PERCEIVED HOME AND NEIGHBOURHOOD BUILT ENVIRONMENT CORRELATES OF PHYSICAL ACTIVITY AMONG SCHOOL-GOING CHILDREN IN KAMPALA CITY IN UGANDA

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DECLARATION

This thesis is my original work and has not been presented before for a degree in this or any other university.

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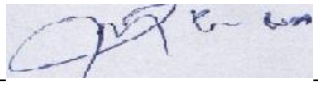
2. Signature____  _____Date_____11th /8/2021_____

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DEDICATION

To my family John Spire, Henry, Robert and Hailey Elizabeth. Your support, motivation and love has been invaluable to me.

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LIST OF ABBREVIATIONS AND ACRONYMS

ACSM: American College of Sports Medicine

AHA: American Heart Association

ANOVA: Analysis of Variance

BEAP: Built Environment and Active Play

BMI: Body Mass Index

CCLaS: Cork Children Lifestyle Study

CDC: Centre for Disease Control

CHMS: Canadian Health Measures Survey

CHOP: Childhood Obesity Project

CI: Confidence Interval

CLAN: Children Living in Active Neighbourhoods

CLASS: Children's Leisure Activities Study

CPM: Counts per Minute

DEDIPAC-KH: Determinants of Diet and Physical Activity – Knowledge Hub

EU: European Union

GIS: Geographical Information System

GPS: Global Positioning System

GSHS: Global School-based Health Survey

G5AP: Grade 5-i-Pass

HICs: High Income Countries

HSES: High Socioeconomic Status

ICAD: International Children's Accelerometry Database

IOTF: International Obesity Task Force

IPEN: International Physical Activity and Environment Network

ISCOLE: International Study of Childhood Obesity, Lifestyle and the Environment

KCCA: Kampala Capital City Authority

LICs: Low Income Countries

LMICs: Low- and Middle-Income Countries

LPA: Light Intensity Physical Activity

LSES: Low Socioeconomic Status

METs: Metabolic Equivalents

MPA: Moderate Intensity Physical Activity

MVPA: Moderate–to-Vigorous Physical Activity

NCDs: Non-communicable Diseases

NEWS-Africa: Neighbourhood Environment Walkability Scale for Africa

NHANES: National Health and Nutrition Examination Survey

NICC: Non-Communicable Diseases Information and Control Centre

NICE: National Institute for Health and Clinical Excellence.

NIK: Neighbourhood Impact on Kids Study

PA: Physical Activity

PAGs: Physical Activity Guidelines

PAL: Physical Activity Levels

SD: Standard Deviation

SEM: Social-ecological Models

SES: Socioeconomic Status

SSA: Sub-Saharan Africa

STATA: South Texas Art Therapy Association

UBOS: Uganda Bureau of Statistics

UK: United Kingdom

USA: United States of America

VPA: Vigorous intensity Physical Activity

WHO: World Health Organisation

DEFINITION OF TERMS

Accelerometers: A monitoring device that measures the intensity of an activity (Institute of Medicine, 2005).

Accessibility: Distance to or from destinations or facilities. (Institute of Medicine, 2005)

Built Environment: The totality of places built or designed by humans, including buildings, grounds around buildings, layout of communities, transportation infrastructure, and parks and trails (Institute of Medicine, 2005).

Connectivity: Degree to which roads and paths are connected and allow direct travel between destinations (Institute of Medicine, 2005).

Land use Mix: Refers to locating different types of land uses (residential, commercial, institutional, recreational, etc.) close together (Institute of Medicine, 2005).

Perception: A belief or opinion, often held by many people and based on how things seem (Cambridge Advanced Learner's Dictionary, 2013)

Physical activity: Physical activity is defined as any bodily movement produced by skeletal muscle that requires energy expenditure (World Health Organisation [WHO], 2010)

OPERATIONAL DEFINITON OF TERMS

Aesthetics: Attractiveness of neighbourhood surroundings including trees, street maintenance, cleanliness, pollution, and scenery.

Children: School-going humans aged 10 to 12 years attending either a public or a private primary school in Kampala City, Uganda.

Correlates/Correlations: Cross-sectional associations or relationships.

High socioeconomic status: high parental education level (diploma/degree/postgraduate) and family ownership of one or more cars.

Home: The physical structure within which children and their parents/guardians live such as a house or an apartment.

Insufficient physical activity: Not meeting the WHO, 2010 physical activity guidelines that is < 60 minutes of MVPA / day.

Low socioeconomic status: low parental level of education (ordinary level/advanced level) and no motorized means of family transport.

Neighbourhood: The immediate area surrounding the child's home which they can walk within 10 to 15 minutes and people who live in this area.

Parental Perception: The way parents observe their home and neighbourhood in relation to their children's physical activity.

Physical Activity Intensity Level: Accelerometer measured energy expenditure in movement counts per minute (cpm) based on the definition by Evenson et al., (2008) as;

sedentary (0–100 cpm), light (101–2295 cpm), moderate (2296–4011 cpm), and vigorous (≥4012 cpm).

Physical Activity: Total movement counts of moderate-to vigorous physical activity (MVPA) in minutes/day as measured by accelerometers.

Residential density: Amounts and types of residences in the neighbourhood.

Sedentary time: Evenson et al. (2008) cut points of ≤100cpm.

Social support: Parents' perception of emotional, informational, and logistical support for their children's participation in physical activity.

Sufficiently physical activity: Compliance to the World Health Organisations [WHO] (2010) physical activity guidelines (≥ 60 minutes / day.

Valid Wear time: At least 10 hours of wake wear time per day with 4 valid days including 1 weekend day.

Non-wear time: Any consecutive 20 minutes of 0 counts during wake wear time.

Weight status: The ratio of the body weight in kilograms to the height in meters squared expressed as body mass index (BMI)

ABSTRACT

Children's regular participation in physical activity is associated with numerous health benefits. However, majority of children globally are insufficiently active. There is scarcity of objectively measured physical activity data in many African countries. The aim of this study was to assess accelerometer-measured physical activity and determine the socio-demographic and parental perceived home and neighbourhood-built environment correlates of physical activity among school going children in Kampala city. School going children (n=256) aged between 10 and 12 years from randomly selected schools participated in this cross-sectional study. Physical activity was measured using the ActiGraph GT3X+ accelerometer (ActiGraph LLC, Pensacola, FL, USA) for 7 consecutive days. Socio-demographics and parental perceived home and neighbourhood-built environment characteristics were assessed using a parent/guardian questionnaire. Weight and height of each child were measured. Multi-level mixed effects logistic regressions tested for the correlations between parental perceived home and neighbourhood-built environment attributes and children's physical activity. Data were analysed using STATA statistical software version 14.2. Children spent most of their time sedentary (590.6±124 minutes/day) and less time in moderate-to-vigorous physical activity (MVPA) (56±25.7 minutes/day). Only 36.3% of the children met the physical activity guidelines. Boys, public schools, and thin/normal weight children were more likely to meet physical activity guidelines. Socio-demographic factors associated with odds of meeting physical activity guidelines were attending a public school (OR: 7.5, 95% CI: [4.24 – 13.32], $p < 0.001$), thin/normal weight status (OR: 5.88; 95% CI: [2.30 - 15.00], $p < 0.001$), lower maternal level of education (OR: 3.64, 95% CI: [2.12 - 6.24], $p <0.001$) and no car ((OR: 4.72, 95% CI: [2.10 – 10.60], $p < 0.001$)). At home level, parents of children in private schools reported more rules for physical activity, child's personal electronics and play equipment. The number of play equipment at home inversely predicted children's MVPA compliance (OR: -1.31, 95% CI: [-1.94 - 0.67], $p<0.001$). At neighbourhood level, parents of children from private schools perceived higher crime safety, while parents of children from public schools perceived a higher residential density and street connectivity. Parental perceived crime in the neighbourhood inversely predicted children's MVPA compliance (OR: -0.25, 95% CI: [-0.45 - 0.04], $p < 0.05$); whereas parental perceived residential density positively predicted children's MVPA compliance (OR: 0.59, 95% CI: [0.13 - 1.05], $p < 0.05$). The current study recommends effective and sustainable intervention strategies that will increase children's physical activity (MVPA) and reduce sedentary time. Sociodemographic factors of weight status (overweight/obese), maternal education level (high), car ownership (one or more cars) may be relevant evidence base to consider when designing intervention programmes that promote physical activity among school going children in Kampala city.

CHAPTER ONE: INTRODUCTION1.1 Background to the Study

Insufficient physical activity accounts for 6% to 10% of major non-communicable diseases (NCDs) such as type 2 diabetes, coronary heart disease, and cancer (Lee et al., 2012; World Health Organization [WHO], 2009). NCDs are the major cause of mortality worldwide, responsible for 60% of all deaths, with 80% of the global burden to NCDs found in low and middle-income countries (LMICs), Uganda inclusive (Hallal et al., 2012). The risk factors for NCDs are established during childhood and are influenced by children's lifestyles and behaviours, such as physical activity (Summerbell et al., 2005; Talema, 2009).

Physical activity in children is associated with numerous immediate and long-term health benefits such as weight control, low blood pressure, improved cardiorespiratory fitness and enhanced psychological wellbeing (Jansen & Le Blanc, 2010). In a review of literature on objective physical activity intensity levels and health in school-going children and adolescents, Poitras et al. (2016) established that physical activity was positively correlated with physical, psycho-social, and cognitive health. They further found out that all physical activity intensity levels including light intensity physical activity (LPA) are beneficial for health although higher physical activity intensity levels such as moderate intensity physical activity (MPA) and vigorous intensity physical activity (VPA) offer greater health benefits. Therefore, children are required to participate in at least 60 minutes and up to several hours of MVPA daily (Bull et al., 2020; WHO, 2010) to benefit from physical activity.

However, global trends in insufficient physical activity among school-going children and adolescents showed that majority of the children were insufficiently active (Guthold et al., 2020; Hallal et al., 2012). Increasing physical activity levels of children is an important public health challenge (WHO, 2010; WHO, 2018) because there is evidence that physical activity tracks into adulthood (Talema et al., 2014). Moreover, the current physical activity data are primarily from studies that used self-reports (Guthold et al. 2020). Self-reports are prone to recall and social desirability biases which result in overestimation of physical activity (Adamo et al., 2009; Prince et al., 2008), are usually restricted to measuring MVPA, underestimate sedentary time and rarely provide data on LPA (Poitras et al., 2016). To reduce biases associated with self-report, some large-scale epidemiological studies have used device-based methods like accelerometry to quantify children's physical activity and sedentary time (Doherty et al., 2017; Katzymarsyk et al., 2013; Troiano et al., 2008). However, these results are skewed to high income countries (HICs), which creates a data gap and a need for high-quality data using more objective device-measures such as accelerometers, particularly in low-income counties (LICs) like Uganda, to better describe children's physical activity (Bauman et al., 2012; Cooper et al., 2015; Manyanga et al., 2018; Muthuri et al., 2014b).

Furthermore, a systematic review of trends in physical activity among school-going children from sub-Saharan Africa (SSA) by Muthuri et al. (2014b) found that urbanization was associated with lower levels of physical activity. Studies from LICs, also found that physical activity was lower in urban residents compared to rural residents (Ojiambo et al., 2012; Onywera et al., 2012: Sallis et al., 2016b). This is a worrying finding because of rapid urbanisation and high rates of rural to urban migration reported by most LICs. The

Uganda Bureau of Statistics (UBOS, 2018) reported an increase in the number of people living in urban areas from 15% in 2009/2010 to 23% in 2016/2017. But there is almost no objective measured data on physical activity among urban children in Uganda. Therefore, continued assessment of children's physical activity is crucial to guide the formulation and evaluation of interventions aimed at increasing children's physical activity. Accelerometers are currently the most frequently used devices for objectively quantifying children's physical activity because they enable real-time monitoring of frequency, intensity, and duration of physical activity in free-living conditions (Ainsworth et al., 2015; Hills et al., 2014). Accelerometry made it possible to assess the physical activity intensity levels and the proportion of children in Kampala who met the physical activity guidelines.

To develop effective physical activity interventions in children, correlates of children's physical activity need to be well understood. Children's physical activity is a complex behaviour which is influenced by a diverse range of factors at multiple levels ranging from sociodemographic factors and the built environmental in which they live (Bauman et al., 2012; Franzini et al., 2009; Sallis et al., 2000). Socio-demographic correlates of children's physical activity such as age, sex, type of school, weight status, socioeconomic status (SES), maternal level of education and family car ownership have been widely studied (Bauman et al., 2012). Results from various studies show that, boys are more active than girls (Cooper et al., 2015; Currie et al., 2012; Guthold et al., 2020; Muthuri et al., 2014c; Muthuri et al., 2014b; Sallis et al., 2016a). Children's physical activity levels decline with increasing age (Cooper et al., 2015; Corder et al., 2015; Farooq et al., 2020; Iannotti & Wang, 2013). Regarding weight status, higher weight status (BMI scores) has been

associated with lower levels of physical activity (Hu, 2008; Muthuri et al., 2014a; Riso et al., 2018; Schwarzfischer et al., 2017; Wilkie et al., 2018). On the contrary, high socioeconomic status (HSES) in HICs (Currie et al., 2012) and low socioeconomic status (LSES) in LICs (Muthuri et al., 2014b; Muthuri et al., 2014c), were associated with increased participation in physical activity. Furthermore, children whose mothers had acquired a higher level of education had lower MVPA (Muthuri et al., 2014c; Sherar et al., 2016; Wilk et al., 2017). Also, children from families that have one or more cars engaged in lower MVPA (Pouliou et al., 2015; Van Sluijs et al., 2018). Yet, the socio-demographic factors cannot fully explain the insufficient physical activity exhibited by children (Sallis et al., 2008). In addition, interventions based on socio-demographic factors focus on individuals rather than the general population and have achieved limited and short-term increases in physical activity (Brown et al., 2009; Reilly & McDowell, 2003; Summerbell et al., 2005).

Built environment attributes have recently received tremendous support as promising correlates of physical activity because the environment in which people live and interact are important (Bauman et al., 2012; Sallis & Glanz, 2009). Among children, physical activity takes place within the built environment settings of schools, homes, and neighbourhoods (Duranceau & Bergeron, 2013). Children's physical activity is correlated with built environment attributes at home and neighbourhood because children interact within these settings daily and do not spend time exclusively at school (D'Haese et al., 2014; Oliver et al., 2015; Tappe et al., 2013). In addition, children have more free time to engage in physical activity at home and in the neighbourhoods than at school, because there are no restrictions such as sitting in class (Ishii et al., 2015). Therefore, the home

and neighbourhood-built environments are important in influencing children's physical activity.

The home-built environment may be more essential in influencing children's physical activity (Crawford et al., 2010) because children spend 47.2% of their time at home (Tandon et al., 2014). Karsten (2005), found that the time children spend at home in urban areas has increased, with the increased parent/guardian supervision, the home has become more of a child's space. Therefore, the social environment that parents create at home by providing social support for children's physical activity through encouragement to participate, role modelling and logistical support; and implementing rules related to physical activity shapes children's physical activity behaviour (Salmon et al., 2005; Van Der Horst et al., 2007; Verloigne et al., 2012a). The physical home environment factors such as opportunities created at home for sedentary pursuits like electronic and media devices; and for physical activity through the availability of play equipment at home, have been associated with children's physical activity (Maitland et al., 2013; Tandon et al., 2014). For example, the absence of physical activity equipment in the home promotes the use of electronic media like computers and video games, which replace more active pursuits (Ross et al., 2013). Although some studies show correlations between the home-built environment with children's physical activity (Rosenberg et al., 2010; Tandon et al., 2014), the results have been inconclusive, the home-built environment has received less attention and a lot is still unknown (Ferreira et al., 2007).

All people, including children, benefit from a physical activity enhancing neighbourhood-built environment. Neighbourhoods accommodate children by providing them with space for outdoor activity and independent mobility, which have been correlated with children's

physical activity (Ferreira et al., 2007; Karsten, 2005; Sallis et al., 2000). Zhang and Li (2012) observed that children aged 9 to 12 years were independent and they engaged in physical activity with friends in the neighbourhood, in streets and parks. The social neighbourhood environment influences children's physical activity through safety (Muthuri et al., 2016; Oliveira et al., 2014). Parental concerns about safety (crime, traffic, stranger danger and personal) strongly determine parents' restriction of their children's outdoor play and independent mobility; thus, reducing their physical activity levels (Carver et al., 2008; Ding et al., 2011; Vlaar et al., 2019).

Review studies report that children are more likely to engage in physical activity if they reside in neighbourhoods that have access to recreation facilities, presence of walking and cycling infrastructure, access to various destinations and public transport (Bauman et al., 2012; Davison & Lawson, 2006; Ding et al., 2011; Oliveira et al., 2014). However, most of these findings were inconsistent (Davidson & Lawson, 2006; de Vet et al., 2011); and most have been reported from developed countries like Australia, United States of America (USA) and United Kingdom (UK) (Oliveira et al., 2014). Although such findings are plausible, they are not universal and therefore, they may not apply to school-going children living in other countries and cultures (Watts et al., 2011), including Uganda. Giles-Corti et al. (2016) acknowledged that translating results from HICs to LMICs where urban environments varied greatly was a challenge. Kampala city is currently undergoing rapid industrialization and economic growth coupled with increased rural to urban migration, which has resulted in a rapid growth in the urban population (Kampala Capital City Authority [KCCA], 2014). This generates grave concern because cities pose many problems for children, especially in lack of play and green spaces (Christensen & O'Brien,

2003), increased reliance on motorized transport, television viewing and use of labour-saving devices at home (Katzmarzyk & Manson, 2009; Ojiambo et al., 2012); all of which decrease children's participation in physical activity.

The neighbourhood-built environment has been widely studied among adults (Adams et al., 2013; Bauman et al., 2012; Oyeyemi et al., 2012; Prince et al., 2011; Sallis et al., 2016b). Review studies have highlighted that neighbourhood-built environment correlates of physical activity differ with age (Bauman et al., 2012; McGrath et al., 2015). For example, lower street connectivity has been associated with more activity among children because it reduces traffic volume and provides a safe place for children to play (Tappe et al., 2013). On the other hand, another study found that among adults, higher street connectivity in neighbourhoods was associated with more active travel (Saelens & Handy, 2008). However, results from adult studies cannot be generalised to children, because children, unlike adults, have more free time for play and are under adult supervision (Davidson & Lawson, 2006; D'Haese et al., 2014; Pedroni et al., 2019). Therefore, this study may highlight variance in built environment correlates of children's physical activity specific to Ugandan children who reside in Kampala city.

1.2 Problem Statement

Regular participation in physical activity is associated with numerous health benefits (Poitras et al., 2016); but evidence shows that many children worldwide do not meet the physical activity recommendations (Guthold et al., 2020). Promoting children's participation in physical activity is important for public health because the consequences of insufficient physical activity during childhood is reflected in adolescence and spills

over into adulthood (Talema et al., 2014). However, documented prevalence of physical activity among children in most African countries such as Uganda is almost non-existent. this is especially true about the scarcity of physical activity data particularly the objective accelerometer-measured physical activity data (Manyanga et al., 2018).

Socio-demographic correlates, although widely studied (Cooper et al., 2015; Currie et al., 2012; Muthuri et al., 2014b; Muthuri et al., 2014c), cannot fully explain the insufficient levels of physical activity. No study has assessed the socio-demographic correlates of physical activity in the current study population. Although, parental perceived home and neighbourhood built environmental attributes have been identified as promising correlates of children's physical activity, the findings are inconclusive (Davidson & Lawson, 2006; Ding et al., 2011; Maitland et al., 2013). Most of these studies are skewed in favour of developed countries in north America, Europe, and Australia (Oliveira et al., 2014). Therefore, differences in culture and the built environment at different locations make it impossible to apply the findings to Uganda an African country. This study, therefore, sought to investigate the correlations between parental perceptions of socio-demographics, home and neighbourhood-built environment and physical activity among school children in Kampala, Uganda.

1.3 Purpose of the Study

The purpose of this study was to determine children's physical activity intensity levels and their compliance to the WHO (2010) physical activity guidelines. The study further assessed associations between parents' perceptions of the home and neighbourhood-built environment and children's physical activity in Kampala city, Uganda.

1.4 Objectives of the Study

The study was guided by the following specific objectives:

I. To determine whether the physical activity intensity levels (Sedentary time, LPA, MPA, and VPA) among 10- to 12-year-old school children in Kampala city in Uganda comply with the WHO physical activity guidelines.

II. To assess the association between socio-demographic factors such as sex, age, type of school, weight status and parental marital status, parental education level, family car ownership, and number of siblings and physical activity among 10 to 12-year-old school-going children in Kampala city in Uganda.

III. To assess the association between selected home-built environment factors such as parental support, parental rules for physical activity, electronic and media equipment, and play equipment at home and physical activity among 10 to 12-year-old school-going children in Kampala city in Uganda.

IV. To assess the association between parental perceived neighbourhood-built environment attributes such as residential density, land use mix-diversity, land use mix-access, street connectivity, walking and cycling infrastructure, aesthetics, traffic safety, crime safety, personal safety, and stranger danger and physical activity among 10 to 12-year-old school-going children in Kampala city in Uganda.

1.5 Research Question

The study was guided by the following research question.

Do the physical activity intensity levels among 10- to 12-year-old school children in Kampala city in Uganda comply with the WHO physical activity guidelines?

1.6 Research Hypotheses

The study was guided by the following hypotheses:

Ho1 There are no significant associations between the following socio-demographic factors of sex, age, type of school, weight status, parental marital status, parental education level, family car ownership and number of siblings and physical activity among 10 to 12-year-old school-going children in Kampala city in Uganda.

Ho2 There are no significant associations between the home-built environment factors of parental support, rules for physical activity, electronic and media equipment, and physical activity equipment at home and physical activity levels among 10 to 12-year-old school-going children in Kampala city in Uganda.

Ho3 There are no significant associations between the parental perceived neighbourhood-built environment attributes of residential density, land use mix-diversity, land use mix-access, street connectivity, walking and cycling infrastructure, aesthetics, traffic safety, crime safety, personal safety, and stranger danger and physical activity among 10 to 12-year-old school-going children in Kampala city in Uganda.

1.7 Significance of the Study

The study findings may be used by public health and community organisations to plan local physical activity programmes and interventions for school-going children. The results may also be used to create awareness and sensitization of children and their parents about physical activity. In addition, because physical activity behaviour is more likely to be influenced in environments where it occurs (Sallis et al., 2008); assessing parental

perceptions of the different attributes of home and neighbourhood-built environment will enable more precise identification of correlates that may inform effective evidence-based interventions.

The study revealed promising correlates that could guide policymakers and city planners in designing built environments that stimulate physical activity and thus, increase levels of physical activity in children. Additionally, the new information from the current study identified attributes of the built environment that are specific to school-going children in Kampala city which may advise possible local interventions in Uganda. For instance, Kampala capital city authority (KCCA) has a new plan for the city, which is underway, the plan involves retrofitting the existing built environment and later constructing new infrastructure to expand and decongest the city (KCCA, 2014). The current study findings may inform the ongoing implementation of the new city plan.

The study results contributed to the national and international growing body of literature on built environment correlates of children's physical activity. It also revealed some characteristics that suggest opportunities for further investigations and used as a reference by other researchers in this area.

1.8 Delimitations of the Study

The study was conducted within the following scope:

i. Only primary school-going children aged 10 to 12 years in private and public mixed day primary schools in Kampala city and their parents participated in the study.

ii. The study focused on the home and neighbourhood environment of only residents of Kampala city.

1.9 Limitations of the Study

The study encountered the following limitations.

i. Accelerometers did not accurately quantify some types of physical activity, like water-based activities and weight-bearing activities which may have resulted in the underestimation of physical activity levels. Accelerometers are also limited in capturing context-specific physical activity like walking and therefore do not specify the domains of physical activity undertaken such as transportation, work, or recreation (Corder et al., 2007). However, primary school children in Uganda rarely participate in water-based activities like swimming, therefore physical activity may not have been underestimated in the current study (Education Statistical Abstract, 2017).

ii. The use of parent-proxy reports for the home and neighbourhood environment may have resulted in bias by the respondents because the questionnaire was long (Oyeyemi et al., 2016). The interview manual for the neighbourhood environment walkability scale for Africa (NEWS-Africa) survey (Appendix N) was used to explain if some questions were difficult for respondents. Telephone prompts to respondents were also used to minimise non-response.

iii. This study is cross sectional and is therefore can only identify associations between variables and cannot make casual inferences.

1.10 Assumptions

The study made the following assumptions:

i. All the five divisions of Kampala city had relatively homogeneous neighbourhoods.

ii. The 7 days of accelerometry represented the child's usual daily and weekly physical activity behaviour.

1.11 Theoretical and Conceptual Framework

1.11.1 Theoretical Framework

The Social-ecological model (SEM) of health behaviour was employed in the current study because the theory helps to understand the multiple and interactive influences of personal and environmental factors on physical activity (Sallis et al., 2008). There is also an increased interest among public health professionals in the use of socio-ecological model to study and understand the complex nature of physical activity behaviour (Sterdt et al., 2014). SEM evolved from the psychosocial theory (Bandura, 1986) which explains behaviour as resulting from the interaction of personal, behavioural, and environmental conditions. Although the psychosocial theory has been widely used to study the correlates of physical activity, the theory can only explain the social environment at the expense of the physical environment (Handy, 2004).

The SEM of health behaviour asserts that change in health behaviour cannot be fully explained without considering the ecological niche in which the person resides

(Bronfenbrenner, 1988). The SEM recognise both the social and physical environments and were proposed as more productive frameworks for understanding and promoting physical activity and other healthy behaviours (Sallis et al., 2006; Sallis et al., 2008). Specifically, this model proposes that there are multiple levels of influence on behaviour, including individual and social levels, but also built environment and policy, rather than positing that only a narrow range of psychosocial variables influences behaviour. Thus, SEM distinguished by their explicit inclusion of environmental and policy variables that are expected to influence behaviours (Sallis et al., 2006). For example, the SEM was used to guide the development of the WHO strategy for promotion of diet, physical activity behaviour in obesity prevention (WHO, 2004).

However, because the model assesses multiple influences on physical activity at each level (individual, social and environmental), the study presents the various associations, but SEM may not be able to predict the strength of their associations (Sallis et al., 2008, Sterdt et al., 2014). Despite assessing multiple levels of influence, SEM may broaden options for interventions, policy and environmental changes which may affect virtually the entire population in contrast to interventions that focus only on individual and interpersonal interventions that only reach individuals that choose to engage in physical activity programs (Sallis et al., 2008).

1.11.2 Conceptual Framework

The current study utilised the SEM framework to assess the multiple correlates of children's physical activity. The conceptual framework depicted in Figure 1.1 related children's physical activity (MVPA) to socio-demographic factors such as sex, age, school

type, weight status, parental marital status, parental education level, family car ownership and number of siblings. The home-built environmental factors like parental social support, and rules for physical activity, and home media and electronic, and physical activity equipment. The neighbourhood-built environment factors such as residential density, land use mix-diversity, land use mix-access, street connectivity, walking and cycling infrastructure, aesthetics, traffic safety, crime safety, personal safety, and stranger danger.

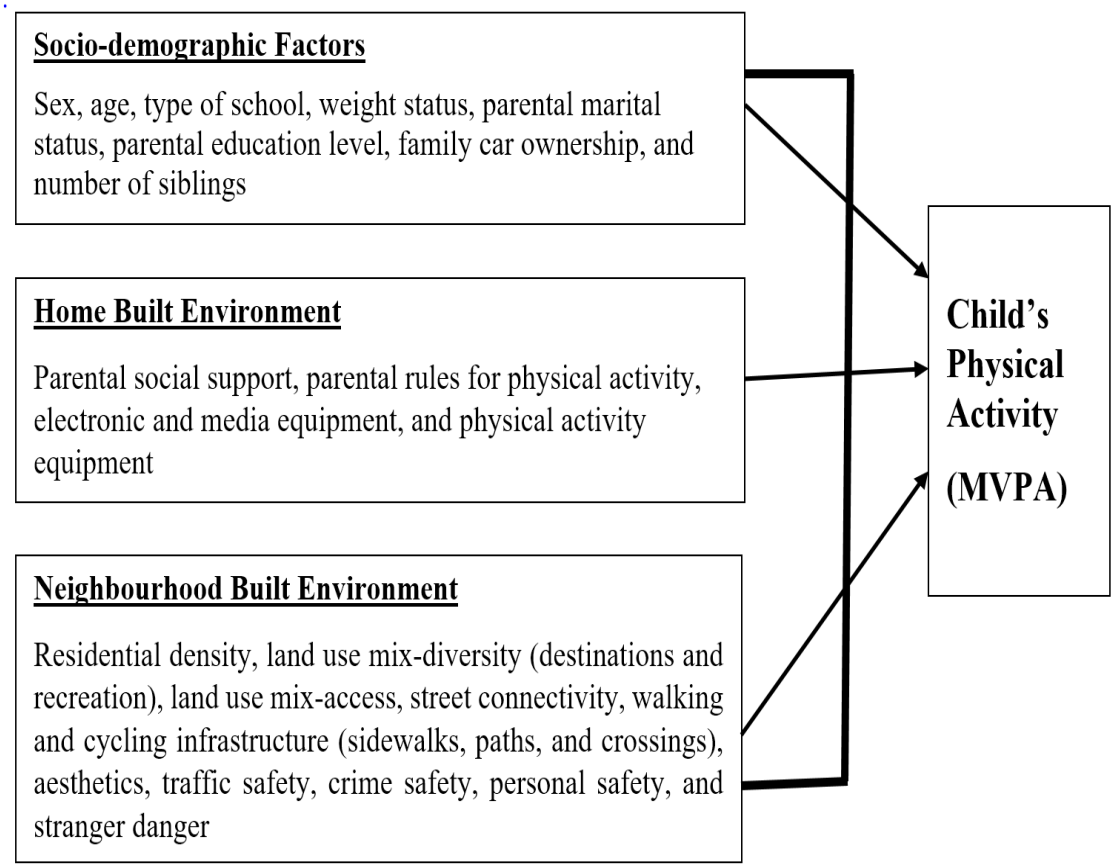

Figure 1.1. A social-ecological model of socio-demographic, home, and neighbourhood-built environment correlates of physical activity in school-going children in Kampala city in Uganda (Adapted from Sallis & Owen, 1999)

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

Physical activity is any bodily movement resulting from the contraction of skeletal muscles that increases energy expenditure above resting levels (WHO, 2010). Regular participation in physical activity decreases the risk of premature all-cause mortality (Rhodes et al., 2017; Warburton et al., 2010). For example, Warburton et al. (2010) reported a 31% decrease in all-cause mortality among sufficient active individuals when compared to their insufficient active peers.

However, Sallis et al. (2016a), found no evidence of global increases in physical activity, implying that the global pandemic of physical inactivity is still existent. The insufficient physical activity levels are a concern due to the associated burden of disease, reduced quality of life and the direct and indirect costs to society and the health care system (Kohl et al., 2012; Lee et al., 2012). The global burden of physical inactivity was estimated at $ 54 billion in health care cost in 2013 (Ding et al., 2016). In USA, physical inactivity is responsible for 10% of premature mortality and approximately $117 billion in health costs every year (Piercy et al., 2018).

Therefore, promoting physical activity is a public health priority which was adapted by the WHO in 2004 in the “global strategy on diet and physical activity and amplified by the global action plan on physical activity 2018-2030 with the aim of reducing the burden of disease and death worldwide due to NCDs (WHO, 2004; WHO, 2010; WHO, 2018).

2.2 Children's Physical Activity

Among children, regular participation in physical activity has been strongly and consistently associated with improved adiposity, metabolic syndrome markers (cholesterol, high blood pressure, triglycerides, and fasting blood glucose), health related physical fitness (cardiorespiratory, muscular strength and endurance), bone strength, confidence and social skills, concentration and learning, and sleep (Janssen & Leblanc, 2010; Poitras et al., 2016). Nonetheless, children worldwide do not engage in sufficient physical activity for health. Guthold et al., (2020) reported that, 81% of children and adolescents aged 11 to 17 years did not meet the physical activity guidelines. Children can engage in sufficient amounts of physical activity daily as part of play, games, sport, transportation, chores, recreation, physical education (PE), or planed exercises at home, school, and neighbourhood (WHO, 2010).

2.2.1 Measurement of Physical Activity in Children

Various tools are used to assess the amount and type of physical activity engaged in by children in different settings (Hills et al., 2014). Measurement of physical activity in free-living conditions is necessary to assess intensity levels and correlates of physical activity (Trost, 2007). Physical activity being inherently a complex and multidimensional behaviour, has no recognized "gold standard" technique used to quantify it (Freedson et al., 2012). Therefore, getting the accurate measurement is a challenge (Trost, 2007); particularly in children because children exhibit sporadic and intermittent movements (Bailey et al., 1995; Hill et al., 2014; Welk et al., 2000). Also choosing an accurate and objective measure of physical activity suitable for large sample studies is a challenge

because of the high costs and logistics (Feito, 2013). However, making a choice on the suitable measurement tool, can, be guided by factors like; affordability, the sample size, age of participants, the study setting, participant burden, research questions, level of accuracy required, type of physical activity measured and data management challenges (Dollman et al., 2009; Spruijt-Metz et al., 2018; Welk et al., 2000; Westerterp, 2009).

Physical activity measures are grouped into subjective and objective measures (Welk et al., 2000). Objective and subjective measures of physical activity quantify different constructs of physical activity, which are related but not the same (Troiano et al., 2014). Whereas subjective measures assess the time spent engaging in different modes of physical activity, objective measures like accelerometers measure volume and intensity of physical activity and quantify sporadic and intermittent physical activity (Rhodes et al., 2017). In children, objective, and subjective methods available for assessment of physical activity include self-report (recall-based), direct observations, movement sensors (device-based) and physiological responses (Sirard & Pate, 2001).

2.2.1.1 Subjective Measurement of Physical Activity

Recall-based measures such as questionnaires, activity diaries and activity logs are the most common and widely used subjective measures in epidemiological studies especially in adults; they require parents to report their children's physical activity (Strath et al., 2013). Nevertheless, self-report measures have significant validity and reliability limitations, including information bias introduced by respondents or interviewers, participant burden and social desirability. Subjective measures are not also recommended for use among children because children cannot accurately recall and report the mode, duration, frequency, and intensity of their own physical activity (Adamo et al., 2009;

Trost, 2007; Welk et al., 2000). The bias in subjective measures may lead to overestimation or underestimation of physical activity. For example, in Canada, a prevalence estimate difference of 14% was observed between questionnaire (77%) and objective (91%) measures (Statistics Canada 2015).

2.2.1.2 Objective Measurement of Physical Activity

Objective measurement tools of physical activity include movement sensors such as pedometers and accelerometers; indirect measures such as heart rate monitors, calorimetry, doubly labelled water; and direct observations (Welk et al., 2000). Objective measures eliminate many of the limitations of self-reported measures and are also used to validate subjective measures (Prince et al., 2008). Indirect measures such as calorimetry are usually laboratory-based, expensive and may not be convenient to use in studies examining physical activity in free-living conditions (Hills et al., 2014). Heart rate monitors on the other hand are not direct measures of physical activity, they are a measure of stress placed upon the cardiorespiratory system by physical activity (Rowlands & Eston, 2007). Heart rate monitors have limitation for measuring physical activity because, various factors such as anxiety, emotional stress, hydration status and environmental factors influence heart rate (Gibson et al., 2019). On the other hand, although direct observation is a recommended measure of children's physical activity, it can only be used to study a small sample of children and a proportion of physical activity occurring in a specific context, observations may also not be feasible because of the associated time and cost coupled with the observer bias (Ainsworth et al., 2015; Westerterp, 2009).

In the past two decades, emerging technological advances have improved accuracy and precision measurement of children's physical activity via motion sensors such as

accelerometers (Lee & Shiroma, 2014; Troiano, 2005) and pedometers (Clemes & Biddle, 2013). Pedometers are the most used motion sensors, which count steps taken when walking or running (Hills et al., 2014). Pedometers are not expensive and have no analytical burden because output data is easy to understand and can further be used to raise awareness and motivate people to engage in physical activity (Clemes & Biddle, 2013). However, pedometers count steps taken and do not provide information about intensity and duration of activity (Clemes & Biddle, 2013; Colley et al., 2011; Corder et al., 2007; Trost, 2007). Pedometers do not account for individual height and weight which are predictors of stride length and walking speed (Hills et al., 2014). They are also prone to data loss especially when used in children (Clemes & Biddle, 2013); because children constantly look at the number of steps taken and they may manipulate them to increase step counts (Hills et al., 2014).

2.2.2 Accelerometry

Accelerometers have been used to quantify physical activity for the past two decades (Cain et al., 2013b). Accelerometers have also been used in large epidemiological studies in children such as the UK biobank study (Doherty et al., 2017), USA national health and nutrition examination survey (NHANES) (Troiano et al., 2008) and international study of childhood obesity lifestyle and environment (ISCOLE) (Katzmarzyk et al., 2013). Accelerometers are acceptable as accurate, valid, reliable, and promising device-based measures of physical activity in children (Cain et al., 2013a; Trost, 2007).

Accelerometers contain a microelectromechanical system that measures acceleration in one (vertical) or three (vertical, medio-lateral & antero-posterior) planes, which is used to

quantify body movements (Chen & Basset, 2005). According to Trost et al. (2005), the acceleration signals are integrated over a specified time interval known as an epoch (ranging from 1 second to several minutes) and then summed up and stored. For children, a shorter epoch length is recommended to capture their intermittent and sporadic movements (Edwardson & Gorely, 2010). The output from accelerometers are counts, these counts are calibrated against energy expenditure (Freedson et al., 2005). Count thresholds (cut-offs) equivalent to various levels of energy expenditure have been generated and these are used by researchers to compute the time spent at different physical activity intensity levels (Evenson et al., 2008; Treuth et al., 2004). The time spent in different physical activity intensities (sedentary time, LPA, MPA & VPA) is the most common outcome of interest (Evenson et al., 2008; Treuth et al., 2004).

The ActiGraph GT3X is a tri-axial accelerometer and therefore provides a more valid assessment of physical activity in the vertical, antero-posterior, and medial-lateral axes (Hanggi et al., 2013). It also has an inclinometer that detects posture such as lying, sitting, standing and non-wear when placed at the hip (Haggi et al., (2013). The ActiGraph GT3X+ is small, has a long-life rechargeable battery, a high memory and is more flexible in scoring data (Cain et al., 2014a). However, accelerometers when placed on the hip have limitations in estimating energy expenditure in non-ambulatory activities such as cycling, isometric and resistance exercises such as weightlifting. Most accelerometers are also not water-resistant, and they must be removed when engaging in water-based activities which may lead to underestimation of physical activity (Feito, 2013). There is always a chance of reactivity (change in behaviour) since the participants are aware that they are being monitored (Hill et al., 2014). Accelerometers also, do not identify the mode

(type) and domain of physical activity (Matthews, 2005). Interpretation of results may also have limitations given the various methods used to generate outcome variables during data processing. For example, decisions on wear time versus non-wear time, what constitutes a valid day or data file, which cut-offs to use to define different physical activity intensities and sedentary time and the epoch length to use (Banda et al., 2016). Differences in data reduction methods makes comparison of results difficult (Cooper et al., 2015; Hill et al., 2014). Consequently, the current study employed the ISCOLE accelerometry protocol (Katzymarsyk et al., 2013) to ensure that the results were comparable. The study also used the epoch length that was used to generate the Evenson et al. (2008) activity cut points. The Evenson cut-offs were also used to generate the physical activity intensity levels of interest for this study. It is important to note that swimming and cycling are not quite common activities which Ugandan children engage in, and this reduces the chances of underestimation of physical activity in the current study participants (Education Statistical Abstract, 2017).

Traditionally accelerometry protocols required the participant to take off the monitors at night when going to bed and put them on upon waking (Troiano et al., 2008). Recently, for purposes of increasing wear time, various studies are requesting participants to wear the monitor for 24 hours (Katzymarsyk et al., 2013; Tudor-Locke et al., 2015a). The 24-hour accelerometry protocol allows for assessment of children's physical activity, sedentary behaviour and sleep concurrently using the same monitor and over the same period which reduces participant burden and research costs (Meredith-Jones et al., 2016). However, the 24-hour protocol introduces another challenge for researchers because it requires identifying and accounting for sleep time before physical activity and sedentary

behaviour can be analysed accurately (Tudor-Locke et al., 2014). Meredith-Jones et al. studied various methods of removal of sleep and found that the methods had no effect on estimates of MVPA. Nevertheless, non-wear time and the amount of sedentary time were affected. In addition, software programmes like the sleep algorithms built into the ActiLife Version 6.13.3 software (ActiGraph LLC, Pensacola, Florida, USA) can be used to identify sleep onset and offset (Sadeh et al., 1994); and can therefore be used to score sleep for each day of wear for each participant, although it is a tedious process particularly with a large sample.

Despite the technological advances, quantifying children's physical activity is still a challenge; it requires an assessment of physical activity intensity levels as well as identifying the type, context, location, frequency, and duration. Even objective measures like accelerometers may not generate all the information (accelerometers cannot assess the type and context of physical activity). Therefore, without appropriate and accurate measures of physical activity, it may be challenging to identify correlates of children's physical activity (Biddle et al., 2011). However, accelerometers are more feasible and accurate over parental self-report and observations (Evenson et al., 2008). Also, since the use of accelerometers to quantify children's physical activity and estimate habitual physical activity has recently increased (Ainsworth et al., 2015; McCarthy & Grey, 2015), employing accelerometry for evaluating physical activity among school-going children in Kampala city was ideal. However, it was non-existent.

2.3 Physical Activity Intensity Levels

Physical activity can be categorised and assessed based on domains (context or setting) in which it occurs. These include leisure or recreation, transportation, household and occupational (Rhodes et al., 2017). Physical activity is often described and assessed using the FITT principle in which F is the frequency (how often an individual is active) and is expressed as days/week, I is the intensity (amount of energy expended when participating in physical activity), the first T is the time (total duration of the activity) which is measures as some unit of time, and the second T is the type (domain of activity engaged in) (Chen & Basset, 2005; Rhodes et al., 2017). Expressing intensity of physical activity is a challenge. However, children's physical activity intensity can be expressed as percentage of maximum oxygen consumption, percentage of maximum heart rate, body movement per unit time, steps per unit time, caloric expenditure, metabolic equivalent of tasks (METs) and rate of perceived exertion (RPE) (Gibson et al., 2019). Intensity of exercise expressed as METs is the ratio of the person's exercise metabolic rate to their resting metabolic rate, such that 1 MET is the energy expended while sitting quietly (Gibson et al., 2019). When expressing physical activity intensity using METs, physical activity intensity levels can be grouped into, sedentary (≤1.5METs), LPA (< 3METs), MPA (3-6 METs) and VPA (> 6 METs) (Ainsworth et al., 2011). In the current study, physical activity intensity levels were expressed as movements per unit time (counts per minute [cpm]) which were generated from the Evenson et al. (2008) cut-offs as sedentary (0–100 cpm), LPA (101–2295 cpm), MPA (2296–4011 cpm) and VPA (≥4012 cpm). Therefore, physical activity intensity levels range on a continuum from no activity (sedentary) to extremely active (VPA) (Rhodes et al., 2017).

2.3.1 Sedentary Time

Sedentary time is the duration spent in sitting or lying activities during waking hours equivalent to an energy expenditure ≤ 1.5 METs (Tremblay et al., 2017) or a threshold of counts/minute cut offs of 0–100 cpm (Evenson et al., 2008). Examples of this can be noted in children's sedentary behaviours when traveling to school by car, sitting in class, watching television, and using a computer all of which contribute to sedentary time (O'Brien et al., 2018). According to Chapat et al. (2014), a typical physical activity pattern includes > 40% of sedentary time. Also, Lou (2014) reviewed literature on sedentary time found that on average children spent 6 hours in sedentary pursuits during and out of school. Belgian primary school going children aged 10 to 12 years spent 60% of their wake time sedentary (Verloigne et al., 2017). Similar amounts of sedentary time have also been reported in Sub-Saharan Africa. In Dakar in Senegal, school going children aged 8 to 11years spent 65% of their time in sedentary pursuits (Diouf et al., 2016). Urban children from Eldoret in Kenya spent 72% of their wake time sedentary (Ojiambo et al., 2012). Results from the ISCOLE study conducted in Kenya, revealed that school-going children aged 9 to 11 years old spent 6.6 hours in sedentary pursuits (Muthuri et al., 2014c). More to this emerging evidence of adverse effects of sedentary time on children's health (Biswas et al., 2015; Carson et al., 2016; Hoare et al., 2016; Tremblay et al., 2017), it was necessary to determine sedentary time among school-going children in Kampala city.

2.3.2 Light Intensity Physical Activity

LPA is movement equivalent to 101 to 2295 cpm (Evenson et al., 2008), or energy expenditure equivalent to < 3 METs (Ainsworth et al., 2011). Most previous studies used subjective methods to assess physical activity, they were limited to measuring MVPA, little data were available for LPA (Lee & Shiroma, 2014). Consequently, there are no guidelines on what amount of LPA is beneficial for health (Lee & Shiroma, 2014; Poitras et al., 2016). With technological advances in measuring physical activity, LPA has been measured with the use of accelerometers (Lee & Shiroma, 2014). Studies show that children spend four to six hours of their wake time in LPA which contributes the greatest percentage to overall physical activity (Chaput, et al., 2014; Colley et al., 2011; Wilkie et al., 2018). In the European Union (EU) childhood obesity project (CHOP), 80% of the physical activity captured was LPA (Schwarzfischer et al., 2018). Among public school children from Dakar in Senegal, Diouf et al. (2016) reported five hours of LPA. Rural South African children and adolescents aged between 7 and 15 years, accumulated mostly LPA (Craig et al., 2013). Results from the ISCOLE study in Nairobi Kenya indicated that children aged 10 to 11 years on average engaged in LPA for 7.7 hours/day (Muthuri et al., 2014c). Although accelerometers have made it possible to measure children's LPA, there is no study that has assessed LPA among school-going children in Kampala city in Uganda.

2.3.3 Moderate Intensity Physical Activity

MPA is defined as any motion that rises the heart rate or energy expenditure between 3.0 and 6.0 METs (Gibson et al., 2019). In the current study, MPA was defined following

according to the Evenson et al. (2008) cut offs from 2296 to 4011 cpm. At moderate intensity physical activity, the energy expenditure is thrice that of resting level (Rhodes et al., 2017). The international recommendations for physical activity include MPA, and as such, children accumulate their highest percentage of MVPA at moderate intensity (Colley et al., 2011; Riso et al., 2018; Wilkie et al., 2018). MPA is more tolerated and easier for children to engage in than VPA (Westerterp, 2001). As revealed by school going children aged 8 to 11years in Dakar, Senegal who accumulated 53±20 minutes/day of MPA compared to 21±16 minutes/day of VPA (Diouf et al., 2016). In Nairobi Kenya, school-going children aged 10 to 11 years on average, engaged in 32 minutes/day of MPA versus 4 minutes/day of VPA (Muthuri et al., 2014c).

2.3.4 Vigorous Intensity Physical Activity

Gibson et al. (2019) defined VPA as any activity that causes rapid breathing and increased heart rate (>6 METs). The current study defined VPA according to Evenson et al. (2008) as ≥4012 cpm. Higher intensity physical activity levels such as VPA, are consistently related to more health benefits (Janssen & Le Blanc 2010; Owens et al., 2016; Poitras et al., 2016). VPA is also favoured over MPA with regard to obesity prevention and bone health (Owens et al., 2016). The American College of Sports Medicine (ACSM) (1988) recommended children engage in 30 minutes of VPA every day. The WHO (2010) physical activity guidelines and the current physical activity guidelines for Americans (Piercy et al., 2018) recommend children to engage in vigorous physical activity for at least 3 days in a week, but they do not specify the amount of VPA required. Although VPA is highly advocated, the dose of VPA required for optimal health benefits is less

known (Reilly, 2016; Rhodes et al., 2017). Although, Schwarzfischer et al. (2017) suggested that 15 to 20 minutes of daily VPA was equivalent to 60 minutes of MVPA, studies show that children do not engage in sufficient amounts of VPA. The Canadian health measures survey (CHMS) revealed that 4% of the children and youth who participated, engaged in sufficient amounts of VPA (Colley et al., 2011). Only 28% of the American children aged 6 to 17years engaged in VPA (Trioano et al., 2008). Among Walloon children aged 10 to 13 years three quarters of the 1970 children participated in VPA for 2 days per week (Pedroni et al., 2019). School-going children aged 10 to 11 years in Nairobi city accumulated 4 minutes of VPA on average (Muthuri et al., 2014c). Despite the greater health benefits associated with participation in VPA, very few children engage in VPA and levels of VPA among school-going children in Kampala city are not yet established.

Therefore, assessing levels of physical activity is important in identifying the health benefits attained at each level. Since physical activity levels act as a reference for people who want to be more active, it is also important to measure physical activity levels before designing physical activity promotion programmes for purposes of monitoring the efficiency of the programmes.

2.4 Public Health Physical Activity Guidelines for Children

Physical activity guidelines (PAGs) are designed to provide information and guidance on the types and amount of physical activity required for health. The physical activity guidelines are generated from systematic reviews of the associations between physical activity and health, and these guidelines have changed to reflect the increased

understanding of the association between physical activity and health (O'Donovan et al., 2010; Poitras et al., 2016). In the 1980s both children and adults were expected to accumulate 20 minutes of continuous VPA (ACSM, 1988). Bailey et al. (1995) later suggested that short intermittent bouts of VPA might be required for children's normal growth and development. In view of Bailey et al. (1995) suggestions, the Council for Physical Education for Children (1998) came up with guidelines for school-aged children in which ≥ 60 minutes/day of physical activity suitable for age was required. In 2010, WHO generated the "Global recommendations on physical activity for Health", which states, "Children and young people aged between 5 and 17 years should accumulate at least 60 minutes of MVPA daily" (WHO, 2010:8).

Developed countries like the UK (Department of Health, 2011) and USA (Piercy et al., 2018), and WHO (Bull et al., 2020) have recently revised physical activity guidelines. The revised guidelines, however, still emphasize that children should engage in 60 minutes or more of MVPA daily. A review that included studies that objectively measured physical activity in children and adolescents, also supported the current physical activity guidelines that children achieve at least 60 minutes or more of MVPA each day of the week (Poitras et al., 2016). Despite all the recent revisions and improvements in the assessment of physical activity, the recommendations have remained relatively consistent with all guidelines suggesting that children should engage in at least 60 minutes or more of MVPA daily.

2.4.1 Prevalence of Physical Activity

Although all levels of physical activity are important for disease prevention and health (Carson et al., 2014; Poitras et al., 2016), most studies and public health surveillance concerning children's physical activity have focused on whether children meet the recommendations of ≥ 60 minutes of MVPA every day (Bull et al., 2020; Janssen & Le Blanc, 2010; WHO, 2010). Recent global averages showed that 81% of school-going children aged between 11 and 17 years did not meet these guidelines (Guthold et al., 2020). However, most primary sources involving this data were parent proxy reports for younger children and self-reports by adolescents. In addition, most of the data was skewed to HICs. In the USA, 42% of the children aged between 6 and 11 years achieved recommended levels of physical activity (Troiano et al., 2008). A harmonized analysis of accelerometer-measured physical activity among European children also showed that 66% of the children and adolescents were insufficiently active (Steene-Johannessen et al., 2020). More disturbingly results from the CHMS showed that 87% of children aged between 5 and 11 years old did not meet physical activity recommendations (Statistics Canada, 2015). Encouragingly, the Childhood Obesity Project (CHOP) study among 11-year-old children from five European countries showed that 63.2% of the children met the physical activity guidelines (Schwarzfischer et al., 2017). In the UK millennium cohort study, Griffiths et al. (2016) reported that about half (51%) of the children met the recommended guidelines for physical activity. Pedroni et al. (2019) reported that only 23% of the 1970 children aged between 10 and 13 years from Wallonia, Germany engaged in ≥ 60 minutes of MVPA daily. The physical activity transition is not only affecting HICs but also LMICs. For example, in a nationwide study among Thai children aged between

6 and 17 years, Amornsriwatanakul et al. (2017) found that only 23.4% were sufficiently active. Among children and adolescents from rural South Africa, only 1% engaged in ≥ 60 minutes of MVPA daily (Craig et al., 2013). In Morocco, 38.8% of the children and adolescents aged between 8 and 14 years met the recommended ≥ 60 minutes/day of MVPA (Baddou et al., 2018). Muthuri et al. (2014c) reported that in Nairobi city, only 12.6% of the children aged 10 to 11 years met the physical activity guidelines.

Bringing Ugandan situation into perspective, the percentage of school-going children (in Uganda) who meet the physical activity guidelines is not known. In Uganda, Peltzer and Pengpid (2011) found that most of the adolescents aged between 13 and 15 years in Uganda were insufficiently active. However, they analysed secondary data from the global school-based students' health survey (GSHS) in which physical activity was self-reported. Tharenos and Santorino (2009) studied physical activity of youth in Mbarara and found that most of the youth engaged in physical activity for more than 1 to 2 hours a week. However, their assessment was based on photographic interpretation methods rather than device-based measures. Christoph et al. (2017) in their pilot study, also found that most of the urban and rural school-going children aged between 11 and 16 years in central Uganda participated in varied physical activity, such as muscle strengthening, active commuting to school, sport-related, and household-related activities. However, the study used self-report measures to assess types of activities children engaged in and did not assess physical activity intensity levels. Although there is emerging evidence about physical activity in Uganda, the research is limited by use of self-report measures to assess physical activity. Therefore, accelerometer measured levels of physical activity and the

percentage of school-going children who meet the physical activity guidelines in Kampala city is timely.

2.5 Correlates of Children's Physical Activity

Physical activity is a complex and multidimensional behaviour associated with various individual, social, and environmental factors which can be explained by the SEM (Sallis et al., 2008). SEM propose that correlates of children's physical activity may be at an individual level (age, sex, school type, weight status and SES), or environmental level (home and neighbourhood attributes) (Sallis et al., 2008). Identifying the various factors associated with children's physical activity is a public health priority and is crucial prerequisite in the generation of physical activity promotion and intervention strategies. Identifying socio-demographic factors associated with children's physical activity can be beneficial in identifying the target group for intervention. Whereas identifying built environmental correlates of physical activity, guides the formulation of population-wide interventions that are long lasting.

2.5.1 Socio-Demographic Correlates of Children's Physical Activity

Socio-demographics of sex, age, weight status and SES are the most widely studied, because there is extensive interest in sociodemographics (Currie et al., 2012; Cooper et al., 2015; Lu et al., 2017; Sallis et al., 2000). Furthermore, studies show that the largest variation in children's physical activity operates at an individual level (Czerwinski et al., 2015; Pereira et al., 2017; Sallis et al., 2000; Salway et al., 2019). The socio-demographic variables are discussed in detail below.

2.5.1.1 Sex

Studies (using both device-based and self-report measures of physical activity) have consistently reported that boys engaged in more MVPA than girls (Amornsriwatanakul et al., 2017; Best et al., 2017; Cooper et al., 2015; Li, Kearney et al., 2017; Gomes et al., 2017b; Muthuri et al., 2014c; Verloigne et al., 2012b; Weinberg et al., 2019; Wilk et al., 2018). Recent global estimates showed that 77.6% of boys and 84.9% of girls were insufficiently active (Guthold et al., 2020). A Canadian national survey found that 9% of boys and 4% of girls aged 6 to 19 years met the MVPA recommendations (Colley et al., 2011). In Australia, 22% of boys and 20% of girls aged between 9 and 11 years were sufficiently active (Australian bureau of statistics, 2013). Schwarzfischer et al. (2017) found that at 11years, girls who participated in the CHOP study recorded 36 minutes/day less of MVPA compared to boys. Among 10 to 12-year-old children across five European countries, Verloigne, et al. (2017) found that 4.6% of females and 16.8% of the males participated in sufficient physical activity. Results from the built environment and active play (BEAP) study, also found that 60% of the boys compared to 40% of the girls were sufficiently active (Roberts et al., 2016). The Cork Children Lifestyle Study (CCLaS) study results showed that 26.8% of the boys and 16.2% of the girls met the physical activity guidelines (Li et al., 2017). Among children aged between 8 and 11 years from Dakar in Senegal, MVPA was lower in girls (47.8%) compared to boys (52.2%) (Diouf et al., 2016). From Nairobi in Kenya, a higher percentage of boys (17.6%) compared to girls (8.3%) met the recommended daily minutes of MVPA (Muthuri et al., 2014c).

2.5.1.2 Age

Literature shows that children's physical activity declines with increasing age (Cooper et al., 2015; Currie et al., 2012; Dumith et al., 2011; Farooq et al., 2020). The health behaviour in school children survey (HBSC) 2009/2010 reported declining levels of physical activity among girls as they grew older, with physical activity levels dropping by 10% between ages 11 and 15 (Currie et al., 2012). The children living in active neighbourhoods (CLAN) longitudinal study observed a decrease in MVPA over the five-year period (Crawford et al., 2010). Although, many of the studies in the international children's accelerometry data (ICAD) are cross-sectional, the ICAD depicts declines in physical activity across childhood (Cooper et al., 2015). Similarly, in their systematic review of longitudinal changes in MVPA in children and adolescents Farooq et al. (2020) found significant declines in physical activity across all ages starting from nine years. In the CCLaS study, Li et al. (2017) found out that older children were less likely to meet physical activity guidelines than younger children. Also, among Thai children aged between 6 and 17 years, physical activity decreased with increasing age (Amornsriwatanakul et al., 2017). However, insignificant associations (Schwarzfischer et al., 2017; Tung et al., 2016; Wilk et al., 2018) and inconsistent associations (Lu et al., 2017; Sallis et al., 2000; van der Host et al., 2007), between age and children's physical activity have also been reported.

2.5.1.3 Weight status

More amount time spent in physical activity by children has been linked to low weight status (Griffith et al., 2016; Schwarzfischer et al., 2018). Various studies report physical activity to be lower in overweight/obese children compared to their normal weight

counterparts (Amornsriwatanakul et al., 2017; Cooper et al., 2015; Diouf et al., 2016; Gomes et al., 2017b: Jiménez-Pavón et al., 2013; Li et al., 2017). In a longitudinal study among children 6 to 11 years old, normal weight children spent 47 minutes/day more in physical activity compared to their overweight/obese peers (Schwarzfischer et al., 2018). Across the ISCOLE 12 country sites, overweight/obese children did not meet physical activity guidelines compared with normal weight children (Gomes et al., 2017b). In a pilot study carried out among rural and urban children in Uganda, Christoph et al. (2017) found that normal weight children were sufficiently active. However, some studies show inconsistence (Sallis et al., 2000), and no associations between weight status and physical activity (Bauman et al., 2012; Lu et al., 2017).

2.5.1.4 Parental Marital Status

Although the family structure in which children are brought up may promote or hinder their participation in physical activity, there is limited literature on associations between parents' marital status and children's physical activity (Langøy et al., 2019). Wang and Qi (2016) found that adolescents aged between 10 to 16 years from Shanghai with single parents engaged in more MVPA compared with those living with both parents. On the other hand, among Norwegian children and youth aged between 11 and 16 years, Langøy et al. (2019) found that children living with single parents were more likely not to engage in sufficient physical activity. Furthermore, Canadian children and youth in grade 6 to 10 had lower odds of participating in organised sport if their parents were single compared to their peers from traditional families (McMillan et al., 2016). Similarly, children of single parents participated less in organised sports (Langøy et al., 2019). Conversely, Wilk et al. (2018) found no significant association between children's physical activity and

family structure (single parent). Moreover, results from a meta-analysis indicated no differences in physical activity levels between children of single parents and those of two parents (Singhammer et al., 2015)

2.5.1.5. Number of Siblings at Home

Siblings may increase children's participations in physical activity because they live in the same home as the child and may also assume the role of peers (Kracht & Sisson, 2018). Results from a meta-analysis and systematic review showed that children with siblings engaged in more MVPA/day than only children. Moreover, the higher the number and the older the siblings in the family the more MVPA engaged in by children (Kracht & Sisson, 2018). Among Portuguese children aged 9 to 11 years, the number of siblings was associated with MVPA with each additional sibling translating into 3 more minutes of MVPA (Gomes et al., 2017a). Nevertheless, in a Norwegian HBSC study Langøy et al. (2019) found no significant associations between children's MVPA and having siblings. Also, among adolescents aged between 10 and 16years, Wang and Qi (2016) found no significant differences in MVPA of adolescents with siblings and MVPA of only children.

2.5.1.6 Socio-Economic Status

Socio-economic status (SES) differences in physical activity may show ways through which SES leads to poor health (Sherar et al., 2016). In Uganda, people of HSES are more prone to having an NCD than their peers of LSES (UBOS, 2018). Lower physical activity among HSES groups have been reported in LMICs which is contrary to the higher physical activity reported for HICs (Sallis, Bull et al., 2016; Sherar et al., 2016). From the 2009/2010 HBSC survey, adolescents from affluent families were more likely to meet

physical activity guideline than their counterparts from less affluent families (19.8% as opposed to 16.3%) (Currie et al., 2012).

Muthuri et al. (2014c) report on Kenya showed a negative impact of HSES on children's physical activity. Children from HSES families were 96.4% less likely to accumulate sufficient physical activity compared to children from LSES families. Reviews have reported positive associations between children's physical activity and SES (Bauman et al., 2012; Gustafson & Rhodes, 2006; Sterdt et al., 2014). On the other hand, Sallis et al. (2000) and Lu et al. (2017) found no association between SES and children's physical activity. Tandon et al. (2012), also found no differences in MVPA among children from different socio-economic status. SES has also been inconsistently related to children's physical activity in various review studies (Biddle et al., 2011; van der Host et al., 2007).

2.5.1.7 Parental Level of Education

Lower levels of parental education were correlated with lower levels of physical activity in school-going children in HICs (Baskin et al., 2013). Results from the ICAD study showed that higher maternal education levels were related to lower accelerometer-measured physical activity (Sherar et al., 2016). In the UK millennium cohort study, Pouliou et al. (2015) found that higher children's physical activity was associated with lower maternal education level. Baseline data from the Grade 5-i-Pass (G5AP) intervention study revealed that physical activity was lower among children whose fathers had acquired higher level of education than those whose fathers had lower levels of education (Wilk et al., 2018). Among rural South African children and adolescents aged 11 to 15 years, higher parental education level was associated with decreased children's physical activity (Mickelesfied et al., 2014). Muthuri et al. (2014c) found that increasing

parental education was negatively correlated with physical activity. On the contrary, among primary school children from Klang, Selangor Malaysia, children whose parents had completed tertiary education reported higher MVPA compared with children of parents with no formal education (Tung et al., 2016). While Best et al. (2017) found no relationship between parental education level and children's physical activity. A systematic review of factors associated with physical activity among Chinese children and adolescents found no association between parental education level and children's physical activity (Lu et al., 2017)

2.5.1.8 Family Car Ownership

Owning a car is an indicator of HSES as well as a hindrance to walking and cycling for transport; whereas not possessing a car is an indicator of LSES and is characterized by walking and cycling as a means of transport (Muthuri et al., 2014c; Pouliou et al., 2015). When the built environment is not supportive for active travel, people give up walking as soon as they can afford a car (Devarajan et al., 2020). There is a decline in active travel especially in LMICs such as Uganda, where many people are reverting to use of motorized travel. Children from families without a car are more likely to walk to various destinations particularly to school; which enables them to engage in physical activity, when compared to their peers from families with one or more cars (Faulkner et al., 2009; Nyström et al., 2019; Oyeyemi & Larouche, 2018). Accelerometer-measured physical activity among 7-year-old children in the UK millennium cohort study was higher among children in families with no car (Pouliou et al., 2015).

Therefore, there was interest in describing physical activity and its socio-demographic correlates among school-going children in Kampala, Uganda to identify groups of children at risk for immediate intervention.

2.5.2 The Built Environment

The built environment is defined as the physical environment that has been modified or constructed by humans such as buildings, parks, and transportation infrastructure (Handy et al., 2002). Although the built environment is broadly defined as the physical environment and independently correlates with physical activity, the social environment moderates the relationship between the built environment and physical activity and maybe independently correlated with physical activity (Bauman et al., 2012; Davison & Lawson, 2006; Franzini et al., 2009). The built environment was identified as a key facilitator or barrier of physical activity. That is why various international organisations and policy makers advocate for a change in the built environment to facilitate physical activity behaviour change that affects the general population (National Institute for Health and Clinical Excellence [NICE], 2018; WHO, 2018). The SEM shows that other than socio-demographic factors, built environment factors are also associated with physical activity (Sallis et al., 2008), the assumption is that children's physical activity occurs within an ecological niche such as home and neighbourhood (Sallis & Glanz, 2009). Although the school environment offers various opportunities for children's physical activity, due to the time children spend at school and availability of both infrastructure and instructors (Morton et al., 2016; Pereira et al., 2017), schools may have a challenge for children to fit physical activity in the crowded academic schedule due to increased pressure on schools

for academic distinctions (Centre for Diseases Control and Prevention [CDC], 2002-2003). Insufficient physical activity is related to urban planning and transportation infrastructure in the neighbourhood that favour motorized travel, in addition to increase in the use of labour-saving devices and electronic entertainment options at home (Sallis & Glanz, 2009; Sallis et al., 2012). The home and neighbourhood-built environment shapes children's physical activity through the provision of accessible, convenient, and safe places for physical activity (Bauman et al., 2012; Ding et al., 2011; Sallis et al., 2000; Sallis & Glanz, 2009). Understanding how the built-environment in places where children spend most of their time like the home and neighbourhood is related to their physical activity could inform evidence-based interventions that target the entire population (Duraceau & Bergeron, 2013; Millistein et al., 2011).

2.5.2.1 Measurement of the Built Environment

According to Carlson, Dean and Sallis (2017), the built environment is assessed at different levels, using varied methods in specific settings (home and neighbourhood). Brownson et al. (2009) identified three types of built environment measures: perceived measures, which are self-reported in questionnaires or interviews, observation measures that involve use of audit tools; and archival data sets which involve evaluation of secondary data using geographical information system (GIS). The built environment measures are discussed further below.

GIS can be used to assess built environmental characteristics, select study samples, neighbourhoods, and arrange information used in observations, using measures of distance, density, and diversity (the 3D's) (Buck et al., 2015). Most studies that assessed the built environment with GIS applied measures such as density, land use mix, and street

patterns (Buck et al., 2015; Forsyth et al., 2006). Although GIS measures have gained interest among researchers, issues of accuracy, completeness of the secondary data sources, and the data are non-existent in many settings (Brownson et al., 2009; Forsyth et al., 2006), Kampala city inclusive. In addition, obtaining, cleaning and analysing GIS data requires trained personnel and time; and the software for data analysis is also expensive. In addition, GIS measures for physical activity have not been well documented and standardized and therefore replication of studies and comparison of result may not be possible (Forsyth et al., 2006). Measurement problems have also been identified for home environment because GIS is limited for use indoor (Maitland et al., 2013).

Observation audits are used to assess the environment as it is seen (Brownson et al., 2009). Observation audits can be used to collect primary data of features that may not be existent in the archival data. Audit tools require in-person observation, such that the researcher walks or drives through the neighbourhood and home and codes characteristics using a standardized form. In homes, objective measures of inventories are used to assess density, availability, and accessibility of equipment (Sirard et al., 2008). The limitations of observations are time consuming, require skill and training, and are subject to observer bias.

Most studies about built environment and children have often used self-reported measures (Bauman et al., 2012; Brownson et al., 2009; Ding et al., 2011). Various questionnaires have been developed to assess the home-built environment (Hume et al., 2004; Rosenberg et al., 2010; Saelens et al., 2003b; Sirard et al., 2008) and neighbourhood-built environment (Oyeyemi et al., 2016; Rosenberg et al., 2009). Although self-reported measures of the built environment have limitations such as recall bias, participant burden

and low response rate, the parents' perception of the built environment is important because children rely heavily on parents' decisions which may greatly influence their physical activity (Pedroni et al., 2019). In a systematic review and meta-analysis review McGrath et al. (2015) established that parents supervised half of the children's outdoor activity. Another strength of self-reported measures is that they may reveal built environmental features that objective measures may not identify like safety and aesthetics (Kurka et al., 2015).

2.5.3 Home Built Environment Correlates of Children's Physical Activity

The home-built environment includes all areas both inside and outside that enable or hinder physical activity (Sirard et al., 2010). The Home environment is the primary unit of socialization for children and is central in shaping physical activity (Atkin et al., 2015). Children can be active at home through unstructured play, exercise and chores (WHO, 2010). Parents determine the environment at home, because they set the rules, arrange the home space, and decide about the equipment to buy and the use of the equipment. Therefore, parents can easily modify the physical activity environment in their homes (Maitland et al., 2013). Because children have limited independent mobility and may receive higher exposure to stimuli in the home compared to the neighbourhood, the home-built environment may be more correlated with children's physical activity (D'Haese et al., 2013; Sirard et al., 2010). For example, in the Neighbourhood Impact on Kids (NIK) study, children aged between 6 and 11 years spent most of their time at home (47.5% of total wear time) (Kneeshaw-Price et al., 2013). Similarly, another home space study found that children aged between 9 and 12 years spent 46% of their time at home (Sheldrick et

al., 2019). The CLAN five-year longitudinal study revealed that the home environment had a higher influence on physical activity among children aged between 10 and 12 years, than the neighbourhood environment (Crawford et al., 2010). Attributes of the home-built environment correlated with children's physical activity are discussed further below.

2.5.3.1 Social Support

The social environment parents create at home through social support was strongly associated with children's physical activity (Best et al., 2017; Sallis et al., 2000; Van de Host et al., 2007; Verloigne et al., 2012a; Xu et al., 2015; Yao & Rhodes, 2015). Parents' approach to physical activity, encouragement, their actual engagement in physical activity (role modelling) and logistical support are important (Bauman et al., 2012; Harrington et al., 2016; Sallis et al., 2000; Van der Horst et al., 2007). In a meta-analysis of parental correlates in child and adolescent physical activity, Yao and Rhodes (2015) proposed that parental social support should be considered for future interventions. In their review Xu et al., (2015) found moderate to strong associations between social support and children's physical activity, suggesting that children whose parents supported them or encouraged them to engage in physical activity were more likely to have higher levels of physical activity. Conversely, Wilk et al. (2018) found no associations between children's physical activity and parental social support.

2.5.3.2 Rules for Physical Activity

Parents influence children's activity through implementation of rules for physical activity and sedentary time (Crawford et al., 2010; Salmon et al., 2005). Because children are not independent in their choices, parental controls in the form of rules may limit their physical activity and result in insufficient physical activity (Carver et al., 2010; Kneeshaw-Price et

al., 2015; Panter et al., 2010). This is supported by D'Haese et al. (2013) who found that having many rules that restrict children's movements correlated inversely with children's weekday MVPA. On the other hand, a review reported weak associations between rules for physical activity and children's physical activity. However, this was based the inconsistent findings from few studies included in the review (Xu et al., 2015).

2.5.3.3 Play Equipment at Home

Play equipment at home can provide convenient methods that prompt children engage in physical activity at home (Harrington et al., 2016). Tandon et al. (2014) reported that having a basketball hoop at home was positively associated with sufficient physical activity among children aged between 6 and 11 years old. Handy (2004) found that home physical activity equipment was positively associated with VPA. Also, having exercise equipment at home was positively related to physical activity among adolescent girls and women (Sirard et al., 2010). One may expect that having play equipment in the home would create chances for children to be active. However, Davison and Lawson (2006) in their review found no association between objective and self-reported home play equipment and children's physical activity. On the other hand, though Maitland et al. (2013), reported no association between children's physical activity and play equipment, their review found that children who had more play equipment at home, spent less time in sedentary pursuits. Whereas the Determinants of Diet and Physical Activity-Knowledge Hub (DEDIPAC-KH) found inconclusive results for availability of play equipment at home and children's MVPA (Carlin et al., 2017).

2.5.3.4 Electronic and Media Equipment at Home

The literature concerning availability of electronic media in the child's bedroom and having personal electronics has been associated with less physical activity; and increased opportunity to engage in sedentary pursuits (Crawford et al., 2010; Kaushal & Rhodes, 2014; Noonan et al., 2016; Tandon et al., 2014; Tandon et al., 2012). Studies also show that many children engage in screen time (watching TV/videos, playing video games and on the computer) for more than the recommended 2 hours/day (Australian Bureau of Statistics, 2013; Tremblay et al., 2011; Wachira et al., 2018). Spending more time in screen time is associated with little physical activity (Harrington et al., 2016) and unfavourable health outcomes (Carson et al., 2016; Wachira et al., 2018). Studies also show that children residing in homes with multiple televisions and electronic media in their bedrooms are more likely to be insufficiently active and have more sedentary time (Lou, 2014). Nonetheless, some studies have reported no relationship between electronic and media equipment and children's physical activity (Maitland et al., 2013; Sheldrick et al., 2019) and inconsistencies have also been reported (Harrington et al., 2016).

Although studies show associations between the home-built environment and children's physical activity most available studies were from HICs, that focused on adolescents (Baskin et al., 2013; Kaushal & Rhodes, 2014; Sirard et al., 2010), generated contradictory results and much is still unknown (Ferreira et al., 2007). Also, no study has examined the home-built environment correlates of school-going children's physical activity in Kampala city in Uganda.

2.5.4 Neighbourhood Built Environment Correlates of Children's Physical Activity

The neighbourhood-built environment is made up of buildings, roads, recreation facilities and transportation infrastructure. Nevertheless, social environment factors such as safety are intimately linked with the physical neighbourhood environment (Bauman et al., 2012; Davison & Lawson, 2006). Handy et al. (2002) identified dimensions of the neighbourhood-built environment to include, density (the number of people, buildings or businesses concentrated in one place), mix of land uses (relative proximity of different land uses within a given mixed-land use area such as homes, shops, offices and parks), connectivity of street networks (directness and availability of alternative routes from one point to another), and aesthetic qualities (attractiveness or pleasantness of a place).

Neighbourhoods influence outdoor play, active travel and provide children with opportunities to socialise with other children and to be in touch with nature (Ding et al., 2011; Durancaeau & Bergeron, 2013; Tappe et al., 2013). The neighbourhood environment should make children's physical activity an easy, affordable, and accessible choice (Heath et al., 2012). Neighbourhoods, characterised by a high residential density, connected street networks, accessible, diverse, and proximate destinations, and walking and cycling infrastructure, influence physical activity particularly walking for transport (Ewing & Carvero, 2010; Saelens & Handy 2008). Recreation facilities (parks, playgrounds) increase recreational physical activity (Kaczynski & Henderson, 2007). The design and maintenance of the neighbourhood environment and people's perceptions regarding aesthetic appeal and safety also influence physical activity (Ding et al., 2011; Faulkner et al., 2015). For example, perceived aesthetics, safety from crime, traffic and

strangers can affect leisure walking (Owen et al., 2004); and influence parents' decisions in allowing their children to be active in the neighbourhood (Faulkner et al., 2015).

Although studies report mixed and contradictory results, some consistent neighbourhood-built environment correlates of children's physical activity include proximity and access to recreation facilities (parks, and playgrounds), residential density, low traffic, land use mix and presence of walking and cycling infrastructure (Bauman et al., 2012; Davison & Lawson, 2006; Ding et al., 2011; Martins et al., 2017; Rhodes et al., 2017). However, most results were generated from HICs where the neighbourhood built environmental attributes are different from those in Kampala city in Uganda.

2.5.4.1 Residential Density

Residential density refers to the number of housing units per unit or land area (Handy et al., 2002; Saelens et al., 2003b). According to Handy (2004), the higher the residential density the more walking and use of other non-motorised trips. Cities need to get more compact to increase active travel that is less driving and more walking (Giles-Corti et al., 2016). Increased residential density was associated with physical activity particularly walking for transport among adults (Sallis et al., 2016b). In a systematic review, Bauman et al. (2012) reported robust correlations between children's physical activity and residential density. Among Belgian children aged between 10 and 12 years, a high residential density explained their physical activity (De Meester et al., 2014). On the other hand, Chinese children, show an inverse association between residential density and children physical activity (Xu et al., 2010). A review by Ding et al. (2011) revealed inconsistent associations between neighbourhood residential density and children's physical activity.

2.5.4.2 Land Use Mix-Diversity (Destinations)

Land use mix-diversity refers to the level of integration of institutional, commercial and residential uses that are frequently accessed (Saelens et al., 2003b; Sallis et al., 2012). Placing residential and commercial areas in proximity decreases motorized travel and increases active travel (Davidson & Lawson, 2006; Panter et al., 2010; Sallis et al., 2012). Studies show that when a lot of destinations (shops, schools, recreation) are nearby, people are more likely to use non-motorised transport to get to these destinations (D'Haese et al., 2014; Saelens & Handy, 2008). King et al. (2015) found that places that were near home increased transportation physical activity among adults. Reviews also show that proximity to various destinations in the neighbourhood particularly school was associated with higher MVPA among children (Davison & Lawson, 2006; Ding et al., 2011). However, in a systematic review, Carlin et al. (2017) found that proximity to destinations was negatively associated with children's overall physical activity.

2.5.4.3 Land Use Mix-Diversity (Recreation)

Davison and Lawson (2006) classified recreation facilities for children as private (located in and around children's homes) public (managed by the municipality such as parks, and schools' playgrounds) and private public (businesses that provide places for children to engage in physical activity such as commercial clubs). Neighbourhoods with easy access to recreational facilities increase chances for both, organised physical activity (team sports) and unstructured physical activity (outdoor play and active travel) (Mitchell et al., 2016). Review studies that examined neighbourhood-built environment correlates of children's physical activity concluded that presence of recreational facilities in the neighbourhood positively correlated with children's physical activity (Davidson &

Lawson, 2006; DeVet et al., 2011; Ding et al., 2011; Oliveira et al., 2014; Sallis et al., 2000). A review of literature from China by An et al. (2019) also found that presence of nearby and accessible recreation facilities was associated with increased physical activity among children. Availability and proximity to recreation facilities such as parks has also been associated with physical activity among children in other studies (Pedroni et al., 2019; Tappe et al. 2013). Among children from Washington DC, Roberts et al. (2016) found that parents of sufficiently active children perceived a high number of recreation facilities in their neighbourhoods compared to parents of insufficiently active children. However, the Carlin et al. (2017) systematic review found inconsistent associations between proximity of parks, playgrounds and open spaces and children's physical activity. Wilk et al. (2018) found no relationship between distance to closest school playground, recreation facility and park.

2.5.4.4 Land Use Mix-Access

Land use mix-access is the ease with which various destinations and services can be reached (Handy, 2004). Good land use mix-access increases transportation physical activity such as daily active commuting to school and work as well as recreation active travel (Sallis & Glanz, 2006; Wang et al., 2016). In a review study Handy (2004) found that perceived proximity and convenience of recreation facilities, local shopping and transit stops were significantly positively correlated with physical activity. Positive associations between access to destinations and children's physical activity were found in another review study (Davison & Lawson, 2006). In Nairobi-Kenya, 85.2% of the parents perceived destinations like shops, markets and other places to get personal effects to be within easy walking distance (Muthuri et al., 2016). Tung et al. (2016) found that presence

of accessible services, stores and public transport within the neighbourhood was positively correlated with higher levels of children's physical activity. Also, the Carlin et al. (2017) systematic review reported positive associations between accessibility and leisure time active travel.

2.5.4.5 Street Connectivity

Street connectivity is defined as the ease of travel between two points in relation to street design (Handy et al., 2002; Saelens et al., 2003b). Street connectivity influences the route options that are available in neighbourhoods making it easier to get to various destinations (Sallis et al., 2006). For example, among adults, high street connectivity provides more direct routes for active travel and has been consistently associated with physical activity (Saelens & Handy 2008; Saelens et al., 2003a). Whereas among children, lower street connectivity was associated with higher physical activity in the neighbourhood (Mecredy et al., 2012; Tappe et al., 2013). Lower street connectivity has cul-de-sacs or low traffic areas which offers safe opportunities for children to play (Saelens & Handy, 2008; Tappe et al., 2013). In a review study among youth, Ding at al. (2011) found inconsistent associations between children's physical activity with street connectivity. Yet Bauman et al. (2012) found no associations between children's physical activity and street connectivity.

2.5.4.6 Walking and Cycling Infrastructure

These are built and planted features that provide pedestrian or cyclists amenities or that affect pedestrian or cyclist mobility, safety and comfort for example marked pedestrian crossings, sidewalks, and bike paths (Handy et al., 2002). Walking and cycling infrastructure like sidewalks, cycling paths, access to public transit encourage residents to

walk or cycle more and thus accumulate more physical activity (Ewing & Cervero, 2010; Timperio et al., 2015). Davison and Lawson (2006) reviewed literature of influence of the built environment on children's physical activity and found out that the presence of pedestrian amenities was associated with more active travel among children, particularly the presence and condition of sidewalks. Oliveira et al. (2014) in a review study also found that the presence of sidewalks and cycling lanes in the neighbourhood were strongly correlated with children's physical activity. Results from another review study found high associations between pedestrian safety structures like traffic lights and crosswalks and children reported physical activity (Ding et al., 2011). De Meester et al. (2014) reported that higher levels of physical activity were associated with the presence of walking and cycling infrastructure. Higher multi-use paths in neighbourhoods have been correlated with sufficient physical activity among children (Mitchell et al., 2016). Among 9- to 11-year-old children from Nairobi-Kenya, the presence of cross walks and signals on busy streets were associated with meeting MVPA guidelines (Muthuri et al., 2016). On the other hand, negative street characteristics like lack of sidewalks or cross walks, lack of signals on busy streets and lack of streetlights impacted negatively on children's overall physical activity (Carlin et al., 2017; D'Haese et al., 2014; Muthuri et al., 2016; Roberts et al., 2016). On the other hand, Davison, and Lawson (2006) found no relationship between bike paths with levels of cycling. Carver et al. (2008) also found no associations between children's physical activity and crossing infrastructure.

2.5.4.7 Aesthetics

Aesthetics is the visual appeal or pleasantness of the neighbourhood environment. Neighbourhood aesthetics such as attractive buildings, landscaping, trees, lighting, natural

sights and views are significant correlates of physical activity in particular walking for recreation (Handy et al., 2002; Handy, 2004; Sallis & Glanz, 2009). A systematic review found that neighbourhood aesthetics like having many interesting things to look at was positively related to overall physical activity in children (Carlin et al., 2017). In the NIK study, aesthetics correlated with more physical activity in the neighbourhood (Tappe et al., 2013). According to Tappe et al., if neighbourhoods are attractive parents may perceive a sense of order and become comfortable in letting their children engage in outdoor play. Roberts et al. (2016) in their study among 7 to 12-year-old children from Washington DC Metropolitan, found that parents of sufficiently active children agreed with the importance of attractive neighbourhoods for active play. Conversely, some studies found no relationship between children's physical activity and neighbourhood aesthetics (Limstrand, 2008; Noonan et al., 2016).

2.5.4.8 Crime Safety

Children engage in more physical activity when they reside in neighbourhoods that are perceived as being free of crime (D'Haese et al., 2015; Molnar et al., 2004). A meta-analysis on objectively measured crime and perceived crime safety, showed that higher perceived crime safety and lower objective crime were associated with higher physical activity (Rees-Punia et al., 2018). Reviews showed that neighbourhood crime safety was negatively related to children's physical activity (Davison & Lawson, 2006; de Vet et al., 2011; Ding et al., 2011). Parental concerns regarding their children's safety from crime, has been consistently negatively associated with physical activity (Carver et al., 2008). Positive parental perceptions of crime safety were significantly associated with increased children's independent mobility (Vlaar et al., 2019). According to D'Haese et al. children

engaged in physical activity in neighbouring streets and sidewalks when parents perceived them to be safe from crime. Therefore, perceived crime of the neighbourhood strongly shapes parents' restriction of their child's outdoor play and independent mobility (Timperio et al., 2015). Pedroni et al. (2019) found that perceived crime safety was related to physical activity only among girls. Literature also shows that parental perceptions of crime safety may be more important than children's perceptions (Carver et al., 2008).

2.5.4.9 Traffic Safety

Traffic speed and volume are often cited as major concerns among parents, which limit children's outdoor play and independent mobility (Faulkner et al., 2015; Santos et al., 2013; Weir et al., 2006). For example, a systematic review study reported traffic related hazards to be negatively correlated with children's MVPA (Carlin et al., 2017). Review studies focusing on neighbourhood built-environmental correlates of children's physical activity also found consistent negative associations between children's physical activity and safety from traffic (Davidson & Lawson, 2006, Ding et al., 2011; DeVet et al., 2011). Tung et al. (2016) found negative correlation between traffic hazard and physical activity among Malaysian primary school children aged between 9 and 12 years from Klang, Selangor. Among South African children aged between 10 and 11 years old Uys et al. (2016) reported low after school MVPA among children from neighbourhoods that had a higher traffic risk. On the other hand, most studies reviewed by Oliveira et al. (2014) showed positive parental perceptions of traffic and children's physical activity. However, some studies have reported inconsistent associations between traffic safety and children's physical activity (Carver et al., 2008; Panter et al., 2010).

2.5.4.10 Personal Safety

In the ISCOLE study conducted in Nairobi-Kenya, Muthuri et al. (2016) found that parental perceptions of positive neighbourhood social cohesion contributed to children meeting the MVPA recommendations. Whereas the presence of roaming dogs in the neighbourhood has been associated with lower rates of walking and cycling among children (Carver et al., 2005). Panter et al. (2010) reported negative associations between street lighting and children's physical activity. Nonetheless, personal safety was not related with MVPA among Australian children (Carver et al., 2008).

2.5.4.11 Stranger Danger

Stranger danger is one of the most important concern for children and their parents (Carver et al., 2008) and has been a key factor in limiting children's physical activity in the neighbourhood (Mitra et al., 2014; Francis et al., 2017). Foster et al. (2014), reported less independent mobility (which contributes to children's physical activity) for children whose parents had heightened fear for strangers. A study among Newzeland children aged between 8 and 13 years found that stranger danger was the most common reason for parents not letting their children go out alone (Lin et al., 2017). Throughout literature, stranger danger has been highlighted as a correlate to restrictive independent mobility (Vlaar et al., 2019). Therefore, the relationship between children's physical activity and stranger danger may be indirectly associated with children's outdoor play and independent mobility which have been shown to increase the likelihood of children engaging in physical activity (De Meester et al., 2014; Ding et al., 2011; Foster et al, 2014; Mitchell et al., 2016). Low parents' perceptions of stranger danger were reported for children in the NIK study (Kneeshaw-Price et al., 2015). However, D'Haese et al. (2013) found no

relationship between stranger danger and children's MVPA in Belgian children aged between 10 and 12 years. Similarly, Salmon and Timperio (2007) found no association between stranger danger and physical activity.

In conclusion, there is limited data on parental perceptions of the neighbourhood-built environment and children's physical activity in LICs. Most concerning neighbourhood-built environment studies are from developed countries and the findings may not be applicable LICs such as Uganda, where the cultural context and built environment features may differ (Sallis et al., 2016b). The neighbourhood-built environment may also be important to children because of the constraints imposed by parents that hinder children's independent mobility. Parental restrictions limit children's physical activity to neighbourhood places they can actively travel to (Loebach & Gilliland, 2016). No other study has assessed the correlation of the neighbourhood-built environment and children's physical activity in Kampala city Uganda.

2.6 Summary of Literature Review

Although regular participation in physical activity in children is associated with various health benefits many children globally are insufficiently active. Therefore, increasing children's participation in physical activity is important to public health. Identifying correlates of children's physical activity is necessary to guide effective policies and interventions that promote physical activity. Socio-ecological models of health behaviour show that socio-demographic and built environment factors at home and in the neighbourhood influence children's physical activity. Children interact with the home and neighbourhood environments daily and characteristics of these environments may hinder

or promote their physical activity. Although some studies show an association between the home environment attributes and children's physical activity much is still unknown, and no study has examined home-built environment correlates of children's physical activity in Kampala city. Furthermore, most of the evidence on neighbourhood-built environment correlates of children's physical activity is contradictory and has been generated from HICs. Thus, the current study examined whether these correlates are similar for Kampala city with a large local built environment and cultural difference. A better understanding of the parental perceived home and neighbourhood built environmental correlates of children's physical activity can improve the generation and implementation of local intervention strategies to promote physical activity by making informed environment change and changing the perceptions of parents. This study measured physical activity using accelerometers which provided the much-needed accelerometer data for, school-going children in Kampala city Uganda. No study has assessed the correlation of parental perceived home and neighbourhood-built environment attributes and accelerometer measured physical activity among school-going children in the context of Kampala city in Uganda.

CHAPTER THREE: METHODOLOGY

3.1 Research Design

The current study used a cross-sectional research design, with an analytical survey research model. Children's physical activity levels were quantified and the correlation between physical activity and parental perceptions of the home and neighbourhood built environmental factors of school-going children aged 10 to 12 years in Kampala city were assessed at a single point in time. The cross-sectional design was ideal for the current study because many correlates were studied in a short time and at a lower cost (Levin, 2006).

3.2 Measurement of Variables

The dependent variable was physical activity, which was measured using accelerometers. The independent variables were sociodemographic factors (sex, type of school, weight status, parental marital status, parental education level, family car ownership and the number of siblings), the home built environment (parental support, parental rules for physical activity, electronic and media equipment and play equipment at home) and neighbourhood built environment (residential density, land use mix-diversity [destinations and recreation], land use mix-access, street connectivity, walking and cycling infrastructure [sidewalk, path, and crossing], aesthetics, traffic safety, crime safety, personal safety, and stranger danger). All these were assessed using a questionnaire. The weight status of each child was indicated using BMI, which was calculated from the anthropometric measures of height and weight.

3.3 Study Area

The study was carried out in Kampala city, which is the capital and largest city in Uganda. (See map in Appendix O). Kampala has an area of 189 Km^2 and a population of about 1.5 million inhabitants from diverse ethnic groups and SES (UBOS, 2018). Kampala city is in the south-central part of Uganda, surrounded by Wakiso and Mukono districts and lies along the shores of Lake Victoria (KCCA, 2014). The city is administratively divided into five divisions namely: Central, Kawempe, Makindye, Nakawa, and Lubaga. Kampala city was chosen for the study because previous studies have reported a physical activity transition in Sub-Saharan Africa, particularly in urban areas (Muthuri et al., 2014b; Onywera et al., 2012). Such transition in physical activity study is yet to be determined in Uganda and was addressed in the current study. In addition, most of the measures of the built environment have been tested and used in towns and may lack relevance if used in rural places (Brownson et al., 2009; Saelens et al., 2003b). Like most urban areas Kampala has high density, is well connected, has a variety of destinations in easy proximity, with pedestrian and cyclist infrastructure and public transport (Sallis et al., 2016b). Kampala Capital City Authority (KCCA) also has a new plan for the city, which involves retrofitting the existing built environment and later constructing new transportation and recreational infrastructure. Therefore, this study generated important information that may inform design and implementation of the plan.

3.4 Target Population

All children aged 10 to 12 years attending either public or private day mixed sex schools in Kampala city were potential participants. This population was chosen because children

in transition from childhood to adolescence gain some autonomy in decision making regarding their physical activity and therefore this is a critical period for the change in physical activity behaviour (Brooke et al., 2016). Besides, it is important to focus on children because insufficient physical activity during childhood has health implications during adulthood (Kwon & Janz, 2012; Talema et al., 2014). The population size of school-going children aged between 10 and 12 years in private and public mixed sex day primary schools from which participants were drawn is not known because of lack of detailed information from KCCA. However, lists of primary schools in Kampala city were used as the sampling frame.

3.4.1 Inclusion Criteria

The study included all males and female children aged 10 to 12 years attending either private or public day mixed sex primary schools in Kampala city, who provided both assent and signed parental informed consent. The children had no visible physical condition limiting their participation in physical activity and wore the accelerometers for the stipulated period. The children and their parents were residents of Kampala city, and could read and write English.

3.4.2 Exclusion Criteria

Children attending boarding schools were excluded because they resided in boarding houses and have restricted access to their home and neighbourhood-built environment.

3.5 Sample Size

The suitable sample size was determined using the Daniel (1999) formula which generated a sample size of 254. However, because the study used a multistage sampling technique a larger sample was required to achieve precision (Naing et al., 2006). Therefore, the sample size generated above was multiplied by the design effect (Cochran, 1977) which estimated that 500 respondents were required to achieve reliable results for the study.

$$n = \frac{Z^2 \times p\,(1-p)}{d^2} \times DE$$

$$n = \frac{1.96^2 \times 0.21\,(1-0.21)}{(0.05)^2} \times 2$$

$$= 500$$

Where n is the sample size of the study group, Z is the statistic corresponding to a constant value of 1.96 at 95% Confidence Interval (Confidence Interval; used in most scientific studies). P is the expected prevalence which can be obtained from previous studies published in the study area, d is the precision which corresponds to effect size (5%) and DE is the design effect (2). A previous study, Millistein et al. (2011) found that parental proxy reports of home and neighbourhood environment (pieces of equipment at home, traffic safety, walking facilities and street connectivity) were responsible for 21.4% of children's physical activity. This was used as the assumed prevalence (p) for this study. In the interest that children may fail to provide valid and/or incomplete data, the enrolment target was set to 600 children.

3.6 Sampling Techniques

A multi-stage sampling method ensured that a diverse population was sampled, and the resources and effort were concentrated in the selected divisions of Kampala city (Sedgwick, 2015). The primary sampling unit was divisions of Kampala city. The sampling frame was a list of all primary schools in Central and Nakawa divisions provided by the Directorate of Education and Social Services, KCCA. The third sampling unit was classes in the school that best corresponded to children aged between 10 and 12 years. In the first stage, two divisions of Kampala city (Central and Nakawa) were randomly selected to provide a sample for the study. In the second stage, schools were stratified by division and by SES (high and low). There is variability in SES between schools in Kampala city. Public schools (managed by KCCA) represent lower socioeconomic strata and private schools represent high socioeconomic strata (basing on fees structure of different private schools). Seven schools were sampled (four private and three public). Each selected school was visited to introduce the study and seek approval from the school administration to recruit the school. Whenever a school refused to participate in the study, the next school on the list replaced it. More private schools were selected because there were more private schools but there were also more children in public schools. In the third sampling frame included children aged between 10 to 12 years. Fifth and sixth grade pupils were sampled in each school to have 75 to 100 children (proportional to the distribution of public and private school attendance) from the school to participate. 600 parent/child pairs were recruited as presented in Table 3.1. Out of the 600 parent/child pairs who received packages to take back home to their parents, 328 children obtained parents' consent to participate in accelerometry and anthropometry. Out of the 328

recruited for accelerometry, 256 had complete questionnaire, anthropometry and accelerometry data and formed the final sample.

Table 3.1 Participant recruitment by division and school type

	School Type		
Division	**Public (LSES)**	**Private (HSES)**	**Total**
Nakawa	3	1	4
Central	1	2	3
Participants			
Target number of valid participants	300	300	600
Actual Questionnaire respondents	196	204	400
Actual accelerometry participants	106	150	256

Note: LSES: Low Socioeconomic Status, HSES: High Socioeconomic Status

3.7 Research Instruments

3.7.1 ActiGraph GT3X+ Accelerometer (ActiGraph, Pensacola, Florida)

A hip-mounted tri-axial accelerometer ActiGraph GT3X+ accelerometer (ActiGraph, Pensacola, Florida, USA) (Appendix H), measured physical activity. The ActiGraph GT3X+ is a light motion sensor that measures acceleration from body movements in three directions (Chen & Basset, 2005). Accelerometry is currently the most valid technique for assessing physical activity among children in free-living conditions (Konstabel et al.,

2014). The device contains a micro-electrical-mechanical system-based accelerometer and light sensor. The accelerometer quantified the intensity of the activity at the exact moment in which it occurs, at different times of the day (Yang & Hsu, 2010).

A checklist was used to track participants during the accelerometry data collection. On the checklist, the participant identification number, accelerometer serial number, initialization date, distribution and retrieval dates and download dates were recorded. Also, information on whether the child was monitored once or twice (additional monitoring) was included.

3.7.2 Accelerometer Wear Log

The accelerometer wear time log (see Appendix I) is a day-to-day log which is traditionally used by participants to record dates and times the monitor was put on and taken off (Cain et al., 2013b). This helped in data processing and served as a reminder to wear the monitor, and was thus a self-monitoring tool, which increased compliance to accelerometer wear.

3.7.3 Parental/Guardian Questionnaire

A questionnaire on socio-demographic factors, home, and neighbourhood-built environment factors (see Appendix M), was adapted from two previously validated tools. The neighbourhood environment walkability scale for Africa (NEWS-Africa) questionnaire (Oyeyemi et al., 2016). The brief scales assessing electronic, and sport and exercise equipment in the home (Rosenberg et al., 2010).

In the first part of the questionnaire, parents provided information concerning socio-demographic factors such as the child's date of birth and sex. Parents also reported their

own age, sex, marital status, highest level of education, number of cars at home, number of siblings in the household and the time spent at the current residence.

In the second part of the questionnaire, the home social environment was assessed using two scales: parental social support and parental rules for physical activity, which were adapted from the NIK study survey (Saelens et al., 2012). Parental rules on physical activity were assessed using fifteen items, such as do not go into the street, come in before dark with "Yes" or "NO" responses. Whereas parental social support was assessed by asking parent questions such as "How many days during a typical week they watched the child participate in sport or physical activity, transported their child to physical activity venues, encouraged the child to play a sport or participate in physical activity". The items were rated on a 5-point scale ranging from 1 "Never" to 5 "Everyday". Parents also completed the brief scales to assess electronic and media equipment and play equipment in the home (Rosenberg et al., 2010). It consisted of two parts: the first part was the home electronic and media equipment which assessed the number and types of electronic equipment available in the home categorized into electronics in the child's bedroom (5 items), and personal electronics (2 items) (Rosenberg et al., 2010). The second part was the home play equipment which consisted of thirteen types of play equipment inside and outside of the home (such as bike, basketball hoop, jump rope, sports equipment, swimming pool, roller skates, fixed play equipment, home aerobic equipment, exercise mats, weight training equipment, water equipment, exercise, play or recreation room, trampoline and stairs).

In the third part of the questionnaire, parents reported their perception of the neighbourhood environment using the NEWS-Africa questionnaire. The NEWS-Africa

questionnaire was developed for Africa; therefore, it was expected to capture relevant attributes of the built environment in Uganda and provide appropriate results for this study (Oyeyemi et al., 2016). The NEWS-Africa was adapted to apply to ages 12 years and above (Oyeyemi et al., 2016). Also, in an analysis of data from three African countries (Kenya, Mozambique and Nigeria), the reliability of NEWS-Africa among children was found to be acceptable but the constructs validity was poor to moderate (Dr. Adewale Oyeyemi, personal communication, 24th June 2018). The NEWS-Africa questionnaire contained fourteen scales that assessed the parental perception of the neighbourhood-built environment concerning their children's physical activity. The scales included, residential density (1 item); proximity to destinations (21 items); proximity to recreational destinations (4 items); ease of access to non-residential uses (7 items); street connectivity (5 items); sidewalk infrastructures (5 items); path infrastructures (2 items); crossing infrastructures (4 items); infrastructure and safety for pedestrians and cyclists (12 items); aesthetics (8 items); traffic safety (6 items); crime safety (4 items); personal safety (3 items); and stranger danger (3 items) (Oyeyemi et al., 2016).

3.7.4 Stadiometer

The Seca 213 Portable Stadiometer (Hamburg Germany), (Appendix J) was used to measure heights to the nearest 0.1 cm without shoes. The Stadiometer was suitable for mobile use because it has an integral level for correct positioning, it is easy to set up, it has a large footplate for stability and visible results that were easy to read (www.seca.com).

3.7.5 Weighing Scale

The Seca 869 portable electronic digital Weighing Scale (Hamburg Germany), (Appendix J**)** was used to measure weight to the nearest 0.1Kg with minimal clothing. The weighing scale was suitable for mobile use because it has a levelled base that could be set up on all types of surfaces; it has a weight capacity of 250kg, it gives extra weighing functions like BMI and has a digital readout for easy use (www.seca.com).

3.8 Pre-Testing

A feasibility study that lasted a fortnight was carried out by conducting a full run of the whole research procedure. The feasibility study helped to identify potential problems before the actual study was carried out, to determine the logistics and time required to complete the whole procedure (Lewis et al., 2004). Pre-testing accelerometry was essential to identify faulty batteries and check if the devices collected data. The full run of the accelerometry process also showed that field work (data collection) would take longer than planned. Pre-testing was carried out in one primary school in Wakiso municipality among 20 children.

3.8.1 Research Assistants

Pre-testing focused on training and familiarisation of the current study's procedures for the research assistants. The current study enrolled two research assistants (1 graduate and 1 undergraduate). The graduate research assistant had knowledge on research methods and experience in conducting research whereas the undergraduate student had experience in working with school children. They were trained to work as a team with the researcher,

to implement and adhere to the approved research protocol. During the pre-testing, the research assistants were trained on participant recruitment, obtaining informed consent and assent from the participants plus maintaining accurate and confidential records.

The research assistants were further trained on their roles such as, setting up the room and measurement devices for anthropometry, taking and recording accurate readings. They were also trained on educating the participants on the use and wear instructions for accelerometers, fitting the accelerometers, completing participant checklists and follow up of participants with accelerometers such as daily school visits, calling parents and sending reminder messages. Research assistants were further trained in checking the completeness of the questionnaires and logical accuracy of the entries.

3.9 Validity and Reliability

The validity of the ActiGraph was tested in children aged between 3 and 16 years using doubly labelled water, moderate correlations were reported ($r = 0.39$ to 0.58) (Plasqui & Westerterp, 2007). In addition, Rich et al. (2013) found high reliability ($r = 0.86$) which increased as the number of days and wear time increased.

BMI is recognised as a valid indirect measure of childhood weight status in large populations (Dietz & Bellizi, 1999). However, the degree of accuracy varies with the degree of body fatness. That is, in children with a percentile of ≥ 85 there is a moderately high sensitivity (70% to 80%) and a high specificity of 95% in classifying their weight status (Freedman & Sherry, 2009).

Scales used to assess the social environment at home were tested for individual item reliability with parental support (ICC = 0.69 to 0.85) and rules for physical activity (ICC = 0.39 to 0.78) (Joe et al., 2010).

The Brief Scales to assess physical activity and sedentary equipment in the home was tested for reliability in adolescents and parents of adolescents with results showing an acceptable test-retest reliability (ICC = 0.54 to 0.92) with parent and adolescent reports being similar (Rosenberg et al., 2010).

The NEWS-Africa survey was adapted and tested for reliability among youth and adults in seven African countries (Oyeyemi et al., 2016). The study results showed excellent (ICC > 0.75) or good (ICC = 0.60 to 0.74) tool reliability. Oyeyemi et al. (2017) further tested the construct validity of the NEWS-Africa survey and reported partial support for construct validity with low effect size (1% to 2%) of variance in walking.

3.10 Data Collection and Scoring Procedure

3.10.1 Participant Enrolment

Data were collected from 10- to 12-year-old boys and girls in private and public mixed sex day primary schools in Kampala. Permission to access schools was obtained from the Directorate of Education and Social Services KCCA (Appendix E) and from the respective school head teachers. In the schools, children aged 10 to 12 years (5^{th} to 7^{th} grade) and parents/guardians of these children were invited to participate in the study. All study information that included a parental/guardian consent form (Appendix F) and parental/Guardian Questionnaire (Appendix M), were sent to the parents/guardians by the

schools through children. Only those parents/guardians who signed consent for themselves and their children to participate in the study, were requested to complete a written questionnaire (Appendix M). Only those children, whose parent/guardian provided written consent, and their own written assent (Appendix, G) were enrolled as study participants to undertake anthropometric measurements and accelerometry.

3.10.2 Questionnaire Data Collection and Scoring

The study questionnaire collected data on independent variables such as children and parents' socio-demographics, and parents' perceptions of home and neighbourhood-built environment attributes. Information about the child's socio-demographics, home and neighbourhood environment, was provided by a parent/guardian with whom the child spent a significant amount of time (≥ 3 months).

3.10.2.1 Socio-Demographics

Parents/guardians provided demographic information such as their child's sex (male/female) and date of birth (which was used to verify child's actual age during accelerometry). Parents further reported their socio-demographics such as age, sex (male or female), marital status, highest level of education, number of cars at home, and the number of children (6 to 17 years) in their household. Parental level of education and car ownership were used as indicators of SES such that high parental level of education (diploma/degree/postgraduate) and households with one or more cars represented HSES. On the other hand, low parental level of education (Ordinary level/advanced level) and households with no cars represented LSES.

3.10.2.2 Home Built Environment

Parental social support: This was assessed by the total of 4 items. The responses were scored from 1 (never) to 5 (everyday). The average of the 4 items was computed and dichotomised into low social support (< 2.5) and high social support (≥ 2.5), for analysis.

Parental rules for physical activity: All the 15 questions elicited a Yes/No response. The responses were tallied to describe parental rules for physical activity. However, only the 'yes' responses were summed up to generate a total score that was used in the analysis.

Home electronics and media equipment: Parents reported the various types of electronic and media equipment devices available in the child's bedroom (5 items) and for the child's personal use (2 items). All items required a Yes/No response. Only the 'Yes' responses were summed up to create a total score of electronics and media equipment in the home which was used in the analysis.

Home play equipment: The scale consisted of a checklist that elicited a Yes/No response on the availability of the13 types of play equipment in and around the home. Home play equipment score was the total number of the available equipment at home (regardless of usage) which was used in the analysis.

3.10.2.3 Neighbourhood Built Environment

To describe the neighbourhood environment all NEWS-Africa scales (except for residential density and land use mix-diversity [destinations and recreational]) were assessed on a 4-point Likert scale ranging from "strongly disagree" (1) to "strongly agree" (4). For a description of the neighbourhood environment, all the scale responses were dichotomised into 'Disagree' (strongly disagree and somewhat disagree/ 1 and 2 on the 4-

point Likert scale) versus ‘Agree’ (strongly agree and somewhat agree/ 3 and 4 on the 4-point Likert scale).

Residential density (A): The type of residences in the neighbourhood were rated on a 6-point scale ranging from 1 (lowest housing density) to 6 (highest housing density). Each item was tallied to describe parent perceived residential density, and a dichotomous score of low density (1 to 3) and high density (4 to 6) was tallied and used in the analysis.

Land use mix diversity (destinations and recreation) (B): Destination and recreation facilities in the neighbourhood were rated on a 5-point Likert scale; 1-5 minutes (min) (1), 6-10 min (2), 11-20 min (3), 21-30 min (4) and 31+ min and do not know (5). All items were reverse coded that is 5 was assigned to destinations close to home (1-5 min) and 1 to destinations further from home (31+ min and do not know). For purposes of describing parental perceived proximity of various destinations and recreation facilities within the neighbourhood, the number of stores or facilities within ≤ 20 minutes’ walk from home and those ≥ 21 minutes’ walk from home were tallied.

Destination subscale: For the destination subscale, the mean of items 1 to 20 and 25 was computed, with higher average score representing destinations that were easy to walk to.

Recreation subscale: For recreation facilities subscale the mean of items 21 to 24 was computed, with a higher mean value signifying more recreation facilities that were in proximity.

Land use mix access (C): Access to services and places was calculated as the mean score for all the seven questions with a greater mean value showing more nearby services and destinations in the neighbourhood.

Street connectivity (D): Roads and walking paths in the neighbourhood were computed as the mean of all the 5 items with item 5 reverse coded. A greater average score showed a higher street connectivity.

Walking and cycling infrastructure (E): Places for walking, cycling and playing scale was assessed with 12 items that were subdivided into 3 subscales.

Sidewalk infrastructure subscale was computed as the mean of items 1 to 5 with item 3 reverse coded. A higher score implied more sidewalks.

Crossing infrastructure subscale was computed as the mean of items 6 to 9 with item 9 reverse coded. A higher score implied more crossing infrastructure.

Path infrastructure subscale was computed as the mean of items 10 and 11. The higher the score the more paths in the neighbourhood.

The total walking and cycling infrastructure was computed as the mean of all items 1 to 12 with item 3 and 11 reverse coded. A higher score translated into more pedestrian and cyclists' infrastructure.

Aesthetics (F): The neighbourhood surroundings (aesthetics) was computed as the mean of all items 1 to 8. A higher score suggested a more aesthetically pleasing neighbourhood.

Traffic safety (G): Safety from traffic was computed as the mean score of all items 1 to 6 with all items reverse coded. The closer the average score was to 4, the safer the parent/guardian felt, whereas a lower score translated into lesser safety.

Crime safety (H): Safety from crime was computed as the mean score of items 1 to 4, all the items reverse coded. The higher the score the higher the parent/guardian perceived safety.

Personal safety (I): Personal safety was calculated as the mean of all items 1 to 3, with item 2 reverse coded. A higher score indicated a perception of higher personal safety.

Stranger danger (J): Stranger danger was computed as the mean of all items 1 to 3, with all items reverse coded. A higher score indicated a lower perception of stranger danger.

3.10.3 Children's Weight Status

Children's anthropometric measures (height and weight) were taken by trained research assistants following a standardized protocol (Appendix J). For purposes of accuracy, all measurements were performed twice and were repeated the third time if the first two readings differed by 0.5 cm for height and 0.5 kg for weight. The average of two closest measurements was calculated and used for computation of children's weight status. Weight status was calculated as body mass index (BMI); that is weight in kilograms divided by height in square meters (Weight (kg)/Height (m^2). Age and gender-specific BMI percentiles were generated using the World Health Organization (WHO) references de, Onis et al. (2007) for children 5 to 19 years (Appendices K and L). The following percentiles cut offs were used to categorize participants weight status as; thin/normal weight = $< 85^{th}$ percentile; overweight/obese = $\geq 85^{th}$ Percentile.

3.10.4 Accelerometry Data Collection and Scoring

3.10.4.1 Accelerometer Initialisation

Accelerometers were fully charged before initialisation. The Initialisation process involved preparing the monitors for data collection. Data collection start dates, and time were set as well as other accelerometer features relevant to the study. The ActiLife Version 6.13.3 software (ActiGraph LLC, Pensacola, Florida, USA) was used to initialise the monitors. The ActiGraph GT3X+ accelerometer was set to collect second to second data at a sampling rate of 80 HZ. Since the study was interested in capturing data for 24 hours daily, the 'Idle sleep mode' (which saves the battery life when no movement is detected) was disabled during initialisation because it interfered in the full recording of raw data signals. The start date and time were set at midnight of the following day that the children received the monitors. The first day the children received the monitor was considered a familiarisation day and as such children were requested to immediately wear the meter following distribution.

3.10.4.2 Accelerometer Wear Instructions and Period

Accelerometers were distributed to schools on a rolling basis. All children from the same class could participate to increase adherence to the accelerometer data collection protocol among peers. Accelerometers were distributed to the children face to face in a school classroom setting. The research team demonstrated and individually fitted the monitor for the children. Children were further asked to remove and re-attach the belt to demonstrate appropriate placement and orientation of the monitor. Accelerometer wear instructions were read aloud in the classroom to the children and a hard copy of instructions with an illustration of the correct attachment of the monitor were handed out to each participant

to take home. And the researcher's contact information in case parents had concerns. The monitor was attached on an adjustable elastic belt and worn around the waist with the accelerometer placed in line with the right-side mid-axillary line, lying on the iliac crest. Children were instructed to wear the monitor at the hip because the study used the Evenson et al. (2008) cut offs to estimate time in different intensities of physical activity; and because accelerometers placed on the hip provide more accurate physical activity and sedentary measures (Rosenberg et al., 2013).

To improve wear time, the children were requested to wear the accelerometers for 24 hours per day Tudor-Locke et al. (2015a). Children wore the monitor for seven days including two weekend days, only removing the monitor when participating in water-based activities like bathing and swimming. Children were further urged to maintain their normal activity habits during the monitoring period.

3.10.4.3 Accelerometer Wear Compliance Enhancing Strategies

Various strategies were put in place to increase compliance with the wear protocol. Parents/guardians were contacted via telephone twice a week especially during weekend days to encourage daily wear of the accelerometers and filling in of the accelerometer wear logs. Class teachers were requested to inspect and report daily wear of monitors on weekdays. Daily school visits were made to ascertain that the children were wearing the monitors as instructed, and each child who was found wearing the monitor correctly was given an incentive in form of an eraser or a pen. After seven days of accelerometer monitoring, the research team returned to the school and collected the accelerometers.

3.10.4.4 Accelerometer Data Download

Immediately after retrieval, the data were downloaded and checked to determine wear time using the ActiLife Version 6.13.3 software (ActiGraph LLC, Pensacola, Florida, USA). The downloaded data generated GT3X+ raw data files and AGD files with 1-second epoch length (to allow for reintegration into larger epochs), vector magnitude (3 axes) orientation, lux (ambient light), inclinometer and low-frequency Extension (LFE) settings. All accelerometer data from the AGD files were checked, to determine if participants had accumulated 10 hours or greater of wearing time every day for 4 wearing days including 1 weekend day. Children with inadequate wear days were requested to wear the device for an additional 7- day period. However, this decision was individualised. The AGD files were named using these criteria; the participant identification number, the three last digits of the accelerometer serial number and a code showing whether it was the initial or second wear. Invalid accelerometry data were mainly due to accelerometer malfunction or loss, refusal to wear the device and insufficient wear time (that is less than 4 days or missing one weekend day each with 10 hours of waking wear time). Valid data were stored on a personal computer local disk and a backup file was securely stored on an external hard drive as a safety measure.

3.10.4.5 Accelerometer Data Management

Accelerometer 1-second epoch AGD file data were re-integrated into 1-minute epochs AGD files and further screened for possible inclusion in the final data set. The 1-minute epoch AGD files were converted into excel format files (Microsoft cooperation excel, 2016), the spreadsheets displayed the data in 1-minute intervals. Each child's data file was visually inspected to identify data collection start time and verify if the monitor was

initialised as specified in the study protocol. If the monitor was initialised to collect data other than midnight on the first day as specified in the study protocol, all the data collected before midnight was deleted. The last day of data collection was also identified to verify if it was the same as the day the monitor was retrieved and if the last day of data collection was within the 7 days of wear. The last day of data collection was deleted for all the data presented in this thesis to ensure that all days included in the final data set for analysis contained 24 hours of data.

Data files from children who had more than 14 days of data were inspected to verify whether the second participant had worn the monitor without initialisation. These files either contained valid data for two participants in one file or the children returned the monitors late (child forgot the monitor at home, not present on retrieval day and the monitor was not stopped from collecting data upon retrieval) and thereafter any data collected past the 7 days were deleted. Once all the data files were cleaned, consecutive 24-hour days were identified and separated according to "midnight to midnight" and used these to evaluate wake wear time.

3.10.4.6 Accelerometer Data Treatment

Using the 24-hour protocol, required sleep time to be identified and accounted for from within the accelerometer data before evaluating waking wear time and calculating the physical activity variables of interest for the current study (Tudor-Locke et al., 2014). The Sadeh sleep algorithm which was inbuilt into the sleep scoring function in ActiLife Version 6.13.3 software (ActiGraph LLC, Pensacola, Florida, USA) was used to score sleep time (Sadeh et al., 1994). The Sadeh algorithm has been validated against the polysomnography with overall agreements rates between 91% and 93% reported; the

algorithm is also a valid method for removing sleep time (Galland et al., 2012). Each child's file was processed and scored individually. Individualized sleep onset and offset time filters were created for each valid day for each child. The time that was not identified as sleep time was used to identify the non-wear time. Non-wear time was defined as any consecutive 20 minutes of 0 counts. The remaining minutes that were not identified as non-wear time were labelled as wake wearing time. The wake wearing time was used to calculate physical activity variables of interest. Valid wake wear was defined as at least 10 hours of wake wear time per day with 4 valid days including 1 weekend day.

The time spent in different levels of movement intensity were generated based on Evenson et al. (2008) cut points as: Sedentary time (≤ 25 counts/15 s), LPA (26 – 573 counts/15 s), MPA (574 – 1002 counts/15 s) and VPA (≥ 1003 counts/15 s). Because these have been shown to be more accurate in classifying children physical activity intensities (Trost et al., 2011). The outcome measures of interest for the current study that is physical activity intensity levels (sedentary time, LPA, MPA, VPA) were quantified in minutes/day from which the proportion of children who accumulated an average of ≥ 60minuted/day of MVPA were identified. Data were later imported into STATA statistical software version 14.2 for further analysis.

3.11 Data Analysis and Presentation

All the data were processed using STATA statistical software version 14.2 where it was cleaned, coded, and analysed. Descriptive statistics such as frequencies, percentages, means, and standard deviations were computed to characterise the study sample and to describe parental perceptions of the home and neighbourhood-built environment. The out-

come variable which was MVPA was normally distributed as tested with a p-value of 0.475 from the Shapiro-Wilk test and the quartile-quartile plot as the graphical. Student's t-tests were used to test for the differences between each physical activity intensity level (sedentary time, LPA, MPA and VPA) by a factor with two levels namely sex (male and female) school type (public and private), weight status (thin/normal weight and overweight/obese). P-values from t-tests with equal and unequal variances as guided from the variance ratio test were presented. Analysis of variance (ANOVA) p-values for factors with more than two levels namely age (10, 11 & 12 years) and physical activity levels (sedentary time, LPA, MPA and VPA) were also presented. Chi-square test was used to test for differences in meeting physical activity guidelines by children's characteristics such as school type, sex, age and weight status.

For testing the study hypotheses, in the initial model, bivariate statistics were used to identify potential socio-demographic, and home and neighbourhood-built environment variables that were worth testing in the multivariable model. In the bivariable model, various socio-demographics and attributes of parental perceived home and neighbourhood-built environment against the outcome (MVPA) were assessed. For the multivariable model, analyses were conducted to examine key correlation of socio-demographics and parental perceived home-built environment and neighbourhood-built environment with children's compliance with physical activity guidelines ($\geq$ 60 minutes/day of MVPA). The threshold for inclusion of variables in the multivariable model was set at a statistical difference of $p < 0.2$ to reduce the chances of leaving out important variables that may achieve statistical significance at $p < 0.05$ only after adjustment for other covariates (Tabachnick & Fidell, 2013). A multi-level mixed effect

logistic regression model was used to examine associations between compliance with physical activity guidelines (≥ 60 minutes/day of MVPA) and each of the socio-demographic and home and neighbourhood-built environment variables. Interaction between variables: sex and age were tested and found not to be significant. Confounding was also assessed at 10% after ruling out interaction. The bivariate and multivariate analysis were adjusted for clustering at the division and school level to generate robust standard errors. Odds ratios and 95% Confidence Intervals were reported for all analyses. Statistical significance was evaluated at 'p' ≤ 0.05 for all analyses.

3.12 Logistical and Ethical Considerations

Authority to conduct the study and permission to proceed for data collection was sought and obtained from Kenyatta University Graduate School (Appendix A). The study protocol was approved by the Kenyatta University ethical review board (PKU/619/1703 (Appendix C) and the Uganda National Council of Science and Technology (SS 4340) (Appendix D). Permission to access schools was granted by the Directorate of Education and Social Services, Kampala Capital City Authority (REF: DES/KCCA/503) (Appendix E). All the selected schools were requested to be part of the study and permission was obtained from the school management before data collection. Written informed parental consent (Appendix F) and child assent (Appendix G) were obtained before data collection. All tools that were used in the study have been used in previous studies with no negative effect reported. All the information that was collected was handled confidentially and was used only for research purposes. No identification data for participants were used in the current study.

CHAPTER FOUR: RESULTS

4.1 Introduction

This chapter presents the findings of the study that aimed at assessing the association between parental perceived home and neighbourhood-built environment and children's physical activity. As mentioned, all data were analysed using STATA statistical software version 14.2 and presented using tables, graphs, and charts. All the study hypotheses were tested using analytical tests described in section 3.11 (Data analysis and presentation). Descriptive statistics for each study variable were first presented before testing the hypotheses.

4.2 Description of Participants

Overall, seven schools took part in this cross-sectional study, four private schools (owned by individuals/private groups) and three public schools (under KCCA management). Data were collected in two phases. Questionnaire data were collected in the first phase of the study, while anthropometric and accelerometry data were collected in the second phase.

Of the 600 children who received a study package that contained a parent/guardian consent form, child assent form and a parent questionnaire to take home, 487 children returned the study packages. From the 487-questionnaire returned, 35 questionnaires had incomplete demographic data, 32 questionnaires were not filled, and 20 questionnaires were left out because the children did not comply to the study age conditions (because the class teacher advised that all children in a classroom be given packages to take home, so that younger or older children not to feel discriminated). This resulted in 400 (66.7%)

response rate for questionnaires that were valid for analysis. Details of questionnaire response rate are presented in Figure 4.1.

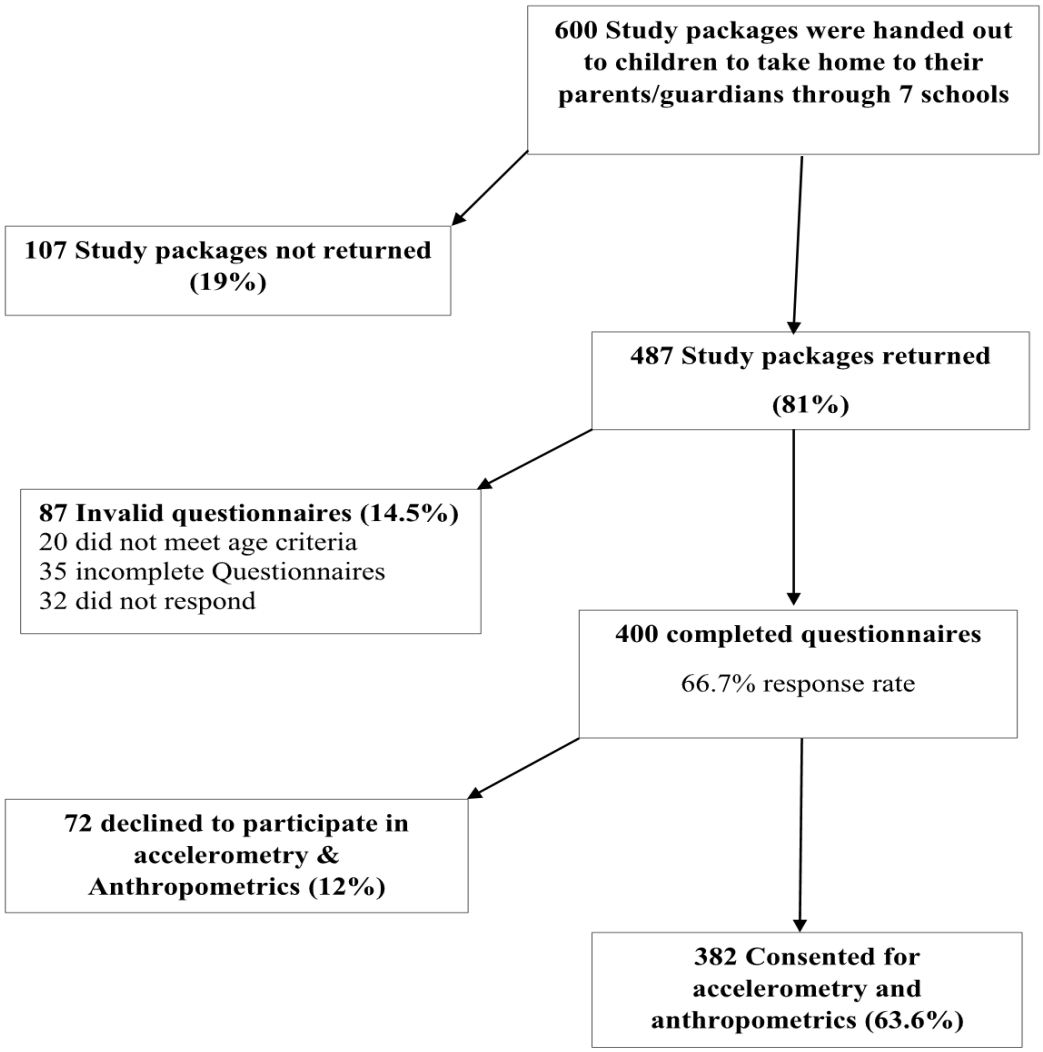

Figure 4.1 Flow diagram for study questionnaire response rate and accelerometry recruitment

4.2.1 Characteristics of Questionnaire Respondents

A total of 400 children-parent/guardian pairs (204 from private and 196 from public primary schools) returned complete questionnaires as presented in Table 4.1 and Table 4.2.

4.2.1.1 Characteristics of Children whose Parents Completed the Survey

Results presented in Table 4.1 show that there was an almost even distribution of children by school type and age, but there were more girls (55.5%) than boys (44.5%). Most of the children were thin/normal weight (78.2%). However, most of the overweight/obese children (19.2%) attended private schools compared to those in public schools (2.5%).

Table 4.1 *Descriptive characteristics of children whose parents completed the survey (N=400)*

Characteristics	School type		
	Private (n=204)	Public (n=196)	Overall (N=400)
Sex			
Male	103 (25.8)	75 (18.8)	178 (44.5)
Female	101 (25.2)	121 (30.2)	222 (55.5)
Age (years)			
10	91 (22.8)	32 (8.0)	123 (30.7)
11	77 (19.2)	61 (15.2)	138 (34.5)
12	36 (9.0)	103 (25.8)	139 (34.7)
Weight status			
Thin/normal weight	125 (39.4)	123 (38.8)	248 (78.2)
Overweight/obese	61 (19.2)	8 (2.5)	69 (21.8)

Note. Data presented as counts and (%), n= sub- total, N= Grand Total

4.2.1.2 Characteristics of Parents Who Completed the Survey

Most parents'/guardians' surveys (61%) were completed by mothers. Majority (47.2%) of the parents were within the age range of 31 and 40 years, 79% of the parents were married or living with a partner. Majority of the parents/guardians (65%) had attained a diploma/degree/postgraduate level of education. More so among parents who had children attending private schools (47.5%) than public school (17.5%). There were more parents (63.3%) who owned one or more cars than those with no car (36.7%). Most parents, who owned one or more cars, had children in private schools (47%) compared to their peers with children in public schools (16.3%). Nevertheless, fewer parents of children in private schools (4%) reported not having a car than parents with children in public schools (32.7%). More than half the parents (59.5%) who participated in the current study reported having 2 to 4 youth living in their household; and had lived in their neighbourhood for an average of 7 years, as presented in Table 4.2.

Table 4.2 *Descriptive characteristics of parents who completed the survey (N=400)*

Characteristics	School type		
	Private (n=204)	Public (n=196)	Overall n (N=400)
Sex			
Male	77 (19.3)	79 (19.7)	156 (39.0)
Female	127 (31.7)	117 (29.3)	244 (61.0)
Age range			
21-30	6 (1.6)	25 (6.7)	31 (8.3)
31-40	92 (24.7)	84 (22.5)	176 (47.2)
41-50	79 (21.2)	68 (18.2)	147 (39.4)
Marital status			
Married/living with partner	174 (43.5)	142 (35.5)	316 (79.0)
single/widowed/divorced	30 (7.5)	54(13.5)	84 (21.0)
Maternal education level			
Certificate (O-level & A-level)	14 (3.5)	126 (31.5)	140 (35.0)
Diploma/degree/postgraduate	190 (47.5)	70 (17.5)	260 (65.0)
Number of cars at home			
No car	16 (4.0)	131 (32.7)	147 (36.7)
≥ One car	188 (47.0)	65 (16.3)	253 (63.3)
Number of youths in the household			
0-1	39 (9.7)	36 (9.0)	75 (18.7)
2-4	131 (32.7)	107 (26.8)	238 (59.5)
5+	34 (8.5)	53 (13.3)	87 (21.8)
Years spent in the house: Mean (SD)*	7.5 (4.7)	6.6 (3.9)	7.0 (4.4)

Note. Data presented as counts and (%), and * mean (standard deviation), n= sub- total, N= Grand Total

4.2.2 Accelerometer Para Data

Accelerometer para data is a process related to data produced during accelerometer data enrolment, collection, management, and processing (Tudor-Locke et al., 2015b). Para data were generated from accelerometers, participant checklists and accelerometer downloaded files. The data presented in Figure 4.2 below includes the number of distributed, lost, and malfunctioned accelerometers and the number of children participating at each stage of data collection; that is enrolment, data collection, data processing and the final locked data set used for analysis.

Children who obtained parental consent for wearing the accelerometer were 328, but only 312 were eligible to participate. The children (12) who were ineligible to participate in the study were mainly outside the study age range (10 to 12 years). During the data collection stage, only 309 accelerometers were distributed because 3 of the children were absent on the day of distribution of monitors. 285 children attempted initial monitoring and 24 children wore the meter the second time (for additional monitoring). On retrieval of accelerometers and after data downloading, 41 accelerometer data files were lost or unusable. The main reason for data loss at this stage was insufficient wear time (31 data files). 20 accelerometers were used in the study, representing a monitoring capacity of 15 participants per accelerometer. The final locked data set comprised of 256 children files with valid waking wear time (83.6%) relative to children who completed monitoring; 78.0% [256/328] response rate). Children with valid data wore the accelerometer for an average of 6.5 days out of the 7 days required by the protocol and 15.6 hours/day of wear time over the 24 hours.

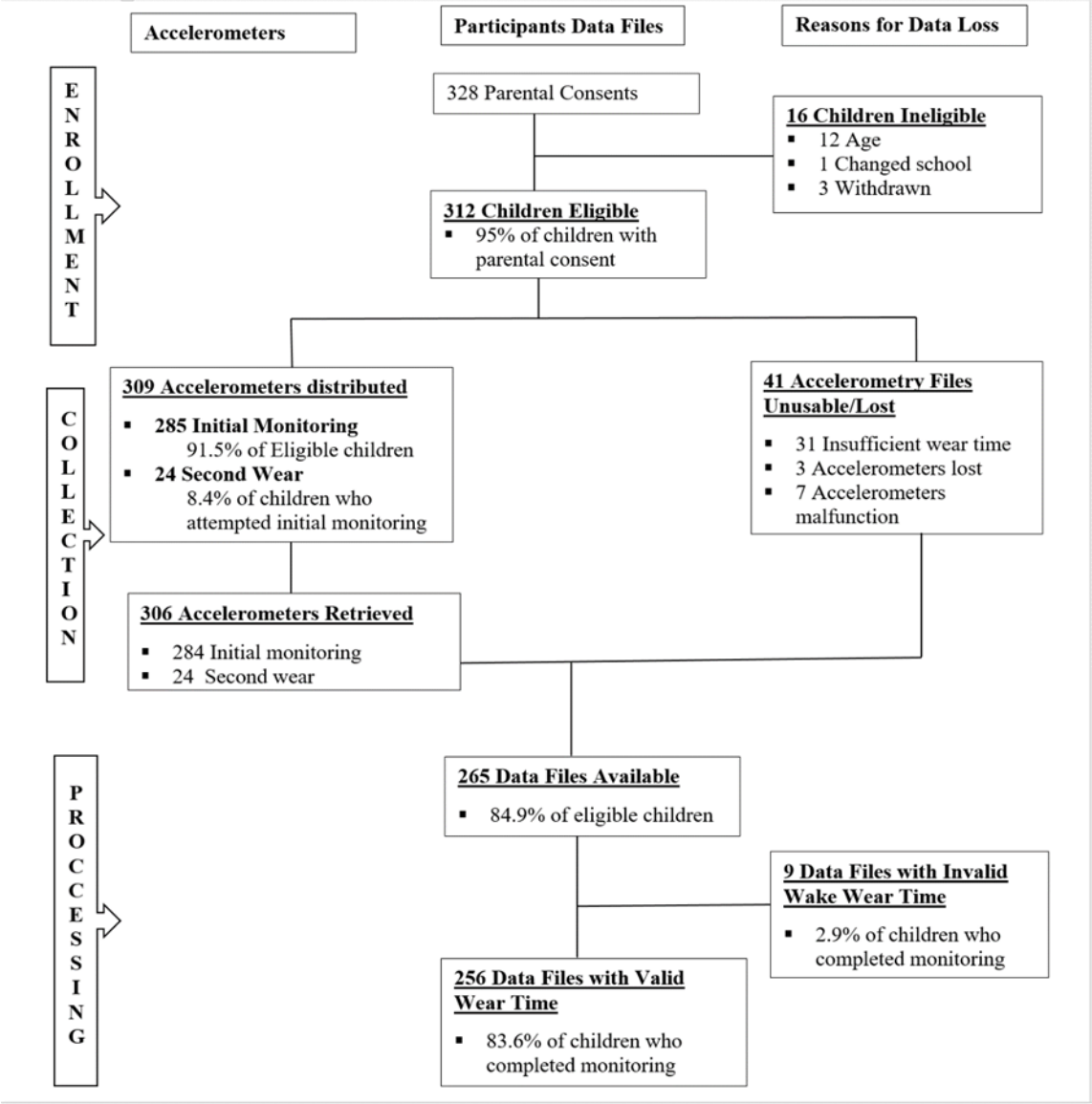

Figure 4.2 Participant flow chart reflecting accelerometry stages of participant enrolment, data collection, data processing and reasons for data loss at each stage (Adapted from Tudor-Locke et al., 2015b)

4.2.3 Descriptive Characteristics of Accelerometry Participants

The final sample used for testing the study hypotheses, as presented in Table 4.3 and Table 4.4, consisted of 256 children-parent/guardian pairs who met the conditions for the study survey, anthropometry and accelerometery data.

4.2.3.1 Characteristics of Children Who Participated in Accelerometry

Most of the children (58.3%) were from private schools versus (41.7%) from public schools. More females (55.9%) participated than males (44.1%) with most of the female children (29.3%) attending private schools. There were more children aged 11 years (36.7%). Majority of the children (79.3%) were thin/normal weight. The highest number of overweight/obese children (18.4%) were from private schools compared to 2.3% of their peers from public schools. Results are presented in Table 4.3.

Table 4.3 *Descriptive characteristics of children who participated in accelerometry (N=256)*

Characteristics	School type		
	Private (n=150)	Public (n=106)	Overall N=256 (100)
Sex			
Male	75 (25.8)	38 (14.8)	113 (44.1)
Female	75 (29.3)	68 (26.6)	143 (55.9)
Age (years)			
10	69 (27.0)	20 (7.8)	88 (34.8)
11	56 (21.9)	38 (14.8)	94 (36.7)
12	25 (9.8)	48 (18.7)	74 (28.5)
Weight status (calculated as BMI)			
Thin/normal weight	103 (40.2)	100 (39.1)	203 (79.3)
Overweight/obese	47 (18.4)	6 (2.30)	53 (20.7)

Note. Data presented as counts and (%), n= sub-total, N= Grand total

4.2.3.2 Characteristics of Parents/Guardians whose Children Participated in Accelerometry

Results presented in Table 4.4 show that more than half (58.6%) of the parents/guardians were female. Majority of the parents (47.1%) were aged between 31 and 40 years, 80.9% were either married or living with a partner. Almost three quarters (74.2%) of the parents had attained a diploma/degree/postgraduate level of education. Most families (70.3%) owned at least one or more cars, 53.9% of whom had children attending private schools. Most of the households (62.1%) had 2 to 4 children aged 6 to 17 years and had on average lived in their home for 6 years.

Table 4.4 *Descriptives characteristics of parents whose children participated in accelerometry (N=256)*

Characteristics	School type		
	Private (n=150)	Public (n=106)	Overall N=256
Sex			
Male	63 (24.6)	43 (16.8)	106 (41.4)
Female	87 (34.0)	63 (24.6)	150 (58.6)
Marital status			
Married/living with partner	128 (50.0)	79 (30.9)	207 (80.9)
single/widowed/divorced	22 (8.6)	27 (10.6)	49 (19.1)
Age range			
21-30	5 (2.1)	12 (5.0)	17 (7.1)
31-40	70 (29.4)	42 (17.6)	112 (47.1)
41-50	62 (26.0)	47 (19.7)	109 (45.8)
Maternal level of education			
Certificate (O level & A level)	10 (3.91)	56 (21.9)	66 (25.8)
Diploma/degree/postgraduate	140 (54.7)	50 (19.5)	190 (74.2)

Number of cars at home			
No car	12 (4.7)	64 (25.0)	76 (29.7)
≥ One car	138 (53.9)	42 (16.4)	180 (70.3)
Number of youths in the household			
0-1	30 (11.7)	13 (5.1)	43 (16.8)
2-4	97 (37.9)	62 (24.2)	159 (62.1)
5+	23 (9.0)	31 (12.1)	54 (21.1)
Time spent in the house: Mean (SD)*	6.3 (3.9)	5.7 (3.0)	6.1 (3.3)

Note. Data presented as counts and (%) and * means (Standard Deviation), n= sub-total, N= Grand total, O = ordinary, A= Advanced.

4.3 Physical Activity

The first objective of the current study was to determine Children's physical activity intensity levels (sedentary time, LPA, MPA & VPA) and adherence to the WHO (2010) physical activity guidelines. As mentioned, physical activity was objectively quantified using the ActiGraph GT3X+ (ActiGraph LLC, Pensacola, FL, USA) tri-axial accelerometer and scored by Actilife version 6.13.3 software. The average minutes of daily physical activity was calculated using the Evenson et al. (2008) cut offs with a 15-second epoch length.

4.3.1 Directly Measured Physical Activity Intensity Levels

Accelerometers provided daily profiles of sedentary time, LPA, MPA and VPA as defined by Evenson et al. (2008) cut points. Descriptives and differences in physical activity intensity levels by socio-demographics (age, sex, school type and weight status) were presented. Children spent most of their time being sedentary 590.6 ± 124.0 minutes/day

and in LPA 273 ± 48.3 minutes /day as compared to MPA (38.6 ± 16.0 minutes/day) and VPA (17.3 ± 12.3 minutes/day). Children spent their least time in VPA.

4.3.1.1 Children's Sedentary Time Levels by Socio-Demographics

Sedentary time was defined by Evenson et al. (2008) cut-points, which was ≤ 25 activity counts per 15-second epoch. The average daily sedentary time for children was 590.6 ± 124.0 minutes/day which was 64% of their waking time. Results from Student's t tests showed that sedentary time was significantly higher for children attending private schools 617.4 ± 142.1 minutes/day compared to their peers in public schools 552.6 ± 78.7 minutes/day, $p < 0.001$. No significant differences were found in sedentary time by sex, age and weight status, as presented in Table 4.5.

Table 4.5 *Descriptive and mean differences in children's sedentary time (minutes/day) by socio-demographics*

Characteristics		Sedentary time Mean (SD)	p-Value
Overall		590.6 (124.0)	
Sex¶	Male	606.1 (146.6)	0.089
	Female	578.4 (101.6)	
Age#	10	591.0 (112.0)	0.995
	11	591.2 (142.6)	
	12	589.4 (113.5)	
School type¶	Private	617.4 (142.1)	<0.001**
	Public	552.6 (78.7)	
Weight status¶	Thin/normal weight	584.4 (117.8)	0.117
	Overweight/obese	614.4 (144.2)	

Note. SD: Standard Deviation, Analysis: mean difference, T-Test¶, One-way ANOVA#, **$p < 0.001$.

4.3.1.2 Light Intensity Physical Activity by Socio-Demographics

Time spent in LPA was defined by Evenson et al. (2008) cut-points, which was 26 to ≤ 574 activity counts per 15-second epoch. On average, the children spent 4.5 hours/day in LPA. A one-way ANOVA test revealed significant differences in children's LPA levels by age ($p = 0.020$). LPA decreased with increasing age being higher among 10-year-old children (283.3 ± 44.2 minutes/day) and lower in 12-year-old children (262.1 ± 48.6 minutes/day. There were no significant differences in LPA by children's sex, school type and weight status. Results are presented in Table 4.6.

Table 4.6 *Descriptives and mean differences in children's LPA (minutes/day) by socio-demographics*

Characteristics		LPA Mean (SD)	p-Value
Overall		273.0 (48.3)	
Sex[¶]	Male	272.5 (48.0)	0.783
	Female	274.0 (48.8)	
Age[#]	10	283.3 (44.2)	0.020*
	11	272.9 (50.4)	
	12	262.1 (48.6)	
School type[¶]	Private	277.1 (45.4)	0.155
	Public	268.3 (52.1)	
Weight status[¶]	Thin/normal weight	275.3 (47.6)	0.758
	Overweight/obese	272.9 (48.6)	

Note. LPA: Light intensity Physical Activity, SD: Standard Deviation, Analysis: mean difference, T-Test[¶], One-way ANOVA[#], *$p < 0.05$.

4.3.1.3 Moderate Intensity Physical Activity by Socio-Demographics

The moderate intensity physical activity (MPA) was defined by Evenson et al. (2008) cut points, as 574 to ≤ 1003 activity counts per 15-second epoch. Results presented in Table

4.7 show that on average children engaged in 38.6 ± 16 minutes/day of MPA. Student's t-tests showed significant differences (p=0.002) in MPA by sex. MPA was higher in boys (39.4 ± 16.3 minutes/day) compared to girls (37.9 ± 15.8 minutes/day). A highly significant difference in MPA was also found by school types ($p < 0.001$). MPA was higher among children from public schools (48.2 ± 16.0 minutes/day) in comparison to their peers from private schools (31.8 ± 12.1 minutes/day). Highly significant differences in MPA ($p < 0.001$), were also found by weight status. Thin/normal weight children had higher levels MPA (40.8 ± 16.4 minutes/day) compared to overweight/obese children (30.0 ± 10.9 minutes/day).

Table 4.7 *Descriptive and mean differences in children's MPA (minutes/day) by socio-demographics*

Characteristics		MPA Mean (SD)	p-Value
Overall		38.6 (16.0)	
Sex[¶]	Male	39.4 (16.3)	0.002*
	Female	37.9 (15.8)	
Age[#]	10	36.9 (13.9)	
	11	39.4 (17.9)	0.459
	12	39.6 (16.0)	
School type[¶]	Private	31.8 (12.1)	
	Public	48.2 (16.0)	<0.001**
Weight status[¶]	Thin/normal weight	40.8 (16.4)	
	Overweight/obese	30.0 (10.9)	<0.001**

Note. MPA: Moderate Intensity Physical Activity, SD: Standard Deviation, Analysis: mean difference, T-Test[¶], One-way ANOVA[#], *$p < 0.05$, **$p < 0.001$.

4.3.1.4 Vigorous Intensity Physical Activity by Socio-Demographics

Children's VPA was defined by the Evenson et. al. (2008) cut-points as, > 1003 activity counts per 15-second epoch. Children participated in an average of 17.3 ± 12.3 minutes/day of VPA which was below the recommendations for VPA (20 minutes/day). Results from Student's t-tests as presented in Table 4.8 revealed significant differences in children's VPA by sex ($p < 0.001$). Boys averaged over (20.7 ± 15.2 minutes/day) of VPA compared to girls (14.9 ± 8.7 minutes/day). Therefore, boys accumulated more 5.8 minutes/day of VPA than girls. Highly significant differences in VPA were also found among children by school type ($p < 0.001$). On average, children from public schools engaged in more VPA (22.9 ± 15.8 minutes/day) than their peers from private schools (13.6 ± 7.0 minutes/day). Highly significant differences in children's VPA and weight status were also revealed ($p < 0.001$). On average thin/normal weight children had higher VPA (19.0 ± 13.0 minutes/day) than their counterparts who were overweight/obese (11.6 ± 6.6 minutes/day).

Table 4.8 *Descriptive and mean differences in children's VPA (minutes/day) by socio-demographics*

Characteristics		VPA Mean (SD)	p-Value
Overall		17.3 (12.3)	
Sex[¶]	Male	20.7 (15.2)	<0.001**
	Female	14.9 (8.7)	
Age[#]	10	15.9 (8.2)	0.090
	11	17.0 (11.0)	
	12	20.0 (17.1)	
School type[¶]	Private	13.6 (7.0)	<0.001**
	Public	22.9 (15.8)	
Weight status[¶]	Thin/normal weight	19.0 (13.0)	<0.001**
	Overweight/obese	11.6 (6.6)	

Note. VPA: Vigorous intensity Physical Activity, SD: Standard Deviation, Analysis: mean difference, [¶]T-Test, [#]One-way ANOVA, **$p < 0.001$.

4.3.1.5 Moderate to Vigorous Physical Activity

The time children spent in MVPA was defined by Evenson et al., (2008) cut-points as ≥ 574 activity counts per 15-second epoch. The total MVPA was 56 ± 25.7 minutes/day and most of this MVPA (69%) was accumulated at moderate intensity. Table 4.9 presents the mean differences in MVPA by socio-demographics. There was a significant difference in MVPA by children's sex ($p = 0.023$); boys engaged in 60.1 ± 28.2 minutes/day of MVPA compared to girls who accumulated 52.8 ± 23 minutes/day. Therefore, boys accumulated more 7.3 minutes daily of MVPA than girls. Significant difference in MVPA by school type ($p < 0.001$) were also found. Children in public schools accumulated 71.2 ± 27.5 minutes/day of MVPA and their peers from private schools accumulated 45.4 ± 17.8 minutes/day. Thus, children from public schools accumulated more 25.8 minutes/day of

MVPA than children from private schools. Differences in MVPA by weight status were statistically significant ($p < 0.001$). MVPA declined with increasing weight status; with overweight/obese children accumulating less MVPA of 41.6 ± 16.4 minutes/day compared to thin/normal weight children whose MVPA was 59.8 ± 26.3 minutes/day.

Table 4.9 *Descriptive statistics and mean differences in children's average daily minutes of MVPA by socio-demographics*

Characteristics	MVPA Mean (SD)	p-Value
Overall	56.0 (25.7)	
Sex[¶]		
Female	52.8 (23.0)	0.023*
Male	60.1 (28.2)	
Age[#]		
10	52.7 (20.9)	0.268
11	56.5 (26.5)	
12	59.6 (29.4)	
School type[¶]		
Private	45.4 (17.8)	<0.001**
Public	71.2 (27.5)	
Weight status[¶]		
Thin/normal weight	59.8 (26.3)	<0.001**
Overweight/obese	41.6 (16.4)	

Note. SD: Standard Deviation, MVPA: Moderate to Vigorous Physical Activity, Analysis: mean difference, [¶]T-Test, [#]One-way ANOVA, *p<0.05, **p<0.001.

4.3.2 Children's Achievement of Recommended Physical Activity

According to the WHO (2010), children and adolescents between ages 6 and 17 should engage in at least 60 minutes (1 hour) or more of MVPA daily. Based on these recommendations, the participants were dichotomised into: 'sufficiently active' (those that accumulated ≥ 60 minutes of MVPA) or 'insufficiently active' (those that accumulated < 60 minutes of MVPA). Of the 256 children, only 36.3% complied with the physical activity recommendations and were classified as sufficiently active, but the largest proportion of children 63.7% did not comply with the physical activity guidelines and were classified as insufficiently active. Differences in achievement of physical activity recommendations by children's socio-demographics as tested using Chi-square test were also presented in Table 4.10. More boys (38.9%) than girls (34.3%) were sufficiently active. The percentage of children who were sufficiently active was significantly higher among public schools (62.3%), compared to private schools (18.6%). More thin/normal weight children (42.9%) met the physical activity guidelines compared to overweight/obese children (11.3%).

Table 4.10 *Chi-Square test results of compliance with physical activity guidelines by children's socio-demographics*

Characteristics	Sufficient PA n=93 (36.3%)	Insufficient PA n=163 (63.7%)	p-Value
Sex			
Male n=113	48 (38.9)	69 (61.1)	0.001**
Female n=143	49 (34.3)	94 (65.7)	
Age			
10 years n=88	29 (32.6)	60 (67.4)	
11 years n=94	35 (37.2)	59 (62.8)	0.064
12 years n=74	29 (39.7)	44 (60.3)	
School type			
Private n=150	27 (18.0)	123 (82.0)	0.001**
Public n= 106	66 (62.3)	40 (37.7)	
Weight status			
Thin/normal weight n=203	87 (42.9)	116 (57.1)	0.001**
Overweight/obese n=54	6 (11.3)	48 (88.7)	

Note. PA= Physical activity**,** n= total, ** $p<0.001$

4.4 Socio-Demographics Correlates of Children's Physical Activity

The second objective of the study was to assess the association between physical activity and children's socio-demographics. In Table 4.11 the various socio-demographics were tabulated against the outcome (MVPA). The researcher used a bivariate logistic regression, adjusted for clustering at the division and school level, to identify the socio-demographic correlates of compliance with physical activity guidelines.

In the unadjusted model, four of the socio-demographic factors were significantly associated with meeting physical activity guidelines. Meeting physical activity guidelines was significantly correlated with the school type the child attended. Specifically, most of the sufficiently active children attended a public school (OR: 7.5, 95% CI: [4.24 – 13.32], $p < 0.001$), with the odds of being sufficiently active 7.5 times higher among children from public schools in comparison to their colleagues from private schools.

Children's weight status was significantly associated with meeting physical activity guidelines. Children were more likely to meet physical activity guidelines if they were thin/normal weight (OR: 5.88; 95% CI: [2.30 - 15.00], $p < 0.001$). The odds of not being active were 5.88 times higher in overweight/obese children in comparison to thin/normal weight children.

Results also showed that there was significant association between mothers' level of education and children's compliance with physical activity recommendations. Mothers with lower levels of education (Ordinary Level/Advanced level) who comprised of 59.1% had children who were more likely to meet physical activity guidelines compared to the 28.4% of mothers with higher levels of education (diploma/degree/postgraduate).

Specifically, children were more likely to meet physical activity guidelines if their mothers reported a lower level of education (OR: 3.64, 95% CI: [2.12 - 6.24], p <0.001).

Children from families with no car (61.8%) met the physical activity guidelines compared to 25.6% of the children from families that owned one or more cars. The number of cars at home associated significantly with sufficient physical activity. Higher odd of being sufficiently active were found for children from families with no car (OR: 4.72, 95% CI: [2.10 – 10.60], p < 0.001). Children from families with no car were 4.72 times more likely to meet guidelines.

Table 4.11 *Bivariate logistic regression results of compliance with physical activity guidelines and children's socio-demographics*

Characteristics		Physical Activity Guidelines n (%)		Crude OR (95% CI)	p-Value
		Active	Inactive		
⁋ School Type					
	Private	27 (18.0)	123 (82.0)	1.00	
	Public	66 (62.3)	40 (37.7)	7.52(4.24,13.32)	<0.001**
Sex					
	Female	49 (34.3)	94 (65.7)	1.00	
	Male	44 (38.9)	69 (61.1)	1.22 (0.71,2.11)	0.469
Age					
	10	29 (32.6)	60 (67.4)	1.00	
	11	35 (37.2)	59 (62.8)	1.23 (0.86,1.74)	0.252
	12	29 (39.7)	44 (60.3)	1.36 (0.55,3.41)	0.507
Weight status					
	Overweight/obese	6 (11.3)	47 (88.7)	1.00	

Thin/Normal weight	87 (42.9)	116 (57.1)	5.88 (3.19, 10.83)	<0.001**
Marital status				
Married/living with partner	70 (33.8)	137 (66.2)	1.00	
Single/widowed/ divorced	23 (46.9)	26 (53.1)	1.73 (0.79,3.77)	0.167
Maternal education level				
Diploma/degree/ postgraduate	54 (28.4)	136 (71.6)	1.00	
Certificate (O & A levels	39 (59.1)	27 (40.9)	3.64 (1.65, 8.00)	<0.001**
Family car ownership				
≥ one car	46 (25.6)	134 (74.4)	1.00	
No car	47 (61.8)	29 (38.2)	4.72 (2.10, 10.60)	<0.001**
Children and youth (6 to 17 years) in the household				
0-1	15 (34.9)	28 (65.1)	1.00	
2-4	54 (34.0)	105 (66.0)	0.96 (0.48,1.90)	0.907
5+	24 (44.4)	30 (55.6)	1.49 (0.53,4.21)	0.448

Note. MVPA: Moderate-to-Vigorous Physical Activity, O-level: Ordinary level, A-level: Advanced Level, n: Total, CI: Confidence Interval, OR: Odds Ratio, ‖ Not clustered, * $p<0.05$, ** $p<0.001$.

Based on the above results school type, weight status, car ownership and maternal level of education were significantly associated with meeting physical activity guidelines while age, sex, marital status, and the number of siblings were not significantly associated. The null hypotheses (Ho1) that there is no significant associations between physical activity and children's socio-demographics of school type, weight status, car ownership and maternal level of education among 10 to 12-year-old school-going children in Kampala

city were therefore rejected. Whereas the null hypotheses (Ho1) that there is no significant associations between children's physical activity and socio-demographic factors of age, sex, marital status, and number of siblings in the household were retained.

4.5 Home Built-Environment

The third objective of the study was to assess the associations between parental perceived home-built environment attributes of parental support, parental rules for physical activity, electronic and media equipment and play equipment at home and children's physical activity. The parental perceived home-built environment was described and the differences in parental perceived home-built environment factors by children's sex, school type and compliance with physical activity guidelines were assessed. The study also assessed the parental perceived home-built environment correlates of children's compliance with physical activity guidelines.

4.5.1 Description of Parent/Guardian Perceptions of Home-Built Environment Attributes.

4.5.1.1 Parent/Guardian Perceptions of Social Support

Out of the total sample, 58.3% of the parents in the current study encouraged their children to engage in sport or physical activity. But 76% of the parents did not engage in physical activity or play sport with their children and 71% did not provide transport for their children to go to places where they can do physical activity or play sport, as tabulated in Table 4.12.

Table 4.12 *Description of parent's perceptions of social support.*

Social Support	N=400*		N=256**	
	Low n (%)	High n (%)	Low n (%)	High n (%)
1. Watched their child participate in physical activity	216 (54.0)	184 (46.0)	143 (55.9)	113 (44.1)
2. Encouraged their child to do sports or physical activity	167 (41.8)	233 (58.3)	110 (43.0)	146 (57.0)
3. Provided transport to a place where their child can do physical activity or sports	284(71.0)	116 (29.0)	176 (68.8)	80 (31.3)
4. Did physical activity or played sport with their child	304(76.0)	96 (24.0)	190 (74.2)	66 (25.8)

Note. n=Total, *full sample, **sample with accelerometer data

4.5.1.2 Parent/Guardian Perceptions of Rules for Physical Activity

Results showed that, 96.8% of the parents cautioned their children not to fight with other children, to stay close to the house/parent (96%) and to respect others particularly adults (93.5%). On the other hand, some parents (37.5%), did not caution their children to stay within the neighbourhood while others did not direct their children to have less than 2 hours of screen time (37.3%). Results are presented in Table 4.13.

Table 4.13 *Counts and percentages of parents' rules for physical activity.*

Rules	N=400*	N=256**
	Yes, n (%)	Yes, n (%)
1. Stay close or within sight of the house/parent	384(96.0)	245 (95.7)
2. Do not go into the street	361 (90.3)	228 (89.1)
3. Come in before dark	369 (92.3)	234 (91.4)
4. Do not go to places alone	366 (91.5)	236 (92.2)
5. Stay in the neighbourhood	250 (62.5)	162 (63.3)
6. Do not ride the bike on the street	313 (78.3)	207 (80.9)
7. Do homework before going out	369 (92.3)	240 (93.8)
8. Watch out for cars	347 (86.8)	226 (88.3)
9. Check in frequently	332 (83.0)	218 (85.2)
10. Stay on paths, trails, or sidewalks	328 (82.0)	215 (84.0)
11. Do not cross busy streets	358 (89.5)	236 (92.2)
12. No TV/DVD/computer before homework	350 (87.5)	228 (89.1)
13. Less than 2 hours of TV/DVD/computer per day	251 (62.7)	158 (61.7)
14. Do not fight with other children	385 (96.3)	248 (96.8)
15. Respect others (particularly adults)	374 (93.5)	243 (94.9)

Note. TV: Television, DVD: Digital Video Disk, n=Total, *full sample, **sample with accelerometer data

4.5.1.3 Parent/Guardian Perceptions of Children's Media and Electronics Equipment at Home

Results summarised in Table 4.14, show that three quarters of the parents reported no electronics in their children's bedrooms and their children possessed no personal electronics. Particularly 91.8% of the children had no Video Cassette Recorders (VCR) or Digital Video Disk (DVD) player and 88% had no televisions in their bedroom. Nevertheless, 18.3% of the children had handheld video game players and 17% had access to cell phones/2-way radios for personal use.

Table 4.14 *Counts and percentages of children's electronic and media equipment at home*

Bedroom electronic and media equipment	N=400*	N=256**
	Yes n (%)	Yes n (%)
1. TV	48 (12.0)	30 (11.7)
2. VCR or DVD player	33 (8.3)	23 (9.0)
3. Computer	53 (13.3)	31 (12.1)
4. Video game system (non-handheld – play station, x-box, etc.	61 (15.3)	40 (15.6)
Personal Electronic and media equipment		
1. Cell phone / 2-way radio	68 (17)	42 (16.4)
2. Handheld video game players (game boy, Sony PSP, etc.	73 (18.3)	55 (21.5)
3. A music player (radio, CD or tape player, stereo, MP3, or I Pod)	66 (16.5)	47 (18.4)

Note. TV: Television, DVD: Digital Video Disk, VCR: Video Cassette recorder., CD: Compact Disk, n=Total, *full sample, **sample with accelerometer data

4.5.1.4 Parent/Guardian Perception of Play Equipment at Home

Although 73.8% of the parents reported having sports equipment such as balls, racquets, sticks, bats, and 73.3% had jump ropes, most of the play equipment were not present in many homes. As shown in Table 4.15, many homes did not have a basketball hoop (95.5%) and trampoline (95.2%).

Table 4.15 *Counts and percentages of play equipment at home.*

Play equipment	N=400*	N=256**
	Yes n (%)	Yes n (%)
1. Bike	190 (47.5)	136(53.1)
2. Basketball hoop	18 (4.5)	14 (5.5)
3. Jump rope	293 (73.3)	187(73.0)
4. Active video games (e.g., with dance pad, Wii)	112 (28.0)	78 (30.5)
5. Sports equipment (e.g., balls, racquets, bats, sticks)	295 (73.8)	192(75.0)
6. Roller skates, skateboard, scooter	66 (16.5)	52 (20.3)
7. Fixed play equipment (e.g., swing set, playhouse, gym)	62 (15.5)	43 (16.8)
8. Home aerobic equipment (e.g., treadmill, cycle, cross trainer, stepper, rower, workout video or audiotapes)	60 (15.0)	40 (15.6)
9. Weightlifting equipment toning devices (e.g., free weights, pull, up bars, exercise balls, ankle weights	51 (12.8)	39 (15.2)
10. Yoga/exercise mats	79 (19.8)	51 (19.9)
11. Exercise, play or recreation room	81 (20.3)	54 (21.1)
12. Trampoline	19 (4.8)	14 (5.5)
13. Stairs	132 (33.0)	95 (37.1)

Note. TV: Television, DVD: Digital Video Disk, VCR: Video Cassette recorder, CD: Compact Disk, n=Total, *full sample, **sample with accelerometer data

4.5.2 Mean Differences in Parent/Guardian Perceptions of the Home-Built Environment Attributes by Children's Characteristics.

The mean differences in parent/guardian perceptions of the home-built environment by children's characteristics of school type, sex and compliance with physical activity guidelines as tested using T-tests were presented.

4.5.2.1 Parent/Guardian Perceptions of the Home-Built Environment by School Type

There was a significant difference in parental rules by school type (OR: 0.5, 95% CI: [0.04 - 1.0], $p < 0.05$). Parents with children attending private schools (13.2 ± 1.9) enforced more rules for physical activity than parents whose children attended public schools (12.7 ± 1.9). Results of the current study also showed significant differences in children's personal electronics (OR: 0.3, 95% CI: [0.1 - 0.5], $p < 0.05$). Children from private schools possessed more personal electronics (0.7 ± 0.9) than their peers in public schools (0.4±0.7). A highly significant difference in play equipment was also found (OR: 2.1, 95% CI: [1.5 - 2.7], $p<0.001$). Private school children had more play equipment (4.8 ± 2.5), than public school children (2.7 ± 2.1). The results are summarised in Table 4.16.

Table 4.16 *Mean differences in parent/guardian perceptions of the home-built environment by school type.*

Home-built environment factors	Type of school *Mean (SD)*		OR (95% CI)	P-value
	Private	Public		
Parental support for PA	2.7 (0.9)	2.6 (1.1)	0.1 (-0.1,0.3)	0.411
Parental rules for PA	13.2 (1.9)	12.7(1.9)	0.5 (0.04,1.0)	0.033*
Electronics in child's bedroom	0.5 (1.0)	0.5 (0.9)	0.04 (-0.2,2.8)	0.756
Child's personal electronics	0.7 (0.9)	0.4 (0.7)	0.3 (0.1,0.5)	0.002*
Play equipment at home	4.8 (2.5)	2.7 (2.1)	2.1 (1.5,2.7)	<0.001**

Note. PA: Physical Activity, CI: Confidence Interval, SD: Standard Deviation, *p<0.05, ** p<0.001

4.5.2.2 Parent/Guardian Perceptions of the Home-Built Environment by Children's Sex

There were no significant differences in home-built environmental factors such as parental social support, parental rules for physical activity, electronics in child's bedroom and personal electronics, and play equipment between boys and girls. Despite, boys having more play equipment (4.2 ± 2.5) compared to girls (3.6 ± 2.6). Results are tabulated in Table 4.17.

Table 4.17 *Mean differences in parents/guardian perceptions of the home-built environment by children's sex.*

Home-built environment factors	Sex Mean (SD)		OR (95% CI)	P-value
	Male	Female		
Parental support for PA	2.6 (0.9)	2.6 (1.0)	0.04 (-0.29, 0.20)	0.725
Parental rules for PA	13.1 (1.7)	12.9 (2.1)	0.28 (-0.18, 0.75)	0.235
Electronics in child's bedroom	0.5 (1.0)	0.5 (0.9)	0.07 (-0.17, 0.30)	0.575
Child's personal electronics	0.6 (0.9)	0.5 (0.8)	0.13 (-0.07, 0.34)	0.203
Play equipment at home	4.2(2.5)	3.6 (2.6)	-0.60 (-0.03, 1.23)	0.062

Note. PA: Physical Activity, CI: Confidence Interval, SD: Standard Deviation

4.5.2.3 Parents/Guardian Perceptions of the Home-Built Environment by Children's Compliance with Physical Activity Guidelines

Differences in parents' perceptions of the home-built environment between sufficiently active and insufficiently active children were investigated and the results are presented in Table 4.18. The number of play equipment at home inversely predicted children's compliance with physical activity guidelines (OR: -1.31, 95% CI: [-1.94 - 0.67], $p<0.001$). Children whose parents reported a high number of play equipment at homes were more likely to be insufficiently active (4.4 ± 2.6) compared to their peers who had a smaller number of play equipment (3.1 ± 2.3).

There were no significant differences between home-built environment attributes of social support, parental rules for physical, child's personal electronics and electronics in the child's bedroom, and compliance with physical activity guidelines. Insufficiently active

children had more personal electronics (0.6 ± 0.9) compared to sufficiently active children (0.4 ± 0.8).

Table 4.18 *Mean differences in parent perceptions of the home-built environment by children's compliance with physical activity guidelines.*

Home-built environment factors	MVPA guidelines Mean (SD)		OR (95% CI)	P-value
	Sufficient PA	Insufficient PA		
Parental support for PA	2.5(1.0)	2.7(1.0)	-0.20 (-0.45,0.05)	0.121
Parental rules for PA	12.9(1.7)	13.0(2.0)	-0.18 (-0.67,0.32)	0.479
Electronics in child's bedroom	0.5(1.0)	0.5(0.9)	-0.001 (-0.25,0.24)	0.995
Child's personal electronics	0.4(0.8)	0.6(0.9)	-0.21 (-0.42,0.004)	0.055
Play equipment at home	3.1(2.3)	4.4(2.6)	-1.31 (-1.94, -0.67)	<0.001**

Note. PA: Physical Activity, CI: Confidence Interval, SD: Standard Deviation, MVPA: Moderate to Vigorous Physical Activity, ** p<0.001

Note: *Results presented in Table 4.16, 4.17 and 4.18, show analysis of difference based on the sample with accelerometer data because descriptive results of the full sample were like those in the sample with accelerometer data as shown in Table 4.12 to Table 4.15.*

4.5.3 Parental Perceived Home-Built Environment Correlates of Children's Physical Activity

Results from a bivariate logistic regression found no significant association between parental perceived home-built environment variables and children's compliance with physical activity guidelines as summarised in Table 4.19.

Parents who perceived having high social support for their children's physical activity, had children (31.6%) who were unlikely to meet physical activity guidelines compared to children (37.2%) whose parents perceived that they had low social support who were more likely to meet physical activity guidelines. However, this relationship was not statistically significant (OR: 1.28, 95% CI: [0.79 - 2.07], $p > 0.05$).

Children whose parents reported a higher number of electronics in their bedroom were less likely to comply with the physical activity recommendations (33.3%) than children whose parents reported a lower number of electronics their bedroom (36.8%). Nevertheless, this relationship was not significant (OR: 1.16, 95% CI: [0.52 - 2.63], $p > 0.05$).

Parents who reported more play equipment at home had children who were unlikely to meet physical activity guidelines (78.1%) compared to children whose parents reported less play equipment at home (60.9%). Although, this relationship was not significant (OR: 1.78, 95% CI: [0.46 - 6.85], $p > 0.05$].

Table 4.19 *Bivariate logistic regression results for associations between parent perceptions of the home-built environment and children's physical activity*

Home built environment attributes		MVPA guidelines n (%)		CRUDE OR (95% CI)	P-value
		Sufficient PA	Insufficient PA		
Parental support for PA					
	High	12 (31.6)	26 (68.4)	1.00	
	Low	81 (37.2)	137 (62.8)	1.28 (0.79,2.07)	0.310
Parental rules for PA					
	High	87 (36.7)	150 (63.3)	1.00	
	Low	6 (31.6)	13 (68.4)	0.80 (0.34,1.85)	0.595
Electronics in child's bedroom					
	High	11 (33.3)	22 (66.7)	1.00	
	Low	82 (36.8)	141 (63.2)	1.16 (0.52,2.63)	0.716
Child's personal electronics					
	High	11 (29.7)	26 (70.3)	1.00	
	Low	82 (37.4)	137 (62.6)	1.41 (0.60,3.35)	0.430
Play equipment at home					
	High	9 (21.9)	32 (78.1)	1.00	0.402
	Low	84 (39.1)	131 (60.9)	1.78 (0.46, 6.85)	

Note. PA: Physical Activity, MVPA: Moderate to Vigorous Physical Activity CI: Confidence Interval, OR: Odds Ratio, n: sub total

Based on the non-significant findings for the association between parental perceived home-built environment attributes and children's physical activity, the null hypothesis (Ho2) that, there is no significant association between the home-built environment attributes of parental support, parental rules for physical activity, electronic and media,

and play equipment at home, and physical activity of 10 to 12-year-old school-going children in Kampala City in Uganda was accepted.

4.6 Neighbourhood-Built Environment

The fourth objective of the study was to assess parental perceived neighbourhood-built environment correlates of children's physical activity. Results from descriptive statistics like frequencies and percentages of parent/guardian perceptions of the neighbourhood environment attributes were presented first. Differences in parent/guardian perceptions of the neighbourhood built environmental attributes by sex, school type and compliance to physical activity guidelines were examined. Associations between parent/guardian perceptions of the neighbourhood-built environment attributes and children's physical activity were also assessed.

4.6.1 Description of Parent/Guardian Perceptions of the Neighbourhood-Built Environment Attributes

In this section, counts and percentages for all parent/guardian perceptions of the neighbourhood-built environment attributes of residential density, land use mix-diversity (destinations and recreation), land use mix-access, street connectivity, walking and cycling infrastructure (sidewalk, paths, and crossing), aesthetics, traffic safety, crime safety, personal safety and stranger danger are presented.

4.6.1.1 Parent/Guardian Perceptions of Residential Density

Results summarised in Table 4.20. show that the most common type of residences, in the neighbourhoods (26.8%) were detached or semi-detached single-family houses with

space/garden, densely packed small houses (1-storey homes that include informal settlements and slums (24.8%) and 22% were very few residential buildings/dwellings within 2 to 5 minutes' walk of each house. Whereas residences with multiple apartment blocks, block/flats of 6 storeys or more with little space between buildings were the least reported (1.8%).

Table 4.20 C*ounts and percentages of parents' perceptions of residential density*

Characteristics	N=400*	N=256**
	n (%)	n (%)
1. Very few residential buildings/dwellings within 2 to 5 minutes' walk of my house	88 (22)	49 (19.1)
2. Detached or semi-detached-single-family houses with space/garden	107 (26.8)	81 (31.6)
3. Attached (row) housing, apartment blocks/flats or multi-family housing with 2 to 5 storeys	69 (17.3)	51 (19.9)
4. Multiple apartment blocks/flats of 6 stories or more with large spaces between buildings.	30 (7.5)	23 (9.0)
5. Multiple apartments blocks/flats of 6 stories or more with little space between buildings	7 (1.8)	3 (1.2)
6. Very densely packed small houses (1-storey homes, including informal settlements and slums)	99 (24.8)	19 (19.1)

Note. N=grand total, n= subtotal, *full sample, **sample with accelerometer data

4.6.1.2 Parent/Guardian Perceptions of Land Use Mix-Diversity (Destinations)

Majority of the parents perceived destinations like tap water, pond, river, or stream for freshwater (94.5%), Kiosks/corner store (85%), taxi or motorbike stop (70%) and saloon/barbershop (hairdresser) (68.8%) to be within a walkable distance, meaning that it took 1 to 20 minutes to get to these places. On the other hand, it took 21 minutes or more to get to destinations like cinemas and theatres (78.3%), Library (78%), Workplace or school (75.8%) and bookstore/book shop (75.5%). Results are summarised in Table 4.21.

Table 4.21 *Counts and percentages of parents' perceptions of land use mix-diversity (destinations).*

Characteristic	N=400*		N=256**	
	1 to 20 minutes n (%)	>21 minutes n (%)	1 to 20 minutes n (%)	>21 minutes n (%)
1. Kiosk/corner store	340 (85.0)	60 (15.0)	219 (85.5)	37 (14.5)
2. Supermarket	250 (62.5)	150 (37.5)	161 (62.9)	95 (37.1)
3. Fruit/vegetable market (food market)	243 (60.8)	157 (39.3)	149 (58.2)	107 (41.8)
4. Fast food restaurant	187 (46.8)	213 (53.3)	118 (46.1)	138 (53.9)
5. Non-fast-food restaurant	184 (46.0)	216 (54.0)	121 (47.3)	135 (52.7)
6. Pub or bar	180 (45.0)	220 (55.0)	121 (47.3)	135 (52.7)
7. Cinema or theatre	87 (21.8)	313 (78.3)	58 (22.7)	198 (77.3)
8. Place of worship/faith centre (church, mosque)	194 (48.5)	206 (51.5)	126 (49.2)	130 (50.8)

9. Computer/cell phone kiosks/places for internet	202 (50.6)	197 (49.4)	130 (51.0)	125 (49.0)
10. Library	88 (22.0)	312 (78.0)	58 (22.7)	198 (77.3)
11. Any school	224 (56.0)	176 (44.0)	144 (56.3)	112 (43.8)
12. Your workplace or school (if a student)	97 (24.3)	303 (75.8)	57 (22.3)	199 (77.7)
13. Book store/book shop	98 (24.5)	302 (75.5)	64 (25.0)	192 (75.0)
14. Health care clinic/hospital	201 (50.2)	199 (49.8)	125 (48.8)	131 (51.2)
15. Pharmacy/chemist	210 (52.5)	190 (47.5)	139 (54.3)	117 (45.7)
16. Saloon/barbershop (hairdresser)	275 (68.8)	125 (31.3)	181 (70.7)	75 (29.3)
17. Clothing store (tailoring/ fashion/designer shop)	232 (58.0)	168 (42.0)	157 (61.3)	99 (38.7)
18. Electronic shop	184 (46.0)	216 (54.0)	115 (44.9)	141 (55.1)
19. Public bus or train stop	182 (45.5)	218 (54.5)	119 (46.5)	137 (53.5)
20. Taxi or motorbike stop	280 (70.0)	120 (30.0)	182 (71.1)	74 (28.9)
21. Tap/well water, pond, river, or stream	378 (94.5)	22 (5.5)	242 (94.5)	14 (5.5)

Note. N=grand total, n= subtotal, *full sample, **sample with accelerometer data

4.6.1.3 Parents/Guardians Perceptions of Land Use Mix-Diversity (Recreation)

The descriptive results presented in Table 4.22 show that, most parents perceived almost all the recreation facilities not to be a within walkable distance from their homes. Most

respondents (81.5%) took ≥21 minutes to walk to recreation places like dance and martial arts classes (karate) (81.5%), 70.3% of the residents took ≥21 minutes to walk to indoor recreational facilities like gymnasium, and fitness centres. Whereas 67.8% noted that outdoor recreation facilities like parks and open spaces, and 65% reported that sports fields or courts for soccer, basketball, tennis were also not easy to walk to.

Table 4.22 *Descriptive statistics of parent/Guardian perceptions of land use mix-diversity (recreation).*

Characteristics	N=400*		N=256**	
	1 to 20 minutes n (%)	>21 minutes n (%)	1 to 20 minutes n (%)	>21 minutes n (%)
1. Sports field or court for basketball, soccer, tennis	140 (35.0)	260 (65)	91 (35.5)	165 (64.5)
2. Other outdoor recreation facilities (park, open space, information play/recreation	129 (32.3)	271 (67.8)	91 (35.5)	165 (64.5)
3. Other indoor recreation facilities (recreation centre, gymnasium, health, and fitness centre	119 (29.8)	281 (70.3)	91 (35.5)	165 (64.5)
4. Dance and martial arts classes (karate)	74 (18.5)	326 (81.5)	59 (23.0)	197 (77.0)

Note. N=grand total, n= subtotal, *full sample, **sample with accelerometer data

4.6.1.4 Parent/Guardian Perceptions of Land Use Mix-Access

Parents/guardians perceived stores/shops (80.8%), transit/transport stop for buses, taxis, motorbikes, tricycles, and trains (77.5%), gathering places like churches and community centres (74.5%), food markets and restaurants (70%) and places to get essential supplies like wood and water (70%) to be within easy walking distance from their houses. Conversely, 58% of the parents disagreed that indoor recreation facilities were within walking distance of their houses. Whereas 50.5% disagreed that outdoor recreation facilities were within walking distance of their homes (see Table 4.23).

Table 4.23 Description of parent/guardian perceptions of land use mix-access

Characteristics	N=400*		N=256**	
	Agree n (%)	Disagree n (%)	Agree n (%)	Disagree n (%)
1. Stores (shops) are within walking distance of my house	323 (80.8)	77 (19.3)	211 (82.4)	45 (17.6)
2. There are many places to go such as food markets and restaurants within easy walking distance from my house	280 (70.0)	120 (30.0)	182 (71.1)	74 (28.9)
3. It is easy to walk to a transit/transport stop (bus, taxi, motorbike, tricycle, train) from my house.	310 (77.5)	90 (22.5)	199 (77.7)	57 (22.3)
4. It is easy to walk to an outdoor recreation play space (park, open space, informal play/recreation area) from my house	198 (49.5)	202 (50.5)	131 (51.2)	125 (48.8)

5. It is easy to walk to an indoor recreation facility (recreation centre, gymnasium, health, and fitness centre) from my house.	168 (42.0)	232 (58.0)	109 (42.6)	147 (57.4)
6. The place to get essential supplies like water and firewood are within easy walking distance of my house	280 (70.0)	120 (30.0)	179 (69.9)	77 (30.1)
7. There are gathering places (community centre, king place, village square, church/worship places etc.) within easy distance	298 (74.5)	102(25.5)	188 (73.4)	68 (26.6)

Note. N=grand total, n= subtotal, *full sample, **sample with accelerometer data

4.6.1.5 Parent/Guardian Perceptions of Street Connectivity

When giving their perceptions about street connectivity in their neighbourhood, 73% of the parents thought the distance they walked to the next street was usually short; and 71.3% felt that there were several alternative roads connecting to one another. However, 51.4% reported that roads and footpaths in the neighbourhoods were blocked by gates and barriers. The results are tabulated in Table 4.24.

Table 4.24 *Descriptive statistics of parent perceptions of street connectivity*

Characteristics	N=400*		N=256**	
	Agree n (%)	Disagree n (%)	Agree n (%)	Disagree n (%)
1. The distance to walk to the (closest) next street in my neighbourhood is usually short (100 meters or less; the length of a football field).	292 (73.0)	108 (27.0)	190 (74.2)	66 (25.8)

2. There are many (3 or more) alternative roads (official routes) for getting from place to place in my neighbourhood (I don't have to go the same way all the time).	285 (71.3)	115 (28.7)	186 (72.7)	70 (27.3)
3. There are many (3 or more) unofficial routes (walking/footpaths) connecting places.	278 (69.5)	122 (30.5)	176 (68.8)	80 (31.3)
4. There are many (3 or more) shortcuts such as footpaths between roads (official routes) in my area.	256 (64.0)	144 (36.0)	155 (60.5)	101 (39.5)
5. Some roads (official routes) or walking/footpaths (unofficial routes) in my area are blocked by gates or barriers.	205 (51.4)	194 (48.6)	123 (48.2)	131 (51.8)

Note. N=grand total, n= subtotal, *full sample, **sample with accelerometer data

4.6.1.6 Parent/Guardian Perceptions Walking and Cycling Infrastructure

Most parents (70.3%) reported that there were informal places for people to walk in their neighbourhoods. Nevertheless, 74.5% reported that there were no designated or marked places such as separate paths or trails or shared used paths for cycling and walking in or near the neighbourhoods. In addition, 73.3% of the parents reported that there were no curb ramps that go from sidewalk level to road level at road crossings that assisted the elderly, wheelchair, or pram users. (See Table 4.25).

Table 4.25 Descriptive statistics of parent/guardian perceptions of walking and cycling infrastructure.

Characteristics	N=400*		N=256**	
	Agree n (%)	Disagree n (%)	Agree n (%)	Disagree n (%)
1. There are formally provided sidewalks (pedestrian pavements) on most of the roads (official routes) in my neighbourhood.	200 (50.0)	200 (50.0)	125 (48.8)	131 (51.2)
2. The sidewalks in my neighbourhood are well maintained (paved, even, and with less cracks).	146 (36.5)	254 (63.5)	94 (36.7)	162 (63.3)
3. The sidewalks in my neighbourhood are often blocked by merchandise, construction materials, parked cars, and gardens/lawns/barricades.	223 (55.8)	177 (44.3)	141 (55.1)	115 (44.9)
4. Sidewalks are separated from the road (vehicle traffic) in my neighbourhoods by parked cars or dedicated parking bays/curbs.	133 (33.3)	267 (66.8)	82 (32.0)	174 (68.0)
5. There is grass/dirt strip that separates the road from the sidewalks in my neighbourhoods.	155 (38.8)	244 (61.2)	93 (36.5)	162 (63.5)

6. There are signals or crosswalks/zebra crossings to help walkers cross the busy roads in my neighbourhood.	145 (36.3)	255 (63.7)	84 (32.8)	172 (67.2)
7. There are curb ramps (decline or smooth grades) that go from sidewalks level to road level at road crossings (intersections /junctions) in my neighbourhood that assist the elderly, wheelchair/pram users.	107 (26.8)	293 (73.3)	62 (24.2)	194 (75.8)
8. There is enough time for people on foot to cross the road at crossing points/junctions with traffic lights, signals, or robots.	164 (41.1)	236 (58.9)	97 (38.0)	158 (62.0)
9. In my neighbourhood/area there are busy roads that are dangerous to cross.	176 (44.0)	224 (56.0)	113 (44.1)	143 (55.9)
10. There are informal places (walk/footpaths) for people to walk in my neighbourhood.	281 (70.3)	119 (29.8)	174 (68.0)	82 (32.0)
11. The walk/footpaths in my neighbourhood are generally of good quality (few potholes, ditches, un-evenness, stones, obstructions), so it is not difficult to walk there.	177 (44.3)	223 (55.8)	111(43.4)	145 (56.6)
12. There are designated or marked places to bicycle, such as separate paths or trails or shared-use paths for cyclists	102(25.5)	298(74.5)	56 (21.9)	200 (78.1)

	and pedestrians in or near my neighbourhood.

Note. N=grand total, n= subtotal, *full sample, **sample with accelerometer data

4.6.1.6.1 Parent/Guardian Perceptions of Sidewalk Infrastructure

As shown in Table 4.25, more than half of the parents (55.8%) agreed that the sidewalks in the neighbourhoods were often blocked by merchandise, construction materials, parked cars, and gardens/lawns/barricades. Conversely 66.5% of the parents disagreed that sidewalks were separated from the road by parked cars/dedicated parking bays/curbs. Also, noted by 63.5% was that the sidewalks were not well maintained, with 61.2% stating that no grass/dirt strip separated the road from the sidewalk.

4.6.1.6.2 Parents' Perceptions of Crossing Infrastructure

Most parents (73.3%) perceived that there were no curbs/ramps that assisted the elderly or wheelchair or pram users. In addition, 63.7% parents perceived no signals or crosswalks or zebra crossings to help pedestrians cross the busy roads. (See Table 4.25)

4.6.1.6.3 Parent/Guardian Perceptions of Path Infrastructure

Table 4.25 shows that, 70.3% of the parents agreed that there were informal places for people to walk in the neighbourhoods. However, the walkways or footpaths were of poor quality, making them difficult to use.

4.7.1.7 Description of Parent/Guardian Perceptions of Neighbourhood Aesthetics

A total of 312 (78%) of the parents agreed that there were attractive buildings or houses in their neighbourhoods; and that their neighbourhoods were free from bad smell and

odours. In the same tone, 60.4% also perceived pleasant natural sounds in their neighbourhoods such as from birds. Results are summarised in Table 4.26.

Table 4.26 Descriptive statistics of parents' perceptions of aesthetics

Characteristics	N=400*		N=256**	
	Agree n (%)	Disagree n (%)	Agree n (%)	Disagree n (%)
1. There are trees along the roads/paths in my neighbourhood.	219 (54.8)	181 (45.3)	143 (55.9)	113 (44.1)
2. My neighbourhood is clean and free of litter, garbage, or stagnant water.	202 (50.5)	198 (49.5)	124 (48.4)	132 (51.6)
3. My neighbourhood is free of bad smell and odours.	252 (63.0)	148 (37.0)	162 (63.3)	94 (36.7)
4. There are beautiful natural sights/views in my neighbourhood.	228 (57.0)	172 (43.0)	144 (56.3)	112 (43.8)
5. There are attractive buildings/houses in my neighbourhood.	312 (78.0)	88 (22.0)	196 (76.6)	60 (23.4)
6. My neighbourhood is generally free of unpleasant noises like highways, factories, trains, bars, music/record studios, night clubs/discotheques etc.	219 (54.8)	181 (45.3)	142 (55.5)	114 (44.5)

7. My neighbourhood is generally free of noticeable pollution and dust, e.g., from traffic or factories.	235 (58.8)	165 (41.3)	145 (56.6)	111 (43.4)
8. There are many pleasant natural sounds in my neighbourhood e.g., from birds	241(60.4)	158 (39.6)	159 (62.1)	97 (37.9)

Note. N=grand total, n= subtotal, *full sample, **sample with accelerometer data

4.6.1.8 Parent/Guardian Perceptions of Crime Safety

When asked about safety from crime in their neighbourhoods, 75.8% of the parents agreed that there was too much crime in their neighbourhoods to go outside for walks or play at night. Specifically, 61% of the parents perceived a high crime rate in their neighbourhoods and groups of people or gangs in neighbourhoods who made them feel threatened when they went out. (See Table 4.27).

Table 4.27 *Counts and percentages of parent/guardian perceptions of crime safety.*

Characteristics	N=400*		N=256**	
	Agree n (%)	Disagree n (%)	Agree n (%)	Disagree n (%)
1. There is a lot of crime rate in my neighbourhood.	244(61.0)	156 (39.0)	160 (62.5)	96 (37.5)
2. There is too much crime in my neighbourhood to go outside for walks or play during the day.	165(41.3)	235 (58.8)	105 (41.1)	57 (58.9)

3.	There is too much crime in my neighbourhood to go outside for walks or play at night.	303(75.8)	97 (24.3)	187 (73.0)	69 (27.0)
4.	There are groups of people or gangs (rascals, hooligans, and thugs) in my neighbourhood who make me feel threatened when I go out.	239(59.8)	161 (40.3)	155 (60.5)	101 (39.5)

Note. N=grand total, n= subtotal, *full sample, **sample with accelerometer data

4.6.1.9 Parent/Guardian Perceptions of Traffic Safety

The assessment of parents' perception of the neighbourhood-built environment for traffic safety revealed that more than half of the parents (53%) agreed that the high amount of traffic along nearby roads made it difficult or unpleasant to walk or play in their neighbourhoods. There was almost equal distribution of parents who agreed with all the remaining statements assessing traffic safety, as summarised in Table 4.28.

Table 4.28 *Descriptive statistics of parents' perceptions of traffic safety*

Characteristics		N=400*		N=256**	
		Agree n (%)	Disagree n (%)	Agree n (%)	Disagree n (%)
1.	There is so much traffic along nearby roads that it is difficult or unpleasant to either walk or play in my neighbourhood.	212 (53.0)	188 (47.0)	140 (54.7)	116 (45.3)
2.	The speed of traffic on most nearby roads in my	197 (49.3)	203 (50.7)	129 (50.4)	127 (49.6)

	neighbourhood is usually slow.				
3.	Most drivers exceed the speed limits (drive extremely fast) in my neighbourhood.	187 (46.5)	214 (53.5)	125 (48.8)	131 (51.2)
4.	Walking or playing is dangerous in my neighbourhood because of careless or aggressive driving.	186 (46.8)	213 (53.3)	128 (50.0)	128 (50.0)
5.	It could be dangerous to ride on a bicycle in or near my neighbourhood because of the speed of traffic.	195 (48.8)	204 (51.2)	137 (53.5)	119 (46.5)
6.	I am worried about playing or walking in my neighbourhood and local streets because I am afraid of being injured by a car.	181 (45.4)	218 (54.6)	119 (46.7)	136 (53.3)

Note. N=grand total, n= subtotal, *full sample, **sample with accelerometer data

4.6.1.10 Parents' Perceptions of Personal Safety

Results tabulated in Table 4.29 show that 87.3% of the parents saw or talked to people as they walked in their neighbourhoods. However, some parents (59.3%) reported that there were stray dogs or dangerous animals in their neighbourhoods that scared them. Other parents (64.3%) reported that roads in the neighbourhoods were not well lit at night.

Table 4.29 *Counts and percentages of parents/guardian perceptions of personal safety.*

Characteristics	N=400*		N=256**	
	Agree n (%)	Disagree n (%)	Agree n (%)	Disagree n (%)
1. I see, and I can talk to people when I am walking in my neighbourhood.	349 (87.3)	51 (12.8)	224 (87.5)	32 (12.5)
2. There are stray dogs or dangerous animals that scare me in my neighbourhood.	237 (59.3)	163 (40.8)	147 (57.4)	109 (42.6)
3. The roads in my neighbourhood are well lit (adequate functioning streetlights) at night.	143 (35.8)	257 (64.3)	92 (35.9)	164 (64.1)

Note. N=grand total, n= subtotal, *full sample, **sample with accelerometer data

4.6.1.11 Parents/Guardian Perception of Stranger Danger

Results presented in Table 4.30 depict that, 70.7% of the parents were not worried about letting their children to be by themselves or with friends in a local or nearby park because they were not afraid of the children being taken or hurt by strangers. Parents (68.8%) were also not worried about letting their children to play or walk by themselves or with friends in the neighbourhood, local streets and around the house because they were not afraid of them being taken or hurt by a stranger.

Table 4.30 *Counts and percentages of parents' perceptions of stranger danger*

Characteristics	N=400*		N=256**	
	Agree n (%)	Disagree n (%)	Agree n (%)	Disagree n (%)
1. I am worried about letting my child play or staying outside alone or with friends around my house (e.g., yard, driveway, apartment common area) because I am afraid, he/she might be taken or hurt by a stranger.	140 (35.0)	260 (65.0)	168(34.4)	88 (65.6)
2. I am worried about letting my child play or walk alone or with friends in my neighbourhood and local streets because I am afraid, he/she being taken or hurt by a stranger.	125 (31.3)	275 (68.8)	74 (28.9)	182 (71.1)
3. I am worried about letting my child to be alone or with friends in a local or nearby park because I am afraid of, he/she being taken or hurt by a stranger.	117 (29.3)	282 (70.7)	68 (26.7)	187 (73.3)

Note. N=grand total, n= subtotal, *full sample, **sample with accelerometer data

4.6.2 Mean Differences in Parent/Guardian Perceptions of the Neighbourhood-Built Environment Attributes by Child's Characteristics.

The mean differences in parent/guardian perceptions of the home-built environment by children's characteristics of school type, sex and compliance with physical activity guidelines as tested using T-tests were presented.

4.6.2.1 Parent/Guardian Perceptions of Neighbourhood-Built Environment Attributes by Child Sex

The study results summarised in Table 4.31 show the only significant difference in parent perceptions of the neighbourhood-built environment between boys and girls was residential density (OR: 0.49, 95% CI: [0.06 - 0.91], $p < 0.05$). Parents with female children perceived a higher residential density (3.2 ± 1.8) compared to parents with male children (2.7 ± 1.6).

Table 4.31 *Mean differences in parent/guardian perceptions of the neighbourhood-built environment attributes by sex.*

Neighbourhood built environment factors	Child's sex Mean (SD)		OR (95% CI)	P-value
	Female	Male		
Residential density	3.2 (1.8)	2.7 (1.6)	0.49 (0.06,0.91)	0.024*
Land use mix-diversity (Destinations)	2.7 (0.7)	2.6 (0.7)	0.08 (-0.11,0.26)	0.413
Land use mix-diversity (Recreation)	2.0 (1.0)	2.1 (1.0)	-0.11 (-0.36,0.14)	0.395

Land use mix-access	2.9 (0.6)	2.9 (0.6)	0.03 (-0.12,0.18)	0.710
Street connectivity	2.9 (0.6)	2.9 (0.5)	-0.02 (-0.17,0.13)	0.834
Sidewalk's infrastructure	2.2 (0.7)	2.3 (0.7)	-0.16 (-0.32,0.01)	0.069
Street crossing infrastructure	2.1 (0.7)	2.0 (0.7)	-0.04 (-0.14,0.21)	0.697
Path's infrastructure	2.6 (0.8)	2.5 (0.9)	0.09 (-0.12,0.30)	0.379
Overall walking and cycling infrastructure	2.2 (0.6)	2.2 (0.6)	-0.03 (-0.17,0.11)	0.708
Aesthetics	2.6 (0.6)	2.7 (0.6)	-0.09 (-0.25,0.06)	0.237
Crime safety	2.8 (0.8)	2.7 (0.8)	0.04 (-0.17,0.24)	0.722
Traffic safety	2.5 (0.7)	2.6 (0.7)	-0.01 (-0.19,0.17)	0.912
Personal safety	2.8 (0.6)	2.7 (0.6)	0.05 (-0.10,0.20)	0.523
Stranger danger	2.5 (0.5)	2.5 (0.6)	-0.06 (-0.20,0.08)	0.386

Note. CI: Confidence Interval, SD: Standard Deviation, *p<0.05

4.6.2.2 Parent Perception of the Neighbourhood-Built Environment attributes by School Type

There was a significant difference in parental perceptions of crime (OR: 0.26, 95% CI: [0.06 - 0.47], $p < 0.05$) by school type. Parents who had children in private schools perceived a higher safety from crime in their neighbourhood (2.9 ± 0.8) than parents who had children in public schools (2.6 ± 0.8).

Parent perception of residential density was higher for children attending public schools (3.8 ± 2.0) compared to their peers attending private schools (2.4 ± 1.2). This difference was significant (OR: 1.32, 95% CI: [-1.76 - 0.89], p<0.001); the odds of residing in a high

residential density neighbourhood were 1.32 times higher among children attending public schools compared to their peers in private schools.

As seen in Table 4.32, parental perceptions of street connectivity was significantly different (OR: 0.17, 95% CI: [-0.31 - 0.02], $p < 0.05$) between children in private schools and their peers in public schools. Parent perceptions of street connectivity was higher among public school children (3.0 ± 0.6) than private school children (2.8 ± 0.3). Parents of children in public schools perceived higher street connectivity (3.0 ± 0.6) compared to parents with children in private schools (2.8 ± 0.3).

Table 4.32 *Mean differences in parental perceptions of the neighbourhood-built environment by school type.*

Neighbourhood built environment factors	Type of School Mean (SD)		OR (95% CI)	P-value
	Private	Public		
Residential density	2.4 (1.2)	3.8 (2.0)	-1.32 (-1.76, -0.89)	<0.001**
Land use mix-diversity (destinations)	2.7 (0.7)	2.6 (0.8)	0.13 (-0.06,0.31)	0.176
Land use mix-diversity (recreation)	2.0 (1.0)	2.0 (1.1)	0.05 (-0.20,0.30)	0.695
Land use mix-`access	2.9 (0.6)	2.9 (0.6)	-0.03 (-0.18,0.12)	0.698
Street connectivity	2.8 (0.5)	3.0 (0.6)	-0.17 (-0.31, -0.02)	0.024*
Sidewalk's infrastructure	2.3 (0.7)	2.2 (0.7)	0.03 (-0.14,0.21)	0.077
Street crossing infrastructure	2.0 (0.7)	2.2 (0.8)	-0.16 (-0.35,0.02)	0.086

Path's infrastructure	2.5 (0.8)	2.6 (0.9)	-0.09 (-0.30,0.12)	0.379
Overall walking and cycling infrastructure	2.2 (0.5)	2.2 (0.6)	-0.08 (-0.22,0.06)	0.276
Aesthetics	2.7 (0.6)	2.6 (0.7)	0.1 (-0.03,0.30)	0.099
Crime safety	2.9 (0.8)	2.6 (0.8)	0.26 (0.06,0.47)	0.012*
Traffic safety	2.5 (0.7)	2.6 (0.7)	-0.07 (-0.25,0.11)	0.431
Personal safety	2.7 (0.6)	2.8 (0.6)	-0.05 (-0.2,0.10)	0.491
Stranger danger	2.2 (0.9)	2.0 (0.9)	-0.21 (-0.44,0.02)	0.067

Note. CI: Confidence Interval, SD: Standard Deviation, *p<0.05, **p<0.001

4.6.2.3 Parent Perceptions of the Neighbourhood-Built Environment attributes by Children's Compliance with Physical Activity Recommendations.

Differences in parent perceptions of the neighbourhood environment and children's compliance with physical activity recommendations were assessed. Results summarised in Table 4.33 show significant difference in parent perceptions of crime in the neighbourhood (OR: -0.25, 95% CI: [-0.45 - 0.04], $p < 0.05$). Children whose parents perceived low crime (2.6 ± 0.8) in their neighbourhood were more likely to meet physical activity guidelines compared to children whose parents perceived high neighbourhood crime (2.8 ± 0.8).

There was a significant difference in parent perceptions of residential density and children's compliance to physical activity guidelines (OR: 0.59, 95% CI: [0.13 - 1.05], $p < 0.05$). Children whose parents perceived high residential density (3.4 ±1.9) in their neighbourhood were more likely to meet physical activity guidelines compared to children whose parents perceived low residential density (2.8 ±1.6).

Table 4.33 *Mean differences in parents' perceptions of the neighbourhood-built environment by children's compliance with physical activity guidelines*.

Neighbourhood built environment factors	MVPA guidelines Mean (SD)		OR (95% CI)	P-value
	Sufficient PA	Insufficient PA		
Residential density	3.4 (1.9)	2.8 (1.6)	0.59 (0.13,1.05)	0.012*
Land use mix-diversity (destinations)	2.7 (0.8)	2.7 (0.7)	-0.05 (0.24,0.14)	0.618
Land use mix-diversity (recreation)	2.0 (1.0)	2.0 (1.0)	-0.05 (-0.31,0.21)	0.720
Land use mix-access	2.8 (0.6)	2.9 (0.6)	-0.06 (-0.22,0.09)	0.440
Street connectivity	2.9 (0.6)	2.8 (0.6)	0.08 (-0.07,0.23)	0.297
Sidewalk's infrastructure	2.2 (0.7)	2.3 (0.7)	-0.11 (-0.03,0.07)	0.236
Street crossing infrastructure	2.0 (0.7)	2.1 (0.7)	-0.07 (-0.25,0.11)	0.458
Path's infrastructure	2.5 (0.8)	2.5 (0.9)	0.01 (-0.20,0.23)	0.894
Overall walking and cycling infrastructure	2.1(0.5)	2.2 (0.6)	-0.07 (-0.21,0.07)	0.357
Aesthetics	2.6 (0.7)	2.7 (0.6)	-0.07(0.23,0.10)	0.417
Crime safety	2.6 (0.8)	2.8 (0.8)	-0.25 (-0.45,0.04)	0.022*
Traffic safety	2.6 (0.7)	2.5 (0.7)	0.01 (-0.18,0.19)	0.931
Personal safety	2.7 (0.6)	2.8 (0.6)	-0.06 (-0.21,0.10)	0.472
Stranger danger	2.1 (0.1)	1.9 (0.1)	-0.16 (-0.39,0.79)	0.194

Note. CI: Confidence Interval, SD: Standard Deviation, MVPA: Moderate to Vigorous Physical Activity, *p<0.05

4.6.3 Parental Perceived Neighbourhood-Built Environment Correlates of Children's Physical Activity

Parents (50.7%) who perceived a high residential density in their neighbourhood had children who were more likely to meet physical activity guidelines compared to parents (30.4%) who perceived a low residential density in their neighbourhood. Specifically, children whose parents perceived low residential density had lower odds of meeting physical activity guidelines (OR = 0.43; 95% CI: [0.22 - 0.82], p < 0.05). Children whose parents perceived high residential density were 57% more likely to meet physical activity guidelines. Other parental perceived neighbourhood-built environment variables were not significantly correlated with children's compliance with physical activity guidelines. Results are tabulated in Table 4.34.

Table 4.34 *Bivariate logistic regression results of associations between parent perceptions of neighbourhood-built environment and children's physical activity.*

Neighbourhood built environment factors		MVPA guidelines n (%)		Crude OR (95% CI)	P-value
		Sufficient PA	Insufficient PA		
Residential density					
	High	38 (50.7)	37 (49.3)	1.00	
	Low	55 (30.4)	126 (69.6)	0.43 (0.22,0.82)	0.010*
Land use mix-diversity (destinations)					
	Agree	33 (37.5)	55 (62.5)	1.00	

Disagree	60 (35.7)	108 (64.3)	0.93 (0.50,1.72)	0.808
Land use mix-diversity (recreation)				
Agree	18 (34.0)	35 (66.0)	1.00	
Disagree	75 (36.9)	128 (63.1)	1.14 (0.52,2.47)	0.741
Land use mix-access				
Agree	42 (33.6)	83 (66.4)	1.00	
Disagree	51 (38.9)	80 (61.1)	1.26 (0.93,1.71)	0.138
Street connectivity				
Agree	48 (40.0)	72 (60.0)	1.00	
Disagree	45 (33.1)	91 (66.9)	0.74 (0.47,1.17)	0.199
Sidewalk’s infrastructure				
Agree	14 (31.8)	30 (68.2)	1.00	
Disagree	79 (37.3)	133 (62.7)	1.27 (0.87,1.86)	0.213
Crossing infrastructure				
Agree	11 (32.4)	23 (67.6)	1.00	
Disagree	82 (36.9)	140 (63.1)	1.22 (0.70,2.16)	0.482
Path’s infrastructure				
Agree	36 (37.9)	59 (62.1)	1.00	
Disagree	57 (35.4)	104 (64.6)	0.90 (0.45,1.80)	0.762
Overall walking and cycling infrastructure				
Agree	5 (21.7)	18 (78.3)	1.00	
Disagree	88 (37.8)	145 (62.2)	2.18 (0.99,4.83)	0.054
Aesthetics				
Agree	31 (36.5)	54 (63.5)	1.00	
Disagree	62 (36.3)	109 (63.7)	0.99 (0.66,1.49)	0.965
Crime safety				
Agree	38 (31.9)	81 (68.1)	1.00	
Disagree	55 (40.2)	82 (59.9)	1.43 (0.76,2.69)	0.268
Traffic safety				
Agree	28 (35.0)	52 (65.0)	1.00	
Disagree	65 (36.9)	111 (63.1)	1.09 (0.70,1.69)	0.711

Personal safety					
	Agree	40 (34.8)	75 (65.2)	1.00	
	Disagree	53 (37.6)	88 (62.4)	1.23 (0.65,1.97)	0.667
Stranger danger					
	Agree	24 (39.3)	37 (60.7)	1.00	
	Disagree	69 (35.4)	126 (64.6)	0.84 (0.45,1.59)	0.601

Note. CI: Confidence Interval, SD: Standard Deviation, MVPA: Moderate to Vigorous Physical Activity, OR: Odds Ratio, $p<0.05$

Therefore, the null hypothesis Ho3, that there is no significant association between residential density and physical activity of 10 to 12-year-old school-going children in Kampala City, Uganda was rejected.

Conversely null hypotheses (Ho3) that there is no significant correlation between parent perceptions of neighbourhood-built environment attributes of land use mix-diversity [destinations and recreation], land use mix-access, street connectivity, walking and cycling infrastructure [sidewalk, path, and crossing], aesthetics, crime safety, traffic safety, personal safety and stranger danger with physical activity of 10 to 12-year-old school-going children in Kampala city in Uganda were accepted.

4.7 Key Socio-Demographics and Parental Perceived Home and Neighbourhood Built Environment Correlates of Children's Physical Activity

A multi-level logistic regression analysis was run to identify the variables that had the strongest association with children's compliance with physical activity guidelines. All sociodemographics, parental perceived home and neighbourhood environment variables that were associated with children's Physical activity at $p < 0.2$ were advanced for further analysis in the multivariate model.

Results presented Table 4.35 showed that children's weight status, maternal level of education and the number of cars at home were the strongest predictors of children's compliance to physical activity guidelines. Thin/normal weight associated significantly with meeting guidelines (OR: 4.02, 95% CI: [2.00 - 8.04], p <0.001). A lower maternal level of education associated significantly with children's compliance with physical activity guidelines (OR: 2.09, 95% CI: [1.14 - 3.83], p < 0.05). Not owning a car also associated significantly with children's compliance with physical activity guidelines (OR: 2.83, 95% CI: [1.42 - 5.75], p < 0.05). There was no significant correlation between all parental perceived home and neighbourhood built environmental attributes and children's compliance with physical activity guidelines in the multivariate model.

Table 4.35 *Multi-level logistic regression analyses of correlations between socio-demographics, parental perceived home and neighbourhood-built environment and children's physical activity.*

Variables	Unadjusted OR (95% CI)	P-value	Adjusted OR (95% CI)	P-value
Weight Status				
Overweight/obese	1.00		1.00	
Thin/normal weight	5.88 (2.30,15.00)	<0.001**	4.02 (2.00,8.04)	<0.001*
Number of cars at home				
≥ One	1.00		1.00	
None	4.72 (2.10,10.60)	<0.001**	2.83 (1.42,5.75)	0.003*
Marital status				
Married/living with partner	1.00		1.00	
Single/widowed/divorced	1.73 (0.79,3.77)	0.167	1.18 (0.42,3.32)	0.748
Maternal education level				
Diploma/degree/postgraduate	1.00		1.00	
Certificate (O & A-levels)	3.64 (2.12, 6.24)	<0.001**	2.09 (1.14, 3.83)	0.016*

Residential density					
	Agree	1.00		1.00	
	Disagree	0.43 (0.22,0.82)	0.010*	0.74 (0.32,1.71)	0.487
Land use mix-access					
	Agree	1.00		1.00	
	Disagree	1.26 (0.93,1.71)	0.138	1.29 (0.85,1.97)	0.237
Street connectivity					
	Agree	1.00		1.00	
	Disagree	0.74 (0.47,1.17)	0.199	0.83 (0.55,1.27)	0.393
Walking and cycling infrastructure					
	Agree	1.00		1.00	
	Disagree	2.18 (0.99,4.83)	0.054	2.01 (0.66, 6.18)	0.221

Note. CI: Confidence Interval, SD: Standard Deviation, MVPA: Moderate to Vigorous Physical Activity, OR: Odds Ratio, *p<0.05, **p<0.00

CHAPTER FIVE: DISCUSSION OF FINDINGS

5.1. Physical Activity

The study described children's physical activity intensity levels (sedentary time, LPA, MPA, VPA) and children's compliance with the WHO (2010) physical activity guidelines using accelerometer-based measurements. The Evenson et al., (2008) cut-offs were used to generate the minutes/day children engaged in different intensity levels of physical activity and to identify the children who complied with the physical activity guidelines.

5.1.1. Children's Physical Activity Levels

The findings of the study indicated that, children spent most of the time in sedentary pursuits and LPA and the least time in MPA and VPA. These outcomes are like those reported by Colley et al. (2011) in the Canadian Health Measures Survey (CHM), Muthuri et al. (2014c) in the ISCOLE study from neighbouring Nairobi city, Kenya and Diouf et al. (2016) among public school children in Dakar Senegal. This trend is linked to economic development and technological advances that lead to inventions and popular use of labour-saving devices such as motor vehicles and electronic equipment which have greatly reduced the daily occupational, household and transportation physical activity (Hu, 2008; Katzymarsyk & Manson 2009). Schwarzfischer et al. (2018) also noted that children's lifestyle is currently influenced by digitalised activities involving the use of mobile phones, video games, televisions and other screen time which influence their physical activity and sedentary time.

5.1.1.1 Sedentary Time

Children spent most of their waking time (9.8 hours/day; 64% of wake time) sedentary. These findings are in line with those reported in a systematic review study by Elemesmari et al. (2018) that children spend 70% or more of their waking time sedentary which translates into 10 hours of daily sedentary time. The CHMS also revealed that children and youth aged between 6 and 19 years, spent 8.6 hours/day sedentary (Colley et al. 2011). Verloigne et al. (2017) found that European children aged between 10 and 12 years spent 8 hours a day in sedentary pursuits. Riso et al. (2018) reported 62% of wear time as sedentary among 10 to 12-year-old Estonian school going children. Diouf et al. (2016) found that 65% of wake time in Senegalese school children aged between 8 and 11 years was spent sedentarily. Also, in Kenya, Ojiambo et al. (2012) found 72% of the children's wake time was sedentary. From the ISCOLE study conducted in Nairobi city, Muthuri et al., (2014c) reported 6.6 hours of sedentary time among school-going children aged 9 to 11 years. The main driver of high levels of children's sedentary time is the increased screen time (e.g., watching TV, playing video games, using computers and phones) (Lou, 2014). Conversely, among school-going children in South-Germany, Hoffmann et al. (2017) reported 3.5±1.5 hours of sedentary time which was lower than that reported in other studies. However, Hoffmann et al. (2017) clarified that in Germany school ends at lunch time which reduces the time children spend sitting in class, unlike in other countries.

These results are worrying due to the recent evidence on the role of sedentary time on poor health and overall mortality which is independent of participation in physical activity (Biswas et al., 2015; Carson et al., 2016; Hoare et al., 2016). Although the effect of sedentary behaviour on physical activity is not clear, an increase in sedentary time must

displace some physical activity time (Reilly, 2016). Also engaging in sedentary activities is a competition for children's time and reduces the time available for them to participate in physical activity, which may hinder them from achieving the physical activity guidelines (Hoffmann et al., 2017; Olds et al., 2012).

In the present study, overweight/obese children recorded the highest sedentary time. Similarly, in Dakar Senegal, overweight and obese school children engaged more in sedentary pursuits (Diouf et al., 2016). Elemesmari et al. (2018) also reported significantly higher sedentary time in obese children than normal weight children. More time spent sedentary has also been related to higher weight status (Le Blanc et al., 2015; Schwarzfischer et al., 2017). Inconsistent differences in sedentary time by weight status among children have also been reported (Biddle et al., 2017; Wachira et al., 2018); as well no significant differences (Hoffmann et al., 2017). Therefore, it is necessary to reduce the amount of time children spend in sedentary pursuits because of the associated health risk factors, particularly obesity. More studies are also needed to advance on the current knowledge of sedentary time because it was not the focus of this study.

5.1.1.2 Light Intensity Physical Activity

In this study children spent 4.5 hours in LPA, which contributed the highest percentage to physical activity. Like in the current study, literature shows that children spend several hours of their waking time engaging in LPA (Carson et al., 2013; Colley et al., 2011; Willkie et al., 2018). Therefore, LPA contributes a substantial amount to children's physical activity. For example, in the CHOP study, 80% of physical activity reported was LPA (Schwarzfischer et al., 2017). Muthuri et al., (2014c) also found that children from Nairobi city, Kenya, spent a substantial proportion of their time (7.7 hours/day) in LPA.

Emerging evidence shows that if children engaged more in LPA than in sedentary pursuits, they may achieve some health benefits (Poitras et al., 2016; Tremblay et al., 2010). Studies further show that LPA is beneficially related to cardio-metabolic health in children (Carson et al., 2013; Poitras et al., 2016). Thus, replacing sedentary time with LPA is linked to health benefits (Bull et al., 2020; Smith et al., 2015); and may be a realistic target instead of solely focusing on MVPA, which takes up < 5% of the 24 hours' physical activity pattern (Schwarzfischer et al., 2018). Also, LPA is an easier substitute for sedentary time due to its light intensity (Hubbard et al., 2016; Schwarzfischer et al., 2017). Nevertheless, Cooper et al. (2015) identified a displacement of LPA by sedentary behaviour among children in the ICAD study. For that reason, intervention studies aiming at promoting LPA among children as an alternative to sedentary behaviour should be considered because LPA may be a foundation to reducing negative health effects.

5.1.1.3 Moderate Intensity Physical Activity

Children in the present study spent 38.6 ± 16 minutes/day in moderate intensity physical activity (MPA), which contributed a higher percentage to MVPA. Studies show that children accumulate the highest percentage of MVPA at moderate intensity (Colley et al., 2011; Riso et al., 2018; Willkie et al., 2018). Among Japanese children aged between 5 and 15 years, Ishii et al. (2015) reported 53 ± 20 minutes/day of MPA compared to 21 ± 16 minutes/day of VPA. In Kenya, 32 minutes of MPA compared to 4 Minutes of VPA were reported for school going children from Nairobi city (Muthuri et al., 2014c). According to Powell et al. (2011), 1 minute of VPA provides the same health benefits as 2 minutes of MPA.

Boys accumulated more MPA than girls. Literature shows that boys are more active across all physical activity intensity levels, inclusive of MPA (Colley et al., 2011; Riso et al., 2017; Schwarzfischer et al., 2017). Among Japanese children and youth aged between 3 and 15 years, boys accumulated more time in MPA compared to girls (Ishii et al., 2015). In Senegalese school children, more boys engaged in MPA than girls (17 boys versus 7 girls) (Diouf et al., 2016).

The results also revealed that overweight/obese children had significantly lower levels of MPA. Similarly, Schwarzfischer et al. (2017) found that overweight/obese children spent less time in MPA than normal weight children. In a study among children aged between 6 and 17 years, Jiminez-Pavon et al. (2013) also noted that overweight/obese children recorded less time in MPA compared to their normal weight peers. However, because MPA is more tolerated than VPA, encouraging children to spend more time in MPA can improve children's physical activity levels, particularly girls and overweight/obese children.

5.1.1.4 Vigorous Intensity Physical Activity

The WHO (2010) recommended that children engage in VPA at least three times every week because superior health benefits can be gained from VPA and it is also time efficient (Janssen & Leblanc, 2010; Owens et al., 2016). However, results of the current study showed that, children spent least time (17.4 ± 12.3 minutes/day) in VPA. Results from the CHMS showed that only 4% of the Canadian children and youth engaged in 20 minutes of VPA at least three days a week (Colley et al., 2011). School going children in Nairobi city also accumulated only 4 minutes of VPA daily (Muthuri et al., 2014c). The limited time children spend in VPA may be explained by its nature of being short and intermittent

(Bailey et al., 1995: Westerterp, 2001). VPA may also increase the risk of injury and decrease exercise adherence because children may not be able to sustain VPA for extended periods (Longmuir et al., 2014; Powell et al., 2011). Like the current study, literature shows boys engage in more VPA when compared to girls (Colley et al., 2011; Pedroni et al., 2019; Riso et al., 2018; Schwarzfischer et al., 2017; Weinberg et al., 2019).

Similarly, Hu (2008) found that VPA was more strongly associated with decreased body weight status. Increased participation in VPA was also shown to be favourable for obesity prevention (Schwarzfischer et al., 2017: Willkie et al., 2018). Therefore, because VPA is associated with greater health benefits, it is important to address the low participation in VPA by children.

Given the high level of sedentary time and exceptionally low levels of VPA among children in the current study, most children would benefit from increasing their physical activity levels and reducing sedentary time. Children who are insufficiently active can achieve greater health benefits by increasing their levels of physical activity even if they do not meet the recommendations because all physical activity levels including LPA are beneficial to children's health (Poitras et al., 2016; Smith et al., 2015). Although studies show that LPA is better than being sedentary, MVPA offers greater health benefits (Colley et al., 2011; Griffith et al., 2016; Powell et al., 2011). Consequently, children should be provided opportunities and encouraged to participate in a variety of activities that will take up most of their waking time to increase their physical activity intensity levels.

5.1.2 Compliance with Physical Activity Guidelines

The study results revealed that children accumulated an average of 56 minutes of MVPA per day, and only 36.3% of the children met the physical activity guidelines. Correspondingly, literature which shows that children do not engage in sufficient amounts of physical activity (Colley et al., 2011; Guthold et al., 2020; Hallal et al., 2012; Cooper et al., 2015; Sallis et al., 2016). For example, 38.8% of children in Morocco met the recommendations of 60 minutes/day of MVPA (Baddou et al., 2018). Among children in rural South Africa only 1% met the recommendations of 60 minutes/day of MVPA (Craig et al., 2013). In Nairobi Kenya, Muthuri et al., (2014c) found that children accumulated 36 minutes/day of MVPA and only 12.6% of the children engaged in sufficient physical activity.

The insufficient levels of physical activity among children may be explained by the decline in habitual transportation, occupational and household physical activity and increase in sedentary activities due to increased use of motorised travel, manual labour-saving devices at home and work, and desk jobs (Katzmarzyk & Manson, 2009; Onywera, 2010; WHO, 2004). Literature also shows declines in children's independent mobility, which provides children with chances to take part in free play and active travel in their neighbourhood thus increasing physical activity (Carver et al., 2008; Herrington & Brussoni, 2015)

The prevalence of meeting guidelines was higher among boys compared to girls. These findings have been consistently reported in previous studies from around the world that girls participate in a smaller amount of MVPA than boys (Baddou et al., 2018; Cooper et

al., 2015; Diouf et al., 2016; Gomes et al., 2017b; Guthold et al., 2020; Hallal et al., 2012; Ishii et al., 2015; Tung et al., 2016; Verloigne et al., 2012b; Weinberg et al., 2019). A similar urban study in Kenya found that Kenyan boys aged 9 to 11 years accumulated more MVPA than their female counterparts (Muthuri et al., 2014c). Similarly, Gomes et al. (2017a) found that among Portuguese children who participated in the ISCOLE study, boys were more sufficiently active than girls by over 20 minutes of MVPA. Price et al. (2018) examined children's compliance with MVPA using average MVPA/day versus MVPA measured over the week, they found that, irrespective of the method used, boys were still more likely to meet the guidelines when compared to girls. According to Gomes et al. (2017b) cultural factors may explain why boys participate in more MVPA across countries. For example, Oyeyemi et al. (2014) noted that African culture may be more restrictive of girls' participation in physical activity because of the gender constructed expectations that often limit them. The difference in MVPA between boys and girls may also result from the different roles played by boys and girls at home and in the society which result in different behaviours and interest, that in turn, may determine inequalities in physical activity between sexes (Fueyo et al., 2016). Baskin et al. (2013) found that boys and girls preferred different types of activities, for example, girls engaged in activities related to personal care, leisure, and household chores, whereas boys reported participation in structured physical activity like sports. These activities correspond to different physical activity intensities which may contribute to the sex differences in MVPA. Girls also engaged in more inactive activities like socializing instead of physical activity which is quite common among girls in this age group (Mitchell et al., 2016). Muthuri, et al. (2014c) further proposed that the greater drive innate in boys and their participation in team sports may explain their higher MVPA values. Also, the fact that

boys have more independent mobility (children's free will to move around in their neighbourhood without adult control) gives them access to more physical activity opportunities (De Meester et al., 2014; Foster et al., 2014). According to Faulkner et al. (2015) boys are more likely to play outdoors for longer hours compared to girls; and longer hours of outdoor play are significantly associated with higher levels of physical activity (Ferreira et al., 2007; Sallis et al., 2000). For example, a study that used objective measures of the built environment and geographical positioning system (GPS) showed that the neighbourhood size that predicts boys' MVPA was 800m compared to 500m for girls, suggesting that boys had fewer restrictions for independent mobility than girls and may thus engage in more physical activity (Mitchell et al., 2016). In Dar er Salaam city in Tanzania, Bwire (2011) found that 72% of the children who were not allowed to go out alone, were girls, this highlighted that parent permitted more independent mobility to boys and thus participation in more physical activity. Therefore, sex differences in meeting physical activity guidelines must be considered when designing policies and interventions aimed at increasing physical activity with emphasis on girls.

Regarding type of school attended, most children, who met the physical activity recommendations, attended public schools compared to their peers in private schools. Like these findings, Muthuri et al. (2014c) also found that a higher percentage of children in public schools accumulated more MVPA compared to private schools.

Results from the current study further revealed that overweight/obese children were less likely to meet the physical activity recommendations. Literature shows that overweight/obese children spend less time in MVPA (Copper et al., 2015; Gomes et al., 2017b; Muthuri et al., 2014c). For example, in a review study, Elmesmari et al. (2018)

found that obese children consistently spent less than 60 minutes/day in MVPA. These findings indicate that special efforts are needed to increase MVPA among girls, children attending private schools and overweight/obese children.

5.2 Socio-Demographic Correlates of Children's Physical Activity

Assessing socio-demographic correlates of children's physical activity helped to identify subgroups of children that required immediate intervention. Children's compliance with MVPA guidelines was associated with type of school (public), weight status (thin/normal weight) and SES measures such as maternal education level (low) and car ownership (no car).

5.2.1 Relationship between Weight Status and Children's Physical Activity

Although results from studies on the relationship between weight status and physical activity are inconsistent (Bauman et al., 2012; Kwon et al., 2012; Marques et al., 2016; Sallis et al., 2000), in the current study there was an inverse association between children's physical activity and overweight/obesity. Like this study, some literature shows that higher weight status (overweight/obese) was associated with reduced odds of meeting physical activity guidelines (Cooper et al., 2015; Elmesmari et al., 2018; Wilkie et al., 2018). In a longitudinal analysis, Schwarzfischer et al. (2018) found that engaging more in MVPA was associated with reduced weight status. In addition, among 9 to 11-year-old children in Portugal, overweight/obese children had 5 minutes less of MVPA compared to their normal weight peers (Gomes et al., 2017a). The inconsistent findings may be due to differences in defining weight status (differences in weight status cut off and reference

data for example WHO, Centre for Disease Control [CDC] & International Obesity Task Force [IOTF]) (Elmesmari et al., 2018). For example, Muthuri et al. (2014c) stated a lesser percentage of overweight/obese children when using the CDC (15.8%) and IOTF (14.9%) compared to the WHO (20.8%). Also, the interpretation of results in the present study should be done with caution due to its cross-sectional nature; reverse causality could not be ruled out because high weight status may be associated with inactivity and inactivity may lead to high weight status (Bauman et al., 2012; Hu, 2008).

5.2.2 Relationship between Maternal Education Level and Children's Physical Activity

Current study findings revealed that, lower levels of maternal education correlated significantly with greater odds of meeting physical activity guidelines. In line with the current study, among 7-year-old children in the UK millennium cohort study, physical activity was associated with lower maternal education level (Pouliou et al., 2015). In a pooled analysis of accelerometry data across 10 countries from Europe, USA, Australia, Portugal and Brazil, Sherar et al. (2016) found that a lower maternal level of education was associated with higher levels of accelerometer-measured physical activity. Wilk et al. (2017) and Wilk et al. (2018) also reported low physical activity among children whose fathers had attained the highest level of education than those whose fathers had a lower level of education. Crawford et al. (2010) suggested that more educated mothers may not be available at home because of full-time employment and may, therefore, have limited time to model positive physical activity behaviour for their children.

5.2.3 Correlation between Car Ownership and Children's Physical Activity

The current study further revealed that children from families that owned one or more cars had lower odds of meeting physical activity guidelines in comparison to their peers from families with no car. Similarly, the UK millennium cohort study reported higher physical activity among children from families with no car (Pouliou et al., 2015). These results suggest that children from less affluent families accumulate most of their MVPA through the mode of travel. For example, a review by Oyeyemi and Larouche (2018), found that children from poorer families were consistently more likely to walk or cycle to their destinations. Another study in Nairobi, Kenya reported that children who attended private schools, which reflected affluence, reported low levels of transportation physical activity (Muthuri et al., 2014c). Gomes et al. (2017b) also found that children who actively commuted to and from school accumulated higher levels of physical activity and this routine might have explained their achieving physical activity guidelines.

Therefore, there is a need to encourage children to actively commute to destinations such as school, particularly children from families that own a car to enable them to meet the physical activity guidelines.

5.2.4 Relationship between Social Economic Status and Children's Physical Activity

Determining associations between physical activity and SES is important because it may highlight a pathway through which SES leads to poor health (Sherar et al., 2016). Findings from the current study agreed with those reported for most African countries that low maternal education and no family car (LSES) was associated with higher odds of meeting physical activity guidelines (Muthuri et al., 2014a & Muthuri al., 2014c; Ojiambo et al.,

2012; Onywera et al., 2012). However, unlike results from this study, in some developed countries, physical activity was reported to be higher among children from HSES (Sallis et al., 1999; Stalsberg & Pedersen, 2010). The mixed findings may be due to the multiple proxy indicators used to measure SES (Stalberg & Pedersen, 2010). It is important to note that, in developing countries like Uganda, participating in physical activity may be a necessity rather than a choice for many children from LSES families. While children from HSES families, technological advances like car ownership may decrease physical activity, requiring more deliberate effort from HSES children to be more active (Sherar et al., 2016). Results from the current study may further be explained by limited ownership and access to motorised transport among children from LSES as compared to their peers from HSES. Children from LSES are more likely to use active transport to various destinations, which is linked to higher physical activity levels thus meeting guidelines (Larouche et al., 2014; Muthuri et al., 2014b; Muthuri et al., 2014c).

Therefore, from the socio-demographic correlates of children's physical activity, the current study identified subgroups of children for whom special interventions programmes need to be developed such as overweight/obese children and children from affluent families (families with highly educated mothers and families that own one or more cars).

5.3 Home-Built Environment Correlates of Children's Physical Activity

The built environment at home can affect children's physical activity behaviour through the provision of opportunities and cues for physical activity (Rosenberg et al., 2010). Although studies argue that the home built environment may be more relevant to children's physical activity than the neighbourhood built environment (Crawford et al.,

2010; Maitland et al., 2013; Tandon et al., 2014; Verloigne et al., 2012a), in the current study the hypothesis that "There are no significant associations between the following home-built environment factors (parental support and rules for physical activity, electronic and physical activity equipment at home) and physical activity levels among 10 to 12-year-old school-going children in Kampala city in Uganda" was retained. However, given that this is the first study in Kampala city to assess the home-built environment correlates of children's physical activity, it may be early to conclude that the home-built environment is not correlated with children's physical activity. There are several potential explanations for the discrepant findings in the present study.

5.3.1 Correlation between Parental Social Support and Children's Physical Activity

Although previous studies have consistently shown a strong positive association between parental social support and children's participation in physical activity (Bauman et al., 2012; Gustafson & Rhodes, 2006; Sallis et al., 2000; Van der Horst et al., 2007; Xu et al., 2015; Yao & Rhodes, 2015), in the current study there were no significant associations. These findings are not surprising because Bauman et al. (2012), noted that results from HICs that social support was related to children's physical activity were not supported in LICs like Uganda. Harrington et al. (2016) also found that social support was significantly related to MVPA for all countries that participated in the ISCOLE study except Kenya (the only LIC in that study). Also, the ISCOLE study in South Africa found no relationship between social support and children's physical activity (Uys et al., 2016). Children in developed countries may be more reliant on organized sports which require parental support (like transportation and payment of participation fees) (Harrington et al., 2016);

as opposed to free play and active travel which is predominant in LICs (Muthuri et al., 2014b). The non-significant correlation found in this study may also be explained by the low parental social support for physical activity reported, for example, only 24% of the parents participated in physical activity with their children (role modelling) and 29% provided transport to places where their children could engage in physical activity (logistical support). Rhodes and Quinlan (2014) argued that children are likely to model adult behaviour. In this study few parents participated in physical activity with their children. In addition, in situations where children do not spend the whole day with their parents, demonstration may be limited (Wilk et al., 2018). Among Chinese school-aged children, (Liu et al. 2017) and in European children, (Verloigne et al. 2012a), parental support for physical activity through encouragement, role modelling, financial support, and engagement was positively associated with higher levels of children's MVPA. Nonetheless, these studies examined parental social support measures separately and in the present study measures were aggregated. Studies further show that children's perceptions and not parental perceptions of support for physical activity were more strongly associated with children's physical activity (Ding & Gebel, 2012; Wilk et al., 2018). But the current study assessed parental perceptions only.

5.3.2 Association between Parental Rules and Children's Physical Activity

According to Salmon et al. (2005), parents impact their children's physical activity through effecting rules regarding physical activity and sedentary behaviour. However, there was no significant relationship between children's physical activity and parental rules for physical activity, in the present study. Similarly, in a review study, Xu et al.

(2015) found no relationship between parental rules and children's physical activity. Xu et al. in their review study found low support for associations between parental rules and children's physical activity because of the limited number of studies. Xu et al. suggested that evidence on associations between parental rules and children's physical activity may be limited by the difference in levels of obedience of rules and the various measures used to assess parental rules. In the current study HSES families had significantly more rules for physical activity than their peers from LSES families which may explain their low levels of MVPA; having more rules for physical activity was inversely correlated with children's weekday MVPA (D'Haese et al., 2013).

5.3.3 Association between Play Equipment at Home and Children's Physical Activity

The home environment provides children with a variety of play equipment which increases chances for children to be active at home (Kaushal & Rhodes, 2014). The exploration of the differences in presence of play equipment at home between sufficiently active children and their peers were insufficiently active revealed that children with a higher number of play equipment at home were unlikely to meet guidelines. This result was unexpected because one may expect a higher number of play equipment to increase participation in physical activity. But reporting many play equipment may not be as important as having unlimited access and time to make use of the equipment when at home (Sirard et al., 2010). Sirard et al. (2008) further emphasized that accessibility to play equipment is an important cue that prompts children to be active. Yet the current study assessed only availability of play equipment at home and not accessibility and frequency of use.

In the present study, children form HSES families had more play equipment compared to their peers from LSES families because they had the means to buy the play equipment. Dumuid et al. (2016) found that low-income households possessed relatively less play equipment.

Similar to findings by Sirard et al. (2010), the current study found sex differences in physical activity equipment at home. Boys reported more physical activity equipment compared to girls. Padnote et al. (2010) also found that the availability of play equipment was significantly related to boys' physical activity.

Like the current study, results reported in reviews (Davison and Lawson 2006; Maitland et al., 2013) and other studies (de Vet et al., 2011; Dumuid et al., 2016), did not find association between play equipment at home with children's physical activity. However, results from the ISCOLE study showed that having eight or more physical activity equipment at home in countries like Australia, Canada and Finland was related to more physical activity. Nevertheless, like in the current study, having more equipment at home was related to less MVPA in Kenya (Harrington et al., 2016). In a Determinants of Diet and Physical Activity (DEDIPAC) umbrella systematic literature review, Carlin et al. (2017) found inconclusive results concerning availability of play equipment at home. They noted that play equipment at home was more important for pre-school children who had limited independent mobility and spent more time at home. Also, among adolescents, Sirard et al. (2010) and Baskin et al. (2013) found a strong positive association between home play equipment and physical activity. Results from a review showed that the presence of play equipment at home was more likely to be used by adolescent and adult females (Kaushal & Rhodes 2014). Therefore, the differences in results may be due to

participant's age that is play equipment at home may be more important in pre-school children, adolescent girls, and adults than in school-going children.

Tandon et al. (2014) found that the having a basketball hoop and not small play equipment (e.g., jump rope, balls, racquets, and sticks) was positively associated with physical activity. However, in this study, only 4.5% of the parents had a basketball hoop at home. The most popular physical activity equipment reported in the study was small sports equipment like balls, racquets, bats, sticks and jump ropes. This implies that basketball is not a popular sport among children in Kampala city. Tandon et al. proposed that among non-American children, other fixed equipment like soccer equipment, might be commonly used equipment that prompt activity at home. Harrington et al. (2016) found that total number of equipment was positively associated with after school MVPA. This study, however, studied overall MVPA. The current study assessed parental perceptions of the availability of physical activity equipment. Instead of using objective measures, the dependence on parental responses may have introduced bias and social desirability. Therefore, methodological issues related to a lack of consistency in the assessment of the home play equipment may have contributed to the non-significant findings in the present study.

5.3.4 Correlation between Electronics in the Child's Bedroom and Personal Electronics with Children's Physical Activity

Electronic and media equipment such as televisions in children's bedrooms, hamper their participation in physical activity (Crawford et al., 2010). In the current study, children from private schools had a higher number of electronic media devices which may have

explained their insufficient physical activity compared to children from public schools. In line with results from the present study, Maitland et al. (2013) in their review found that most of the studies reported no correlation between electronics in the child's bedroom and children's MVPA. However, Harrington et al. (2016) found a negative relationship between the presence of one piece of electronic media equipment in the child's bedroom and MVPA. Negative association between having a television in the bedroom and physical activity has also been reported in the literature (Sirard et al., 2010; Tandon et al., 2012). Differences in findings may be attributed to the smaller number of children in the current study that had a television in their bedroom (12%) and personal electronics (18%). Manyanga et al. (2018) had earlier clarified that recreational screen time was low among LICs like Uganda.

The non-significant results of correlations between home-built environment and children's physical activity in the current study may be explained by differences in how the study variables were examined. For example, some studies examined the home environment variables separately (Liu et al., 2017; Verloigne et al., 2012a). However, in this study variables were aggregated. The home-built environment attributes are expected to correlate with physical activity accumulated in specific locations like home. Thus, the use of total MVPA in this study may have underestimated the contribution of the home environment to children's physical activity. In addition, the questionnaire that was used in the current study to assess the home-built environment, was not adapted to the current study home environment. Therefore, it may not have been sensitive to the local home environment which may differ from that where the questionnaire was developed.

5.4 Parental Perceived Neighbourhood-Built Environment Correlates of Children's Physical Activity

The neighbourhood-built environment comprises buildings, transportation infrastructure such as roads, cycle lanes and sidewalks, and recreation facilities such as parks and open spaces which could create opportunities for or barriers to children being active (Davidson & Lawson, 2006; Ding et al., 2011; Sallis & Glanz, 2006). In the current study, only residential density had statistically significant association with children's physical activity in the bivariate analysis, but the association was non-existent in the multivariate analysis. Therefore, the present study provided less support of correlation between neighbourhood-built environment attributes and children's physical activity than studies among adults in Africa (Oyeyemi et al., 2012; Oyeyemi et al., 2017). In their review, Ding et al. (2011) found no associations between children's objectively measured physical activity and neighbourhood environment attributes. Noonan et al. (2016) also found no associations between neighbourhood environment and children's physical activity.

5.4.1 Association between Residential Density and Children's Physical Activity

High residential density is necessary for other neighbourhood environmental factors; neighbourhoods that have more residences in proximity also have connected streets, and many destinations within walking distance of each other (Sallis et al., 2016b). In this study, children who attended public schools and sufficiently active children were more likely to reside in high residential density neighbourhoods. High residential density may explain the more minutes of MVPA and the higher percentage of sufficiently active children in public schools compared to private school children. Higher residential density

was associated with meeting physical activity recommendations in the bivariate analysis, however, the association disappeared in the multivariate analysis. In their review, Bauman et al. (2012) found that residential density was one of the robust factors that was associated with children's physical activity. Children who reside in neighbourhoods that have many residences have high chances of walking and cycling to school (Braza et al., 2004). However, another review study found inconsistent associations between residential density and children's physical activity (Ding et al., 2011). Norman et al. (2006) also found no relationship between residential density and accelerometer measured physical activity among children in the USA. Xu et al. (2010) found an inverse association between residential density and physical activity among Chinese adolescents such that adolescents from high residential density neighbourhoods had lower physical activity.

5.4.2 Relationship between Land Use Mix-Diversity (Destinations) and Children's Physical Activity

Retail shops and services are frequent destinations in the neighbourhood that may encourage walking (King et al., 2015; Sallis et al., 2016). This study revealed that destinations from which to get basic needs like water and food were the nearest to children's homes in Kampala. But land use mix diversity which has been consistently associated with children's physical activity in the literature (Bauman et al., 2012; Davison & Lawson, 2006; Ding et al., 2011) was not correlated with children's physical activity in this study. Faulkner et al. (2015) found that children were more likely to engage in physical activity (outdoor play) for longer periods if the neighbourhood had shops, restaurants, and other destinations within walkable distances. The possible explanation for

the insignificant findings in this study may be the limitation of subjective measures (parental perceptions) (Brownson et al., 2009). Because the data were based on parents' recall of time it took for their children to walk to the nearest retail shop and service and not the actual number of shops and services; or actual distance from the child's home to the nearest shop and service which may be biased and prone to error (Browson et al., 2009; Tappe et al., 2013). The current study also defined the neighbourhood as the area around the child's home in relation to time (15 minutes' walk from home) which may differ from what the parents/guardians perceived as their neighbourhood (Smith et al., 2010).

5.4.3 Associations between Land Use Mix-Diversity (Recreation) and Children's Physical Activity

Recreation facilities (parks, school playgrounds, sports centres) in the neighbourhood provide children with suitable places to be active (Sallis et al., 2000). Although proximity to recreation facilities is an important correlate of children's physical activity (Bauman et al., 2012; Biddle et al., 2011; Davidson & Lawson, 2006; Ding et al., 2011; Oliveira et al., 2014; Sallis et al., 2000; Sterdt et al., 2014), it did not related to children's physical activity in the current study. Similarly, Wilk et al. (2017) found no association between recreation facilities and children's physical activity. The results of the current study are not surprising, because most of the parents perceived recreation facilities to be located outside their neighbourhoods ($\geq$ 21 minutes), therefore it may not be easy for children to access these facilities. In addition, the Non-Communicable Diseases Information and Control Centre (NICC) of Uganda assessed the availability and quality of parks in Kampala city. The centre found a limited park space compared to the increasing urban population.

Besides, majority of these parks and open spaces have been encroached on by commercial developers, privately owned, and concentrated in the central division. Most of them required children to pay money and walk greater distances to access them (see APPENDIX P). Tappe et al. (2013) showed that perceived lack of recreation facilities in the neighbourhood lowered the odds of children being active. Fueyo et al. (2016) emphasized that longer distances from children's homes to recreation facilities reduced their use by children. Thus, making lack of recreation facilities a strong barrier to children's physical activity. Neighbourhoods, with greater access to recreation facilities like parks and sports fields provide opportunities for organised team sports and children's free play and active travel (Mithchell et al., 2016). In addition, the current study did not assess the composition and quality of parks which improves their use (Tucker et al., 2007). Future studies assessing availability, accessibility and quality of recreation facilities are required to better understand how recreation facilities promote children's physical activity. These may be a useful finding for KCCA, which is in the process of developing physical activity-friendly environments in the city.

5.4.4 Associations between Land Use Mix-Access and Children's Physical Activity

According to Wang et al. (2016), land use mix access is an important predictor of transportation physical activity. Many of the parents perceived stores or shops and transit or transport stops respectively to be within walking distance of their house. Similarly, Muthuri et al. (2016) found that a large percentage of parents in Nairobi city perceived shopping areas and transit stops to be within easy walking distance.

Although previous studies found significant associations between access to various destinations within the neighbourhood and children's physical activity (Davison & Lawson, 2006; Tung et al., 2016), the current study found no such significant correlation. Muthuri et al. reported associations between parental perceived transit stops within easy walking distance and children's MVPA. However, because responses were aggregated the current study did not assess the relationship. Among Malaysian children, Tung et al. found that access to various destinations and services was positively correlated with high levels of physical activity. Such differences in findings may be due to the differences in the measurement of physical activity because studies show that neighbourhood environment attributes correlate more with domain of physical activity (Giles-Corti et al., 2005). Tung et al. used self-report measures which specified the domain of physical activity while the current study used accelerometers which measured total physical activity.

5.4.5 Correlation between Street Connectivity and Children's Physical Activity

Differences in street connectivity between private and public-school children showed that parents of children from public schools perceived higher street connectivity. This may be responsible for high MVPA exhibited by children attending public schools because high street connectivity is associated with physical activity (Saelens & Handy 2008). Although street connectivity provides direct pathways for pedestrians, cyclists, and motorists (Sallis et al., 2016b), there was no correlation between street connectivity and children's physical activity in the current study. Similar to this study, a review by Bauman et al. (2012), found no associations between street connectivity and children's physical activity. The review

by Davison and Lawson (2006) and Ding at al. (2011) also found inconsistent associations for street connectivity and children's physical activity. However, Mecredy et al. (2012) and Tappe et al. (2013) found that lower street connectivity correlated with higher neighbourhood physical activity among children. Lower street connectivity such as streets with longer block lengths and fewer alternative route or pathways may increase the likelihood for driving rather than walking. Conversely, lower street connectivity may reduce traffic volume providing a safe place for children to play (Tappe et al., 2013).

5.4.6 Correlation between Walking and Cycling Infrastructure and Children's Physical Activity

Pedestrian and cyclists' infrastructure like paths provide an opportunity for transportation physical activity (Larsen et al., 2012). Unlike the findings in the current study, a systematic review by Oliveira et al. (2014) found that in most studies reviewed, the presence of sidewalks and cycling lanes related positively with children's physical activity. As found by Ding et al. (2011) in their review, the existence of sidewalks and bike paths related to active transport. Davison and Lawson (2006) reviewed literature and found backing for a positive correlation between the existence and state of sidewalks and children's physical activity. It is probable that for children in Kampala, just like most adults in Nigeria, walking is necessary regardless of the availability and quality of infrastructure in their neighbourhoods (Oyeyemi et al., 2012). For example, in the current study, parents confirmed the presence of informal places for people to walk in their neighbourhoods though most of them were of poor quality. Devarajan et al. (2020) emphasise further that children from LICs walk despite the non-usable sidewalks. Thus,

walking among children in Kampala city may be a necessity rather than a choice, irrespective of the availability and quality of walking and cycling infrastructure.

5.4.7 Associations between Aesthetics and Children's Physical Activity

Attractive neighbourhoods (buildings and gardens) may be an assurance for parents to allow their children to play outside (Tappe et al., 2013). Favourable aesthetics may also increase children's enjoyment of outdoor play and in turn increases physical activity (Noonan et al., 2016). However, in this study neighbourhood aesthetics did not relate to children's physical activity. Similarly, a review by Limstrand (2008) found no associations between aesthetics and children's physical activity. Aesthetics were also not associated with children's non-motorised travel (D'Haese et al. 2015) and children's self-reported physical activity (Noonan et al. 2016). According to Laxer & Janssen (2013) children residing in unattractive neighbourhoods may become familiarized to the environment and may not be discouraged from participating in physical activity in their neighbourhood. However, Tappe et al. (2013) and Robertson et al. (2016) found that neighbourhood aesthetics were related to children's neighbourhood physical activity. The discrepancy in findings may be explained by the differences in the measurement of physical activity. Tappe and colleagues studied physical activity specifically engaged in by children in the neighbourhood whereas the current study studied the overall physical activity.

5.4.8 Association between Parental Perceived Crime Safety and Children's Physical Activity

Lower MVPA was found in neighbourhoods with high crime rates compared to neighbourhoods with low crime (Kneeshaw-Price et al., 2015). Similarly, in the current study, parents of children who were insufficiently active perceived significantly higher crime in their neighbourhoods compared to parents of children who were sufficiently active. The literature further highlights those children of parents who perceive their neighbourhood as unsafe engaged in less physical activity (Franzini et al., 2009; Weir et al., 2006).

In this study, parental perceptions of crime in the neighbourhood were not associated with children's physical activity. Like the current study, a review by Davison and Lawson (2006) and studies by Kneeshaw-Price et al. (2015) and D'Haese, et al. (2015) all found no relationship between parents' reported crime and children's physical activity. Results from the ISCOLE study also showed that perceived crime did not significantly relate to MVPA among children from LICs (Sullivan et al., 2017). However, in some studies, parental perception of crime correlated inversely to children's physical activity (Biddle et al., 2011; de Vet et al., 2011). These mixed results may be due to the differences in assessment of crime (parental perceived crime vs police report and audit reports). In reviews Davison and Lawson; and Kneeshaw-Price et al., strong associations between police-reported (objective) crime and children's physical activity were reported but no associations were found for parental perceived crime. A meta-analysis also found that people who resided in neighbourhoods with higher police-reported crime had 28% lower odds of engaging in sufficient physical activity (Rees-Punia et al., 2018). Furthermore, the

relationship between crime and physical activity may depend on the physical activity domain (leisure vs transportation). For example, children may be required to walk or cycle to various destinations regardless of parental safety perceptions, but they may be restricted to engage in recreation physical activity in unsafe places (Patch et al., 2019; Rees-Punia et al., 2018). In addition, Rees-Punia et al. suggested that the average country income may play a role in the insignificant findings because associations between perceived crime safety and increased physical activity in HICs were significant but not for LMICs. In LMICs people engage in physical activity because it is a necessity for either transportation or occupation which minimizes their perception of safety (Rees-Punia et al., 2018).

5.4.9 Associations between Parental Perceived Traffic Safety and Children's Physical Activity

The present study results revealed no significant correlation between traffic safety and children's physical activity. Oliveira et al. (2014) also found inconclusive associations between children's physical activity and traffic safety. However, the findings from literature indicate that traffic safety is a negative correlate of children's physical activity (Bauman et al., 2012; Davison & Lawson, 2006; Ding et al., 2011; Salmon & Timperio, 2007). Results from the CLASS study by Salmon et al. (2004) showed that children of parents who reported road safety concerns, were insufficiently active. McGrath et al. (2015) also found negative associations between traffic speed and children's physical activity. Elsewhere parental perceptions of traffic safety were also associated with restrictions of children's walking and cycling to school, independent mobility (Santos et al., 2013) and outdoor play (Faulkner et al., 2015). All of which associate significantly

with children's physical activity (Faulkner et al., 2015; Sallis et al., 2012). The ISCOLE study conducted in South Africa reported a negative relationship between children's out of school MVPA and objective traffic risk (Uys et al., 2016). Nevertheless, in the current study total physical activity was assessed and traffic safety was self-reported.

5.4.10 Association between Parental Perceived Personal Safety and Children's Physical Activity

Personal safety did not correlate with children's physical activity in the current study. Similarly, Carver et al. (2008) found no relationship between children's MVPA and parental perceived personal safety in Australia. However, high positive parental perception of personal safety correlated with higher after school MVPA among adolescent boys in Australia (Carver et al., 2008). Muthuri et al. (2016) reported that parental perceptions of positive neighbourhood social cohesion (parental perceptions of seeing and talking to many people in their neighbourhoods) was associated with meeting MVPA guidelines. The positive correlations reported in other studies may be due to differences in physical activity measures (total MVPA versus after school MVPA), the age group studied (children versus adolescents) and analysis of variables (separated variables versus aggregated variables).

5.4.11 Associations between Parental Perceived Stranger Danger and Children's Physical Activity

Stranger danger did not correlate with children's MVPA in the current study. Correspondingly, D'Haese et al. (2013) found no associations between stranger danger

and children's MVPA among Belgian children aged between 10 and 12 years. Timperio et al. (2004) also found no relationship between children's perceptions of stranger danger and parental reported active travel among children. Literature, however, shows parental concerns about children interaction with strangers as a consistent barrier to increased outdoor play (Faulkner et al., 2015) and independent mobility (Ding et al., 2012; Foster et al., 2014; Santos et al., 2013), and thus less physical activity. However, in the current study, three quarters of the parents perceived no fear for strangers. Literature also reports higher parental fear of strangers for girls than boys (Ding et al., 2012; Foster et al., 2014), but in the current study parental perception of stranger danger was not different between boys and girls.

While studies in HICs have demonstrated strong associations between children's physical activity and attributes of the neighbourhood-built environment, these associations were attenuated in the current study. However, finding limited parental perceived neighbourhood built environmental correlates of children's physical activity has also been reported in literature (de Vet et al., 2011; Ding et al., 2011; Ferreira et al., 2007; Muthuri et al., 2016; Noonan et al., 2016; Uys et al., 2016; Wilk et al., 2018). The non-significant correlations revealed in the current study may be due to the differences in definitions and measurements of the neighbourhood-built environment and physical activity. In this study, accelerometers were used to measure physical activity and accelerometry data did not specify the domains of physical activity engaged in by the children. Nevertheless, neighbourhood built environmental attributes have been associated with specific physical activity domains, that include transportation and recreation physical activity (Giles-Corti et al., 2005; Saelens et al., 2003a; Sallis & Owen, 2015) or specific to locations of physical

activity for example, neighbourhood and home (Davidson & Lawson, 2006; Tappe et al., 2013).

In addition, the current study focused on parental perceptions of neighbourhood attributes close to home, which were defined in terms of time and distance from the child's homes which may have differed from the parents' perceptions or definitions of their neighbourhood (Smith et al., 2010). Furthermore, literature shows that children are mobile, and their movements may not be limited to their neighbourhood, particularly bearing in mind that many parents these days drive their children to structured activities that are outside their neighbourhood (Hillsdon et al., 2015; Kwon, 2012). Parent's perceptions of their neighbourhood, as witnessed in the current study, did not differ so much. There were limited differences in parental perceptions of the neighbourhood-built environment by school type, sex and meeting physical activity guidelines. The limited variability in parental perceptions of the neighbourhood-built environment may have reduced the power to allow for any associations to be detected (Sallis et al., 2000).

The diversity of populations studied in literature also increased the difficulty in comparing results of the current study. According to Sallis et al. (2000), differences in sample characteristics generate different results of correlates of children's physical activity. Studies have assessed neighbourhood-built environment attributes by sex, SES and environmental settings (urban vs rural) which generated different correlates that could not be compared to those of the current study.

The neighbourhood-built environment was self-reported in this study and may have been subjected to measurement error, including over-reporting on socially desirable responses

(Brownson et al., 2009). In addition, the less supportive evidence of neighbourhood-built environment could be that the NEWS-Africa measure does not work well for children in Africa and parents' perception of the neighbourhood-built environments may not correspond to the reality of the children's perceptions. According to Devarajan et al. (2020), in developing countries unlike developed countries walkability does not go hand in hand with physical activity, that is children walk because they have no choice, they walk despite the oncoming speeding traffic and undesignated walkways. In addition, although the NEWS-Africa Survey is recommended for use in adults, the length of the questionnaire may have limit its use (Oyeyemi et al., 2016).

Literature also shows that the most consistent correlates of children's physical activity were generated from objectively measured neighbourhood environmental attributes (Bauman et al., 2012; Ding et al., 2011; Uys et al., 2016). However, although objectively measured neighbourhood-built environment attributes are more credible, objective neighbourhood built environmental measures were not readily available in the current study setting.

Therefore, future research using multiple measures of physical activity and the neighbourhood-built environment are required to further assess the neighbourhood-built environment correlates of children's physical activity in Kampala city and Uganda.

CHAPTER SIX: SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 Summary of Findings

The study measured children's physical activity intensity levels (sedentary time, LPA, MPA and VPA) using accelerometers and assessed children's compliance to WHO (2010) physical activity guidelines. The study also used a social-ecological model (SEM) to assess the correlations of socio-demographics, and parental perceived home and neighbourhood built environmental attributes with children's accelerometer-measured physical activity. The null hypotheses on correlation between physical activity and children's socio-demographics of type of school, weight status and SES measures such as car ownership, maternal level of education; and parental perceived neighbourhood environment of residential density among 10 to 12-year-old school-going children in Kampala city were rejected.

6.1.1 Physical Activity Intensity Levels and Compliance with Physical Activity Guidelines

The study results showed that children spent most of their time either being sedentary and in LPA, and limited time in MPA and VPA. Sedentary time was significantly different by type of school and that children from private schools spent most of their time being sedentary compared to their peers from public schools. Boys accumulated a higher volume of physical activity across all physical activity intensities (MPA and VPA) than girls. Physical activity levels (MPA and VPA) differed by type of school, with children attending public schools recording more activity across all physical activity intensities.

The study results further showed that obese children recorded the highest sedentary time and the lowest VPA.

Regarding the WHO (2010) physical activity guidelines (≥ 60minutes/day), children accumulated an average of 56 ± 23 minutes /day of MVPA and only 34.2 % of the children complied with the recommendations. Boys were more likely to engage in ≥ 60minutes/day compared to girls. There was a clear difference in adherence to physical activity guidelines by type of school, children from public schools engaged in sufficient physical activity than their counterparts from private schools. Differences in meeting guidelines were also noted for weight status, overweight/obese children were less likely to achieve recommendations when compared to their peers who were thin/normal weight.

6.1.2 Socio-Demographic Correlates of Children's Physical Activity

Meeting physical activity guidelines correlated with socio-demographics such as type of school (public or private school), weight status (thin/normal weight or overweight/obese) and SES (based on proxies like car ownership) and maternal education levels (lower education level) in the bivariate analysis. However, in the multivariate analysis, the only factors that remained significant were weight status (thin/normal weight), maternal education level (lower education level) and car ownership (no family car). Therefore, the null hypotheses (Ho1) that "There are no significant associations between socio-demographic factors of type of school, weight status, maternal education level and family car ownership and physical activity among 10 to 12-year-old school-going children in Kampala city in Uganda" were rejected.

6.1.3 Parental Perceived Home Built Environment Correlates of Children's Physical Activity

The results indicated no significant correlations between parental perceived home-built environment factors and children's sufficient physical activity. However, children from private schools had more restrictive rules for physical activity and reported more electronics media devices and play equipment in their homes. Therefore, the null hypotheses that "There are no significant associations between home-built environment factors (parental support and rules for physical activity, electronic and physical activity equipment at home) and physical activity levels among 10 to 12-year-old school-going children in Kampala city in Uganda" was retained.

6.1.4 Parental Perceived Neighbourhood Built Environment Correlates of Children's Physical Activity

At the neighbourhood level, children were more likely to comply with physical activity recommendations if their parents perceived a higher residential density, nevertheless, this correlation disappeared in the multivariate analysis. All the other parental perceived neighbourhood-built environment attributes such as residential density, land use mix-diversity (destinations and recreation), land use mix-access, street connectivity, walking and cycling infrastructure (sidewalk, path and crossing), aesthetics, traffic safety, crime safety, personal safety and stranger danger, did not correlate with children physical activity. However, parents perceived a significantly higher residential density for girls. Parents of children who attended a private school perceived higher crime in their neighbourhoods; whereas parents of children who attended public schools perceived a

higher residential density and street connectivity in their neighbourhoods. Furthermore, parents who perceived lower crime and higher residential density had children who were more likely to meet the physical activity guidelines.

Therefore, the null hypothesis that "There is no significant associations between residential density and physical activity among 10 to 12-year-old school-going children in Kampala city in Uganda" was rejected. On the other hand the null hypotheses that "There are no significant associations between parental perceived neighbourhood built environment attributes of land use mix-diversity (destinations and recreation), land use mix-access, street connectivity, walking and cycling infrastructure (sidewalk, paths, and crossing), aesthetics, traffic safety, crime safety, personal safety, and stranger danger and physical activity among 10 to 12-year-old school-going children in Kampala city in Uganda" were accepted.

6.2 Conclusion

This was the first study to measure physical activity in school-going children in Kampala city, Uganda using accelerometers. The children spent most of their time being sedentary and in light physical activity. Only 34.2% of the children complied with the WHO (2010) physical activity recommendations of 60 minutes or more of daily MVPA. Girls, overweight/obese children, and children attending private schools were less likely to meet the physical activity guidelines. In the bivariate analysis, accelerometer-measured physical activity among 10 to 12-year-old school-going children correlated significantly with children's socio-demographics of type of school, weight status and SES proxies like car ownership and maternal level of education and parental perceptions of the

neighbourhood-built environment attribute of residential density. However, in the multivariate analysis, only sociodemographics like weight status (thin/normal weight), maternal education level (lower level) and car ownership (no car) remained significant. None of the home built environmental attributes correlated with children's MVPA. The results of the current study indicate that although the neighbourhood-built environment (residential density) was associated with children's physical activity in the bivariate analysis, the dominant correlates of children's physical activity were socio-demographic factors such as weight status, SES proxies like maternal education level and car ownership rather than the home and neighbourhoods where they live. Salway et al. (2019) and Best et al. (2017) also found that the largest variation in children's physical activity level was explained by individual factors. According to the SEM, physical activity behaviour is impacted by the most proximal factors of the sample being studied (Sallis et al., 2008). These results may also reflect the limited opportunities available for children in Kampala city to be active in their homes and neighbourhoods. The findings of the current study provide a useful overview of the current presence of built environment attributes that support children's physical activity and highlight the need for improvement in activity-friendly built environment infrastructure in Kampala city.

6.3 Recommendations for Policy and Practice

Reversing the low rates of physical activity requires comprehensive and coordinated strategies that need partnership between the children, parents, schools, the education, and health sector but also transportation, urban planning, recreation, and environmental health. More action is also required at home and in the neighbourhoods.

i. Various international organisations and countries especially HICs have prioritized the promotion of childhood physical activity, yet Uganda has not been keen on surveillance and promotion of children's physical activity. Therefore, the Ministries of Health, and Education and Sport together with other stakeholders should implement policies aimed at promoting children's physical activity and reducing sedentary time.

ii. Schools are the best settings for implementation of programs that help children learn about the need to increases physical activity and reduce sedentary time (that is children should move more and sit less). The Physical Education teachers should educate the children about the benefits of regular participation in physical activity and encourage them to engage in physical activity, not only to enable them to comply with the recommendations, but also to develop physical activity habits that are practiced for a lifetime, particularly girls, children who attend private schools and overweight/obese children. Schools should encourage children to walk or bike to school (when it is safe to do so) as well as play during recess at school.

iii. There should be sensitization efforts targeting parents/guardians about the importance of physical activity in childhood and the role of parents in promoting children's physical activity. These awareness programmes can be done at school during parents' meetings; with special attention paid to highly educated parents, and those who own cars to counteract the negative influences of SES on children's physical activity. In addition, educating and sensitizing both the parents and children on the use of the built environment at home and in the neighbourhood to increase physical activity (e.g., walking and cycling and active play in neighbourhoods). This is because presence of built environment attributes at home and in the neighbourhood may not automatically impact physical activity in the absence of awareness of these attributes.

iv. In addition, parents should be actively involved in their children's participation in physical activity and not depend on the school system to keep their children active. This can be achieved by increased social support for physical activity through financial support (paying for sports activities and equipment), transporting their children to physical activity sessions and encouraging their children to engage in more physical activity. Also parents participating in physical activity with their children specifically parents changing their physical activity behaviours may improve children's Physical activity.

v. Parents should continue the practice of limiting electronic and media equipment at home particularly in bedrooms and for personal use as an important preventive measure for healthy homes in reducing sedentary time.

vi. Some of the neighbourhood built environmental factors that were associated with physical activity in this study (residential density) may easily be modified through policy. However, these hypotheses need to be tested further. For example, for the neighbourhood-built environment in Kampala city, policy changes developed by KCCA transport and planning departments, for building, retrofitting and maintaining physical activity supporting features in the city aimed at increasing residential density may be expected to increase children's physical activity.

vii. The consistency in the association between land use mix-diversity (recreation) and children's physical activity in literature (Ding et al., 2011; Tappe et al., 2013; Oliveira et al., 2014) suggests that this is a powerful correlate of children's physical activity. Therefore, KCCA which is developing a more activity-friendly city should focus on creating accessible and child-friendly recreation facilities and outdoor spaces on the policy agenda for KCCA to promote children's physical activity. Policies that favour

increased formation and access to public recreation facilities should be formulated, signing agreements with schools which support the opening of school facilities for community use, and the introduction of tax incentives for private recreation facilities located in neighbourhoods.

viii. Developing community based activities for children which are open and welcoming to all, with a focus of having fun and developing motor skills rather than competition may increasing children's Physical activity.

6.4 Recommendations for Further Research

Based on the current study's findings, the following recommendations for future research and interventions are advanced.

i. Results from the current study show that children spend 9.8 hours/day in sedentary pursuits, but do not specify the type of sedentary activities engaged in during the 9.8 hours. Therefore, future research using both accelerometry and self-report data is required to identify the context (home, school, work) and type (sitting at school, homework, screen time) of sedentary behaviour.

ii. Future studies should assess and stratify accelerometer generated activity counts by types or domains of reported physical activity such as transportation, leisure or work because the correlation between the built environment and physical activity is more context and domain specific.

iii. Research on home and neighbourhood-built environment and children's physical activity in Kampala city and Uganda at large is greatly needed for purposes of

continued surveillance, to inform the development of health promotion programs and help monitor progress in the implementation of the proposed KCCA plan.

iv. Future research requires the use of improved methodological approaches such as improved measurement of the built environment because correlations vary by measurement used; incorporating both subjective and objective measures of the built environment may generate more accurate results. Studies should endeavour to combine GPS tracking technologies with GIS (if detailed GIS data is readily available) and accelerometry data to assess children's real-time exposure to their home and neighbourhood environments and understand where physical activity occurs.

v. Development of a reliable and culturally sensitive measure of the home environment that will accurately capture the local home-built environment attributes. This will require adjusting the home environment monitoring tool to suit the Ugandan home-built environment context.

vi. Future research should also explore ways of shortening the NEWS-Africa questionnaire to improve its use among children and adults.

vii. Results of the current study also revealed that availability of play equipment at home does not guarantee their use. Therefore, future studies should assess both accessibility and use of play equipment at home.

viii. This study did not examine the school-built environment correlates of children's physical activity. Therefore, studies assessing school environment factors are also necessary because children also spend time at school. Therefore, the school-built environment may have more influence on their physical activity.

ix. The current study used a cross-sectional design that was limited in understanding determinants or causes of children's physical activity. Therefore, longitudinal cohort studies and experimental studies are needed to identify home and neighbourhood environment attributes that have strong casual associations with children's physical activity. This will improve on the rigor of research in this area.

x. Future studies are also needed to develop interventions studies especially among girls, children attending private schools and overweight and obese children. The intervention studies should focus on reducing sedentary time and increasing physical activity (children should move more and sit less). For example, replacing sedentary time with LPA because it is a more feasible and sustainable alternative than MPA and VPA.

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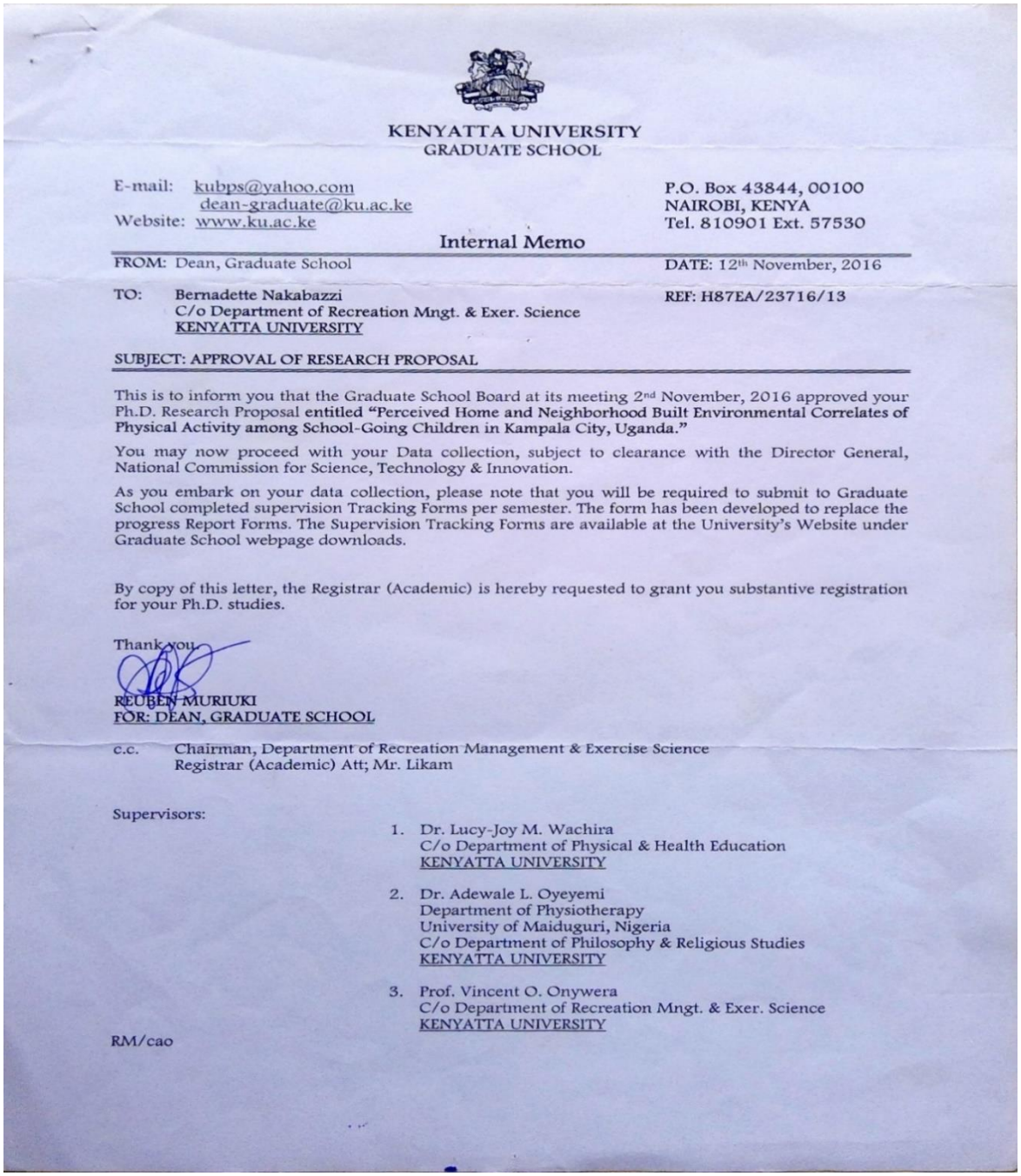
APPENDICES

Appendix A: Approval of Research Proposal by Kenyatta University Graduate School



KENYATTA UNIVERSITY
GRADUATE SCHOOL

E-mail: kubps@yahoo.com
dean-graduate@ku.ac.ke
Website: www.ku.ac.ke

P.O. Box 43844, 00100
NAIROBI, KENYA
Tel. 810901 Ext. 57530

Internal Memo

FROM: Dean, Graduate School

DATE: 12th November, 2016

TO: Bernadette Nakabazzi
C/o Department of Recreation Mngt. & Exer. Science
KENYATTA UNIVERSITY

REF: H87EA/23716/13

SUBJECT: APPROVAL OF RESEARCH PROPOSAL

This is to inform you that the Graduate School Board at its meeting 2nd November, 2016 approved your Ph.D. Research Proposal **entitled "Perceived Home and Neighborhood Built Environmental Correlates of Physical Activity among School-Going Children in Kampala City, Uganda."**

You may now proceed with your Data collection, subject to clearance with the Director General, National Commission for Science, Technology & Innovation.

As you embark on your data collection, please note that you will be required to submit to Graduate School completed supervision Tracking Forms per semester. The form has been developed to replace the progress Report Forms. The Supervision Tracking Forms are available at the University's Website under Graduate School webpage downloads.

By copy of this letter, the Registrar (Academic) is hereby requested to grant you substantive registration for your Ph.D. studies.

Thank you

REUBEN MURIUKI
FOR: DEAN, GRADUATE SCHOOL

c.c. Chairman, Department of Recreation Management & Exercise Science
Registrar (Academic) Att; Mr. Likam

Supervisors:

1. Dr. Lucy-Joy M. Wachira
   C/o Department of Physical & Health Education
   KENYATTA UNIVERSITY
2. Dr. Adewale L. Oyeyemi
   Department of Physiotherapy
   University of Maiduguri, Nigeria
   C/o Department of Philosophy & Religious Studies
   KENYATTA UNIVERSITY
3. Prof. Vincent O. Onywera
   C/o Department of Recreation Mngt. & Exer. Science
   KENYATTA UNIVERSITY

RM/cao

Appendix B: Research Authorization Letter by Kenyatta University Graduate School

KENYATTA UNIVERSITY
GRADUATE SCHOOL

E-mail: kubps@yahoo.com
dean-graduate@ku.ac.ke
Website: www.ku.ac.ke

P.O. Box 43844, 00100
NAIROBI, KENYA
Tel. 8710901 Ext. 57530

Our Ref: H87EA/23716/13

Date: 12th November, 2016

The Director General,
National Commission for Science, Technology & Innovation,
P.O. Box 30623-00100,
NAIROBI

Dear Sir/Madam,

RE: RESEARCH AUTHORIZATION FOR BERNADETTE NAKABAZZI REG. NO. H87EA/23716/13

I write to introduce Nakabazzi who is a Postgraduate Student of this University. The student is registered for a Ph.D. degree programme in the **Department of Recreation Management & Exercise Science in the School of Applied Human Sciences.**

Nakabazzi intends to conduct research for Ph.D. thesis entitled **"Perceived Home and Neighborhood Built Environmental Correlates of Physical Activity among School-Going Children in Kampala City, Uganda."**

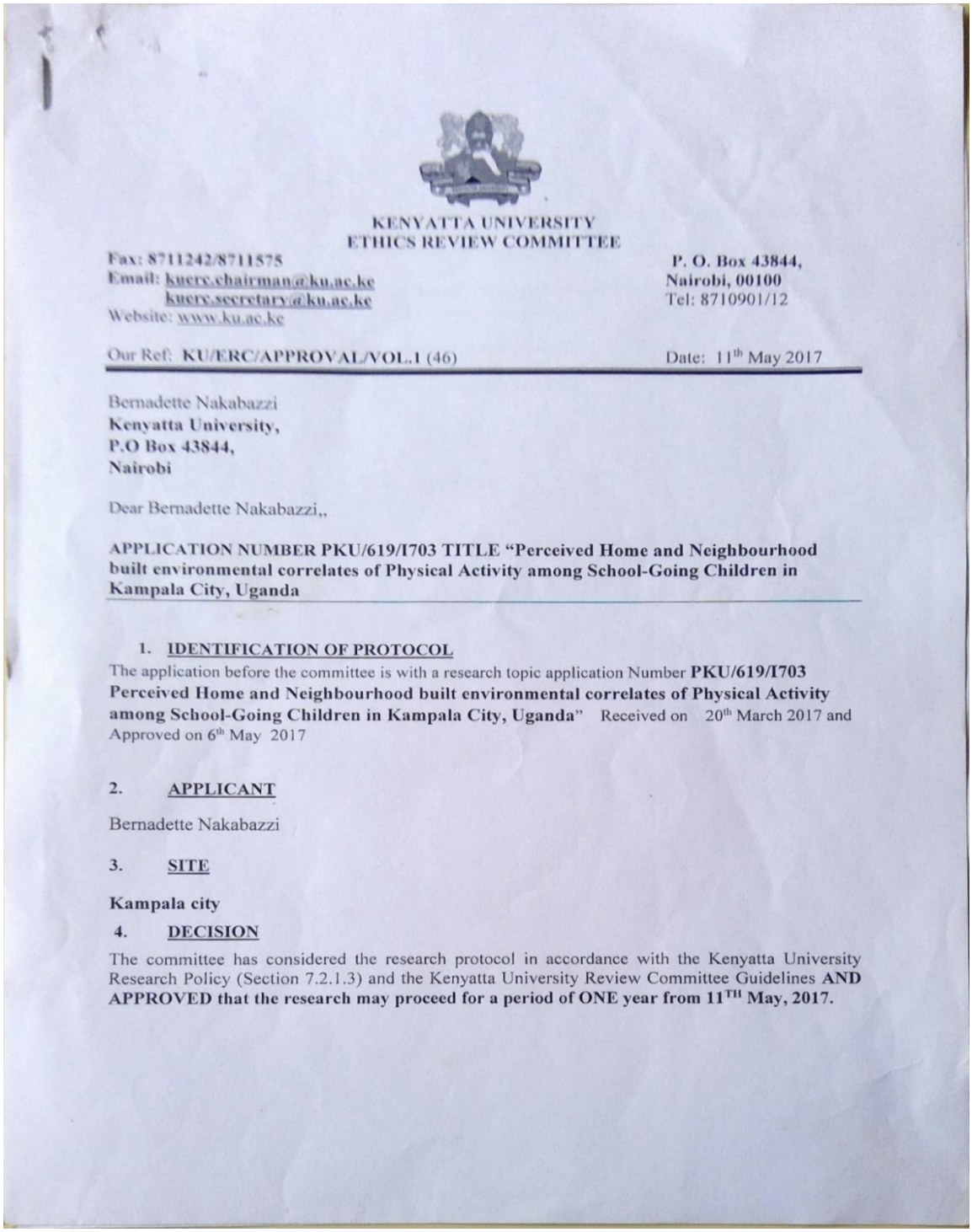
Any assistance given will be highly appreciated.

Yours faithfully,

MRS. LUCY N. MBAABU
FOR: DEAN, GRADUATE SCHOOL

RM/cao

Appendix C: Ethics Review Approval Letter by Kenyatta University Ethics Review Committee



KENYATTA UNIVERSITY
ETHICS REVIEW COMMITTEE

Fax: 8711242/8711575
Email: kuerc.chairman@ku.ac.ke
kuerc.secretary@ku.ac.ke
Website: www.ku.ac.ke

P. O. Box 43844,
Nairobi, 00100
Tel: 8710901/12

Our Ref: KU/ERC/APPROVAL/VOL.1 (46) Date: 11th May 2017

Bernadette Nakabazzi
Kenyatta University,
P.O Box 43844,
Nairobi

Dear Bernadette Nakabazzi,,

APPLICATION NUMBER PKU/619/I703 TITLE "Perceived Home and Neighbourhood built environmental correlates of Physical Activity among School-Going Children in Kampala City, Uganda

1. **IDENTIFICATION OF PROTOCOL**

The application before the committee is with a research topic application Number **PKU/619/I703 Perceived Home and Neighbourhood built environmental correlates of Physical Activity among School-Going Children in Kampala City, Uganda**" Received on 20th March 2017 and Approved on 6th May 2017

2. **APPLICANT**

Bernadette Nakabazzi

3. **SITE**

Kampala city

4. **DECISION**

The committee has considered the research protocol in accordance with the Kenyatta University Research Policy (Section 7.2.1.3) and the Kenyatta University Review Committee Guidelines **AND APPROVED that the research may proceed for a period of ONE year from 11TH May, 2017.**

ADVICE/CONDITIONS

i. Progress reports are submitted to the KU-ERC every six months and a full report is submitted at the end of the study.
ii. Serious and unexpected adverse events related to the conduct of the study are reported to this committee immediately they occur.
iii. Notify the Kenyatta University Ethics Committee of any amendments to the protocol.
iv. Submit an electronic copy of the protocol to KUERC.

When replying, kindly quote the application number above.
If you accept the decision reached and advice and conditions given please sign in the space Provided below and return to KU-ERC a copy of the letter.

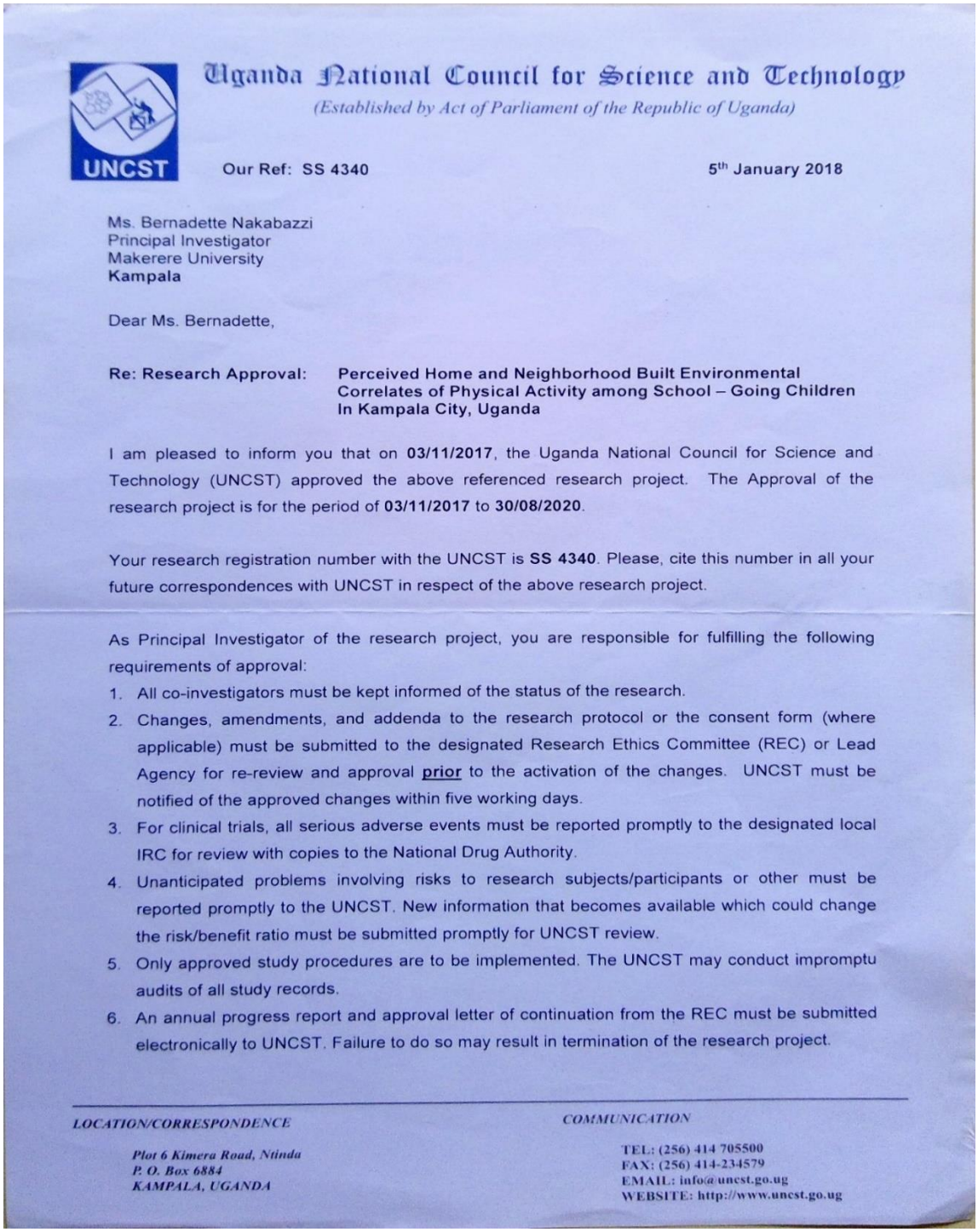
KENYATTA UNIVERSITY OFFICE OF THE CHAIRMAN 25 MAY 2017 ETHICS REVIEW COMMITTEE 13844 - 00100 NAIROBI

DR. TITUS KAHIGA.
CHAIRMAN ETHICS REVIEW COMMITTEE

I Bernadette Nakabazzi accept the advice given and will fulfill the conditions therein.

Signature..... Dated this day of... 25th May 2017.....2017.

Appendix D: Research Authorization Letter by Uganda National Council for Science and Technology



Uganda National Council for Science and Technology

(Established by Act of Parliament of the Republic of Uganda)

UNCST

Our Ref: SS 4340

5th January 2018

Ms. Bernadette Nakabazzi
Principal Investigator
Makerere University
Kampala

Dear Ms. Bernadette,

Re: Research Approval: **Perceived Home and Neighborhood Built Environmental Correlates of Physical Activity among School – Going Children In Kampala City, Uganda**

I am pleased to inform you that on **03/11/2017**, the Uganda National Council for Science and Technology (UNCST) approved the above referenced research project. The Approval of the research project is for the period of **03/11/2017** to **30/08/2020**.

Your research registration number with the UNCST is **SS 4340**. Please, cite this number in all your future correspondences with UNCST in respect of the above research project.

As Principal Investigator of the research project, you are responsible for fulfilling the following requirements of approval:

1. All co-investigators must be kept informed of the status of the research.
2. Changes, amendments, and addenda to the research protocol or the consent form (where applicable) must be submitted to the designated Research Ethics Committee (REC) or Lead Agency for re-review and approval **prior** to the activation of the changes. UNCST must be notified of the approved changes within five working days.
3. For clinical trials, all serious adverse events must be reported promptly to the designated local IRC for review with copies to the National Drug Authority.
4. Unanticipated problems involving risks to research subjects/participants or other must be reported promptly to the UNCST. New information that becomes available which could change the risk/benefit ratio must be submitted promptly for UNCST review.
5. Only approved study procedures are to be implemented. The UNCST may conduct impromptu audits of all study records.
6. An annual progress report and approval letter of continuation from the REC must be submitted electronically to UNCST. Failure to do so may result in termination of the research project.

LOCATION/CORRESPONDENCE

Plot 6 Kimera Road, Ntinda
P. O. Box 6884
KAMPALA, UGANDA

COMMUNICATION

TEL: (256) 414 705500
FAX: (256) 414-234579
EMAIL: info@uncst.go.ug
WEBSITE: http://www.uncst.go.ug

Uganda National Council for Science and Technology

(Established by Act of Parliament of the Republic of Uganda)

Below is a list of documents approved with this application:

	Document Title	Language	Version	Version Date
1.	Research proposal	English	2.0	April 2017
2.	Child assent form	English	2.0	October 2017
3.	Parent/Guardian consent form	English	2.0	April 2017
4.	Parental questionnaire	English	2.0	April 2017
5.	Interview manual for news - Africa survey	English	2.0	April 2017
6.	Height and weight protocols	English	2.0	April 2017
7.	Lists of schools in Kampala	English	2.0	April 2017
8.	Proposed study budget	English	2.0	April 2017
9.	Instructions for wearing the actigraph activity monitor	English	2.0	April 2017
10.	Accelerometer wear log	English	2.0	April 2017

Yours sincerely,

Isaac Makhuwa
For: Executive Secretary
UGANDA NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

Copied to: Chair, Makerere University School of Social Sciences, Research Ethics Committee

LOCATION/CORRESPONDENCE

Plot 6 Kimera Road, Ntinda
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FAX: (256) 414-234579
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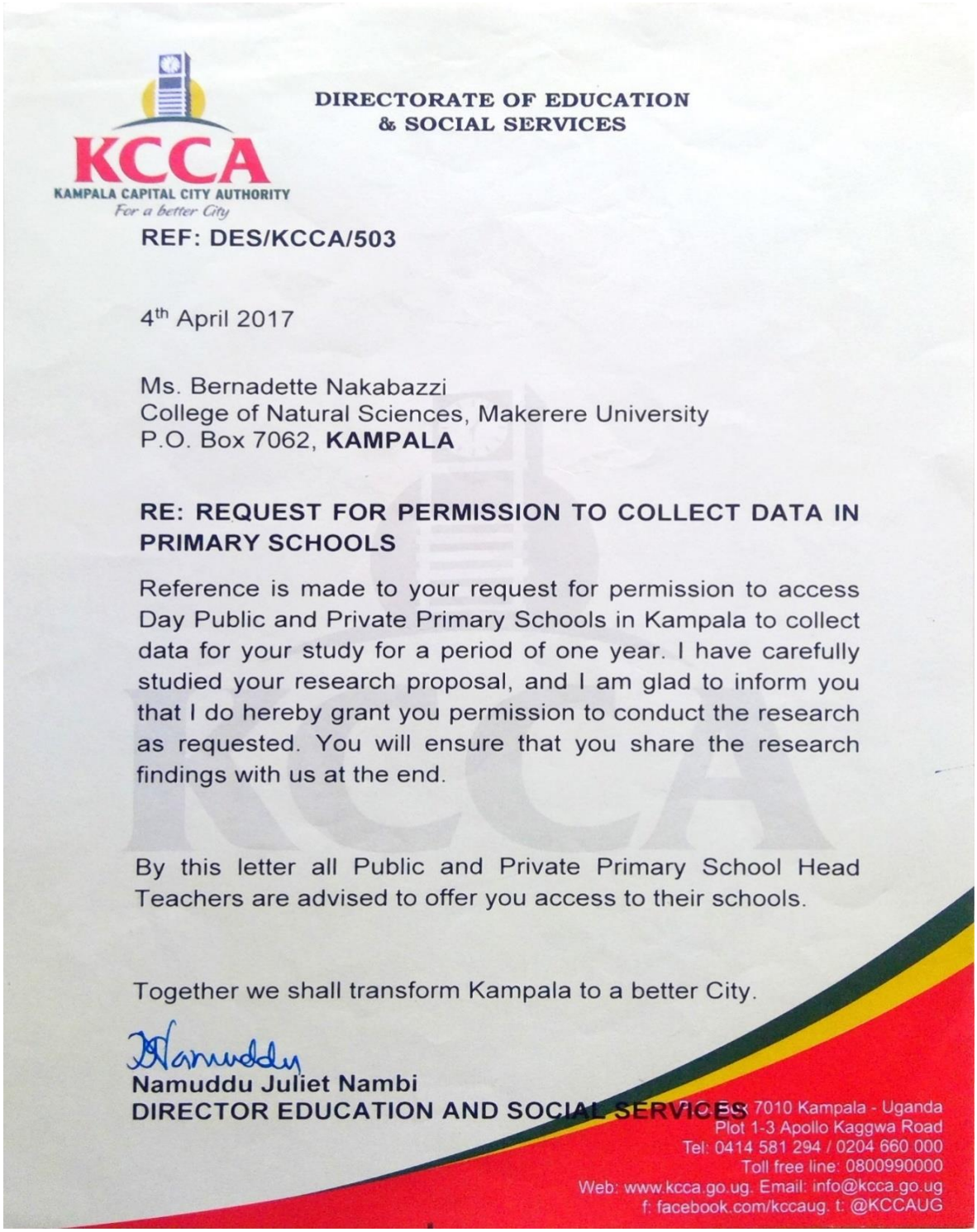
Appendix E: Research Authorization Letter by the Directorate of Education and Social Services, Kampala Capital City Authority (KCCA)



KCCA
KAMPALA CAPITAL CITY AUTHORITY
For a better City

DIRECTORATE OF EDUCATION & SOCIAL SERVICES

REF: DES/KCCA/503

4th April 2017

Ms. Bernadette Nakabazzi
College of Natural Sciences, Makerere University
P.O. Box 7062, **KAMPALA**

RE: REQUEST FOR PERMISSION TO COLLECT DATA IN PRIMARY SCHOOLS

Reference is made to your request for permission to access Day Public and Private Primary Schools in Kampala to collect data for your study for a period of one year. I have carefully studied your research proposal, and I am glad to inform you that I do hereby grant you permission to conduct the research as requested. You will ensure that you share the research findings with us at the end.

By this letter all Public and Private Primary School Head Teachers are advised to offer you access to their schools.

Together we shall transform Kampala to a better City.

Namuddu Juliet Nambi
DIRECTOR EDUCATION AND SOCIAL SERVICES

P.O. Box 7010 Kampala - Uganda
Plot 1-3 Apollo Kaggwa Road
Tel: 0414 581 294 / 0204 660 000
Toll free line: 0800990000
Web: www.kcca.go.ug. Email: info@kcca.go.ug
f: facebook.com/kccaug. t: @KCCAUG

Appendix F: Parent/Guardian Consent Form

PERCEIVED HOME AND NEIGHBOURHOOD BUILT ENVIRONMENT CORRELATES OF PHYSICAL ACTIVITY AMONG SCHOOL-GOING CHILDREN IN KAMPALA CITY, UGANDA

Your child is being invited to participate in a research study. This study is being conducted by Bernadette Nakabazzi from the School of Applied Human Sciences in Kenyatta University Nairobi.

Before you decide to participate in this study, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss this research project with your child. Thank you for reading this.

Background

There are numerous health benefits of regular participation in physical activity for children. Also, physical activity behaviours acquired during childhood tracks into adulthood. However, children worldwide including Uganda are not sufficiently active for health. This is alarming and it points to an urgent need to increase physical activity in children. Studies suggest that the built environment in most settings where children spend most of their time such as home and neighbourhood may provide opportunities or barriers for participation in physical activity. However, the relationships between physical activity and home and neighbourhood environment have not been studied in school-going children in Kampala city in Uganda.

This study will be the first in Kampala to describe this relationship. The study will help guide interventions to increase physical activity among school-going children, urban planners and policy makers may also use the results to plan a physical activity environment tailored for children. The study will guide parents in creating physical activity environments in their homes.

What is the Purpose of the Study?

The purpose of the study is to understand the relationship between children's physical activity and parental perception of the built environment at home and in the neighbourhood. The study wants to see if the built environment at home and in the neighbourhood influences participation in physical activity of school-going children aged between 10 and 12years in Kampala city in Uganda.

What would my child have to do?

An information package has been provided to you through your child, which includes this consent form, a questionnaire (which includes individual information, physical activity participation, home, and neighbourhood environment information). If you decide to consent to tour child's participation, you and your child will be required to complete these forms and return them to the class teacher before they are collected by the research coordinator. Your child will also be requested to complete a physical activity participation questionnaire. Your child's height and weight will also be measured. Your child will also be requested to volunteer to wear a motion sensor (accelerometer) for 7 days. The accelerometer is an unobtrusively worn on the hip via an elastic belt. It is removed when bathing or swimming. Some parental assistance will be needed to help the child put on the accelerometer and to record the time when devise was put on and put off.

What are the risks?

There are no expected risks to participate in this study. The measurements will be done under close supervision, privacy and every effort will be made to ensure your child's safety. However, initially the child may experience some discomfort in wearing the device.

Are there any Benefits for my Child?

Your child's participation in this research will help us better understand how the built environment at home and in the neighbourhood influences children's participation in

physical activity and may guide physical activity promotion strategies, that may help reverse the declining levels of physical activity in children.

Does my child have to participate?

Your child's participation in this study should be completely voluntary. Choosing not to participate in this study will in no way affect your child's school program. If your child decides to participate, he/she will be at liberty to withdraw at any time without any consequences or explanations.

Will my Child's Record be Kept Private?

All the information collected will remain strictly confidential. Your child's privacy will be assured. Confidentiality will be protected by using a study identification number in the data base. All study results that are reported will in no way identify study participants.

If you have any questions regarding this study, please contact Bernadette Nakabazzi on.

Mobile: **+256772439068/ +256759439068** or Email: **bnakabazzi@cns.mak.ac.ug**

Your signature below indicates that you understand the above information of your child's participation in this study, and you agree to allow your child to participate in this study. We also ask that your child signs below to indicate that he/she is happy to be involved in the study.

_____ _____

Parent Name ***Parent signature***

Date_____

Thank you for taking your time to read this information letter!

Please keep a copy of this form for your records.

Appendix G: Child's Assent Form

CHILD ASSENT FORM

My name is *Bernadette Nakabazzi* from Kenyatta University Kenya. I am doing a study to establish how the environment at your home and in your neighbourhood is related to your daily activity. We are asking you to take part in the research study because your home is in Kampala city and you are in the age group of 10 to 12 years (primary 5, 6 and 7).

For this research, we will require you to wear an activity monitor (accelerometer) and complete the activity monitor wear log for seven consecutive days. In addition, your weight and height will also be measured. We will keep all your measurements private, and will not show them to other children, your teacher, or your parent(s)/guardian. Only people working on the study will see them and they will only use them for study.

Nothing will happen to you as part of this study, but you might feel uncomfortable because of wearing the belt on the activity monitor. However, after some time you will get used to it since it is painless. We may also ask you to wear the monitor again in case you do not wear it properly.

You will feel good about helping us to learn about the influence of the environment at home and in the neighbourhood on your activity levels. You will help us come up with recommendations that will promote physical activity and reverse the declining levels of physical activity in children. You will be rewarded with an eraser or pen for participating in this study. You should know that:

- You do not have to be part of this study if you do not want to. You will not get into any trouble with us, your teacher, or the school if you said no.
- You withdraw from the study at any time.
- Your parent(s)/guardian(s) were asked if it was okay for you to participate in this study. However, even if they agreed, it is still your choice whether to take part.

- You can ask any questions you may have, now or if you think of a question later, you or your parents can contact me on Mobile; +256772439068/+256759439068 or email me bnakabazzi@cns.mak.ac.ug.

Sign this form only if you:

- have understood what you will be doing for this study,
- have had all your questions answered,
- have talked to your parent(s)/ guardian about this study, and
- agree to take part in this study.

_____

Your Signature Printed Name Date

_____

Name of Parent(s) or Legal Guardian(s)

_____

Researcher explaining study.

Signature Printed Name Date

Appendix H: Instructions for Wearing the ActiGraph Activity Monitor

Downloaded from www.actigraph.com

How to wear the Accelerometer?

The accelerometer records general body movements and allows us to get a better idea of your levels of activity. It will not tell what kind of specific activity you are participating in. It is expensive for researchers but has no street value. At first the belt may feel awkward, but after a few hours you will probably get used to it and not notice it as much. It is particularly important for the study that you wear the accelerometer properly. If it is not worn properly, we may have to ask you to wear it again. Please follow these instructions carefully:

Wear the meter attached to the belt around your waist, just above your right hipbone. You can wear it either underneath or on top of your clothing.

Wear the meter so that the star sticker is facing up.

Wear the meter tightly against your body. If you have to you can adjust the belt by pulling on the end of the straps to make it tighter. Or to loosen the belt by pushing more of the strap through the loop. Wear the belt tight enough so that the meter does not move when you are being active.

Please put it on first thing in the morning- either just after you get out of bed or just after you shower or take a bath in the morning.

The meter must not get wet (such as when swimming, bathing etc.)

Keep the activity meter on all day (unless swimming or in water)

Record on the time sheet the periods when the meter was not worn in the activity log provided.

Do not let anyone else wear it.

Wear for 7 complete days.

You need to start wearing the meter right away – The battery will only last for 20 days.

Go about your normal activities - do not do anything different.

You need to be in Kampala or staying at your primary residence when wearing the meter.

Put the meter next to your bed or cell phone where you will see it first thing each morning.

Complete the meter log each day as a reminder.

Someone from our office will call you the day after tomorrow and on weekend days to check on you.

There is no “ON” and “OFF” switch that you need to worry about turning on or off every day. The meter runs on battery like your watch and is programmed to run continuously without you needing to turn it on. Please do not try to open the activity meter.

At the end of the measurement period, please return the meter and the time sheet in the envelope provided. It is extremely important that the meter is returned promptly.

For more information, please call + 256772439068 / +25675943906

Appendix I: Accelerometer Wear Log

Wear the movement meter for seven (7) days in a row, including weekends. In the spaces below, write down the dates, days, and times which you wear it. Please also write down the times school starts and ends each day. If you take the devices off for more than 30 minutes, such as for swimming, record when they were removed and for what reason. If you are unable to wear the meter for *at least* 12 hours one day, please wear it one extra day. Thank you!

Please start wearing your meter on or before _____.

The last full day that your meter will work is _____.

Day 1

(Circle Day) Mon Tues Wed Thurs Fri Sat Sun Date_____

Time Meter Put On:	am / pm	Time school started:	am / pm
Time Meter Taken Off:	am / pm	Time school ended:	am / pm
Time removed during the day (e.g., 10:30-11am):	_____	_____	
Why removed (e.g., swimming):	_____	_____	

Day 2

(Circle Day) Mon Tues Wed Thurs Fri Sat Sun Date_____

Time Meter Put On:	am / pm	Time school started:	am / pm
Time Meter Taken Off:	am / pm	Time school ended:	am / pm
Time removed during the day (e.g., 10:30-11am):	_____	_____	
Why removed (e.g., swimming):	_____	_____	

Day 3

(Circle Day) Mon Tues Wed Thurs Fri Sat Sun Date_____

Time Meter Put On:	am / pm	Time school started:	am / pm
Time Meter Taken Off:	am / pm	Time school ended:	am / pm
Time removed during the day (e.g., 10:30-11am):	_____	_____	
Why removed (e.g., swimming):	_____	_____	

Day 4

(Circle Day) Mon Tues Wed Thurs Fri Sat Sun

Date_____

Time Meter Put On:	am / pm	Time school started:	am / pm
Time Meter Taken Off:	am / pm	Time school ended:	am / pm
Time removed during the day (e.g., 10:30-11am):	_____	_____	
Why removed (e.g., swimming):	_____	_____	

Day 5

(Circle Day) Mon Tues Wed Thurs Fri Sat Sun Date_____

Time Meter Put On:	am / pm	Time school started:	am / pm
Time Meter Taken Off:	am / pm	Time school ended:	am / pm
Time removed during the day (e.g., 10:30-11am):	_____	_____	
Why removed (e.g., swimming):	_____	_____	

Day 6

(Circle Day) Mon Tues Wed Thurs Fri Sat Sun Date_____

Time Meter Put On:	am / pm	Time school started:	am / pm
Time Meter Taken Off:	am / pm	Time school started:	am / pm
Time removed during the day (e.g., 10:30-11am):	_____	_____	
Why removed (e.g., swimming):	_____	_____	

Day 7

(Circle Day) Mon Tues Wed Thurs Fri Sat Sun Date_____

Time Meter Put On:	am / pm	Time school started:	am / pm
Time Meter Taken Off:	am / pm	Time school ended:	am / pm
Time removed during the day (e.g., 10:30-11am):	_____	_____	
Why removed (e.g., swimming):	_____	_____	

FOR OFFICE USE ONLY

Participant ID _____ Date Initialized: _____

Recruiter _____ Valid meter days: _____

Meter Number _____ First Mail Day: _____

Appendix J: Height and Weight Protocols

Recommended Equipment

Seca 213 Portable Stadiometer (Hamburg, Germany)

Seca 869 Potable Weighing Scale (Hamburg, Germany)

Height

Definition: The perpendicular distance between the top of the head (the vertex) and the bottom of the feet.

Equipment: SECA 213 portable stadiometer.

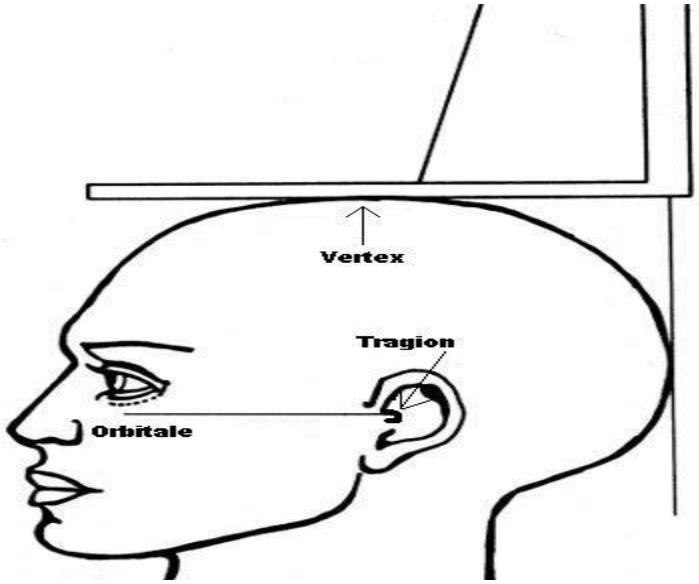
Assembling the stadiometer

The stadiometer comes in eight pieces and is easy to assemble. Start with the base of the stadiometer. Place this on the floor, close to a wall. Slot the measurement rods into the base of the stadiometer in the correct order. Start with the rod that has a large arrow facing down. Make sure it is inserted fully. Add one of the white stabilizers with the long arm pointing backwards toward the wall, followed by the headboard facing forward, and then the second stabilizer facing backward. Connect the next three measurement rods in order. Move the top stabilizer and the headboard up above the two-meter mark and leave the other stabilizer down low. Push the completed stadiometer closer to the wall so that both stabilizers are touching the wall.

Method

Ask the subject to stand on the centre of the base with their back to the stadiometer. Ask them to put their feet together and move back until their heels touch the bottom of the stadiometer upright. Their buttocks and upper part of their back should also be touching the stadiometer upright. Their head does not have to touch the stadiometer.

The respondent's head should be in the Frankfort plane. This is achieved when the lower edge of the eye socket (the Orbitale) is horizontal with the Tragion [see Figure 1]. The vertex will be the highest point on their head. If their head is not aligned properly, (and for most respondents it probably will not be), ask them to raise or lower their chin until it is in the Frankfort Plane.



Source: Adapted from the ISAK Manual, 2001.

When you are happy that the respondent is in the correct position, ask them to take a deep breath and hold it. Lower the blue headboard until it is in contact with the head. Compress the hair if needed. Make sure you do not bend the headboard from the horizontal, nor move the respondent's head. Hold the headboard firmly at its final position and take the reading to the nearest 0.1 cm and record it.

When you have completed the reading, ask the respondent to step away from the stadiometer.

Note: If the respondent is as tall as you, or taller, you will need to stand on a box to judge when the head is in the right position and to take the reading, as both these actions need your eyes to be in the same horizontal plane as the object you are looking at.

Weight

Definition: Weight is the force the matter in the body exerts in a standard gravitational field.

Equipment required: SECA 869 Potable weighing scales.

Setting the scales

Place the scales on a hard-flat surface. If carpet is the only floor covering in the measurement location, put your board down on the carpet and place the scales on the board.

Method

Ask the child to remove extra layers of clothing, jewellery, and any items in his/her pockets.

Press firmly on the centre of the scales to turn them on. Once the zeros appear, ask the respondent to stand on the scales. Ask the subject to stand on the centre of the scales without support, with their arms loosely by their sides, head facing forward and with their weight distributed evenly on both feet. A reading will appear in a few seconds. The numbers will change, and then stop. Once the numbers have stopped, take the reading to the nearest 0.1 kg.

Ask the subject to step off the scale. Record the reading.

Repeating the measurements

Once you have measured height and weight, once through, repeat the measurements, in order, using the same techniques as previously until you generate three readings that do not differ by 1%.

Packing up

Once you have finished with the equipment, it is best that you pack it away. Put the scales in the pouch. Take apart the portable stadiometer and place all the pieces in the bag. Do not forget to take this equipment with you when you leave!

Calculate Body Mass Index (BMI) from measured heights and weights as the ratio of body weight in kilograms to the height in meters squared.

Classify children's weight status using the using the BMI cut-offs from the World Health Organization (WHO) references 2007 for children 5 to 19 years (shown below).

Appendix K: Body Mass Index-for-Age Percentile rank chart for Girls

BMI-for-age GIRLS

5 to 19 years (percentiles)

World Health Organization

Year: Month	Month	L	M	S	Percentiles (BMI in kg/m²)							
					1st	3rd	5th	15th	25th	50th	75th	85th	95th	97th	99th
11: 4	136	-1.4436	17.4847	0.12882	13.6	14.2	14.5	15.5	16.1	17.5	19.2	20.3	22.5	23.6	25.9
11: 5	137	-1.4389	17.5464	0.12914	13.7	14.2	14.6	15.5	16.2	17.5	19.3	20.4	22.6	23.7	26.0
11: 6	138	-1.4339	17.6088	0.12946	13.7	14.3	14.6	15.6	16.2	17.6	19.3	20.4	22.7	23.8	26.1
11: 7	139	-1.4288	17.6719	0.12978	13.7	14.3	14.7	15.6	16.3	17.7	19.4	20.5	22.8	23.9	26.2
11: 8	140	-1.4235	17.7357	0.13009	13.8	14.4	14.7	15.7	16.3	17.7	19.5	20.6	22.9	24.0	26.4
11: 9	141	-1.4180	17.8001	0.13040	13.8	14.4	14.8	15.7	16.4	17.8	19.6	20.7	23.0	24.1	26.5
11:10	142	-1.4123	17.8651	0.13070	13.9	14.5	14.8	15.8	16.4	17.9	19.6	20.8	23.1	24.2	26.6
11:11	143	-1.4065	17.9306	0.13099	13.9	14.5	14.9	15.8	16.5	17.9	19.7	20.8	23.2	24.3	26.7
12: 0	144	-1.4006	17.9966	0.13129	14.0	14.6	14.9	15.9	16.6	18.0	19.8	20.9	23.3	24.4	26.8
12: 1	145	-1.3945	18.0630	0.13158	14.0	14.6	15.0	15.9	16.6	18.1	19.9	21.0	23.4	24.5	26.9
12: 2	146	-1.3883	18.1297	0.13186	14.0	14.7	15.0	16.0	16.7	18.1	19.9	21.1	23.5	24.6	27.0
12: 3	147	-1.3819	18.1967	0.13214	14.1	14.7	15.0	16.1	16.7	18.2	20.0	21.2	23.6	24.7	27.2
12: 4	148	-1.3755	18.2639	0.13241	14.1	14.7	15.1	16.1	16.8	18.3	20.1	21.3	23.7	24.8	27.3
12: 5	149	-1.3689	18.3312	0.13268	14.2	14.8	15.1	16.2	16.8	18.3	20.2	21.3	23.8	24.9	27.4
12: 6	150	-1.3621	18.3986	0.13295	14.2	14.8	15.2	16.2	16.9	18.4	20.2	21.4	23.9	25.0	27.5
12: 7	151	-1.3553	18.4660	0.13321	14.3	14.9	15.2	16.3	17.0	18.5	20.3	21.5	23.9	25.1	27.6
12: 8	152	-1.3483	18.5333	0.13347	14.3	14.9	15.3	16.3	17.0	18.5	20.4	21.6	24.0	25.2	27.7
12: 9	153	-1.3413	18.6006	0.13372	14.3	15.0	15.3	16.4	17.1	18.6	20.5	21.7	24.1	25.3	27.8
12:10	154	-1.3341	18.6677	0.13397	14.4	15.0	15.4	16.4	17.1	18.7	20.6	21.8	24.2	25.4	27.9
12:11	155	-1.3269	18.7346	0.13421	14.4	15.1	15.4	16.5	17.2	18.7	20.6	21.8	24.3	25.5	28.0
13: 0	156	-1.3195	18.8012	0.13445	14.5	15.1	15.5	16.5	17.3	18.8	20.7	21.9	24.4	25.6	28.1
13: 1	157	-1.3121	18.8675	0.13469	14.5	15.2	15.5	16.6	17.3	18.9	20.8	22.0	24.5	25.7	28.2
13: 2	158	-1.3046	18.9335	0.13492	14.6	15.2	15.6	16.7	17.4	18.9	20.9	22.1	24.6	25.8	28.4
13: 3	159	-1.2970	18.9991	0.13514	14.6	15.3	15.6	16.7	17.4	19.0	20.9	22.2	24.7	25.9	28.5

2007 WHO Reference

Appendix L: Body Mass Index-for-Age Percentile rank chart for Boys

BMI-for-age BOYS

5 to 19 years (percentiles)

World Health Organization

Year: Month	Month	L	M	S	Percentiles (BMI in kg/m^2)							
					1st	3rd	5th	15th	25th	50th	75th	85th	95th	97th	99th
11: 4	136	-1.7884	17.1262	0.11228	13.8	14.3	14.6	15.4	16.0	17.1	18.6	19.5	21.4	22.3	24.4
11: 5	137	-1.7880	17.1746	0.11266	13.9	14.4	14.6	15.4	16.0	17.2	18.6	19.6	21.5	22.4	24.5
11: 6	138	-1.7873	17.2236	0.11304	13.9	14.4	14.7	15.5	16.0	17.2	18.7	19.6	21.6	22.5	24.6
11: 7	139	-1.7861	17.2734	0.11342	13.9	14.4	14.7	15.5	16.1	17.3	18.8	19.7	21.7	22.6	24.7
11: 8	140	-1.7846	17.3240	0.11379	13.9	14.5	14.7	15.6	16.1	17.3	18.8	19.8	21.8	22.7	24.8
11: 9	141	-1.7828	17.3752	0.11415	14.0	14.5	14.8	15.6	16.2	17.4	18.9	19.8	21.8	22.8	24.9
11:10	142	-1.7806	17.4272	0.11451	14.0	14.5	14.8	15.6	16.2	17.4	18.9	19.9	21.9	22.9	25.0
11:11	143	-1.7780	17.4799	0.11487	14.0	14.6	14.9	15.7	16.3	17.5	19.0	20.0	22.0	23.0	25.1
12: 0	144	-1.7751	17.5334	0.11522	14.1	14.6	14.9	15.7	16.3	17.5	19.1	20.1	22.1	23.1	25.2
12: 1	145	-1.7719	17.5877	0.11556	14.1	14.6	14.9	15.8	16.3	17.6	19.1	20.1	22.2	23.1	25.3
12: 2	146	-1.7684	17.6427	0.11590	14.2	14.7	15.0	15.8	16.4	17.6	19.2	20.2	22.3	23.2	25.4
12: 3	147	-1.7645	17.6985	0.11623	14.2	14.7	15.0	15.9	16.4	17.7	19.3	20.3	22.3	23.3	25.6
12: 4	148	-1.7604	17.7551	0.11656	14.2	14.8	15.1	15.9	16.5	17.8	19.3	20.3	22.4	23.4	25.7
12: 5	149	-1.7559	17.8124	0.11688	14.3	14.8	15.1	16.0	16.5	17.8	19.4	20.4	22.5	23.5	25.8
12: 6	150	-1.7511	17.8704	0.11720	14.3	14.8	15.1	16.0	16.6	17.9	19.5	20.5	22.6	23.6	25.9
12: 7	151	-1.7461	17.9292	0.11751	14.3	14.9	15.2	16.1	16.6	17.9	19.5	20.6	22.7	23.7	26.0
12: 8	152	-1.7408	17.9887	0.11781	14.4	14.9	15.2	16.1	16.7	18.0	19.6	20.6	22.8	23.8	26.1
12: 9	153	-1.7352	18.0488	0.11811	14.4	15.0	15.3	16.2	16.8	18.0	19.7	20.7	22.9	23.9	26.2
12:10	154	-1.7293	18.1096	0.11841	14.5	15.0	15.3	16.2	16.8	18.1	19.7	20.8	23.0	24.0	26.3
12:11	155	-1.7232	18.1710	0.11869	14.5	15.0	15.4	16.3	16.9	18.2	19.8	20.9	23.1	24.1	26.4
13: 0	156	-1.7168	18.2330	0.11898	14.5	15.1	15.4	16.3	16.9	18.2	19.9	20.9	23.1	24.2	26.5
13: 1	157	-1.7102	18.2955	0.11925	14.6	15.1	15.4	16.4	17.0	18.3	19.9	21.0	23.2	24.3	26.7
13: 2	158	-1.7033	18.3586	0.11952	14.6	15.2	15.5	16.4	17.0	18.4	20.0	21.1	23.3	24.4	26.8
13: 3	159	-1.6962	18.4221	0.11979	14.7	15.2	15.5	16.5	17.1	18.4	20.1	21.2	23.4	24.5	26.9

2007 WHO Reference

Appendix M: Parent/Guardian Questionnaire

We would like to learn more about you, your child, your home, and neighborhood. Please answer all questions as accurate as you can. Remember that there are no right or wrong answers, and that every person is different. We will not share any of your personal information with anyone else, and all your answers will remain private.

Instructions

Please try not to miss any questions. Provide only one answer for each question, using black or blue ink.

SECTION A: SOCIO-DEMOGRAPHIC INFORMATION

Please respond to these questions for the child who is participating in the study.

1.Your child's date of birth _____

2. Child's sex:

0. ☐ Male

1. ☐ Female

Please respond to these questions about yourself.

3. Your age: _____ years

4. Your sex:

0. ☐ Male

1. ☐ Female

5. What is your marital status?

1 ☐ Married

2. ☐ Widowed/divorced/separated

3 ☐ Single

4 ☐ Living with partner

6. What was the highest education level you completed?

1. ☐No formal schooling
2. ☐ Primary
3. ☐ O level certificate
4. ☐ A level Certificate
5. ☐ Diploma
6. ☐ Bachelor's degree
7. ☐ Postgraduate degree

7. How many functioning motorized transport / vehicles (cars, motorcycles/bikes, tricycles, and trucks) are available for use in your household?

☐ None ☐ Two

☐ One ☐ Three or more

8. How long have you lived at your present address (house)? ____

____years and _____months.

9. How many children and youth (aged 0-17 years) live in your household most of the time? _____youth.

Think about your child's <u>activities</u> over the PAST YEAR as you answer the following questions, unless otherwise specified.

<u>SECTION B: QUESTIONS ABOUT YOUR HOME</u>

Please put a check mark (√) in the box besides the answer that best applies to you, your child, and your home.

Parental Support During a typical week, how often have you or another adult in the household:	Never	1-2 days	3-4 days	5-6 days	Every day
1. Watched your child participate in physical activity or sports	☐	☐	☐	☐	☐
2. Encouraged your child to do sports or physical activity	☐	☐	☐	☐	☐
3. Provided transport to a place where your child can do physical activity or play sports	☐	☐	☐	☐	☐
4. Done a physical activity or played sports with your child	☐	☐	☐	☐	☐

Parent Rules **Which of the following rules do you enforce about your child's activity?**	**Yes**	**No**
1. Stay close to or within sight of the house/parent	☐	☐
2. Do not go into the street	☐	☐
3. Return home before dark	☐	☐
4. Do not go places alone	☐	☐
5. Stay in the neighborhood	☐	☐
6. Do not ride bike on the street	☐	☐
7. Do homework before going out	☐	☐
8. Watch out for cars	☐	☐
9. Check in frequently	☐	☐
10. Stay on paths, trails, or sidewalk	☐	☐
11. Do not cross busy streets	☐	☐
12. No TV/DVD/computer before homework	☐	☐
13. Less than 2 hours TV/DVD/computer per day	☐	☐
14. Do not fight with other kids	☐	☐
15. Do not disrespect others (particularly adults)	☐	☐

Play Equipment

Please indicate (√) if you have the following items in your home, yard or apartment complex, and if you have them, how often your child uses each item. Please circle the answer that best applies to your child.

	Not Available (I Do not Have)	**Available but never used**	**Once a month or less**	**Once every other week**	**Once a week or more**
1. Bike	☐	☐	☐	☐	☐
2. Basketball hoop	☐	☐	☐	☐	☐
3. Jump rope	☐	☐	☐	☐	☐
4. Active video games (e.g., with dance pad, Wii, etc.)	☐	☐	☐	☐	☐
5. Sports equipment (e.g., balls, racquets, bats, sticks)	☐	☐	☐	☐	☐
6. Roller skates, skateboard, scooter	☐	☐	☐	☐	☐
7. Fixed play equipment (e.g., swing set, playhouse, gym)	☐	☐	☐	☐	☐
8. Home aerobic equipment (e.g. treadmill, cycle, cross trainer stepper, rower, workout video or audio tapes)	☐	☐	☐	☐	☐
9. Weightlifting equipment, toning devices (e.g., free weights, pull, up bars, exercise balls, ankle weights etc.)	☐	☐	☐	☐	☐
10. Yoga/exercise mats	☐	☐	☐	☐	☐
11. Exercise, play or recreation room	☐	☐	☐	☐	☐
12. Trampoline	☐	☐	☐	☐	☐
13. Stairs	☐	☐	☐	☐	☐

Things in Your Child's Bedroom **Please indicate (√) whether the following are in your child's bedroom.**		
1. TV	Yes	No
2. VCR or DVD player	Yes	No
3. Music players (radio, CD or tape player, stereo, MP3, or iPod)	Yes	No
4. Computer	Yes	No
5. Video game system (non-handheld—Play station, x-box, etc.)	Yes	No
Your Child's Personal Electronics **Does your child have the following items for his/her own use?**		
6. Cell phone or 2-way radio	Yes	No
7. Handheld videogame players (game boy, Sony PSP, etc.)	Yes	No

SECTION C: QUESTIONS ABOUT YOUR NEIGHBORHOOD

We would like to find out more information about what you perceive or think and how you feel about your neighborhood. By neighborhood we mean ALL the areas that you could walk to in 10 to15 minutes from your house (within approximately one kilometer or half a mile of your house). Please check (√) the answer that best applies to you and your neighborhood.

A. Types of residences in your neighborhood

Please put a check mark (√) in the box beside the answer that best applies to you and your neighborhood (please select only one answer).

1.What is the main type of housing in your immediate neighborhood?

□ Very few residential buildings/dwellings within 2 to 5 min walk of my house.

□ Detached or semi-detached single-family houses with space/garden

□ Attached (row) housing, apartment blocks/flats or multi-family housing with 2 to 5 storeys.

□Multiple apartment blocks/flats of 6 stories or more, with large spaces between buildings.

□Multiple apartment blocks/flats of 6 storeys or more, with very little space between buildings.

□ Very densely packed small houses (1-storey homes, including informal settlements and slums)

B. Stores, facilities, and other things in your neighborhood

Please think about one common destination you go to from your house very often, and how many minutes does it take you? Thinking about how long it takes you to walk to this destination can help you with the next questions. ***Approximately how long would it take you to walk from your house to the nearest places or locations listed below. Please put only one check mark (√) for each business or facility.***

	1-5 min	**6-10 min**	**11-20 min**	**21-30 min**	**31+ min**	**I Don't know**
Example: gas / petrol station	1	2	3 √	4	5	8
Kiosk/corner store/small grocery	1	2	3	4	5	8
Supermarket	1	2	3	4	5	8
Fruit / vegetable market (food Market)	1	2	3	4	5	8
Fast food restaurant	1	2	3	4	5	8
Non-fast-food restaurant	1	2	3	4	5	8
Pub or bar	1	2	3	4	5	8
Cinema or theatre	1	2	3	4	5	8
Place of worship / faith center (church, Mosque, Shrine)	1	2	3	4	5	8
Computer / cell phone kiosks. places for internet or phone calls	1	2	3	4	5	8
Library	1	2	3	4	5	8
Any school	1	2	3	4	5	8
Your workplace or your school (if a student)	1	2	3	4	5	8
Book store / book shop	1	2	3	4	5	8
Health care clinic / hospital	1	2	3	4	5	8
Pharmacy / chemist	1	2	3	4	5	8
Salon / barber shop (hairdresser)	1	2	3	4	5	8

Clothing store (Tailoring / fashion / designer shop)	1	2	3	4	5	8
Electronic shop	1	2	3	4	5	8
Public bus or train stop	1	2	3	4	5	8
Taxi or motorbike stop	1	2	3	4	5	8
Sports field or court for basketball, soccer, tennis etc.	1	2	3	4	5	8
Other outdoor recreation facilities (park, open space, informal play / recreation area)	1	2	3	4	5	8
Other indoor recreation facilities (recreation center, gymnasium, health, and fitness center)	1	2	3	4	5	8
Dance and martial arts classes (karate)	1	2	3	4	5	8
Tap/well water, pond, river, or stream for fresh water (if plumbing is in house choose "1-5" minutes)	1	2	3	4	5	8

C. Access to services and places

Please circle the answer that best applies to the neighborhood where you and your child live. Both <u>local</u> and <u>within walking distance</u> mean within a 10-15-minute walk from your house.

1. Stores (shops) are within easy walking distance of my house.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

2. There are many places to go such as food markets and restaurants within easy walking distance of my house.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

3. It is easy to walk to a transit / transport stop (bus, taxi, motorbike, tricycle, train) from my house.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

4. It is easy to walk to an outdoor recreation play space (park, open space, informal play / recreation area) from my house.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

5. It is easy to walk to an indoor recreation facility (recreation center, gymnasium, health and fitness center) from my house.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

6. Places to get essential supplies like water and firewood are within easy walking distance of my house.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

7. There are gathering places (community center, king place, village square, church / worship places etc.) within easy distance of my house.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

D. Roads and walking paths

Please circle the answer that best applies to you and your neighbourhood.

1. The distance to walk to the (closest) next street in my neighborhood is usually short (100 meters or less; the length of a football field or less).

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

2. There are many (3 or more) alternative roads (official routes) for getting from place to place in my neighbourhood (I do not have to go the same way all the time).

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

3. There are many (3 or more) unofficial routes (walking / foot paths) connecting places in my area.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

6. There are many (3 or more) shortcuts such as foot paths between roads (official routes) in my area.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

7. Some roads (official routs) or walking / foot paths (unofficial routes) in my area are blocked by gates or barriers.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

E. Places for walking, cycling, and playing.

Please circle the answer that best applies to you and your neighbourhood.

1. There are formally provided sidewalks (pedestrian pavements) on most of the roads (official routes) in my neighbourhood.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

2. The sidewalks in my neighborhood are well maintained (paved, even, and not a lot of cracks).

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

3. The sidewalks in my neighborhood are often blocked by merchandise, construction materials, parked cars, gardens / lawns / barricades.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

4. Sidewalks are separated from the road (vehicle traffic) in my neighbourhood by parked cars or dedicated parking bays / curbs.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

5. There is grass / dirt strip that separates the road from the sidewalks in my neighbourhood.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

6. There are signals or crosswalks / zebra crossings to help walkers cross the busy roads in my neighborhood.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

7. There are curb ramps (decline or smooth grades) that go from sidewalks level to road level at road crossings (Intersections / junctions) in my neighbourhood that assist the elderly or wheelchair / pram users.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

8. There is enough time for people on foot to cross the road at crossing points / junctions with traffic lights, signals, or robots.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

9. There are informal places (Walk / footpaths) for people to walk in my neighbourhood.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

10. The walk / foot paths in my neighborhood are generally of good quality (few potholes, ditches, un-evenness, stones, obstructions), so it is not difficult to walk there.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

11. In my neighborhood / area there are busy roads that are dangerous to cross.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

12. There are designated or marked places to bicycle, such as separate paths or trails or shared use paths for cycle and pedestrians in or near my neighbourhood.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

F. Neighborhood surroundings

Please circle the answer that best applies to you and your neighborhood.

9. There are trees along the roads / paths in my neighborhood.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

10. My neighborhood is clean and free of litter, garbage, or stagnant water.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

11. My neighbourhood if free from bad smell and adors.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

12. There are beautiful natural sights / views in my neighbourhood.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

13. There are attractive buildings / houses in my neighbourhood.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

14. My neighborhood is generally free of unpleasant noises like highways, factories, trains, bars, music / record studios, night clubs / discotheques etc.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

15. My neighbourhood is generally free of noticeable pollution and dust, such as from traffic or factories.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

16. There are many pleasant natural sounds in my neighbourhood such as from birds.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

G. Safety from traffic.

Please circle the answer that best applies to you and your neighborhood.
.

1. There is so much traffic along nearby roads that it is difficult or unpleasant to walk nor play in my neighbourhood.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

2. The speed of traffic on most nearby roads in my neighbourhood is usually slow.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

3. Most drivers exceed the speed limits (drive fast) in my neighborhood.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

4. Walking or playing is dangerous in my neighborhood because of careless or aggressive driving.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

5. It could be dangerous to ride on a bicycle in or near my neighbourhood because of speed of traffic.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

6. I am worried about playing or walking in my neighbourhood and local streets because I am afraid of being injured by a car.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

H. Safety from crime

Please circle the answer that best applies to you and your neighborhood.

1. There is a lot of crime rate in my neighborhood.

1	2	3	4

strongly disagree	somewhat disagree	somewhat agree	strongly agree

2. There is too much crime in my neighborhood to go outside for walks or play during the day.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

3. There is too much crime in my neighbourhood to go outside for walks or play at night.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

4. There are groups of people or gangs (rascals, hooligans, and thugs) in my neighbourhood who make me feel threatened when I go out.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

I. Personal Safety

Please circle the answer that best applies to you and your neighborhood.

1. I see and I can talk to people when I am walking in my neighbourhood.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

2. There are stray dogs or dangerous animals that scare me in my neighbourhood.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

3. The roads in my neighbourhood are well lit (adequate functioning streetlights) at night.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

J. Stranger Danger

If you are a parent with a child 17 years old or below, please answer the questions below. When responding to the questions, please think mainly about the child who brought the survey.

ix. I am worried about letting my child *play or being outside alone or with friends* around my house (e.g., yard, driveway, apartment common area), because I am afraid of them being taken or hurt by a stranger.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

x. I am worried about letting my child play or walk *alone or with friends* in my neighborhood and local streets because I am afraid of them being taken or hurt by a stranger.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

xi. I am worried about letting my child be alone or *with friends* in a local or nearby park because I am afraid of them being taken or hurt by a stranger.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

THANK YOU AND WE APPRECIATE YOUR HELP IN COMPLETING THE LONG QUESTIONNAIRE

Appendix N: Interview Manual for NEWS-Africa Survey

As an interviewer administering the NEWS-Africa survey, you are required to be familiar with the information in this manual. The information is to help inform you about the meaning of items in the survey and guide you on what and how to prompt and explain if some questions are difficult for the respondents. Please ensure you understand and clarify with the research team all difficult items not clear to you before proceeding with respondents' interviews.

SECTION A: DEMOGRAPHIC INFORMATION

The demographic section of NEWS-Africa survey was designed to collect demographic variables that are comparable across African countries. When using NEWS-Africa it is important to collect demographic data in ways that are consistent with those described below:

Variables Indicators

1. Age: Ask for the age in years or the date of birth from the respondents

2. Sex: Collect data to be able to determine % of female from total sample

3. Marital status: Collect data to be able to dichotomize into "Married/living with partner" vs "others". Mark not "not applicable" for youth

4. Education: Collect data to allow for grouping into "less than high school", "some high school/completed high school", and "more than high school".

5. Motorized transport: "None", "one", "two", and "three or more" are required indicators for this variable

6. Frequency of motor: Less than once a week (including none), a few times a week, most days of the week, and everyday are the minimum required indicators for this variable

7. Income: Not a compulsory variable for NEWS-Africa, but if possible, to collect from the respondents, the idea is to identify three categories ("low income", "middle

income" and "high income"), so use the cut-points specified by the research team (Note that this variable is not relevant for youth)

8. Adults in household: Count adults who live there "most of the time".

9. Youth in household: Count youth 17 years or younger who live there "most of the time".

10. Present address: Collect either the specific street address with city/town, or nearest street intersection

11. Height: Collect data as continuous variable (direct measurement or self- report). Specify the unit in metres.

12. Weight: Collect data as continuous variable (direct measurement or self- report). Specify the unit in kg.

SECTION B: QUESTION ABOUT YOUR NEIGHBOURHOOD

Instruction: Please emphasize to the respondents that the intention of this section is to know more about the areas where they live, and their perceptions about the built environment (houses, roads, infrastructures, and physical and social facilities) in their neighbourhood as it affects their mobility and activities such as walking, cycling, and playing. Please, *emphasize to the respondents to think of their neighbourhood as all the areas that are about one kilometre or half a mile of their house or all the areas that they can walk to in 10-15 minutes.*

A- TYPES OF HOUSING

The intention of this section is to capture the housing density in the areas where the respondent lives. Please explain to the respondents that the various housing types have been ordered and ranked from the lowest (1) to the highest (6) residential density. Please use the provided photos (#1 to #6) of the various housing types to aid the respondents' understanding of the main type of housing in their neighbourhood. Respondents can only select one type of housing in this section.

B- STORE, FACILITIES, AND OTHER THINGS IN YOUR NEIGHBOURHOOD

The purpose of this section is to rate the time it takes to walk to diverse places, destinations, or locations from the respondent's home. Note that the various places or destinations listed in the questionnaire are not necessarily intended to be available in the respondent's immediate neighbourhood, but at any nearest locations in or outside of their neighbourhood. Respondents do not need to estimate the exact minutes; they can use the ranges of minutes on the questionnaire.

For participants having difficulties estimating the time taken to walk to any of the listed destinations, please prompt them to estimate this time relative to the time taken to walk to a common destination they always go (e.g., faith-based places, work, or school). This can help them estimate distances to walk to places that are nearer and farther. "Walking" refers to their usual pace or speed.

If participants do not know where a destination is (absent or not available in the neighbourhood) or it takes longer than one hour to go, please instruct them to choose the "Don't know" option or to answer with the highest category of minutes on the response scale.

C- ACCESS TO SERVICES AND PLACES

This section focuses on the degree to which respondents can access important places and destinations in their neighbourhood within easy walking distance from homes. Please clarify to respondents that the words "It is easy to walk" and "Easy walking distance" used in this section can mean 10-15 minutes. For each of the items, please emphasize only the examples that are specific to the respondents' location rather than all the listed examples. For example, when interviewing respondents who live in the city, it will be more appropriate and less confusing to prompt them about gathering places such as faith places (e.g., church, mosque) rather than on king palace, village square and community centre.

To enhance the understanding of the scoring of items in this section and the remaining sections, please prompt and carefully explain the response options to the respondents. For example, ask the respondents to first indicate whether they agree or disagree to the

question. Then follow-up and ask whether the degree of agreement/disagreement is strong or somewhat (a bit). Please use these definitions as guide:

"strongly agree" means to say "definitely yes" to the question "strongly disagree" means to say "definitely no" to the question "somewhat disagree" means to say "a bit or little no" to the question "somewhat agree" means to say "a bit or little yes" to the question.

D- ROADS AND WALKING PATHS IN MY NEIGHBOURHOODS

The purpose of the questions in this section is to assess the perceptions of the respondents on how connected the roads or streets in their neighbourhoods are, and to know if it is easy to move (walk or bicycle) from one location to the other in their neighbourhood without barriers. Please note that a well-connected street will have more intersections (closer to many other streets), more shortcuts and many alternative roads for getting from place to place.

To improve the clarity of items in this section, please emphasize and explain the distinction between road and pathways/shortcuts/foot paths to the respondents. Roads are formal routes (either tarmacked or not), that is, official places for cars with or without pedestrian facilities. On the other hands, pathways, shortcuts, and foot paths are informal (unofficial) places where people can walk or bicycle but not primarily meant for cars. Please use photos where necessary to facilitate better understanding of these concepts and questions among the respondents. Photos #7 provides examples of formal/official routes (roads), while photo #8 provides examples of informal/unofficial routes (pathways, footpaths, shortcuts).

E- PLACES FOR WALKING, CYCLING AND PLAYING

The aims of this section are to assess the availability and quality of pedestrian infrastructures/ facilities in the respondents' neighbourhood, and to gauge their perceptions on safety of places they walk, cycle and play. In addition to probing to improve the clarity of the response options and concepts of formal (roads) and informal (walk paths) routes as indicated in section C and D above, please use the provided photos (#9 through #15) to facilitate the understanding of each of items Q1 (sidewalks), Q4

(sidewalks separated from road by parked cars or dedicated parking bay/curbs), Q5 (sidewalks separated from roads by grass/dirt strip), Q6 (signals or crosswalks/zebra crossings), Q7 (curb ramps that from sidewalk to road level at road crossings), Q8 (cross points/junctions with traffic lights, signals or robots), and Q12 (separate paths or trails or shared used paths for bicycling). For Q12, please clarify to the respondents that the assumption of marked places is not for all routes but some routes in their neighbourhoods.

F- NEIGHBOURING SURROUNDINGS

Questions in this section are to assess the aesthetic qualities of neighbourhood surroundings. As a guide, an aesthetically good neighbourhood will not only be pleasant and imbued with beautiful and attractive features but also be clean and free of litter, garbage, odour, noise, and other pollution. One strategy that can be used to improve respondents' responses to aesthetic items is to first ask the participants to indicate whether they agree or disagree with each of the statements while thinking aloud, then have them to rate the degree of their agreement or disagreement using the method cited in section C above.

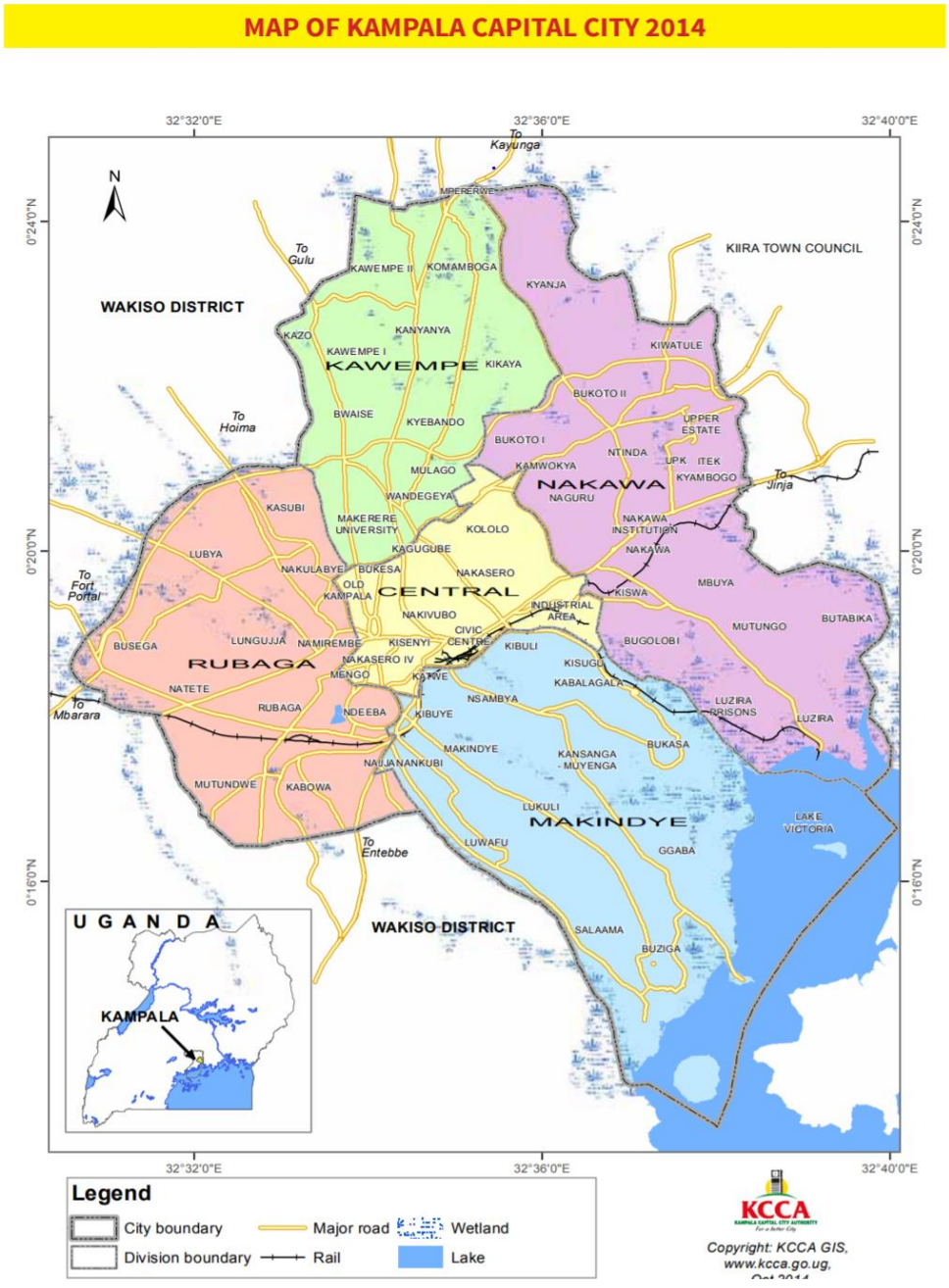
G, H & I – SAFETY FROM TRAFFIC AND CRIME

The purpose of these three sections is to assess the residents' perceptions on how speed of traffic and crime rate affect their ability and willingness to walk and cycle in their neighbourhood. Please use some of the strategies highlighted in sections C, D, E and F above to improve respondents' responses to the items in these two sections.

J – STRANGER DANGER

Please ensure that the parents or guardians think about the child who brought home the survey when responding to questions in this section.

Appendix O: Map of Kampala City, Uganda



Appendix P: Recreation Parks in Kampala City

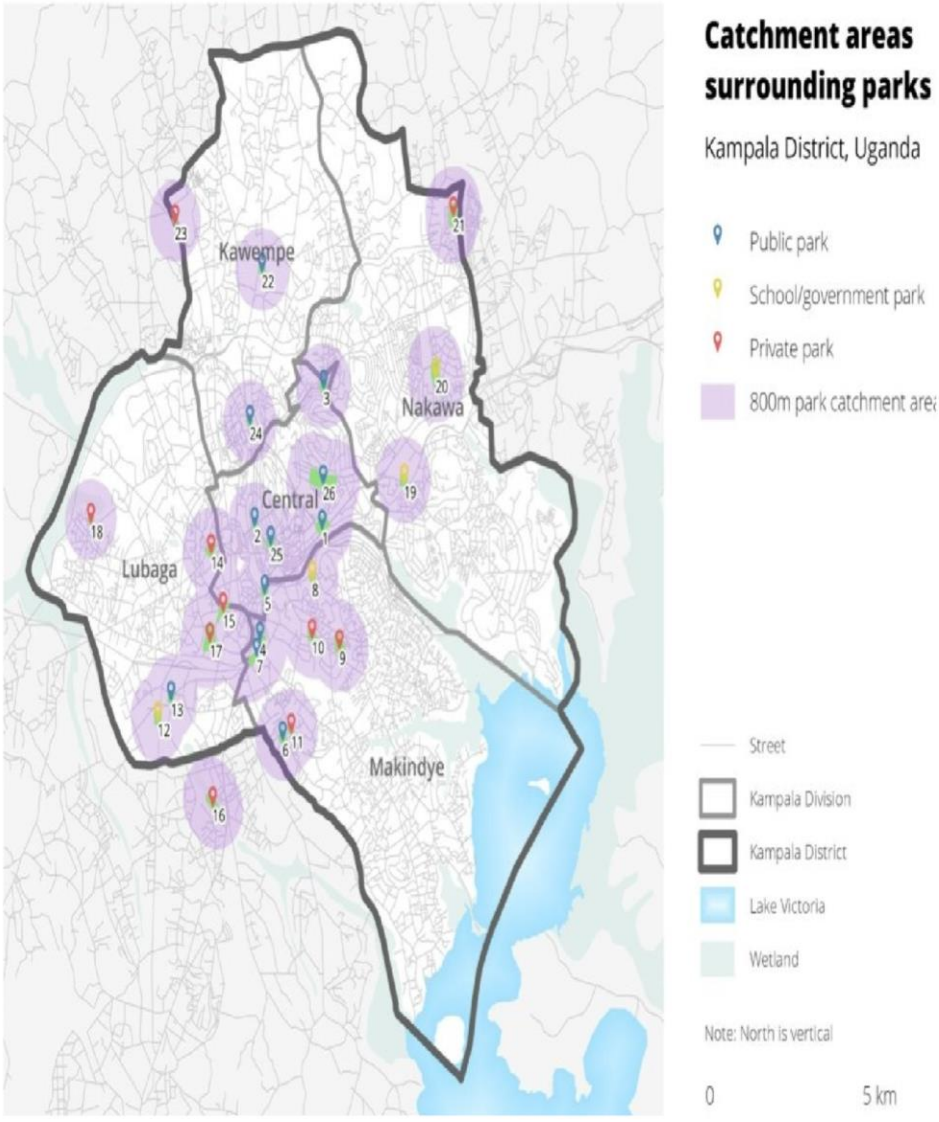


Figure 1: Parks in Kampala and the walking distance around them