CHILDHOOD OBESITY: PARENTS VS. ENVIRONMENT, WHO HAS THE GREATER INFLUENCE?

by

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A thesis submitted to the

Faculty of the Graduate School of the

University of Colorado in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

Health and Behavioral Sciences

2012
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September 11, 2012
Gorman, Ira (Ph.D., Health and Behavioral Sciences)
Childhood Obesity: Parents vs. Environment, Who Has the Greater Influence?
Thesis directed by Associate Professor Deborah Thomas, Ph.D.

ABSTRACT

Obesity prevention is among the great public health challenges of the 21st century, and childhood obesity, in particular, is a major national and global health priority. Data from 2009-2010 National Health and Nutrition Examination Survey (NHANES) demonstrate that 16.9% (12.5 million) of US children age 2-19 years are obese (BMI $\geq 95^{th}$ percentile) and 31.7% are overweight (BMI $\geq 85^{th}$ percentile). The primary purpose of this dissertation research was to determine how parental influences at the household level interact with the built environment to moderate levels of obesity among young adolescents, ages 10-14 years old, using fitness level as a potentially more sensitive measure than BMI in studying health related impacts of childhood obesity. The study took place in 5 northeast Denver communities involving 15 census tracts surrounding the new Stapleton development, a neighborhood specifically designed for active living. Two hundred and fifty-six pairs of parent and child interviews were performed in the home as well as measuring height, weight and fitness on children between the ages of 10-14. This study sought to explain observed neighborhood and census tract variation of variables at the census tract level (walking audits) in addition to individual level variables (parent safety, travel to school, TV time). Multilevel models were used in this study, which considers the effect of clustering within groups such as neighborhoods or census tracts. The results of this study showed significant main effects at the census tract level with respect to child obesity measures, including BMI percentile and fitness measures of Curl Up percentile and
Vertical Jump percentile. It was determined that the built environment concepts of walking condition and walking safety at the census tract level are associated with BMI percentile and the fitness measures of Curl Up and Vertical Jump. Parental safety perception at the individual level was positively associated with Curl Up and moderates the effect of walking infrastructure at the census tract level. Community based interventions designed to combat child obesity should consider how parental influence and the built environment interact to affect child obesity outcomes.

The form and content of this abstract are approved. I recommend its publication.

Approved: Deborah Thomas, Ph.D.
DEDICATION

I dedicate this work to two individuals, friends, who have died from preventable causes. One from a virus (HIV) where the spread of this disease could have been prevented even before a medical intervention was known or available. The other of a socio-political disease on 9/11/2001 in NYC where we have seen that attacking the problem via a war has not lead to any changes but more deaths and morbidity. Instead we should have been looking at the environment that created this problem and focus energy on the root causes that could have saved his and many other lives. In both of these cases individual lives could have been saved by thoughtful prevention activities and a mindset that looks at root causes for social and biomedical problems. I hope my daughters have the opportunity to live in a world where prevention is the prominent strategy and intervention that guides healthcare decisions because that is where and how social causes of illness, injury and disease are best understood and subsequently treated efficiently, effectively and most thoroughly.
ACKNOWLEDGMENTS

First, I would like to thank my committee members Dr. Deborah Thomas, Dr. Debbi Main, Dr. Miriam Dickinson and Dr. Peter Anthamatten for their time and support, encouragement, knowledge and experience and who never gave up on me.

I wish to acknowledge Leah Haverhals, MA, Patti Iwasaki, MSW, Kyla Krause, Steve Lockhart, and the many data collectors who assisted me with this study along with the many community members of TNH2H.

I want to thank Janet Meredith, Executive Director of 2040 Partners for Health, and the Colorado Health Foundation for funding this work.

In addition I want to express my appreciation of the assistance of Caroline Emsermann- Lead analyst- SeDLAC, University of Colorado.

I want to recognize my colleagues at Regis University for their support and assistance. I want to especially thank my Dean at Regis University, Dr. Barbara Tschoepe for her continued support and encouragement and for allowing me the flexibility to complete this work. I also appreciate my students at Regis University for giving me purpose and meaning for my advanced study and who will allow me the opportunity to apply and share this knowledge over the upcoming years.

I wish to thank my HBS Cohort- Sharon, Sara, Maria, Penny and Lisa for their friendship and camaraderie.

Finally, there is my wonderful wife Nancy and my two beautiful daughters, Codi and Alyssa, all who sacrificed in so many ways during my project that I cannot begin to delineate and adequately state what they gave up for me during this entire process.

This research was supported by NIH/NCATS Colorado CTSI Grant Number KL2 TR000156.

Contents are the authors’ sole responsibility and do not necessarily represent official NIH views.
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CHAPTER I
INTRODUCTION

"Obesity in this country is nothing less than a public health crisis. It's threatening our children, it's threatening our families and, more importantly, it's threatening the future of this nation."
(Michelle Obama, Jan 28, 2010)

The Health Problem- Obesity

Obesity is a nationwide epidemic with considerable personal and societal consequences. It is identified as a fundamental cause of diabetes, cardiovascular disease (CVD), and other metabolic disorders (Burton & Foster, 1985; Mokdad et al., 2003; Must et al., 1999), resulting in reduced life expectancies. In 2008, the health costs attributable to obesity were $147 billion, which accounted for 10% of all annual medical spending. In fact, persons who are obese spend 42% more in health care dollars than healthy weight individuals (Finkelstein, Trogdon, Cohen, & Dietz, 2009).

Obesity prevention is among the great public health challenges of the 21st century, and childhood obesity, in particular, is a major national and global health priority (Olds & Maher, 2010; Story, Sallis, & Orleans, 2009). During the past 20 years, obesity rates in the US have increased in all age groups and have led to higher overall mortality rates (Flegal, Carroll, Ogden, & Curtin, 2010; Mokdad, Marks, Stroup, & Gerberding, 2004). While there are geographic differences at different scales across the US, these trends have been consistent over time. For example, while Colorado has routinely been the leanest state in the Union, rates have increased from under 10% in 1990 to 21.4% in 2010 (CDC, 2010), the first time they have been above the 20% prevalence rate.
Childhood Obesity

Even more disturbing are the rates of childhood obesity. The most recent CDC data from 2009-2010 National Health and Nutrition Examination Survey (NHANES) demonstrate that 16.9% (12.5 million) of US children age 2-19 years are obese (BMI ≥ 95th percentile) and 31.7% are overweight (BMI ≥ 85th percentile). The prevalence for boys (18.6%) is higher than for girls (15.0%) and especially observed in the 6-11 age group (Ogden, Carroll, Kit, & Flegal, 2012b). In addition, 11.9% are at or above the 97th percentile of BMI-for-age growth charts (Ogden, Carroll, Curtin, Lamb, & Flegal, 2010). Since 1994, The NHANES data demonstrate the prevalence of overweight among children aged 6-11 years has increased from 11% to 19.6%, and among adolescents aged 12-19 years from 11% to 18.1% (Ogden et al., 2010). The 5% obesity goal of children in Healthy People 2010 has clearly not been met at this time (U.S. Department of Health and Human Services, 2010).

These figures are particularly troubling due to the elevated health risks associated with increasing children’s BMI, leading to poorer health outcomes across the lifespan, including cardiovascular disease, disorders of the metabolic system and dysfunction of other body systems (Daniels, 2006; Dietz, 1998; Franks et al., 2010; Freedman, Katzmarzyk, Dietz, Srinivasan, & Berenson, 2009; Juonala et al., 2011). Studies estimate that 80% of adolescents who are overweight become obese as adults (Whitaker, Wright, Pepe, Seidel, & Dietz, 1997) with about half of school-aged children who are obese remaining obese as adults (Freedman et al., 2005; Serdula et al., 1993). A more recent systematic review revealed a moderate likelihood of persistent overweight (highest RR=10.1) among overweight or obese youth (children and adolescents). The percentage of obese adolescents becoming overweight or obese adults varied between 24% and 90% in three high quality studies reviewed (A. S. Singh, Mulder, Twisk, van
Mechelen, & Chinapaw, 2008). This high variation in findings was due to the length of follow-up between the studies, that height and weight were measured both by self-report and actual measurement and the inclusion of male only, female only, and combination. In summary, they found that the risk of overweight children becoming overweight adults was at least two times that for normal weight children and the risk was even greater with obese children (A. S. Singh et al., 2008). As with obesity among adults, the financial burden of childhood obesity is also high. The direct annual health care costs of childhood obesity which includes prescription drugs, emergency department visits and outpatient medical care are $14.1 billion (Cawley, 2010).

Insufficient amounts of physical activity (PA), along with increases in sedentary behaviors such as computer use and TV viewing time, and inadequate dietary intake are considered to be some of the modifiable risk factors for obesity in children (Anderson & Butcher, 2006). These health behaviors are complex because they are influenced by a range of multilevel child, parent, and household factors, and broader neighborhood factors, such as the physical and social environment (Biddle & Goudas, 1996; Dunton, Kaplan, Wolch, Jerrett, & Reynolds, 2009; Franzini et al., 2009; Kimbro, Brooks-Gunn, & McLanahan, 2011). An ecological systems model, which conceptualizes the child as nested within a broader and multi-influence contextual system, is a useful guide for understanding the complex multi-level scales of influence on a child’s behavior, which in turn affects the child’s weight status (Davison & Birch, 2001).

**Objective of Study**

The primary purpose of this dissertation research is to determine how parental influences at the household level interact with the built environment to moderate levels obesity among young adolescents, ages 10-14 years old, using fitness level as a potentially more sensitive
measure than BMI in studying health related impacts of childhood obesity. This study uses ecological systems theory (Galvez, Pearl, & Yen, 2010; Green, Richard, & Potvin, 1996) to guide the investigation because children’s physical activity and health outcomes are influenced at various levels including parents, household and environment. Specifically, the Family Influence Model (Fig 1) (Dempsey, Kimiecik, & Horn, 1993), which is based on ecological systems theory, will be used as the key conceptual model that guides this dissertation research, more specifically testing the effects of the environment and parents (household) on child physical activity. The Family Influence Model describes the hypothesis that parental influences on child outcomes are moderated by characteristics of the family, as well as the environment. Additionally, this present study challenges the use of BMI as the best measure of obesity in children by using child fitness test results as a potentially more sensitive outcome measure related to the effect of the built environment and parental influence.
Figure I.1 Family Influence Model-(Kimiecik, Horn & Shurin, 1996)
Parents

Research on parental influences on childhood obesity has focused primarily on specific parental and household behaviors. One major parental influence is setting rules around TV accessibility and what may be watched, as well as boundaries (or lack thereof) around actual amount of time watching TV. Half of school-aged children spend more than two hours per day watching TV, and that number increases to almost eight hours per day when including total media time (e.g., computers, VCR, DVD, video games) (Lindsay, Sussner, Kim, & Gortmaker, 2006). Parents especially influence the health behaviors of children, including physical activity, through a variety of mechanisms, including direct modeling, establishing or eliminating barriers or rules, and providing resources (Baranowski, 1997). Parents who watch TV more than two hours per day have children who are twice as likely to be physically inactive compared to children whose parents watch less than 2 hours (OR =1.95 (95% CI=1.5-2.6)) (Wagner et al., 2004). Watching excessive TV leads to less availability to participate in physical activity, but also exposes the child to commercials for unhealthy foods (Ludwig & Gortmaker, 2004).

Whitaker et.al reported there is a 79% chance of obesity in 10-14 year old children who have at least one parent who is obese (Whitaker et al., 1997). Kimiecik et.al., who examined the Family Influence Model and the effect on child behavior of moderate to vigorous physical activity (MVPA), discovered that the environment outside of the home and the family characteristics moderate the effect of the home environment on children’s physical activity (Kimiecik, Horn, & Shurin, 1996). In addition, the role of parents and their beliefs, attitudes, and concerns about safety and social cohesion in the neighborhood can moderate the effect of the environment and this effect may differ in neighborhoods that vary in social or physical characteristics. Kimbro and Schacter found that mothers who believe they are in a neighborhood
with high social cohesion and collective efficacy buffer the safety fear that would prevent children from playing outdoors (Kimbro & Schachter, 2011). Social cohesion and collective efficacy can be measured by how often neighbors get together or rely on each other for assistance or favors (Sampson, Raudenbush, & Earls, 1997). Demographic variables, including household income or parent’s education level and health status, were also shown to be associated with child health status; however, mechanisms were not identified (Case & Paxson, 2002). It is not known to what degree these parental influences extend to children’s physical activity levels and behaviors.

Further, the effect of parental influences may vary by certain demographic groups (e.g., age, gender, and ethnicity) but this has not specifically been investigated in the middle school population (children between the ages of 10-14 years of age); an especially important population since these children are a part of the cohort experiencing the greatest increase in obesity rates (Ogden, Carroll, Kit, & Flegal, 2012a). Additionally, these children are at an age of transitional influence- they are less dependent on their parents than a younger age group, but not quite peer-dependent as with older children (Sumter, Bokhorst, Steinberg, & Westenberg, 2009). This power effect of the parents on their physical activity and behavior reinforces the importance of understanding how parental influence may moderate the effect of the environment and have a different effect based on the child’s age or gender.

Since children are also dependent upon their immediate environment, including their neighborhood, for most of their physical and emotional needs (Story, Kaphingst, & French, 2006), understanding the environmental influences on childhood obesity is essential. In particular, it is imperative to investigate further the environmental and parental influences on physical activity of children who live and play in that environment since research supports that
parental decisions, including safety concerns, have an important influence on where children play (Veitch, Bagley, Ball, & Salmon, 2006).

**Built Environment**

For well over a decade now, there has been an increase in the amount of research focusing on the built environment and its influence on health behavior and increases in obesity levels (Brownson, Hoehner, Day, Forsyth, & Sallis, 2009; Galvez et al., 2010). The majority of this research has focused on adult populations, with far less on the relationship between children’s obesity levels and the environment where they live, which includes the characteristics of neighborhoods and nearby parks (Galvez et al., 2010; Papas et al., 2007; J. F. Sallis & Glanz, 2006). Experts have called for increased specificity in ecologic models that look at individual neighborhood characteristics as they relate to physical activity levels in children (Giles-Corti, Timperio, Bull, & Pikora, 2005). Proximity to public parks was associated with increased physical activity in urban areas especially with low income and minority males (D. A. Cohen et al., 2007). One study looked at the effect of the environment on children’s physical activity and found differences between the effects of the social and physical environment on child physical activity (Franzini et al., 2009). Using structural equation modeling that included the social and physical neighborhood factors modeled as separate latent variables they found that a favorable neighborhood social environment which included parental collective efficacy, social exchange, social contact and safety perception, was positively associated with child physical activity and negatively associated with child BMI. Neighborhood physical environment measured by traffic volume, physical disorder, residential density and amount of mixed land use was not significantly associated with any measure of physical activity (Franzini et al., 2009). The authors concluded that the lack of association between the physical neighborhood factors and child
physical activity may be due to the type of physical activity measured (teams, lessons, gym in school) and the fact that the physical environment measures included measures of traffic, density and land use that may not be associated with these type of activities. In addition the decision to participate in these physical activities is made by their parents who may not be related to the physical environment as much as the social environment as defined above. These findings are relevant to my study where I will test the effect of the parents influence and the physical environment on the same outcomes.

**Child Outcome Measures**

As previously mentioned, one of the challenges in conducting research with children, specifically with regard to obesity, is the use of BMI as an outcome measure. Body Mass Index (BMI) has historically been used as the measure of obesity in adults (Weigley, 2000), and more recently in children based on reference data supplied by CDC growth charts for children in the US (Kuczmarski et al., 2002). BMI has been used as a proxy measure for body fatness, with the gold standard being Dual Energy X-ray Absorptiometry (DEXA) (Freedman & Sherry, 2009). The United States Preventive Services Task Force (USPSTF) has questioned the use of BMI as a screening tool in children because the limited evidence of its relationship to health status (Moyer et al., 2005) and concern about the stigma associated with labeling children based on BMI measured in school settings (R. M. Puhl & Heuer, 2009). While BMI has been established as a sound epidemiologic tool for the assessment of overweight and obesity in populations due to the ease in measuring height and weight for its calculation and its overall reliability, it is most appropriate for surveillance purposes (Dietz, Story, & Leviton, 2009). Despite all of this, BMI continues to be used as a primary outcome measure in studies looking at predictors and correlates of childhood obesity especially when actual measurements of height and weight of
children are taken in the field rather than child or parent self-report (Franzini et al., 2009; Kimbro et al., 2011; Rodearmel et al., 2006).

Since child BMI represents a measure of weight adjusted for height, sex and age and is not an actual direct measure of health status (Dietz & Bellizzi, 1999), additional measures, such as fitness level, may be a more sensitive measure of a child’s health risk behavior as it relates to their environment. Research has shown that weight is gained when there is an imbalance between energy intake and expenditure (Anderson & Butcher, 2006; J. O. Hill, Wyatt, Reed, & Peters, 2003). Studies on the expenditure side of the equation have looked at physical activity and specific physiologic measures, such as the basal metabolic rate (BMR), as outcome measures leading to obesity (Bandini, Schoeller, & Dietz, 1990). Researchers have called for an increased focus on the lack of physical activity (PA) as a cause of this problem in children because there is a lack of evidence that physiologic measures such as BMR directly affect childhood overweight. While BMI is often chosen as the outcome variable to assess the role of the environment on physical activity, fitness level may be more appropriate since it is more proximal to the effect of the environment and therefore more accurate (better sensitivity and specificity) as an outcome variable. Effects of physical activity on BMI are more distal in nature and may be influenced by other unknown variables, such as food choices, making it less sensitive as an outcome measure and prone to confounding. Fitness measures as predictors of physical activity levels moderated by environmental factors in the 10-14 age group have not yet been investigated.

Physical activity levels can be determined through a reliable and validated survey instrument (CDC, 2006b). Reliable fitness measures can be obtained for children with relative ease using tests and norms adapted from The President’s Challenge (Wingfield, Graziano, McNamara, & Janicke, 2011).
Gaps in Literature Addressed in this Research

Although the relationship between health and place has been studied previously in adults along with the relationship between physical activity and the environment (Bernard, 2007), there has been limited application to childhood obesity (Rahman, Cushing, & Jackson, 2011). Models looking at utility and cost value in adults may not apply to children, since children are not simply miniature adults and have less agency (Kimiecik et al., 1996). Various studies have documented the positive effect of the built environment on shaping opportunities for physical activity. These efforts have attempted to focus on the specificity of ecological models, such as the features of parks (Kaczynski, Potwarka, & Saelens, 2008) and to focus on specific age groups such as adolescents (Babey, Hastert, Yu, & Brown, 2008), young children (Roemmich et al., 2006), and childhood behavior, such as walking to school (Cooper, Page, Foster, & Qahwaji, 2003). This proposed dissertation will contribute to the research on childhood obesity by investigating an understudied population: children aged 10-14 years old. Further, it will examine the role of parents in this pivotal age group as a moderating influence on the relationship between the child’s physical environment and child’s BMI, PA levels and fitness measures by providing data collected simultaneously, but separately, from the child and parent. In addition, this dissertation research will examine the utility of using fitness measures and BMI in this age group to determine the most effective measure related to parental influence and the built environment.

Research Question
To what extent do parental influences moderate the relationship between the built environment and child PA levels, fitness measures and BMI? This research is designed to address a secondary research question of whether fitness measures are a more sensitive outcome measure than BMI, in adolescents ages 10-14.
Specific Aims

SA1: To determine if Fitness or BMI as a child outcome measure has a more direct proximal link (stronger link) to the effects of the built environment and parental safety attitude.

H1a: The age and gender adjusted percentile scores for Fitness measures will have a stronger relationship with the built environment than BMI age and gender percentile, as evident by a model with 1) smaller p values; 2) larger t-statistic.

H1b: The standardized outcome scores for Fitness will have a stronger relationship with parental safety attitudes than BMI age and gender percentile, as evident by a model with 1) smaller p values; 2) larger t-statistic.

SA2: To determine the extent to which parental safety attitudes moderate the relationship between the built environment and child PA, fitness level and BMI.

H2a. There will be a significant main effect of parent’s safety attitudes on the outcome of fitness and BMI, after adjusting for walking built environmental constructs, child age, gender and physical activity.

H2b. There will be a significant main effect of the walking built environment constructs on the outcome of fitness and BMI, after adjusting for parental safety attitudes, child age, gender and physical activity.

H2c. There will be a significant interaction between parent’s safety concerns and census level environmental constructs, and child physical activity levels and the built environmental constructs on the outcome of child fitness and BMI.
Figure I.2 Model of proposed mechanism between predictor variables through child PA leading to outcomes of BMI, Fitness and Child Health
**Hypothesis:** There will be a significant main effect of Path a, Path b and/or Path c and moderation present of the built (outside) environment (path b) by the parental factors (main effect path a) by a significant interaction effect in path d.

Figure I.3 Pathways of Main Effects and Moderation Effect
**Significance of this research**

While the literature can support the model of the relationship between the built environment and obesity in adults, (Giles-Corti, Timperio, Bull & Pikora, 2005) this research will expand the body of knowledge by focusing on a children aged 10-14 years from diverse racial/ethnic groups and various income levels in five urban neighborhoods in the northeast Denver area. Further, this study considers the parental role as a moderator of the effect of the built environment on the outcome variables specifically measured on the target population (BMI, physical activity levels, fitness measures). This study aims to provide community members with a better understanding of the role of parents and the impact of the built environment on BMI, physical activity levels, and fitness levels in children. This work will enable local policy-makers, in conjunction with members of the community, to better develop and target intervention programs in order to avert significant morbidity later in life.
CHAPTER II

REVIEW OF THEORY AND RELEVANT LITERATURE

In March, 2005, The Commission on Social Determinants of Health (CSDH) convened by the World Health Organization, adopted the term the “causes of the causes” to convey the economic, social, cultural and environmental contributors to death and disease. While healthcare is certainly an integral part of combating diseases and health conditions, such as obesity, it is the “causes of the causes” that require a more public health approach and a focus on the factors or determinants that may be outside of healthcare. In an earlier seminal article in *JAMA*, McGinnis and Foerge described the *actual causes of death* in the US vs. the *leading causes of death* as the external modifiable factors that contributed to death (McGinnis & Foege, 1993). For example, heart disease was the leading cause of death in the US in 2000, while the causes of that Cardiovascular disease (CVD) mortality were poor diet and physical inactivity (Mokdad et al., 2004). Along the same lines, obesity is caused by an imbalance between energy intake and output (J. O. Hill et al., 2003); however, what are the underlying causes of that energy imbalance and how can interventions be developed that target the actual cause of the cause of death and morbidity attributable to obesity? This chapter will present the relevant theory that drives the inquiry into the expenditure side of the equation. A review of the relevant literature surrounding childhood obesity and physical activity will be included, as well as the theoretical models that inform an investigation of children’s physical activity in relation to parental influence and environmental factors in the community.
Relevant Theory

The theoretical constructs that support this dissertation are listed in Figure II.1 and described below.

Figure II.1 Theoretical Perspective

Structuration Theory

Is health a result of the characteristics of people or the places that they live? The debate between the effect of the composition of a neighborhood by its inhabitants vs. the contextual effect of the neighborhood itself is an attempt to explain health as an either/or proposition. In reality it may be due to the complicated effect of both (Kawachi & Berkman, 2003). When attempting to disentangle the compositional-contextual effects, understanding the relationship between neighborhoods and health is complicated by the decisions of the individuals who inhabit
these neighborhoods. Is the distribution random or intentional on the part of the choices made by the people that live there? Giddens’ Structuration Theory (Giddens, 1984) attempts to bridge this chasm by addressing the relationship between structure and agency and provides a mechanism for the impact neighborhoods have on health beyond a “social miasma” which means that simply living near to deprived people decreases one’s own health (S. Macintyre & A. Ellaway, 2003). Giddens states that structure and agency are two sides of the same coin and that one influences the other and the other reinforces the previous. Structuration implies that neither has dominance in society. Neighborhood residents (agents) are influenced by the environmental and social structure but their behavior and action reinforce the structure (Bernard et al., 2007). So do individuals buy products (food) that are readily available in their community or do their buying decisions affect what is then made available to them by retailers? This of course is now even more significant as retailers can now electronically monitor your consumer purchases through grocery loyalty cards or other systems or devices (smart phones) that monitor your browsing and ultimate purchases. Do parents make their decisions about children playing outside based on the safety they perceive or is the safety of the neighborhood an effect of parents not allowing their children outside and the lack of parental presence in parks and on the streets?

The dichotomies of action and structure, agency and structure, objective and subjective need to be overcome and Structuration Theory may accomplish this. Giddens’ theory proposes that a neighborhood is a relational social structure (Bernard et al., 2007). He further states that there are rules and resources, with one type of resource being allocative resources or the material features of the environment (Giddens, 1984). One rule Giddens discusses is simple proximity to resources which for parks can be measured using GIS, but proximity can also be shaped by the social environment such as economic forces or social relationships (Bernard et al., 2007). These
may include how a parent’s influence can affect the choices made available to a child in a neighborhood for physical activity. If there are fees to use a park or facility this can be a barrier for kids just as distance, transportation and perceived safety.

For the purpose of informing how social and health policy should be constructed, or how to modify risk or health behavior such as physical activity, the role of the actor or agent cannot be ignored. Does agency improve the individual’s chance of incurring change and resisting the structure or does the structure lead the individual down the road that in some cases become necessary to improve health and wellbeing? Physical activity, eating habits, living conditions, sanitation: are these expectations of behavior that are structurally based in society or are improvements in these areas due to the agency that individuals display in improving their lifestyle? I feel the combination and integration proposed by Structuration may accomplish the synthesis of structure and agency in a positive and productive manner. This false dualism that has been created should be broken down recognizing that the relationship between people and place is reciprocal and mutually reinforcing (Cummins, Curtis, Diez-Roux, & Macintyre, 2007). A social ecological framework can apply structuration by recognizing the position an individual sits in, nested within an environment that exerts various forces or constraints. The supposed tension between composition and context is the relationship between the two areas of structure and agency. The Family Influence Model described further below and a model which my research question is based upon recognizes the way structure and agency interact and lead in children to the health behavior of physical activity.
Social Ecological Theory

According to Stokols, “a person’s efforts to modify his or her own health practices are often impeded by economic, social and cultural constraints” (Stokols, 1996)(p284). Social ecology is viewed as an overarching framework, or a set of theoretical principles, for understanding the interrelations among diverse personal and environmental factors in human health and illness (Stokols, 1996). Individuals are embedded within a greater social matrix, which should not be ignored in the pursuit of an intervention that may be aimed at this level. Social ecological theory, an extension of the biological concept of ecology, creates a framework within which to situate and discuss health beyond the individual level. Many models of social ecology have been described and applied in various types of intervention programs and for diverse types of health problems such as smoking, seat belt use, and various health screenings. Bronfenbrenner’s model (Bronfenbrenner, 1979) describes three levels of environmental-individual interaction, the microsystem (i.e. interpersonal interactions), mesosystem (i.e. interactions among various settings such as work, family and social networks) and the exosystem (i.e. cultural, political and economic forces). The model proposed by McLeroy, et al. in 1988 (McLeroy, Bibeau, Steckler, & Glanz, 1988) is composed of five classes of factors: intrapersonal factors, interpersonal processes and primary groups, institutional factors, community factors, and public policy. Behavior is the outcome of interest and is determined by the five classes with four of the five pertaining to the person’s environment and is clearly beyond the intrapersonal. Moos’ ecological model (Moos, 1980), which is geared toward health behavior is constructed of physical settings, organizational factors, human aggregates and social climate. A very common construction of social ecology related to physical activity is provided by Sallis and Owen (J. Sallis & Owen, 2002) which proposes that behaviors are influenced by intrapersonal, sociocultural, policy, and
physical-environmental factors. The important point in recognizing the diversity of models used
to describe social ecological theory is to observe the common threads between them. Each
reflects the interrelationship between structural layers from individual level characteristics to
large-scale social forces which is related to the community I have chosen to do my study in.

Four primary assumptions regarding social ecological theory have been described
(Stokols, 1992, 1996). First, intrapersonal, social and physical environments work jointly to
influence health behavior. Second, environmental influences on health are the result not only of
physical and social components, but also of the perception of these variables by the individual.
Recognition of various collective levels of human interaction with the environment (individual-environment, community-environment or population-environment, for example) comprises
Stokols’ third assumption. The fourth and critical assumption of social ecological theory is the
relationship between environmental levels and collections of individuals. In short, altering
behaviors among individuals will influence environmental level characteristics, which will, in
turn, further influence groups of individuals within a community or population.

Ecological Systems Theory (EST), another term to describe social ecology, proposes that
behaviors such as physical activity participation should be considered within a broader context
(Davison & Birch, 2001). Ecological models can range from the simple (Figure II.2) to the more
complex.

![Figure II.2 Ecological Model](image-url)
A more comprehensive ecological model which was built on previous models as shown in Figure II.3 was developed to illustrate the four domains of active living where child behavior occur (J. F. Sallis et al., 2006). Behavior is defined as the interaction between the person and the environment. Three of these four domains were examined in my study of children including active recreation (bicycle riding), active transport (traveling to school) and household activities (TV, video watching). This complex multilevel model captures the various levels of influence on active living with individual behavior as the outcome of these various influences. The many variables looked at in this review are included at different levels including observed environmental measures of the neighborhood, school and recreation environment, perceived environmental and intrapersonal measures, and policy level influence.

Figure II.3 Four Domains of Active Living (J. F. Sallis et al., 2006)
A recent review (Galvez et al., 2010) uses the Ecological Systems Theory (EST) in Figure II.4 as a model to examine the strength of the literature with respect to child obesity and the role of neighborhood factors. Child weight is located in the inner circle subject to further external influences located in the outer rings such as the age of the child, the parental influences and finally the societal influences. Forty-eight articles were reviewed, with fifteen articles specifically focusing on physical activity. The authors looked at studies that related the built environment including walkability, neighborhood safety, active commuting, diet, and outcomes of physical activity and child’s BMI. Gender differences were noted including girls being more sensitive to cost barriers and aesthetics of facilities. This study will be able to look at gender, ethnic and socioeconomic differences as it pertains to physical activity and if the effect of the environment or parents is affected by these factors. They further concluded that while progress has been made in this area, there is still much work to be done to enhance our understanding of neighborhood level factors, specifically as they relate to children (Galvez et al., 2010). Variables measured in this study are circled and include outcome, predictors and covariates at the various levels of the ecological model.
Finally an additional ecological framework developed by Brennan Ramirez et.al. (Fig II.5) demonstrates the range of community correlates that affect physical activity and how macro policy level, individual level and interpersonal level factors can modify the impact of these community level factors (Brennan Ramirez et al., 2006).
Family Influence Model

Parents can influence the physical activity of their children through a number of mechanisms that include direct modeling, providing resources, establishing or eliminating barriers to physical activity participation and positively reinforcing behavior. (Trost & Loprinzi, 2011). Parental influence can be direct or indirect, with direct effects including facilitating the child’s efforts to be active while indirect effects may include the predisposing factors that may mediate the child’s physical activity (Welk, Wood, & Morss, 2003). A study of younger pre-
school age children age 3-5 in Canada showed that children were less active if their parents were older and the children watch more than one hour of TV/video per day. Children who received greater parental support were 6.3 times more likely to be physically active (Zecevic, Tremblay, Lovsin, & Michel, 2010).

Kimiecik and colleagues used the Family Influence Model to test the influence of parental influence through the home environment on the effect on child’s moderate to vigorous physical activity. This model was adapted from Eccles (Parsons) expectancy-value model incorporating the expectancy of success in the activity based upon the parents’ defining the value of that activity to the children (Dempsey et al., 1993). Their subsequent model also drew on theory supported by Bandura’s Social Cognitive Theory (SCT), which posits that behavior is a function of reciprocal interaction among the personal, environmental and behavioral components (Bandura, 2001). Of the many individual behavior change models, SCT recognizes the reciprocal relationship between the environment and a person’s psychological elements. SCT has been used as a theoretical model to understand physical activity, including in children and adolescents (Motl, 2007). The other components of SCT, including self-efficacy, are mediated through the environmental variables either directly or indirectly. This model fits well with my proposed research that will test the relationship between the household (parental) variables in relation to the environmental variables on child physical activity.

Figure II.6 illustrates a hypothesized model of how the environment through excessive urban sprawl affects obesity and overall health by a decrease in physical activity (A. Kelly-Schwartz, Stockard, Doyle, & Schlossberg, 2004).
Urban sprawl is just one example of how the built environment can affect health through its impact on the level of physical activity and subsequent effect on obesity in a community. While many interventions and research questions have been aimed at various aspects of this model, most target medical conditions of individuals within a biomedical model context. Efforts to reduce obesity have tended to focus on the individual, utilizing various theories and models of individual behavioral change, not the primary focus of this dissertation (Bandura, 1997, 2001; Baranowski, Perry, & Parcel, 2002; Fishbein, 1967; Janz, Champion, & Strecher, 2002; Montano & Kasprzyk, 2002; Prochaska, Redding, & Evers, 2002). While these theories have been utilized in large studies and programs such as the Multiple Risk Factor Intervention Trials (Zukel, Paul, & Schnaper, 1981) in an attempt to reduce cardiovascular disease, the modest impact of these interventions demonstrate a limitation of primarily focusing on the individual behavior change models for health promotion (Stokols, 1996). Previous efforts to increase physical activity by focusing solely on individual approaches have been shown to be less effective and have only short term benefit versus a more long term sustainable change (Hillsdon, Thorogood, White, & Foster, 2002).

Figure II.7 demonstrates my conceptual model of the multilevel spheres of influence that impact child behavior (physical activity) and various potential primary and secondary data
sources available in this study. Parental influence variables were measured via household survey, while environmental variables were observed via neighborhood audit and park audit.

**Conceptual Model**

*multilevel influences on child outcomes*

![Conceptual Model Diagram]

**Figure II.7- Conceptual Model of Influences on Child Physical Activity**

**Review of Current Literature**

**Neighborhoods and Health**

Real estate agents always claim that there are three important elements about a property: location, location, and location. The observed geographic variability in health outcomes has caused recent researchers to look at not just “who you are” but also “where you are” (Macintyre & A. Ellaway, 2003). This has led to increased interest in studying neighborhoods and the effect of place on health. It has been reported that there is an association between place and health beyond the individual level risk factors for a number of health conditions, including smoking, general mortality and cardiovascular disease (Diez-Roux, Link, & Northridge, 2000). This is not
a new finding, it actually dates back to the 5th century BCE with the publication of *Airs, Waters, Places* as a part of the Hippocratic medical corpus (S. Macintyre & A. Ellaway, 2003).

Neighborhoods are a unique system of health-relevant resources (Bernard et al., 2007). In a study of four areas in Scotland, Macintyre and Ellaway described five aspects of neighborhood that form an opportunity structure. These are physical features, environments that support healthful lifestyle, quality services, sociocultural features and the area’s reputation (S. Macintyre & A. Ellaway, 2000). These aspects are a part of some of the variables I look at in my study of the social and physical environment of my study communities as it relates to children’s physical activity.

A neighborhood approach highlights theoretical and practical tensions, such as social selection versus social causation, the definition of neighborhoods versus communities, and the distinction between contextual-compositional effects (Kawachi & Berkman, 2003). The compositional point of view argues that the observed geographical variation in health is due to the characteristics of the inhabitants or the makeup of the community. The contextual explanation argues that these patterns and spatial variations are due to the actual differences in environmental features of the locations. Researchers recently have argued, however, that this compositional/contextual distinction is artificial and that “people create places and places create people” (S. Macintyre & A. Ellaway, 2003). An additional issue relates to what has been termed the ecological fallacy, defined as an incorrect causal inference from group data to individual behaviors (Schwartz, 1994). The ecologic fallacy was originally described by Robinson while examining immigrants and the literacy rate in the US (W. S. Robinson, 1950). He showed a positive correlation (0.53) between the literacy rate in a state and the number of people born outside of the US, yet when individuals were considered the correlation dropped to –0.11.
Immigrants were settling in states where there was a higher literacy rate but were not driving the higher rate. Consequently, drawing a conclusion about individuals based on the aggregated state data was a fallacy. While the fallacy is a danger when aggregate data are used as a proxy for individual data, there is a proper use of this type of analysis when one might be looking at the social and physical environment effect on the health of individuals in a population and is more clearly defined as an ecological perspective (Koopman & Longini, 1994; S Macintyre & A Ellaway, 2000; Susser, 1994).

It was first argued over 30 years ago that obesity was a product of the environment, prompting the debate to extend beyond the individual perspective of obesity as a medical disease (A. A. Rimm & White, 1979). The term “obesogenic environment” is defined as “the sum of influences that the surroundings, opportunities, or conditions of life have on promoting obesity in individuals or populations”(Swinburn, Egger, & Raza, 1999). The word “environment” is used broadly, extending beyond just the physical environment to also include socio-cultural, economic and policy aspects. While the evidence supports the relationship between the environment and obesity-promoting behavior, the mechanisms through which these environments may affect a child’s behavior are not well understood. Researchers have attempted to dissect the effect of the environment into four areas (physical, socio-cultural, economic and policy) to understand the relationship on individual and population obesity (Swinburn & Egger, 2002; Swinburn et al., 1999). The obesity epidemic arises from a complex interplay between individual behaviors and the environmental context.

In summary understanding the childhood obesity epidemic in the United States and the role that physical activity plays in this epidemic requires a social-ecological perspective that recognizes the multi-level influences on human behavior; a model that lends itself well to
environmental and policy interventions (Deshpande, Dodson, Gorman, & Brownson, 2008; J. F. Sallis et al., 2006). For decades, this social-ecological perspective has received support from research, demonstrating that the characteristics of places result in risks for the people who live there (Kawachi & Berkman, 2003; Macintyre, Ellaway, & Cummins, 2002).

Parks have been associated with physical activity including looking at proximity to where people live (D. A. Cohen et al., 2007) and the mechanism for how specific structural characteristics can lead to increased activity and subsequent health benefits (Bedimo-Rung, Mowen, & Cohen, 2005). Tools have been developed to measure specific features and activities in parks (Bedimo-Rung, Gustat, Tompkins, Rice, & Thomson, 2006; McKenzie, Cohen, Sehgal, Williamson, & Golinelli, 2006)

In a special journal issue, The Future of Children (2006), leading experts reviewed progress in understanding and approaches for decreasing childhood obesity – its causes, correlates and potential strategies for its prevention. Included in this review, Sallis and Glanz (2006) called for greater focus on the built environment for understanding patterns of physical activity and healthy eating among children—and for new approaches to childhood obesity prevention that go beyond a focus on individual behaviors, by considering where and how these children live their daily lives (J. F. Sallis & Glanz, 2006).

**Epidemiology of obesity**

“Epidemic” is a word that has been used to describe the rapid rise of obesity that spreads by our common exposure to an environment that encourages eating and physical inactivity (Jain, 2004). Obesity is a condition caused by an imbalance between the lack of physical activity and increase in caloric intake or the eating of energy dense foods (J. O. Hill et al., 2003).
Obesity is presently a global problem, affecting 300 million people worldwide (Racette, Deusinger, & Deusinger, 2003). US Data from NHANES 1999-2000 (4115 adult men and women), which is now a continuous survey without breaks in cycles, demonstrated a prevalence of age-adjusted obesity (BMI \( \geq 30 \)) of 30.5%, up from 22.9% in the previous year’s survey. The total prevalence of overweight (BMI \( \geq 25 \)) which includes obesity, increased from 55.9% to 64.5% for the adult US population. These data demonstrated increases across men and women in all age groups and racial/ethnic groups; the prevalence was highest among non-Hispanic black women. Low SES has also been shown to be associated with obesity (Mokdad et al., 1999).

When looking at children using the 1999-2000 NHANES data, which included 4722 children from age 2 through 19, prevalence for overweight was estimated at 15.5% for ages 12-19, 15.3% among 6-11 year olds and 10.4% among 2 - 5 year olds. This represents a doubling of the prevalence for 2-5 and 12-19 age groups, while the prevalence for age group 6-11 tripled from the previous NHANES III in 1988-1994(Ogden, Flegal, Carroll, & Johnson, 2002). Approximately 9 million American children over the age of 6 are presently considered overweight (IOM, 2005). Obesity is the single most important modifiable risk factor for the development of Type 2 diabetes (T2D) in children (Amed, Daneman, Mahmud, & Hamilton, 2010). Just as with obesity rates in children, Type 2 diabetes rates have also increased dramatically for children. This has prompted a change in the terminology for T2D, which was previously referred to as “adult onset diabetes” (Racette et al., 2003).

After the successes of improving childhood life expectancy and quality of life through the promotion of seatbelts, child car seats, bike helmets and even municipal water fluoridation, this emerging epidemic has now become the major challenge of the 21st century for children’s health. In 2001, the U.S. Surgeon General issued the Call to Action to Prevent and Decrease Overweight
and Obesity which ended up in having Congress direct the Centers for Disease Control and Prevention (CDC) to request that Institute of Medicine (IOM) develop an action plan targeted to the prevention of childhood obesity in the U.S. This report has 10 recommendations, many involving intervention at the environmental level (IOM, 2005). Creating social and physical environments as a part of social determinants of health are now an important part of the overarching goals of Health People 2020. This renewed focus is on an ecological approach and a commitment to interventions at various levels and across all age groups. Healthy People 2020 recognizes health behaviors are determined by influences at multiple levels and include an emphasis on health enhancing social and physical environments (HHS, 2010).

More than a third of young people in grades 9–12 do not regularly engage in vigorous-intensity physical activity, defined as activity that makes you breath hard, during which conversation would be difficult (CDC, 1996). This may include activities such as running, swimming, cycling uphill, cycling at a speed greater than 10 mph, or moving or pushing furniture. While the terms physical activity and exercise tend to be used interchangeably, one is actually a subset of the other (Brownson, Boehmer, & Luke, 2005). Both terms are used to describe bodily movement that expends energy, while exercise is defined as planned, structured and repetitive movement (CDC, 1996). Daily participation in high school physical education classes dropped from 42% in 1991 to 28% in 2003 (Grunbaum et al., 2004). While a number of explanations have been proposed for the childhood obesity epidemic, the decrease in physical activity is believed to account for much of the rise in child weight trends over the years (Dunton et al., 2009). A review of studies published after 2005 revealed that the associations between physical activity and the environment in children differed on a number of factors. These included gender, age, SES, population density and whether the reports were made by parents or child.
Additionally, the review calls for further studies that examine the role of mediators and moderators between the physical environment and obesity including interactions (Dunton et al., 2009). A goal of this study is to obtain data to examine these variables as they relate to the outcomes of child fitness, obesity (BMI) and physical activity levels.

**Measurement of Obesity**

Physiologically, obesity refers to excess fat or adipose tissue, not just weight. Body mass Index (BMI) is defined as body weight (kg)/ht(m)^2. If using pounds and inches you must then multiply weight (lbs)/height(in)^2 by a conversion factor of 703 (IOM, 2005). Underwater weighing used to be the standard method for assessing body fat composition but has now been replaced by a process called dual energy X-ray absorptiometry (DEXA) which has been validated against previous methods (Haarbo, Gotfredsen, Hassager, & Christiansen, 1991). Since this process is inconvenient and expensive, health professionals and researchers typically calculate the body mass index (BMI) as a measure in the definition of obesity in clinical situations. This measure can be calculated from self-report of height and weight (as is practiced by BRFSS) or through actual clinical measures of height and weight (as is practiced by NHANES). While trends are consistent over time with self-report, measures such as weight tend to be under-reported vs. actual measurement data (Davison & Lawson, 2006). Table 1 lists the categories of BMI and the terms used to define various levels of obesity in adults. These two classification systems, one by the National Heart, Lungs and Blood Institute (NIH, 1998) and the other by the World Health Organization (WHO, 2003) are similar and used by many researchers in the US and internationally (Jain, 2004).
Table II.1 Adult BMI Terminology

<table>
<thead>
<tr>
<th>NHLBI Terminology</th>
<th>BMI Range</th>
<th>WHO Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>&lt;18.5</td>
<td>Underweight</td>
</tr>
<tr>
<td>Normal</td>
<td>18.5-24.9</td>
<td>Normal</td>
</tr>
<tr>
<td>Overweight</td>
<td>25.0-29.9</td>
<td>Preobese</td>
</tr>
<tr>
<td>Obesity Class 1</td>
<td>30.0-34.9</td>
<td>Obese Class 1</td>
</tr>
<tr>
<td>Obesity Class 2</td>
<td>35.0-39.9</td>
<td>Obese Class 2</td>
</tr>
<tr>
<td>Obesity Class 3- Extreme Obesity</td>
<td>≥ 40.0</td>
<td>Obese Class 3</td>
</tr>
</tbody>
</table>

The National Heart, Lung and Blood Institute terminology using BMI defines normal weight between 18.5 and 24.9 with overweight as a BMI of > 25.0 to 29.9. Obesity is defined as BMI >30.0 (NIH, 1998). The term morbid obesity is also used clinically to refer to BMI ≥ 40.00 (Jain, 2004).

For childhood obesity, an expert panel convened in 1994 and decided to avoid the actual term obesity since obesity was used for body fat and BMI technically only was a measure of height and weight (Himes & Dietz, 1994). In addition some felt that the term should be avoided due to the potential stigma attached to this label (Latner & Stunkard, 2003). In 2005 the Institute of Medicine purposely added the term obesity for children with a BMI ≥ to the 95th per centile to express the seriousness and importance of the problem. This was later endorsed by an expert panel (Himes, 2009).

The problem of stigma as it relates to using BMI as a screening tool in schools was discussed in chapter 1 with the introduction of BMI report cards (R. M. Puhl & Heuer, 2009; R. M. Puhl & Latner, 2007). Researchers concerned with the stigma of individual children in the
schools have called for alternative measures to BMI, such as monitoring access to healthy food, participation in sports activities, types of activities and levels or average hours of physical activity (MacLean et al., 2010). In addition, the categories of healthy, overweight and obese are based on means and population standard deviations rather than clinically relevant cutoffs and based on the year 2000 CDC growth charts (Ogden, Kuczmarski et al., 2002). Cole and colleagues (Cole, Bellizzi, Flegal, & Dietz, 2000) have designed charts that are used in the UK based on children in six diverse regions of the world, including the United States and the UK.

For children ages 2-18, the following definitions were initially used.

**Overweight** = \( \geq 95^{th} \) percentile BMI for age and sex based on the 2000 CDC growth charts.

**At risk** = \( \geq 85^{th} \) but < \( 95^{th} \) percentile for age and sex.

In 2005 the American Medical Association, in conjunction with CDC, convened an expert committee that was charged with providing revised recommendations regarding the assessment, prevention and treatment of child and adolescent overweight and obesity (Barlow, 2007). This committee recommended changing the term of “at risk” to overweight and “overweight” to obesity. It was argued that these terms better reflected the health risks associated with excess body fat, which is denoted in the term “obesity”. This also allows continuity with the adult definitions and resolves the ambiguous term of “at risk”. In addition, these changes maintained the cutoff values and therefore did not affect the prevalence rates of these BMI categories (Barlow, 2007). Recognizing an increasing prevalence in extreme obesity and the different social and medical effects involved, the committee recommended a third cutoff point for severe obesity in children using the 99\(^{th}\) percentile. Presently CDC growth charts only plot up through the 97\(^{th}\) percentile (Kuczmarski et al., 2002).
Table II.2 Terminology of BMI Categories for Children 2-19

<table>
<thead>
<tr>
<th>BMI Category</th>
<th>Former terminology</th>
<th>New Terminology</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;5&lt;sup&gt;th&lt;/sup&gt; percentile</td>
<td>Underweight</td>
<td>Underweight</td>
</tr>
<tr>
<td>5&lt;sup&gt;th&lt;/sup&gt;-84&lt;sup&gt;th&lt;/sup&gt; percentile</td>
<td>Healthy weight</td>
<td>Healthy Weight</td>
</tr>
<tr>
<td>85&lt;sup&gt;th&lt;/sup&gt;-94&lt;sup&gt;th&lt;/sup&gt; percentile</td>
<td>At risk of overweight&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>Overweight&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>≥95&lt;sup&gt;th&lt;/sup&gt; percentile</td>
<td>Overweight or obese&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Obesity&lt;sup&gt;cd&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a</sup> AMA expert committee recommendations, 1998
<sup>b</sup> CDC recommendations, 2002
<sup>c</sup> International Obesity Task Force, 2000
<sup>d</sup> Institute of Medicine, 2005

Excess weight in particular locations on the body also presents risks to health (Dalton et al., 2003). Abdominal or central obesity is associated with diabetes and coronary heart disease, especially in middle aged men (E. B. Rimm et al., 1995). If you carry more fat around your waist relative to your hips or thighs then you are at greater risk for disease, even if BMI is in the healthy range. This is known as the waist to hip ratio and varies for men and women across age groups (ACSM, 2005).

Table II.3 Waist to Hip Ratio

<table>
<thead>
<tr>
<th>Waist to Hip Ratio</th>
<th>Male</th>
<th>Female</th>
<th>Health Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.95 or below</td>
<td>0.80 or below</td>
<td>0.80 or below</td>
<td>Low Risk</td>
</tr>
<tr>
<td>0.96 to 1.0</td>
<td>0.81 to 0.85</td>
<td>&gt;0.85</td>
<td>Moderate Risk</td>
</tr>
<tr>
<td>&gt; 1.0</td>
<td>&gt;0.85</td>
<td>&gt;0.85</td>
<td>High Risk</td>
</tr>
</tbody>
</table>
Research and intervention programs that have specifically focused on the link between children’s activity levels and where they live has been limited as compared to research on adults which has been more extensive (J. F. Sallis & Glanz, 2006). In addition, the research on children with regard to the type of environment in which they live in may have disparate findings from adult studies, due to the effect of crime and safety on children’s physical activity. The built environment of a community in the suburbs that may not be as conducive to physical activity, as an urban community may show the opposite effect since children may be more sensitive to the effects of urban crime and other social effects vs. the physical environmental design (Lopez & Hynes, 2006).

The influence of the built environment on community levels of physical activity has been studied over the past two decades (Giles-Corti & Donovan, 2002). Research has shown that urban designs that encourage high population density, connectivity of streets and mixed land use (homes, shops and businesses) are associated with increased physical activity because they encourage people to walk to places near their homes (Booth et al., 2001; Saelens, Sallis, & Frank, 2003). Among children and adolescents, those with access to recreation centers and amenities for physical activity near their homes were more active than same-aged youth without access (J. F. Sallis, Prochaska, & Taylor, 2000). These findings are also supported by research on obesity. One study found that the design factor most associated with lower levels of obesity was living in mixed-use neighborhoods within walking distance to shops, businesses, and a range of services; residential density and connectivity of streets also related to weighing less. People were less likely to drive and more likely to walk if they lived in mixed use neighborhoods (Ewing, Schmid, Killingsworth, Zlot, & Raudenbush, 2003; Frank, Andresen, & Schmid, 2004).
A large barrier to active commuting found in one study was related to a series of parental concerns (Kerr et al., 2006). Parental concerns regarding traffic and pedestrian safety and esthetics played a role in determining kids walking in the neighborhood. In neighborhoods that had a high walkability measure (ease of walking) the parental concerns played a greater role in determining whether kids walked to school. Safety may influence child physical activity because care-takers who perceive neighborhoods as unsafe may not allow their children to play outside or walk to school. Left indoors, children are more likely to engage in sedentary behaviors, such as watching television and videos, using computers and playing video and other electronic games. Parental impressions of neighborhood safety have been shown to be associated with childhood obesity (Lumeng, Appugliese, Cabral, Bradley, & Zuckerman, 2006). There is a need for greater understanding of the factors that may increase the physical activity levels of children to help prevent the growing rates of childhood obesity in this nation. It is also important to understand how parental and environmental factors relate in promoting physical activity in children.

The environmental influences on eating, physical activity and subsequent obesity have been reviewed in detail. Present trends in the reduction of physical activity in children are due to increased screen time (Laurson et al., 2008), increased automobile use (Frank et al., 2004; Lopez-Zetina, Lee, & Friis, 2006) and the reduction of accessibility to parks and recreational space (Kaczynski & Henderson, 2008). These have caused the obesity epidemic to spread demonstrate the need to intervene at the environmental level (IOM, 2005). Simple interventions such as placing music and artwork in stairwells have led to a 39% increase in stair use (French, Story, & Jeffery, 2001) and additional architectural changes, such as designing buildings with stairwells easier to access than elevators can make differences in daily activity and energy expenditure levels that would surpass the 100 kcal/day recommendation of Hill and colleagues.
The use of signage in buildings to locate stairs, inform workers, students and visitors of distances has been effective in increasing physical activity (Bungum, Meacham, & Truax, 2007).

In the early 21st century researchers began to look at the effects of urban sprawl on physical activity, obesity and subsequent morbidity (Ewing et al., 2003; A. Kelly-Schwartz et al., 2004). The emphasis of these studies by transportation researchers has been to look at the effect the built environment has on utilitarian travel, defined as travel for purposes related to the outcome of the trip such as work, school or even shopping. It has been discovered that walking for utilitarian purposes is more commonly associated with a more dense type of neighborhood or a higher sprawl index. The lower the index the more sprawl the county or metropolitan region is considered (Ewing et al., 2003). Due to the cross-sectional nature of this ecological study, causation was not established, just an association between sprawl and lower physical activity, obesity, diabetes and hypertension was observed (Ewing et al., 2003). A 2004 study report revealed that walking remains the most dangerous mode of transportation and the highest rates are associated with cities that demonstrate the greatest amount of urban sprawl (Ernst, 2004).

In order to promote health, the ecosystem must offer economic and social conditions conducive to healthy lifestyles (Green et al., 1996). While dentists can encourage using a fluoride treatment to prevent decay, the next logical step was to put it in the toothpaste. When this did not result in the desired use, the next step was to fluorinate municipal water. Of course, this is now being undermined a bit by the present increase use of bottled water. Auto safety went through similar steps first with active seatbelt use (you must manually put it on) to eventually looking at more effective passive restraints, first with automatic seatbelts and then with air bags. The compliance rate improves as the power of decision is removed from the user. It is for this
reason that it is essential to determine the motivating factors as well as the barriers for people to participate in Healthy Eating and Active Living (HEAL), a term used in United States and Canada by various public and private health programs and funding agencies to describe communities that promote physical activity and healthful eating. Various funding agencies, such as the Robert Wood Johnson Foundation, the WK Kellogg Foundation, Kaiser Permanente, The California Endowment, Nemours Children’s Health System and CDC, have developed the HEAL convergence partnership to fund and develop interventions through policy and environmental change that can be successful in slowing down the present obesity epidemic (www.convergencepartnership.org).

While there are many theories that help explain individual behavior change and models that guide intervention strategies (Ajzen, 1991; Bandura, 2001; Janz et al., 2002; Montano & Kasprzyk, 2002; Prochaska et al., 2002), long term sustainability is possible only if structural environmental and social changes are created at the community level. Interventions must be ultimately designed based on an ecological approach and on data collected and analyzed at various levels. Physical activity, while an individual behavioral act, is performed in specific places so ecological models are a natural method to look at the characteristics that can hinder or facilitate physical activity (J. F. Sallis et al., 2006).

Recently more research has examined associations between the built environment and youth weight and physical activity (Tucker et al., 2009). Many of these studies use population based surveys and are often restricted to the data that have been collected and the level of environment due to privacy issues (G. K. Singh, Siahpush, & Kogan, 2010).
Gaps In The Literature

My dissertation research will address gaps in the literature in the following areas regarding neighborhood research and physical activity, highlighting children and youth in this uniquely-designed Denver metropolitan area.

- Recent studies have tended to focus on local areas, such as neighborhoods defined by zip or postal codes or census block (Stafford et al., 2007). Micro-environmental structures can be influenced by individuals, whereas regional scales are outside the sphere of influence of individuals and would require government organizations to affect change (Swinburn et al., 1999). I will analyze smaller units, such as neighborhoods and census tracts. Previous work by Ewing (2003), and Kelly-Schwartz (2004) used Primary Metropolitan Statistical Area (PMSAs) and large cities and counties and recommended smaller geographic areas for unit of analysis in future work. This study will use community-defined neighborhoods that coincide with official city-designated neighborhoods and US Census tracts.

- Active transport was not captured in previous studies, as respondents were asked how often they walked a mile without stopping as opposed to walking for particular functions, such as shopping or getting to school. This study will specifically examine walking or biking to school or parks in the neighborhood.

Various outcomes have been used to measure child obesity and the effect of interventions including BMI, physical activity levels and fitness measures. When attempting to determine the effect of parent- or environmental influences, fitness measures may be a more appropriate variable than BMI. This study will examine the utility of fitness measures as an outcome vs. self-
report physical activity levels and BMI to determine if fitness measure of children aged 10-14 is a more sensitive measure of the effect of the environment. This study will also test the strength of the effect of parental influence vs. environmental influence on the various outcomes of BMI, physical activity levels and fitness.

There has been a call for more studies that specifically look at the relationship between physical activity and the built environment in children (Kligerman, Sallis, Ryan, Frank, & Nader, 2007). This dissertation will focus on children in middle school between the ages of 10-14. This group has had a doubling of obesity rates based on BMI over the last 10 years (Ogden et al., 2006). In addition, this is a group of interest because they are at an age where they are independent enough to walk or bike through a neighborhood if encouraged and supported by their parents. Children in high school are subject to more complicated social pressures that could confound findings of changes in physical activity levels due to parental influence.

Physical activity has been measured in various ways in children and adolescents (Sirard & Pate, 2001). This has included primary, secondary, and subjective measures. Primary measures include direct observation, such as the use of doubly-labeled water and indirect calorimetry which are measures of energy expenditure, a result of physical activity (Montoye, Kemper, Saris, & Washburn, 1996). While direct observation has demonstrated high inter-observer agreement, the drawbacks include high experimenter burden and the potential for reactivity of the participants (J. Puhl, Greaves, Hoyt, & Baranowski, 1990). This study used subjective measures of child self-report and parent report. It also directly measured children’s BMI and fitness measures (V-sit, curl ups and vertical jump) using the presidential challenge tests, which has not been utilized in previous studies.
CHAPTER III
STUDY DESIGN AND METHODS

The primary research question of this dissertation is: How do parental safety attitudes and built environment walking constructs effect young adolescents ages 10-14 fitness levels and BMI?

The specific aims are:

SA1: To determine if Fitness or BMI as a child outcome measure has a more direct proximal link (stronger link) to the effects of the built environment and parental safety attitude.

SA2: To determine the extent to which parental safety attitudes moderate the relationship between the built environment and child PA, fitness level and BMI.

Design Overview

This cross-sectional observational study first tested the utility of using fitness tests vs. BMI as an outcome measure on children of the effect of the environment and parental safety attitudes. Physical activity was also tested as a main effect as an independent variable and then as a dependent variable as a possible mediator of the effect between the independent variables of parental safety and the built environment and the BMI and fitness outcomes. It then tested the two main effects and then subsequently test for interaction between the independent variables (parental influence and the environment) on the both outcomes of BMI and fitness. A face-to-face household survey of parent/child pairs specifically developed for this project, along with neighborhood level data collected previously by the Taking Neighborhood Health to Heart Study (TNH2H) (Main et al., 2012) was utilized. Neighborhood level data include variables collected via TNH2H street audits measuring three environmental constructs (safety, condition and infrastructure).
Study Area

Beginning in 1929 The Stapleton International Airport located in northeast Denver provided aviation services for the Denver metropolitan area. Residential communities that surrounded the airport property were negatively impacted by the noise, traffic, air pollution and other social and environmental stressors that the airport created. These adjacent neighborhoods are Original Aurora, East Montclair, Northeast Park Hill, and Greater Park Hill.

![Study Area Map](image)

Figure III.1 The Study Area.

Each neighborhood has a unique cultural, political, and economic history and identity. These neighborhoods are ethnically diverse with high rates of poverty (See Table III.1 below for a brief description of each neighborhood). The relocation of the airport with the opening of Denver International Airport in 1995 and the subsequent redevelopment of the Stapleton property provided a natural social and physical environmental experiment to observe and
measure the effects of a community designed specifically to encourage healthful living through urban design for the residents of this new community and also the adjacent existing communities. Stapleton is presently the largest urban renewal project and 11th best selling master planned community in the US. It is on 4700 acres (7.5 sq miles), with 1116 acres of parks, including 1/3 mixed used, green space, pocket parks, bike and walking trails, wide sidewalks (Forest City, 2011). Stapleton offers house facades that feature a front porch (the garage is accessed from the rear alley), smaller lots with public open space (parks) as gathering places, sidewalks with tree lawns to encourage pedestrian activity, village shops and restaurants within walking distance of most residences (higher density and sidewalks make these easy to get to), workplaces and cultural venues close to housing (no need to get on the interstate).

Table III.1. The Study Neighborhoods (TNH2H)

<table>
<thead>
<tr>
<th>Neighborhood</th>
<th>Pop Households</th>
<th>10-14 population</th>
<th>Ethnicity</th>
<th>% persons in Poverty**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>68.5% Afr.Am</td>
<td></td>
</tr>
<tr>
<td>NE Park Hill</td>
<td>8,729 (2744)</td>
<td>671</td>
<td>50.7% Afr.Am</td>
<td>24%</td>
</tr>
<tr>
<td>**2000 Census</td>
<td>7,821(2760)</td>
<td>518</td>
<td>30.3% Latino</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2010 Census</td>
<td></td>
<td>36% Afr.Am</td>
<td>9.4%</td>
</tr>
<tr>
<td>Greater Park Hill</td>
<td>19,118 (7522)</td>
<td>755</td>
<td>10% Latino</td>
<td></td>
</tr>
<tr>
<td>**2000 Census</td>
<td>17,972 (7308)</td>
<td>950</td>
<td>24% Afr.Am</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2010 Census</td>
<td></td>
<td>12% Latino</td>
<td></td>
</tr>
<tr>
<td>East Montclair</td>
<td>7,506(4218)</td>
<td>671</td>
<td>31.6% Afr.Am</td>
<td>22.4%</td>
</tr>
<tr>
<td>**2000 Census</td>
<td>10,191(4276)</td>
<td>701</td>
<td>31.9% Latino</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2010 Census</td>
<td></td>
<td>24.3% Afr.Am</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>27.7% Latino</td>
<td></td>
</tr>
<tr>
<td>NW Aurora</td>
<td>24,400 (7773)</td>
<td>2763</td>
<td>14.7% Afr.Am</td>
<td>27%</td>
</tr>
<tr>
<td>2000 Census</td>
<td>36,461</td>
<td>3053</td>
<td>57.6% Latino</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2009 ACS</td>
<td></td>
<td>17% Afr.Am</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>58% Latino</td>
<td></td>
</tr>
<tr>
<td>Stapleton</td>
<td>5,296 (1871)</td>
<td>N/A</td>
<td>N/A</td>
<td>0%</td>
</tr>
<tr>
<td>*Piton estimate</td>
<td>10,225 (2543)</td>
<td>235</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2009 ACS</td>
<td></td>
<td>10% Afr. Am</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>13% Latino</td>
<td></td>
</tr>
</tbody>
</table>

Methods

Protection of Human Subjects Overview

All research conducted as part of the TNH2H study has been previously approved by the Colorado Multiple Institutional Review Board (COMIRB 06-0264). In addition, as a doctoral dissertation in the Department of Health and Behavioral Sciences at the University of Colorado Denver, this project was approved by the University Colorado Denver Human Subjects Review Committee (HSRC) under protocol # 2008-131 for additional primary data collection of household parent/child pairs interviews and child measures. Subsequent continued review has been performed and the study and all present research activities are covered by the COMIRB approval process through March 2013. The research was designed to protect the safety, rights, and welfare of human subjects and poses minimal risk to human subjects. The principle investigator and all personnel associated with data collection underwent IRB and HIPAA training through COMIRB.

Primary Outcomes

The primary outcomes measures of this research are children’s BMI and various fitness measures from the President’s Challenge. All dependent variables (BMI percentile and Fitness scores) were examined as nominal and continuous variables (Table III.2). The height and weight of each child was measured during the face to face household interview and BMI calculated. The raw score BMI was converted to a standardized age and gender percentile using 2000 CDC growth charts (Cole et al., 2000). The fitness measures are based on the President’s Challenge and were also measured during the household interview by the trained data collectors.
### Table III.2. Primary Study Measures

<table>
<thead>
<tr>
<th>1. Physical Activity</th>
<th>2. Built and Social Environment: Neighborhood, Family</th>
<th>3. Healthy Weight, strength and flexibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Number of days engaging in 60 min of MVPA</td>
<td>▪ TV and computer time rules (Y/N) and amount of TV and computer time</td>
<td>• Child BMI: percentiles categories: Obese Overweight Healthy Underweight</td>
</tr>
<tr>
<td>▪ Meets CDC recommended PA guidelines(Yes/No)</td>
<td>▪ Walking Audit scores  o Condition  o Safety  o Infrastructure</td>
<td>▪ Curl ups- age and gender normalized</td>
</tr>
<tr>
<td>▪ Amount of TV/video/computer time</td>
<td></td>
<td>▪ V-Sit- age and gender normalized</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Vertical Jump- age and gender normalized</td>
</tr>
</tbody>
</table>

Descriptive analyses were conducted of the variables collected in Table III.2 by neighborhood and census tract as well as by other relevant demographic covariates such as age, gender, ethnicity and household income.

**Primary Data**

Existing sampling frames were used and selection of blocks and households were made based upon the TNH2H NHLBI-funded project (Main et al., 2012) in order to (1) select a sample of 250 households for face-to-face interviews with a randomly selected child in the targeted age group and their parent/primary caregiver, and (2) provide relevant neighborhood-level measures from this footprint on the built environments in five target neighborhoods. Multivariate analyses were performed to address study hypotheses and descriptive research questions, such as: How do neighborhood-level indicators vary across neighborhoods? How does childhood BMI and fitness vary across neighborhoods, families and individual factors?
Data Collector Selection and Training

Data collectors were initially recruited through the TNH2H advisory council and the Healthy Neighborhood Council. Subsequent additional data collectors also included Regis University doctoral physical therapist students and Johnson and Wales University students that lived in the study area. All data collectors were members of one of the target communities and attempts were made to have as many recruiters as possible that were Spanish speaking. All data collectors were required to attend a one-day training and practicum to ensure the safety and quality of data collection efforts (Appendix A). Specific protocols, scripts, interview techniques and exercise-testing methods were reviewed with each data collector during this training as well as discussions regarding issues that may come forward during the interview and fitness measures such as child apprehension or family or child refusal. All team members were required to have IRB and HIPAA training through COMIRB which covered informed consent. Team members were expected to complete the CITI online training and present a certificate from COMIRB prior to data collection. During the one-day training program the study protocol was explained in detail and informed consent and child assent were discussed. Data collectors also role played interactions and practiced consent process with their peers.

Prior to full-scale data collection all measures and methods were reviewed to enhance their comprehension, clarity, and community and cultural relevance. Because a percentage of our participants preferred to speak Spanish, all existing surveys and additional items such as consent and assent forms were translated in line with proposed guidelines on translation, back-translation, committee review, pre-testing and pilot-testing by a COMIRB approved translator (Guillemin, Bombardier, & Beaton, 1993; Hendricson et al., 1989).
The initial data collection teams were paired by male/female and one Spanish speaking member in each pair. This insured that the children were comfortable with a male or female and that if the household was Spanish speaking only, effective communication and recruitment occurred. All survey instruments including parent consent and child assent forms were made available in English and Spanish. All recruitment flyers were also in English and Spanish. A total of 23 different recruiters (6 male/17 female, 6 Spanish speaking) were used throughout the data collection period each working approximately 12 hours per week. Biweekly team meetings were held with the data collectors and other research team members to discuss recruitment strategies and share information and feedback on how the community involvement and data recruitment were proceeding.

Face-to-Face Interviews

Identifying household interview sample

Using the methods from the TNH2H project (Main et al., 2012) and data from the most recent US Census (2000) available at the time, all five neighborhoods adjacent to and including Stapleton were divided into their respective census tracts and block groups. Randomly selected blocks based on the number of blocks within each census tract or block group were selected for the household interview. Since Stapleton was a new neighborhood, and therefore 2000 Census data were not available, developer plans were used to replicate the same sampling methods as in the other neighborhoods and create block groups from the single Stapleton census tract. These same blocks ultimately selected in the TNH2H study were used as the “footprint” for this current research project with children in the same neighborhoods.

Specific blocks in the study area were sampled based upon the randomly selected blocks that were used previously (Main et al., 2012) which insured that the blocks selected for the household
survey also corresponded with blocks that were audited for environment purposes in the TNH2H study. Because households with children aged 10-14 were limited within the study area, a saturation sampling method was used to approach each house on the selected block vs. a random selection method or systematic selection method such as every 4th house on the block used in the TNH2H study. This insured a representative sample from the 5 neighborhoods of children between the ages of 10-14.

**Block Selection**

1. The goal of 50 households to be sampled per neighborhood was adjusted to represent the percentage of households with children ages 5-14 (account for growth from 2000 Census) that occur in that neighborhood within the entire study area.

**Table III.3 Neighborhoods and target goals**

<table>
<thead>
<tr>
<th>Neighborhood</th>
<th>Original Goal</th>
<th>% of residences in study area</th>
<th>Adjusted Goal</th>
<th>Census Tracts</th>
<th>Surveys completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>NE Park Hill</td>
<td>50</td>
<td>11.1</td>
<td>23</td>
<td>2</td>
<td>38</td>
</tr>
<tr>
<td>East Montclair</td>
<td>50</td>
<td>16.9</td>
<td>34</td>
<td>2</td>
<td>40</td>
</tr>
<tr>
<td>Northwest Aurora</td>
<td>50</td>
<td>40.0</td>
<td>81</td>
<td>6</td>
<td>98</td>
</tr>
<tr>
<td>Park Hill</td>
<td>50</td>
<td>31.9</td>
<td>65</td>
<td>4</td>
<td>52</td>
</tr>
<tr>
<td>Stapleton</td>
<td>50</td>
<td>*</td>
<td>48</td>
<td>1</td>
<td>28</td>
</tr>
</tbody>
</table>

The number of households to be sampled in each neighborhood was adjusted in each block group to represent the percentage of households that occur in that block group within the neighborhood. Census data were used to determine the population by census tract of children between the ages 10-14 which is the target sample for this study. As an example, based on those data the NE Park Hill neighborhood made up of two census tracts would have a child population of 260 in census
tract 41.01 and 411 in census tract 41.02. With a goal of surveying 23 children across the two census tracts each tract was adjusted by their 10-14 population and the target numbers for each census tract was determined. The number of block groups was based on the TNH2H audits performed previously along with the number of blocks within the study area for each census tract. The goals are the number of surveys for each census tract spread across the block groups.

NE Park Hill
41.01- 3 block groups- 21 blocks surveyed - survey goal 9
41.02- 4 block groups- 24 blocks surveyed - survey goal 14

East Montclair
44.03- 2 block groups- 40 blocks surveyed- survey goal 17
44.04- 2 block groups- 19 blocks surveyed- survey goal 17

Aurora
72.02 -2 block groups - 14 blocks surveyed - survey goal 18
73.00- 4 block groups -31 blocks surveyed - survey goal 9
74.00- 1 block group - 15 blocks surveyed - survey goal 11
78.00- 4 block groups- 33 blocks surveyed - survey goal 14
79.00- 4 block groups- 29 blocks surveyed - survey goal 16
80.00- 6 block groups- 34 blocks surveyed - survey goal 14

Gr. Park Hill
41.03- 6 block groups- 34 blocks surveyed - survey goal 18
41.04- 6 block groups- 33 blocks surveyed - survey goal 21
42.01- 6 block groups- 31 blocks surveyed - survey goal 15
42.02- 6 block groups- 30 blocks surveyed - survey goal 11

Stapleton
41.05- 4 block groups- 59 blocks surveyed - survey goal 48

2. Blocks in each block group were assigned to high- or low-density groups according to the number of households that were on that block to account for apartments. The original TNH2H project was not initially successful in recruiting participants in high density block groups due to the difficulty accessing apartment buildings. We continued to attempt to survey in these high density blocks in the same manner as the other blocks.
since children in the target age may live in apartments and their physical activity levels may be affected by the household factors in the survey. Working closely with apartment building managers allowed us access into high density buildings if they were on the selected block list.

3. Households were surveyed on each block until the number of blocks for each neighborhood was achieved, however this saturation may vary due to the possibility of a limited amount of homes with children in the targeted age range.

**Household Selection**

Once a block had been selected, households were selected using a saturation process. Since initial review of census data revealed a limited number of children in the target age group in these neighborhoods, it was felt sampling eligible households with children aged 10-14 might be a challenge. It was investigated to purchase a sample from a private marketing vendor (Genesys sampling) that would identify households with children within our randomly sampled blocks. This was done and it confirmed the limited number of children ages 10-14 in these neighborhoods and reinforced the plan to move to a saturation sampling method. Surveying continued until the required number of households on the block was reached, or there were no more households available on the block. In addition once a block was selected there was an attempt to recruit as many families as possible with children in the targeted age so families that were selected were asked which households on the block also have children ages 10-14. Since the block was randomly selected from the total sampling frame within the neighborhood, the selection of households within the block with children was actively recruited since the marketing lists tended to under represent the actual households with children. In addition flyers were
handed out at middle schools in the neighborhoods and at parks. These flyers just alerted families about the study and did not attempt to sign up families outside of their home. In addition data collectors also attended community events at parks, recreation centers and movie theaters to hand out flyers about the study.

Pairs of data collectors would walk the selected blocks carrying backpacks with all study materials including consent forms, data collection forms, surveys, scale, stadiometer, v-sit measuring device and foam pad. Each data collector had a picture ID badge identifying them as a data collector in the study that was associated with the University of Colorado. The team would knock on the door of each home on the selected block and follow the script in Appendix B. Once it was determined that the household was eligible and a parent with a child between the ages 10-14 were at home and willing to participate, the team met together with parent-child pairs to review the purpose of the study, describe the interview questions, the timeframe required to complete the interview and the child measures (no more than 30-40 minutes) and explain the incentive for participation ($10 gift card). The parents were then consented and the child assented (Appendix C). It was explained that participants may decline at any time before, during or after the survey. Any questions deemed sensitive by the respondent may be refused. Children may refuse to have themselves weighed or any fitness tests performed. At the conclusion of the interview and measures the parent and child were asked if they wish to participate further in future research projects. Phone numbers were collected for possible follow up studies or programs. Once the data was returned to the Stapleton 2040 office a $10.00 gift card was placed in the mail in the self-addressed envelope that was completed at the time of data collection.

As shown in Table III.5, age appropriate items/scales with established psychometric properties were used for most of the measures. Interviews with an index child and a parent were
conducted and included a series of questions for both children and their parents to address study objectives. Table III.4 below provides more detail of the content and scope of these interviews.

Column 1 and 2 in Table III.4 lists the items in the parent and the child surveys by group or category with appropriate citations for the validated source of the survey item. Column 3 lists the physical measures performed on the child and their reference. Height and weight were measured per protocol (Appendix D) using a Seca 217 stadiometer and a Seca Clara 803 digital scale. Fitness tests also followed strict protocol (Appendix D) following the President’s Challenge guidelines.

Currently the national recommendation is that children and adolescents “Engage in at least 60 minutes of physical activity on most, preferably all, days of the week” (CDC, 2006c). Whenever possible, child health questions from national surveys such as the National Survey of Children’s Health (van Dyck et al., 2004) the Colorado Child Health Survey (CDPHE, 2006) and the middle school version of the Centers for Disease Control and Prevention’s Youth Risk Behavior Surveillance Survey (CDC, 2007) were used. The parent interview used many of the same measures that were used in the TNH2H telephone survey such as BRFSS and other validated measures.

Data collectors turned in data sheets on a daily basis to the Stapleton 2040 office where data were then entered into a secure Microsoft Access™ data base. Hard copies of data forms were filed in a locked file cabinet organized by neighborhood, census tract and block group. The data set was then transferred to an Excel™ spreadsheet and imported into SAS® 9.3 for preliminary analysis and data cleaning. Frequencies were run on all survey responses and outliers were observed for possible data entry or coding errors. Missing data were appropriately coded or imputed, although this was minimal except in the area of household income where the refusal
and missing rate was close to 20%. No imputation of income was performed. Initial data cleaning was performed and ordinal scales were modified (reverse coding) so the level of responses (0-5) was consistent for directionality. Ordinal scales were maintained in the data set although certain survey questions were collapsed down to dichotomous responses for analysis and ease of presentation of descriptive data. These included variables such as how to get to school, # of PE days, meeting CDC physical activity guidelines and other child behaviors. Dummy variables were created for gender, race/ethnicity categories and reasons for walking in the neighborhood. Parent safety scores were presented as percent answered “yes” or “agree” in descriptive tables but as a continuous measure for regression models. Fitness outcome scores are continuous variables and were checked for normality. They were converted to percentiles using age and gender norms based on the President’s Challenge (2012) or the Texas Test-University of Texas, Austin (www.exrx.net/Calculators/VerticalJump.html)
Table III.4. Face-to-Face Interview with Index Child and Primary Caregiver (Appendix E)

<table>
<thead>
<tr>
<th>Parent Interview</th>
<th>Child Interview</th>
<th>Child physical strength and flexibility measures</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Health</strong>: Health Status, chronic health conditions (J. F. Sallis, 1999)</td>
<td><strong>Demographics</strong>: Age, sex, grade, race, school (CDC, 2007)</td>
<td>Health: BMI (height and weight); (CDC, 2006c)</td>
</tr>
<tr>
<td>Built environment use (Bedimo-Rung et al., 2005)</td>
<td><strong>Sedentary time</strong>: time watching television, computer time (CDC, 2006c, 2007)</td>
<td>Curl ups test</td>
</tr>
<tr>
<td>Child’s physical activity (J. F. Sallis, 1999)</td>
<td><strong>Neighborhood measures</strong>: Perceptions of safety, quality, amenities, availability/access, and friendliness (Bedimo-Rung, Gustat, Tompkins, Rice, &amp; Thompson, 2006)</td>
<td>V-Sit test</td>
</tr>
<tr>
<td><strong>Household equipment, resources</strong> (Roemmich et al., 2006; Trost et al., 2003)</td>
<td></td>
<td>Vertical jump</td>
</tr>
<tr>
<td><strong>Socio-economic characteristics</strong>, including: Household Income (CDC, 2006a)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Health care access</strong>: Health insurance, Usual source of care, Ability to Pay (CDPHE, 2006)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Socio-demographics</strong>, Education level (CDC, 2006a)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Neighborhood measures</strong>: Perceptions of safety, quality, amenities, availability/access, and friendliness (SPACES) (Pikora et al., 2002)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Collective Efficacy</strong>: social cohesion among neighbors; willingness to intervene on behalf of the common good (Earls, Brooks-Gunn, Raudenbush, &amp; Sampson, 1997; Gomez, Johnson, Selva, &amp; Sallis, 2004)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Secondary Data

Walking Audits

During the initial TNH2H project, objective measures of the built environment were collected on over 1000 blocks within the target neighborhoods (J. L. Hill, 2009). Walking audit data provide independent, objective indicators of several features of target neighborhoods including type and condition of housing or businesses, density, connectivity, land use mix, street and sidewalk width, activity friendliness, and aesthetic qualities. The audits were originally based on previously published reports such as The Systematic Pedestrian and Cycling Environmental Scan Instrument (SPACES) (McCormack, Masse, Bulsara, Pikora, & Giles-Corti, 2006; Moudon & Lee, 2003; Pikora et al., 2002; Pikora et al., 2006) but were adapted for the TNH2H study by Diane King and Jenny Hill (J. L. Hill, 2009). The audits were conducted from June 2007-October 2007 by trained auditors which included this author. Two days of training with field testing in the Capitol Hill neighborhood of Denver was performed prior to performing data collection and walking audits. Once the audits were performed inter-rater reliability was confirmed with kappa statistics greater than .70. Since the initial audit and data collection, these data were systematically reduced and scales were created to represent three environmental constructs according to recent literature (Steiner, et.al., in preparation). Audit items were assigned to one of the three conceptual areas (condition, safety and infrastructure) and mean scores for each census tract were used as an environmental score variable.

Census and Neighborhood Level Data

Census data were obtained for each of the neighborhoods, excluding Stapleton which had no data for the time period, from the 2000 U.S. Census. The 2000 U.S. Census data was used to create maps for each of the study neighborhoods by census tract, block group, and blocks. Other
variables available from the census include socio economic indicators (e.g. income, poverty, income inequality, educational attainment).

Other area-based data were obtained from the Piton Foundation (www.piton.org), which compiles data for Denver’s 77 neighborhoods based on the most recent available US Census data. These data include maps, graphs, neighborhood population and demographics (age, gender, and ethnicity/race), health status, median house price, median income, educational reports including school level data, and crime for each neighborhood. These data will be used to supplement the U.S. Census data when appropriate.

The Stapleton redevelopment project did not in exist during the 2000 U.S. Census. Therefore, population statistics, maps, and other data similar to that of the other neighborhoods were compiled utilizing data the developer tracks and other purchased data sets particular to that development. Replication of methods from the other neighborhoods was used to select approximate block group and block levels for data collection in the new Stapleton neighborhood. At the time of the collection of these data Stapleton was one single neighborhood and one census tract. Since that time the neighborhood has begun to sub divide into different neighborhoods as further development progresses.

Table III.5 below lists the specific variables in the study with the theory or construct being tested, the scale or measurement tool used and the scoring of the variable. Variables are divided into the two dependent variables, the independent predictor variables and the covariates. Multilevel regression models will be constructed using these variables as outcomes and predictors with appropriate coefficients calculated to determine the strength and significance of the main effects and if interaction is present.
<table>
<thead>
<tr>
<th>Dependent/Outcome Variables</th>
<th>Theory/Construct measured</th>
<th>Measure/Scale Used</th>
<th>Scoring/Variable type</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI/Obesity</td>
<td>Structuration Giddens, 1984 Freedman, 2009 Dietz, 2009</td>
<td>Measured Ht/Wt</td>
<td>Continuous-Calculated from height/weight, age and gender percentiles Categories- healthy, overweight, obese</td>
</tr>
<tr>
<td>Child Fitness measures</td>
<td>Structuration Giddens, 1984 Wingfield, 2011</td>
<td>President’s Challenge</td>
<td>Normative Scoring- Continuous Standardized age and gender percentiles</td>
</tr>
</tbody>
</table>

### Independent/ Predictor Variables

#### Census Tract level

- Built environment observed
  - Infrastructure
  - Condition
  - Safety
  

- Walking audit 3 Constructs- mean scores
  Summary score of items that include condition of housing/buildings, sidewalks, aesthetics, transportation, and others. Three separate scores

#### Household level

**Parental Influence**

- Parental Perceived Neighborhood Safety
  
  Parental Influence Model Weir, 2006 survey questions P17-23 Summary score- centered on mean for continuous measure

- # TVs, in home
  
  Parental Influence Model Roemmich, 2006 Survey question P39 Continuous

- # computers in home
  
  Parental Influence Model Roemmich, 2006 Survey question P40 Continuous

- Rules about TV
  
  Parental Influence Model Robinson, 1999 Survey K18 Dichotomous/Binary

- Rules about computer
  
  Parental Influence Model Robinson, 1999 Survey K19 Dichotomous/Binary

- Travel to school
  
  Parental Influence Model Timperio, 2004 Survey K5 Categorical

#### Anticipated Co-Variates

- Age /Child
  
  Parental Influence Model Kimiecik, 1996 Survey K1 YRBS, 2007 Categorical

- Child Race/ethnicity
  
  Parental Influence Model Kimiecik, 1996 Survey P55 YRBS, 2007 Categorical;

- Child Gender
  
  Parental Influence Model Kimiecik, 1996 Survey K2 YRBS, 2007 Dichotomous

- Household income
  
  Parental Influence Model Kimiecik, 1996 Survey P57 Categorical- ordinal

- Physical Activity levels
  
  Structuration Giddens, 1984 Wingfield, 2011 YRBS-2007 Number of days engaged in at least 60 minutes of moderate to vigorous physical activity (MVPA)

- Parents Educational Attainment
  
  Parental Influence Model Kimiecik, 1996 Survey P49 Categorical-ordinal

- Parents Marital Status
  
  Parental Influence Model Kimiecik, 1996 Survey P52 Categorical- nominal

YRBS- Youth Risk Behaviors Survey
BRAT- DO- Bedimo-Rung Assessment Tools-Direct Observation
Data Analysis Plan

Descriptive Analyses

Prior to addressing specific aims 1 and 2, the data were examined by neighborhood and census tract using frequencies, bivariate associations or simple linear regression models to report these predictor variables by the relevant covariates in Table 8. Means and SD were reported for interval data, medians, modes and ranges were reported for categorical, nominal, and skewed data. One way ANOVA was used for preliminary analysis of continuous data, $\chi^2$ for nominal categorical data and Kruskal-Wallis and Mann-Whitney for ordinal data. Aggregate scales for the predictor variables were constructed when appropriate such as for parent safety using multiple survey questions averages or summation. Cronbach’s alpha was computed as a measure of internal consistency of the various survey items and used to justify a composite score.

Multilevel Analysis

A generalized linear mixed models was used to account for the random effects of census tract along with the fixed effects of the predictors in this multilevel data (Littell, Miliken, Stroup, Wolfinger, & Schabenberger, 2006). According to Raudenbush and Bruk (Raudenbush & Bryk, 2002) this method will help account for the possible dependence between survey respondents leading to more accurate error estimates due to their proximity by living in similar neighborhoods or census tracts. Utilizing methods described by Subramanian, Jones, and Duncan (Subramanian, Jones, & Duncan, 2003) a two level model (children-households) within census tracts was constructed.

The two dependent variables, children’s BMI and physical fitness tests, were analyzed using separate mixed effects regression models controlling for the relevant covariates listed in Table III.5.
Predictor variables were added to the model based on literature using hierarchical modeling. ICCs were calculated and checked for the amount of between group (census tract) variance accounted for in the dependent variable. Assumptions for multiple regression were checked including; 1) normality of the DV, 2) a linear relationship of the IVs and DV, 3) no multicollinearity of the IVs. Variables were recoded or transformed using log transformation or centering to the mean, and predictors were combined or removed if assumptions were violated.

**Specific Aim 1**

To address specific aim 1 and hypothesis 1a and 1b, testing was performed for the main effect of the parental variables on the different outcomes via level 1 models. In the level 1 models, individual outcomes were modeled as a function of parental characteristics (fixed effects), such as sociodemographic variables (age, race, income, and marital status), parental perceived safety, # TVs, and computers and TV and computer use rules. The sociodemographic covariates were tested individually using bivariate correlations before being entered into the model. Significant correlations at .20 or greater was used as a criterion for inclusion as a covariate.

**Level 1 models**

\[
Y_{ij} (\text{BMI}) = \beta_{0j} + \beta_{1j} (\text{perceived safety})_{1ij} + \beta_{2j} (\text{child PA})_{2ij} + \beta_{3j} (\#TVs)_{3ij} + \beta_{4j} (\text{TV rules})_{4ij} + \beta_{5j} (\text{Age})_{5ij} + \beta_{6j} (\text{Gender})_{6ij} + \epsilon_{ij}
\]

\[
Y_{ij} (\text{Fitness}) = \beta_{0j} + \beta_{1j} (\text{perceived safety})_{1ij} + \beta_{2j} (\text{child PA})_{2ij} + \beta_{3j} (\#TVs)_{3ij} + \beta_{4j} (\text{TV rules})_{4ij} + \beta_{5j} (\text{Age})_{5ij} + \beta_{6j} (\text{Gender})_{6ij} + \epsilon_{ij}
\]

**Level 2 model**

In the next step a random effect (census tract) was added to the models above containing only parental level variables. The ICCs for children within census tracts with and without adjusting for individual level variables such as age, sex, family income, etc. were computed.
The census tract-level models specify the relationship between the census tract-level predictors (walking audit constructs) and the coefficients in the Level 1 model. Specifically, I am interested in $\beta_{0j}$, the predicted outcome of a child in neighborhood $j$, adjusted for parental level variables (Table III.5). These beta values are inserted into the level 1 model to account for the environment effect.

$$
\beta_{0j} = \gamma_{00} + \gamma_{01} \text{ (built environment var)} + u_{0j}
$$

$$
\beta_{1j} = \gamma_{10}
$$

$$
\beta_{2j} = \gamma_{20}
$$

Thus, for a standardized model, $\gamma_{00}$ is the overall (adjusted) mean, $\gamma_{01}$ represents the main effect of built environment on the outcome, $\gamma_{11}$ represents the main effect of perceived safety on the outcome, and $\gamma_{11}$ represents the main effect # computers on the outcome. The census tract-level random effect, $u_{0j}$, reflects the between-census tract variance and is the difference in between the mean for the $j$th census tract and the predicted mean based on the model, and $u_{0j} \sim \text{N}(0, \tau_{00})$. These coefficients will give me the main effects of the parental variables and the environmental variables.

I will determine which outcome has a more direct effect with the parental and environment variables by looking at the p-values, confidence intervals, GOF statistics, and the ICC changes of the various models.

**Test for Moderation Specific Aim 2; H2a, 2b and 2c**

After testing each of the main effects of the built environment and the parental influence on the BMI and fitness outcome variables separately using a general linear model, it was determined which outcome was a stronger fit with the predictor variables. The predictor variables were then tested together in the model to measure their unique contribution and then
finally tested for interaction between the environmental variables and the parental variables in order to see if the parental variables moderate the effect of the built environment on child outcomes of BMI and fitness (Baron & Kenny, 1986; Kraemer, Stice, Kazdin, Offord, & Kupfer, 2001; Kraemer, Wilson, Fairburn, & Agras, 2002). This involves adding the parental perceived safety x built environment term to the model above (mixed model notation).

H1b the hypothesis of moderation of the environment by the parents is tested by:

\[ H_0: \gamma_{11} = 0 \text{ vs. } H_1: \gamma_{11} \neq 0 \]

where \( \gamma_{11} \) represents the main effect environmental variables (walking audits).

There are 5 neighborhoods, 15 census tracts, 60 block groups and 447 blocks represented in the sample. Because the target sample size was 250 and there will not be enough individual households for analysis at the block or block group level, the upper level of analysis was performed at the census tract level. This choice gave more specific environmental scores which were more closely aligned to the household than the neighborhood level score. Walking audit scores were collected at the block level and aggregated up to the census tract level and neighborhood level. Because a recent study had failed to find an association between neighborhood characteristics and physical activity in children and adolescents (McDonald et al., 2012), the conventional definition of neighborhood may be a concern and using a more specific geographic locale such as census tract in this case was warranted. Assuming an equal split of predictors across the census tracts, a medium effect size for changes in the dependent variable would be approximately .35-.50 SD. To attain 80% power over 3 predictors a sample size of 240 would be required.
CHAPTER IV

RESULTS

Height and weight were measured on all children in the study with only three children refusing to have their weight measured giving accurate BMI on 253 of the 256 respondents. BMI was converted from a raw score to an age and sex adjusted percentile and children were also placed in categories of: underweight, healthy weight, overweight and obese according to CDC guidelines (Kuczmarski, 2002). The continuous percentile was used as an outcome in multilevel models.

Data from the TNH2H study walking audits were used as a level two predictor. The variables underwent rigorous scale construction by the authors of the TNH2H study (Steiner et al., in preparation) in order to develop summary scores in three separate conceptual areas of the built environment related to active transport. These conceptual areas consisted of safety, condition and infrastructure. Safety variables capture actual and perceived safety indicators such as bars on windows, neighborhood watch signs, traffic volume and permanent obstructions on the sidewalks interfering with walking. Condition variables measure the impact on use and activity by looking at the amount of graffiti or litter, broken windows, abandoned houses, sidewalk and alley condition and the overall condition of buildings, homes, grounds and yards. Infrastructure variables represent features such as parks and other opportunities for physical activity, homes with front porches and size of front borders (hedges and/or fences), presence of mixed used buildings or non-residential destinations, condition of bus or train stops, size and types of sidewalks and whether there were contiguous walking routes and bike lanes on the street. A higher value indicated a more supportive built environment for active transport. Each census tract and neighborhood had a mean score of the items reduced from the initial data
collection performed by trained auditors and then aggregated up from the initial data collection at
the block level.

**Sampling and Recruitment**

A total of 447 blocks were walked by the recruiters in 15 census tracts across the 5
neighborhoods. 256 paired (parent and child, 512 total) completed surveys have been entered
into the Access™ data base. Figure IV.1 below demonstrates the overall recruitment pattern of
the study. A total of 8749 homes were initially touched with 4594 homes where actual contact
was made through the first attempt door to door recruitment process during June – Sept 2008. An
additional 617 households (including 112 from the first round) were contacted through the
second attempts for a total of 5099 households contacted by data collectors/recruiters. Reasons
for no contact included an abandoned home, empty lot, no one home, dangerous dog or no
solicitation sign. Those homes where contact was made, many were ineligible for the study (n= 4026) because a child between the ages of 10-14 did not live in the home. There were 136
refusals in the first contact attempt and 15 in the second go back attempts. In addition there were
challenges with recruiting due to loss of daylight hours in the afternoon once school began in the
fall and the competition with after school activities. Weekend recruitment was a challenge as
well due to families not being home or involved in other out of the home activities in the summer
and early fall. Based on the final number of households that were eligible for the study (n=535)
the overall participation rate was 48% (256/535) with a refusal rate of 28% (151/535) of those
households considered eligible for the study.
Figure IV.1 Sampling and Recruitment Plan

8749 Houses touched

4155 no contact

4594 Contact made

112 come back

456 Eligible

28 Missing

62 No parent

25 No child

205 Surveys

4026 Ineligible

136 Refused

4267 No contact from first round

3650 no contact

617 Contact

6 come back

79 eligible

532 ineligible

256 Total Surveys

535 eligible

48% response rate

51 surveys

15 refused

10 No parent

1 no child

2 missing
Table IV.1 lists the number of surveys collected in each neighborhood and census tract. These were unbalanced groups with an average number across census tracts of 17 with a minimum of 5 in one census tract and a maximum of 30. Multilevel analysis does not assume equal group size and experimental simulations performed have shown no discernible effect on the ML multilevel estimates or standard errors (Maas & Hox, 2005). These census tracts and block groups, as well as the randomly selected blocks from which these households were selected, all coincide with the blocks assessed in the environmental audit performed in the initial TNH2H study and allowed analysis between the households in this survey and the neighborhood and census tract environmental audit data.

Table IV.1 Neighborhoods, census tracts and number of survey pairs in each

<table>
<thead>
<tr>
<th>Neighborhood</th>
<th>Census Tract</th>
<th>Number of household surveys (subject pairs) collected</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Montclair</td>
<td>44.03</td>
<td>21</td>
</tr>
<tr>
<td>(2 census tracts, 3 block groups)</td>
<td>44.04</td>
<td>19</td>
</tr>
<tr>
<td>NE Park Hill</td>
<td>41.01</td>
<td>8</td>
</tr>
<tr>
<td>(2 census tracts, 6 block groups)</td>
<td>41.02</td>
<td>30</td>
</tr>
<tr>
<td>Northwest Aurora</td>
<td>72.02</td>
<td>17</td>
</tr>
<tr>
<td>(6 census tracts, 17 block groups)</td>
<td>73.00</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>74.00</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>78.00</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>79.00</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>80.00</td>
<td>15</td>
</tr>
<tr>
<td>Park Hill</td>
<td>41.03</td>
<td>19</td>
</tr>
<tr>
<td>(4 census tracts, 15 block groups)</td>
<td>41.04</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>42.01</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>42.02</td>
<td>5</td>
</tr>
<tr>
<td>Stapleton</td>
<td>41.05</td>
<td>28</td>
</tr>
<tr>
<td>(1 census tract, 4 block groups)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Descriptive Results

Descriptive statistics were computed to describe household characteristics by neighborhood and census tract. Distribution by census tract is listed in tables in the appendix. Mean and standard deviations along with frequencies describe the variables. ANOVA and appropriate post hoc tests were used to test differences between neighborhoods and census tracts of continuous variables, for categorical variables chi-square and other appropriate non parametric tests were used. Simple linear regression measured the relationship between independent and dependent variables. Significant differences in variables observed at the neighborhood level usually persisted at the census tract level unless otherwise noted. This was mostly true in all areas except the Greater Park Hill neighborhood where the census tracts divided the neighborhood into two distinct areas by north and south and the characteristics in the northern census tracts of Greater Park Hill mimicked the adjacent neighborhood of NE Park Hill more than the southern Greater Park Hill census tracts.

Demographic characteristics of the parent and child are listed below in Table IV.2. Study participant’s demographics are listed for parents and children separately. Significant differences between neighborhoods and census tracts did exist for parental demographics. Parent’s age $F(4,250)=8.17, p<.0001$, H.S. Education ($\chi^2(4, N = 256) = 81.39, p < .0001$), and marital status ($\chi^2(4, N = 255) = 19.85, p < .001$) were significantly different across neighborhoods and census tracts. One hundred percent of the parents in Stapleton had at least a high school degree while only 32% of the parents in East Montclair had a high school degree. The overall sample average was 65%. The city of Denver boasts itself as having the highest percentage of high school graduates of any metropolitan area in the US at 92.1%. The US national average is 81.7% for individuals with high school diplomas (US Census).
Overall the average age of the children in the study was 11.7, 49% were female, 44% identified as Hispanic, 28% African American/Black and 20% White NH. Seventy-five percent had health care coverage with 39% of those with health coverage reported being on Medicaid or SCHIP. Fifty-eight percent of parents reported that their children had a personal family physician, physician assistant or nurse who knew their child. Children’s age as a mean across groups (neighborhood or census tract) or as a categorical variable was not significantly different. The sample was slightly weighted toward the younger age groups. Gender was not significantly different between the neighborhoods or census tracts however racial differences did exist across neighborhoods. This was also true when race was collapsed to a dichotomous variable of White NH or not ($\chi^2(4, N = 256) = 81.75, p < .0001$). The demographic differences across the five neighborhoods were more evident between Stapleton and Greater Park Hill vs. Aurora, East Montclair and NE Park Hill. Stapleton and Greater Park Hill parents were slightly older, had higher income and higher education level than the other three neighborhoods in this sample. NE Park Hill that had the lowest married rate also had the lowest income rates above $50,000.00 (close to Denver city median) and highest below $20,000 (close to US FPL for family of four). Eighty percent of the parents interviewed in this sample were female with no significant differences noted across neighborhoods ($\chi^2(4, N = 256) = 4.4, p = .359$). However this may demonstrate in this sample the concern over the disproportionately high poverty rates of single mothers in the US (US Census, 2010). Sixteen percent of the sample declined to answer the income question. This was similar to the reported 17% in the TNH2H study (J. L. Hill, 2009). Seventy-eight percent of the refusals were in the three lower income neighborhoods leading to the possibility that the total sample income levels in the study are lower than actually reported.
Table IV.2 Parent and child sample demographics by neighborhood

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Total Sample N=256</th>
<th>NW Aurora N=98</th>
<th>East Montclair N=40</th>
<th>NE Park Hill N=38</th>
<th>G Park Hill N=52</th>
<th>Stapleton N=28</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parents</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age mean(SD)</td>
<td>40(10.6)</td>
<td>36(10.1)</td>
<td>39(8.5)</td>
<td>39(13.3)</td>
<td>45(9.7)</td>
<td>45(6.7)</td>
</tr>
<tr>
<td>Female</td>
<td>80%(204)</td>
<td>85%(83)</td>
<td>73%(29)</td>
<td>84%(32)</td>
<td>75%(39)</td>
<td>75%(21)</td>
</tr>
<tr>
<td>Income</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below $20,000</td>
<td>38%(78)</td>
<td>43%(33)</td>
<td>61%(23)</td>
<td>71%(15)</td>
<td>13%(6)</td>
<td>4%(1)</td>
</tr>
<tr>
<td>Above $50,000</td>
<td>31%(63)</td>
<td>13%(10)</td>
<td>8%(3)</td>
<td>10%(2)</td>
<td>58%(26)</td>
<td>85%(22)</td>
</tr>
<tr>
<td>H.S. Education</td>
<td>65%(166)</td>
<td>32%(31)</td>
<td>75%(30)</td>
<td>84%(32)</td>
<td>87%(45)</td>
<td>100%(28)</td>
</tr>
<tr>
<td>Married</td>
<td>65%(166)</td>
<td>70%(69)</td>
<td>65%(26)</td>
<td>34%(13)</td>
<td>75%(39)</td>
<td>68%(19)</td>
</tr>
<tr>
<td><strong>Children</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age mean(SD)</td>
<td>11.7(1.5)</td>
<td>11.7(1.5)</td>
<td>11.9(1.4)</td>
<td>11.7(1.4)</td>
<td>11.8(1.5)</td>
<td>11.5(1.3)</td>
</tr>
<tr>
<td>Age Group</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 year old</td>
<td>30%(78)</td>
<td>34%(33)</td>
<td>25%(10)</td>
<td>26%(10)</td>
<td>31%(16)</td>
<td>32%(9)</td>
</tr>
<tr>
<td>11 year old</td>
<td>17%(44)</td>
<td>16%(16)</td>
<td>15%(6)</td>
<td>29%(11)</td>
<td>13%(7)</td>
<td>14%(4)</td>
</tr>
<tr>
<td>12 year old</td>
<td>18%(45)</td>
<td>12%(12)</td>
<td>23%(9)</td>
<td>13%(5)</td>
<td>21%(11)</td>
<td>29%(8)</td>
</tr>
<tr>
<td>13 year old</td>
<td>20%(50)</td>
<td>20%(20)</td>
<td>25%(10)</td>
<td>16%(6)</td>
<td>17%(9)</td>
<td>18%(5)</td>
</tr>
<tr>
<td>14 year old</td>
<td>15%(39)</td>
<td>17%(17)</td>
<td>15%(5)</td>
<td>16%(18)</td>
<td>17%(9)</td>
<td>7%(2)</td>
</tr>
<tr>
<td>Males</td>
<td>51%(131)</td>
<td>51%(50)</td>
<td>48%(19)</td>
<td>47%(18)</td>
<td>56%(29)</td>
<td>54%(15)</td>
</tr>
<tr>
<td>Race/ethnicity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White NH</td>
<td>20%(52)</td>
<td>3%(3)</td>
<td>10%(4)</td>
<td>8%(3)</td>
<td>44%(23)</td>
<td>68%(19)</td>
</tr>
<tr>
<td>Black NH</td>
<td>28%(72)</td>
<td>10%(10)</td>
<td>38%(15)</td>
<td>63%(24)</td>
<td>29%(15)</td>
<td>29%(8)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>44%(113)</td>
<td>84%(82)</td>
<td>30%(12)</td>
<td>26%(10)</td>
<td>17%(9)</td>
<td>0%(0)</td>
</tr>
</tbody>
</table>

Frequency p-values=$\chi^2$

Means(SD) p-values = ANOVA

Means(SD) p-values = ANOVA
Figure IV.2 graphically displays the BMI of 253 participants in the study by category and gender. The overweight and obese categories were combined for simplicity since they were equal in the totals and demonstrate the more clearly the severity of the problem with children being either overweight or obese. Males tend to be slightly heavier but not significantly different even when age is controlled CMH (1, 253=2.68, \( p = .44 \))

![BMI categories graph](image)

**Figure IV.2 BMI categories of 253 study participants (p=0.4 gender)**

**Percentiles adjusted for age and gender based on CDC definitions**

Table IV.3 shows the outcome measures for this study on the 256 children. BMI is reported as an age and gender adjusted percentile with a sample mean of 61 and SD of 30. The sample is heavily skewed toward the high end with almost 25% over the 90\(^{th}\) percentile and only 5% below the 10\(^{th}\) percentile. Over 30% of the sample is in the overweight and obese categories defined as equal or above the 85\(^{th}\) percentile. Twenty-three of the 253 children in the sample fall at or above the 97\(^{th}\) percentile (highest BMI cut point for CDC) accounting for over 9% of the
sample. National data reveal 11.9 percent of children between ages 2-19 were at or above the 97th percentile (Ogden, JAMA 2010).

Table IV.3- outcome measures by Neighborhood

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Total Sample N=253</th>
<th>NW Aurora N=97</th>
<th>East Montclair N=38</th>
<th>NE Park Hill N=38</th>
<th>G.Park Hill N=52</th>
<th>Stapleton N=28</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BMI</strong> mean(SD)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Underweight</td>
<td>61(30)</td>
<td>70(27)</td>
<td>66(29)</td>
<td>58(34)</td>
<td>52(29)</td>
<td>46(26)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Healthy</td>
<td>64(163)</td>
<td>59(57)</td>
<td>58(22)</td>
<td>55(21)</td>
<td>77(40)</td>
<td>82(23)</td>
<td>.002</td>
</tr>
<tr>
<td>Overweight</td>
<td>15(39)</td>
<td>16(15)</td>
<td>18(7)</td>
<td>21(8)</td>
<td>10(5)</td>
<td>14(4)</td>
<td></td>
</tr>
<tr>
<td>Obese</td>
<td>15(39)</td>
<td>26(25)</td>
<td>16(6)</td>
<td>10.5(4)</td>
<td>7.7(4)</td>
<td>0(0)</td>
<td></td>
</tr>
<tr>
<td>BMI overweight/obese</td>
<td>31(78)</td>
<td>41(40)</td>
<td>34(13)</td>
<td>32(12)</td>
<td>17(9)</td>
<td>14(4)</td>
<td>.01</td>
</tr>
<tr>
<td><strong>Fitness Measures</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V-sit percentile mean(SD)</td>
<td>47.0(31)</td>
<td>39.2(27.5)</td>
<td>66.3(33.2)</td>
<td>52.7(28)</td>
<td>40.2(31)</td>
<td>51.8(33)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Curl ups percentile mean(SD)</td>
<td>28.7(26)</td>
<td>20.6(22)</td>
<td>24.5(29)</td>
<td>33.8(25)</td>
<td>36.8(26)</td>
<td>40.9(26)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Vertical Jump percentile</td>
<td>37.3(30)</td>
<td>33.1(28)</td>
<td>35.7(27)</td>
<td>29.3(30)</td>
<td>48.7(33)</td>
<td>43.6(29)</td>
<td>&lt;.01</td>
</tr>
</tbody>
</table>

Neighborhood differences are noted with once again Stapleton and Greater Park Hill showing differences in this outcome as compared to the other three neighborhoods F(4,248)=5.87, p<.001. No obese children were observed in Stapleton with only 7.7% in Greater Park Hill, half of the total 5 neighborhood rate. The children shown in Figure IV.3 in the overweight/obese category in Stapleton were all overweight, but not obese.
Fitness measures were taken on all children. Initial raw scores prior to conversion to percentiles all showed significant differences by age (Curl up $F(4,251)=7.42, p<.0001$) Vertical Jump $F(4,250)=5.91, p<.0001$ except V-sit $F(4, 241)=1.08, p=.37$ and all by gender (Curl Up $F(1,254)=24.88, p<.0001$) V-sit $F(1,254)=23.61, p<.0001$, Vertical Jump $F(1,253)=8.30, p=.004$. As expected males had consistently higher mean scores than females and mean scores increased with age for males and females although the gender differences were less apparent when the child was younger; Curl Up $F(3, 252)=17.95, p<.0001$, Vertical Jump $F(3, 251)=9.87, p<.0001$, V-Sit $F(3, 252)=10.64, p<.0001$, (with interaction terms). The figures below demonstrate the effect on the fitness measures by age and gender and justified the decision to
convert these measures to age and gender percentiles. These models show the interaction between age and gender and that the effect of gender increases for older children.

**Figure IV.4 Regression Plot for Curl ups**
Figure IV.5 Regression Plot for Vertical Jump
Due to these observed gender age interactions raw scores were converted to age and gender percentiles based on norms for the V-Sit and Curl ups by the President’s Challenge and for the Vertical Jump by the Texas Test at the University of Texas, Austin. For Curl up the 50th percentile scores for an 11 year old are 37 for boys and 32 for girls. To be ranked in the 85th percentile an 11 year old boy must complete 47 curl ups, and a girl must complete 42. For the V-sit the 50th percentile scores for an 11 year old are 1 inch for boys and 3 inches for girls. The 85th percentile score for 11-year-old boy is 4 inches and 6.5 inches for a girl. For the Vertical
Jump the 50th percentile for an 11 year old boy is 12.1 inches, for a girl it is 10.5 inches. The 85th percentile for an 11 year old boy is 14.7 inches and for a girl 12.9 inches.

Once these scores were converted gender differences as expected disappeared across all age groups for all fitness measures Curl Up F(1,254)=.03, p =.87, V-Sit F(1,253)=.05, p =.83 and Vertical Jump F(1,254)=1.81, p =.18. Differences between neighborhoods and census tracts persisted and were significant for V-Sit F (4,250) = 6.99, p<.001, Curl ups F(4,251) = 6.34, p<.001 and Vertical Jump F(4,251) =3.46, p<.01 once converted to a percentile. Stapleton and Greater Park Hill had the highest scores for Curl ups percentile and Vertical Jump percentile but not for V-Sit percentile.

All outcome variables were tested for normality. Raw scores demonstrate better normality with similarity in mean, median and mode along with low skewness and kurtosis values. GOF tests for normal distribution such as the Kolmogorov-Smirnov test were not significant. Once the outcome variables were converted to percentiles, BMI percentile, V-sit percentile, Vertical Jump percentile and Curl Up percentile had heavy tails and a flattened pattern secondary to the nature of the percentile distribution and may violate normality assumptions. Data were checked for coding errors and extreme outliers ( >95th percentile) were reduced to the highest value at 90th percentile and models were rechecked. Since the effect of outliers was no longer a problem due to the nature of the percentile conversion, fitness data at the percentile level was kept intact as initially reported so as not to lose data for analysis.

Safety perception of the parents is hypothesized to be a primary predictor variable based on the Family Influence Model. Table IV.4 describes the differences in these predictor variables across neighborhoods. Parents perception of safety, a key predictor variable was tested in the models as a composite scale (safety sum) based on the literature supporting the development of
these questions (Gomez et al., 2004; Weir et al., 2006). The variable was then centered on its mean for inclusion in the multilevel models for ease of interpretation of the intercept. These items were checked for internal consistency prior to formulating the composite scale ($\alpha=.87$). The safety sum term was significantly different across neighborhoods $F(4, 249) = 30.16, p < .0001$ and census tracts $F(14, 239) = 11.60, p < .0001$. Parents in the neighborhoods of Stapleton and Greater Park Hill reported higher levels of safety as compared to the other neighborhoods across all items including safety issues related to gangs $\chi^2(4, N = 256) = 79.99, p < .0001$, traffic $\chi^2(4, N = 256) = 26.37, p < .0001$, and crime $\chi^2(4, N = 256) = 30.82, p < .0001$. There were no parents in Stapleton in this sample that reported feeling unsafe outdoors, fear about gangs or concern about the crime rate while fear about gangs rose as high as 80% in NW Aurora. While child safety perceptions were also significantly different across neighborhoods $\chi^2(4, N = 256) = 32.25, p < .0001$, children’s perception of safety was significantly less than the parents based on comparison of means and confidence intervals ($p = .05$) on survey responses. This was true regardless of the age of the child $\chi^2(4, N = 90) = 1.92, p = .75$. Girls (48%) had a higher percentage than boys (40%) that felt unsafe although the differences were not significant $\chi^2(1, N = 256) = 1.48, p = .22$. There were no significant differences noted between gender for safety perception when age was controlled (CMH (1, N=256)= 0.86, $p = .35$).

A number of interesting findings were related to the parental perceptions of safety data. Parents of minority children felt less safe outside than parents of white children $\chi^2 (1, N = 253) = 8.64, p = .003$. Parents of girls did not feel differently than parents of boys $\chi^2(4, N = 254) = 1.85, p = .76$ and the differences were not present across age groups $\chi^2(4, N = 253) = 3.03, p = .55$. Children’s safety responses also differed by neighborhood $\chi^2(4, N = 256) = 32.25, p = <.0001$. Only 4% of children in Stapleton felt unsafe playing outdoors while this rose as high as 60% in
East Montclair. Overall there were no differences noted by age \( \chi^2(4, N = 256) = 1.91, \ p = .75 \) or gender \( \chi^2(4, N = 256) = 1.48, \ p = .22 \). White children responded that they felt more safe than the minority children while playing outdoors \( \chi^2 (1, N = 256) = 10.69, \ p < .01 \). This difference between white children and minority children did not differ by gender (CMH(1, N=256)=1.4705, \ p = .23) or age group (CMH (4, N=256)= 1.5257, \ p = .82). Ninety-four percent of parents in households with income greater than $50,000 reported feeling safe outdoors as compared to 73% of parents in households with income below $50,000 \( \chi^2 (1, N = 203) = .9.81, \ p < .01 \).

**Table IV.4 - Parent Safety responses**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total Sample N=254</th>
<th>NW Aurora N=97</th>
<th>East Montclair N=40</th>
<th>NE Park Hill N=38</th>
<th>Gr. Park Hill N=52</th>
<th>Stapleton N=27</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parent Safety Items</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Don’t feel safe outside</td>
<td>22%(56)</td>
<td>38%(36)</td>
<td>28%(11)</td>
<td>24%(9)</td>
<td>0%(0)</td>
<td>0%(0)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Worry about gangs if my child plays outdoors</td>
<td>49%(126)</td>
<td>80%(78)</td>
<td>45%(18)</td>
<td>50%(19)</td>
<td>21%(11)</td>
<td>0%(0)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Worry my child will be hurt by other children</td>
<td>34%(87)</td>
<td>61%(60)</td>
<td>23%(9)</td>
<td>26%(10)</td>
<td>14%(7)</td>
<td>4%(1)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Safe place to play outside</td>
<td>74%(186)</td>
<td>60%(57)</td>
<td>74%(30)</td>
<td>76%(29)</td>
<td>84%(44)</td>
<td>100%(27)</td>
<td>.0002</td>
</tr>
<tr>
<td>Letting my children outside is dangerous</td>
<td>34%(87)</td>
<td>47%(46)</td>
<td>45%(18)</td>
<td>39%(15)</td>
<td>16%(8)</td>
<td>0%(0)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Too much traffic</td>
<td>37%(94)</td>
<td>46%(45)</td>
<td>53%(21)</td>
<td>42%(16)</td>
<td>21%(11)</td>
<td>4%(1)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Crime rate makes it unsafe</td>
<td>31%(78)</td>
<td>50%(48)</td>
<td>24%(10)</td>
<td>17%(7)</td>
<td>9%(5)</td>
<td>0%(0)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Composite safety score (7 items 1-4 likert)</td>
<td>19.1(4.6)</td>
<td>16.8(3.6)</td>
<td>18.1(3.8)</td>
<td>18.3(5)</td>
<td>22.1(3.5)</td>
<td>24.2(2.6)</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>

Table IV.5 lists the self-reported child behaviors including how they travel to school, reasons for walking in the neighborhood, helmet and seat belt use and physical activity level. Physical activity level is reported as a continuous variable that was used as a covariate in
predictive models and also as a dichotomous variable as either meeting or not meeting CDC guidelines. Seventy–three percent of children report that they walk in their neighborhood to go to a friend’s house. This was not significantly different between neighborhoods $\chi^2(4, N = 256) = 2.53, p = .64$ or census tracts $\chi^2(14, N = 256) = 15.60, p = .34$. Seventy-one percent of children did report they walked in their neighborhood to a park or recreation center although significant differences did exist at the neighborhood level $\chi^2(4, N = 256) = 26.25, p < .0001$ and census tract level $\chi^2(14, N = 256) = 32.15, p < .01$. Significant differences exist between neighborhoods in all other areas in Table 13 except seat belt use which was extremely high in all neighborhoods and census tracts. One census tract in NE Park Hill had a 90% seat belt use and one census tract in NW Aurora had a 91% use rate. Twelve of the fifteen census tracts had 100% of the children report at least sometimes wearing a seat belt with 5 of the 12 census tracts having 100% responding most of the time. Eighty-nine percent of the children in the sample wear a seat belt most of the time, 73% always. This compares to bike helmet use of 27% at least most of the time and only 20% always. This behavior differed across neighborhoods $\chi^2(4, N = 256) = 34.59, p < .0001$, and census tracts $\chi^2(14, N = 256) = 48.55, p < .0001$.

Most children travel by car to school (Figure IV.7) which was the highest in all neighborhoods except East Montclair where bus travel was the highest. Differences were significant between neighborhoods in how children travel to school as noted in Figure IV.8 below.
Figure IV.7 - How children travel to school for the entire sample

Figure IV.8 - How kids get to school by neighborhood
Children were asked how many days/wk. they participated in physical education (PE) in school. Eleven percent of children, distributed across all neighborhoods, reported not participating in PE at all during the previous year. Only 52% said they had PE in school 3 days or more with significant differences across neighborhoods $\chi^2(4, N=246) = 18.44, p=.001$ and census tracts $\chi^2(14, N=246) = 27.67, p=.02$. Nationally only 41% of 9th grade students and 24% of 12th grade students participate in PE five days per week (CDC, 2011). Only 35% percent of children in this sample reported PE in school 5 days per week. Mean values for number of days a child was physically active were not significantly different across neighborhoods $F(4,247)=1.05, p=.38$ or census tracts $F(14,247)=1.33, p=.19$.

### Table IV.5 Self Report Child Health Behaviors by Neighborhood

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total Sample</th>
<th>NW Aurora</th>
<th>East Montclair</th>
<th>NE Park Hill</th>
<th>Gr. Park Hill</th>
<th>Stapleton</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N=256</td>
<td>N=98</td>
<td>N=40</td>
<td>N=38</td>
<td>N=52</td>
<td>N=28</td>
<td></td>
</tr>
<tr>
<td>Travel to School</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walk</td>
<td>23%(59)</td>
<td>38%(37)</td>
<td>5%(2)</td>
<td>30%(11)</td>
<td>6%(3)</td>
<td>22%(6)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Bike</td>
<td>4%(10)</td>
<td>2%(2)</td>
<td>5%(2)</td>
<td>3%(1)</td>
<td>0%(0)</td>
<td>19%(5)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Car</td>
<td>47%(119)</td>
<td>50%(49)</td>
<td>21%(8)</td>
<td>41%(15)</td>
<td>67%(34)</td>
<td>48%(13)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Bus</td>
<td>25%(64)</td>
<td>10%(10)</td>
<td>69%(27)</td>
<td>27%(10)</td>
<td>27%(14)</td>
<td>11%(3)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Walk to friend’s house</td>
<td>73%(187)</td>
<td>70%(69)</td>
<td>68%(26)</td>
<td>82%(31)</td>
<td>75%(39)</td>
<td>75%(21)</td>
<td>NS</td>
</tr>
<tr>
<td>Walk to a park or recreation center</td>
<td>71%(181)</td>
<td>68%(67)</td>
<td>43%(17)</td>
<td>92%(35)</td>
<td>75%(39)</td>
<td>82%</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Wears a Bike Helmet</td>
<td>41%(104)</td>
<td>23%(22)</td>
<td>38%(15)</td>
<td>34%(13)</td>
<td>65%(34)</td>
<td>68%(19)</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Wears a Seat Belt</td>
<td>98%(251)</td>
<td>98%(96)</td>
<td>100%(40)</td>
<td>92%(35)</td>
<td>100%(52)</td>
<td>100%(28)</td>
<td>NS</td>
</tr>
<tr>
<td>Participated in PE 3 days or more</td>
<td>52%(133)</td>
<td>47%(46)</td>
<td>55%(22)</td>
<td>74%(28)</td>
<td>58%(30)</td>
<td>22%(6)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Physically Active 60min/day for 5 days</td>
<td>55%(141)</td>
<td>53%(52)</td>
<td>50%(20)</td>
<td>61%(23)</td>
<td>60%(31)</td>
<td>54%(15)</td>
<td>NS</td>
</tr>
<tr>
<td>Physical Activity 60 min MVPA Days</td>
<td>5.7(2.2)</td>
<td>5.6(2.2)</td>
<td>5.2(2.4)</td>
<td>6.0(2.4)</td>
<td>6.0(2.0)</td>
<td>5.5(1.8)</td>
<td>NS</td>
</tr>
</tbody>
</table>

Frequency- p-values= $\chi^2$ Means(SD) p-values= ANOVA

% (n)
A number of variables were postulated based on the Family Influence Model to be associated with physical activity and BMI or Fitness level. This included the variables listed below in Table IV.6.

Screen time has been shown to be associated with obesity in children (Laurson et al., 2008). The number of TVs or computers in a home along with rules about how much TV or computer use is allowed may impact children’s physical activity and subsequently BMI and fitness level (Henderson, 2007; T. N. Robinson, 1999). Rules about TV or computer use were not significantly different across neighborhoods or census tracts as was the number of TVs in a household. This number varied from 0-12 with a mean of 3.1. The number of computers varied from 0-7 with a mean of 1.4. The number of TVs was not significantly different across neighborhoods $F(4, 255) =2.22, p=.067$ however the number of computers in each household while small, was different across neighborhoods $F(4, 255) =22.31 p<.0001$. Post hoc analysis reveals differences between Stapleton and the other neighborhoods and Greater Park Hill and the other neighborhoods. Stapleton and Greater Park Hill were not different from each other. The number of TVs in a home had a negligible correlation with the amount of physical activity a child had in a week ($r(252)=-0.125, p=.05$) while the number of computers was not correlated with physical activity ($r(252)= 0.017, p =.80$).

The amount of TV/video time was re-coded to a measure of greater or equal to 2 hours per day per American Academy of Pediatrics national guidelines (AAP, 2001). This amount of screen time did not differ across neighborhoods when measured on weekends $\chi^2(4, N = 253) = 3.29, p =.52$, but did differ significantly between neighborhoods on weekdays $\chi^2(4, N = 251) = 24.63, p <.0001$. The same pattern was true at the census tract level for weekends $\chi^2(4, N = 253) = 10.55, p =.72$ and for weekdays $\chi^2(4, N = 251) = 33.96, p =.002$. 
The measure of the built environment was derived from variables collected during the TNH2H study walking audits. As previously described (Steiner, in preparation), three separate and unique concepts were derived from the audit data. The mean score for each neighborhood is listed in Table IV.7 for each conceptual area; condition, safety and infrastructure. Mean scores for each census tract that were used for the multilevel models are listed in Table IV.8. Significant differences exist across neighborhoods and census tracts for each variable. Stapleton remains the highest score for each concept with Greater Park Hill being second for each. Greater Park Hill had the greatest amount of disparity of scores within its neighborhood when observing the census tract scores. There is a natural divide within Greater Park Hill separating the neighborhood north and south where the northern census tracts behave similar to the NE Park Hill neighborhood in
built environment scores as well as income and safety issues. Stapleton remains the most homogenous of the neighborhoods in all areas measured or observed.

Walk condition and walk safety were strongly correlated $r(15) = 0.89, p = .001$, walk condition and walk infrastructure were not correlated $r(15) = .53, p = .02$, and walk safety and walk infrastructure were not correlated $r(15) = .22, p = .42$. Due to the correlation observed as well as the fact that these were defined as three separate constructs regarding built environment features that support active transport, the decision was made to model all three walk variables in separate models. Walk condition had range of values and greatest variation (SD) with the greatest disparity between Stapleton and other neighborhoods and census tracts as compared to walk safety and walk infrastructure. Stapleton had the highest scores in all concepts at the neighborhood level. However in the area of infrastructure there were a number of census tracts with higher scores than the Stapleton census tract. The condition concept looked at the condition of the sidewalks (cracks, broken, weeds), amount of litter and condition of homes and yards. Stapleton, being a brand new neighborhood with overall new construction, would have the highest scores in this area even above the safety and infrastructure concepts with the smallest standard deviation indicating less variance within the neighborhood itself. The Stapleton neighborhood was comprised of a single census tract with 4 block groups.

Table IV.7  Mean (SD) Walking Audit scores by Neighborhood

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total Sample</th>
<th>NW Aurora</th>
<th>East Montclair</th>
<th>NE Park Hill</th>
<th>Gr. Park Hill</th>
<th>Stapleton</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Built Environment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walking Condition mean(SD)</td>
<td>7.44(2.58)</td>
<td>5.33(.59)</td>
<td>6.34(.54)</td>
<td>6.14(.32)</td>
<td>8.16(7.55)</td>
<td>11.71(.14)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Walking Safety mean(SD)</td>
<td>3.76(1.17)</td>
<td>2.78(.32)</td>
<td>3.40(.09)</td>
<td>3.37(.17)</td>
<td>3.93(.65)</td>
<td>5.64(.11)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Walking Infrastructure mean(SD)</td>
<td>7.70(.97)</td>
<td>7.67(.81)</td>
<td>7.35(.49)</td>
<td>7.22(1.0)</td>
<td>7.54(.58)</td>
<td>8.04(.24)</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>

P values =ANOVA
Table IV.8  Mean (SD) Walking Audit scores by Census Tract (N=15)

<table>
<thead>
<tr>
<th>Variable</th>
<th>72.02 (23)</th>
<th>73</th>
<th>74</th>
<th>78</th>
<th>79</th>
<th>80</th>
<th>44.03 (48)</th>
<th>44.04 (1.08)</th>
<th>41.01 (1.16)</th>
<th>41.02 (1.04)</th>
<th>41.03 (2.14)</th>
<th>42.01 (1.91)</th>
<th>42.02 (1.47)</th>
<th>41.05 (1.14)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walk Condition</td>
<td>5.15 (.23)</td>
<td>5.65 (.55)</td>
<td>5.50 (0)</td>
<td>4.14 (.32)</td>
<td>5.53 (.93)</td>
<td>6.03 (.37)</td>
<td>5.84 (.48)</td>
<td>6.84 (1.08)</td>
<td>5.54 (.38)</td>
<td>6.30 (.52)</td>
<td>8.14 (1.16)</td>
<td>7.55 (1.04)</td>
<td>9.10 (1.91)</td>
<td>8.77 (1.47)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Walk Safety</td>
<td>2.41 (.61)</td>
<td>2.89 (.38)</td>
<td>3.33 (0)</td>
<td>2.35 (.27)</td>
<td>2.87 (.50)</td>
<td>3.01 (.43)</td>
<td>3.49 (.10)</td>
<td>3.70 (.41)</td>
<td>3.28 (.79)</td>
<td>4.39 (.52)</td>
<td>3.31 (.46)</td>
<td>4.93 (.16)</td>
<td>3.67 (.35)</td>
<td>5.64 (.11)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Walk Infrastructure</td>
<td>7.08 (.12)</td>
<td>9.00 (.28)</td>
<td>7.83 (0)</td>
<td>8.35 (.35)</td>
<td>7.19 (.64)</td>
<td>6.69 (.09)</td>
<td>7.82 (1.07)</td>
<td>6.84 (.44)</td>
<td>7.42 (1.04)</td>
<td>7.17 (.23)</td>
<td>7.31 (.76)</td>
<td>7.09 (.81)</td>
<td>8.55 (.10)</td>
<td>8.31 (1.96)</td>
<td>8.04 (.24)</td>
</tr>
</tbody>
</table>

Color of census tracts correspond to neighborhoods in other tables.

Prior to analysis the four outcome variables were checked for intercorrelation. Table IV.9 shows the inter-correlations of the four outcome variables and physical activity level which were included in the analysis as a possible mediator of the effect between the predictors and the outcomes. Physical activity was not significantly correlated with any of the outcome variables. BMI percentile, a measure of weight adjusted for height is different than the other three fitness measures. The curl up, a measure of core strength and the vertical jump, a measure of leg strength did negatively correlate with BMI while V-sit, a measure of growth and flexibility appears not to correlate with any of the measures. This inverse relationship between BMI and fitness measures is consistent with previous study (J. F. Sallis, McKenzie, & Alcaraz, 1993; Serdula et al., 1993), however the literature is equivocal about the relationship between strength and flexibility especially in male children (Kim et al., 2005). Studies in the past have included a battery of tests to measure child fitness and using these as a composite score. Recent studies have called into question the value of using so many tests and if they in fact measure different constructs (Dumith, Van Dusen, & Kohl, 2012). It was decided based on initial correlations and literature review to keep these outcomes separate and evaluate their relationship between the
environmental predictors separately. According to Cohen (J. Cohen, 1988) the significant
correlations between BMI and the strength measures are low or weak and therefore these can be
considered as separate and distinct outcomes.

Table IV.9
Inter-correlations for BMI, Curl ups, Vertical Jump, V-sit (N=256)

<table>
<thead>
<tr>
<th>Variable</th>
<th>BMI</th>
<th>Curl Up</th>
<th>Vertical Jump</th>
<th>V-Sit</th>
<th>PA Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. BMI percentile</td>
<td>-</td>
<td>-.19*</td>
<td>-.21**</td>
<td>.04</td>
<td>-.02</td>
</tr>
<tr>
<td>2. Curl Up percentile</td>
<td>-</td>
<td>-</td>
<td>.17*</td>
<td>.10</td>
<td>.02</td>
</tr>
<tr>
<td>3. Vertical Jump</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>.09</td>
<td>.12</td>
</tr>
<tr>
<td>percentile</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. V-Sit percentile</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>.04</td>
</tr>
<tr>
<td>5. PA levels</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

* p < .01, ** p <.001

Table IV.10 demonstrates inter correlations between the various predictor variables and the
outcomes as well as with each other. Correlations between predictors above .70 can lead to
multicollinearity while correlations below .20 between predictor and outcomes may not support
the assumption of a linear relationship (Portney & Watkins, 2000). BMI percentile has negative
correlations with parent and child safety which means that as the safety perception goes up BMI
goes down. This follows based on my theoretical model ((A. Kelly-Schwartz, Stockard, J.,
Doyle, S., & Schlossberg, M, 2004; Kimiecik et al., 1996)) that an increase in safety perception
is associated with more physical activity leading to lower BMI. BMI is positively associated with
TV time consistent with the literature (Laurson et al., 2008). BMI is negatively correlated with
walk condition and walk safety yet has no correlation with walk infrastructure. Curl up and
Vertical Jump, both strength measures show positive correlations with the safety measures,
negative correlation with TV time and positive correlation with walk condition and walk safety.
Once again no correlation was present between the outcome variables and walk infrastructure. Walk condition and walk safety were highly correlated and were not included in predictive models together due to multicollinearity. V-sit percentile, a measure of flexibility did not correlate with any of the predictors.

### Table IV.10
**Means, Standard Deviations, and Inter-correlations for BMI, Curl ups, Vertical Jump, V-sit and Predictor Variables (N=256)**

<table>
<thead>
<tr>
<th>Variable</th>
<th>M</th>
<th>SD</th>
<th>PA levels</th>
<th>Parent Safety</th>
<th>TV Time</th>
<th>Walk Condition</th>
<th>Walk safety</th>
<th>Walk Infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outcome variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI percentile</td>
<td>61</td>
<td>30</td>
<td>-0.02</td>
<td>-0.14*</td>
<td>0.18*</td>
<td>-0.30***</td>
<td>-0.28***</td>
<td>-0.03</td>
</tr>
<tr>
<td>Curl Up percentile</td>
<td>28.7</td>
<td>25.9</td>
<td>0.02</td>
<td>0.19**</td>
<td>-0.12*</td>
<td>0.25***</td>
<td>-0.25***</td>
<td>-0.02</td>
</tr>
<tr>
<td>Vertical Jump percentile</td>
<td>37.3</td>
<td>30.0</td>
<td>0.12</td>
<td>0.11</td>
<td>-0.09</td>
<td>0.18**</td>
<td>0.19**</td>
<td>-0.11</td>
</tr>
<tr>
<td>V-Sit percentile</td>
<td>47.0</td>
<td>31.1</td>
<td>0.04</td>
<td>-0.03</td>
<td>-0.08</td>
<td>0.05</td>
<td>0.09</td>
<td>-0.03</td>
</tr>
<tr>
<td><strong>Predictor variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. PA levels</td>
<td>5.7</td>
<td>2.2</td>
<td>-</td>
<td>-0.04</td>
<td>-0.08</td>
<td>0.01</td>
<td>0.04</td>
<td>0.01</td>
</tr>
<tr>
<td>2. Parent Safety</td>
<td>19.1</td>
<td>4.60</td>
<td>-</td>
<td>-</td>
<td>-0.16*</td>
<td>0.57***</td>
<td>0.53***</td>
<td>-0.002</td>
</tr>
<tr>
<td>3. TV time-weekdays</td>
<td>140.9</td>
<td>126.9</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-0.29***</td>
<td>-0.27***</td>
<td>-0.12</td>
</tr>
<tr>
<td>4. Walk Condition</td>
<td>7.44</td>
<td>2.57</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td>0.89***</td>
</tr>
<tr>
<td>5. Walk Safety</td>
<td>3.76</td>
<td>1.17</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td>0.22</td>
</tr>
<tr>
<td>6. Walk Infra</td>
<td>7.70</td>
<td>0.97</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p < .05, ** p < .01, *** p < .001
Results for the unconditional models for each outcome are listed in Table IV.11. The Intraclass (intra-census tract) correlation (ICC), defined as the ratio of the between census tract variability/ (within census tract variability plus between census tract variability), demonstrate the proportion of the variance explained by the grouping structure of the population (Hox, 2002). According to Kreft & de Leeuw (Kreft & de Leeuw, 1998) if intraclass correlation exists (ICC >.05) then the traditional linear model must be abandoned because the assumption of independent observations has been violated. All ICC values are greater than .05 justifying the use of the mixed multilevel model using a random intercept. The design effect (1+[average cluster size-1] *[ICC) originally defined by Kish (1995) is considered small if it has a value of less than 2. This is further justification of the importance of multilevel analysis and helps determine the effective sample size ((Bickel, 2007; Li, Fisher, Brownson, & Bosworth, 2005). 8.1% of the variability in BMI percentile measured on the children was attributable to between census tract differences, with slightly less at 6.6% for curl up, 6.8 % for V-Sit and 17.7% for Vertical Jump. ICC values for vertical jump scores were higher in all models. This was because when Vertical Jump scores were converted to percentiles the actual exact percentile was available by formula. Curl up and V-Sit percentiles were only available in categories of 5 percentiles off of charts.
### Table IV.11 - Unconditional Models for the four outcomes

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Variance Component Estimate</th>
<th>SE</th>
<th>p</th>
<th>Unconditional ICC</th>
<th>Design Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BMI percentile (n=253)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between-Census Tract Variance</td>
<td>73.52</td>
<td>48.44</td>
<td>.06</td>
<td>.081</td>
<td>2.296</td>
</tr>
<tr>
<td>Within-Census Tract Variance</td>
<td>836.07</td>
<td>76.77</td>
<td>&lt;.0001</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Curl Ups percentile (n=256)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between-Census Tract Variance</td>
<td>44.14</td>
<td>28.63</td>
<td>.06</td>
<td>.066</td>
<td>2.056</td>
</tr>
<tr>
<td>Within-Census Tract Variance</td>
<td>621.96</td>
<td>56.42</td>
<td>&lt;.0001</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>V-sit percentile (n=255)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between-Census Tract Variance</td>
<td>65.21</td>
<td>42.94</td>
<td>.06</td>
<td>.068</td>
<td>2.088</td>
</tr>
<tr>
<td>Within-Census Tract Variance</td>
<td>898.73</td>
<td>81.79</td>
<td>&lt;.0001</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Vertical Jump percentile (n=256)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between-Census Tract Variance</td>
<td>161.41</td>
<td>79.14</td>
<td>.02</td>
<td>.177</td>
<td>3.832</td>
</tr>
<tr>
<td>Within-Census Tract Variance</td>
<td>750.45</td>
<td>68.44</td>
<td>&lt;.0001</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Tables IV.12-15 below are the unadjusted and adjusted parameter estimates for each predictor variable of interest modeled independently for each outcome. *Walk condition* and *walk safety* were significant predictors of BMI percentile and Curl Up percentile, TV time on weekdays was significant predictor of BMI percentile and parent safety was significant of Curl Up, while child safety was a significant predictor of Vertical Jump. There were no independent variables
significantly associated with the V-Sit test as an outcome. Estimates in Table 20 for BMI percentile with walk condition and walk safety were calculated using a fixed effects model with the General Linear Model in SAS without a random effect. All other variable estimates were calculated using a mixed model in SAS with a random effect.

Table IV.12
Unadjusted and adjusted multilevel analyses for BMI percentile N=253
Unconditional ICC=.081

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>SE</th>
<th>p</th>
<th>ICC</th>
<th>Estimate</th>
<th>SE</th>
<th>p</th>
<th>ICC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walk Cond</td>
<td>-4.39</td>
<td>0.88</td>
<td>&lt;.0001</td>
<td>**</td>
<td>-4.44</td>
<td>0.88</td>
<td>&lt;.0001</td>
<td>**</td>
</tr>
<tr>
<td>Intercept</td>
<td>91.28</td>
<td>6.36</td>
<td>&lt;.0001</td>
<td></td>
<td>90.25</td>
<td>6.66</td>
<td>&lt;.0001</td>
<td></td>
</tr>
<tr>
<td>Walk Infra</td>
<td>-1.96</td>
<td>4.4</td>
<td>.67</td>
<td>.087</td>
<td>-2.44</td>
<td>4.58</td>
<td>.60</td>
<td>.088</td>
</tr>
<tr>
<td>Intercept</td>
<td>75.60</td>
<td>33.9</td>
<td>.04</td>
<td></td>
<td>85.56</td>
<td>38.6</td>
<td>.05</td>
<td></td>
</tr>
<tr>
<td>Walk Safety</td>
<td>-9.12</td>
<td>1.94</td>
<td>&lt;.0001</td>
<td>**</td>
<td>-9.27</td>
<td>1.95</td>
<td>&lt;.0001</td>
<td>**</td>
</tr>
<tr>
<td>Intercept</td>
<td>93.07</td>
<td>7.08</td>
<td>&lt;.0001</td>
<td></td>
<td>91.91</td>
<td>7.29</td>
<td>&lt;.0001</td>
<td></td>
</tr>
<tr>
<td>Parent Safety</td>
<td>-.41</td>
<td>.45</td>
<td>.36</td>
<td>.058</td>
<td>-0.24</td>
<td>.46</td>
<td>.60</td>
<td>.066</td>
</tr>
<tr>
<td>Intercept</td>
<td>68.39</td>
<td>8.92</td>
<td>&lt;.0001</td>
<td></td>
<td>75.65</td>
<td>17.5</td>
<td>&lt;.001</td>
<td></td>
</tr>
<tr>
<td>TV Time</td>
<td>.034</td>
<td>.015</td>
<td>.03</td>
<td>.060</td>
<td>.034</td>
<td>.016</td>
<td>.03</td>
<td>.071</td>
</tr>
<tr>
<td>Intercept</td>
<td>56.08</td>
<td>3.41</td>
<td>&lt;.0001</td>
<td></td>
<td>69.71</td>
<td>15.50</td>
<td>&lt;.001</td>
<td></td>
</tr>
<tr>
<td># of TVs</td>
<td>.40</td>
<td>1.18</td>
<td>.74</td>
<td>.080</td>
<td>.13</td>
<td>1.2</td>
<td>.91</td>
<td>.089</td>
</tr>
<tr>
<td># of computers</td>
<td>-2.01</td>
<td>1.60</td>
<td>.21</td>
<td>.058</td>
<td>-2.0</td>
<td>3.8</td>
<td>.59</td>
<td>.065</td>
</tr>
<tr>
<td>Travel to school</td>
<td>4.30</td>
<td>4.28</td>
<td>.32</td>
<td>.072</td>
<td>4.38</td>
<td>4.31</td>
<td>.31</td>
<td>.080</td>
</tr>
</tbody>
</table>

*Individual covariates controlled for: child gender, child age and child physical activity. **GLM used without random effect instead of mixed model
### Table IV.13
Unadjusted and adjusted multilevel analyses for Curl up percentile N=256  Unconditional ICC=.066

<table>
<thead>
<tr>
<th>Variable</th>
<th>Unadjusted Estimate</th>
<th>SE</th>
<th>p</th>
<th>ICC</th>
<th>Adjusted* Estimate</th>
<th>SE</th>
<th>p</th>
<th>ICC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walk Cond</td>
<td>3.24</td>
<td>.86</td>
<td>.002</td>
<td>.012</td>
<td>3.25</td>
<td>.86</td>
<td>.002</td>
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<td>.066</td>
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<td>.013</td>
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<td>.03</td>
<td>.031</td>
<td>.81</td>
<td>.37</td>
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<td>.032</td>
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<td>7.33</td>
<td>.10</td>
<td></td>
<td>8.99</td>
<td>14.8</td>
<td>.55</td>
<td></td>
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<td>TV Time</td>
<td>-.02</td>
<td>.01</td>
<td>.14</td>
<td>.049</td>
<td>-.02</td>
<td>.01</td>
<td>.12</td>
<td>.049</td>
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<td># of TVs</td>
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<td>.067</td>
<td>-.05</td>
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<td>.96</td>
<td>.067</td>
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<tr>
<td># of computers</td>
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<td>1.31</td>
<td>.01</td>
<td>.023</td>
<td>3.99</td>
<td>1.32</td>
<td>.01</td>
<td>.022</td>
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*Individual covariates controlled for: child gender, child age and child physical activity.

### Table IV.14
Unadjusted and adjusted multilevel analyses for Vertical Jump percentile N=256  Unconditional ICC=.177

<table>
<thead>
<tr>
<th>Variable</th>
<th>Unadjusted Estimate</th>
<th>SE</th>
<th>p</th>
<th>ICC</th>
<th>Adjusted* Estimate</th>
<th>SE</th>
<th>p</th>
<th>ICC</th>
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<td>1.8</td>
<td>.09</td>
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<td>12.6</td>
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<td>.145</td>
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<td>19.3</td>
<td>.11</td>
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<tr>
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<td>.167</td>
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<td>5.6</td>
<td>.46</td>
<td>.172</td>
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<tr>
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<td>14.1</td>
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<td>.145</td>
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<td>20.5</td>
<td>.13</td>
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<td>.74</td>
<td>.184</td>
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<td>55.40</td>
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</table>

*Individual covariates controlled for: child gender, child age and child physical activity.
Table IV.15
Unadjusted and adjusted multilevel analyses for V-Sit percentile N=256

Unconditional ICC=.068

<table>
<thead>
<tr>
<th>Variable</th>
<th>Unadjusted Estimate</th>
<th>SE</th>
<th>p</th>
<th>ICC</th>
<th>Adjusted* Estimate</th>
<th>SE</th>
<th>p</th>
<th>ICC</th>
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<td>0.76</td>
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<td>.067</td>
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<td>10.3</td>
<td>.002</td>
<td></td>
<td>27.9</td>
<td>19.0</td>
<td>.17</td>
<td></td>
</tr>
<tr>
<td>Walk Infra</td>
<td>-1.21</td>
<td>4.4</td>
<td>.78</td>
<td>.067</td>
<td>-0.97</td>
<td>4.4</td>
<td>.83</td>
<td>.069</td>
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<td>3.1</td>
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<td>.061</td>
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<td>.37</td>
<td>.063</td>
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<td>19.6</td>
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<tr>
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<td>-.34</td>
<td>.47</td>
<td>.46</td>
<td>.074</td>
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<td>&lt;.0001</td>
<td></td>
<td>39.1</td>
<td>18.1</td>
<td>.05</td>
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</tr>
<tr>
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<td>.02</td>
<td>.43</td>
<td>.063</td>
<td>-0.01</td>
<td>.02</td>
<td>.35</td>
<td>.064</td>
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<td>33.68</td>
<td>16.17</td>
<td>.05</td>
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</tbody>
</table>

*Individual covariates controlled for: child gender, child age and child physical activity.

Hypothesis Testing:

H1a: The age and gender adjusted percentile scores for Fitness measures will have a stronger relationship with the built environment than BMI age and gender percentile, as evident by a model with 1) smaller p values; 2) larger t-statistic.

To test Hypothesis H1a three sets of four models (1a1a-1a4a, 1a1b-1a4b, 1a1c-1a4c) were created to see if BMI or the fitness measures had a stronger relationship with the various built environment variables. Each outcome variable was regressed on walk condition, walk safety and walk infrastructure in separate models controlling for the age and gender of the child and the child physical activity level. When running the mixed models for BMI the conditional ICC went to essentially zero and the G matrix was not positive definite. This showed that virtually all of the between census tract variance had been explained by the walk condition variable and a random effect was not needed to control for that variance. Therefore for the
models with BMI percentile as an outcome, a standard general linear model without a random effect was used versus a mixed model. The value of the $t$ statistic was compared between each outcome. For walk condition the highest $t$ score value absolute value and smallest $p$-value was for BMI over all three fitness measures. Curl Up was significant but a lower $t$ score was present. The negative parameter estimate for BMI is expected as a higher level of walking condition, safety or infrastructure is associated with a lower BMI while Curl up varies positively with walking condition, safety and infrastructure.

**Table IV.16 Model 1a1a.**

*BMI percentile N=253* Since the between census tract variance has been explained by walk_cond for BMI, Proc GLM was used for a model without a random effect.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>SE</th>
<th>$t$ Value</th>
<th>$p$</th>
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</thead>
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<td>3.67</td>
<td>.56</td>
<td>.58</td>
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<tr>
<td>C-Age</td>
<td>-.53</td>
<td>1.26</td>
<td>-.42</td>
<td>.67</td>
</tr>
<tr>
<td>CPhysical Activity</td>
<td>-.17</td>
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<td>-.20</td>
<td>.84</td>
</tr>
<tr>
<td>CWalk Cond</td>
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<td><strong>0.89</strong></td>
<td><strong>-5.00</strong></td>
<td><strong>&lt;.0001</strong></td>
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</tbody>
</table>

$R^2 = .095$

$F(4,248)= 6.41, p <.0001$

**Table IV.17 Model 1a2a**

*Curl up percentile N=256* Random Effects model

<table>
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<th>Variable</th>
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<th>SE</th>
<th>$t$ Value</th>
<th>$p$</th>
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<td>3.22</td>
<td>.60</td>
<td>.56</td>
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<tr>
<td>C-Age</td>
<td>.58</td>
<td>1.09</td>
<td>.60</td>
<td>.56</td>
</tr>
<tr>
<td>CPhysical Activity</td>
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<td>.73</td>
<td>.45</td>
<td>.65</td>
</tr>
<tr>
<td>CWalk Cond</td>
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<td><strong>3.69</strong></td>
<td><strong>.003</strong></td>
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</table>

-2LogLikelihood 2338.4
### Table IV.18 Model 1a3a

*Vertical Jump percentile N=256 Random Effects model*

<table>
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<th>SE</th>
<th>t Value</th>
<th>p</th>
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<td>9.17</td>
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<td>3.54</td>
<td>1.44</td>
<td>.17</td>
</tr>
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<td>C-Age</td>
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<td>1.21</td>
<td>-1.24</td>
<td>.21</td>
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<td>CPhysical Activity</td>
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<td>.81</td>
<td>1.68</td>
<td>.09</td>
</tr>
<tr>
<td><strong>CWalk Cond</strong></td>
<td><strong>3.36</strong></td>
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<td><strong>1.89</strong></td>
<td><strong>.08</strong></td>
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<tr>
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### Table IV.19 Model 1a4a

*V-sit percentile N=255 Random Effects model*

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<th>p</th>
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<td>3.91</td>
<td>.07</td>
<td>.95</td>
</tr>
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<td>C-Age</td>
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<td>1.33</td>
<td>.91</td>
<td>.37</td>
</tr>
<tr>
<td>CPhysical Activity</td>
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<td>.89</td>
<td>.67</td>
<td>.50</td>
</tr>
<tr>
<td><strong>CWalk Cond</strong></td>
<td><strong>.76</strong></td>
<td><strong>1.47</strong></td>
<td><strong>.52</strong></td>
<td><strong>.61</strong></td>
</tr>
<tr>
<td>-2LogLikelihood</td>
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<td></td>
<td></td>
</tr>
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</table>

### Table IV.20 Model 1a5a

*Physical Activity N=252 Random Effects model*

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<th>t Value</th>
<th>p</th>
</tr>
</thead>
<tbody>
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<td>28.61</td>
<td>&lt;.0001</td>
</tr>
<tr>
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<td>-2.68</td>
<td>.02</td>
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<td>.68</td>
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<tr>
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</tbody>
</table>
A similar pattern was evident for *walk safety* as was *walk condition*. Once again virtually all of the between census tract variance in BMI was explained by walk safety so a general linear model was used instead of a mixed model. BMI had the highest absolute *t*-values of all of the outcomes.

**Table IV.21 Model 1a1b.**

*BMI percentile N=253 Since the between census tract variance has been explained by walk safety for BMI, Proc GLM was used for a model without a random effect for BMI percentile.*

<table>
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<td>.54</td>
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<tr>
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<td>1.27</td>
<td>-.54</td>
<td>.59</td>
</tr>
<tr>
<td>CPhysical Activity</td>
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<td>-.05</td>
<td>.96</td>
</tr>
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<td><strong>1.95</strong></td>
<td><strong>-4.74</strong></td>
<td><strong>&lt;.0001</strong></td>
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</table>

*R² = .086  
F(4,248)= 5.77, *p* <.001*

**Table IV.22 Model 1a2b**

*Curl up percentile N=256 Random Effects model*

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<th>Estimate</th>
<th>SE</th>
<th><em>t</em> Value</th>
<th><em>p</em></th>
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</thead>
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<td>.45</td>
<td>.66</td>
</tr>
<tr>
<td>C-Age</td>
<td>.60</td>
<td>1.09</td>
<td>.55</td>
<td>.58</td>
</tr>
<tr>
<td>CPhysical Activity</td>
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<td>.33</td>
<td>.74</td>
</tr>
<tr>
<td><strong>CWalk Safety</strong></td>
<td><strong>6.83</strong></td>
<td><strong>1.92</strong></td>
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<td><strong>.003</strong></td>
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<tr>
<td>-2LogLikelihood</td>
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</tbody>
</table>
Table IV.23 Model 1a3b

*Vertical Jump percentile N=256 Random Effects model*

<table>
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<th>t Value</th>
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</thead>
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<td>.10</td>
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Table IV.24 Model 1a4b

*V-sit percentile N=255 Random Effects model*

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<td>.91</td>
<td>.38</td>
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<tr>
<td>C-Age</td>
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<td>.89</td>
<td>.64</td>
<td>.52</td>
</tr>
<tr>
<td><strong>CWalk Safety</strong></td>
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<td><strong>3.07</strong></td>
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<td><strong>.38</strong></td>
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</table>

Table IV.25 Model 1a5b

*Physical Activity N=252 Random Effects model*

<table>
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<tbody>
<tr>
<td>Intercept</td>
<td>6.03</td>
<td>.21</td>
<td>28.73</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Female</td>
<td>-.74</td>
<td>.27</td>
<td>-2.69</td>
<td>.02</td>
</tr>
<tr>
<td>C-Age</td>
<td>-.04</td>
<td>.09</td>
<td>-.41</td>
<td>.69</td>
</tr>
<tr>
<td><strong>CWalk Safety</strong></td>
<td><strong>.11</strong></td>
<td><strong>.18</strong></td>
<td><strong>.62</strong></td>
<td><strong>.55</strong></td>
</tr>
<tr>
<td>-2LogLikelihood</td>
<td>1104.2</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
There was no association between walk infrastructure and any of the outcomes including physical activity.

Table IV.26 Model 1a1c.

*BMI percentile N=253*

<table>
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<th>t Value</th>
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</tr>
</thead>
<tbody>
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<td>60.25</td>
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<td>22.35</td>
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<tr>
<td>Female</td>
<td>1.84</td>
<td>3.94</td>
<td>.47</td>
<td>.64</td>
</tr>
<tr>
<td>C-Age</td>
<td>-.66</td>
<td>1.33</td>
<td>-.49</td>
<td>.62</td>
</tr>
<tr>
<td>CPhysical Activity</td>
<td>-.19</td>
<td>.88</td>
<td>-.22</td>
<td>.83</td>
</tr>
<tr>
<td><strong>CWalk Infra</strong></td>
<td><strong>-1.96</strong></td>
<td><strong>3.03</strong></td>
<td><strong>-.65</strong></td>
<td><strong>.52</strong></td>
</tr>
</tbody>
</table>

-2LogLikelihood 2432.2

Table IV.27 Model 1a2c

*Curl up percentile N=256*

<table>
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<tr>
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<th>SE</th>
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<th>p</th>
</tr>
</thead>
<tbody>
<tr>
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<td>27.63</td>
<td>2.87</td>
<td>9.63</td>
<td>. &lt;.0001</td>
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<tr>
<td>Female</td>
<td>1.76</td>
<td>3.24</td>
<td>.54</td>
<td>.59</td>
</tr>
<tr>
<td>C-Age</td>
<td>.48</td>
<td>1.11</td>
<td>.43</td>
<td>.66</td>
</tr>
<tr>
<td>CPhysical Activity</td>
<td>.36</td>
<td>.74</td>
<td>.48</td>
<td>.63</td>
</tr>
<tr>
<td><strong>CWalk Infra</strong></td>
<td><strong>.32</strong></td>
<td><strong>3.65</strong></td>
<td><strong>.09</strong></td>
<td><strong>.93</strong></td>
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</tbody>
</table>

-2LogLikelihood 2348.1
### Table IV.28 Model 1a3c

*Vertical Jump percentile N=255*

<table>
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<tr>
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<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>35.20</td>
<td>4.07</td>
<td>8.66</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Female</td>
<td>4.90</td>
<td>3.54</td>
<td>1.38</td>
<td>.19</td>
</tr>
<tr>
<td>C-Age</td>
<td>-1.58</td>
<td>1.21</td>
<td>-1.30</td>
<td>.19</td>
</tr>
<tr>
<td>CPhysical Activity</td>
<td>1.36</td>
<td>.81</td>
<td>1.67</td>
<td>.10</td>
</tr>
<tr>
<td>CWalk Infra</td>
<td>-4.05</td>
<td>5.56</td>
<td>-0.73</td>
<td>.48</td>
</tr>
<tr>
<td>-2LogLikelihood</td>
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</table>

### Table IV.29 Model 1a4c

*V-sit percentile N=256*

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</thead>
<tbody>
<tr>
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<td>3.41</td>
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<td>&lt;.0001</td>
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<tr>
<td>Female</td>
<td>.20</td>
<td>3.91</td>
<td>.05</td>
<td>.96</td>
</tr>
<tr>
<td>C-Age</td>
<td>1.17</td>
<td>1.33</td>
<td>.88</td>
<td>.38</td>
</tr>
<tr>
<td>CPhysical Activity</td>
<td>.61</td>
<td>.89</td>
<td>.68</td>
<td>.50</td>
</tr>
<tr>
<td>CWalk Infra</td>
<td>-1.49</td>
<td>4.31</td>
<td>-.35</td>
<td>.74</td>
</tr>
<tr>
<td>-2LogLikelihood</td>
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### Table IV.30 Model 1a5c

*Physical Activity N=252  Random Effects model*

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</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>6.04</td>
<td>.21</td>
<td>28.56</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Female</td>
<td>-.73</td>
<td>.27</td>
<td>-2.68</td>
<td>.02</td>
</tr>
<tr>
<td>C-Age</td>
<td>-.04</td>
<td>.09</td>
<td>-.39</td>
<td>.70</td>
</tr>
<tr>
<td>CWalk Infra</td>
<td>.56</td>
<td>.25</td>
<td>.22</td>
<td>.82</td>
</tr>
<tr>
<td>-2LogLikelihood</td>
<td>1104.5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
These data do not support hypothesis 1a. Fitness measures do not have a stronger relationship with the built environment predictors than BMI. The models indicated that walking condition $F(3,249)= 8.36, p < .0001$ and walking safety $F(3,249)= 7.58, p < .0001$ at the census tract level were significantly negatively associated with BMI percentile. Children living in census tracts with a higher walking condition and walking safety score did have lower BMI percentile and higher Curl Up percentile. 9.5% of the variance in BMI was explained by the model with walk condition and 8.6% of the variance in BMI was explained by the model with walk safety.

H1b: The standardized outcome scores for Fitness will have a stronger relationship with parental safety attitudes than BMI age and gender percentile, as evident by a model with 1) smaller p values; 2) larger t-statistic.

H1b: The standardized outcome scores for Fitness will have a stronger relationship with parental safety attitudes than BMI age and gender percentile, as evident by a model with 1) smaller p values; 2) larger t-statistic.

Table IV.31 Model 1b1.

<table>
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</thead>
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<td>Female</td>
<td>2.62</td>
<td>3.81</td>
<td>.69</td>
<td>.50</td>
</tr>
<tr>
<td>C-Age</td>
<td>-1.05</td>
<td>1.29</td>
<td>-.81</td>
<td>.42</td>
</tr>
<tr>
<td>CPhysical Activity</td>
<td>.08</td>
<td>.87</td>
<td>.09</td>
<td>.93</td>
</tr>
<tr>
<td>Parent Safety Centered</td>
<td>-.24</td>
<td>.46</td>
<td>-.53</td>
<td>.60</td>
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<tr>
<td>-2LogLikelihood</td>
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</table>
### Table IV.32 Model 1b2.

Curl up percentile N=250

<table>
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<th>t Value</th>
<th>p</th>
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</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>27.41</td>
<td>2.58</td>
<td>10.61</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Female</td>
<td>2.23</td>
<td>3.26</td>
<td>.68</td>
<td>.51</td>
</tr>
<tr>
<td>C-Age</td>
<td>.26</td>
<td>1.11</td>
<td>.23</td>
<td>.82</td>
</tr>
<tr>
<td>CPhysical Activity</td>
<td>.47</td>
<td>.74</td>
<td>.64</td>
<td>.52</td>
</tr>
<tr>
<td>Parent Safety Centered</td>
<td><strong>.78</strong></td>
<td><strong>.38</strong></td>
<td><strong>2.07</strong></td>
<td><strong>.04</strong></td>
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</table>

-2LogLikelihood 2326.6

### Table IV.33 Model 1b3.

Vertical Jump percentile N=250

<table>
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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>35.28</td>
<td>4.2</td>
<td>8.39</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Female</td>
<td>4.96</td>
<td>3.58</td>
<td>1.39</td>
<td>.19</td>
</tr>
<tr>
<td>C-Age</td>
<td>-1.54</td>
<td>1.22</td>
<td>-1.26</td>
<td>.21</td>
</tr>
<tr>
<td>CPhysical Activity</td>
<td>1.34</td>
<td>.82</td>
<td>1.64</td>
<td>.10</td>
</tr>
<tr>
<td>Parent Safety Centered</td>
<td><strong>-.06</strong></td>
<td><strong>.46</strong></td>
<td><strong>-1.14</strong></td>
<td><strong>.89</strong></td>
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</table>

-2LogLikelihood 2384.2

### Table IV.34 Model 1b4.

V-sit percentile N=249

<table>
<thead>
<tr>
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<th>t Value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>46.44</td>
<td>3.48</td>
<td>13.34</td>
<td>&lt;.0001</td>
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<tr>
<td>Female</td>
<td>.51</td>
<td>3.93</td>
<td>.13</td>
<td>.90</td>
</tr>
<tr>
<td>C-Age</td>
<td>1.23</td>
<td>1.33</td>
<td>.93</td>
<td>.36</td>
</tr>
<tr>
<td>CPhysical Activity</td>
<td>.60</td>
<td>.90</td>
<td>.66</td>
<td>.51</td>
</tr>
<tr>
<td>Parent Safety Centered</td>
<td><strong>-.37</strong></td>
<td><strong>.47</strong></td>
<td><strong>-1.79</strong></td>
<td><strong>.43</strong></td>
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</table>

-2LogLikelihood 2411.8
Table IV.35 Model 1b5.

PA Levels N=250

<table>
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</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>6.05</td>
<td>.22</td>
<td>27.93</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Female</td>
<td>-.76</td>
<td>.27</td>
<td>-2.78</td>
<td>.02</td>
</tr>
<tr>
<td>C-Age</td>
<td>-.03</td>
<td>.09</td>
<td>-.30</td>
<td>.76</td>
</tr>
<tr>
<td>Parent Safety Centered</td>
<td>-.03</td>
<td>.03</td>
<td>-96</td>
<td>.34</td>
</tr>
<tr>
<td>-2LogLikelihood</td>
<td>1096.5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The data support Hypothesis 1b for the outcome of Curl Up percentile but not the other fitness outcomes. The multilevel models for each of the outcomes have parent safety as a significant predictor for curl up percentile and not for BMI percentile. The $t$ value is higher for Curl Up and the estimate is consistent with increasing safety predicting increased curl up percentile. None of the other fitness measures are significantly associated with parent safety. In this model parent safety is a stronger predictor of Curl up, a fitness measure than BMI percentile with adjustment for child age, gender, physical activity and for clustering of children within census tracts.
**H2a.** There will be a significant main effect of parent’s perceived safety on the outcome of child obesity as measured by fitness or BMI, after adjusting for environmental constructs and other parental influences.

**H2b.** There will be a significant main effect of the environmental constructs on the outcome of child obesity as measured by fitness or BMI, after adjusting for parent’s influences.

**Table IV.36 Model H2ab1**

*Multiple regression analysis for relationship between walking condition, parents perceived safety, child gender, age, TV time, PA level and child BMI percentile.*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
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<th>P</th>
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</thead>
<tbody>
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<td>23.34</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Female</td>
<td>2.11</td>
<td>3.81</td>
<td>.55</td>
<td>.58</td>
</tr>
<tr>
<td>Centered Child Physical Activity Levels</td>
<td>.087</td>
<td>.852</td>
<td>.10</td>
<td>.92</td>
</tr>
<tr>
<td>Centered TV Time- weekday</td>
<td>.03</td>
<td>.02</td>
<td>1.61</td>
<td>.11</td>
</tr>
<tr>
<td>Centered Age</td>
<td>-1.34</td>
<td>1.30</td>
<td>-1.03</td>
<td>.30</td>
</tr>
<tr>
<td>CWalk Condition$^1$</td>
<td>-4.59</td>
<td>1.14</td>
<td>-4.04</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>CParent Safety $^2$</td>
<td>.49</td>
<td>.49</td>
<td>.99</td>
<td>.32</td>
</tr>
</tbody>
</table>

$R^2=.106$  $F(6,241)=4.64, p <.001$

$^1$ Higher score indicates more supportive environment for walking  
$^2$ Higher score indicates more safe

Figure IV.9 demonstrates the negative association between BMI percentile and *walk condition* for a female child of average age in the study controlling for PA levels and TV time. As census tract *walk condition* went from low to high, BMI percentile decreased. There was no difference observed between parent safety perception being high or low on BMI percentile after adjusting for *walk condition.*
**Figure IV.9 Parent safety and Walk condition for BMI percentile**

**Table IV.37 Model H2ab2**

*Multiple regression analysis* for relationship between walking safety, parents perceived safety, child gender, age TV time, PA level and child BMI percentile.

<table>
<thead>
<tr>
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<th>Estimate</th>
<th>SE</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>60.17</td>
<td>2.60</td>
<td>23.12</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Female</td>
<td>2.81</td>
<td>3.82</td>
<td>.74</td>
<td>.46</td>
</tr>
<tr>
<td>Centered Age</td>
<td>-1.37</td>
<td>1.30</td>
<td>-1.05</td>
<td>.29</td>
</tr>
<tr>
<td>Centered Child Physical Activity Levels</td>
<td>.21</td>
<td>.86</td>
<td>.24</td>
<td>.81</td>
</tr>
<tr>
<td>Centered TV Time- weekday</td>
<td>.03</td>
<td>.02</td>
<td>1.76</td>
<td>.08</td>
</tr>
<tr>
<td>CWalk safety(^1)</td>
<td>-9.37</td>
<td>2.42</td>
<td>-3.86</td>
<td>.0001</td>
</tr>
<tr>
<td>CParent Safety (^2)</td>
<td>.37</td>
<td>.48</td>
<td>.78</td>
<td>.44</td>
</tr>
</tbody>
</table>

\(R^2=.101\) \(F(6,241)=4.40, p <.001\)

\(^1\) Higher score indicates more supportive environment for walking

\(^2\) Higher score indicates more safe
Figure IV.10 demonstrates the negative association between BMI percentile and walk safety for a female child of average age, with average PA level and TV time in this study with a greater slope than for walk condition. As census tract walk safety went from low to high, BMI percentile decreased. Once again no difference is observed between parent safety perception of high or low on BMI percentile after adjusting for walk safety at the census tract level.

**Figure IV.10 Parent safety and Walk Safety for BMI percentile**

High and low parent safety lines are superimposed due to similar values for high and low walk safety.
Table IV.38 Model H2ab3

*Simultaneous multilevel regression analysis for walking infrastructure, parents perceived safety, child gender and age, TV Time, PA levels predicting child BMI percentile.*

<table>
<thead>
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<th>Variable</th>
<th>Estimate</th>
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<th>P</th>
</tr>
</thead>
<tbody>
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<td>7.67</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Female</td>
<td>3.08</td>
<td>3.82</td>
<td>.81</td>
<td>.43</td>
</tr>
<tr>
<td>Centered Age</td>
<td>-1.61</td>
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<td>-1.23</td>
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</tr>
<tr>
<td>TV Time</td>
<td>.04</td>
<td>.02</td>
<td>2.28</td>
<td>.02</td>
</tr>
<tr>
<td>Child Physical Activity Levels</td>
<td>.34</td>
<td>.87</td>
<td>.39</td>
<td>.70</td>
</tr>
<tr>
<td>CWalk infra^1</td>
<td>-1.56</td>
<td>4.14</td>
<td>-.38</td>
<td>.71</td>
</tr>
<tr>
<td>CParent Safety^2</td>
<td>-.14</td>
<td>.45</td>
<td>-.31</td>
<td>.76</td>
</tr>
</tbody>
</table>

^1 higher score indicates more supportive environment for walking  
^2 Higher score indicates more safe

Table IV.39 Model H2ab4

*Multilevel regression analysis for relationship between walking condition, parents perceived safety, child PA level, travel to school, gender and age and child Curl up percentile.*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>SE</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
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<td>8.41</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Female</td>
<td>.50</td>
<td>3.18</td>
<td>.16</td>
<td>.88</td>
</tr>
<tr>
<td>Centered Age</td>
<td>.49</td>
<td>1.07</td>
<td>.45</td>
<td>.65</td>
</tr>
<tr>
<td>Centered Child Physical Activity Levels</td>
<td>.20</td>
<td>.71</td>
<td>.28</td>
<td>.78</td>
</tr>
<tr>
<td>Travel to school</td>
<td>12.24</td>
<td>3.16</td>
<td>3.87</td>
<td>.0001</td>
</tr>
<tr>
<td>CWalk Condition^1</td>
<td>2.88</td>
<td>1.04</td>
<td>2.76</td>
<td>.02</td>
</tr>
<tr>
<td>CParent Safety^2</td>
<td>.09</td>
<td>.42</td>
<td>.20</td>
<td>.83</td>
</tr>
</tbody>
</table>

^1 higher score indicates more supportive environment for walking  
^2 Higher score indicates more safe

^ICC= .062  
^ICC= .017
Figure IV.11 demonstrates a positive association between Curl Up percentile and *walk condition*. As census tract walking condition went from low to high, Curl Up percentile increased. There was no difference noted between parent’s safety perception of being high or low on Curl Up percentile after adjusting for *walk condition*.

![Plot: Safety Parent & Walk Condition](image)

**Figure IV.11 Parent safety and Walk Condition for Curl up percentile**

High and low parent safety lines are superimposed due to similar values for high and low walk condition
Table IV.40 Model H2ab5

Multilevel regression analysis for relationship between walking safety, parents perceived safety, child PA level, travel to school, gender and age and child Curl up percentile.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>SE</th>
<th>t</th>
<th>P</th>
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</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>22.68</td>
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<td>8.38</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Female</td>
<td>.11</td>
<td>3.18</td>
<td>.03</td>
<td>.97</td>
</tr>
<tr>
<td>Centered Age</td>
<td>.49</td>
<td>1.08</td>
<td>.46</td>
<td>.65</td>
</tr>
<tr>
<td>Centered Child Physical Activity Levels</td>
<td>.15</td>
<td>.72</td>
<td>.20</td>
<td>.84</td>
</tr>
<tr>
<td>Travel to school</td>
<td>12.25</td>
<td>3.18</td>
<td>3.86</td>
<td>.0001</td>
</tr>
<tr>
<td>CWalk Safety&lt;sup&gt;1&lt;/sup&gt;</td>
<td>5.73</td>
<td>2.28</td>
<td>2.51</td>
<td>.03</td>
</tr>
<tr>
<td>CParent Safety&lt;sup&gt;2&lt;/sup&gt;</td>
<td>.16</td>
<td>.41</td>
<td>.40</td>
<td>.69</td>
</tr>
</tbody>
</table>

*ICC = .012
<sup>1</sup>higher score indicates more supportive environment for walking
<sup>2</sup>Higher score indicates more safe

Figure IV.12 demonstrates a positive association between Curl Up percentile and walk safety.

As census tract walk safety went from low to high, curl up percentile increased. There was no difference noted between parent’s safety perception of being high or low on Curl Up percentile after adjusting for walk safety, child age, gender, physical activity and method of travel to school.
Figure IV.12 Parent safety and Walking Safety for Curl Up percentile

High and low parent safety lines are superimposed due to similar values for high and low walk safety

Table IV.41 Model H2ab6
Multilevel regression analysis for relationship between walking infrastructure, parents perceived safety, child PA level, travel to school, gender and age and child Curl up percentile.

<table>
<thead>
<tr>
<th>Variable</th>
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<th>P</th>
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<tbody>
<tr>
<td>Intercept</td>
<td>22.04</td>
<td>2.95</td>
<td>7.46</td>
<td>&lt;.0001</td>
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<tr>
<td>Female</td>
<td>.25</td>
<td>3.21</td>
<td>.08</td>
<td>.94</td>
</tr>
<tr>
<td>Centered Age</td>
<td>.32</td>
<td>1.09</td>
<td>.29</td>
<td>.77</td>
</tr>
<tr>
<td>Centered Child Physical Activity Levels</td>
<td>.30</td>
<td>.72</td>
<td>.41</td>
<td>.68</td>
</tr>
<tr>
<td>Travel to school</td>
<td>12.95</td>
<td>3.22</td>
<td>4.02</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>CWalk infra(^1)</td>
<td>-.90</td>
<td>3.29</td>
<td>-.27</td>
<td>.79</td>
</tr>
<tr>
<td>CParent Safety(^2)</td>
<td>.50</td>
<td>.38</td>
<td>1.32</td>
<td>.19</td>
</tr>
</tbody>
</table>

\(^1\)ICC = .049
\(^1\) higher score indicates more supportive environment for walking
\(^2\) Higher score indicates more safe
Table IV.42 Model H2ab7

Simultaneous multilevel regression analysis for walking condition, parents perceived safety, child PA level, travel to school, gender and age and child Vertical Jump percentile.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
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<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
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<td>22.03</td>
<td>9.62</td>
<td>2.29</td>
<td>.04</td>
</tr>
<tr>
<td>Female</td>
<td>4.62</td>
<td>3.60</td>
<td>1.28</td>
<td>.22</td>
</tr>
<tr>
<td>Centered Age</td>
<td>-1.30</td>
<td>1.23</td>
<td>-1.05</td>
<td>.29</td>
</tr>
<tr>
<td>Child Physical Activity Levels</td>
<td>1.39</td>
<td>.82</td>
<td>1.69</td>
<td>.09</td>
</tr>
<tr>
<td>Travel to school</td>
<td>1.84</td>
<td>2.37</td>
<td>.78</td>
<td>.44</td>
</tr>
<tr>
<td>CWalk Condition(^1)</td>
<td>3.85</td>
<td>1.92</td>
<td>2.00</td>
<td>.07</td>
</tr>
<tr>
<td>CParent Safety (^2)</td>
<td>-0.45</td>
<td>0.49</td>
<td>-0.92</td>
<td>.36</td>
</tr>
</tbody>
</table>

\(^*\)ICC = .146
\(^1\) Higher score indicates more supportive environment for walking
\(^2\) Higher score indicates more safe

Table IV.43 Model H2ab8

Simultaneous multilevel regression analysis for walking safety, parents perceived safety, child PA level, travel to school, gender and age and child Vertical Jump percentile.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
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<th>P</th>
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</thead>
<tbody>
<tr>
<td>Intercept</td>
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<td>9.65</td>
<td>2.28</td>
<td>.04</td>
</tr>
<tr>
<td>Female</td>
<td>4.39</td>
<td>3.61</td>
<td>1.22</td>
<td>.24</td>
</tr>
<tr>
<td>Centered Age</td>
<td>-1.28</td>
<td>1.24</td>
<td>-1.04</td>
<td>.30</td>
</tr>
<tr>
<td>Child Physical Activity Levels</td>
<td>1.37</td>
<td>0.83</td>
<td>1.66</td>
<td>.10</td>
</tr>
<tr>
<td>Travel to school</td>
<td>1.96</td>
<td>2.37</td>
<td>0.82</td>
<td>.41</td>
</tr>
<tr>
<td>CWalk Safety (^1)</td>
<td>6.99</td>
<td>4.22</td>
<td>1.66</td>
<td>.12</td>
</tr>
<tr>
<td>CParent Safety (^2)</td>
<td>-0.37</td>
<td>0.48</td>
<td>-0.76</td>
<td>.45</td>
</tr>
</tbody>
</table>

\(^*\)ICC = .149
\(^1\) Higher score indicates more supportive environment for walking
\(^2\) Higher score indicates more safe
### Table IV.44 Model H2ab9

*Simultaneous multilevel regression analysis for walking infrastructure, parents perceived safety, child PA level, travel to school, gender and age and child Vertical Jump percentile.*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
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<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
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<td>6.50</td>
<td>4.20</td>
<td>.001</td>
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<tr>
<td>Female</td>
<td>4.86</td>
<td>3.60</td>
<td>1.35</td>
<td>.20</td>
</tr>
<tr>
<td>Centered Age</td>
<td>-1.61</td>
<td>1.23</td>
<td>-1.31</td>
<td>.19</td>
</tr>
<tr>
<td>Child Physical Activity Levels</td>
<td>1.38</td>
<td>.82</td>
<td>1.67</td>
<td>.10</td>
</tr>
<tr>
<td>Travel to school</td>
<td>.05</td>
<td>.20</td>
<td>.26</td>
<td>.79</td>
</tr>
<tr>
<td>CWalk Infra&lt;sup&gt;1&lt;/sup&gt;</td>
<td>-4.10</td>
<td>5.60</td>
<td>-0.73</td>
<td>.48</td>
</tr>
<tr>
<td>CPARENT Safety&lt;sup&gt;2&lt;/sup&gt;</td>
<td>-0.03</td>
<td>.45</td>
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<td>.95</td>
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</table>

*ICC = .170

<sup>1</sup> Higher score indicates more supportive environment for walking

<sup>2</sup> Higher score indicates more safe

### Table IV.45 Model H2ab10

*Simultaneous multilevel regression analysis for walking condition, parents perceived safety, child PA level, travel to school, gender and age and child V-Sit percentile.*

<table>
<thead>
<tr>
<th>Variable</th>
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<tbody>
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<td>9.96</td>
<td>2.77</td>
<td>.02</td>
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<tr>
<td>Female</td>
<td>.07</td>
<td>3.93</td>
<td>.02</td>
<td>.99</td>
</tr>
<tr>
<td>Centered Age</td>
<td>1.06</td>
<td>1.34</td>
<td>.79</td>
<td>.43</td>
</tr>
<tr>
<td>Child Physical Activity Levels</td>
<td>.86</td>
<td>.89</td>
<td>.97</td>
<td>.33</td>
</tr>
<tr>
<td>Travel to school</td>
<td>4.94</td>
<td>2.51</td>
<td>1.96</td>
<td>.06</td>
</tr>
<tr>
<td>CWalk Condition&lt;sup&gt;1&lt;/sup&gt;</td>
<td>1.65</td>
<td>1.54</td>
<td>1.07</td>
<td>.30</td>
</tr>
<tr>
<td>CPARENT Safety&lt;sup&gt;2&lt;/sup&gt;</td>
<td>-0.58</td>
<td>.52</td>
<td>-1.10</td>
<td>.27</td>
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</table>

*ICC = .053

<sup>1</sup> Higher score indicates more supportive environment for walking

<sup>2</sup> Higher score indicates more safe
Table IV.46 Model H2ab11

*Simultaneous multilevel regression analysis for walking safety, parents perceived safety, child PA level, travel to school, gender and age and child V-Sit percentile.*

<table>
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<th>Variable</th>
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</thead>
<tbody>
<tr>
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<td>2.77</td>
<td>.02</td>
</tr>
<tr>
<td>Female</td>
<td>-.12</td>
<td>3.93</td>
<td>-.03</td>
<td>.98</td>
</tr>
<tr>
<td>Centered Age</td>
<td>1.10</td>
<td>1.33</td>
<td>.82</td>
<td>.41</td>
</tr>
<tr>
<td>Child Physical Activity Levels</td>
<td>.80</td>
<td>.89</td>
<td>.90</td>
<td>.37</td>
</tr>
<tr>
<td>Travel to school</td>
<td>5.17</td>
<td>2.5</td>
<td>2.07</td>
<td>.06</td>
</tr>
<tr>
<td>CWalk Safety&lt;sup&gt;1&lt;/sup&gt;</td>
<td>5.09</td>
<td>3.18</td>
<td>1.60</td>
<td>.13</td>
</tr>
<tr>
<td>CPARENT Safety&lt;sup&gt;2&lt;/sup&gt;</td>
<td>-.67</td>
<td>.51</td>
<td>-1.30</td>
<td>.19</td>
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</table>

<sup>*ICC= .043</sup>
<sup>1 higher score indicates more supportive environment for walking</sup>
<sup>2 Higher score indicates more safe</sup>

Table IV.47 Model H2ab12

*Simultaneous multilevel regression analysis for walking infrastructure, parents perceived safety, child PA level, travel to school, gender and age and child V-Sit percentile.*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
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</thead>
<tbody>
<tr>
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<td>.02</td>
</tr>
<tr>
<td>Female</td>
<td>-.07</td>
<td>3.93</td>
<td>-.02</td>
<td>.99</td>
</tr>
<tr>
<td>Centered Age</td>
<td>1.01</td>
<td>1.34</td>
<td>.75</td>
<td>.45</td>
</tr>
<tr>
<td>Child Physical Activity Levels</td>
<td>.90</td>
<td>.89</td>
<td>1.00</td>
<td>.32</td>
</tr>
<tr>
<td>Travel to school</td>
<td>4.87</td>
<td>2.55</td>
<td>1.91</td>
<td>.06</td>
</tr>
<tr>
<td>CWalk infra&lt;sup&gt;1&lt;/sup&gt;</td>
<td>-.26</td>
<td>4.32</td>
<td>-.06</td>
<td>.95</td>
</tr>
<tr>
<td>CPARENT Safety&lt;sup&gt;2&lt;/sup&gt;</td>
<td>-.33</td>
<td>.47</td>
<td>-.71</td>
<td>.48</td>
</tr>
</tbody>
</table>

<sup>*ICC= .062</sup>
<sup>1 higher score indicates more supportive environment for walking</sup>
<sup>2 Higher score indicates more safe</sup>

Models H2ab1 (F(6,241)=4.64, p < .0001 R²=.106) and H2ab2 (F(6,241)=4.40, p < .001
R²=.101) parameter estimates show that the *walk condition* (-4.59) and *walk safety* (-9.37) at the
census tract level were significantly related to BMI percentile in that a higher *walk condition* or *walk safety* score was associated with a lower BMI percentile at the census tract level. Models H2ab4 and H2ab5 parameter estimates for *walk condition* (2.88) and *walk safety* (5.73) are significantly associated with Curl Up percentile and a higher *walk condition* score or *walk safety* score was associated with a higher Curl Up percentile at the census tract level. Model H2ab6 has a significant parameter estimate for travel to school (12.95) associated with Curl Up. Walking, bike or bus to school is positively associated with a child’s Curl Up percentile. Model H2ab7 shows that *walk condition* parameter (3.85) approached significance (p=.07) in association with Vertical Jump. Thus, there is a trend toward a positive association between Vertical Jump percentile and census tract level *walk condition* scores.

In order to test for a potential mediation effect by child physical activity on the outcomes of BMI and Fitness, physical activity was modeled as an outcome variable of parent safety and walking audit variables as well as a predictor following the approach outlined by Barron and Kenny (Baron & Kenny, 1986). Physical activity was tested as an outcome for a main effect of the two primary predictor variables as a potential mediator of the effect. Below are the models of walking variables, parent safety, age and gender predicting child physical activity along with an interaction variable of parent safety and walking audits. None of the main effects models with physical activity as an outcome variable were significant along with any of the interaction term models.
Table IV.48 Walk Condition PA Main Effects Model

Simultaneous multilevel regression analysis for walking condition, parents perceived safety, child gender and age predicting child PA Level.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>SE</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>6.05</td>
<td>.22</td>
<td>27.96</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Female</td>
<td>-.76</td>
<td>.27</td>
<td>-2.76</td>
<td>.02</td>
</tr>
<tr>
<td>Centered Age</td>
<td>-.03</td>
<td>.09</td>
<td>-2.8</td>
<td>.02</td>
</tr>
<tr>
<td>CWalk Condition(^1)</td>
<td>.06</td>
<td>.10</td>
<td>.58</td>
<td>.57</td>
</tr>
<tr>
<td>CParent Safety (^2)</td>
<td>-.04</td>
<td>.04</td>
<td>-1.12</td>
<td>.27</td>
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</tbody>
</table>

*ICC= .030
\(^1\) higher score indicates more supportive environment for walking
\(^2\) Higher score indicates more safe

Table IV.49 Walk Safety PA Main Effects Model

Simultaneous multilevel regression analysis for walking safety parents perceived safety, child gender and age predicting child PA Levels.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
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<th>P</th>
</tr>
</thead>
<tbody>
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<td>&lt;.0001</td>
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<tr>
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<td>-.77</td>
<td>.27</td>
<td>-2.8</td>
<td>.01</td>
</tr>
<tr>
<td>Centered Age</td>
<td>-.02</td>
<td>.09</td>
<td>-2.5</td>
<td>.01</td>
</tr>
<tr>
<td>CWalk Safety (^1)</td>
<td>.24</td>
<td>.21</td>
<td>1.15</td>
<td>.27</td>
</tr>
<tr>
<td>CParent Safety (^2)</td>
<td>-.05</td>
<td>.04</td>
<td>-1.37</td>
<td>.17</td>
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</tbody>
</table>

*ICC= .027
\(^1\) higher score indicates more supportive environment for walking
\(^2\) Higher score indicates more safe

Table IV.50 Walk Infra PA Main Effects Model

Multilevel regression analysis for relationship between walking infrastructure, parents perceived safety, child gender and age and child PA Levels.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>SE</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>6.05</td>
<td>.22</td>
<td>27.87</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Female</td>
<td>-.76</td>
<td>.27</td>
<td>-2.77</td>
<td>.02</td>
</tr>
<tr>
<td>Centered Age</td>
<td>-.03</td>
<td>.09</td>
<td>-2.8</td>
<td>.02</td>
</tr>
<tr>
<td>CWalk infra (^1)</td>
<td>.06</td>
<td>.26</td>
<td>.23</td>
<td>.82</td>
</tr>
<tr>
<td>CParent Safety (^2)</td>
<td>-.03</td>
<td>.03</td>
<td>-.96</td>
<td>.34</td>
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</table>

*ICC= .031
\(^1\) higher score indicates more supportive environment for walking
\(^2\) Higher score indicates more safe
Table IV.51 Walk Condition PA Model with Interaction

*Simultaneous multilevel regression analysis* for walking condition, parent’s perceived safety, child gender and age predicting child PA Level.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
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<th>P</th>
</tr>
</thead>
<tbody>
<tr>
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<td>24.42</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Female</td>
<td>-.77</td>
<td>.28</td>
<td>-2.77</td>
<td>.015</td>
</tr>
<tr>
<td>Centered Age</td>
<td>-.03</td>
<td>.09</td>
<td>-3.0</td>
<td>.77</td>
</tr>
<tr>
<td>CWalk Condition(^1)</td>
<td>.07</td>
<td>.12</td>
<td>.62</td>
<td>.55</td>
</tr>
<tr>
<td>CParent Safety (^2)</td>
<td>-.04</td>
<td>.04</td>
<td>-1.15</td>
<td>.25</td>
</tr>
<tr>
<td>CParent Safety*CWalk Condition</td>
<td>-.005</td>
<td>.02</td>
<td>-2.25</td>
<td>.81</td>
</tr>
</tbody>
</table>

ICC=.031

\(^1\) higher score indicates more supportive environment for walking

\(^2\) Higher score indicates more safe

Table IV.52 Walk Safety PA Model with Interaction

*Simultaneous multilevel regression analysis* for walking Safety, parent’s perceived safety, child gender and age predicting child PA Level.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>SE</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>6.07</td>
<td>.24</td>
<td>25.09</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Female</td>
<td>-.78</td>
<td>.28</td>
<td>-2.80</td>
<td>.01</td>
</tr>
<tr>
<td>Centered Age</td>
<td>-.03</td>
<td>.09</td>
<td>-2.7</td>
<td>.79</td>
</tr>
<tr>
<td>CWalk safety(^1)</td>
<td>.26</td>
<td>.24</td>
<td>1.08</td>
<td>.30</td>
</tr>
<tr>
<td>CParent Safety (^2)</td>
<td>-.05</td>
<td>.04</td>
<td>-1.38</td>
<td>.17</td>
</tr>
<tr>
<td>CParent Safety*CWalk Safety</td>
<td>-.008</td>
<td>.04</td>
<td>-1.9</td>
<td>.85</td>
</tr>
</tbody>
</table>

ICC=.027

\(^1\) higher score indicates more supportive environment for walking

\(^2\) Higher score indicates more safe
Table IV.53 Walk Infra PA Model with Interaction

*Simultaneous multilevel regression analysis for walking Infrastructure, parent’s perceived safety, child gender and age predicting child PA Level.*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>SE</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
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<td>.22</td>
<td>27.97</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Female</td>
<td>-.75</td>
<td>.27</td>
<td>-2.72</td>
<td>.02</td>
</tr>
<tr>
<td>Centered Age</td>
<td>-.02</td>
<td>.09</td>
<td>-.21</td>
<td>.83</td>
</tr>
<tr>
<td>CWalk infra(^1)</td>
<td>.12</td>
<td>.27</td>
<td>.47</td>
<td>.65</td>
</tr>
<tr>
<td>CPARENT Safety(^2)</td>
<td>-.03</td>
<td>.03</td>
<td>-.92</td>
<td>.36</td>
</tr>
<tr>
<td>CPARENT Safety*CWalk Infrastructure</td>
<td>.06</td>
<td>.05</td>
<td>1.21</td>
<td>.23</td>
</tr>
</tbody>
</table>

\(^*\text{ICC}=.030\)

\(^1\) higher score indicates more supportive environment for walking

\(^2\) Higher score indicates more safe

**H2c.** There will be a significant interaction between parent’s safety concerns and census level environmental constructs on the outcome of child obesity as measured by fitness or BMI.

A cross level interaction term was added to the models with the walking audit level 2 variables and the level 1 parent safety variables. In the models where there were significant main effects of the walking variables the interaction term was not significant in any of the models.

In order to test for moderation by physical activity Models H2c1b-12b included a cross level interaction term between census tract environmental constructs and physical activity. None of the interaction terms were significant in these models.
Table IV.54 Model H2c1a

Simultaneous multiple regression analysis for walking condition, parent’s perceived safety, child gender and age predicting child BMI percentile.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>SE</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>70.59</td>
<td>9.53</td>
<td>7.40</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Female</td>
<td>2.62</td>
<td>3.84</td>
<td>.68</td>
<td>.50</td>
</tr>
<tr>
<td>Centered Age</td>
<td>-.92</td>
<td>1.30</td>
<td>-.71</td>
<td>.48</td>
</tr>
<tr>
<td>Travel to school</td>
<td>-2.71</td>
<td>2.34</td>
<td>-1.16</td>
<td>.25</td>
</tr>
<tr>
<td>Child Physical Activity</td>
<td>-.26</td>
<td>.85</td>
<td>-.30</td>
<td>.76</td>
</tr>
<tr>
<td>CWalk Condition¹</td>
<td>-4.63</td>
<td>1.40</td>
<td>-3.32</td>
<td>.001</td>
</tr>
<tr>
<td>CParent Safety ²</td>
<td>.47</td>
<td>.51</td>
<td>.92</td>
<td>.36</td>
</tr>
<tr>
<td>CParent Safety *CWalk Condition</td>
<td>-.12</td>
<td>.26</td>
<td>-.45</td>
<td>.65</td>
</tr>
</tbody>
</table>

R²=.101  F(7,242)=3.79, p <.001
¹ higher score indicates more supportive environment for walking
² Higher score indicates more safe

Table IV.55 Model H2c1b

Simultaneous multiple regression analysis for walking condition, parent’s perceived safety, child gender and age, PA levels, Travel to school predicting child BMI percentile.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>SE</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>68.75</td>
<td>9.20</td>
<td>7.48</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Female</td>
<td>2.77</td>
<td>3.80</td>
<td>.73</td>
<td>.47</td>
</tr>
<tr>
<td>Centered Age</td>
<td>-1.00</td>
<td>1.30</td>
<td>-.77</td>
<td>.44</td>
</tr>
<tr>
<td>Travel to school</td>
<td>-2.54</td>
<td>2.31</td>
<td>-1.10</td>
<td>.27</td>
</tr>
<tr>
<td>Child Physical Activity</td>
<td>-.14</td>
<td>.86</td>
<td>-.17</td>
<td>.87</td>
</tr>
<tr>
<td>CWalk Condition¹</td>
<td>-7.78</td>
<td>3.08</td>
<td>-2.52</td>
<td>.01</td>
</tr>
<tr>
<td>CParent Safety ²</td>
<td>.52</td>
<td>.50</td>
<td>1.04</td>
<td>.30</td>
</tr>
<tr>
<td>Child Physical Activity *CWalk Condition</td>
<td>.48</td>
<td>.50</td>
<td>.96</td>
<td>.34</td>
</tr>
</tbody>
</table>

R²=.104  F(7,242)=3.90, p <.001
¹ higher score indicates more supportive environment for walking
² Higher score indicates more safe
Table IV.56 Model H2c2a

*Simultaneous multiple regression analysis* for walking safety, parent’s perceived safety, child gender and age, PA levels, Travel to school predicting child BMI percentile.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>SE</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>70.41</td>
<td>9.47</td>
<td>7.43</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Female</td>
<td>3.27</td>
<td>3.87</td>
<td>.85</td>
<td>.40</td>
</tr>
<tr>
<td>Centered Age</td>
<td>-.94</td>
<td>1.31</td>
<td>-.72</td>
<td>.47</td>
</tr>
<tr>
<td>Travel to school</td>
<td>-2.97</td>
<td>2.34</td>
<td>-1.27</td>
<td>.21</td>
</tr>
<tr>
<td>Child Physical Activity</td>
<td>-.14</td>
<td>.86</td>
<td>-.17</td>
<td>.87</td>
</tr>
<tr>
<td>C Walk safety¹</td>
<td>-8.95</td>
<td>2.93</td>
<td>-3.05</td>
<td>.003</td>
</tr>
<tr>
<td>C Parent Safety²</td>
<td>.30</td>
<td>.50</td>
<td>.61</td>
<td>.54</td>
</tr>
<tr>
<td>C Parent Safety* C Walk Safety</td>
<td>-.36</td>
<td>.55</td>
<td>.66</td>
<td>.51</td>
</tr>
</tbody>
</table>

R²=.093  F(7,242)=3.43, p =<.01
¹ higher score indicates more supportive environment for walking
² Higher score indicates more safe

Table IV.57 Model H2c2b

*Simultaneous multiple regression analysis* for walking safety, parent’s perceived safety, child gender and age, PA levels, Travel to school predicting child BMI percentile.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>SE</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>68.62</td>
<td>9.29</td>
<td>7.38</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Female</td>
<td>3.71</td>
<td>3.83</td>
<td>.97</td>
<td>.33</td>
</tr>
<tr>
<td>Centered Age</td>
<td>-.88</td>
<td>1.30</td>
<td>-.68</td>
<td>.50</td>
</tr>
<tr>
<td>Travel to school</td>
<td>-2.83</td>
<td>2.33</td>
<td>-1.22</td>
<td>.23</td>
</tr>
<tr>
<td>Child Physical Activity</td>
<td>-.08</td>
<td>.87</td>
<td>-.10</td>
<td>.92</td>
</tr>
<tr>
<td>C Walk safety¹</td>
<td>-12.4</td>
<td>6.92</td>
<td>-1.79</td>
<td>.07</td>
</tr>
<tr>
<td>C Parent Safety²</td>
<td>.36</td>
<td>.49</td>
<td>.73</td>
<td>.47</td>
</tr>
<tr>
<td>C Parent Activity* C Walk Safety</td>
<td>.40</td>
<td>1.11</td>
<td>.36</td>
<td>.72</td>
</tr>
</tbody>
</table>

R²=.091  F(7,242)=3.39, p =<.01
¹ higher score indicates more supportive environment for walking
² Higher score indicates more safe
Table IV.58 Model H2c3a

*Simultaneous multilevel regression analysis* for walking infrastructure, parent’s perceived safety, child gender and age, PA levels, Travel to school predicting child BMI percentile.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
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<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>67.63</td>
<td>9.72</td>
<td>6.96</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Female</td>
<td>3.31</td>
<td>3.83</td>
<td>.86</td>
<td>.39</td>
</tr>
<tr>
<td>Centered Age</td>
<td>-.98</td>
<td>1.30</td>
<td>-.75</td>
<td>.45</td>
</tr>
<tr>
<td>Travel to school</td>
<td>-2.67</td>
<td>2.46</td>
<td>-1.09</td>
<td>.28</td>
</tr>
<tr>
<td>Child Physical Activity</td>
<td>-.09</td>
<td>.87</td>
<td>-.11</td>
<td>.91</td>
</tr>
<tr>
<td>CWalk infra&lt;sup&gt;1&lt;/sup&gt;</td>
<td>-3.32</td>
<td>3.97</td>
<td>-.84</td>
<td>.42</td>
</tr>
<tr>
<td>CPARENT Safety&lt;sup&gt;2&lt;/sup&gt;</td>
<td>-.37</td>
<td>.45</td>
<td>-.81</td>
<td>.41</td>
</tr>
<tr>
<td>CPARENT Safety*CWALK Infrastructure</td>
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<td>.71</td>
<td>-1.41</td>
<td>.16</td>
</tr>
</tbody>
</table>

*ICC* = .046
<sup>1</sup>higher score indicates more supportive environment for walking
<sup>2</sup>Higher score indicates more safe

Table IV.59 Model H2c3b

*Simultaneous multilevel regression analysis* for walking infrastructure, parent’s perceived safety, child gender and age, PA levels, Travel to school predicting child BMI percentile.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>SE</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>70.75</td>
<td>9.79</td>
<td>7.23</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Female</td>
<td>3.95</td>
<td>3.79</td>
<td>1.04</td>
<td>.30</td>
</tr>
<tr>
<td>Centered Age</td>
<td>-.99</td>
<td>1.29</td>
<td>-.76</td>
<td>.45</td>
</tr>
<tr>
<td>Travel to school</td>
<td>-3.06</td>
<td>2.45</td>
<td>-1.25</td>
<td>.21</td>
</tr>
<tr>
<td>Child Physical Activity</td>
<td>-.48</td>
<td>.88</td>
<td>-.55</td>
<td>.58</td>
</tr>
<tr>
<td>CWalk infra&lt;sup&gt;1&lt;/sup&gt;</td>
<td>12.49</td>
<td>8.59</td>
<td>1.46</td>
<td>.17</td>
</tr>
<tr>
<td>CPARENT Safety&lt;sup&gt;2&lt;/sup&gt;</td>
<td>-.12</td>
<td>.46</td>
<td>-2.27</td>
<td>.06</td>
</tr>
<tr>
<td>Child Physical Activity*CWALK Infrastructure</td>
<td>-2.68</td>
<td>1.33</td>
<td>-2.02</td>
<td>.06</td>
</tr>
</tbody>
</table>

*ICC* = .073
<sup>1</sup>higher score indicates more supportive environment for walking
<sup>2</sup>Higher score indicates more safe
Table IV.60 Model H2c4a

*Simultaneous multilevel regression analysis* for walking condition, parent’s perceived safety, child gender and age, PA levels, Travel to school predicting child V-Sit.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>SE</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>29.94</td>
<td>10.17</td>
<td>2.95</td>
<td>.01</td>
</tr>
<tr>
<td>Female</td>
<td>-.62</td>
<td>.39</td>
<td>-.16</td>
<td>.88</td>
</tr>
<tr>
<td>Centered Age</td>
<td>.97</td>
<td>1.33</td>
<td>.73</td>
<td>.47</td>
</tr>
<tr>
<td>Travel to school</td>
<td>4.86</td>
<td>2.51</td>
<td>1.93</td>
<td>.05</td>
</tr>
<tr>
<td>Child Physical Activity</td>
<td>.83</td>
<td>.89</td>
<td>.94</td>
<td>.35</td>
</tr>
<tr>
<td>CWalk Condition&lt;sup&gt;1&lt;/sup&gt;</td>
<td><strong>2.61</strong></td>
<td>1.78</td>
<td><strong>1.47</strong></td>
<td>.17</td>
</tr>
<tr>
<td>CParent Safety&lt;sup&gt;2&lt;/sup&gt;</td>
<td>-0.69</td>
<td>.53</td>
<td>-1.10</td>
<td>.27</td>
</tr>
<tr>
<td>CParent Safety*CWalk Condition</td>
<td>-0.32</td>
<td>.29</td>
<td>.94</td>
<td>.35</td>
</tr>
</tbody>
</table>

*ICC = .055

<sup>1</sup> higher score indicates more supportive environment for walking

<sup>2</sup> Higher score indicates more safe

Table IV.61 Model H2c4b

*Simultaneous multilevel regression analysis* for walking condition, parent’s perceived safety, child gender and age, PA levels, Travel to school predicting child V-Sit.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>SE</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>28.08</td>
<td>10.0</td>
<td>2.81</td>
<td>.01</td>
</tr>
<tr>
<td>Female</td>
<td>.13</td>
<td>.39</td>
<td>.03</td>
<td>.97</td>
</tr>
<tr>
<td>Centered Age</td>
<td>1.14</td>
<td>1.34</td>
<td>.85</td>
<td>.40</td>
</tr>
<tr>
<td>Travel to school</td>
<td>4.89</td>
<td>2.51</td>
<td>1.94</td>
<td>.05</td>
</tr>
<tr>
<td>Child Physical Activity</td>
<td>.80</td>
<td>.90</td>
<td>.89</td>
<td>.38</td>
</tr>
<tr>
<td>CWalk Condition&lt;sup&gt;1&lt;/sup&gt;</td>
<td><strong>3.31</strong></td>
<td><strong>3.41</strong></td>
<td>.97</td>
<td>.35</td>
</tr>
<tr>
<td>CParent Safety&lt;sup&gt;2&lt;/sup&gt;</td>
<td>-0.58</td>
<td>.52</td>
<td>-1.11</td>
<td>.27</td>
</tr>
<tr>
<td>Child Physical Activity*CWalk Condition</td>
<td>-0.28</td>
<td>.52</td>
<td>-.55</td>
<td>.59</td>
</tr>
</tbody>
</table>

*ICC = .053

<sup>1</sup> higher score indicates more supportive environment for walking

<sup>2</sup> Higher score indicates more safe
### Table IV.62 Model H2c5a

*Simultaneous multilevel regression analysis* for walking safety, parent’s perceived safety, child gender and age, PA levels, Travel to school predicting child V-Sit.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>SE</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>28.94</td>
<td>10.0</td>
<td>2.89</td>
<td>.01</td>
</tr>
<tr>
<td>Female</td>
<td>-.069</td>
<td>.40</td>
<td>-.17</td>
<td>.86</td>
</tr>
<tr>
<td>Centered Age</td>
<td>.98</td>
<td>1.34</td>
<td>.74</td>
<td>.46</td>
</tr>
<tr>
<td>Travel to school</td>
<td>5.21</td>
<td>2.49</td>
<td>2.09</td>
<td>.04</td>
</tr>
<tr>
<td>Child Physical Activity</td>
<td>.79</td>
<td>.89</td>
<td>.88</td>
<td>.38</td>
</tr>
<tr>
<td>CWalk Safety</td>
<td><strong>6.81</strong></td>
<td>3.61</td>
<td>1.89</td>
<td>.08</td>
</tr>
<tr>
<td>CPARENT Safety</td>
<td>-.75</td>
<td>.52</td>
<td>-1.45</td>
<td>.15</td>
</tr>
<tr>
<td>Child Physical Activity*CWalk Safety</td>
<td>-.60</td>
<td>.62</td>
<td>-0.97</td>
<td>.34</td>
</tr>
</tbody>
</table>

*ICC* = .041

1 higher score indicates more supportive environment for walking
2 Higher score indicates more safe

### Table IV.63 Model H2c5b

*Simultaneous multilevel regression analysis* for walking safety, parent’s perceived safety, child gender and age, PA levels, Travel to school predicting child V-Sit.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>SE</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>28.60</td>
<td>9.94</td>
<td>2.88</td>
<td>.01</td>
</tr>
<tr>
<td>Female</td>
<td>-.23</td>
<td>.39</td>
<td>-.06</td>
<td>.95</td>
</tr>
<tr>
<td>Centered Age</td>
<td>1.21</td>
<td>1.34</td>
<td>.91</td>
<td>.37</td>
</tr>
<tr>
<td>Travel to school</td>
<td>5.15</td>
<td>2.49</td>
<td>2.07</td>
<td>.04</td>
</tr>
<tr>
<td>Child Physical Activity</td>
<td>.64</td>
<td>.91</td>
<td>.70</td>
<td>.48</td>
</tr>
<tr>
<td>CWalk Safety</td>
<td><strong>12.06</strong></td>
<td>7.46</td>
<td>1.62</td>
<td>.13</td>
</tr>
<tr>
<td>CPARENT Safety</td>
<td>-.68</td>
<td>.51</td>
<td>-1.33</td>
<td>.19</td>
</tr>
<tr>
<td>Child Physical Activity*CWalk Safety</td>
<td>-1.18</td>
<td>1.15</td>
<td>-1.03</td>
<td>.30</td>
</tr>
</tbody>
</table>

*ICC* = .040

1 higher score indicates more supportive environment for walking
2 Higher score indicates more safe
### Table IV.64 Model H2c6a

*Simultaneous multilevel regression analysis* for walking infrastructure, parent’s perceived safety, child gender and age, PA levels, Travel to school predicting child V-Sit.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>SE</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>27.44</td>
<td>10.12</td>
<td>2.71</td>
<td>.02</td>
</tr>
<tr>
<td>Female</td>
<td>-.15</td>
<td>.39</td>
<td>-.04</td>
<td>.97</td>
</tr>
<tr>
<td>Centered Age</td>
<td>1.00</td>
<td>1.34</td>
<td>.74</td>
<td>.46</td>
</tr>
<tr>
<td>Travel to school</td>
<td>4.89</td>
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<td>.06</td>
</tr>
<tr>
<td>Child Physical Activity</td>
<td>.92</td>
<td>.90</td>
<td>1.02</td>
<td>.31</td>
</tr>
<tr>
<td>CWalk Infrastructure¹</td>
<td>-.49</td>
<td>4.45</td>
<td>-.11</td>
<td>.91</td>
</tr>
<tr>
<td>CParent Safety²</td>
<td>-.35</td>
<td>.48</td>
<td>-.74</td>
<td>.46</td>
</tr>
<tr>
<td>CParent Safety*CWalk Infrastructure</td>
<td>-.23</td>
<td>.75</td>
<td>-.31</td>
<td>.76</td>
</tr>
</tbody>
</table>

*ICC= .066

¹ higher score indicates more supportive environment for walking

Table IV.65 Model H2c6b

*Simultaneous multilevel regression analysis* for walking infrastructure, parent’s perceived safety, child gender and age, PA levels, Travel to school predicting child V-Sit.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>SE</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>28.41</td>
<td>10.11</td>
<td>2.81</td>
<td>.01</td>
</tr>
<tr>
<td>Female</td>
<td>.010</td>
<td>.39</td>
<td>0.00</td>
<td>.998</td>
</tr>
<tr>
<td>Centered Age</td>
<td>1.01</td>
<td>1.34</td>
<td>.75</td>
<td>.45</td>
</tr>
<tr>
<td>Travel to school</td>
<td>4.87</td>
<td>2.55</td>
<td>1.91</td>
<td>.06</td>
</tr>
<tr>
<td>Child Physical Activity</td>
<td>.76</td>
<td>.91</td>
<td>.83</td>
<td>.40</td>
</tr>
<tr>
<td>CWalk Infrastructure¹</td>
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<td>.57</td>
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<tr>
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<td>-.66</td>
<td>.51</td>
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<tr>
<td>Child Physical Activity*CWalk Infrastructure</td>
<td>-.97</td>
<td>1.39</td>
<td>-.70</td>
<td>.49</td>
</tr>
</tbody>
</table>

*ICC= .060

¹ higher score indicates more supportive environment for walking

² Higher score indicates more safe
Table IV.66 Model H2c7a  
*Simultaneous multilevel regression analysis* for walking condition, parent’s perceived safety, child gender, age, physical activity and travel to school predicting child Curl Up.  

<table>
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<td>3.28</td>
<td>.71</td>
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<td>Centered Age</td>
<td>.74</td>
<td>1.11</td>
<td>.67</td>
<td>.51</td>
</tr>
<tr>
<td>Child Physical Activity</td>
<td>.39</td>
<td>.73</td>
<td>.54</td>
<td>.59</td>
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<td>Travel to school</td>
<td>1.35</td>
<td>2.03</td>
<td>.66</td>
<td>.51</td>
</tr>
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</tr>
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<td>.44</td>
<td>.66</td>
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<tr>
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</tr>
</tbody>
</table>

$^*ICC= .016$

$^1$ higher score indicates more supportive environment for walking

$^2$ Higher score indicates more safe

Table IV.67 Model H2c7b  
*Simultaneous multilevel regression analysis* for walking condition, parent’s perceived safety, child gender, age, physical activity and travel to school predicting child Curl Up.  

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<td>.58</td>
<td>.57</td>
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<tr>
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<td>1.11</td>
<td>.47</td>
<td>.64</td>
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<td>Child Physical Activity</td>
<td>.52</td>
<td>.74</td>
<td>.70</td>
<td>.48</td>
</tr>
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<td>Travel to school</td>
<td>1.28</td>
<td>2.01</td>
<td>.64</td>
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<tr>
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<td>.15</td>
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<td>.72</td>
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<td>1.37</td>
<td>.17</td>
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</tbody>
</table>

$^*ICC= .010$

$^1$ higher score indicates more supportive environment for walking

$^2$ Higher score indicates more safe
**Table IV.68 Model H2c8a**

*Simultaneous multilevel regression analysis* for walking safety, parent’s perceived safety, child gender, age, physical activity and travel to school predicting child Curl Up.

<table>
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<th>Estimate</th>
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</thead>
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<td>3.29</td>
<td>.54</td>
<td>.60</td>
</tr>
<tr>
<td>Centered Age</td>
<td>.73</td>
<td>1.11</td>
<td>.66</td>
<td>.51</td>
</tr>
<tr>
<td>Child Physical Activity</td>
<td>.32</td>
<td>.74</td>
<td>.44</td>
<td>.66</td>
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<tr>
<td>Travel to school</td>
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<td>2.70</td>
<td>2.05</td>
<td>.06</td>
</tr>
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<td>CParen Safety$^2$</td>
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<td>.57</td>
<td>.57</td>
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<tr>
<td>CParen Safety*CWalk Safety</td>
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<td>.45</td>
<td>.66</td>
</tr>
</tbody>
</table>

$^1$ICC= .015  
$^2$ Higher score indicates more supportive environment for walking

**Table IV.69 Model H2c8b**

*Simultaneous multilevel regression analysis* for walking safety, parent’s perceived safety, child gender, age, physical activity and travel to school predicting child Curl Up.

<table>
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<th>P</th>
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<td>3.3</td>
<td>.60</td>
<td>.02</td>
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<tr>
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</tr>
<tr>
<td>Child Physical Activity</td>
<td>.44</td>
<td>.75</td>
<td>.59</td>
<td>.55</td>
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<td>Travel to school</td>
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<td>.60</td>
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<td>CParen Safety$^2$</td>
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<td>Child Physical Activity*CWalk Safety</td>
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<td>.96</td>
<td>.34</td>
</tr>
</tbody>
</table>

$^1$ICC= .013  
$^2$ Higher score indicates more supportive environment for walking

Higher score indicates more safe
Table IV.70 Model H2c9a

*Simultaneous multilevel regression analysis* for walking infrastructure, parent’s perceived safety, child gender and age predicting child Curl Up.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
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<th>P</th>
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</thead>
<tbody>
<tr>
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<td>Female</td>
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<td>.05</td>
<td>.96</td>
</tr>
<tr>
<td>Centered Age</td>
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</tr>
<tr>
<td>Child Physical Activity</td>
<td>.31</td>
<td>.72</td>
<td>.43</td>
<td>.67</td>
</tr>
<tr>
<td>Travel to school</td>
<td>13.31</td>
<td>3.30</td>
<td>4.03</td>
<td>&lt;.0001</td>
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<td>1.15</td>
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<td>.35</td>
<td>.73</td>
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<tr>
<td>CParent Safety(^2)</td>
<td>.66</td>
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<td>1.71</td>
<td>.08</td>
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<tr>
<td>CParent Safety* CWalk Infrastructure</td>
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<td>.60</td>
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<td>.04</td>
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</tbody>
</table>

\(^*1\)ICC= .039  
\(^1\) higher score indicates more supportive environment for walking  
\(^2\) Higher score indicates more safe

In model H2c9a where travel to school was significant, the interaction term of parent safety and *walk infrastructure* was also significant demonstrating a moderating effect of *walk infrastructure* on parent safety for Curl Up percentile controlling for age, gender, travel to school and physical activity. Figure IV.13 demonstrates the interaction between the environment and parent’s safety perception. In census tracts where the walking infrastructure is high there is a large difference in child curl up percentile between children with parents whose safety perception is high vs. low while in census tracts with low walking infrastructure the effect is reversed. Thus, the positive effect of *walk infrastructure* is greater for children whose parents perceive greater safety than for children whose parents perceive their area be less safe as seen in Figure IV.13.
Table IV.71 Model H2c9b

Simultaneous multilevel regression analysis for walking infrastructure, parent’s perceived safety, child gender and age predicting child Curl Up.

<table>
<thead>
<tr>
<th>Variable</th>
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</thead>
<tbody>
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<td>3.2</td>
<td>.05</td>
<td>.96</td>
</tr>
<tr>
<td>Centered Age</td>
<td>.32</td>
<td>1.08</td>
<td>.29</td>
<td>.77</td>
</tr>
<tr>
<td>Child Physical Activity</td>
<td>.42</td>
<td>.74</td>
<td>.58</td>
<td>.56</td>
</tr>
<tr>
<td>Travel to school</td>
<td>13.14</td>
<td>3.23</td>
<td>4.07</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>CWalk Infrastructure(^1)</td>
<td>-.84</td>
<td>3.35</td>
<td>-.25</td>
<td>.81</td>
</tr>
<tr>
<td>CParent Safety(^2)</td>
<td>.46</td>
<td>.38</td>
<td>1.20</td>
<td>.23</td>
</tr>
<tr>
<td>CWalk Infrastructure*Child Physical Activity</td>
<td>.92</td>
<td>1.12</td>
<td>.82</td>
<td>.41</td>
</tr>
</tbody>
</table>

*ICC = .054

\(^1\) higher score indicates more supportive environment for walking
\(^2\) Higher score indicates more safe
Table IV.72 Model H2c10a

*Simultaneous multilevel regression analysis* for walking condition, parent’s perceived safety, child gender and age, PA levels, Travel to school predicting child Vertical Jump.

<table>
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<td>1.20</td>
<td>.25</td>
</tr>
<tr>
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<td>1.23</td>
<td>-1.06</td>
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<tr>
<td>Child Physical Activity</td>
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<td>.83</td>
<td>1.68</td>
<td>.09</td>
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<tr>
<td>Travel to school</td>
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<td>2.37</td>
<td>.80</td>
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<td><strong>4.18</strong></td>
<td><strong>2.07</strong></td>
<td><strong>2.02</strong></td>
<td><strong>.06</strong></td>
</tr>
<tr>
<td>CPARENT Safety^{2}</td>
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<td>.50</td>
<td>-.98</td>
<td>.33</td>
</tr>
<tr>
<td>CPARENT Safety*CWalk Condition</td>
<td>-.12</td>
<td>.29</td>
<td>-.42</td>
<td>.67</td>
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</tbody>
</table>

*ICC= .144
^{1}higher score indicates more supportive environment for walking
^{2}Higher score indicates more safe

Table IV.73 Model H2c10b

*Simultaneous multilevel regression analysis* for walking condition, parent’s perceived safety, child gender and age, PA levels, Travel to school predicting child Vertical Jump.

<table>
<thead>
<tr>
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<th>Estimate</th>
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<td>3.60</td>
<td>1.27</td>
<td>.23</td>
</tr>
<tr>
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<td>-1.12</td>
<td>.27</td>
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<tr>
<td>Child Physical Activity</td>
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<td>.83</td>
<td>1.78</td>
<td>.08</td>
</tr>
<tr>
<td>Travel to school</td>
<td>1.92</td>
<td>2.37</td>
<td>.81</td>
<td>.42</td>
</tr>
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<td><strong>.53</strong></td>
<td><strong>.61</strong></td>
</tr>
<tr>
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<td>.49</td>
<td>-.90</td>
<td>.37</td>
</tr>
<tr>
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<td>.47</td>
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</table>

*ICC= .143
^{1}higher score indicates more supportive environment for walking
^{2}Higher score indicates more safe
Table IV.74 Model H2c11a

Simultaneous multilevel regression analysis for walking safety, parent’s perceived safety, child gender and age predicting, PA levels, Travel to school child Vertical Jump.

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<thead>
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<tbody>
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<td>3.65</td>
<td>1.17</td>
<td>.26</td>
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<td>1.24</td>
<td>-1.05</td>
<td>.29</td>
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<tr>
<td>Child Physical Activity</td>
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<td>.83</td>
<td>1.65</td>
<td>.10</td>
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<td>.40</td>
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<td>1.64</td>
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</table>

*ICC=.150
¹ higher score indicates more supportive environment for walking
² Higher score indicates more safe

Table IV.75 Model H2c11b

Simultaneous multilevel regression analysis for walking safety, parent’s perceived safety, child gender and age predicting, PA levels, Travel to school child Vertical Jump.

<table>
<thead>
<tr>
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<th>Estimate</th>
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<td>1.21</td>
<td>.25</td>
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<td>1.24</td>
<td>-1.03</td>
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<tr>
<td>Child Physical Activity</td>
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<td>1.61</td>
<td>.11</td>
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<tr>
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<td>.82</td>
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</table>

*ICC=.150
¹ higher score indicates more supportive environment for walking
² Higher score indicates more safe
Table IV.76 Model H2c12a

*Simultaneous multilevel regression analysis* for walking infrastructure, parent’s perceived safety, child gender and age predicting child Vertical Jump.

<table>
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<th>P</th>
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<tbody>
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<td>2.32</td>
<td>.04</td>
</tr>
<tr>
<td>Female</td>
<td>4.58</td>
<td>3.63</td>
<td>1.26</td>
<td>.23</td>
</tr>
<tr>
<td>Centered Age</td>
<td>-1.39</td>
<td>1.24</td>
<td>-1.12</td>
<td>.26</td>
</tr>
<tr>
<td>Child Physical Activity</td>
<td>1.41</td>
<td>.83</td>
<td>1.69</td>
<td>.09</td>
</tr>
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<td>.50</td>
</tr>
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<td>5.33</td>
<td>-0.75</td>
<td>.47</td>
</tr>
<tr>
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<td>-0.09</td>
<td>.92</td>
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</table>

\(^1\)ICC= .146
\(^2\)higher score indicates more supportive environment for walking

Table IV.77 Model H2c12b

*Simultaneous multilevel regression analysis* for walking infrastructure, parent’s perceived safety, child gender and age predicting child Vertical Jump.

<table>
<thead>
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<td>.04</td>
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</tr>
<tr>
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<td>1.24</td>
<td>-1.15</td>
<td>.25</td>
</tr>
<tr>
<td>Child Physical Activity</td>
<td>1.40</td>
<td>.85</td>
<td>1.65</td>
<td>.10</td>
</tr>
<tr>
<td>Travel to school</td>
<td>1.75</td>
<td>2.39</td>
<td>.73</td>
<td>.47</td>
</tr>
<tr>
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<td>9.07</td>
<td>-.31</td>
<td>.76</td>
</tr>
<tr>
<td>CParent Safety(^2)</td>
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<td>.46</td>
<td>-.31</td>
<td>.75</td>
</tr>
<tr>
<td>Child Physical Activity*CWalk Infrastructure</td>
<td>-.29</td>
<td>1.28</td>
<td>-.22</td>
<td>.82</td>
</tr>
</tbody>
</table>

\(^1\)ICC= .166
\(^2\)higher score indicates more supportive environment for walking

Higher score indicates more safe
CHAPTER V

DISCUSSION

The Family Influence Model suggests that a child’s behavior is affected by her/his parent’s beliefs, which are observed through rules, boundaries, and opportunities existing in the home environment. These are, in turn, moderated by the external environment outside of the home. Taken together, this leads to a child’s moderate to vigorous physical activity (MVPA) in the immediate timeline, and affects longer-term health outcomes. Even further down the road, health outcomes emerge due to limited physical activity, including obesity, an increase in CVD risk factors and reduced cardiovascular functioning (Kimiecik et al., 1996). This study analyzed the effect on obesity outcome measures commonly used on children, including BMI and fitness measures, in relation to the home environment with regard to parental safety beliefs and perceptions, and the external built environment in which children live, travel and play.

Additional variables including method of travel to school, number of TVs and computers in the home, rules about TV/video watching, amount of TV time and a child’s physical activity level were also considered based on the Family Influence Model. Only variables that were significant predictors on univariate analysis were included in the final multivariate models. A social ecological framework also describes the nesting relationship between the household in which the child lives and the environment and how the environment can moderate the relationship between the parent’s beliefs and the outcomes. This study was performed in the context of area originally referred to as the Greater Stapleton community in northeast Denver and northwest Aurora, Colorado, which is divided into 5 contiguous yet distinctive neighborhoods and comprised of 15 census tracts that exhibit observable variation in child behavior, activities, and obesity outcome measures and built environment features.
The results of this study showed significant effects at the census tract level with respect to child obesity measures, including BMI percentile and fitness measures of Curl Up percentile and Vertical Jump percentile (ICCs BMI 8.1%, curl up 6.6% and vertical jump 17.7%). There was no effect on the V-sit outcome with models including the individual household level or the census tract environmental level indicating that the V-Sit test which is a measure of flexibility versus strength, behaves differently in this age population and may not be a valuable outcome measure for children between the ages 10-14 when looking at these types of predictors.

This study sought to explain observed neighborhood and census tract variation of variables at the census tract level (walking audits) in addition to individual level variables (parent safety, travel to school, TV time). Multilevel models were used in this study, which considers the effect of clustering within groups such as neighborhoods or census tracts (Diez-Roux, 2000). The design of this study allowed individual predictor variables to be collected at the household level along with the various outcome variables by simultaneously collecting data from children and parents. In addition, household recruitment followed a specific sampling method in order to utilize level 2 environmental variables from a previous study in the same area to test for a group effect and to determine if there was a moderating effect between the household parent safety variables and the census tract walking variables while controlling for child age, gender and physical activity.

Social ecological theory is a set of theoretical principles that explain human health through the interrelations among personal and environmental factors (Stokols, 1996) This study recognizes that factors beyond the individual level may affect children’s health through their weight and physical activity and that those factors may interact in affecting health related outcomes. Glidden’s Structuration Theory posits that structure and agency are two sides of the
same coin and neither have dominance in society and in fact one may influence the other through the recursiveness of social life (Giddens, 1984). The structure that affects people and individuals can subsequently modify the environment (structure) within which they live work and play. The relationship between parent’s perception of safety and the environment’s objective condition, safety factors or infrastructure reinforce this dualism that Giddens spoke of that can affect health and behavior. The Family Influence Model served as a framework for this study in that child behavior can be influenced by factors at the household level and moderated by the external environment specifically as it relates to physical activity (Kimiecik & Horn, 1998; Kimiecik et al., 1996). The variables chosen for this study include factors that relate to the external environment (walking audits) and household variables (travel to school, TV time, TV/video rules and parent safety perception) according to the adaptation of the Family Influence Model (Appendix H).

**Neighborhood Structure**

While not a primary aim of this study, significant variation was observed between the different neighborhoods, consistent with previous TNH2H findings. The outcome variables and the independent predictor variables varied significantly across neighborhoods and census tract level. These included the built environment measures of the walking audit variables derived from the three constructs of condition, safety and infrastructure and the household variables, including parent safety perception, travel to school, and TV time. This variation was important in describing the sample used and to justify the analysis at the neighborhood and census tract level which included multilevel models with level two variables and cross level interactions. It also helps with the interpretation of the findings as the variation followed patterns based on specific variables including age, gender, physical activity, income, ethnicity and environmental structure.
The pattern of differences was observed between Stapleton/Greater Park Hill and the other three neighborhoods. This pattern persisted for predictors, such as safety, walking audits as well as covariates of parent age, income, education, and minority representation. Stapleton and Greater Park Hill parents were slightly older, had higher income and higher education level and were predominantly white non-Hispanic as compared to the other three neighborhoods in this sample. It is unclear due to the cross sectional nature of this study if the racial composition of the neighborhoods is due to self-selection of the members and thereby distorting the interpretation of any true contextual effect (Diez-Roux, 2000). The NE Park Hill, East Montclair, and NW Aurora communities have a long and rich history of minority representation and a culture that persists today (PitonFoundation, 2011). In this study, the racial/ethnic variation manifested itself in safety perception of parents and children. Children in general felt less safe outside than their parents felt with regard to safety concerns about them playing outside. When asked about crime the numbers reversed with kids feeling safer from crime (66%) vs. parents (44%). City level crime rates were not a significant predictor of maternal fear in a representative study of US urban families (Kimbro & Schachter, 2011). The question referring to “crime” perhaps has a different effect on young children. Children may not see themselves as a victim of crime or know what that exactly means but know when they themselves feel unsafe. They can express that fear based on their previous experiences but may not have had an experience with “true crime”. The bully may make them feel unsafe at school or in the park but they might not associate that behavior as criminal even if an activity like drug dealing was involved. Neighborhood crime rates (not captured in this study) and the reporting of those in the community via media outlets may not be accessible to children as easily as to adults or understood if reported on TV or radio.
Parents of minority children perceived less safety in general than parents of white children regardless of age or gender of the children. This was consistent with findings from the Fragile Families and Child Well-being study where living in a census tract with high black population and households in poverty was associated with high maternal fear (Kimbro & Schachter, 2011). Minority children reported a similar pattern, which persisted across income levels. While the relationship between income and race is complex and confounded by many factors, US Census data has documented an association between minority household and lower median income across the US (PewResearchCenter, 2011). Further, racial segregation by neighborhood persists in the US today (Osypuk, Galea, McArdle, & Acevedo-Garcia, 2009).

What was most striking is the extreme difference between Stapleton (predominately higher income and white) and the other neighborhoods with regard to parent’s safety perception. The construct used for parent’s safety perception in this study consisted of concern of safety due to traffic, gangs and crime. Table IV.4 in the results section shows the individual items that measured safety in addition to the composite score created for the models. The Family Influence Model presents a mechanism for the parent’s beliefs and attitudes to affect a child’s behavior and eventual health outcome.

Household influences controlled by the parent, such as the amount of TV time, the number of computers, and the number of pieces of exercise equipment, followed income-level patterns. Child behaviors including, physical activity levels, walking to a friend’s house and travel to school were not different between neighborhoods or census tracts, except for bike use, which was higher in Stapleton. That activity is likely related to the structural design of the streets as the concern over traffic was significantly lower in the Stapleton neighborhood. Stapleton is built on 4700 acres with 1/3 mixed used, green space, pocket parks, bike and walking trails, wide...
sidewalks and will be home to over 30,000 residents. Stapleton is a community that is based on New Urbanism that addresses the implementation challenges of building walkable neighborhoods and maintaining healthy regions. The conventional suburban model promotes sprawl, the traditional neighborhood design (TND) promotes community (Forest City, 2011). Urban design and city planning may have had a direct effect on child behavior due to the structure of the community and may lead to further neighborhood planning and social policies that can have a positive effect on children’s physical activity and health behavior.

These other activities may be related to factors outside of the neighborhood (school, physical activity at private or commercial facilities) and do not support the differences observed, especially as they relate to SES factors or local built environment features. The greatest within neighborhood differences were observed in Greater Park Hill, as evidenced by the two northern census tracts (41.03, 41.04) behaving in most areas in this research more like NE Park Hill. This was also supported by US Census 2006-2010 median income estimates for these census tracts (US Census Bureau, 2010). In fact, the official map of all 77 Denver neighborhoods has Greater Park Hill listed as North Park Hill and South Park Hill divided as described above (PitonFoundation, 2011). Differences within the NW Aurora neighborhood exist as well. The NW Aurora census tracts seem to differ between the two northern census tracts (79.0, 80.0) and the other census tracts in that neighborhood. These two census tracts are north of Colfax Ave and border Stapleton along its southern border. In some maps this difference is noted as Original Aurora and not grouped together as NW Aurora. The original plan for Stapleton known as “The Green Book” (Stapleton Redevelopment Foundation, 1995) planned for continuity in the streets between the southern border of Stapleton and this part of Aurora crossing over Montview Blvd
and along 25th Ave. The intent as stated by the Stapleton Foundation is that a new community will be created that is “seamlessly connected to the communities that surround Stapleton.”

Once again it is hard to know if the differences in these census tracts are due to the Stapleton development and the improvement in infrastructure that was introduced as that neighborhood was developed or a composition effect of those individuals who reside in those census tracts even prior to the new development. Data from the US Census Bureau American Community Survey (ACS 2005-2009) estimates reveal that the median income of the two census tracts closer to Stapleton are higher than the census tracts to the south. (US Census, 2010) These differences bring up the concern about how neighborhoods are defined and if these artificial geographic constructions are contributing to how children behave as they interact with the physical or social environment. This supports the methods used in this study to collect data at the smallest possible unit such as census tract, or even block group or block whenever possible. These differences at the census tract level, support the idea that individual and family behavior may not coincide with boundaries as broad as neighborhood, and in fact may be linked to more local and specific units or areas of measurement. Social Ecological Theory recognizes varied sizes and levels of nesting (Figures II.2-II.4) that influences the individual. The outer circles of these ecological models are important for policy changes but the closer inside circles outside of the home, along with the artificial and somewhat arbitrary definition of neighborhood may have a greater effect on the individual especially if that person is a child and if the circles are smaller and more proximate to the child’s social and physical world. This may be the case when looking at smaller areas than neighborhood such as census tract, block group or even the block. In fact since this study was performed the Stapleton community (one single census tract 41.05) has now been divided into seven separate neighborhoods by the developer and with the resulting
population increase I am sure will have more than one census tract by the time of the 2020 census.

   Neighborhoods that had lower percentages of children who spent greater than 2 hours per day watching TV or video during the week had a greater percentage of children that participated in at least 1 sport team. This may be reflective of these children being involved in sports after school during the week and not having time for TV with dinner and homework to do in the evening. There is only so much time a child has during a school year, and there may be a need to allocate that time to positive activity promoting behaviors vs. negative obesogenic behaviors.

   Bike helmet use varied by neighborhood and census tract and may be related to income, and is related to helmet ownership, which has a purchase cost. On the other hand, seat belt use has no purchase cost, and therefore these may be more economic decisions instead of a purely safety or health behavior decision. The two neighborhoods with the highest income had the highest bike helmet use (Kendall’s W(1df) =30.81, \( p <.0001 \)). This reinforces the importance of income when it comes to health behaviors and choices. A continuous and prominent thread throughout the analysis of variation noted between neighborhoods is household income (Table IV.2).

   Differences in the mode of transportation to school may be due to availability of bus service in a neighborhood or the location of the schools. The Colfax Avenue corridor is a part of the East Montclair neighborhood which may offer more bus stops convenient to the neighborhood children. Denver Public School children can purchase RTD bus passes and ride commercial bus routes which are present along Colfax Ave. NW Aurora which had the highest walking rate and lowest bus rate is in a different city and school district (Aurora Public Schools) than the other neighborhoods and bus service policies and availability may be different.
Stapleton was unique in the amount of bike travel which can be related to the street design of the neighborhood and the lack of concern over traffic safety which was the lowest of all 5 neighborhoods and census tracts $\chi^2 (4, N = 255) = 126.37, p < .0001$. This reinforces the environmental or structural component that leads to behavior consistent with a social ecological framework of active living (J. F. Sallis & Glanz, 2006). These factors are located in the outer rings of the ecological models and have affects upon a child’s weight and other health behaviors (Davison & Birch, 2001). Yes, choice is important, but what drives that choice or steers it in one direction over another is also important. For example, choices to use public transportation may involve individual decisions, but must also rely on the availability and accessibility of that service like bus routes and the cost involved with that decision.

The fact that the neighborhood with the highest income, highest safety and lowest BMI and highest fitness outcomes has the lowest amount of physical education (PE) days per week likely points to a factor not incorporated into this study. The amount of PE in schools has decreased recently due to concerns over budgets and school academic performance on standardized tests (Trost, 2009). A study by the California Department of Education supports a positive relationship between physical fitness and academic achievement (California Department of Education, 2005). While school based figures on academic achievement are not available in this study the lower amount of children in Stapleton with PE at least 3 days or more per week may be reflective of the types of schools in that neighborhood (i.e. experiential charter school) vs. more traditional schools in the other neighborhoods. Most of the children in Stapleton reported having PE in school only 2 days per week. Only 10% of children reported PE 5 days per week in Stapleton as compared to an almost 40% average of the other neighborhoods. Physical activity (PA) guidelines from the US Department of HHS recommend children are physically
active for 60 min/day daily (HHS, 2008). Only slightly more than 50% of the children in this sample were meeting that guideline with the neighborhood range from 50%-61% and no differences between neighborhoods \( \chi^2(4, N = 252) = 1.55, p = .82 \) or census tracts \( \chi^2 (14, N = 252) = 17.69, p = .22 \). This was also true when PA levels were looked at as a continuous measure of days per week. In a nationally representative survey 77% of children in this same age group reported participating in physical activity in the previous 7 days (CDC, 2012). Twenty percent of children in the sample in Stapleton and forty percent of the children in Gr. Park Hill performed physical activity at a private facility as compared to just 5% of children in East Montclair. This suggests that while PE is important in neighborhoods like Stapleton and Gr. Park Hill, it may not be as necessary and important as in communities with low income households where opportunities for PA are limited due to infrastructure but also income. Race and income can be an individual factor but also are a group factor where the neighborhood may not have the social and economic capital to improve opportunities for PA in safe and effective public recreation facilities and/or schools. Children in a neighborhood like Stapleton are apparently getting their physical activity outside of school in private facilities since the amount of PA does not differ by neighborhood, the private facility usage is higher and yet the school PE days are the lowest of the neighborhoods and census tracts. In addition recent improvements in the Stapleton neighborhood to parks and recreational centers were performed after these data were collected but additional opportunities in neighborhoods with greater economic and social capital may further reduce the need for PE in the schools as a tradeoff for greater academic time.

This once again reinforces that neighborhood effects can limit the choice an individual has and context can determine people’s choices (Kawachi & Berkman, 2003). These differences across neighborhood and census tracts are not simply a reflection of the make up or composition
of the individuals who live there but tied to area itself and the group level variation observed in the data.

**Measures of Physical Activity and Obesity**

This aim evaluated fitness measures as compared to BMI deriving from concerns over the accuracy of BMI measurement when it is self-reported (Goodman, Hinden, & Khandelwal, 2000) and the lack of validity as a measure of body fatness (Freedman & Sherry, 2009). In addition, the stigmatization related to BMI documented in the literature (R. M. Puhl & Latner, 2007) also leads to a question of whether there is a more suitable method to evaluate children in school that is performance based versus labeling or classifying based on statistical categories of height and weight.

The first hypothesis was not supported by the data collected in this study. The walking audit variables that were significantly associated with the outcomes were more often associated with BMI than the fitness measures. Many studies over time have used BMI as an outcome for adults and children in obesity studies. These have been experimental intervention studies as well as cross sectional observational studies. Many times height and weight are self-reported and BMI is then calculated from those self-reported measures. In this study height and weight were measured in the field and BMI calculated and then converted by the principle investigator and author to an age and gender percentile. The CDC BRFSS and YRBS surveys continued to use self-reported height and weight while data from NHANES are actual measurements of height and weight with BMI calculated from those more accurate measures. It is considered a strength of a study using BMI if actual measures are taken versus when body composition measures are based on self-reported data which are known to be susceptible to bias (Harrington & Elliott, 2009). The raw scores of BMI in this study varied from 8.3 to 46 with a mean of 20 and a SD of
4.8. By converting to a percentile the range went from 1-99 with a mean of 60 and a SD of 30. The distribution became more spread out with a larger amount of variation leading to larger standard errors in the models. Even the removal of outliers from the raw score had a small effect on the percentiles since the distribution had a ceiling effect by the percentile of 99 and a more broad range of values between 1 and 99. This effect was similarly noted in the fitness measures when converting to the age and gender percentiles. The distribution lost its normal curve and had greater variance.

While these outcome measures were accurate (within the limitations of measurement error from the different data collectors) the conversion to percentiles may have led to greater error in the model estimates causing lower p-values. Even so the walking audit constructs of condition and safety were associated with BMI and curl up outcomes even though the t values were higher and more significant for BMI. A number of factors can explain why the fitness measures were not more strongly associated with the condition and safety measures of the environment. While widely accepted, easy to apply and validated measures were used (President’s Challenge) for fitness testing along with training sessions for data collectors, the inherent variability in performing these tests on children in the field can distort the results. Height and weight were read off validated equipment with digital read outs. Curl Ups were performed as instructed with the outcome a single count. The Vertical Jump and V-Sit involved taking a measure, reading off of a ruler (with error) and performing a simple calculation that can introduce additional error and while there were efforts to minimize this these two tests were subjected to greater error than the others and could have affected the results. It certainly makes the use of these tests more difficult in the field for research purposes.
The V-sit seemed to have the least association with the other outcome variables and many predictors as well. A 2006 study of Greek primary school children with similar age to this study did show that while there were strong associations between BMI categories and fitness, this did not include flexibility as measured with a similar test (Tokmakidis, Kasambalis, & Christodoulous, 2006). A study performed in the US also showed association between fitness and weight status excluding flexibility in children under 14 (Kim et al., 2005). Other studies on children to assess obesity prevalence have shown that methodological differences with regard to measurement in children can confound results (Valerio et al., 2003). Variation in the V-Sit outcome can be related to a child’s growth and not fitness as would the other strength measures. Hormonal growth spurts occur in boys between ages 10-15 and girls between ages 8-13 causing tightness in lower extremity muscles evident in the V-Sit test. A lack of fitness may exacerbate this tightness but the fact that there were no relationships between the V-Sit and any of the other outcome variables in this study may lead one to believe at this age the low V-Sit scores may be due to growth in stature vs. an increase in weight and poor fitness (variables of interest in this study). While there was no correlation between BMI and V-Sit, perhaps looking at BMI and child’s height alone would reveal an association related to growth in height.

A mechanism for the relationship between poor strength performance such as in the Curl Up or Vertical Jump and BMI is often a biomechanical explanation although this is not unequivocal. Children with larger mass have geometry changes that cause movement inefficiencies and affect motor proficiency (D'Hondt, Deforche, De Bourdeaudhuij, & Lenoir, 2009). Difficulty with the Curl Up and Vertical Jump could both be related to this explanation although in this study the Curl Up seemed to be more related to the hypothesized factors in this
study that affect child weight such as the walking condition and walking safety of the neighborhood and parent safety perception, all which limit outdoor activity and exercise.

As initial raw variables the values between Vertical Jump and the other outcome variables were much closer and it may be the conversion to percentiles using a different method for Vertical Jump (Texas Test) that accounted for the large difference in ICC for that variable. It was important in deciding to perform this analysis that there was variation across groups in the dependent variables and that the number of groups was sufficient for this type of multilevel analysis. If the integration of structure and agency are considered to be a theoretical driver of the effect observed in this study then one would have to acknowledge that both BMI and fitness can be affected by individual decisions and environmental structure. BMI, which has been associated with nutritional factors or the intake side of the equation involving food choices while fitness can be more related to the environmental condition and safety as was evident in the data with curl up as an outcome. Both outcomes were considered while controlling for physical activity a behavior associated with structure and agency.

Multilevel Analysis

Multilevel analysis has been used in the field of education for many years (Raudenbush & Bryk, 2002) as it was recognized that students are nested in schools that are subsequently nested in school districts and therefore the independence of these observations may not be assumed in looking at various outcomes at the student level. Interest in using multilevel analysis in health research has recently grown due to interest in ecological models and the recognition of the role neighborhoods and communities play in determinants of health (Diez-Roux, 2000; Kawachi & Berkman, 2003). Two important reasons are given for consideration of multiple levels of organization of variables (Diez-Roux, 2003). One is the unit of analysis can be defined
at the different levels and the variability of the outcome can be measured at those different levels with inferences made at those levels. What are important in this study are the inferences made about the outcome, in this case childhood obesity. It is either based upon the variability at the household level or the census tract level and that can help determine where an intervention should be aimed. Should efforts be aimed at household factors and improving parent’s perception of safety, rules about TV and computer use or should we target the neighborhood, census tract or even block and improve the condition or opportunity for activity at that higher level. One strategy may involve teachers and health professionals counseling children and parents while the other may involve community activists, bureaucrats and politicians fighting for structural change in neighborhoods and communities. Of course one must also be aware of the ecologic fallacy and the danger of inference to an individual from an analysis performed at the higher group level (Susser, 1994). If neighborhood A has a higher BMI percentile than another (neighborhood B) it does not infer that every child in neighborhood A is on average heavier than every child in neighborhood B. However data at the group (neighborhood or census tract) can tell us about the group itself and help us develop interventions at the group level that can lower the group average and subsequently have an effect on members of that group through the context versus the composition itself. This is the basis for population based health interventions where the intent is to move the mean of a population in a favorable direction as opposed to focusing on the extreme tails of a distribution (Rose, 2004). Living in a healthy neighborhood can improve your health through the benefits that area provides but it does not mean that living there guarantees you are healthy. Social ecology reminds us that context is important and that realizing that children are subjected to factors beyond themselves, their home and family but also their community and even policy decisions in their greater community (Green et al., 1996; J. F. Sallis et al., 2006). It
is the framework of ecological models that require the use of multilevel analysis tools to be able to have accurate estimates of outcomes and appropriate error values.

Additionally the availability of statistical methods and software to allow more accurate and efficient analysis of contextual variables that may impact individual outcomes has led to an increase in health researchers utilizing this type of analysis (Bickel, 2007; Littell et al., 2006; Raudenbush & Bryk, 2002; Snijders & Bosker, 1999). Multilevel regression analysis is essentially a multilevel extension of multiple regression analysis (Maas & Hox, 2005) and is supported by the design of this study and the findings from the initial descriptive analysis. Multilevel models are needed because grouped data violate the assumption of independence of all observations. The amount of dependence is expressed by the ICC of the empty (unconditional) model. ICC values at the census tract level, reported in Table IV.11, varied by outcome with unconditional values for BMI percentile at .081, Curl Ups percentile at .066, V-Sit at .068 and Vertical Jump percentile at .177. This is consistent with previous studies where an ICC of 6.6% “indicated substantial proportion of the variation in adult BMI” across the groups (Harrington & Elliott, 2009).

Walk condition and walk safety were highly correlated so it was expected that they would behave similarly with BMI percentile. The ICC for BMI percentile with walk infrastructure after adjusting for parental safety, age, gender and physical activity was 6.6%. The ICC is the ratio of the between census tract variance and the between plus the within census tract variance in BMI. All of the between census tract variance was explained by the variables that describe the condition of the census tract such as the condition of the sidewalks, houses and yards and the litter and graffiti. The safety concept includes neighborhood watch signs, alarm signs, traffic volume items that affect the safety of the area. Both of these concepts include measures of the
area that seem to affect the BMI of a child while the infrastructure concept did have the same effect. With Curl Up, the ICC decreased more for the walk condition and walk safety but not to the extent as with BMI. A similar result was seen with the Vertical Jump again not as strong as with either BMI or Curl Up. Child weight seems much more affected by the factors of the area that affect use more directly while the infrastructure is more about opportunity. Fitness does not seem to follow this as much and those outcomes may be just as much dependent upon the infrastructure of the area as much as the condition. The parent safety variable was a significant predictor of Curl Up adjusting for walk infrastructure and the significant interaction between parent safety and walk infrastructure points to the contribution of the infrastructure in moderating safety perception of parents. Thus, the positive effect of an area with a high walk infrastructure is greater for children whose parents perceive greater safety than for children whose parents perceive their neighborhoods to be unsafe. Children of parents that perceive a safer area benefit from the better infrastructure linking safety perception with opportunities over condition. It also reinforces the difference between the parent’s perception of safety and the walking audit safety measure that looked at elements that would cause an area to be unsafe like broken windows, neighborhood watch and alarm signs and traffic volume. Maybe perception is not always reality?

The difference between BMI and fitness seem to be in that one is a classification of height and weight and the other are performance measures. Perhaps the infrastructure which measures opportunity for children’s activity is demonstrated better in the performance measures rather than the static weight measures. BMI is also dependent upon food and nutrition factors, something not captured in the walking audits in this study. A factor in understanding the importance of where a child lives is recognizing the value of the opportunities that the
neighborhood can offer which is reflected in the infrastructure concept that even affects the outcome of parent safety perception. Changing the parent safety perception without addressing the higher level factor (walk infrastructure) would not affect the outcome in this case. Social disparities in health are seen because of these contextual effects and not because of the composition of the people that live in a deprived area (Kawachi & Berkman, 2003).

**Parental Safety Concerns**

The second hypothesis was supported by the data in that only the model predicting curl up was associated with parental safety while the model predicting BMI was not. This supports that for individual level factors such as parental safety perception, a fitness measure like the curl up is more strongly associated with the predictor than BMI. Maybe there is another relationship between parent safety and BMI that is not explained by the theories supporting this research such as the family influence model and Gidden’s structuration. Once again structuration implies an integration of the environment and the individual choice and behavior. BMI is dependent upon food choices more so than fitness performance like a curl up. If parent safety is theorized to prevent a child from going outdoors for play, that decision would be more likely to affect an outcome like the curl up rather than their static weight. While safety can affect food choices and opportunities for healthy eating is linked to neighborhood characteristics (Franco, Diez Roux, Glass, Caballero, & Brancati, 2008; Morland, Wing, Diez Roux, & Poole, 2002) it was not measured in this study and a child at ages 10-14 is probably not affected by that structure as much as they are their parent’s safety choice. This can explain the association between curl up and parent safety and the lack of an association with BMI.
The purpose of this second specific aim was to examine the main effects of the level 1 parental safety variable and the level 2 walking audit variables on the various outcome measures and to see if there is a moderating effect by testing a cross level interaction term in the models. Various models were in support of this hypothesis with walk condition and walk safety being negatively associated with BMI percentile and positively associated with Curl up. Most important was that parental safety was positively associated with curl up percentile in a model with walk infrastructure. This was the only model that parent safety was significantly related to any outcome and reinforces the importance of the strength measure curl up for this predictor. The level 2 built environment variables for walking condition and walking safety were associated with either BMI, Curl up or vertical jump after adjusting for physical activity, parental safety, age and gender. Specifically walk condition and walk safety were negatively associated with BMI percentile and walk safety was positively associated with curl up and there was a trend toward a positive association between vertical jump percentile and census tract level walk condition scores. This reinforces the value of the environmental variables as a measure of association with the various outcome measures for childhood obesity. It seems to support that the variables of walking condition contribute independently to the different outcomes with walking condition and walking safety contributing to BMI, walking safety to Curl up and walking condition to Vertical Jump percentile scores. Children living in census tracts with a high walking condition or walking safety score will have lower BMI, higher Curl up and vertical jump, in other words be thinner and more fit based on these tests after adjusting for physical activity, age, gender and parent safety. The model estimates predict the outcome of either BMI, curl up or Vertical jump based on a male of age 11.7 with an average PA level of 5.7 days per week. The
slope of the prediction was greater for walking safety over walking condition for both significant outcomes.

Finally it was hypothesized that the obesity or fitness outcomes of the children may depend upon the parent’s safety perception of the area and the built environment features that support walking. A cross level interaction term was constructed in the models between parent safety and the various built environment constructs related to walking. A significant interaction was discovered between parent safety and walking infrastructure in predicting curl up percentile.

There was a significant main effect of parent safety on Curl up after adjusting for walk infrastructure however there was a significant interaction between parent safety and walk infrastructure. This has an important implication for children in these census tracts and the relationship between the parent’s safety perception or belief according to the family influence model and the effect of the environment specifically the infrastructure that supports walking. If a child lives in a census tract with a higher infrastructure such as more parks and opportunities for physical activity, bike lanes and bus stops, better walking routes with houses with porches and wide sidewalks then the effect of these benefits on their curl up percentile will be stronger if the parents perceive greater safety in the area. This finding is consistent with previous research on adults in Portland, Oregon who felt that the number of street intersections in their neighborhood was conducive to walking if they also perceived the neighborhood to be safe from traffic (Li, et al, 2005). This finding is supported by Gidden’s theory of structuration in that the effect of the infrastructure (structure) is moderated by the parent’s safety perception (agency) and these two components go hand in hand affecting the child outcome. He describes how the neighborhood (or census tract) is a relational social structure and the material features of the environment (infrastructure) are allocative. Proximity is a feature that can be modified by the agency of the
parent with the perception of the safety of the area. The close proximity of a park or activity
opportunity is only valuable if the parent allows the child to use it if they feel the neighborhood
is safe. If the parent does not feel the area is safe then the value of the infrastructure is negated.
Children between the ages of 10-14 can be very susceptible to parental influence (Sumter et al.,
2009) especially about outdoor safety (Kimbro & Schachter, 2011).

Without the neighborhood being safe to the parent the bus stops and bike routes have less
value to the child and he/she will not see the benefit on the outcome in this case a strength
measure like the curl up. Future work that looks specifically at what aspects of the infrastructure
such as park distance from home or features of the park will give researchers, public health
planners and community members more information to specifically design interventions that will
encourage children to be more active and remove barriers that may prevent activity. While it is
important to recognize the main effects at the household or neighborhood/census tract level that
predict these outcomes the interaction between these two levels is also important to see how they
moderate the effect of each other.

**Role of Built Environment**

The built environment is defined as the “physical form of communities” and includes land use
patterns, large and small scale built and natural features and transportation systems and
opportunities (Brownson et al., 2009). It can affect opportunities for physical activity and lead to
changes in measures of obesity such as BMI or fitness in children. Pikora and colleagues (Pikora
et al., 2002) developed a reliable instrument that had four domains (functional, safety, aesthetic
and destination) to measure the physical environment for physical activity. Ramirez and
colleagues identified nine indicators of activity friendly communities with a greater emphasis on
policy variables such as local government funding and community campaigns to increase activity
Brownson and colleagues conducted a review of various ways to measure the built environment as it relates to physical activity. They looked at three different types of methods to measure the built environment. These were perceived self-report measures, observational audit measures and GIS based measures (Brownson et al., 2009). This present study utilized an observational audit measure adapted from The Systematic Pedestrian and Cycling Environmental Scan Instrument SPACES (Pikora et al., 2002) for the TNH2H study in 2007. Observational audit tools are used for research purposes as well as community decision making although the latter are less rigorous and not subject to reliability assessment (Moudon & Lee, 2003). This tool underwent reliability testing during the initial walking audits with acceptable kappa statistics (M=0.49-0.79) (J. L. Hill, 2009) These audits usually require in person direct observation of physical features not often incorporated into GIS databases and therefore are extremely labor intensive.

Similar to the four domains developed by Pikora, this tool had summary measures of three built environment constructs created from 58 items initially assessed and reduced systematically to 25 items; 7 condition, 6 safety and 12 infrastructure. Variation across neighborhoods (Table IV.7) and census tracts (Table IV.8) were observed with census tract means used as an independent variable in the mixed models. Brownson and colleagues (Brownson et al., 2009) have written about how these first generation assessment tools need to be simplified to improve analysis capability and ease of use. The data reduction process described above and performed by Steiner, Main and colleagues (Steiner, 2012 in preparation) is such an example of simplifying a tool for efficient use and analysis.

Variation between census tracts was observed in all three conceptual areas in the outcome variables evident by the unconditional ICCs. Significant associations were found between the
walking audit variables and the outcomes although they did differ by outcome. *Walk condition* and *walk safety* were associated with BMI and separately with Curl Up. Parent safety was associated with Curl Up with an interaction with *walk infrastructure*. This shows that each of these constructs contributes separately to the outcome variables and each has a role in accounting for the variation seen across census tracts. The fact that each of these variables was a significant predictor in at least one model demonstrates the importance of the environmental variables in predicting child obesity outcomes. Larger numbers of individuals within each census tract may have allowed the demonstration of a greater effect from the individual factors. The significant interaction observed between parent safety and walk infrastructure demonstrates that the area effect can moderate the individual factor and that place does matter on the outcomes of child obesity.
CHAPTER VI

CONCLUSION

Colorado continues to rank number one in the nation in regard to obesity prevalence in adults (Flegal, Carroll, Kit, & Ogden, 2012). At just over 20% we are the lowest state in the nation however we are the caboose on a train that is steadily moving forward toward higher obesity rates. For children we are not doing as well. In the 2007 NSCH data Colorado is ranked 23rd in obesity rates in the US (14.2%) and 34th in percentage of children participating in vigorous physical activity leading to a grade for healthy children of D+ (Colorado Health Foundation, 2011). The reasons for this disparity between adult rankings and children’s ranking in obesity are unknown. The adult population in Colorado is subject to migration of young healthy adults who come to Colorado for the healthy lifestyle we promote and yet our children that have grown up here are not following that model. Children are subject to factors such as increase screen time, decreasing formal PE and informal PA in school and changing eating habits and food choices.

This research began with a genuine interest in looking at the problem of childhood obesity through two different lenses. One is the lens of a clinician, a physical therapist, with interest in physical activity, strength and flexibility, overall fitness and a focus on the individual child and their behavior. The second as a public health professional with an understanding of a population based approach and the impact of the multilevel external influences such as the built environment and parental influence on a child’s individual behavior. These two approaches can sometimes be in conflict but this study was interested in how they can both affect the outcomes in a child and possibly interact so that one may moderate the effect of the other. It was also important from a physical therapist perspective to attempt to determine which would be a better
outcome to look at in children, BMI or fitness, as strategies are developed to combat the growing obesity epidemic and methods devised to measure the effectiveness of those interventions and monitor changes in children over time. The IOM recently released a preliminary consensus report that assessed the relationship between youth fitness test items and health outcomes. (IOM, 2012). Recommendations were made regarding specific tests, some which were included in this study.

It was determined that the built environment concepts of walking condition and walking safety at the census tract level are associated with BMI percentile and fitness measures of Curl Up and Vertical Jump. Parental safety perception at the individual level was associated with Curl Up and moderates the effect of walking infrastructure at the census tract level. This is an important finding in showing that fitness measures have a value as an outcome in measuring the effect of individual and census tract level variables on children’s obesity outcomes and that the effect of the parent’s safety perception is moderated by the infrastructure of the area that they live in. While both had significant main effects on the various outcomes, the significant interaction implies that parent’s influence and the impact of environment is not an either or proposition and can work hand in hand on the effect on child obesity.

Limitations

This study had a number of limitations that must be acknowledged. First as a cross sectional study causal inferences for the outcomes of BMI and fitness are not possible without longitudinal data. Correlation between variables X and Y simply indicates that X influences Y and Y may influence X or both are influenced by a common confounding factor (Messerli, 2012). Although causality can be inferred with observational studies that include; a time sequence, consistency, strength of association, a dose response, and biologic plausibility, cross sectional studies suffer from the lack of a time element (Portney & Watkins, 2000). Changes in
the outcome variables would have to be measured over time with an association with the predictors controlling for known possible confounders. Neighborhood studies also cannot deal with problems due to migration and instability of inhabitants (S. Macintyre & A. Ellaway, 2003). The outcome being observed may be related to an exposure that occurred many years before and the population presently may not be the same as the population who received the exposure.

A second limitation is that health and activity levels were self-reported and while perceptions of the inhabitants are essential, they may differ from the objective measures of physical activity using accelerometers and school based data. Measurement error is always a concern when various data collectors are used and when measurements are taken in the field in people’s homes and even front yards. Data collectors went through rigorous training on interview techniques and the practical hands on aspects including height and weight measures with valid equipment and the fitness testing. Weekly meetings were held during the data collection period with all of the collectors and the research team to discuss problems or challenges that came up with recruitment, measurement or feedback from participants. Some of these included neighbors alerting the police about pairs of strangers going door to door. One community had a “mother’s at home blog” that initially asked about the data collectors and then blogged about the importance of the study once they confirmed the credibility of the data collectors. This may ultimately have helped improve our recruitment rather than hinder it.

There were 256 pairs of interviews performed. These observations were nested within 5 neighborhoods and 15 census tracts. Walking audits were performed at the block level and although the household surveys were also coded down to the block level, the total amount of surveys collected and the limited distribution across census tracts prevented analysis beyond the census tract level (Table IV.1). Groups at a more specific level (block groups or blocks) would
have been beneficial based on the variations observed at the census tract level in the outcomes as well as the predictor variables although it has been reported that correlations for census tract and block measures are generally very high (Diez-Roux et al., 2001). The literature on multilevel studies states that the number of groups are more important than the number of individual observations (Browne & Draper, 2000; Maas & Hox, 2005), however when the data were grouped at a block group level there were many singlets as well as block groups with zero values that would have posed a problem with analysis. While the focus of the study was on the between census tract variation a larger number of observations within the clusters would have allowed greater analysis at the within census tract level and the consideration of additional covariates without a loss of power. Effect sizes can be based on the type of data collected. BMI data over time had an effect of 3-5% change with some studies powering for up to a 10% change (Flegal et al., 2010). Medium effect sizes for regression models according to Cohen are .25 (J. Cohen, 1988). With 4 predictors and a desired level of power of .80, a sample size of 53 is required (Dupont & Plummer, 1990). With a small effect size a sample of 597 is required therefore there is a possibility of this study being underpowered.

Previous authors have discussed the complexity in determining sample size for a multilevel study (Bickel, 2007). Multilevel modeling becomes attractive when the number of groups is larger than ten and the design effect greater than two (Snijders & Bosker, 1999). This sample had 15 groups at the census tract level and an average number of 17 per group with design effects greater than 2 for all dependent variables. A previous multilevel study with significant neighborhood effects had an average within cluster sample size of 10 (Li et al., 2005). In the case of BMI percentile a random effects model was not necessary because the variation between census tracts seen in the unconditional model was essentially fully explained by the
variables walk condition and walk safety. In that case a fixed effects model was adequate and was used in these two cases (BMI percentile with walk condition or walk safety as predictors).

Due to the fact that the various fitness measures were not correlated and there is evidence to support that flexibility and strength may be different constructs in children (IOM, 2012), the models were run separately for each outcome along with each environmental predictor. This along with the tests for interaction of the level one and level two variables led to a large amount of models being listed in the results section. Physical activity, while not a primary outcome of this study, was a potential mediator of the effect of the environment on the child outcomes, therefore additional models were created to address that concern as well. Therefore, the significant associations discovered with regard to the walking audit variables could be due to chance as a result of these multiple comparisons especially in light of the limited sample size discussed above. Decisions to model each outcome separately and the environmental constructs separately were based on the intercorrelations between the variables and the literature on child fitness.

Finally since this study was performed in a specific area of northeast Denver on children ages 10-14, the generalizability of findings is limited to children of these ages, in communities of similar geography, social and physical environment and economic makeup.

**Contributions of the Study**

This study demonstrates the importance of understanding the effect of area (neighborhood or census tract) variation on childhood obesity outcomes and how it can be an important part in and developing programs and interventions. The size of the ICCs (8.1%-17.7%) for the various outcomes demonstrates evidence of an important group effect in the outcomes of BMI or fitness for children ages 10-14. The clustering effect of these individual outcomes can
lead to community based programs that can be aimed at the most appropriate level whether it is neighborhood, census tract or even block group. This study shows that a smaller unit such as census tract may have value in the designing of programs for children. This study also highlights that specific concepts of condition, safety and infrastructure can have separate and unique contributions to the outcomes and that further study assess the nature of the relationship between these different walking audit concepts and child obesity outcomes.

Observational audits provide measures of the built environment however these tools need to be tested on various populations including youth (Brownson et al., 2009). This study takes the tool adapted by Main and colleagues (Main et al., 2012) and applies it satisfactorily to outcomes in children ages 10-14.

This study contributes to the literature by including cross level interaction terms and demonstrating how the individual and census tract level factors may interact to moderate the effect on the outcome variables. Previous studies in this area have called specifically for additional research looking at cross level interaction (Li et al., 2005). Lastly this study did show that the fitness measures of curl up and vertical jump have value as an outcome for childhood obesity and these performance measures should be considered in addition to and possibly instead of BMI. Flexibility measures such as the V-sit may not be appropriate in this age group as an outcome measure.

**Implications for Future Research**

Future work would include additional research in this specific geographic area and topic area. This should include additional measures of the built environment such as parks and other recreation areas focusing on specific structure (features) and function (use patterns) as well as
distance from individual’s homes to the built environment. Determining a safe buffer zone for children is important when looking at opportunities for safe physical activity. A larger sample is necessary that would increase the # of groups and determine between group differences (random effects) at a smaller level (block groups). A larger within group sample size is needed to further examine fixed effects differences. The use of GIS to analyze distances to the built environment and other neighborhood features from a child’s home and track a child’s specific activity behavior objectively including where they go in the area and the route traveled to get there.

Future research should include the use of more objective measures of individual behavior such as accelerometer data for PA, GPS for active transport patterns and secondary data for physical education amounts and types of physical activity in schools.

Finally a mixed methods study would add value including qualitative research to decipher meaning and explore issues further from parents, children, teachers, coaches, healthcare providers and other community actors in an attempt to understand the phenomena observed from the quantitative aspect (Patton, 2002).
REFERENCES


APPENDIX A

Taking Neighborhood Health to Heart:
Kids Version
2040 Partners for Health

Community Data Collection Training Manual
May 2008

Funded by: The Colorado Health Foundation

Approved by: University of Colorado Denver HSRC Protocol 2008-131
# Table of Contents

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About the Project

Taking Neighborhood Health to Heart Kids Version is a research project partnership between the University of Colorado Denver, Colorado Health Outcomes Program, 2040 Partners for Health and the neighborhoods of Park Hill, Northwest Aurora, Stapleton and East Montclair. The partnership intends to better understand the health and well-being of the citizens living in these communities to inform future programs and projects to advance health. This project will specifically look at the environmental factors that can influence health and physical activity levels of children aged 10 to 14 in these neighborhoods. The methodology we are using is called community-based participatory research, or CBPR.

“Community-based participatory research is a "collaborative approach to research that equitably involves all partners in the research process and recognizes the unique strengths that each brings. CBPR begins with a research topic of importance to the community and has the aim of combining knowledge with action and achieving social change to improve health outcomes and eliminate health disparities."

WK Kellogg Foundation Community Health Scholars Program

“Research is a scientific approach to answering questions, often involving human participants to test health care treatments or drugs. It is not always possible to know what will happen to the participants; sometimes unexpected or undesirable results happen. The participation of local community representatives in planning and conducting research is, therefore, important. Communities should be informed of the research, possible outcomes (positive and negative), and the results of the research. Research findings belong to participants and their communities as well as the researchers and the research community. Community representatives and researchers can work together to make sure that research is conducted in the most appropriate way.”

Family Health International

The goal of the data collection phase of this project is to conduct a total of 500 parent and child household pair interviews across all of the study neighborhoods: East Montclair, Park Hill, Northwest Aurora and Stapleton. The number of surveys within each neighborhood is as follows:

<table>
<thead>
<tr>
<th>Neighborhood</th>
<th>Original Goal</th>
<th>% of residences in study area</th>
<th>Adjusted Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Montclair</td>
<td>100</td>
<td>16.9</td>
<td>68</td>
</tr>
<tr>
<td>NE Park Hill</td>
<td>100</td>
<td>11.1</td>
<td>45</td>
</tr>
<tr>
<td>Northwest Aurora</td>
<td>100</td>
<td>40.0</td>
<td>162</td>
</tr>
<tr>
<td>Park Hill</td>
<td>100</td>
<td>31.9</td>
<td>129</td>
</tr>
<tr>
<td>Stapleton</td>
<td>100</td>
<td>*</td>
<td>96</td>
</tr>
</tbody>
</table>
**Expectations of Recruiters/Data Collectors**

- Recruiters must be available to participate in training sessions and additional trainings if necessary
- Recruiters will be expected to work some mornings, afternoons, early evenings, and weekends
- Recruiters will work in teams of two. Both persons must be present at a scheduled time to conduct the interviews and exercise measures
- Teams will participate in team meetings/conference calls to discuss audit progress & to address questions
- Teams will set weekly schedules during training using a Google calendar. If changes need to be made, recruiters must clear these changes ahead of time with Kyla Krause, Office Administrator at 2040, and teammates
  - If unplanned changes arise (e.g. illness), you must notify the project coordinator, Leah Haverhals, and your teammate
- The recruiters must wear appropriate clothing and study identification at all times while in the field
- Variations in the blocks or selected blocks should be noted. Drastic changes (e.g. another neighborhood) need to be approved by project coordinator

**Schedules and timecards**

- While the schedule is flexible, recruiters must be available for at least 12 hours per week and have mornings, afternoons and at least 1 weekend day available
- It will be recruiter’s responsibility to track hours, fill out timecards, sign and turn in as necessary to be paid
- **Attend School screening at Roberts Elementary June 9 and June 13**
- **Attend “Know your numbers” fair recruitment**

**Contacts**

- Timecards, schedules, more data collection or entry forms
  - Kyla Krause, Office Administrator at 2040
- Survey or measurement questions
  - Ira Gorman
- Schedule conflicts, running late, etc.
  - Kyla Krause
  - Your teammate
Preparing for household recruitment and data collection

This section is designed to help neighborhood household recruiters understand their responsibilities in recruiting households for the survey and collecting data on the household. In collaboration with our Taking Neighborhood Health to Heart community advisory council, we have developed an approach for recruiting households for the door to door survey and child exercise test measures.

The goal of this section is to provide training materials and prepare neighborhood recruiters to find individuals in households willing to participate in the interview and child BMI and exercise measures.

Suggestions for successful data collection:
- Plan ahead
- Be on time
- Be prepared
- Be sensitive to the needs of the neighborhoods and its residents
- Be flexible
- Have fun!

If you have any questions, please call Ira Gorman at 303-941-2700, Leah Haverhals at 303-724-0381 or Kyla Krause at 303-399-2700 ext 100.

Check off list for data collection
- Household recruitment cover sheets
- Household recruitment script and questionnaire forms (parent and child)
- Consent and Assent Forms
- Pens
- Clip boards
- Door hangers
- Appointment cards
- Stadiometer (height)
- Scale (weight)
- Exercise tests equipment
- Data collection form
- Sunscreen
- Personal cell phone
Professionalism

This section is designed to help you have successful interactions with households and their members completing the survey.

Appearance is usually the first thing someone notices about another person. **Personal Appearance: Dress Down**

1. Do not carry a purse or a large amount of money while in the field. Jewelry should be limited to small costume jewelry.
2. Wear shoes appropriate for walking and running. No high heeled shoes.
3. Dress appropriately and comfortably for the work you will be doing. Do not dress to impress. Wear neutral clothing that does not attract undue attention. Do not wear clothing that will be considered seductive or revealing.
4. Identify yourself, and tell people what you are doing and why.

**Always carry your identification card with you**

Safety Guidelines

- Cell phones: If you have a personal cell phone please carry with you. Teams should trade cell phone numbers in case of need to contact each other or other people.
- Recruiting and data collection should be conducted during daylight hours. Some early evening times will be utilized but it is important to plan to complete work by twilight.
- Do not give out personal information (e.g. address, location of vehicle, office).
- If you feel threatened or are in immediate danger for any reason call 911.
- If the police should stop you and ask you what you are doing, answer all questions that they have and show them your identification.

Avoiding Trouble: Be Alert

- Be aware of your surroundings at all times. If you feel unsafe leave the area and report incident/area to your supervisor
- Stay in view of the street; do not enter shrubbery, buildings, alleys, or other areas where you aren’t visible
- Do not carry weapons (guns or knives)
- Do not carry a lot of cash, wear expensive jewelry, etc.
- Park your vehicle in a legal, well-lit spot, and put away or leave at home any expensive items
Avoid getting in the middle of sales of drugs, into fights, or other potentially dangerous situations

If a potentially dangerous situation develops, leave the area quickly and quietly, without drawing attention to yourself

If you do not feel comfortable entering certain areas, or if you have reason to believe that your safety has been compromised, do not enter that area

Avoid confrontations

**Getting along: Be professional**

1. Develop a friendly, professional relationship with people you come into contact with. While conducting outreach, do not interact with them socially, romantically, or sexually. No flirting!
2. Do not offer rides to individuals, including clients or interview participants.
3. Do not do “special favors” for individuals. Maintain professional boundaries.
4. Do not initiate any hugging of participants you are surveying. Some participants may misunderstand your gestures.
5. Be aware of potential health risks from touching clients (e.g. scabies). Wash hands frequently, and use hand-wipes.
6. Do not buy goods or accept gifts, food or merchandise from participants or others you meet while conducting outreach. Do not give or lend money (or anything else) to any individuals, clients, participants—it suggests favoritism to observers, and it causes problems between staff members.
7. Behave respectfully towards clients, and win their trust and confidence. Avoid communication, through words or posture, which may convey arrogance or a judgmental attitude.
8. Do not counsel participants. Stay focused on the goals of the program. You may provide referrals to them.
9. Be sensitive to confidentiality issues. Avoid putting individuals “on-the-spot” by asking them personal questions, especially while in a group.
10. Never disclose information to others about anyone you learned through outreach or through the study.
11. Speak to children in age appropriate language.

**Presence in the Neighborhoods**

1. Recruiters will not give incentives. These will be mailed to participants after completion of the survey and child exercise measures.
2. Recruiters will work in pairs. Shift times will be between 9 am-12 p.m. and 4-7 p.m. Monday through Friday and on Saturday and Sunday initially. If these are not productive we will adjust times
3. All recruiters are hired for 12 hours per week which would be four 3 hour shifts.
Professional conduct

• It is expected that recruiters will conduct themselves in a professional manner at all times when in the field
  o Please remember you are representing the larger study group and we wish to foster a positive relationship within our neighborhoods
• Recruiters should be prepared to greet folks in the neighborhood if approached and clearly explain who they are and what they are doing

What to say when approached

Who you are:  Please state name (first name only is acceptable).
- Explain that you are part of a team working with the Taking Neighborhood Health to Heart Kids’ Project.
- This project is a collaborative effort between the University of Colorado, 2040 Partners in Health and participating neighborhood boards, community groups and community members.

What you are doing:  We are recruiting households to participate in a survey regarding children’s physical activity and health in this and surrounding neighborhoods.

FAQ’s and how to answer them

1) How can I participate?
   You may also participate in small focus groups or community-based information sessions that will be done at a later time
   - If interested, please have them contact Ira Gorman at 303-941-2700

2) How can I find out the results of the study?
   a) When the study is finished the information will be shared back with the neighborhoods and community members through meetings or newsletters/local newspapers. The meetings will be widely advertised in various local news sources (e.g. neighborhood papers)
Paperwork

**VERY important –**
Check your paperwork as you go.

Procedures for managing recruitment files & data

**Pick up/Drop off data collection materials:**
- Data collection materials are stored in a file cabinet at Stapleton Foundation, 7350 E 29th Ave., suite 203 in Stapleton town center. Office is open 8:30 a.m.-4:30pm weekdays.
- You may park on the street in front or around back in the parking lot. To get to back parking lot take a right at the 4-way stop (Udi’s is on the left), then take the next right into the parking lot. Take the elevator to the 2nd floor. Exit elevator to the right, straight ahead you will see the 2040 office. Kyla will be there to collect your data each day.
- If Kyla is not present there will be a bin by her desk for you to leave your data sheets and a file that will have additional forms if you need any.

**Beginning of Shift:**
- You should aim to turn in your materials frequently, next day if possible.
- If you are going out again the next day, you may keep the materials folders and take extra forms so you do not have to return unless it’s on a Sunday and you must return them the first working day.
- If any of materials are running low, contact Kyla.

**End of Shift:**
- Drop off completed forms at the office, at a minimum on Mondays before 9 a.m. and Thursdays before 9 a.m.
- Another staff member will be entering data. **PLEASE WRITE CLEARLY.**
Payment

As a data collector and interviewer for the Taking Neighborhood Health to Heart Research Project, you are going to enter into an independent contractor relationship with 2040 Partners for Health. As an independent contractor you need to consider the following:

- You have entered into a written subcontract agreement with 2040 Partners for Health.
- You are going to be paid based on an hourly wage that you have agreed to.
- You are going to have to declare this income as part of your 2008 taxes and pay any applicable taxes.
- The amount of taxes you will have to pay will depend on laws specific to Colorado, your total income and the amount of expenses that you will claim.
- COMIRB documentation - see form

Adapted from Education Messages Services 1099 Fact sheet.

STOP HERE...COMPLETE EMPLOYEE PAPERWORK
Overview of Data Collection

Prior to going into the field prepare necessary materials:
- Bring sufficient copies of the household recruitment cover forms, consent forms, assent forms and questionnaires
- Write down emergency numbers for each person
- See Check Off List for data collection!

Approaching the potential respondents:
- Approach the household indicated by the survey sampling design
- Complete the household initial data cover sheet, including male or female, primary and alternate phone number, complete name and address of person in household
- See attached face to face interview procedure
- Complete parent consent form first
- If parent consents then obtain child assent and then start interview process
- If child does not wish to participate but parent does the child must assent otherwise you must leave the home without conducting interviews ANY interviews

Finishing the Interview
- Review the forms for completeness
- Finish the interaction with the respondent completing a self addressed envelope so we can mail them their gift card
- Thank the respondents
- Inquire if they want to participate in the additional study component--accelerometers/pedometers. If so, get their phone number to be contacted by Ira for this component.

At the door script- handout
Consent Form
Assent Form

STOP HERE...ROLEPLAY

We will now practice the “at the door recruitment script” and the consent and assent process.
**In the Field**

**Approaching the Potential Participant**

Experience in many surveys has shown that there are three factors that encourage respondents to participate in the survey:

1. **The potential respondent needs to feel that his/her interaction with the interviewer will be pleasant and satisfying.** In interviews this one factor "makes or breaks" an interview. Respondents are usually willing to accept an interviewer who is different from them if the administrator appears to be understanding and accepting.

2. **The potential respondent needs to feel that the survey is important and worthwhile.** This means that the interviewer should get the potential respondent interested in the study and convince him/her of the importance of her participation. The potential respondent will need to have a clear understanding of what is expected of her during the survey process, the purpose of the survey, and how the information he/she gives will be used. If presented properly, the potential respondent may feel that this is an opportunity to make a meaningful contribution to his/her community.

**Recruitment Tips**

- Be confident in your approach.
- Don’t give up too soon but know when to give up – know when to say when!
- Avoid awkward exchanges at the door. To prevent uncomfortable, abrupt exchanges be sure you have enough time and confidentiality to engage potential participants – provide time and space.
- Learn from failed attempts. Think about ways of improving your recruiting success and try to understand reasons why people did not want to participate. Be sure to note these reasons so we can learn from them.
- Document reasons for refusals, monitor trends, discuss them with your supervisor and team.
- Watch the recruitment techniques of others on your team. Different people have different strengths, and it will be beneficial to learn from others.
- Discuss with your team different scenarios that you have encountered and problem-solve together. Continue to brainstorm new ways to increase completed surveys and participation.
- Try and overcome any insecurities or hesitancies.
- Maintain an up-beat and positive attitude about the study.
- Effective communication, strong belief in the project, and demonstrative motivation, persistence, and high energy are the keys to successful recruiting.
- Make eye contact and smile as you approach the potential respondent. In certain cultures it is disrespectful to have prolonged eye contact or can be seen as flirtatious.
Overcoming Refusal

1. Introduce yourself as written on the at-the-door script:

2. Often, the potential respondent asks, "How long will this take?" Tell him/her that it should take about 15-20 minutes for the interviews and 10 minutes for the exercise tests.

3. Avoid questions that can permit negative responses. The recruiter should suggest the course of action she desires. For example, instead of asking, "Are you busy now?" ("Yes, I'm in a hurry") or "Could I interview you now?" ("No, not now"), say "I would like to talk with you about having someone in your household participate in a neighborhood survey on health..." Questions that permit negative responses can lead the potential respondent into refusing to be interviewed.

4. Adapt your approach to the situation. Approach every potential respondent as though he/she is friendly, but vary your approach according to your intuition about the person. Some potential respondents require only brief explanations of the basic points; others will require more detailed information.

5. Establish rapport quickly. The respondent's impression of you when you introduce yourself and the way that you adapt yourself to the situation are factors in determining whether rapport will develop. Rapport is built through verbal communication and non-verbal communication, such as eye contact and smiling. Talking about the weather, baseball, clothing sales or any topic that establishes some common ground with the potential respondent may help him/her feel more comfortable.

6. Guide the potential survey participant thru initial questions. As the recruiter, you are responsible for helping the potential respondent understand what is expected of him/her. Let him/her know that any questions concerning the study can be answered by calling the contact number. Emphasize the importance of his/her responses.

7. Misconceptions must be neutralized in your very first statements. You can do this quickly by making convincing statements about the purpose of the study, the fact that the household was randomly selected to participate in this neighborhood health survey, the confidential nature of the interview, the beneficial uses of the research findings, and by your encouraging personality. You must adapt yourself to each individual.
**Answering Respondent Questions**
Respondents will sometimes provide answers without you asking any questions. Other respondents will ask questions about you, the interview, the incentive, etc. When this happens, you must be prepared to answer their questions convincingly, succinctly and without raising any bias of the survey.

The following questions are frequently asked by people. The responses provided below can be learned by all recruiters.

I don’t have time, I’m in a hurry.

“I’ve already done it” (Especially important if they participated in last year’s telephone survey. Explain that this is a different study focused on children).

"Who are you?"
   "I am (your name), and I work for the Taking Neighborhood Health to Heart Kids’ Project. Show your project ID badge again.

"Why are you here?"
   "We are talking to people around here to learn about the health of children in the community."

“I’m not interested”
   “Okay, but do you mind telling me why you don’t want to participate? What is it about doing surveys that you don’t like/don’t want to do?”

"Why did you pick me?"
   "We are trying to get a random sample of people in the community, so we’re asking different people to talk to us."

"Why do you want me to answer this?"
   "Because you’re part of the community. We are not interested in specifics about you, but rather about the health of people, specifically children, in this community. Your willingness to do this survey will help us understand the community better."

"How long is this going to take?"
   "It will take about 15 minutes to complete the adult and child’s survey and about 10 minutes for the child to complete the exercise tests."

"Who are you going to tell what I tell you?"
   "No one is going to know exactly what you tell me. Your name will not be on the recruitment or the survey form. My supervisor and some data entry people on the study team are the only other people who will see this recruitment form."
“I don’t want to give you my name”

“We will not record your name with any of the information collected and will not report any names with the data. Your full name is needed if you answer the survey and want to be mailed an incentive for participating.”

Refusals to Participate
Occasionally, despite your best efforts, the potential respondent will refuse to respond to your initial questions. If this happens, thank him/her for her time, record the refusal, and continue to the next household. If you encounter consistent refusals, talk with your field supervisor; there may be something happening in the community that your team is unaware of (like a recent police crackdown), or you may want to review techniques with your fellow field staff.

Some suggestions for keeping the person involved include:

- Assure respondent of confidentiality of responses. No information identifying the respondent will be published or given to anyone.
- Remind respondent of how information will be used.
- Thank respondent for time and assistance.

Other motivating techniques include paying close attention to body language, and being respectful and attentive.

Informed Consent
There will be a written informed consent that must be completed by the parent and then a verbal or written assent to participate completed or agreed upon by the child.

Protecting Confidentiality of Participants
Participation in the project is confidential. Participant names or other personal identifiers are not linked to the questionnaire. Recruitment forms and survey responses are maintained in confidential environments and stored in locked filing cabinets. Only authorized persons have access to files.

All staff who handle the recruitment data or are involved in data collection must abide by confidentiality guidelines issued by the Colorado Multiple Institutional Review Board.

Employees may not discuss personal information about participants with anyone outside the study. If you see a participant outside of a study setting, you should not let it be known how you know that person and should not acknowledge that person unless she first acknowledges you. Please report any confidentiality breach to 2040 Partners for Health and /or research staff immediately by phone and also include this in your weekly report.
Recruitment forms and script
The data collector's goal is to collect accurate information. To attain this goal, you need some basic facts about the questionnaire and its use.

A questionnaire is the basic tool used to obtain survey information. The purpose of a questionnaire is to help us obtain accurate and complete information. It does this by meeting two criteria:

1. The questionnaire is based on the research objective of the study. The QUESTIONNAIRE is designed to obtain certain information.

2. The questionnaire standardizes the data collection. The researchers involved in the TNH2H kids' study will combine and statistically analyze the survey data collected across all neighborhoods. This means that the data must be collected in the same manner in every neighborhood.

Guidelines for recruiting at the door:
The recruiter has two roles in recruiting a household and then administering the questionnaire:

1. The "data collector" who uses standard interviewing techniques and uses the same form for each interview; and

2. A fellow human being who creates a non-judgmental and warm relationship with each respondent.

How To Deal With...
Reluctant individual:
Sometimes, you will find someone hesitant to finish the survey or physical activity measures. Remind the respondent that all information will be kept strictly confidential. Acknowledge their discomfort and validate their feelings of finding the questions difficult to answer:

If they are willing to participate in the survey but do not have time to answer all questions now, have them fill out an appointment card to return at a future date and time that contains their first and last name, gender, primary phone number, and address.

Finishing up with recruitment
When finished, the data collector should check that all paperwork is complete (consent forms, surveys, physical activity measures, self-addressed stamped envelope) and respondent has been given their appointment card.

STOP HERE...ROLEPLAY Interview survey parent and child
Face-to-Face Interviews

- Following a random selection method of blocks within the targeted neighborhoods, data collection teams will select a house on that block and knock on the door.

- Using the attached recruiting script you will explain the study purpose and inquire if a child between the ages of 10 and 14 lives in the home. If there is more than one child present then the next birthday method will be used to select the child to be interviewed. This means that you ask which child has the next birthday, and that is the child who will be interviewed.

- If the parent agrees to participate in the study and is willing to at the time you are there, then data collectors will ask to enter the home and start the consent process.

- Teams will meet initially together with parent-child pairs to review the purpose of the interviews, describe the questions, the timeframe required to complete the interview (no more than 30 minutes) and the incentive for participation (one $10 gift card per household).

- Then the parent will be asked to consent to the study after the consent form is explained to the parent, and then the child will be asked to assent either verbally or written. The consent and assent process will be performed with both the parent and child together in the same room. If the parent consents and the child does not wish to participate, the team will leave. There will be no option for parental override in this study.
• Once both interviews are completed, the physical measures will be performed on the child with the parent present. The exercise testing and physical measures will be conducted in the home on the floor.
  o A yoga/stretching mat will be placed on the floor to provide a soft surface for the curl up and V-Sit tests.
  o The vertical jump test will be performed against a wall and the height and weight measures will be performed standing using a portable bathroom scale for weight and a portable stadiometer for height.
  o All measures will be conducted according to the protocol in the President’s Challenge at the end of this manual.
  o The child will be asked to have loose fitting comfortable clothing on and remove their shoes.
Safety IN the field

Safety is first!

1. Review your schedule and plan for the travel between places you will be recruiting.

2. Always work with teams of at least two people.

3. Have an emergency plan- including a code word that will indicate to your partner it is time to leave, emergency contact information for each have a plan in case of an emergency.

4. T-shirts, ID badges, and outreach bags help identify you.

5. Say no to all solicitors and people asking for pocket change and if you want let them know it is against your employer's policy. Avoid using ATMs.

6. If the people you're recruiting seem uninviting, just leave.

7. If possible take a cell phone with you every time you are in the field and keep it out of view of people you are recruiting.

8. Be sure to have a reliable vehicle, with gas and park it preferably in a lighted area close by so that you may exit right away.

9. Be sure to be polite and respectful to those you approach.

10. Use caps or visors on hot days to avoid sunburns and other heat injuries.

11. Wear sunscreen and drink plenty of water. Collecting data in areas where there may be high crime rates, drug use, and frequent solicitations (sexual, drugs, or just asking for money) is quite different from surveying in a clinic or an office; all staff must be alert to their safety and their fellow team members’ safety.

A basic awareness of your surroundings is critical when you are working in the community. The term "surroundings" means more than just the physical context, more than just a street or alley. Stay in view of traffic when possible; stay in view of one another at all times; don't carry weapons (guns or knives); yelling with or at anyone is discouraged; avoid people that seem "under the influence" or behaving strangely; leave a dangerous situation immediately. As a household recruiter, try not to react, but project a clear purpose. Thoroughly think things through beforehand.
Who do I contact?

Ira Gorman  
Principal Investigator  
Regis University  
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Denver, CO 80221  
303.941.2700  
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This training manual was adapted from Prevention Options for Women Equal Right (POWER) research study training manual.
APPENDIX B

Recruiting Script (2 minutes)

Hello, my name is _________ and this is _________ and we’re from the Taking Neighborhood Health to Heart Research Project that is being conducted in your neighborhood by the University of Colorado Denver with assistance from the Stapleton 2040 Initiative and the Colorado Health Foundation. I’m here today to tell you about the Taking Neighborhood Health to Heart Kids’ research project and see if you and your child, if you have one, are eligible to participate.

IF THEY SAY THEY HAVE NO CHILD, STOP HERE AND THANK THEM FOR THEIR TIME.

This project is gathering information about the physical activity of children ages 10 to 14 in four metro Denver neighborhoods—East Montclair, Northwest Aurora, Stapleton, and Park Hill neighborhoods. The reason I’m stopping by today is to see if you have a child in the home that is between the ages of 10 and 14 and if you and your child would be interested in completing a survey now which will take about 30 minutes. All of your responses will be confidential and your family will receive a $10 gift card to Target for taking the survey. Would you be interested?

If “NO” tell them: “Thank you for your time.”

If “Yes,” ask: “Is there more than one child that age in the home?”

If “No,” ask: Is that child between 10 and 14 years old at home presently?

If “Yes” ask: We would like to survey the child who has the next upcoming birthday. This is to insure a random selection and not just choose the child that is home today. Is that child at home?

If “No” ask: “Is there a time we can come back that would be a better time for you and your child to complete the survey and exercises?”

If “Yes,” ask:

There are two short surveys, one for you and one for your child. If the child agrees to participate as well, they will be asked to perform three small exercises to measure their strength and flexibility and we will take their height and weight, but that part is all voluntary. The whole process should take approximately 30 minutes. Is this a good time now to do this?

If “Yes,” ask:

“May we come in and begin the surveys? We have some consent forms that need to be signed as well before we begin. They will explain the study in more detail to you and your child.”

If “No”: “Is there a time we can come back that would be a better time for you and your child to complete the survey and exercises?” Please complete this appointment card that will give us a day and time to come back. We will leave a copy for you as a reminder.
You and your child are being asked to be in a research study. This form provides you with information about the study. A member of the research team will describe this study to you and answer all of your questions. Please read the information below and ask questions about anything you do not understand before deciding whether or not to take part.

**Why is this study being done?**

This study plans to learn more about how children’s physical activity is affected by factors in the home and in their neighborhood including how much time they watch TV, how much time they spend on the computer, proximity to parks, neighborhood safety and other recreational opportunities.

You are being asked to be in this study because you are a family with a child in your household between 10 and 14 years old and live in one of the study communities of East Montclair, Northwest Aurora, Park Hill neighborhoods and Stapleton.

Up to a total of 1000 individuals including 500 children and 500 adults will participate in the study.
What happens if I join this study?

If your child joins the study, you and your child will be asked questions about health insurance, about of time spent watching TV and using the computer, exercise equipment in the home, physical activity levels and questions about the neighborhood including parks and schools. We will measure your child’s height and weight, flexibility and strength.

Your participation will consist of a total thirty minute commitment for the interviews and child physical activity measures.

What are the possible discomforts or risks?

Discomforts your child may experience while in this study include mild muscle soreness as well as increased heart rate and breathing rate during the physical activity measures. If your child has any known medical problems you should disclose this information to the researchers before signing this paper. With all research studies, there may be additional risks that are unknown to the investigators at this time. The researchers will take all precautions necessary to minimize these risks to the children in the study including keeping all of your information confidential and secure.

What are the possible benefits of the study?

This study is designed for the researchers to learn more about children’s physical activity and the factors that can affect children’s physical activity.

This research is being paid for by the Colorado Health Foundation.

Will I be paid for being in the study? Will I have to pay for anything?

You will not be paid to be in the study. Your child will receive a $10.00 gift card for participating.

It will not cost you or your child anything to be in the study.

Is my participation voluntary?

Taking part in this study is voluntary. You have the right to choose not to take part in this study. If you choose to take part, you have the right to stop at any time. If you refuse or decide to withdraw later, you will not lose any benefits or rights to which you are entitled.
Who do I call if I have questions?

The researcher carrying out this study is Ira Gorman. You may ask any questions you have now. If you have questions later, you may call Ira Gorman at 303-941-2700.

You may have questions about your rights as someone in this study. You can call Ira Gorman with questions. You can also call the Human Subject Research Committee (HSRC). You can call them at 303-315-2732.

Who will see my research information?

We will do everything we can to keep your records a secret. It cannot be guaranteed. Both the records that identify you and the consent form signed by you may be looked at by others. They are:

- Federal agencies that monitor human subject research
- Human Subject Research Committee
- The group doing the study
- The group paying for the study
- Regulatory officials from the institution where the research is being conducted who want to make sure the research is safe

The results from the research may be shared at a meeting. The results from the research may be in published articles. Your name will be kept private when information is presented.

Agreement to be in this study

I have read this paper about the study or it was read to me. I understand the possible risks and benefits of this study. I know that being in this study is voluntary. I choose to be in this study. I will get a copy of this consent form.

Signature:_________________________________________ Date:_______

Print Name:_________________________________________

Consent form explained by:_________________________ Date:___________

Print Name: ________________________________

Investigator:____________________________________ Date:___________
Date: Valid for Use Through:

Study Title: Environmental and individual factors that influence children’s physical activity

Principal Investigators: Ira Gorman, Debbi Main
HSRC No: 2008-131
Version Date: March 26, 2008
Version No: 1

Informed Assent for: Environmental and individual factors that influence children’s physical activity

Person In Charge of the Study: Ira Gorman
Name of Organization (e.g. University of Colorado Denver)
HSRC # 2008-131

Why are you doing this study?
The goal of this study is to learn more about kids’ physical activity. It is to see if things in your home and your neighborhood, such as how much TV you watch or how much you use the computer, change your physical activity.

Why are you asking me?
You are being asked to be in the study because you are a child in between 10 and 14 years old in a family that lives in one of these communities: East Montclair, Northwest Aurora, Park Hill neighborhoods, and Stapleton.

What Do I Have to Do or What Will Happen to Me?
If you are in the study, you will:
- Answer a few questions about your activity levels.
- Answer a few questions about how much time you spend watching TV and using the computer.
- Have your height and weight taken.
- Perform three exercises that measure the muscles in your legs and stomach.

Will this Hurt?
Your muscles may be sore after doing the exercises for a few moments just like being in P.E. class at school.

Do I get anything for being in the study?
If you are in the study, you will get a $10.00 gift card.

Can I ask Questions?
You can ask any questions you have now about the study or at any time during the interview. All your questions will be answered.
If you have a question later, you can ask and get an answer. If you want to, you can call Ira Gorman at 303-941-2700.

**Do I Have to Do This?**
You do not have to be in this study. No one will be mad at you if you say no.

I want to be in the study at this time. ☐ Yes ☐ No

I will get a copy of this form to keep.

*Child’s Printed Name:*________________________________________
*Child’s Signature or Acknowledgement of Verbal Assent:*______________
*Date:*____________________________

**Witness or Mediator:**________________________________________
*Date:*____________________________

_I have explained the research at a level that is understandable by the child and believe that the child understands what is expected during this study._

*Signature of Person Obtaining Assent:*__________________________
*Date:*__________

*Initials:*________

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APPENDIX D

Physical Measures and Exercise Tests

**Height** *(Seca 217 stadiometer, SECA USA Medical Scales and Measuring Systems, Hanover, MD)*
Child will stand against the wall up against the stadiometer without shoes on. Height will be recorded in centimeters to the nearest .5 cm.

**Weight** *(SECA Clara 803 digital scale) SECA USA, Hanover, MD)*
Child will stand on the scale without shoes on and no heavy items in pockets or on belt. Weight will be recorded in pounds to the nearest tenth of a pound.

**Curl-ups test**
This event measures abdominal strength and endurance.

Have child lie on cushioned, clean surface with knees flexed and feet about 12 inches from buttocks. Partner holds feet. Arms are crossed with hands placed on opposite shoulders and elbows held close to chest. Keeping this arm position, child raises the trunk curling up to touch elbows to thighs and then lowers the back to the floor so that the scapulas (shoulder blades) touch the floor, for one curl-up. To start, a timer calls out the signal "Ready? Go!" and begins timing child for one minute. The child stops on the word "stop."

**Curl-ups tip**
Instruct helpers to count aloud the number of repetitions.

**Curl-ups scoring**
"Bouncing" off the floor is not permitted. The curl-up should be counted only if performed correctly.

**V-sit reach Test**
This event measures flexibility of the lower back and hamstrings.

**V-sit testing**
Mark a straight line two feet long on the floor as the baseline. Draw a measuring line perpendicular to the midpoint of the baseline extending two feet on each side and marked off in half-inches. The point where the baseline and measuring line
intersect is the "0" point. Child removes shoes and sits on floor with measuring line between legs and soles of feet placed immediately behind baseline, heels 8-12" apart. Child clasps thumbs so that hands are together, palms down and places them on measuring line. With the legs held flat by a partner, child slowly reaches forward as far as possible, keeping fingers on baseline and feet flexed. After three practice tries, the child holds the fourth reach for three seconds while that distance is recorded.

V-sit tip
Participants are most flexible after a warm-up run. Best results may occur immediately after performing the endurance run.

V-sit rules
Legs must remain straight with soles of feet held perpendicular to the floor (feet flexed). Children should be encouraged to reach slowly rather than "bounce" while stretching. Scores, recorded to the nearest half inch, are read as plus scores for reaches beyond baseline, minus scores for reaches behind baseline.

Vertical Jump Test

Test Procedures

The vertical jump test involves measuring the difference between the standing reach and the height reached at the peak of a vertical jump.

- Review jumping technique
- Warm-up with several easy jumps proceeded with a few minutes rest
- While resting, stand with side toward wall or under vertical jump flag (illustrated) and reach up as high as possible keeping the feet flat on the ground. Record or mark standing reach.
- Standing slightly away from the wall or under vertical jump flag. Jump up as high as possible using both arms and legs to assist in projecting the body upwards. Touch the wall or vertical jump flag at the highest point of the jump.
- Perform multiple attempts with short rests until a plateau or decrease in performance is observed.
- Calculate the "net height" by subtracting the standing reach height from the jump height.
- Best of three scores is recorded to the nearest ½ inch.

Recommendations

- Hold yardstick up against the wall after measuring up from the floor.
- Put chalk (or water) on finger tips to mark spot on yardstick.
APPENDIX E

Start of Survey

We will not keep your name on file or ask any other personal information that can identify you. You do not have to answer any question you do not want to, and you can end the interview at any time. Any information you give me will be confidential. This survey should take no more than 10 minutes to complete. Following completion of the survey and the child exercise tests, which are optional, we will have you complete a self addressed envelope so we can send you a $10 gift card to Target for your participation.

Parent questions (12-14 minutes)

P1. Does your child have any medical conditions or disabilities that would limit his or her physical activity? (Sallis, M-SPAN, 1999)
   1. Yes
   2. No
   96. Don’t know/not sure
   99. Refused

During the past 7 days, how many days did your child do physical activity or sports at these locations? (Circle one number per location.) (Sallis, M-SPAN, 1999)

Number of Days

P2. School grounds (weekends only) 0 1 2
   96. Don’t know/not sure
   99. Refused

P3. School grounds (week days) 0 1 2 3 4 5
   96. Don’t know/not sure
   99. Refused

P4. Public recreation center 0 1 2 3 4 5 6 7
   96. Don’t know/not sure
   99. Refused
P5. Neighborhood park or playground 0 1 2 3 4 5 6 7
96. Don’t know/not sure
99. Refused

P6. Private facility (e.g., health club, dance studio, gymnastics facility)
0 1 2 3 4 5 6 7
96. Don’t know/not sure
99. Refused

P7. Other location, specify: ____________ 0 1 2 3 4 5 6 7
96. Don’t know/not sure
99. Refused

P8. During a typical week in the summer, how often does someone provide transportation so your child can go to a place where he or she can do physical activities or play sports? (Circle one number.)
Times per week: 0 1 2 3 4 5 6 7 or more times per week
96. Don’t know/not sure
99. Refused


Estimate the number of hours per week during the school year your child:
P9. Participates in after school sports or dance programs run by the school__________
P10. Participates in other after school sports or dance programs__________
P11. Plays outdoors after school__________
P12. Plays outdoors with an adult after school or on weekends__________
Respond how often your child presently

**P13.** Plays outside their house
- 1. Never
- 2. Sometimes
- 3. Frequently
- 4. Always

96. Don’t know/not sure
99. Refused

**P14.** Plays, walks or bicycles in their neighborhood
- 1. Never
- 2. Sometimes
- 3. Frequently
- 4. Always

96. Don’t know/not sure
99. Refused

**P15.** Plays in a neighborhood park or playground
- 1. Never
- 2. Sometimes
- 3. Frequently
- 4. Always

96. Don’t know/not sure
99. Refused

**P16.** Goes to a neighborhood park or playground with an adult
- 1. Never
- 2. Sometimes
- 3. Frequently
- 4. Always

96. Don’t know/not sure
99. Refused
Neighborhood safety
Please tell me your level of agreement with the following statements

P17. I worry that my child will be hurt by gangs if he/she plays outside.
   1. Strongly Agree
   2. Agree
   3. Disagree
   4. Strongly Disagree

   96. Don’t know/not sure
   99. Refused

P18. I worry that my child will be hurt by other children if he/she plays outside.
   1. Strongly Agree
   2. Agree
   3. Disagree
   4. Strongly Disagree

   96. Don’t know/not sure
   99. Refused

P19. There is a safe area in my neighborhood for my child to play outdoors.
   1. Strongly Agree
   2. Agree
   3. Disagree
   4. Strongly Disagree

   96. Don’t know/not sure
   99. Refused

P20. Letting my children play outside in my neighborhood is dangerous.
   1. Strongly Agree
   2. Agree
   3. Disagree
   4. Strongly Disagree

   96. Don’t know/not sure
   99. Refused
P21. There is too much traffic in my neighborhood for my child to play outdoors.
   1. Strongly Agree
   2. Agree
   3. Disagree
   4. Strongly Disagree

   96. Don’t know/not sure
   99. Refused

P22. The crime rate in my neighborhood makes it unsafe for my child to play outdoors.
   1. Strongly Agree
   2. Agree
   3. Disagree
   4. Strongly Disagree

   96. Don’t know/not sure
   99. Refused

P23. I do not feel safe outside of my apartment/house in my neighborhood.
   1. Strongly Agree
   2. Agree
   3. Disagree
   4. Strongly Disagree

   96. Don’t know/not sure
   99. Refused

P24. Does the neighborhood have a crime prevention program or a neighborhood watch?
   1. Yes
   2. No

   96. Don’t know/not sure
   99. Refused
P25. How safe from crime do you consider your neighborhood to be? (BRFSS, 2006)
   1. Extremely safe
   2. Quite safe
   3. Slightly safe
   4. Not at all safe

   96. Don’t know/not sure
   99. Refused

Now I’m going to read some statements about things that people in your neighborhood may or may not do. For each of these statements, please tell me whether you strongly agree, agree, disagree or strongly disagree.

P26. People around here are willing to help their neighbors. Would you say you strongly agree, agree, disagree, or strongly disagree?
   1. Strongly Agree
   2. Agree
   3. Disagree
   4. Strongly Disagree

   96. Don’t know/not sure
   99. Refused

27. This is a close-knit neighborhood. (May need to define) Would you say you strongly agree, agree, disagree, or strongly disagree?
   1. Strongly Agree
   2. Agree
   3. Disagree
   4. Strongly Disagree

   96. Don’t know/not sure
   99. Refused
**P.28.** People in this neighborhood can be trusted. Would you say you strongly agree, agree, disagree, or strongly disagree?

1. Strongly Agree  
2. Agree  
3. Disagree  
4. Strongly Disagree  

96. Don’t know/not sure  
99. Refused

**P29.** People in this neighborhood generally don’t get along with each other. Would you say you strongly agree, agree, disagree, or strongly disagree?

1. Strongly Agree  
2. Agree  
3. Disagree  
4. Strongly Disagree  

96. Don’t know/not sure  
99. Refused

**P30.** People in this neighborhood do not share the same values. Would you say you strongly agree, agree, disagree, or strongly disagree?

1. Strongly Agree  
2. Agree  
3. Disagree  
4. Strongly Disagree  

96. Don’t know/not sure  
99. Refused
For each of the following, please tell me if it is very likely, likely, unlikely or very unlikely that people in your neighborhood would act in the following manner.

**P31.** If a group of neighborhood children were skipping school and hanging out on a street corner, how likely is it that your neighbors would do something about it? Would you say it is very likely, likely, unlikely, or very unlikely?

1. Very likely  
2. Likely  
3. Unlikely  
4. Very Unlikely

96. Don’t know/not sure  
99. Refused

**P32.** If some children were spray-painting graffiti on a local building, how likely is it that your neighbors would do something about it? Would you say it is very likely, likely, unlikely, or very unlikely?

1. Very likely  
2. Likely  
3. Unlikely  
4. Very Unlikely

96. Don’t know/not sure  
99. Refused

**P33.** If there was a fight in front of your house and someone was being beaten or threatened, how likely is it that your neighbors would break it up? Would you say it is very likely, likely, unlikely, or very unlikely?

1. Very likely  
2. Likely  
3. Unlikely  
4. Very Unlikely

96. Don’t know/not sure  
99. Refused
P34. Suppose that because of budget cuts the fire station closest to your home was going to be closed down by the city. How likely is it that neighborhood residents would organize to try to do something to keep the fire station open? Would you say it is very likely, likely, unlikely, or very unlikely?
   1. Very likely
   2. Likely
   3. Unlikely
   4. Very Unlikely

96. Don’t know/not sure
99. Refused

Neighborhood ties set of questions

P35. How often do you and people in this neighborhood do favors for each other?
   1. Often
   2. Sometimes
   3. Rarely
   4. Never

96. Don’t know/not sure
99. Refused

P36. When a neighbor is not at home, how often do you and other neighbors watch over their property?
   1. Often
   2. Sometimes
   3. Rarely
   4. Never

96. Don’t know/not sure
99. Refused
**P37.** How often do you and other people in neighborhood ask each other advice about personal things?
   1. Often
   2. Sometimes
   3. Rarely
   4. Never
   
   96. Don’t know/not sure
   99. Refused

**P38.** How often do you and people in your neighborhood visit in each other’s homes?
   1. Often
   2. Sometimes
   3. Rarely
   4. Never
   
   96. Don’t know/not sure
   99. Refused

**P39.** How many TVs are in your home?__________ (Roemmich, 2006)

**P40.** How many computers are in your home?_________ (Roemmich, 2006)

**P41.** What is the name of the nearest park that your child uses?
   Provide list of parks in neighborhoods

**P42.** What is the number of large pieces of recreation or exercise equipment in your home such as treadmills, exercise bicycles, weight machines, outdoor playground equipment? (Trost, 1997)
   List equipment and add up number:
   
   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________
These last few questions include background information that would be helpful to have to describe people who have participated in this interview. Remember, this information is confidential—we will never link it to your name, but only to your anonymous responses to the survey.

**P43.** Does your child have any kind of health care coverage, including health insurance, prepaid plans such as HMOs, or government plans such as Medicaid?  
*Colorado Child Health Survey -2006*

1 Yes  
2 No *(skip to P44)*  
96 Don’t know / Not sure  
99 Refused  

**P43b.** Is he/she insured by Medicaid or the State Children’s Health Insurance Program, sometimes called CHP+ (pronounced ‘chip’)? [interviewer prompt which plan if answer is yes]  
*Colorado Child Health Survey -2006*

1 Yes, Medicaid  
2 Yes, CHP+  
3 No  
96 Don’t know/not sure  
99 Refused  

**P44.** During the past 12 months, was there any time when (he/she) was not covered by ANY health insurance?  
*Colorado Child Health Survey -2006*

1 Yes  
2 No  
96 Don’t know / Not sure  
99 Refused
P45. Is there a particular doctor’s office, clinic, health center, or other place that you usually go if your child is sick or needs advice about their health? (TNHTH)

1 Yes
2 No
3 More than one place

96 Don’t know/not sure
99 Refused

P46. A personal doctor or nurse is a health professional who knows your child well and is familiar with your child’s health history. This can be a general doctor, a pediatrician, a specialist doctor, a nurse practitioner, or a physician assistant. Do you have one or more persons you think of as your child’s personal doctor or nurse? Colorado Child Health Survey -2006

1 Yes
2 No

96 Don’t know / Not sure
99 Refused

Do not include: acupuncture, chiropractor, homeopath, naturopath, etc.

P47. During the past 12 months, did your child receive all the medical care (he/she) needed? Colorado Child Health Survey -2006

1 Yes Go to P49
2 No  Go to P48
96 Don’t know / Not sure Go to P49
99 Refused Go to P49
P48. Why did your child not get all of the medical care that (he/she) needed?
Mark all that apply. Prompt with choices if necessary
Colorado Child Health Survey -2006

1 Cost too much
2 No insurance
3 Health plan problem
4 Can’t find a doctor who accepts child’s insurance
5 Not available in area/transportation problems
6 No convenient times/could not get appointment
8 other- please specify_____________________

96 Don’t know / Not sure
99 Refused

P49. What is the highest grade or year of school you completed?
1- Never attended school or only kindergarten
2- Grades 1-8 (Elementary)
3- Grades 9-11 (some High School)
4- Grades 12 or GED (High school graduate)
5- College 1 year to 3 years
6- College 4 years or more (College graduate)
7. Some graduate/doctoral work or advanced degree

96 Don’t know / Not sure
99 Refused

P50. How old are you?_____________

P51. What is your sex?
1. Female
2. Male

P52. Are you
1. Married
2. Never married
3. Previously Married

P53. How long have you lived in this house/apartment?_______months_____yrs
**P54.** Do you own or rent?
   1. Own
   2. Rent

**P55.** Is your child Hispanic or Latino?
   1. Yes
   2. No
   96. Don’t know/not sure
   99. Refused

**P56.** What is your child’s race? *(Select one or more responses.)*
   1. American Indian or Alaska Native
   2. Asian
   3. Black or African American
   4. Native Hawaiian or Other Pacific Islander
   5. White
   96. Don’t know/not sure
   99. Refused

**P57.** Please mark which category your annual household income from all sources falls into:
   1. Less than $10,000
   2. $10,000 to below $15,000
   3. $15,000 to below $20,000
   4. $20,000 to below $25,000
   5. $25,000 to below $35,000
   6. $35,000 to below $50,000
   7. $50,000 to below $75,000
   8. $75,000 to below $100,000
   9. $100,000 +
   10. I decline to answer
One last question.

**P58.** Could we contact you regarding other stages of this project such as giving your child a device like a pedometer to wear to measure their physical activity?

1. Yes
2. No

If yes, can you please give us your phone number?

_______________________
___________________________
APPENDIX F

**Kids questions -color code paper (6-10 minutes)**

K1. How old are you? (YRBS-2007)

1. 10 years old
2. 11 years old
3. 12 years old
4. 13 years old
5. 14 years old

96. Don’t know/not sure
99. Refused

K2. What is your sex? (YRBS-2007)

1. Female
2. Male

K3. What school do you go to?____________________

96. Don’t know/not sure
99. Refused

K4. In what grade are you? (YRBS-2007)

1. 5\textsuperscript{th} grade
2. 6\textsuperscript{th} grade
3. 7\textsuperscript{th} grade
4. 8\textsuperscript{th} grade
5. Ungraded or other grade

96. Don’t know/not sure
99. Refused
K5. How do you get to school on a typical day? (Colorado CHS-2006)

   1. Car
   2. Bus
   3. Walk
   4. Bike
   5. Skate Board
   6. Scooter
   7. Homeschooled
   8. Other

   96. Don’t know/not sure
   99. Refused

K6. In the past year in school have you participated in a physical education (PE) class?

   1. Yes
   2. No

   96. Don’t know/not sure
   99. Refused

   If no go on to K8

K7. In an average week during the last year when you are in school, on how many days do you go to physical education (PE) classes? (YRBS-2007)

   1. 0 days
   2. 1 day
   3. 2 days
   4. 3 days
   5. 4 days
   6. 5 days

   96. Don’t know/not sure
   99. Refused
K8. During the past 12 months, on how many sports teams did you play? (Include any teams run by your school or community groups). (YRBS-2007)

1. 0 teams
2. 1 team
3. 2 teams
4. 3 or more teams
96. Don’t know/not sure
99. Refused

K9. When you ride a bicycle, how often do you wear a helmet? (YRBS-2007)

1. I do not ride a bicycle
2. Never wear a helmet
3. Rarely wear a helmet
4. Sometimes wear a helmet
5. Most of the time wear a helmet
6. Always wear a helmet
96. Don’t know/not sure
99. Refused

K10. When you rollerblade or ride a skateboard, how often do you wear a helmet? (YRBS-2007)

1. I do not rollerblade or ride a skateboard
2. Never wear a helmet
3. Rarely wear a helmet
4. Sometimes wear a helmet
5. Most of the time wear a helmet
6. Always wear a helmet
96. Don’t know/not sure
99. Refused
K11. How often do you wear a seat belt when riding in a car? (YRBS-2007)

1. Never
2. Rarely
3. Sometimes
4. Most of the time
5. Always

96. Don’t know/not sure
99. Refused

K12. During the past 7 days, on how many days were you physically active for a total of at least 60 minutes per day? (Add up all the time you spend in any kind of physical activity that increases your heart rate and makes you breathe hard some of the time.) (YRBS-2007)

1. 0 days
2. 1 day
3. 2 days
4. 3 days
5. 4 days
6. 5 days
7. 6 days
8. 7 days

96 Don’t know/not sure
99. Refused

K13. In a typical week during the summer, how many hours do you spend playing sports or doing some other physical activity like dance, roller-skating, or bicycling? (Colorado CHS-2006)

___ ___ Number of hours

96 Don’t know / Not sure
88 None
99 Refused
K14. On a **typical weekend day**, how many hours do you spend watching TV, DVDs, or videos? (Colorado CHS-2006)
_ _ _ Hours and minutes per day
6  More than 7 hours per day
8  None
96 Don’t know / Not sure
99 Refused

K15. On a **typical weekday**, how many hours do you spend watching TV, DVDs, or videos? (Colorado CHS-2006)
_ _ _ Hours and minutes per day
6  More than 7 hours per day
8  None
96 Don’t know / Not sure
99 Refused

K16. On a **typical weekend day**, how many hours do you spend playing video games, computer games, or using the Internet? (Include activities such as Nintendo, Game Boy, Play Station, Xbox, computer games, and the Internet.) (Colorado CHS-2006)
_ _ _ Hours and minutes per day
6  More than 7 hours per day
8  None
96 Don’t know / Not sure
99 Refused

K17. On a **typical weekday**, how many hours do you spend playing video games, computer games, or using the Internet? (Include activities such as Nintendo, Game Boy, Play Station, Xbox, computer games, and the Internet.) (Colorado CHS-2006)
_ _ _ Hours and minutes per day
6  More than 7 hours per day
8  None
96 Don’t know / Not sure
99 Refused
K18. Are there rules or limits at home about how much time you can watch TV? 
  1. Yes 
  2. No 
  
  96. Don’t know/not sure 
  99. Refused 

K19. Are there rules or limits at home about how much time you can spend on a computer? 
  1. Yes 
  2. No 
  
  96. Don’t know/not sure 
  99. Refused 

K20. I walk in my neighborhood to go to (circle all that apply) (Timperio, 2004) 

  1. Friends’ houses 
  2. Parks or rec centers 
  3. School 
  4. Shops/ Stores 
  5. Restaurants 
  6. Church or any religious organization 
  7. Public transport (bus stops) 
  8. Do not walk in my neighborhood 
  
  96. Don’t know/not sure 
  99. Refused
K21. Not feeling safe in my neighborhood keeps me from playing outdoors (Gomez, 2004)
   1. Definitely true
   2. Mostly true
   3. Sort of true
   4. Mostly not true
   5. Not true at all

   96. Don’t know/not sure
   99. Refused

K22. How safe from crime do you consider your neighborhood to be (BRFSS, 2006)
   1. Extremely safe
   2. Quite safe
   3. Slightly safe
   4. Not at all safe

   96. Don’t know/not sure
   99. Refused
Measurement Data Form

Child Height_________________ in

Child Weight_________________ lbs

Curl up______________________ number performed in one minute

V-sit________________________ Distance with positive or negative

Vertical Jump_________________ net height in inches (jump height - stand height)
APPENDIX G

-BMI Charts

**FIGURE 1. Growth chart for boys**

Data from CDC\(^1\)
2 to 20 years: Girls
Body mass index-for-age percentiles

<table>
<thead>
<tr>
<th>Date</th>
<th>Age</th>
<th>Weight</th>
<th>Stature</th>
<th>BMI^*</th>
<th>Comments</th>
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</tr>
</tbody>
</table>

*BMI = Weight (kg) / Stature (m)^2

To Calculate BMI: Weight (kg) = Stature (cm) - Stature (cm) x 10,000
or Weight (kg) = Stature (m) - Stature (m) x 703

Published: May 30, 2000 (modified 12/18/02)
SOURCE: Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000).
http://www.cdc.gov/nchs/
### APPENDIX H

**Budget for Project**

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<td>Office Supplies</td>
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<td>Incentives</td>
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<td>Exercise Supplies</td>
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<td>Indirect</td>
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**$40000**
APPENDIX I
Family Influence Model
(Klimiecik, Horn & Shurin, 1996)

Environment Outside Home
(Moderator)

Home Environment
Parent’s Beliefs
Parent’s Behavior
Household Rules (TV)

Child Perceptions
(Mediator)

Child Behavior
Physical Activity
Fitness
BMI

Demographics/ Family Characteristics
Age
Gender
SES
Ethnicity
Family type
(Moderator)

CVD Risks
Hypothesis: There will be a significant main effect of Path a, Path b and/or Path c

Child Physical Activity levels
How many days 60 m in/ day MVPA (K12)

Environmental variables - Level 2 Census Tract 3 constructs from TNW study (Main et al, 2012)
1) Safety
2) Crime
3) Infrastructure

Parental factors - moderating variables
1) Parent safety - survey questions P17-23 (Cronbach’s alpha 86)
2) # TV’s - Survey question P33 (Cronbach’s alpha with question P46 = 0.37)
3) # Computers - Survey question P40 (Cronbach’s alpha with P9 = 0.37)
4) Rules on TV - Survey question E13
5) Rules on computer - Survey question K19
6) Travel to school - Survey question K1

Main Effect Path C

Dependent variables
BMI percentile or Fitness Measures Levels

Demographic Variables
Covariates level 1
1) Child Age - Survey question K1
2) Child Gender - Survey question K2

Parental Factors x Built Environment Interaction

Parental Factors and Built environment (Parks and Walking audit) Interaction, Parental factors and Physical activity Interaction, Path d
## Descriptive statistics of survey data by census Tract

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<th>Total</th>
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<th>74</th>
<th>78</th>
<th>79</th>
<th>80</th>
<th>44.03</th>
<th>44.04</th>
<th>41.01</th>
<th>41.02</th>
<th>41.03</th>
<th>41.04</th>
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<td>10%</td>
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<td>63%</td>
<td>33%</td>
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<td>32(11.5)</td>
<td>33.8(11.1)</td>
<td>32.6(11.4)</td>
<td>*</td>
</tr>
<tr>
<td>Vertical jump</td>
<td>10.5(3.6)</td>
<td>13.0(4.9)</td>
<td>8.1(2.2)</td>
<td>11.1(2.5)</td>
<td>8.6(2.3)</td>
<td>10.6(2.7)</td>
<td>10.7(4.3)</td>
<td>10.5(4.2)</td>
<td>9.7(2.9)</td>
<td>8.3(3.1)</td>
<td>9.9(4.9)</td>
<td>13.2(2.3)</td>
<td>9.6(3.9)</td>
<td>10.3(3.0)</td>
<td>14.7(6.2)</td>
<td>10.7(3.9)</td>
<td>*</td>
</tr>
</tbody>
</table>
APPENDIX L

Certificate of Approval

16-Mar-2012

Not Approved to Enroll Subjects! Recruiting of new subjects will require new COMIRB approval

Investigator: Ira Gorman
Sponsor(s): Colorado Health Foundation
Subject: COMIRB Protocol 2006-131 Continuing Review
Effective Date: 16-Mar-2012
Expiration Date: 15-Mar-2013
Expedited Category: 4.7.B
Title: ENVIRONMENTAL AND INDIVIDUAL FACTORS THAT INFLUENCE CHILDREN’S PHYSICAL ACTIVITY

All COMIRB Approved Investigators must comply with the following:

- For the duration of your protocol, any change in the experimental design/consent and/or assent form must be approved by the COMIRB before implementation of the changes.
- Use only a copy of the COMIRB signed and dated Consent and/or Assent Form. The investigator bears the responsibility for obtaining from all subjects “Informed Consent” as approved by the COMIRB. The COMIRB REQUIRES that the subject be given a copy of the consent and/or assent form. Consent and/or assent forms must include the name and telephone number of the investigator.
- Provide non-English speaking subjects with a certified translation of the approved Consent and/or Assent Form in the subject’s first language.
- The investigator also bears the responsibility for informing the COMIRB immediately of any Unanticipated Problems that are unexpected and related to the study in accordance with COMIRB Policy and Procedures.
- Obtain COMIRB approval for all advertisements, questionnaires and surveys before use.
- Federal regulations require a Continuing Review to renew approval of a project within a 12-month period from the last approval date unless otherwise indicated in the review cycle listed below. If you have a restricted/high-risk protocol, specific details will be outlined in this letter. Non-compliance with Continuing Review will result in the termination of this study.

You will be sent a Continuing Review reminder 75 days prior to the expiration date. Any questions regarding this COMIRB action can be referred to the Coordinator at 303-724-1055 or UCHSC Box F-490.

Review Comments:

This approval includes:
Continuing Review Form, CRV004
Application for Protocol Review, 3/13/12
Attachments F, H; version 3/13/12
Protocol, no version date

Sincerely,

UCD Panel S