as found by Colabianchi et al. (2014).

### **Participation and social network**

The social environment comprises the physical surroundings, social relationships and cultural milieu within which people function and interact (Barnett & Casper 2001). It has been shown to influence obesity-risk behaviours in adults (Lawrence et al. 2011) those reporting low social support from family and friends are more likely to be insufficiently active for health benefits compared to those with high levels of social support (Leslie et al. 2005). The social environment also plays an important role in relation to children's physical activity and sedentary behaviour. The social environment of children includes the influence of parents, siblings, friends, neighbours, teachers, and coaches (Osterling & Hines 2006).

While parents are the most important source of influence in early life. Parental influence on their child's day-to-day behaviour becomes less evident as the child matures (Giles-Corti et al. 2010). Children and adolescents spend a significant portion of their time at school with friends and peers. Evidence suggests that the dietary behaviour of a friend or group of friends influences the dietary behaviour of the individual, with similar results observed for sports participation and sedentary behaviour (Ali et al. 2011).

According to Sawka et al. (2013), overall higher levels of physical activity among friends are associated with higher levels of physical activity of the individual. Longitudinal studies reveal that an individual's level of physical activity changes to reflect his/her friends' higher level of physical activity. They conclude that boys tend to be influenced by their friendship network to a greater extent than girls. As a result, a friend's physical activity level appears to have a significant influence on individual's physical activity level (Sawka et al. 2013).



**Figure 5:** The neighbourhood and community interaction that supports children's health

### **The Built Environment and Healthy Eating**

Childhood eating behaviours are attracting increasing interest in nutrition research because they embody various aspects of diet and are related to children's diet quality and weight status (Dubois et al. 2007). Poor diet quality at a young age and deviations from optimal weight have been associated with an increased risk of developing chronic diseases later in life (WHO 2013). A better understanding of eating behaviour determinants during childhood is of particular importance, it is a combination of genetic and environmental factors that influences eating behaviours (Klump et al. 2014). One of the leading causes of childhood obesity is the consumption of fast food and physical inactivity.

### **Location of fast food outlets**

Fast-food restaurants have shown the highest growth in terms of number of establishments. Urban planning has encouraged the construction of neighbourhoods with low mixed usages development, making it more difficult for people to access supermarkets and fresh produce (Quebec 2012). Also, people are preparing fewer meals at home. All of these factors promote a higher caloric intake of foods that are often lacking in nutritional value.

Scientific literature shows that the retail food environment influences eating habits of residents. For example, the presence of supermarkets in residential neighbourhoods has been associated with better eating habits among local residents (Moore et al. 2008). Likewise, improved access to supermarkets around schools has been linked to a lower body mass index (BMI) among teenagers attending the schools, while the presence of convenience stores in these environments has been linked to a higher BMI and overweight (Dehghan et al. 2005).

Disadvantaged neighbourhoods are particularly exposed to junk food. Across the United States, low-income neighbourhoods have fewer supermarkets where residents can buy

fresh produce at an affordable price (Powell et al. 2007). Fast-food restaurants, on the other hand, are more numerous in these neighbourhoods than in higher income neighbourhoods (Sallis et al. 2012)

The available research on nutrition environments outside schools and homes is based on concepts and empirical data from the fields of public health, health psychology, consumer psychology, and urban planning. It falls generally under two headings, “community nutrition environments”, which include the number, type, and location of food outlets, and “consumer nutrition environments”, which covers the availability and cost of, as well as information about, healthful and less healthful foods inside those food outlets (Sallis et al. 2006). The distinction is important because each could have broad effects on child health, and the opportunities for modifying each can be quite different.

### **Community nutrition**

In the community nutrition environment, stores and restaurants are the most numerous food outlets. Accessibility can include large issues, such as whether and to what extent these outlets are located in certain communities, as well as such smaller issues as whether they have drive-through windows and what their hours of operation are. Other food sources, such as cafeterias in schools, work sites, place of worship, and health care facilities, are considered “organizational nutrition environments,” although the non-school sources may be more influential for adults than for children and youth (Morland et al. 2002).

The community nutrition environment may explain some of the racial, ethnic, and socioeconomic disparities in nutrition and health, such as the increasing prevalence of overweight in low-income children (Zenk et al. 2005). Supermarkets, for example, are less common in lower income and minority neighbourhoods than in other neighbourhoods.

### **Consumer nutrition**

Data on consumer nutrition environments, by contrast, reflect what consumers encounter within and around a store or restaurant, including the availability of healthful choices, price, promotions, placement, and nutritional information. Price is an influential feature of the nutrition environment. A study of why Americans eat what they do found that cost was the second most important factor, behind taste, convenience was ranked fourth, just after nutrition (Sallis & Glanz 2006).

The availability of healthful foods is also important. Some healthful foods, such as low-fat dairy products and fruits and vegetables, are less available and of poorer quality in minority and lower-income areas. Three studies have documented that disadvantaged neighbourhoods have a proportionally lower availability of healthful options and produce of poorer quality than do more affluent and white neighbourhoods (Horowitz et al. 2004). A

study in Los Angeles compared healthful food options and food preparation at restaurants in poorer neighbourhoods and at restaurants in higher-income neighbourhoods and found fewer healthful menu selections in the lower-income areas (Lewis et al. 2005).

### **Policies and regulations: a new arsenal to increase access to healthy foods in residential neighbourhoods**

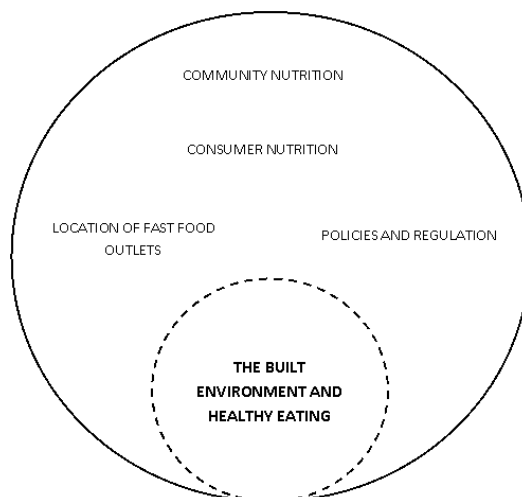
A more thorough understanding of the environmental factors that influence eating habits has led experts and major health organizations such as the World Health Organization and, in the United States, the Institute of Medicine, the Surgeon General and the Centres for Disease Control and Prevention, to declare that interventions aimed at countering the rise in childhood obesity must be focused on policies and the food environment (Sallis & Glanz 2006). In its report on the prevention of childhood obesity, the Institute of Medicine concluded that these were the most promising strategies. Options include banning, limiting and restricting negative factors and promoting supportive factors.

The town of Concord, in Massachusetts, has banned fast-food outlets and restaurants with drive-through service. The cities of Carlsbad, in California, and Newport, in Rhode Island, have also enacted zoning laws to ban this type of restaurant, although the purpose of the legislation in these cases was more to ease traffic congestion and enhance the city's aesthetic appeal than to get rid of junk food (Mair et al., 2005). A ban on fast-food restaurants is sometimes limited to certain parts of the city, as is in the cities of Solvang and Davis in California. Other cities, like Stockton, in California, and Seattle, in Oregon, have chosen to ban mobile vendors near schools and parks, except for those selling fruits and vegetables (Ashe et al., 2003).

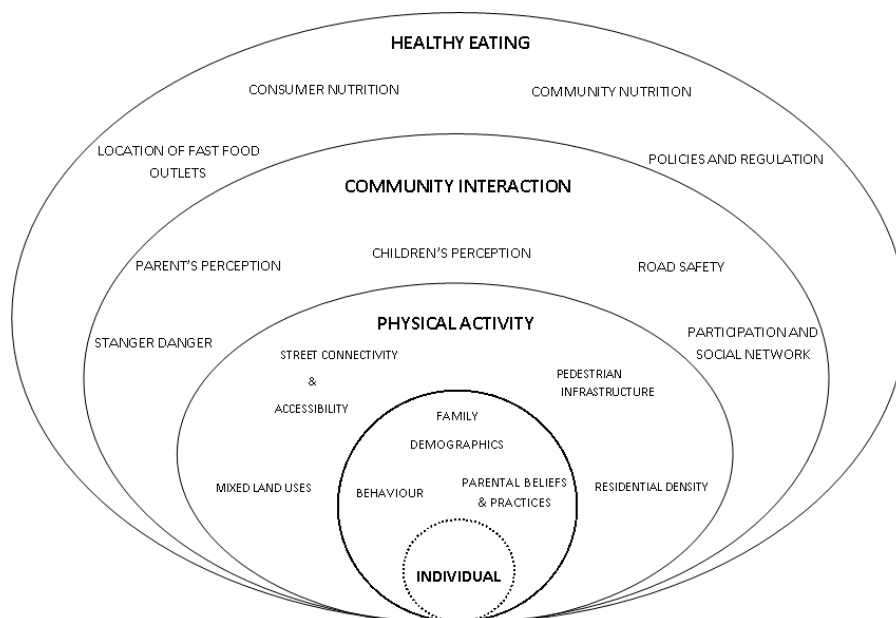
Municipalities must use means other than banning to ensure that residents have access to healthy foods in their neighbourhoods. For instance, they can (Dubois et al. 2007):

- Regulate the number of fast-food restaurants by setting quotas
- Regulate the density of fast-food restaurants in a given area
- Establish minimum distances between fast-food restaurants and other institutional or residential uses—for example, by enacting a zoning law that prohibits fast-food restaurants within two kilometres of elementary and secondary schools
- Limit food advertising on billboards
- Facilitate the establishment of local grocery stores and public markets
- Develop bike paths and safe sidewalks to facilitate access to food retailers
- Develop the surroundings and parking facilities of food retailers to ensure the safety of pedestrians and cyclists, and ease of access for delivery trucks and cars.





**Figure 6:** The built environment and healthy eating that supports childhood health



**Figure 7:** Overall conceptual framework of the relationship between the built environment and childhood obesity

**Conclusion**

This paper has examined the role of the built environment that supports childhood health from an individual to a more complex level. The three aspects, which are physical activity, community interaction and healthy eating can directly and indirectly influence childhood obesity (Kent & Thompson 2014). The purpose of this current paper is to determine the relevant variables for each aspect that supports childhood health and conceptualize the relationship. The study has found that generally, physical activity in a child's health is very

important to mitigate childhood obesity. The variables that greatly influence childhood health within the built environment and physical activity are street connectivity and accessibility, mixed land uses, pedestrian infrastructure and residential density. This paper has also shown that community interaction is very important in supporting childhood health. Due to the fact that children often spend most of the time playing and interacting within the neighbourhood, it is very important to look into the child's and parent's perception towards the neighbourhood environment, the common fear of strangers, road safety, and also the child's participation and interaction level. The third major finding shows that healthy eating is also a contributor to childhood obesity. The availability of healthy foods within the neighbourhood and schools is very important to mitigate childhood obesity. The proximity of fast food outlets and convenience stores within a neighbourhood and schools tends to lead to higher BMI status in children (Rahman et al. 2011). The findings of this study suggest the variables of each aspect between the relationship of the built environment and childhood obesity and conceptualize this relationship. The study has gone some way towards enhancing our understanding of childhood health and the built environment in this expanding field of study. While this paper is only a conceptualization on the field, there still needs to be further research and study done to test this concept.

## References

- Ali, M.M., Amialchuk, A. & Heiland, F.W., 2011. Weight-related behavior among adolescents: the role of peer effects. *PloS one*, 6(6), p.e21179. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3121719&tool=pmcentrez&rendertype=abstract> [Accessed March 25, 2014].
- Alton, D. et al., 2007. Relationship between walking levels and perceptions of the local neighbourhood environment. *Archives of disease in childhood*, 92(1), pp.29–33. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2083158&tool=pmcentrez&rendertype=abstract> [Accessed April 8, 2014].
- Barnett, E. & Casper, M., 2001. A Definition of “ Social. , 91(3), p.2001.
- Beck, L.F. & Greenspan, A.I., 2008. Why don't more children walk to school? *Journal of safety research*, 39(5), pp.449–52. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/19010117> [Accessed April 16, 2014].
- Biro, F.M. & Wien, M., 2010. Childhood obesity and adult morbidities 1 – 4. , 91, pp.1499–1505.
- Booth, K.M., Pinkston, M.M. & Poston, W.S.C., 2005. Obesity and the built environment. *Journal of the American Dietetic Association*, 105(5 Suppl 1), pp.S110–7. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/15867906> [Accessed January 28, 2014].

Bringolf-Isler, B. et al., 2010. Built environment, parents' perception, and children's vigorous outdoor play. *Preventive medicine*, 50(5-6), pp.251–6. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/20346370> [Accessed March 26, 2014].

Brownson, R.C. et al., 2001. Environmental and policy determinants of physical activity in the United States. *American journal of public health*, 91(12), pp.1995–2003. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1446921&tool=pmcentrez&rendertype=abstract>.

Brownson, R.C. et al., 2009. Measuring the built environment for physical activity: state of the science. *American journal of preventive medicine*, 36(4 Suppl), pp.S99–123.e12. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2844244&tool=pmcentrez&rendertype=abstract> [Accessed February 3, 2014].

Carver, A. et al., 2010. Are children and adolescents less active if parents restrict their physical activity and active transport due to perceived risk? *Social science & medicine* (1982), 70(11), pp.1799–805. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/20347200> [Accessed March 28, 2014].

Carver, A., Timperio, A. & Crawford, D., 2008. Playing it safe: the influence of neighbourhood safety on children's physical activity. A review. *Health & place*, 14(2), pp.217–27. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/17662638> [Accessed March 24, 2014].

Carver, A., Timperio, A.F. & Crawford, D. a, 2008. Neighborhood road environments and physical activity among youth: the CLAN study. *Journal of urban health : bulletin of the New York Academy of Medicine*, 85(4), pp.532–44. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2443253&tool=pmcentrez&rendertype=abstract> [Accessed April 8, 2014].

Casey, R. et al., 2014. Determinants of childhood obesity: What can we learn from built environment studies? *Food Quality and Preference*, 31, pp.164–172. Available at: <http://linkinghub.elsevier.com/retrieve/pii/S0950329311000991> [Accessed February 6, 2014].

Chin, G.K.W. et al., 2008. Accessibility and connectivity in physical activity studies: the impact of missing pedestrian data. *Preventive medicine*, 46(1), pp.41–5. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/17920671> [Accessed April 8, 2014].

Colabianchi, N. et al., 2014. Adolescent self-defined neighborhoods and activity spaces: Spatial overlap and relations to physical activity and obesity. *Health & Place*. Available at: <http://linkinghub.elsevier.com/retrieve/pii/S1353829214000069> [Accessed January 27, 2014].

Collins, D.C. & Kearns, R. a, 2001. The safe journeys of an enterprising school: negotiating landscapes of opportunity and risk. *Health & place*, 7(4), pp.293–306. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/11682329>.

- Dahl, E. & Malmberg-Heimonen, I., 2010. Social inequality and health: the role of social capital. *Sociology of health & illness*, 32(7), pp.1102–19. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/21044094> [Accessed April 13, 2014].
- Davison, K.K. & Lawson, C.T., 2006. Do attributes in the physical environment influence children 's physical activity? A review of the literature. , 17.
- Deforche, B. et al., 2010. Perceived social and physical environmental correlates of physical activity in older adolescents and the moderating effect of self-efficacy. *Preventive medicine*, 50 Suppl 1, pp.S24–9. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/19818363> [Accessed March 26, 2014].
- Dehghan, M., Akhtar-Danesh, N. & Merchant, A.T., 2005. Childhood obesity, prevalence and prevention. *Nutrition journal*, 4, p.24.
- Ding, D. & Gebel, K., 2012. Built environment, physical activity, and obesity: what have we learned from reviewing the literature? *Health & place*, 18(1), pp.100–5. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/21983062> [Accessed February 6, 2014].
- Dubois, L. et al., 2007. Preschool children's eating behaviours are related to dietary adequacy and body weight. *European journal of clinical nutrition*, 61(7), pp.846–55. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/17180152> [Accessed April 16, 2014].
- Foster, S. & Giles-Corti, B., 2008. The built environment, neighborhood crime and constrained physical activity: an exploration of inconsistent findings. *Preventive medicine*, 47(3), pp.241–51. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/18499242> [Accessed March 26, 2014].
- Foster, S., Giles-Corti, B. & Knuiaman, M., 2010. Neighbourhood design and fear of crime: a social-ecological examination of the correlates of residents' fear in new suburban housing developments. *Health & place*, 16(6), pp.1156–65. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/20719555> [Accessed March 26, 2014].
- Gable, S. & Lutz, S., 2000. Household, Parent, and Child Contributions to Childhood Obesity\*. , (573), pp.293–300.
- Giles-Corti, B. et al., 2010. The co-benefits for health of investing in active transportation. *New South Wales public health bulletin*, 21(5-6), pp.122–7. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/20637168>.
- Goodman, A., Mackett, R.L. & Paskins, J., 2011. Activity compensation and activity synergy in British 8-13 year olds. *Preventive medicine*, 53(4-5), pp.293–8. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/21820009> [Accessed April 13, 2014].
- Grafova, I.B., 2008. Overweight children: assessing the contribution of the built environment. *Preventive medicine*, 47(3), pp.304–8. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/18539318> [Accessed February 6, 2014].

- Handy, S.L. et al., 2002. How the built environment affects physical activity: views from urban planning. *American journal of preventive medicine*, 23(2 Suppl), pp.64–73. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/12133739>.
- Hillman, M., 2006. Children's rights and adults' wrongs. *Children's Geographies*, 4(1), pp.61–67. Available at: <http://www.tandfonline.com/doi/abs/10.1080/14733280600577418>.
- Horowitz, C.R. et al., 2004. Barriers to buying healthy foods for people with diabetes: evidence of environmental disparities. *American journal of public health*, 94(9), pp.1549–54.
- Karsten, L., 2005. It all used to be better? Different generations on continuity and change in urban children's daily use of space. *Children's Geographies*, 3(3), pp.275–290. Available at: <http://www.tandfonline.com/doi/abs/10.1080/14733280500352912> [Accessed April 8, 2014].
- Kent, J.L. & Thompson, S., 2014. The Three Domains of Urban Planning for Health and Well-Being. *Journal of Planning Literature*, p.0885412214520712–. Available at: <http://jpl.sagepub.com/cgi/doi/10.1177/0885412214520712> [Accessed February 21, 2014].
- Klump, K.L. et al., 2014. Changes in Genetic and Environmental Influences on Disordered Eating Across Adolescence. , 64(12), pp.1409–1415.
- Koohsari, M.J., Badland, H. & Giles-Corti, B., 2013. (Re)Designing the built environment to support physical activity: Bringing public health back into urban design and planning. *Cities*, 35, pp.294–298. Available at: <http://linkinghub.elsevier.com/retrieve/pii/S0264275113000978> [Accessed January 23, 2014].
- Lawrence, W. et al., 2011. Specific psychological variables predict quality of diet in women of lower, but not higher, educational attainment. *Appetite*, 56(1), pp.46–52. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3685814&tool=pmcentrez&rendertype=abstract> [Accessed April 16, 2014].
- Lee, R.E., Cubbin, C. & Winkleby, M., 2007. Contribution of neighbourhood socioeconomic status and physical activity resources to physical activity among women. *Journal of epidemiology and community health*, 61(10), pp.882–90. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2652966&tool=pmcentrez&rendertype=abstract> [Accessed March 25, 2014].
- Leslie, E. et al., 2005. Residents' perceptions of walkability attributes in objectively different neighbourhoods: a pilot study. *Health & place*, 11(3), pp.227–36. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/15774329> [Accessed April 4, 2014].
- Lewis, L.B. et al., 2005. African Americans' access to healthy food options in South Los Angeles restaurants. *American journal of public health*, 95(4), pp.668–73.

- Lorenc, T. et al., 2008. Attitudes to walking and cycling among children, young people and parents: a systematic review. *Journal of epidemiology and community health*, 62(10), pp.852–7. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/18791040>.
- Matthews, H. & Limb, M., 1999. Defining an agenda for the geography of children: review and prospect. *Progress in Human Geography*, 23(1), pp.61–90. Available at: <http://phg.sagepub.com/cgi/doi/10.1191/030913299670961492> [Accessed April 8, 2014].
- McDonald, N.C. et al., 2011. U.S. school travel, 2009 an assessment of trends. *American journal of preventive medicine*, 41(2), pp.146–51. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/21767721> [Accessed March 26, 2014].
- Moore, L. V et al., 2008. NIH Public Access. , 167(8), pp.917–924.
- Morland, K. et al., 2002. Neighborhood characteristics associated with the location of food stores and food service places. *American journal of preventive medicine*, 22(1), pp.23–9. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/11777675>.
- Mullan, E., 2003. Do you think that your local area is a good place for young people to grow up? The effects of traffic and car parking on young people's views. *Health & Place*, 9(4), pp.351–360. Available at: <http://linkinghub.elsevier.com/retrieve/pii/S1353829202000692> [Accessed April 8, 2014].
- Nelson, N.M. et al., 2008. Active commuting to school : How far is too far ? , 9, pp.1–9.
- Oakes, J.M., Forsyth, A. & Schmitz, K.H., 2007. The effects of neighborhood density and street connectivity on walking behavior: the Twin Cities walking study. *Epidemiologic perspectives & innovations : EP+I*, 4, p.16. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2228289&tool=pmcentrez&rendertype=abstract> [Accessed March 20, 2014].
- Of, H. & Contents, T.O.F., 2012. Modifying the Built Environment to Promote Healthy Eating Among Youth. , (JULy).
- Ogden, C.L. et al., 2012. Prevalence of obesity and trends in body mass index among US children and adolescents, 1999-2010. *JAMA : the journal of the American Medical Association*, 307(5), pp.483–90. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/22253364> [Accessed March 22, 2014].
- Oluyomi, A.O. et al., 2014. Parental safety concerns and active school commute: correlates across multiple domains in the home-to-school journey. *The international journal of behavioral nutrition and physical activity*, 11(1), p.32. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3975836&tool=pmcentrez&rendertype=abstract> [Accessed April 16, 2014].
- Osterling, K.L. & Hines, A.M., 2006. Mentoring adolescent foster youth : promoting resilience during developmental transitions Correspondence : , pp.242–253.

- Page, A.S. et al., 2009. Independent mobility in relation to weekday and weekend physical activity in children aged 10-11 years: The PEACH Project. *The international journal of behavioral nutrition and physical activity*, 6, p.2. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2636750&tool=pmcentrez&rendertype=abstract> [Accessed March 26, 2014].
- Panter, J.R. & Jones, A.P., 2008. Associations between physical activity, perceptions of the neighbourhood environment and access to facilities in an English city. *Social science & medicine (1982)*, 67(11), pp.1917–23. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/18835074> [Accessed March 26, 2014].
- Panter, J.R., Jones, A.P. & van Sluijs, E.M., 2008. Environmental determinants of active travel in youth: a review and framework for future research. *The international journal of behavioral nutrition and physical activity*, 5, p.34. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2483993&tool=pmcentrez&rendertype=abstract> [Accessed March 26, 2014].
- Powell, L.M. et al., 2007. Food store availability and neighborhood characteristics in the United States. *Preventive medicine*, 44(3), pp.189–95. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/16997358> [Accessed March 20, 2014].
- Rahman, T., Cushing, R.A. & Jackson, R.J., 2011. Contributions of built environment to childhood obesity. *The Mount Sinai journal of medicine, New York*, 78(1), pp.49–57.
- Saelens, B.E. & Handy, S.L., 2010. NIH Public Access. , 40(206).
- Sallis, J.F. et al., 2006. An ecological approach to creating active living communities. *Annual review of public health*, 27, pp.297–322. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/16533119> [Accessed March 27, 2014].
- Sallis, J.F. et al., 2012. Role of built environments in physical activity, obesity, and cardiovascular disease. *Circulation*, 125(5), pp.729–37. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3315587&tool=pmcentrez&rendertype=abstract> [Accessed April 8, 2014].
- Sallis, J.F. & Glanz, K., 2006. The role of built environments in physical activity, eating, and obesity in childhood. *The Future of children / Center for the Future of Children, the David and Lucile Packard Foundation*, 16(1), pp.89–108.
- Sandy, R. et al., 2013. Effects of the built environment on childhood obesity: the case of urban recreational trails and crime. *Economics and human biology*, 11(1), pp.18–29.
- Santos, M.P. et al., 2009. Perceptions of the built environment in relation to physical activity in Portuguese adolescents. *Health & place*, 15(2), pp.548–52. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/19004663> [Accessed April 8, 2014].
- Sawka, K.J. et al., 2013. Friendship networks and physical activity and sedentary behavior among youth: a systematized review. *The international journal of behavioral nutrition and physical activity*, 10, p.130. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/24289113>.

- Southward, E.F. et al., 2012. Contribution of the school journey to daily physical activity in children aged 11-12 years. *American journal of preventive medicine*, 43(2), pp.201–4. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/22813686> [Accessed March 24, 2014].
- Sugiyama, T. et al., 2009. Physical activity for recreation or exercise on neighbourhood streets: associations with perceived environmental attributes. *Health & place*, 15(4), pp.1058–63. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/19473867> [Accessed March 26, 2014].
- Timperio, a, 2004. Perceptions about the local neighborhood and walking and cycling among children. *Preventive Medicine*, 38(1), pp.39–47. Available at: <http://linkinghub.elsevier.com/retrieve/pii/S0091743503002299> [Accessed March 26, 2014].
- Trilk, J.L. et al., 2011. Do physical activity facilities near schools affect physical activity in high school girls? *Health & place*, 17(2), pp.651–7. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3056935&tool=pmcentrez&rendertype=abstract> [Accessed April 8, 2014].
- WHO, 2013. WHO | Obesity and overweight.
- Williams, A.J. et al., 2012. A systematic review of associations between the primary school built environment and childhood overweight and obesity. *Health & place*, 18(3), pp.504–14. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/22381422> [Accessed February 6, 2014].
- Wolch, J. et al., 2011. Childhood obesity and proximity to urban parks and recreational resources: a longitudinal cohort study. *Health & place*, 17(1), pp.207–14. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/21075670> [Accessed February 6, 2014].
- Yang, J. & French, S., 2013. The travel - obesity connection: discerning the impacts of commuting trips with the perspective of individual energy expenditure and time use. *Environment and Planning B: Planning and Design*, 40(4), pp.617–629.
- Zenk, S.N. et al., 2005. Neighborhood racial composition, neighborhood poverty, and the spatial accessibility of supermarkets in metropolitan Detroit. *American journal of public health*, 95(4), pp.660–7. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1449238&tool=pmcentrez&rendertype=abstract> [Accessed April 16, 2014].