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**“PERCEIVED NEIGHBOURHOOD WALKABILITY” AND PHYSICAL
ACTIVITY IN FOUR URBAN SETTINGS IN SOUTH AFRICA**

MSc (Medicine) DISSERTATION

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Science

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Declaration/Preface

I Moses Isiagi, declare that this work is my original work (except where acknowledgements indicate otherwise). Part of this work was used for the award of my honours degree BSc (Hons) (Med) Exercise science Biokinetics (part of the literature review as the research question arose from my honours thesis "Perceived neighbourhood environment" Neighbourhood walkability" and Physical activity in two urban settings in South Africa."

Signed by candidate

Date: 27th June 2019

Dedication

This thesis is dedicated to all who have made me who I am, above all to the Lord almighty, my heart, my love, my all, my whole.

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Acronyms

NCDs: Non Communicable Diseases

WHO: World Health Organization

CVD: Cardio Vascular Disease

T2DM: Type 2 Diabetes Mellitus

SES: Socioeconomic Status

LMICs: Low to Middle Income Countries

LICs: Low Income Countries

BMI: Basal Metabolic Index

TVSE: Television Sedentary Time

MVPA: Moderate to Vigorous Physical Activity

ICCs: Intra Class Correlations

GIS: Geographic Information Systems

NEWS: Neighbourhood Environmental Walkability Scale

IPAQ: International Physical Activity Questionnaire

SOPLAY: System for Observing Play and Leisure in Youth

SOPARC: System for Observing Play and Recreation in Communities

IPEN: International Physical Activity Network

SBP: Systolic Blood Pressure

DBP: Diastolic Blood Pressure

CDI: City Development Index

Keywords

The Neighbourhood Environmental Walkability Scale (NEWS)

Physical activity

Walkability

Ground-truthing

Geographic Information Systems.

Socio-economic status

Built environment

Walking

Transportation, recreation, ground-truthing.

Abstract

Introduction.

In Africa, studies on the associations between the perceived neighbourhood walkability and physical activity, particularly, by socio-economic status (SES) remain scarce. This study explores these associations by validating the Neighbourhood Environmental Walkability Scale (NEWS-Africa) in an urban setting of South Africa to gain a better understanding of the construct of neighbourhood “walkability”.

Methods.

A convenient sample of residents from four suburbs in urban metropole (n=52, 18-65yr, 81% women) in the Western Cape Province, South Africa (viz. Langa, Khayelitsha, Pinelands and Table View) were recruited through invitations following community gatherings and church services. Measures were obtained on perceived neighbourhood walkability, self-reported and measured physical activity and socio-economic status. Langa and Khayelitsha represented two primarily low-SES townships, whereas Pinelands and Table View represented suburbs of a higher-SES. Participants completed the 76-item (13 subscales) NEWS–Africa survey by structured interviews and reported weekly minutes of walking for transport and recreation using items from the International Physical Activity Questionnaire. Objective data on physical activity was collected using accelerometers, and ground-truthing was used to assess the neighbourhood environment using global information systems (GIS) in a 1000m buffer around each geocoded household. The research was carried out in three parts: **1)** Evaluating the reliability and construct validity of the NEWS-Africa instrument between the two-SES groups. **2)** Examining some of the walkability constructs and subscales of the NEWS-Africa instrument using GIS and ground-truthing, and the extent to which the SES of communities influenced these associations. **3)** Examining the differences in self-reported physical activity (domains), measured physical activity (MVPA) when groups are divided according to SES, GIS walkability (1000m buffers) and if the data support the notion of utilitarian walking in low SES groups, irrespective of the built environment attributes.

Results.

For the combined-SES groups, the test-retest reliability indicated a good reliability with 10 out of the 13 scales of the NEWS-Africa being significantly and positively correlated. The

Spearman's correlations ranged from ($r_s = -0.43$, $p=0.00$ to $r_s = 0.79$, $p=0.00$). For construct validity of the NEWS -Africa instrument against self-reported physical activity, only three scales were related to walking for transport: *Neighbourhood surroundings scale* ($r_s = -0.34$, $p=0.01$), *Safety from Traffic scale* ($r_s = 0.34$, $p<0.01$) and *Safety from Crime scale* ($r_s = -0.39$, $p=0.00$). *The Safety from Traffic scale and Safety from Crime scale* were in the opposite direction (Perceived safety from traffic and perceived safety from crime) were associated with less transport related physical activity. For construct validity of objectively measured physical activity, in the combined-SES groups, none of the scales was significantly associated with total physical activity.

People living in high-SES neighbourhoods perceived sports fields and places of worship to be further away than they actually were ($r_s = -0.60$, and $r_s = -0.50$, respectively, $P < 0.05$) and people in the low-SES and combined SES perceived public bus/ train stops to be nearer than they actually were ($r_s = -0.50$, $P < 0.05$). Of the 13 scales of the NEWS-Africa questionnaire, 6 were significantly correlated to GIS-measured walkability index parameters.

The *Roads and walking paths scale* was positively associated with GIS-measured walkability ($r_s = 0.3$), and the *Stranger danger scale* was negatively associated with GIS-measured walkability ($r_s = -0.4$). When we considered GIS-measured Land use mix, 3 of the NEWS-Africa scales were correlated (For the entire sample, the scales including *Places for walking, cycling and playing overall scale* ($r_s = 0.3$), and *Neighbourhood surroundings scale* ($r_s = 0.3$), were positively associated respectively). Conversely, *Stranger danger scale* was inversely correlated ($r_s = -0.6$). Intersection density measured with GIS was significantly and positively associated with the *Roads and walking paths scale* for all groups combined ($r_s = 0.3$).

For GIS-measured walkability, self-report physical and measured physical activity, there were no associations in any of the domains for self-reported physical activity within the 1000m buffer for all groups. However, for the objectively measured physical activity in the 1000m buffer, vigorous physical activity ($r_s = -0.39$) was inversely associated with intersection density in the low-SES and moderate ($r_s = -0.29$) and total MVPA ($r_s = -0.31$) were inversely associated with Intersection density in the high SES.

Conclusions: The overall results of the current study across all chapters generally show a mismatch between the perceived and objectively-assessed built environment, particularly in low-income communities. Furthermore, in low-SES communities, we failed to show the expected relationships between attributes of the built environment and physical activity, suggesting that physical activity in these communities is more utilitarian in nature, and as such, may not be as influenced by aspect of the built environment.

In summary, the data suggest that the environment (including crime rates, poor access to physical activity facilities and public transportation predominantly made by buses) has less of an association with physical activity in LMICs and more disadvantaged communities, where physical activity is used for utilitarian, rather than recreational purposes. This study stemmed from the need to broaden research on the relationship between the built environment and physical activity, considering walkability constructs. These findings also suggest that the definition of the construct of walkability be re-examined, in relation to low SES settings.

Key words:

Physical activity, Built environment, walkability, walking, Transportation, Recreation, Ground-truthing.

CHAPTER ONE

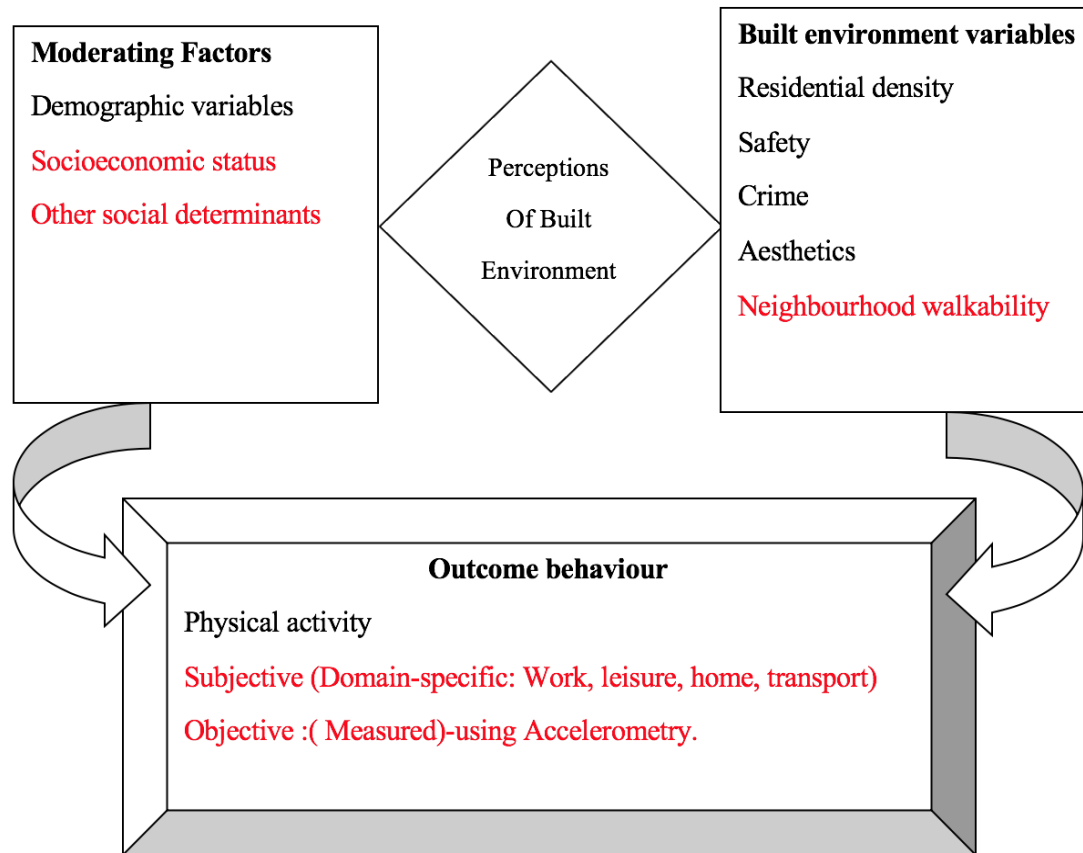
SCOPE OF THE THESIS AND LITERATURE REVIEW

1.1 Scope of the Study

The burden of physical inactivity is heavy in the nation of South Africa, as it grapples with a concurrent epidemic of infectious and non-infectious chronic diseases (Mayosi et al., 2009). The positive effects of adequate physical activity on health and quality of life is a strong justification to prioritise the promotion of regular physical activity as part of a comprehensive strategy to reduce non-communicable diseases (NCDs). This can best be achieved by routine surveillance of physical activity and measurement of the environmental and socio-ecological determinants of physical activity, as potential targets for population-based interventions, often lacking in low and middle-income countries (Bauman et al., 2012). The ecological model provides a framework to understand these interventions based on a premise of healthy behaviours being shaped at both individual and community level, coupled with strategies targeting the built environment and policies (Oyeyemi et al., 2013a). This model (Figure 1) has provided a foundational base for examining the correlates of physical activity and other behaviours that can impact on the overall physical activity of populations over time.

For the present study, the focus is on two significant correlates (or determinants) of physical activity namely, socio-economic status (SES) and perceived and/or objectively measured attributes of the built environment. In particular, we were interested in the interaction between these two factors. The principal reason for examining the built environment is because many environments can create unsafe, inconvenient and even impossible situations for physical activity (Michael, 2011). Alternatively, the built environment may enhance opportunities for and access to safe and enjoyable physical activity, whether walking for leisure or transportation, or for recreating in one's leisure time (Michael, 2011). The ease and access for walking and cycling to various destinations in these environments for various purposes are collectively termed as "walkability" (Hanson & Gluckman, 2011).

Figure 1: The social-ecological model adapted to physical activity and adapted from (Sallis JF, 2002)



Supportive attributes of the built environment and physical activity done for transportation and recreation purposes have been documented several times (Bauman et al., 2012; Oyeyemi et al., 2017), yet most of this evidence is from high-income countries. In Africa, studies of built environment and physical activity relationships remain scarce particularly, by socio-economic status (SES) (Oyeyemi et al., 2014).

The Neighbourhood Environment Walkability Scale (NEWS) is perhaps the most widely-used instrument to examine the perceptions of the neighbourhood built and social environment concerning physical activity (Leslie et al., 2005). The earliest findings of NEWS, in 2003, at its inception, strongly supported the test-retest reliability of this self-report measure of neighbourhood environment characteristics around “walkability”, related to lifestyle physical activity and walking for transport (Saelens et al., 2003). The scale was later found valid and reliable in the Global North (Adams et al., 2009),(Cerin et al., 2013) and the first of its kind in Africa, was demonstrated in Nigeria (Oyeyemi et al., 2013).

The NEWS-Nigeria found associations between perceived attributes of the built environment and physical activity in Nigerian adults. However, the study was limited to two cities in Nigeria and may have restricted environmental variability and therefore, may have underestimated the strengths of association between the environment and physical activity. Subsequent to this work in Nigeria, the development of an African-wide version of the NEWS, was undertaken.

The African wide-version of the NEWS was adapted and evaluated in seven sub-Saharan African countries across the East (Kenya, Uganda), West (Ghana, Nigeria), Central (Cameroon) and Southern Africa (Mozambique, Republic of South Africa) and over 95% of the NEWS measures of perceived walkability (scales and sub-scales) fell into the “excellent” or “good” category with respect to test-retest reliability and over half of the computed scales fell into the “excellent” agreement category. However, the study failed to differentiate and compare results between high- and low- SES and high- and low-walkable communities, across the sample which may have limited the generalizability of the findings (Oyeyemi et al., 2016). Furthermore, this study relied only on self-report physical activity, as a means of providing some form of construct validity. Objectively-measured physical activity would provide a more valid measure of physical activity, against the perceived built environment attributes. Additionally, ground-truthing studies, using GIS to measure actual distances to amenities, intersection density, residential density, and objective measurements of traffic and crime, were proposed. Ground-truthing, or direct observation, provides a way of comparing the perceived environment against the actual environment, thereby providing additional insights into the factors related to the perceived environment which would potentially impact on physical activity behaviour.

This thesis, therefore, aimed to explore associations between the built environment and physical activity, by validating the NEWS-Africa scale, using ground-truthing and remote-sensing technology (i.e. Geographic Information Systems, GIS) in an urban South African setting to gain a better understanding of the construct of neighbourhood walkability, in low- and high-income communities. Ground-truthing may involve direct observation ("on foot"), environmental or street audits which require a visit to each area, facility, or street to observe and rate characteristics of the built environment (Charreire et al., 2014) or or GIS. Few studies have been done on ground-truthing the built environment in relation to physical activity.

Individuals from four suburbs in the urban metropole (n=52, 18-65 years, 81% women) in the Western Cape Province, South Africa (viz. Langa, Khayelitsha, Pinelands and Table View) were recruited to obtain information on perceived walkability and self-reported and objectively-measured physical activity, in relation to socio-economic status (SES). Langa and Khayelitsha represented two primarily low-SES communities, whereas Pinelands and Table View represented suburbs of a higher-SES. Participants completed a 76-item (13 subscales) of NEWS–Africa by interviewer-administered questionnaires and reported weekly minutes of walking for transport and recreation using items from the International Physical Activity Questionnaire (IPAQ). Physical activity was objectively measured using accelerometers, and ground-truthing was done, using GIS and household addresses.

1.1.1 Thesis Outline:

Chapter 1: Literature review.

The literature review covers the burden of physical inactivity which has contributed to the global burden of non-communicable diseases (NCDs) and all-cause mortality. It also reveals the need to prioritise the promotion of regular physical activity as a comprehensive strategy to reduce NCDs. This can best be achieved by routine surveillance of physical activity and measurement of the environmental and socio-ecological determinants of physical activity. The literature review centres on the ecological model, of which we focused on two significant correlates/determinants of physical activity namely; socio-economic status (SES) and the perceived and objectively-measured attributes of the built environment. We were particularly interested in the interaction between these factors.

“Walkability“, as a construct, refers to environments that encourage people to walk or cycle for transportation and leisure (Hanson & Gluckman, 2011). Walkable neighbourhoods are ones in which it is easy to walk or cycle directly to multiple destinations. The literature review interrogates how walkability has been measured (i.e. subjectively and objectively), and the tools (questionnaires and surveys) used in different regions and countries to measure walkability are discussed. The gaps and recommendations from the use of these tools have been highlighted. Many studies have underscored the relationship between supportive attributes of the built environment and physical activity undertaken for transportation or recreation (Bauman et al., 2012; Oyeyemi et al., 2017; Inoue et al., 2011; Cerin et al., 2007;

McCormack et al. 2008) yet most of this evidence is from high-income countries. However, in Africa, studies of the built environment and physical activity relationships remain scarce (Oyeyemi et al., 2014).

One of the tools for measuring walkability, the Neighbourhood Environmental Walkability Scale (NEWS), is perhaps the most widely-used instrument. It is used to assess perceptions of the neighbourhood built and social environment, concerning physical activity (Leslie et al., 2005). More recently, the NEWS survey has been adapted for use in African urban settings. To this end, a group of health scientists from Africa, in collaboration with colleagues from the University of San Diego met (Saelens et al., 2003) intending to retain as many original concepts and items, but with a theme of appropriation to local culture and environment in Sub-Saharan Africa.

Consultation with urban planners, transport authorities and other stakeholders, resulted in the final adaptation of the NEWS survey and included all items of the original instrument with minor modifications in language. Additional items within the various sub-scales included:

- *Destinations scale*- Place of worship/faith centre, tap/well(pond, river or stream for fresh water), places for hunting/collecting firewood,
- *Access to services scale*- Places to get essential supplies like water and firewood are within easy walking distance of the home.
- *Roads and walking paths scale*- There are many unofficial routes connecting places in the area.
- *Merchandise, construction materials, etc. often block sidewalk scale*- The sidewalks in the neighbourhood.
- *Path infrastructure scale*- There are informal places for people to walk in the neighbourhood, the walking/footpaths in the neighbourhood are generally of good quality.
- *Neighbourhood surroundings scale*- The neighbourhood is free from bad smells and odours; the neighbourhood is generally free of unpleasant noises like highways, factories, trains, bars, there are many pleasant natural sounds in the neighbourhood such as from birds.
- *Traffic scale*- Walking or playing is dangerous in the neighbourhood because of careless or aggressive driving.

- *Crime scale*- There are groups of people or gangs in the neighbourhood who make one feel threatened when they go out.
- *Personal Safety scale*- There are stray dogs or dangerous animals that scare people in the neighbourhood.

Measures of reliability and validity of the NEWS-Africa tool were then carried out (Oyeyemi et al., 2016). However, one of the limitations of the NEWS-Africa study was that it relied entirely on self-reported physical activity as the measure to determine construct validity. These measures are prone to bias, recall problems and inaccuracy of measurement (Oyeyemi et al., 2016), especially of physical activity and intensities.

This study broadens the research on associations between the built environment and physical activity by validating the NEWS-Africa scale, using objectively-measured physical activity and ground-truthing with remote-sensing technology (Geographic Information Systems, GIS) in an urban South African setting.

1.1.2 Specific objectives of the thesis

Chapter Two: This chapter aimed to assess the test-retest reliability and construct validity of the NEWS-Africa, in high- and low-income communities. The adaptation and evaluation of the NEWS was previously carried out in seven sub-Saharan African countries across the East (Kenya, Uganda), West (Ghana, Nigeria), Central (Cameroon) and Southern Africa (Mozambique, Republic of South Africa). Overall, over 95% of the NEWS measures of perceived 'walkability" (scales and sub-scales) fell into the "excellent" or "good" category and with respect to test-retest reliability and over half of the computed scales fell into the "excellent" agreement category. Spearman's rank-order correlations were calculated between environmental variables (NEWS scales, subscales and single items) and IPAQ self-reported physical activity measurements and objective accelerometer data. However, in this multi-site study, they were not able to consider any differences in reliability and construct validity in high- and low- income communities. This thesis will address differences in the instrument properties, in communities varying by income.

Chapter Three: In this chapter, we examined walkability constructs and subscales of the NEWS-Africa instrument against GIS-based ground-truthing of similar, but objectively-measured attributes. Furthermore, we examined the extent to which the socioeconomic status of communities influenced these associations.

This study followed the methods developed by Adams et al. (Adams et al., 2014), which employed the individual-level, street network buffer- based GIS measures. The sample was divided into four groups using a median split for the walkability score (Low-SES/Low walkable (n=11), High-SES/ High walkable (n=13), Low-SES/High walkable (n=13), High-SES/High walkable (n=13). Perceived neighbourhood variables (including estimated walking distances or proximity to destinations, and the various walkability subscales) were compared to objectively-measured distances in three buffer zones (500m, 1000m, 1600m). We then examined differences in the perceived attributes of neighbourhood walkability in the high- and low- income and high- and low- walkable communities (Kerr et al., 2013).

Chapter Four: In this chapter, we examined the differences in self-reported physical activity (domains) and measured physical activity (MVPA), in participants from neighbourhoods according to socioeconomic status and GIS-measured walkability (500 and 1000m buffers). Perceived neighbourhood variables (including estimated walking distances or proximity to destinations, and the various walkability subscales) were compared to objectively-measured distances in the 500m and 1000m buffer zones, as well as the GIS-measured attributes that comprise the measure of walkability.

Chapter Five: In this chapter, we summarise all the findings of the previous chapters, review the strengths and limitations of the studies, and provide recommendations and a way forward for future research arising from the findings in this study, as well as any implications for public health.

1.2 Literature Review

1.2.1 The burden of physical inactivity.

NCDs death is projected to rise by a proportion of 15% globally between 2010 and 2020, accounting for 44 million deaths (WHO, 2010b). Furthermore, almost 4 out of every 5 NCD-based deaths occur in low and middle-income countries (Wagner & Brath, 2012). Pillay et al., (Pillay-van Wyk et al., 2016), highlighted that the top ten causes of death in South Africa have not changed from 1997 to 2012, although the rates and rankings have changed. In 2012, 43.3% of the deaths were attributed to NCDs.

The main risk factors for these NCDs are similar in most countries and include but are not limited to genetics, socio-economic and ecological factors, and modifiable risk behaviours (Mayosi et al., 2009; Wagner & Brath, 2012). Worldwide, physical inactivity presents a significant public health concern, as it ranks fourth in the leading causes of death (Lee et al.,

2012b; Vineis et al., 2014; Lee et al., 2012b). Physical inactivity increases the risk for overweight and obesity (Gaskin et al., 2012), and premature death and morbidity due to chronic diseases including cardiovascular disease (CVD), Type 2 diabetes mellitus (T2DM) and some cancers (Dempsey et al., 2014).

Recently, Ding et al., (Ding et al., 2016) undertook the first detailed study of the global economic burden of physical inactivity, representing more than 93% of the world's population. They found that the disease burden associated with physical inactivity amounted to 13.4 million Disability Adjusted Life Years worldwide. Furthermore, while the economic burden of physical inactivity was evenly spread across the regions, the actual disease burden was different according to levels of economic development. Only a small proportion of the economic burden but a significant portion of the disease burden was shared by the low income and middle-income countries (Ding et al., 2016).

The burden of physical activity is substantial in the nation of South Africa, as it grapples with a concurrent epidemic of infectious and non-infectious chronic diseases (Mayosi et al., 2009). Mayosi et al. (Mayosi et al., 2009) highlighted the fact that along with the political transition in South Africa, there was a concomitant rise in NCD's. Non-communicable diseases are exacerbated by so-called “modifiable risk factors” such as physical inactivity, unhealthy eating and overweight, smoking and an excessive intake of alcohol. However, there is growing recognition of the ecological, environmental and social determinants of non-communicable diseases, which are not under the control of the individual, but may only be addressed through policy solutions, targeting issues of social and environmental justice (Bryant et al., 2015). Therefore, there is a strong justification to not only prioritise the promotion of regular physical activity as part of a comprehensive strategy to reduce NCDs, but to understand ecological and environmental barriers to achieving this aim. This can best be achieved by routine surveillance of physical activity and measurement of the environmental and socio-ecological determinants of physical activity — data which are lacking in low and middle-income countries.

1.2.2 Guidelines and Recommendations for physical activity

The effects of physical activity on health and disease include but are not limited to: reduction in risk of colon cancer (Demark et al., 2012), improvement in muscle and liver insulin sensitivity and improvement in control of Type 2 diabetes mellitus and metabolic syndrome (Hayes & Kriska, 2008; Kavookjian et al., 2014; Kirk et al., 2007; Riddell & Sigal, 2013),

reduced blood pressure in hypertensive patients (Cerin et al., 2013), improvements in blood lipid profiles (Durstine et al., 2002) and reduced weight and the associated risk of the comorbidities of obesity (Christ et al., 2004).

The World Health Organisation recommendations and guidelines for physical activity, first published in 2010 (WHO, 2010a) suggested that adults between the ages of 18-65 years should engage in:

- *“At least 150 mins of moderate-intensity aerobic physical activity weekly;*
- *alternatively, do at least 75 mins of vigorous-intensity aerobic physical activity weekly*
- *alternatively, an equivalent combination of moderate- and vigorous-intensity activity.*
- *Aerobic activity should be performed in bouts of at least 10 minutes in duration, and for additional health benefits, adults may increase their weekly levels of moderate-vigorous physical activity. “*

In light of the above, physical inactivity has been defined as the activity level insufficient to meet these recommendations by WHO (Hallal et al., 2012; Vineis et al., 2014). Using this definition, it has been estimated that one-third of the world's population is insufficiently active (Hallal et al., 2012). In South Africa, the prevalence of physical inactivity has been estimated to be between 43%-49% in the age group of 15 years and older (Craig et al., 2013; Joubert et al., 2007). Therefore, it is essential to understand the various correlates and determinants of physical activity, to adequately address the barriers to participation and improve access and opportunities for safe and enjoyable physical activity for all.

1.3 Correlates and determinants of physical activity

Physical activity is a culmination of many factors. Individual-level, environmental and policy interventions have been put forward worldwide to promote physical activity because they can influence large groups and bring about population-wide range changes (Bauman et al., 2012). The ecological model in Figure 1 above provides a framework to understand these interventions based on a premise of healthy behaviours being shaped at both individual and cooperative level, coupled with strategies targeting the built and social environments, as well as public policies (Oyeyemi et al., 2013a). This model has provided a foundational base

for examining the correlates of physical activity and other behaviours, as they can impact a large population group over time.

In a review of reviews, Bauman et al. described some consistent correlates of physical activity, including individual-level factors such as: age, sex, health status, self-efficacy and previous physical activity (Bauman et al., 2012). They also reviewed studies in which ecological factors related to the physical and social environment, socioeconomic status, urbanisation, and social norms were shown to be important determinants of physical activity (Bauman et al., 2012). Finally, they drew attention to the fact that there is limited data on correlates and determinants of physical activity in lower and middle-income countries (LMICs). One of the factors that mitigated comparisons in these settings is that the studies done in LMICs have typically focused more on the correlates of the most prevalent domains of physical activity, which are transport and occupational activity.

In the intervening period since the Bauman et al. review (Bauman et al., 2012), there have been few additional studies that have examined the correlates of physical activity among adults in low-income countries. One such study (Koyanagi et al., 2017) investigated physical activity correlates (sociodemographic, health behaviour and physical health) among community-dwelling older adults (aged ≥ 50 years) in six low- and middle-income countries. The countries included: China, Ghana, India, Mexico, Russia and South Africa. The study revealed unemployment and older age to be the most consistent sociodemographic correlates of low physical activity in older adults and highlighted that next to physically-demanding labour, active transport to and from work might be an underlying reason for the higher physical activity levels among employed persons. The study also underscored that a multitude of factors influenced physical activity in older adults and that these could inform future interventions across low- and middle-income countries to assist people of this age group to engage in physical activity.

One of the first established studies on the built environment as a correlate of physical activity provided a basis for studying the importance of behaviour-specific environments (Hovell et al., 1990). Since then, many tools have been used to measure the perceived built environment in relation to physical activity behaviour (Brownson et al., 2009b). These measures examine the extent to which individuals perceive barriers and access to physical activity based on different elements of recreational facilities and green space, land use and transportation environments (Brownson et al., 2009a). The principal reason for examining the built

environment is because many environments can create unsafe, inconvenient and even impossible situations for physical activity. Alternatively, the built environment may enhance opportunities for and access to safe and enjoyable physical activity, whether walking for leisure or transportation, or for recreating in one's leisure time (Michael, 2011).

For the present thesis, the focus is on two specific correlates/determinants of physical activity namely; socio-economic status (SES) and perceived and objectively measured attributes of the built environment in low-income countries. We are particularly interested in the interaction between these factors.

1.3.1 Socio-Economic Status (SES) and physical activity in low- income countries.

The relationship between SES and physical activity has been studied extensively in the Global North, with cross-sectional studies showing consistently lower levels of physical activity among populations with a lower - SES (Giles-Corti, 2002; Bauman et al., 2012). Hanson et al. (Hanson et al., 2007) reviewed the relationship between SES status and physical activity in adolescents, using different indicators such as household income, employment status and material affluence. Of the 20 studies that were included in the review, 80% reported that high-SES groups engaged in more physical activity than their low-SES counterparts. The study further underscored that individuals living in low SES communities may spend more time indoors, because of unsafe neighbourhoods or lack of green spaces in which to exercise, compared to their high SES-counterparts.

In the Koyanagi et al. review of physical activity correlates in older adults described previously, involving six LMICs (Ghana India, Mexico, Russia and South Africa), unemployment was the most consistent socio-demographic correlate of physical inactivity. However, other sociodemographic factors had mixed results depending on the country. For example, increasing levels of wealth were associated with higher odds of physical activity in China and Ghana, where the opposite trend was observed in Russia. The study further showed that urbanicity was related to low physical activity in Ghana and India and individuals with larger household size were significantly less likely to engage in physical activity in India, Russia and South Africa. While in Ghana, the relationship was in the opposite direction.

The study underscored that a multitude of factors influence physical activity, that could inform future interventions across LMICs to assist people of this age group to engage in physical activity. For example, the study highlighted that the differences in urban-rural

physical activity may be related to differences in issues of personal safety and higher crime rates, as well as the availability of motorized transport and lack of crosswalks, sidewalks and safe bicycle lanes in many cities. Although the review had limitations, it provided guidance for health policymakers and researchers by underscoring the need to focus not only on individual correlates and determinants, but to identify and address barriers within the built and social environments, in order to enable persons in LMICs to become more active.

1.3.2 Attributes of the built environment and domain-specific physical activity

The built environment may be shaped by various planning and design processes including:

- Urban planning (Integrated citywide planning/spatial planning/ land use management, urban design/landscape architecture (design for public places),
- Civil engineering (Planning and design structure like roads and sanitation), and
- Architecture (building design) and finally transport planning (Pilkington et al., 2008).

The general targets of the built environment for policies and structural interventions concerning physical activity are typically found in the domains of “active travel” and recreation or leisure time. For this study we shall focus on these two domains. Walkable community designs may influence active transport (Pikora et al., 2003)-(non-motorised transport to and from destinations) particularly when there are destinations close to where people live,. In addition, access to public transport hubs, and structural interventions such as sidewalks, cycle lanes and traffic calming, support active transportation (Pikora et al., 2003; Forsyth, 2015; Lachapelle et al., 2016).

Active recreation may be influenced in turn, by active transportation interventions, but more directly by the availability of recreational facilities including parks and trails, good neighbourhood aesthetics and social cohesion, safety from crime and safety from traffic. Some studies have shown that the location and nature of recreation facilities, shopping and transit destinations may influence the levels of physical activity and walking, in particular (Kolbe et al., 2010: McCormack et al., 2017) highlights that sidewalks and non-recreational destinations within 1.6 kilometres of home could encourage higher overall levels of neighbourhood-based physical activity (Whitfield et al., 2018; Hirsch et al., 2018; Langlois et al., 2016).

Many studies have documented the relationship between supportive attributes of the built environment and physical activity for transportation and recreation purposes (Bauman et al., 2012) yet most of this evidence is from high-income countries. In Africa, studies of built environment and physical activity relationships remain scarce (Oyeyemi et al., 2014, Oyeyemi et al., 2017).

1.3.3 Characteristics of the built environment in LMICs

The disparity between the LMICs and the developed countries is seen in the various planning and design processes. Developed countries have integrated city-wide planning, including efficient land use management coupled with an urban design well suited for the population and efficient architecture (proper planning in terms of the public spaces) (Pilkington et al., 2008).

The built environment in the LMICs and the developed nations differs in the following ways:

Urban overcrowding is a major characteristic of the built environment in LMICs. Cervero (Cervero, 2013) underscores the enormity of the urban planning challenges in developing countries. He states that overcrowded urban road networks, spatial mismatches between housing and growth, deteriorating environmental conditions and economic losses from extreme traffic by congestion are among the more distressing challenges faced by developing cities and all these could be alleviated through improved coordination of transportation. One of the differences in the built environments of the Global South is the comparatively underdeveloped road infrastructure. For example, less than 10% of the land area in Africa, South Asia and South-East Asia is devoted to roads in major cities (Nairobi, Kolkata and Jakarta) contrasting with 25% to 30% in much of continental Europe (London, Paris) and 35% or more in America's largest auto-mobile-oriented cities (Houston and Atlanta).

Urban overcrowding, applied to residential density, is demonstrated not only in LMICs, but also in well-resourced nations with excellent built environment characteristics.. Herath & Bentley (Herath & Bentley, 2017) reveal that although Australian capital cities are among the most expensive in the world, the persistent shortage of affordable housing has led to housing overcrowding especially in the private rental sector. They examined the extent and spatial distribution of overcrowding in the five largest cities in Australia—Sydney, Melbourne, Brisbane, Perth and Adelaide and considered its spatial distribution in relation to

socioeconomic disadvantage. They found that in some cases, more than 20% of residents lived in overcrowded housing, and that there was a strong overlap in the geographies between overcrowding and socioeconomic disadvantage. This is just one example, that urban residential overcrowding is not unique to LMICs, but is also experienced in developed nations, often linked to socioeconomic disadvantage.

Similarly, lack of or unequal distribution of public open and green spaces is another characteristic of the built environment that is seen in many disadvantaged communities in HICs, as well as, in many large cities in LMICs, undergoing rapid and often unplanned urbanisation. Strategies to address this challenge may be targeted at a policy level in terms of urban planning (Madureira & Andresen, 2014), and a community level through public engagement, and community and multi-sector participation.

Daniel (Daniel, 2018) describes 3 such examples for creating open public spaces in African cities: Accra in Ghana, Kampala in Uganda, and Niamey in Niger. In these examples, five strategies were utilised including; community engagement, capacity building, awareness-raising, infrastructure and policy changes. The resultant projects have increased awareness about the importance of public spaces, increased park usage, increased trust in the respective communities with government officials.

The creation of open public spaces in these three examples can be compared to the European typical pattern , which involves the systematic inclusion of green space ,as part of overall urban planning (Mensah, 2014). Lack of green spaces is not unique to LMICs, and Fuller and Gaston have shown that it is also a major problem in the developed world. Their study of 386 European cities revealed a decline in coverage of green spaces which was attributed to this rapid urbanization (Fuller & Gaston, 2009).

Poor road design, coupled with poorly integrated public transit systems and access, is also another characteristic of the built environment often seen in LMICs. However, there are an increasing number of LMIC cities addressing the issue of integrated public transport, the most notable of these is perhaps the Transmilenio in Bogota, Colombia (Kash & Hidalgo, 2014).

In Africa, the first such example, and one which has been regarded as the “gold standard” is the DART Bus Rapid Transit System in Dar es Salaam, Tanzania. There are 6 phases planned, covering a total of over 160km. With the 21km Phase 1 completed, the average commuting times have been reduced for users from 2 hours to around 45 minutes. Commuting costs have been reduced by nearly one-third and there has been a reduction in traffic accidents in the DART corridor. (Scruggs, 2018). Other such systems are being developed, for example in South Africa, with the MyCiti IRT in Cape Town (Haiden, 2012) and Areyeng in Pretoria (Knopjes, 2016) and Rea Vaya in Johannesburg (Venter, 2013) modelled to a large extent on these other examples.

Other strategies that encourage non-motorised transport, used in many developed countries include a road hierarchy, enabling all users to safely access and utilise these routes. Certain principles including traffic-calming in mixed-use areas, and a hierarchical classification system for the road network, based on use and volume (Schepers et al., 2017).

1.3.4 The Built environment in Cape Town

Africa has experienced an exponential growth rate in the urban centres with estimating it at 3.2 % urban growth rate making it the fastest-growing among the six continents (Gauthier & Weinstock, 2010). With respect to Cape town, the State of Cape Town report (2016) shows Cape town as the 10th most populous city in Africa (City of Cape Town, 2016). The population was projected to grow to 3.5 million at an annual growth rate of 0.6% by 2014 (City of Cape Town, 2006). Two distinct economies are evident (the first and second economies). The first economy is characterised by a well-structured environment catering for the affluent section of the population, while the second is characterised by under-development, operating in the midst of poverty (City of Cape Town, 2006). In this report, the City of Cape Town (City of Cape Town, 2006) elaborates on some of the key challenges in Cape Town which include: poverty, housing backlogs, health disparities and crime. The visible and widespread presence of informal settlements and backyard shacks highlight the shortage of low-cost housing and a housing backlog estimated at 265,000 units.

However, overall Cape Town has a higher City Development Index (CDI) at 0.88 than the rest of Western Cape province at 0.81. The CDI is an average of indices including infrastructure, health, education, and income. The extent of this development differs in areas, Khayelitsha and Langa being among the poorest with an overall CDI of 0.75 (their

infrastructure and health were lying at averages of 0.60). With respect to the Human Development Index (HDI) a measure of indices including: health (based on life expectancy), education (based on adult literacy and gross enrolment indices) and income (based on average household income) the city of Cape Town had a higher HDI compared to the provincial average of 0.72. Khayelitsha and Langa again proved to be among the poorest areas with the lowest health indices averaging 0.47 and income indices below par.

The report (City of Cape Town, 2006), also emphasizes the critical issue of social infrastructural backlogs with high population density areas including Khayelitsha and Langa. The city's expanding population was highlighted to create more stress on the social infrastructure and services (education, health care, housing and policy making). Even with the supply of low-cost housing, the economic capacity of potential first-time homeowners was deemed inadequate. Six critical bottlenecks critical to good economic performance are highlighted in the report, they include:

- “Spatial planning (a need to break down racial barriers, by allowing previously excluded areas better access to the first economy and its benefits thereof)”
- “Ageing bulk infrastructure and slow capital expenditure
- “Traffic congestion”
- “Widened gap between the first and second economy”
- “Operational deficiency”
- “Weak debtors collection”

Dwelling Profile

In a 2016 community survey that measured the trends in Cape Town from 1996 to 2016 (Small, 2017). This survey reveals that the percentage of Cape Town households living in formal dwellings has shown little change between 1996 and 2016, increasing from 79.1% in 1996 to 81.6% in 2016, having fallen to 77% in 2001. However, the number of households living in the formal dwellings in Cape Town has doubled over the 20 years from 516,867 to 1,032,497 in five years from 2011 to 2016, this indicates an increase of 23%. For the households living in informal dwellings, the report shows that the number increased from 3.3 % in 1996 to 6.1 % in 2016 with the number of households increasing by 55,859 indicating a 256.5% increase. The population growth in the city of Cape Town is expected to be at 4.2

million people by 2022 and 4.46 million by 2032 (City of Cape Town, 2016). Between 2011 and 2035, 0.6 million more households are expected in Cape Town bringing it to a grand total of 1.7 million households with an average of 3 people in the households(City of Cape Town, 2016).

Compared to other LMICs

Compared to the rest of LMICs, Abubakar and Doan (Abubakar & Doan, 2017) show that there is a unique pattern of overcrowded urban core in post-colonial new capital cities in Africa. Cities like Abuja (Nigeria), Gaborone (Botswana), Lilongwe (Malawi), and Dodoma (Tanzania) have failed to provide adequate housing and infrastructure and the projects to improve on these are capital-post colonial cities are exorbitant.

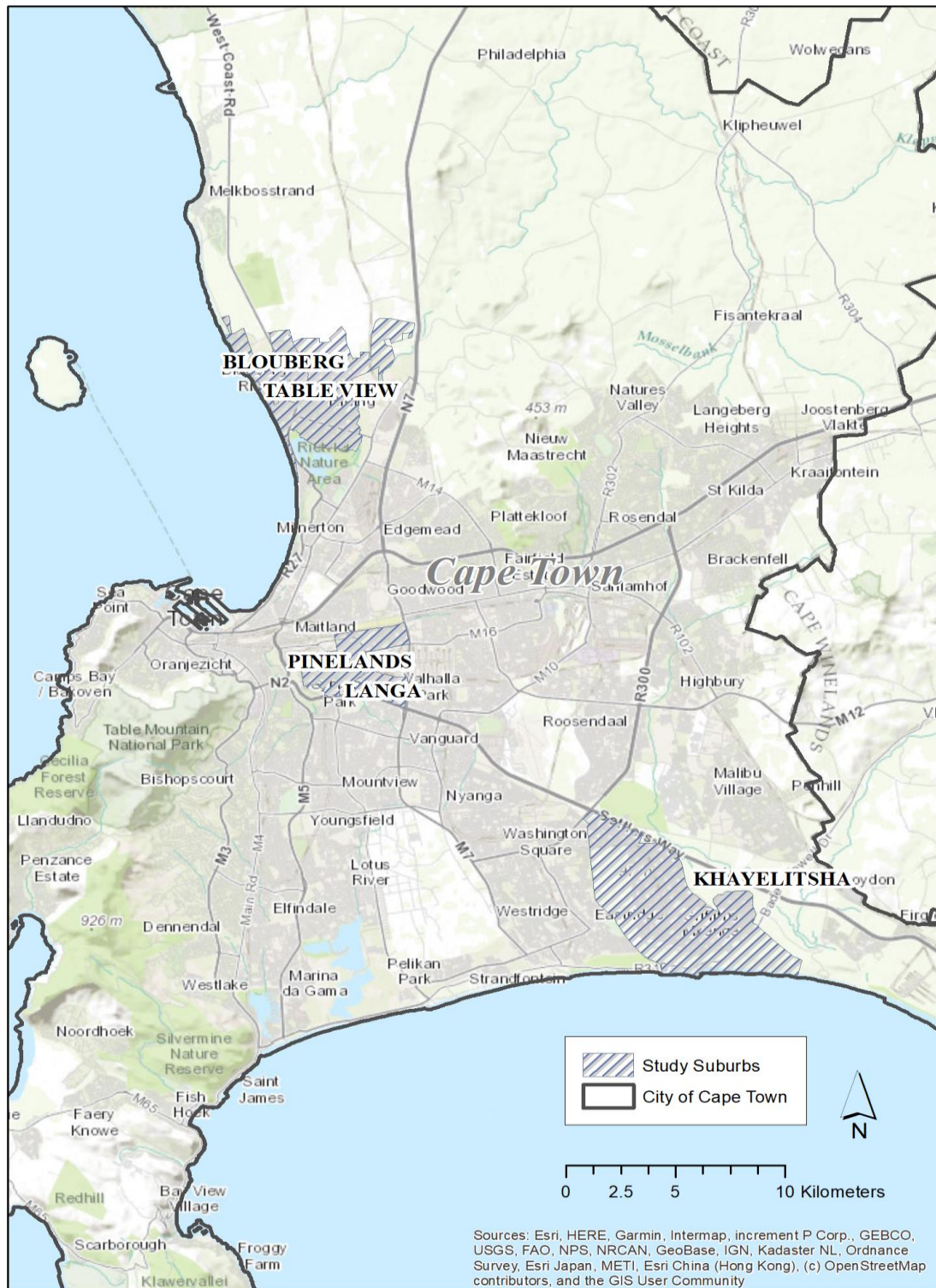
Green spaces

Willemse & Donaldson (Willemse & Donaldson, 2012) underscore that the existing park literature in South Africa is limited in scope and dates back to the apartheid era, with barely any information pertaining to community neighbourhood park (CNP) use especially in townships. The apartheid's government policy was based on "urban racial segregation and town planning was the prime tool through which new and existing urban landscapes were fashioned. These historical spatial imbalances in the development of residential neighbourhoods resulted in the unequal distribution of CNPs which is clearly seen and portrayed in Cape Town.

Their research sought the perceptions, preferences, needs and uses of CNPs in five black townships in Cape Town including (Khayelitsha, Langa, Gugulethu, Nyanga and Lwandle). Their research revealed that these townships had few CNPs, which therefore entailed travelling greater distances by public transport for access. Furthermore, the lack of private garden space forced the respondents to visit the CNPs and spend more time there thereby participating in either active or passive recreation. The main concerns for the CNPs included safety, maintenance and a lack of CNP facilities.

The map below shows a visual representation of Cape Town, with the four study areas included, the proportion of green spaces and the connectivity in the city.

Figure 2 :The spatial distribution of the four study areas showing green spaces, roads and dwelling places. (University of Cape Town EBE faculty GIS labs).



1.4 Measurement of the Built Environment and Walkability

Measurement of the built environment has mainly taken three forms;

- Perceived/ Self-reported environment measures obtained by questionnaires.
- Archival data sets that are layered and analysed by Geographic Information Systems.
- Systematic observations of the community, using specific protocols or audits that researchers have developed to measure the actual physical environment as it is directly observed.

In this thesis, we will be focused on the first 2 methods: perceived/self-reported environment measures and objective measures gathered using Geographic Information Systems.

1.4.1 Perceived built environment measures (Questionnaires or Surveys)

Many tools have been used to measure the perceived built environment in relation to physical activity behaviour (Brownson et al., 2009b). These measures examine the extent to which individuals perceive barriers and access to physical activity based on different elements of recreational facilities and green space, land use and transportation environments. Brownson et al. (Brownson et al., 2009a), highlight that more than 100 studies have examined physical activity behaviour concerning perceptions of the environment, and, the “umbrella” term, environment in these studies encompassed; the physical (built) environment, social factors and policy influences.

This present study focuses on a select set of tools that have been used to measure the perceived built environment from 1997 to date. They are relatively comprehensive, that is, they have been used to assess multiple environmental constructs, and have covered a variety of populations, administrative modes and levels of details. Each of these instruments has a record, describing the process of development and the psychometric/measurement properties of the tool (primarily test-retest reliability).

This included percent agreement which indicates the proportion of exact agreement in terms of response categories, Intraclass correlations (ICCs) which represent the proportion of total variance accounted for by the variability between rather than within measures, and is derived by using one way analysis of variance (ratings suggested by Landis and Koch: 1.0-0.8 (almost perfect), 0.8-0.6 (substantial agreement), 0.6-0.4 (moderate agreement), 0.4- 0.2 (fair agreement) and 0.2 -0.0 (poor agreement). This summary is of instruments only used in adult populations, as our sample is limited to adults in the present study.

Table 1.1: Summarizes the selected instruments measuring perceived built environment

Instrument	Year	Country tested	# of items	Mode of data collection (sample size and sample type)	Domains covered (reliability, r or k) and findings.	The strengths of the study	Limitations
San Diego scales of home & neighbourhood environments and convenient facilities.	1997	USA	43	It was self-administered, and in person with a sample size of (n=110). It comprised of 83 males and 27 females with a mean age of 20.6 years.	(Test-retest reliability, ICC) The 43 items yielded three scales. Home equipment ICC (0.89) Total neighbourhood ICC (0.68) Convenient facilities ICC (0.80) From Sallis et al., (Sallis et ., 1997).	The study reported the development and initial evaluation of the three scales. It further proposed a multi-level conceptualisation of a built environment that includes the three scales.	The sample consisted of only university students from one geographical area. The study also relied on self-reports, and finally, showed weaker associations.
The US Women's determinants Survey.	1999	USA	14	It was an interview and telephone-administered with sample size: n=199). Hispanics: African Americans, and Native Americans (women) aged 40+ years. A comparison group of white women aged ≥ 40 years was also surveyed.	(Test-retest reliability and kappa) The reliability interviews compared closely with the full survey population in terms of socio-demographic characteristics: Good neighbourhood k (0.44-0.84) Easy access to facilities k (0.44-0.75) Workplace and alcohol policy k (0.67) Local government policy k (0.32-0.47) From Brownson et al., (Brownson et al., 1999).	It was the first study to illustrate an efficient method of sampling and validating a population-based sample of women from various racial /ethnic and minority groups.	The study showed lower reliability in black women. The difficulty in explaining variations in the study led to a call for research that combined qualitative and quantitative methods.
Neighbourhood Quality Index; tested.	2002	Taiwan	15	It was self-administered and in person (n=1084). The setting was in Southern Taiwan in metropolitan Kaohsiung area, eight surrounding communities, representing urban, suburban and rural districts were chosen.	(Test-retest, r) Factor analysis with varimax rotation was used to examine the construct of Neighbourhood Quality. Internal consistency reliability of each resulting factor was assessed using Cronbach's. Three subscales explained 54.8 % of the variance in the Neighbourhood Quality Index, viz: perceived social	The study developed a reliable and valid instrument to measure neighbourhood quality with reliable internal consistency. Neighbourhood quality was confirmed as a multi-dimensional construct with three factors viz. i) perceived neighbourhood,	Other aspects of the neighbourhood that have relevance to mental health outcomes could have been missed in this study. Self-reports of neighbourhood quality is susceptible to bias and contamination by general subjective well-being. The cross-sectional nature of the study made it difficult

Instrument	Year	Country tested	# of items	Mode of data collection (sample size and sample type)	Domains covered (reliability, r or k) and findings.	The strengths of the study	Limitations
					capital (Cronbach $\alpha=0.84$), perceived security ($\alpha=0.78$), and adequacy of services and facilities ($\alpha=0.67$). From Yang 2002, (Yang, 2002).	ii) social capital and iii) neighbourhood security and adequacy of services and amenities.	to draw causal relationships.
Perceptions of Environmental Support Questionnaire	2003	USA	26	It was an interview, and telephone-administered (n=408). Respondents home addresses were mapped using GIS (n=1112). A second survey in an independent sample (n= 408) assessed neighbourhood test-retest reliability.	(Test-retest reliability and kappa, as an indicator of validity, kappa statistics were used to measure agreement between perceptions and objective measures identified in neighbourhood community levels using GIS. k= (-0.02- 0.37), rho=(0.42 - 0.74) Community survey items k=(-0.07 - 0.25) and rho= (0.28 to 0.56). From Kirtland et al., (Kirtland et al., 2003).	The study validated physical-activity environmental survey items with objective measures using GIS and demonstrated that GIS comparisons of the scales had high accuracy. GIS data from the study enhanced the visual representation and identification of the neighbourhoods and communities with environmental supports for physical activity, unlike the previous studies.	The GIS from the study could not get data on some barriers like unattended dogs, and traffic volume. The recommendation, therefore, was to include the use of short distances such as a 3-mile or 5-mile radius for the community to define geographical areas especially if the surveys required information beyond the respondent's homes.
Women and Physical Activity Survey.	2003	US	7	Surveys were conducted in person and over the telephone with (n=344) white, Latina, African American and Native American women between ages 20-50 years living in rural and urban areas of the United States of America.	(Test-retest, ICC). 40% were insufficiently active. Reliability for the physical activity measure was 0.69 (95% CI, 0.62-0.74) with an ICC of 0.30 to 0.95. Overall the seven items on the physical environment had substantial reliability. (ICC =0.64 -0.91) Traffic (0.64); Sidewalks (0.91) Lights at night (0.69) Unattended dogs (0.72)	The study provided psychometric evidence that a questionnaire on physical activity and its environmental correlates was reliable among diverse women 20-50 from various ethnic groups.	Although most of the measures in the study were shown to be reliable, this study revealed a need for more validation studies as only one study had previously reported on the validity of the physical activity measure.

Instrument	Year	Country tested	# of items	Mode of data collection (sample size and sample type)	Domains covered (reliability, r or k) and findings.	The strengths of the study	Limitations
					<p>Crime (0.65) Places to walk (0.75) Places to exercise (0.67).</p> <p>From Evenson et al., (Evenson et al., 2003).</p>		
Perceived walking environment.	2004	Australia	8	<p>It was an interview and telephone-administered (n=80).</p> <p>It constituted a sample of 80 adults, including 35 men and 45 women.</p>	<p>(Test-retest,ICC)</p> <p>Logistic regression models were used to examine associations relative to a change in the perceived environment. Results were as follows (ICC) for all.</p> <p>Aesthetics (0.93) Convenience (0.86), Access to services (0.86) Traffic as a problem (0.73) From Humpel et al.,(Humpel et al., 2004).</p>	<p>This was the first study to prospectively examine the relationship between perceptions of the environment and changes in walking behaviour and it showed regular self-reported perceptions of activity behaviour changed over time.</p> <p>The participants in the study with the least positive perceptions demonstrated the most significant increase in scores compared to participants with more positive perceptions.</p>	<p>Data in the study was also collected using self-report, and telephone interviews and such data may have been subject to bias in comparison to objectively collected measures.</p> <p>Also, the data in the study was collected from participants in an intervention trial, and although the intervention was not designed to influence their perceptions of the neighbourhood environment, bias cannot be ruled out as a possibility.</p>
St Louis Environmental Instrument	2004	USA	30	<p>It was an interview and telephone-administered with (n=99).</p> <p>A test-retest study was conducted among adults in the continental USA (n=289) (18 years and older).</p>	<p>The results below are for the St Louis instrument (all ICC).</p> <p>Walking trails (0.92) Safe while walking (0.60), Most liked features of the trail (0.19) Least liked features of the trail (0.58) Safe from crime (0.58) Workplace incentives (0.70) Workplace policy support (0.44), workplace safe stairways (0.42)</p>	<p>This questionnaire, with two other questionnaires, was used to measure the environment for friendliness toward physical activity, and these three surveys showed evidence of reliability.</p>	<p>The study relied on self-reported telephone data, and objective measures were not included in the data that would allow for assessment of validity, this reinforced a need for valid measures.</p>

Instrument	Year	Country tested	# of items	Mode of data collection (sample size and sample type)	Domains covered (reliability, r or k) and findings.	The strengths of the study	Limitations
					Walking/cycling infrastructure (0.51-0.75) Neighbourhood surroundings (0.42) Neighbourhood safety (0.36-0.80). From Brownson et al., (Brownson et al., 2004).		
Neighbourhood walking survey	2005	USA	15	It was a cross-sectional, multilevel design with neighbourhoods as primary sampling unit and senior residents as a secondary unit, 577 residents participated in the study. The study was conducted in 56 city defined neighbourhoods in Oregon. Neighbourhood-level variables were constructed using GIS.	(Test-retest, r) Proximity to local facilities (0.56) Safety for walking (0.56), Safety from traffic (0.56) The number of nearby recreation facilities (0.64). From Li et al., (Li, Fisher et al., 2005)(Li et al., 2005)	The findings in the study provided preliminary evidence of neighbourhood-level change and predictors of change in walking activity in older adults. This study underscores policies to consider features of the built environment that facilitate older adults walking activity in their neighbourhood.	The study was restricted to a single geographical area, the city of Portland. The results might only be generalizable to the geographic characteristics that were similar to that region. Walking was based on self-reports, and may, therefore, have been subject to bias.
Perceived physical activity environment	2005	USA	51	It utilised telephone interviews with 106 African and white women and men (n= 27) African American women, (n= 25) African American men, n= 30 white women, and n= 24 white men living in either Forsyth County, North Carolina or Jackson, Mississippi.	(Test-retest, ICC) Access to facilities and destinations (0.16-0.87) Functionality and safety (0.19-0.79) Aesthetics (0.37-0.64) Natural environment (0.34-0.60) From Evenson, (Evenson & McGinn, 2005).	The study provided some psychometric evidence for the use of many of the questions in studies examining the effect of self-reported physical environment measures on physical activity behaviours among African American and white women and men.	Despite the short time between the administrations, the study showed that exact changes were unlikely and could have occurred between the surveys which would weaken the reported reliability estimates.
International Prevalence Study of Physical Activity Environmental Module (now	2006	Sweden	17	It was self-administered, and questionnaires were mailed out to participants (n=2,500), and every sixth subject (n=416) was invited to participate in the retest of the environmental	(Test-retest) Overall percentage agreement ranged from between 55.1-92.9%. Intraclass correlations (ICC) for the total sample ranged from 0.36-0.98.	It was the first study to measure gender differences regarding the test-retest reliability of environmental attributes, and the results showed that the ICC ranged	Validity was not carried out in this study as GIS, or other objective data may have provided additional information.

Instrument	Year	Country tested	# of items	Mode of data collection (sample size and sample type)	Domains covered (reliability, r or k) and findings.	The strengths of the study	Limitations
called Physical Activity Neighbourhood Environment Survey (PANES).				module. 18-74 years.	<p>The following are the test-retest, ICC):</p> <p>Residential density (0.95), Access to destinations (0.46-0.81) Neighbourhood infrastructure (0.70-0.78) Aesthetic qualities (0.65) Social environment (0.47) Street connectivity (0.71), neighbourhood safety (0.36-0.65).</p> <p>From Alexander et al., (Alexander et al., 2006).</p>	from moderate to substantial agreement for women.	
Neighbourhood Physical Activity Questionnaire (NPAQ)	2006	Australia	32	<p>It was self-administered and with a convenience sample of (82).</p> <p>The instrument was based on IPAQ-short version and Active Australia survey.</p>	<p>(Test-retest reliability) Reliability of recall whether the participants had walked within (k=0.84) and outside (0.73) was acceptable. Similarly the recall of frequency and duration of transport and recreational-related walking trips outside the neighbourhood (ICC \geq 0.84).</p> <p>Reliability for the duration of walking outside the neighbourhood was fair to good (ICC =0.55). The reliability of indices of total physical activity based on MET min/week (ICC =0.82).</p> <p>From Giles et al., (Giles-Corti et al., 2006).</p>	<p>The study was deemed sufficiently reliable for studies examining environmental correlates of walking within the neighbourhood.</p> <p>The NPAQ offers a more stable and reliable measure for use in longitudinal or experimental studies that seek to monitor changes in behaviour in the same individual time because it assesses 'usual' behaviour rather than the behaviour taken during the last seven days.</p>	The study utilised self-reports to measure physical activity and was also based on a small convenience sample which would not be a representation of the general population.

Instrument	Year	Country tested	# of items	Mode of data collection (sample size and sample type)	Domains covered (reliability, r or k) and findings.	The strengths of the study	Limitations
Multi-Ethnic Study of Atherosclerosis; Measures of Neighbourhood Socioeconomic Position.	2007	USA	28	<p>It utilised telephone surveys of (n=5,988) residents of three study sites in the USA(Baltimore, Maryland; Forsyth County, North Carolina; and New York, New York).</p> <p>The estimation used was that 5,800 residents across the three sites would yield 25 participants per neighbourhood cluster. The surveys were administered in English and Spanish, and the re-interviews were 2-3 weeks after the initial interview for the assessment of test-retest reliability.</p>	<p>The test-retest correlation of the 120 participants in the test-retest reliability study ranged from 0.73 to 0.83 for the Cronbach's alpha coefficient.</p> <p>Aesthetic quality (0.83) Walking environment (0.60) Safety (0.88), violence (0.72) Social cohesion (0.65), Activities with neighbours (0.73)</p> <p>The test-retest reliabilities ranged from 0.60-0.88, Intra neighbourhood correlations were 0.28-0.51, and neighbourhood reliabilities were 0.64-0.78 for census tracts of most scales.</p> <p>From Mujahid et al., (Mujahid et al., 2007).</p>	The paper generally demonstrated the feasibility of measuring constructs that vary over geographic areas using survey data, and it also showed the validity and reliability of these measures.	The data had a wide range in the number of participants in each area. The number of survey responses ranged from 1 to 62 in each census tract and from 2 to 322 in another. Some neighbourhood responses were based on the responses of a few participants, and in some extreme cases, this participant was a single individual.

The summary of the instruments on the aspects of test-retest reliability is as follows:

Measures: The instruments mentioned in the Table 1.1 above primarily covered the test-retest reliability of perceived neighbourhood instruments, with test items ranging from 7 to 68 in number. The most common variables included: *land use*, *traffic* and *aesthetics*, and *safety from crime* at a neighbourhood or community level. Most of the studies were conducted in mid-sized to large cities, primarily undertaken in middle- and high-income countries.

Reliability: The majority of questions and scales in these instruments that reported reliability fell in the substantial or almost perfect range of agreement. In the studies where physical and social environment were measured, the physical environmental variables tended to show higher reliability than those in the social environment (that is, safety from crime and social capital).

1.4.2 The NEWS Scale

The Neighbourhood Environment Walkability Scale (NEWS) has been in use since 1997 (Saelens et al., 2003). It has been advanced by collaborations such as International Physical Activity and the Environmental Network (www.ipenproject.org). As an adaptation of this instrument forms the basis of this study, we will now examine the attributes of the NEWS instrument in more detail. The Neighbourhood Environment Walkability Scale (NEWS) is perhaps the most widely used instrument to examine the perceptions of the neighbourhood built and social environment concerning physical activity (Leslie et al., 2005).

The original NEWS by (Saelens et al., 2003) had eight subscales and sample items, namely:

- *Residential density*; which was based on the number of detached single family residences, in relation to the number of apartments and condos (higher density), with 1-3 levels, in the immediate neighbourhood.
- *Land use-mix diversity*; which was based on self-report of the estimated time required for participants to travel to various local destinations from their homes on foot. The various amenities included, for example, convenience/small grocery stores, the post office, video stores, and restaurants and fast food outlets.
- *Land use-mix access*; which gauged the participant's perceptions of access to shopping at local stores and if, for example, parking was difficult for them.

- *Street connectivity*; which was used to find out if distances between intersections in the neighbourhood were relatively short and if they were many cul-de-sacs in the neighbourhood streets.
- *Walking/cycling facilities*; which assessed perceptions of the proximity, maintenance and availability of sidewalks, cycle paths and walkways.
- *Aesthetics*; which addressed perceptions of neighbourhood attractiveness, natural environmental attributes, and whether or not the area was perceived to be well-maintained.
- *Pedestrian/Automobile traffic safety*; which assessed perceptions of the speed and volume of traffic in these neighbourhoods.
- *Crime Safety*: which characterised perceptions of safety from crime, including the presence of street lighting.

This study sought to provide a preliminary test for the often-stated hypothesis that neighbourhood walkability, as defined by land-use and community design, is related to physical activity and body weight.

The early findings in NEWS strongly supported the test-retest reliability of this self-report measure of neighbourhood environment characteristics, hypothesised to be related to lifestyle physical activity and walking for transport (Saelens et al., 2003). Most of the subscales in this NEWS showed a high level of consistency, as many of the the scores were above (0.75) for test-retest ICCs including: *Residential density* (0.63), *Land use- mix diversity* (0.78), *Land use-mix access* (0.79), *Street connectivity* (0.63), *Walking and cycling facilities* (0.58), *Aesthetics* (0.79), *Pedestrian /traffic* (0.77), *Crime safety* (0.80). The scales that assessed *Residential density*, *Walking/cycling facilities* had lower but acceptable reliability. This was the first use of NEWS to document the association between neighbourhood design and physical activity and further extended transportation research findings by proposing that higher non-motorized transport rates in high-walkability neighbourhoods may contribute significantly to physical activity.

The study also recommended that there be evaluation of more neighbourhood environment variables, as well as a study of the relationship between objective and perceived measures of the environment, to identify parsimonious yet accurate assessments of the neighbourhood environmental attributes and their interpretation. The NEWS was later adapted and modified

to a shortened form or abbreviated version of NEWS-A (Cerin et al., 2006), and translated into different languages.

The table below (Table 2.1), gives a summary of the NEWS instrument from its inception in 2003 to date, including the different adaptations over time (NEWS-Australia, NEWS-China, Abbreviated NEWS, A-NEWS). It highlights the different countries and places where it has been tested, the number of items in each version (scales and subscales), the mode of data collection, the reliability/validity of the study and finally the strengths and limitations of the study including recommendations.

Table 1.2 : Summary of evolution of the NEWS tool from its inception to date

Instrument	Year	Country tested	Number of Items	Mode of data collection (sample size)	Reliability and Construct Validity	The strength of the study	Limitations
Neighbourhood Environmental Walkability Scale (NEWS).	2003	USA	68	<p>It utilised the telephone and mail.</p> <p>107 adults from 2 neighbourhoods in (San-Diego, California) were selected.</p> <p>Physical activity was examined using self-report and accelerometers, height and weight were assessed by self-report.</p>	<p>(Test-retest reliability and validity).</p> <p>Test-retest reliabilities were as follows: all ICC: Residential density (0.63) Land use mix diversity (0.78) Land use-mix access (0.79) Street connectivity (0.63) Walking and cycling facilities (0.58) Aesthetics (0.79), Pedestrian /traffic (0.77) Crime safety (0.80)</p> <p>The test-retest reliabilities were moderate to high, and residents of a high-walkability neighbourhood reported higher residential density, land use mix, street connectivity, aesthetics and safety.</p> <p>From Saelens et al.,(Saelens et al., 2003).</p>	<p>The findings in the study supported the test-retest reliability and validity of a new self-report measure of neighbourhood environment whose characteristics were hypothesised to be related to lifestyle physical activity and mainly walking for transport.</p> <p>Most of the NEWS-subcales in the study had test-retest reliability above 0.75, which is a high level of consistency.</p>	<p>This study was a cross-sectional design. It might not have allowed the researchers to determine whether the neighbourhood design caused physical activity differences or whether individuals self-select into neighbourhoods according to physical activity opportunities including walkability.</p>

Modified NEWS.	2005	Australia	62	<p>The recruitment in the study was by mail (n=98).</p> <p>Potential participants were identified from a one-high walkable suburb(Norwood) and one low-walkable suburb (Hawthorndene) using street address data available in a Legal property Identifying System.</p>	<p>(Test-retest and ICC).</p> <p>Residential density (0.78),Land-use mix (0.88),Street connectivity (0.74) Infrastructure for walking (0.76) Aesthetics (0.86) Traffic safety (0.62) Crime safety (0.63)</p> <p>The residents of high-walkable neighbourhood rated attributes of residential density, land-use mix (access and diversity) and street connectivity higher than residents of the low-walkable neighbourhood while traffic safety and safety from crime did not differ. Perceived neighbourhood environment characteristics had moderate to high test-retest reliabilities.</p> <p>From Leslie et al.,(Leslie et al., 2005).</p>	<p>The mean values of land use mix and street connectivity for low and high neighbourhoods in the study were higher than the original news of Saelens et al., (Saelens et al., 2003).</p> <p>(Test-retest reliabilities, (intraclass correlations) for subscales ranged from 0.58-0.80 are comparable to the US. This study ranged from (0.62-0.88).</p>	<p>The study utilised a convenient sample (participants willing to complete the survey).</p> <p>Participants were not matched on individual respondent characteristics, and these may be potential modifiers of environmental perceptions.</p> <p>Participants recruited from only two neighbourhoods at extremes of walkability and might be that these neighbourhoods had other.</p>
Abbreviated Neighbourhood Environment Walkability Scale (ANEWS).	2006	USA	54	<p>It was an interview and telephone-administered with a sample size of (n=1286).</p> <p>A stratified two-stage cluster sample design was used to recruit 1286 adults. The sample was drawn from within eight high-and eight low-walkable neighbour-hoods matched for socio-economic status.</p> <p>The participants completed the NEWS and reported weekly</p>	<p>(Test-retest, r and criterion validity).</p> <p>Confirmatory factor analysis of the long version of the IPAQ showed a small to moderate size and ranged from 0.02-0.49.</p> <p>The two-level measurement model of the NEWS-A based on multilevel CFA of the NEWS showed a good level of fit.</p> <p>The criterion validity of the NEWS and NEWS-A; Respondents reported an average of 118 weekly</p>	<p>This study utilised two measurement models at the individual (based on within block group variations in response to items) and at block group level (based on between-block group variations in response to the items), and the study in overall supported the construct validity of NEWS (and NEWS-A).</p>	<p>Though the measurement models were the same, they differed in certain measures for example when compared with the NEWS, the measurement model of the NEWS-A showed a better fit to the data and marginally better criterion validity concerning walking for transport.</p>

				<p>minutes for walking for transport and recreation using items from the IPAQ.</p>	<p>minutes of walking for recreation(median =60; SD=190) and 163 minutes of walking for transport (Median =60; SD=289), Residential density 0.63.</p> <p>All the variance in walking for recreation was attributed to (within-blockgroup) differences between individuals. In contrast, approximately 5% of the total variance of walking for transport was due to differences between blockgroups.</p> <p>From Saelens et al., (Saelens et al., 2003) and Cerin et al., (Cerin et al., 2006).</p>		
<p>An Australian version of the Neighbourhood Environment Walkability Scale: Validity evidence(NEWS -AU).</p>	2008	Australia	65	<p>The study employed questionnaires, and hand mail (2,650).</p> <p>This study was a stratified two-stage cluster sampling design.</p> <p>The Adults (20-65years) were recruited from Adelaide, and the sample was drawn from residential addresses within eight high-walkable and eight low-walkable neighbourhoods.</p> <p>GIS was utilised to examine neighbourhood walkability measures. (IPAQ) also used.</p>	<p>(Test-retest reliability and validity, Multilevel Confirmatory Analysis). All except one item ("It is easy to walk to public transport from my home" (35) had acceptable values using the maximum likelihood estimation.</p> <p>For the validity evidence-based on the relations with criterion variables :</p> <p>The respondents reported 185 min/week of walking for transport(median(Median) =90,Interquartile range (IQR)b=150 ;SD =220) . From Owen et al., (Owen et al., 2007).</p>	<p>The study provided some validity evidence for NEWS-AU based on its internal structure and associations with external criterion variables.</p>	<p>Although the factorial structure of the NEWS-AU resembled that of the original version of the NEWS, it differed in many ways, and the discrepancies raised concerns about the reliability and generalizability of the internal structure of NEWS to different geographical and cultural settings.</p>

Cross-validation of the factorial structure of the NEWS and NEWS-A.	2009	USA	NEWS-67, NEWS - A-54.	<p>Email correspondence and online surveys were employed in this study.</p> <p>912 adults were recruited from a selected 16 neighbourhoods in Seattle, Baltimore region. The neighbourhoods were stratified according to their transport related to walkability level and GIS. Participants self-completed the NEWS.</p>	<p>(Cross validity of the individual and block-level measurement model of NEWS and NEWS-A).</p> <p>Individual measurement models of NEWS and NEWS A-showed the same results for all except one item (Sidewalks separated from the road/traffic in my neighbourhood parked cars.</p> <p>From Cerin et al., (Cerin et al., 2009).</p>		<p>There were relatively low response rates in this study due to extensive measurement tools, including surveys and accelerometer monitoring on two occasions.</p> <p>All these three validation studies of the NEWS were conducted in the USA and Australia, two countries that have similar cultures and language, as well as a preponderance of low-density land, uses.</p>
Reliable and Valid NEWS for Chinese seniors: Measuring perceived neighbourhood attributes related to walking, NEWS-C.	2010	China	76	<p>It was an interview and telephone-administered (484).</p> <p>The translated NEWS was pre-tested with 50 Chinese speaking adults aged 65years and older.</p> <p>The final version was administered to 484 seniors residing in four selected Hong-Kong districts and varied in walkability and socio-economic status.</p>	<p>(Test-retest, ICC and factorial validity).</p> <p>Residential density (0.72) Land use diversity (0.76) Access to services (0.62) Street connectivity (0.58) Infrastructure for walking (0.53) Indoor places for walking (0.66) Aesthetics (0.62) Presence of people (0.37) Crowdedness (0.72) Traffic and road hazards (0.62) Traffic speed (0.53) Social disorder/littering (0.62), crime (0.62)</p> <p>The –test-retest reliability was moderate to good (ICCS >50 or % agreement > 60) except for four items measuring the distance to destinations.</p> <p>From Cerin et al., (Cerin et al., 2010).</p>	<p>The NEWS-CS possesses sufficient levels of reliability and factorial validity to be used for measuring perceived neighbourhood environment in Chinese seniors.</p>	<p>The study used a convenient sample of Hong Kong residents and extensively focused on them (all members of the Elderly Health Centres).</p> <p>The neighbourhood definition was defined as an area within 10-15 minute walk from home, and this definition remained to be seen if it was clearly understood and corresponded with that of the respondents.</p> <p>There was an effect of neighbourhood size on associations between the built environment, and walking was unclear.</p>

<p>Sharing good NEWS across the world: developing comparable scores across 12 countries for the NEWS scale.</p>	<p>2013</p>	<p>It utilised data from 12 countries, Australia, Belgium, Brazil Columbia, Czech-Republic Denmark, Hong Kong Mexico, New Zealand, Spain the United Kingdom the United States of America).</p>	<p>NEWS-67, NEWS - A-54.</p>	<p>The data was self /Interviewer based on a sample size of ((14,305). Participants were recruited from neighbourhoods varying in walkability and socio-economic status in the 12 countries using the version of NEWS/NEWS-A. CFA was used to derive comparable country-specific measurement models of the NEWS/NEWS-A.</p>	<p>Test-retest reliability, ICC. The final version of the NEWS-consisted of 14 subscales and four single items(76 items). The test-retest reliability was moderate to good (ICC> 50% or % agreement > 60%. The final country-specific models of the NEWS/NEWS-A provided acceptable levels of fit to the data and shared the same factorial structure with six latent factors and two single items. The correspondence between the standard and alternative subscales of Land use mix access in, infrastructure, and safety for walking/cycling, Aesthetics was high. The Brazilian version of the Traffic safety subscale was high, while the Australian and Belgian versions were marginal compared to the standard version. From Cerin et al.,(Cerin et al., 2013).</p>	<p>The aim was to compare the subsets of the comparable NEWS/NEWS-A items across 12 IPEN countries and based on the empirical evidence of their CFA-derived individual-level measurement models, propose scoring protocols that maximise cross-country comparability of responses. The study also proposed a relatively simple analytical approach that could be used to create comparable measures for multi-country pooled analyses when some deviations in the measurement protocol exist across study sites.</p>	<p>Differences in the participant recruitment procedures, survey administration mode and use of somewhat different versions of NEWS/NEWS-A.</p>
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An abbreviated version of NEWS was tested for validity in the USA (Cerin et al., 2006) and also tested for reliability and validity in different terrains and topography including Hong Kong (Cerin et al., 2007b) and China (Cerin et al., 2010). In a recent study, the subsets of the NEWS and NEWS-A items were also compared across 12 IPEN countries based on the Confirmatory Factor Analysis (CFA) measurement models (a form of factor analysis, most commonly utilised in social research. It usually tests where the measures of a construct are consistent with the measurement properties). The CFA spoke to the psychometric properties of the NEWS across these twelve countries, and it was used to derive country-specific measurement models of the NEWS/NEWS-A.

These analysable factor subscales were determined by estimating the correlations and mean standardised difference (Cohen's *d*) between, them using the countries that had included the items from both standard and alternative versions of the subscales. The results of this study highlighted that models of the NEWS/NEWS-A provided acceptable levels of fit to the data and shared the same factorial structure with six latent factors and two single items. The study, therefore, proposed scoring protocols that maximised cross country comparability of responses. It also proposed a relatively simple analytical approach that could be used to create comparable measures for multi-country pooled analyses when some deviations in the measurement protocol exist across study sites.

Relevance and weakness of NEWS

The original NEWS instrument was used to evaluate the relationship between the neighbourhood environment, physical activity and weight status of residents in two neighbourhoods. The findings supported the test-retest reliability of the measure (Saelens et al., 2003). The weakness of this study was that it was a cross-sectional design, and as such, could not rule out the fact that some individuals may self-select into the neighbourhoods, according to physical activity opportunities including walkability. The study indicated a need for larger and more elaborate studies regarding the effect of neighbourhood design on physical activity.

The Modified NEWS compared residents' perceptions of the attributes of two neighbourhoods that differed on measures derived from GIS, and findings were comparable to the original NEWS (Leslie et al., 2005). The study showed that it was feasible to assess the environmental attributes relevant to walking using both objective and self-report methods.

This suggested that an instrument such as NEWS might be used practically, as part of population monitoring and surveillance of physical activity and its correlates.

The study of the Abbreviated NEWS (NEWS-A) examined the factorial and criterion validity and the results supported the notion that NEWS-A possessed adequate levels of factorial and criterion validity (Cerin et al., 2006). The weakness was that although the NEWS and NEWS-A were similar in terms of measurement properties, their models were not equivalent indicating that the environmental attributes measured by these two items might group in different ways within and across neighbourhoods/block groups. Based on these findings, calls were made for explicit recommendations regarding how to score the NEWS and NEWS-A for various study purposes.

The Australian version of the NEWS (NEWS-Australia), provided evidence of validity and confirmed associations of the neighbourhood walkability attributes for transport-related physical activity (Owen et al., 2007). The study called for policy initiatives to create more-walkable neighbourhoods and further studies of the interactions of individual factors and neighbourhood environments. Perhaps the limitations of many of these studies was the fact that physical activity measures were based on self-report.

The cross-validation of the factorial structure of the NEWS and NEWS-A in the USA showed the same results for the individual measurements of the NEWS and NEWS-A (Cerin et al., 2009). It provided support for the generalizability of the individual-level measurement models of the NEWS and NEWS-A to different urban geographical locations in the USA. And although it achieved some generalizability, there was an overall low response rate in the study, partly due to the extensive measurement protocol which included surveys and accelerometer monitoring. The recommendation from the study was to include different forms of mixed land use, different pedestrian and bicycling infrastructure and different public transit access to facilities in the modified versions of the NEWS and NEWS-A.

The 12 country IPEN study aimed to develop scoring protocols to maximise cross-country comparability in responses. The final country-specific measurement models of the NEWS/NEWS-A provided acceptable levels of fit to the data and shared the same factorial structure with six latent factors and two single items. The study recommended some country-specific modifications to the original scoring protocol of the NEWS/NEWS-A.

(Not all the NEWS questionnaires from its inception were selected for this review, as we hoped to give a context of the papers that led to its adaptation in Africa).

NEWS: adaptation in the African Context

The original NEWS instrument had been used previously in studies in Africa, in Nigeria for adults and adolescents, and in South Africa, in adults (Malambo et al., 2017) and older adults (Kolbe-Alexander et al., 2010). In South Africa, Kolbe et al. (Kolbe et al., 2010) examined the strength and direction of the association between the built environment and physical activity in South African older adult men and women (> 50 years of age) living in low-(LSA) and high socio-economic areas (HSA). They used self-reported physical activity and Actigraph GT3x accelerometers to quantify physical activity objectively and administered the Neighbourhood Environment Walkability Scale (NEWS). Participants from high-income areas reported significantly more leisure time physical activity and less transport-related physical activity. Further, both device-measured and self-reported physical activity were significantly higher in older adults from high-income areas, than for those from low-income areas. In this study, senior adults perceived lack of safety as a barrier to physical activity (self-report and device-measured), whereas neighborhood surroundings and satisfaction had the opposite relationship.

The study was a pilot study, and as such, employed a convenience sample of participants, recruited within a 5km radius to a commercial gym or who were already part of a community-based exercise club. This may have resulted in a potential bias, but at least both groups had access to recreational exercise facilities within proximity to their homes. However, to our knowledge, the study was the very first to investigate the relationship between the built environment and physical activity in South Africa.

The NEWS in Nigeria, (NEWS-Nigeria), selected the single items based on methods that were utilised and proposed by Cerin and colleagues after the cross-validation of the confirmatory factor analysis of the NEWS (Cerin et al., 2009). There were 18 new items added to specific scales:

- Six items were added to the '*land use mix diversity scale*'.
- One item to '*land use "mix access."*'
- Eight items to '*infrastructure and safety for walking and cycling scale*'.
- One item to '*traffic hazards*'.

- One item to '*safety and crime.*'
- Presence of unattended domesticated animals was scored as a single item.

Reliability of the adapted version of NEWS among Nigerian adults (386) from two cities was assessed using the intraclass correlation coefficient (Oyeyemi et al., 2013). Sub-scales including: *Perceived residential density* (0.66), *land use mix-diversity* (0.87), *land use mix-access* (0.76), *street connectivity* (0.72), *infrastructure and safety for walking and cycling* (0.59), *aesthetics* (0.91), *traffic safety* (0.65), and *safety from crime* (0.66), all had significant reliability. Self-reported activity for leisure, walking for different purposes, and overall physical activity was assessed with the International Physical Activity Questionnaire (IPAQ). The results showed moderate to high test-retest reliability (ICC ranged 0.59-0.91) with a total of 23 items having good reliability, 43 having moderate and 17 having poor reliability. The poor reliability was probably due to lack of variance in the answers.

The construct validity was low to moderate with residents of high-walkable neighbourhoods reporting significantly higher residential density, more land-use mix diversity, higher street connectivity, more traffic safety and more safety from crime, but lower infrastructure and safety for walking/cycling and aesthetics than residents of low-walkable neighbourhoods. The construct validity correlation values ranged from $r = 0.10-0.13$, for self-reported physical activity. Participants were recruited from six–non adjacent neighbourhoods, 3 each in the inner city, based on GRA layout. GRA refers to Government Reserved Areas, representing a new layout of areas in the inner cities of Nigeria, that have a diversity of housing patterns, land use mix and access to street characteristics, consistent with high walkability. Allocation of neighbourhoods as high- and low-walkable was done by the research team and local urban planning experts. The NEWS-Nigeria, therefore, demonstrated acceptable test-retest reliability measurement properties among Nigerian adults (ICCS ranged from 0.59-0.91), which were comparable to the original NEWS in the USA (ICC =0.58 to 0.80)(Saelens et al., 2003). However, construct validity measured against self-reported physical activity was not as promising, and suggested a need for further adaptation and evaluation, to develop a version suitable for the African region, in general.

In a collaborative effort by a group of health and physical activity researchers in Africa and the University of San Diego in the USA, the NEWS was subsequently adapted, in an effort to make it more compatible for use in communities and cities from the African continent

(Oyeyemi et al., 2016). The adaption and evaluation the NEWS was carried out in seven sub-Saharan African countries across the East (Kenya, Uganda), West (Ghana, Nigeria), Central (Cameroon) and Southern Africa (Mozambique, Republic of South Africa). A meeting was convened in Nairobi (2013) to begin to adapt the instrument for the NEWS-Africa version of the questionnaire, suitable for all age groups (youth, adults and older adults). The committee reviewed all sections of the original NEWS, including the additional items from NEWS-Youth (Rosenberg et al., 2009) and NEWS for older adults (Shigematsu et al., 2009). Various items were discussed with respect to the 'lived experience' in Africa, and the goal was to retain as many items as possible in order to enhance the comparability with other regions. The modifications made and any addition of items were aimed at accomodating rural and urban environments, and varying cultures. Additional input was sought from local professionals in the 7 countries, with expertise in diverse fields including: community design, transportation, parks, and public health advocacy.

The key outputs from the adaptation process included a draft of a modified NEWS which was agreed upon by the committee. Several new modifications were added into the scales to showcase the essential attributes in an African setting.

- A new scale of *personal safety* was created and added.
- The *aesthetics scale* was added to reflect African specific characteristics.
- The six items on the *residential density* were reduced to a single unweighted item, and the responses were re-defined to include common housing patterns pertinent to urban and rural areas in Africa.
- The response scale for housing density was re-defined from lowest to highest.
- Questions on roads and pedestrian infrastructures were added to focus on unpaved walking /footpaths to represent the stages of infrastructural development across the African continent. Additionally, the instrument asked for indications as to whether roads were formal//informal, and if the routes for cars were paved/unpaved, and with/without pedestrian facilities.

The final NEWS-Africa survey produced through this process had 76 individual items and 13 subscales that assessed the following environmental characteristics:

- *Types of residences* (6 items).
- *Destinations scale* (21 items).

- *Recreation scale* (4 items).
- *Roads and walking paths scales* (5 items).
- *Sidewalk scale* (5 items).
- *Crossing paths scale* (4 items).
- *Paths infrastructure scale* (2 items).
- *Places for walking, cycling, and playing overall scale* (12 items).
- *Neighbourhood surroundings scale* (8 items).
- *Safety from Traffic scale* (6 items).
- *Safety from Crime scale* (4 items).
- *Personal safety scale* (3 items).
- *Stranger danger scale* (3 items).

The harmonized versions of the NEWS-Africa survey and interviewer manual were translated into the local dominant languages in these countries; Cameroon (French), Ghana (Twi and Krobo), Kenya (Swahili), Mozambique (Portuguese), Nigeria (Yoruba), South Africa (Isi-Xhosa) and Uganda (Luganda) by knowledgeable bilingual people in these respective countries. The instrument was back-translated to English in these countries by lay persons who would not be so familiar with the project or the construct of neighbourhood walkability.

Oyeyemi et al. (Oyeyemi et al., 2016), showed that the NEWS Africa had an overall average of ICC of 0.68 (SD=0.06, range, 0.50-0.82) for the 76 individual items. The average ICC was slightly higher for the 13 computed scales with a mean scale ICC= 0.73 (SD=0.07, range=0.60-0.82). Overall, over 95% of the NEWS measures (individual coupled with the computed scales fell into the “excellent” or “good” category and over half of the computed scales fell into the “excellent” agreement category.

In a further a study on the construct validity of the NEWS scale in Africa, they examined the relationships of the NEWS-Africa Scales with self- reported walking for transportation and recreation among a total of 469 adults from the six sub-Saharan African countries (Oyeyemi et al., 2017). This study showed that of the 13 NEWS-Africa scales, six were related to reported walking behaviour in pooled analyses and provided initial support for the construct validity of the NEWS-Africa instrument.

The 6 scales included land mixed-use access ($\eta^2= 0.020$, $P=0.006$) and stranger danger scales ($\eta^2= 0.021$, $P=0.004$) had a positive relationship with transport walking. Proximity of

recreational facilities ($\eta^2 = 0.016$, $P=0.015$), road/path connectivity ($\eta^2 = 0.025$, $P=0.002$), path infrastructure ($\eta^2 = 0.021$, $P=0.005$) and overall places for walking and cycling ($\eta^2 = 0.021$, $P=0.029$) were positively related to recreational walking. Because several NEWS-Africa scales had different scaling, for consistency of interpretation, partial η^2 was determined to reflect the strength of independent associations; partial $\eta^2 = 0.01- 0.05$ was a small effect, partial $\eta^2 = 0.06 - 0.13$ was moderate effect, partial $\eta^2 > 0.13$ was large effect. (Partial η^2 is explained as the ratio of variance accounted for by the predictor divided by the variance plus error (residual) variance). It is an effect size representing the proportion of unexplained variation in the outcome uniquely explained by a given predictor, after adjusting for variance accounted for by other predictors in the model. The overall “walkability index” for NEWS was related to self-reported walking both for transportation and leisure purposes, although the direction of the associations of the NEWS scores was generally smaller compared to similar studies from the Western countries (Oyeyemi et al., 2017).

These studies were largely based on convenience sampling, with unequal sample sizes across countries. Furthermore, they failed to compare high- and low- walkable communities and high- and low- income settings (Oyeyemi et al., 2016). The studies also failed to provide criterion validity using device-measured physical activity or objective measures of built environment attributes. The authors highlighted the need to explore the construct and predictive validity in future studies. Ground-truthing studies using GIS regarding actual distances to amenities, traffic and crime were also proposed as they would provide additional insights into the factors related to the perceived environment which would potentially impact on physical activity.

Malambo et al., (Malambo et al., 2017) in South Africa, also assessed the relationship/s between perceived built environment characteristics and leisure-time and transport-related physical activity among urban and rural South African adults, using the original NEWS instrument. The study involved 671 South Africans (the overall sample was larger than the entire NEWS-Africa sample which had 469 adults combined in the 6 Countries) aged ≥ 35 years of age, and utilised the IPAQ long questionnaire, for self-reported transport and leisure time physical activity. The sample population included both rural and urban areas, providing geographical variability. However, the analysis focused on the individual NEWS items, and not the subscales.

After adjusting for gender, proximity to transit stops was significantly associated with the leisure-time physical activity (OR=4.04, 95%CI=1.21-13.48) and walking for leisure (OR=2.11, 95%CI=1.33-3.36) (all these were individual items and not scales), and the presence of sidewalks also predicted the likelihood of walking for leisure (OR=1.91, 95%CI=1.11-3.29). Conversely, street lights were associated more walking for leisure (OR=2.12, 95% CI=1.24-3.61), and the perception of a high crime rate during the day was inversely associated with leisure-time physical activity (OR =0.31, 95%CI=0.13-0.74). Transport-related physical activity was independently related to the distance between intersections (OR=3.78, 95%CI=1.34-10.65) and the presence of four-way intersections (OR=4.32, 95%CI=1.11-1.68).

The study demonstrated some construct validity of individual NEWS items and underscored the need for policy strategies aimed at improving or maintaining these perceived environmental attributes to promote physical activity. The limitation of the study was also the reliance on self-reported physical activity and perceived environment, rather than objectively measured physical activity. The study also lacked data on socio-economic status which may be a strong confounder of the associations between perceived environmental factors and transport-related physical activity. The recommendations from the study, therefore, were to consider the objective assessment of, for example, neighbourhood aesthetics and physical activity, particularly in urban-dwelling South Africans.

In conclusion, many studies have documented the relationship between perceived supportive attributes of the built environment and physical activity, measured largely by self report, for transportation and recreation purposes (Bauman et al., 2012; Oyeyemi et al., 2017), with most of this evidence from high-income countries. In Africa, studies of the built environment and physical activity relationships are limited, with little insights into the impact of SES and physical activity domains (Oyeyemi et al., 2014).

1.5.1 Walkability and physical activity

The construct of “walkability” refers to environments that encourage people to walk or cycle for transportation and leisure (Hanson & Gluckman, 2011). Walkable neighbourhoods are ones where it is easy to walk or cycle directly to multiple destinations. The determinants of and barriers to walking as described by Handy et al. (Handy et al., 2002) are as follows:

- Residential density is typically defined as the number of persons residing (living) per unit area and has been associated with walking for transport as measured by self-report. Frank and Pivo, (Frank & Pivo, 1994) examined over 300 census tracts with trip origins and destinations for which there was information regarding mode choice from the Puget Sound Travel Survey. They found a correlation between employment density, and walk trips ($r = 0.43$).

Destination proximity and land-use mix suggest that a neighbourhood has "destinations" including, not only residential dwellings but retail settings, offices and businesses, parks and public open space. Infrastructure quality refers to the quality of the built environment concerning transport and leisure time physical activity, including well-maintained sidewalks, cycle and footpaths, adequate lighting, visibility and signage for traffic calming, and aesthetics.

- Connectivity of roads/routes/networks describes the directness and availability of alternate routes from one point to another. It can be measured by the number of pedestrian streets divided by the area within the participant buffers (500m, 1000m and 1600m). Peponis (Peponis et al., 2008) defines connectivity as a measure of relatedness and emphasises that it is a pre-requisite for pedestrian activity. Berrigan et al. (Berrigan, Pickle, & Dill, 2010) have shown that the more connected a built environment is, the more conducive it is for walking.

Ozbil et al., (Ozbil et al., 2011) have described four approaches to understanding connectivity. The first approach is by capturing distinct features which are measurable, such as the number of intersections or cul de sacs in a defined area (Cervero & Radlsch, 1996). The second approach is to capture factors that directly influence connectivity for pedestrians, including block sizes per area (Frank et al., 2010) and intersection density (Hess et al., 1999). The third approach is to use measures that characterise a particular location on a network, such as a walking catchment or route directedness (Stangl, 2012). Finally, the fourth approach measures accessibility based on the configuration of individual street elements (Peponis et al., 2008). The two key measures in the fourth approach are integration and choice. Integration primarily focuses on how accessible each

street line is from all other parts of the network while choice focuses on how many shortest paths are between all possible origins and destinations.

- Aesthetics (previously referred to under the quality of infrastructure) describes the qualities that enhance the visual experience or perception of a place; including not only design, but for example, freedom from litter, graffiti or vandalism, and the presence of trees, foliage and other landscaping. Jáuregui et al., (Jáuregui et al., 2016) highlight that easy access to neighbourhood parks and proximity to metropolitan parks and aesthetics are essential correlates to physical activity among Mexican adults.
- Walkability is influenced by neighbourhood safety, including *safety from crime* and *road traffic*. Bennet et al., (Bennett et al., 2007), highlighted that residing in a neighbourhood that is perceived to be unsafe at night is a barrier to regular physical activity among individuals. Feeling unsafe may also diminish confidence in the ability to be more physically active and that these two factors may limit physical activity promotion strategies where safety is an issue.

Kolbe et al. (Kolbe-Alexander et al., 2010) highlight that the construct of “walkability” of a neighbourhood and the relationship between the perceived neighbourhood environment and physical activity levels is important and may not be the same, for example in high- and low-income settings. The attributes that comprise "walkability" of an area, such as higher residential density, greater street connectivity, greater land use mix and more destinations, have been associated with increased levels of walking and cycling in persons living or working in the area (Cerin et al., 2006), primarily in high- and middle-income settings. Walking is one of the most natural, most common and most accessible forms of physical activity; it can be done through recreation and transport (Owen et al., 2007).

1.5.2 Geographic Information Systems (GIS) Measures/ Ground-truthing

Geographic Information Systems (GIS) have been defined as the “integration of software, and hardware for capturing, sorting, analysing and displaying all forms of geographically referenced information to understand relationships trends and patterns’ <http://www.esri.com/what-is-gis/>. In a review, Brownson et al. (Brownson et al., 2009a) refer to GIS measures as measures of the built environment derived primarily from existing data

sources that have a spatial reference (that is, addresses or census boundary identification). They emphasise that using GIS is the only feasible way to generate objective measures for studies involving individuals or neighbourhoods dispersed across large areas. This review had more than 50 illustrative studies derived from various sources of literature which included the public health and travel behaviour literature and the studies with various physical activity-related outcome measures for example walking, obesity, and vehicles miles travelled and trials were included. The measures that these studies focused on are described below:

- **Population density**; which was defined as (population per total land area) and net residential density (housing units per residential acre). This involves the number of residents living in census tracts or census area blocs per area (gross population density)/number of people in housing units per unit land area in parcels/number of housing patterns per residential acre.
- **Land-use mix**; which was categorised in terms of accessibility (the degree to which mixed land activities were accessible to residents in terms of proximity to residential and non-residential places).
- **Access to recreation facilities**; which was categorised in terms of accessibility (distance to network/straight line) to the nearest facility/amenity like a playground, park, trial, gyms, recreation).
- **Street patterns**; which was described as the number of intersections per area (or intersection density, the percentage of four-way intersections and number of intersections per length of the street network.
- **Others**; which included:
 - vehicular traffic (street width which excluded sidewalks) likely to impact on the volume of traffic and incidents of accidents.
 - Crime (number of crimes per 100,000 people which included both violent and property crimes.
 - Sidewalk coverage (sidewalk length divided by road length.
 - Slope any 100m road segment with $\geq 8\%$ slope.
 - Greenness/vegetation (normalised difference in vegetation index.

-Composite (a variable index which represented a combination of some of the measures above).

There was a significant degree of variability in the operationalisation of the measures and this made it challenging to compare the results of the studies. In one recent study, Adams et al., (Adams et al., 2014) aimed to develop a common methodological approach or protocol to measure the key components of neighborhood walkability using GIS, (residential density, street connectivity, mix of land uses), as well as access to public transit, parks, and private recreation facilities around each participant's residential address, utilising a 500m and 1000m street network buffer.

The GIS protocol included:

- **Buffer size and type:** Two neighbourhood buffers of 500 m and 1km were created around each home address. These buffers were labelled 'street network' and 'pedestrian enhanced network' buffers and all the environmental variables computed in GIS around the 500m and 1 km buffer. The spatial data sets and geocoding were done on the participants in individual countries to the level of street or parcel address, and 500m or 1km street networks were calculated using ESRI's ArcGIS Network analysis.
- **Net residential density:** Residential density was calculated as the number of dwellings (numerator) divided by the land area within the buffers that were devoted to residential use, and these were obtained from the census data in these individual countries.
- **Land use and mix:** There were six land uses; residential, retail commercial, civic/institutional, entertainment, food-related and recreation, the largest number of comparable land uses from the six land uses were four (residential, retail combined, institutional/civic and recreation) and the land use mix was calculated using the entropy equation (Song et al., 2013) (Frank et al., 2005), where values closer to 1.0 indicated a more equal distribution of available residential, combined and institutional/civic land area within the buffer across the uses.
- **Street connectivity:** This was defined as intersection density or the ratio of the number of intersections within the buffers around each participant's home divided by the total buffer area. The intersections were defined as points where three or more road segments interacted especially after removal of limited access roads and pseudo intersection nodes.

- **Walkability:** a walkability index was computed as the sum of Z scores (standardised) of net residential density, land use mix and intersection density.
- **Public transport:** There were various means of transport for these countries, including public bus, light and heavy rail, ferries and regular bus, rapid transit bus.
- **Recreational density:** Recreational facilities were defined and operationalised as indoor and outdoor places where participants could be physically active. However, the places had to be open for public use and included facilities such as fitness centres, health clubs, swimming pools, tennis centres. The recreational density was defined as the number of parcel/facilities of the buffer /by the entire buffer.
- **Parks:** Parks included government-designated parks of any size which were free and open to the public and maintained by respective government agencies, within a specified buffer zone. The park density was computed as the number of parks divided by the entire area.

This study also aimed to present the range of variation observed across the countries on key components of walkability. The study demonstrated the feasibility of creating a common template, using GIS-derived variables, that could be used and was relevant to physical activity from urban to suburban regions. In the development of the templates, priority was given to themes based on physical activity literature. The core GIS templates included: street network buffers, residential land use, retail land use, civic and institutional land use, entertainment land use, recreation land use, food-related land use, street connectivity, public transit access, private recreational facility and finally park access. The 107-page document of IPEN adult GIS templates aimed to provide GIS teams in each country with specificity for common concepts, clear and consistent definitions, guidance on preferred variables and procedures and a place to document the variations. With this, IPEN was able to achieve the objective of deriving comparable measures across various settings and continents and also improving on the methodological limitations of previous studies, based on the recommendation to clarify operational definitions. Hence, this operationalised the concept of “ground-truthing”, in which the utilisation of GIS gives a measure of what truly exists, against the perceptions of the built environment, derived from instruments such as NEWS (Caspi & Frieber, 2016).

One of the limitations of the study was difficulty in harmonisation. For example, the most difficult variable to create was the land use mix, as each country utilised a different number of land use categories and it was problematic to reconcile. There was also inconsistency in measuring street connectivity as local circumstances in some countries made it unrealistic to exclude roads that would be considered “limited access” compared to freeways in North America. In addition, the variables in existing GIS databases were collected by multiple governments for various purposes and most were not explicitly used for public health. As such, many of the environmental variables believed to be relevant to physical activity were not available in GIS, such as sidewalk presence and characteristics, intersection characteristics such as pedestrian signals and crosswalk striping and traffic calming interventions.

In one of the few studies in Africa, Malambo et al. (Malambo et al., 2018) evaluated the relationship between objectively measured attributes of the built environment (using GIS) and physical activity, along with other CVD risk factors (systolic blood pressure, diastolic blood pressure, obesity) in an urban South African context. In a cross-sectional study, with participants drawn from a township in urban South Africa (n=341), complete GIS data and accelerometer data were collected, providing an objective measurement of both physical activities and built environmental attributes for three road distance buffers (500m, 1000m and 1600m). These road distance buffers that reflect walking times of approximately 5-7 minutes, 10-12 minutes and 15-18 minutes, at an average walking pace, respectively.

The study measured destination proximity to services and facilities such as community centres (police station, health clinic and open space), distance to transit stops (taxi rank) and distance to retail shopping centres (shopping malls). The results showed that attributes of the objectively measured built environment were significantly associated with BMI, systolic, diastolic blood pressure and moderate-to-vigorous physical activity. The study, in general, observed a significant positive relationship between objectively measured distance (1600m) to shopping centres and body mass index, while the distance (1000m) to the centre (1000m) centre was positively associated with diastolic blood pressure and moderate-to-vigorous physical activity thereby supporting evidence of walkable neighbourhood environment being associated with lower CVD risk.

The study was the first in an African setting to provide evidence of a direct association between objectively measured built environment and physical activity with BMI, systolic

blood pressure, and diastolic blood pressure in an African setting. Although the mechanism by which the built environment attributes and CVD risk have yet to be fully explained, Malambo et al. suggested that a shorter distance from the respondent's home to the community centre might, for example, increase physical activity levels through walking, thereby lowering the risk of obesity and hypertension. They further suggested that considering the low wages of their participants and low prevalence of car ownership, it would be most likely that the majority of them relied on walking and public transport, thereby perceiving proximal rather than distant destinations. The limitation in the study was the cross-sectional design which prevented any causal association among characteristics. Also the study area was a small, geographically defined, low-income community (Langa Township) which had a limited variability regarding land use. The study revealed a need for more GIS data to better study built environment association in South Africa. The study also did not establish a link between walkability and physical activity.

1.6 Conclusion and objective of the literature review

It is clear that physical inactivity has contributed to the global burden of non-communicable diseases (NCDs), morbidity and mortality, thereby highlighting the need to prioritise the promotion of regular physical activity as a comprehensive strategy to reduce NCDs. This can best be achieved by routine surveillance of physical activity and measurement of the environmental and socio-ecological determinants of physical activity. The literature review has centred on the ecological model, of which we focused on two significant correlates/determinants of physical activity namely; socio-economic status (SES) and perceived and objectively measured attributes of the built environment. We were particularly interested in the interaction between these factors.

Many studies have documented the relationship between supportive attributes of the built environment and physical activity undertaken for transportation or recreation (Bauman et al., 2012; Oyeyemi et al., 2017; Inoue et al., 2011; Cerin et al., 2007; McCormack et al. 2008) yet most of this evidence is from high-income countries. However, in Africa, studies of built environment and physical activity relationships remain scarce (Oyeyemi et al., 2014). One of the tools for measuring walkability, the Neighbourhood Environmental Walkability Scale (NEWS), is perhaps, the most widely used instrument. It is used to assess perceptions of the neighbourhood built and social environment, concerning physical activity (Leslie et al., 2005). More recently, the NEWS survey has been adapted for use in African urban settings.

The objective of this thesis was, therefore, to explore associations between the built environment and physical activity, by validating the NEWS-Africa scale, using ground-truthing and remote-sensing technology (i.e. Geographic Information Systems, GIS) in an urban South African setting to gain a better understanding of the construct of neighbourhood walkability, in high- and low-income neighbourhoods.

CHAPTER TWO

RELIABILITY AND VALIDITY OF THE NEWS-AFRICA

2.0 Introduction

The Neighbourhood Environment Walkability Scale (NEWS), is a widely-used questionnaire that examines the perceptions of the neighbourhood environment in relation to physical activity (Leslie et al., 2005). The very first NEWS had 8 Sub-scales and sample items namely: *Residential density*, *Land use-mix diversity*, *Land use-mix access*, *Street connectivity*, *Walking/cycling facilities*, *Aesthetics*, *Pedestrian/Automobile traffic safety*, and *Crime Safety*, (Saelens et al., 2003). The findings in the original NEWS strongly supported the test-retest reliability of this novel, self-report measure of neighbourhood environment characteristics hypothesised to be related to lifestyle physical activity, mainly, walking for transport and leisure. Most of the Sub-scales in this NEWS had a high level of consistency with an overall intra-class correlation coefficient of 0.75 (Saelens et al., 2003). Saelens et al. highlighted the relevance of NEWS (Saelens et al., 2003), emphasising that it was the first instrument to document the association between perceived neighbourhood attributes and design and physical activity. The NEWS further extended transportation research findings by proposing that participation in non-motorized transport was higher in neighbourhoods with high-walkability and that this physical activity contributed significantly to total daily physical activity. The study also recommended the evaluation of more neighbourhood environment variables and the relationship between objective measures of the built environment against perceived environmental measures, to identify the most parsimonious, yet accurate assessments of neighbourhood walkability.

Because the NEWS had been developed in the United States, there were concerns about its generalizability, or that it may not cater for the diversity in terrain and geographical locations (Cerin et al., 2010), particularly in settings that did not conform to a Global North urban form. It was also later adapted and modified to a shorter form, as survey response rates can be negatively impacted by the survey length (Cerin et al., 2006). Subsequently, it was also translated into many different languages (Cerin et al., 2007; Cerin et al., 2008; Cerin et al., 2013).

The findings of the NEWS instrument, especially as regards the measurement properties, such as test-retest reliability have been found to be similar in: China (Cerin et al., 2010), Hong Kong (Cerin et al., 2014), the United States (USA), Australia and Belgium (Van Dyck et al., 2012), Iran (Hakimian & Lak, 2016), South Korea (Kim et al., 2016), India (Adlakha et al., 2016), Shanghai (Zhou et al., 2013), and Japan (Inoue et al., 2010) and in a 12 country study that included Brazil, Mexico, Columbia, Spain (Cerin et al., 2013). Questions remain regarding the applicability of such surveys constructed in the Global North to the local urban contexts of Africa. Africa, as a continent, has limited evidence concerning the association between the built environment and physical activity (Oyeyemi et al., 2013).

The first evaluation of the measurement properties of the NEWS instrument in an African country was conducted in Nigeria. The Nigerian study (Oyeyemi et al., 2013) systematically adapted the NEWS for Nigeria and evaluated aspects of reliability and validity of the adapted version among Nigerian adults. Overall, in the Nigerian urban setting, the NEWS demonstrated acceptable measurement properties and the findings with respect to reliability were similar to those for the USA, Australia and China (Oyeyemi et al., 2013). However, the study was limited to two cities in Nigeria and may have had limited environmental variability. This may have underestimated the strengths of association between the built environment and physical activity (Oyeyemi et al., 2013).

The NEWS was later collectively adapted to assess neighbourhood environmental characteristics relevant to mostly urban settings in Sub-Saharan Africa, by a group of health and physical activity researchers in Africa, in conjunction with the IPEN centre in the United States (Oyeyemi et al., 2016). Saelens et al. (Saelens et al., 2003), emphasized that the basis of the NEWS instrument was the “empirical literature from the transportation and urban planning fields” and while it was important to retain as many of the original constructs as possible, the instrument ought to be suitable for “appropriation to a local culture and environment” of a region.

The final adaptation of the NEWS-Africa survey included all items from the original instrument (Saelens et al., 2003), some of which were retained in their original form and some of which were modified. This harmonised version of the NEWS (NEWS-Africa) and interviewer manual were translated into the local dominant languages in these countries: Cameroon, Ghana, Kenya, Mozambique, Nigeria, South Africa and Uganda, and back-translated to English. The findings in this NEWS-Africa study, conducted across seven

countries, indicated that the instrument was reliable for use across diverse demographic, urban African contexts and languages (Oyeyemi et al., 2016). The mean for the intra-class correlation coefficients (ICC) across all comparisons was 0.69 (SD=0.07, range 0.50-0.82).

In a recent paper, these same authors examined the construct validity of the NEWS scale in Africa, comparing the NEWS-Africa Scales with self-reported walking for transportation and recreation, among adults from six sub-Saharan African countries (Oyeyemi et al., 2017). Of the 13 NEWS-Africa scales, six were related to reported walking behaviour and provided initial modest support for the construct validity of the NEWS-Africa instrument. The overall walkability index was significantly related to walking, both for transportation and leisure purposes, although the magnitude of the associations was generally smaller, compared similar studies from the Western countries (Oyeyemi et al., 2017). However, the NEWS-Africa study failed to compare the properties of the survey in high- and low- socioeconomic status (SES) communities, which may have limited the generalizability of the findings (Oyeyemi et al., 2016).

Oyeyemi et al., (Oyeyemi et al., 2017) highlighted the need to further the study of the validity of the NEWS in specific countries and emphasised that careful attention should be paid to ensuring that the environments studied represented the full variation in that country. The first part of this thesis, therefore, aims to evaluate the reliability and construct validity of the NEWS-Africa instrument, in another urban setting in South Africa, explicitly comparing results from high and low-income neighbourhoods.

2.1 Methods.

2.1.1. Research settings

The research study was conducted in four suburbs in the Western Cape Province of South Africa, including Langa, Pinelands, Khayelitsha and Table View and all were in the urban metropole, South Africa. Langa and Khayelitsha represented two primarily low socioeconomic status (SES) townships, whereas Pinelands and Table View represented suburbs of a higher SES. This was derived from the socio-economic profile of the City of Cape Town (City of Cape Town, 2006), based on the City Development Index (CDI), that averaged indices of infrastructure, health, education and income. The suburbs of Khayelitsha and Langa have an average CDI of 0.75 compared to the provincial average of 0.81, whereas

the suburbs of Table View and Pinelands have a CDI above 0.90. The four suburbs can be compared, as they are mainly residential, but have various commercial centres with retail, business, recreational facilities and public open space, with varying degrees of land use mix.

2.1.2 Study population

This study involved a convenience sample of 66 adults, of which 14 had missing or incomplete data, for a total of 52 participants with complete data (Pinelands = 13, Table View = 13, Khayelitsha =12, Langa =14). Of these, 10 were men and 42 were women and were regular members of either church or community groups in these four suburbs.

2.1.3 Inclusion and exclusion criteria

The study population comprised adults between ages 18 and 65 years residing in their place of residence for at least three months. Within this age group, individuals were eligible for inclusion irrespective of their religious affiliation, employer, type or grade of occupation, literacy level, length of employment contract, type of employment contract (full or part-time contract) and whether they worked in other locations. Of the initial 66 recruited, 10 moved to another area during the study and another 4 had incomplete data and therefore the total for NEWS1, NEWS 2 and IPAQ was 52. Of these 51 had valid accelerometer data.

2.1.4 Recruitment and enrolment

During the recruitment phase, an information letter including the background and purpose of the study was given to the potential subjects after a visit had been made to community gatherings and the church services within these neighbourhoods. An independent translator translated the study information letter and consent forms and back-translated by a second translator to ensure all information was correctly understood. Written consent to participate in the study was then obtained.

2.2 Study measures

The study was a cross-sectional design and was administered as follows.

- 1) **Subjective measures:** The NEWS-Africa questionnaire was administered twice, separated by 1 week for test-retest reliability. The International Physical Activity Questionnaire (IPAQ-Long) was administered once, on the same day as the first administration of the NEWS-Africa questionnaire.

- 2) **Objective measures of physical activity:** Participants were fitted with accelerometers (Actigraph GT3X, Firmware 3:2:1, Actigraph, Pensacola, USA) worn on an elastic belt around their waist. They were asked to wear them for 7 days, and only to remove them when bathing or when they went to bed at night. Data were downloaded and analysed using Actilife 6:10:4 software (ActiGraph, Pensacola, USA).
- 3) **Demographic variables:** Information regarding age, gender, level of education, marital status, vehicle ownership and use, income level, and housing density were obtained from the participants. Marital status was classified as: married, living with a partner, single and widowed/divorced/separated. Education level was categorised as: no formal schooling, primary school only, some high school, completed high school, diploma/higher diploma, bachelor's degree, graduate degree.
- 4) **Height and weight:** Height was measured using a portable stadiometer (Seca 213, Seca, Hamburg, Germany), and weight was measured using a digital scale (Seca, model 8741321009, Hamburg, Germany), which could measure weight to a maximum of 150/200kg. Body mass index (BMI) was calculated as body weight divided by height in m² (kg/m²).

2.2.1 The Neighbourhood Environmental Walkability Scale (NEWS-Africa)

NEWS-Africa questionnaire has 89 items comprised of 13 computed sub-scales and 76 individual items. These were designed to gauge environmental characteristics such as *Residential density* (1 item), *Land use mix access* (adjacency to non-residential land uses) (27 items), *Access to services* (7 items), *Connectivity of streets* (5 items), *Infrastructure and safety for walking and cycling* (12 items), *Aesthetics* (8 items), *Safety from Traffic* (6 items), *Safety from Crime* (4 items), *Personal Safety* (3 items), and lastly, child related-questions on *Stranger Danger* (3 items). The latter was only answered by parents, with a child below 18yrs of age. The eight key NEWS-Africa sub-scales that are considered essential for this thesis are described.

2.2.1.1 Residential density scale (Types of residences)

The single item on residential density was specific to the type of housing in the area, and it was termed as types of residences. Categories included: very few residential buildings within 2-5 minutes' walk of my house, home detached or semi-detached family houses, attached

housing/ apartment/ multiple family housing with 2-5 stories, multiple apartment block/flat of 6 stories or more with large spaces between buildings, multiple apartment blocks/flats of 6 stories or more with very little space between the buildings, very densely small packed houses (1-story homes, including informal settlements and slums).

2.2.1.2 Land use mix Scale (Destinations scale and Recreation scale)

The proximity of destinations was assessed as the perceived walking distance from home to (proximity) to 27 destinations (Oyeyemi et al., 2016). The proximity of destinations was scored using a 5 point Likert scale, and a score of 1 indicated that destination was close to home (less than a 5 min walk) and score 5 indicated that the destination was far from home (more than a 30 min walk). The mean value of the 27 responses was recorded, and lower scores indicated more proximal destinations, and therefore a greater land use mix.

Two separate scales were derived from the items comprising Land use mix: proximity to diverse destinations (*Destinations scale*), which was the mean of 21 items and a Recreational scale which was the mean of 4 items including sports fields/courts, other outdoor recreation space, indoor recreation facilities and dance/martial arts facility/ies. Two items (“places for hunting/collecting firewood” and “farm”) in the *Destinations scale* were not utilised in this study as the participants were living in an urban setting.

2.2.1.3 Access to services scale

Participants rated the accessibility to services within their neighbourhood. The average of the scores for the seven items was recorded as the *Access to services scale*, with a higher score indicating easier access to services.

2.2.1.4 Places for walking, cycling, and playing overall scale

Three additional scales were computed from the *Roads and walking path scale* including the *Sidewalks scale* (5 items), *Crossing scale* (3 items) and *Path infrastructure scale* (2 items) as described by Oyeyemi et al., (Oyeyemi et al., 2016). The items assessed the perceived proximity, availability and quality of paths, in addition to alternate routes, sidewalks, unofficial routes, pedestrian and cycle trails and physical barriers between the walk/cycle paths and roads. The corresponding higher scores on the separate scales implied better and greater infrastructure, better walking and facilities to bolster walking and cycling.

2.2.1.5 Neighbourhood Surroundings scale

This scale included an assessment of participant's perception of the neighbourhood surroundings including the presence of trees, attractive sights, and the absence of litter and pollution. The higher total average score from the Likert scale indicated that the neighbourhood surroundings were considered to be aesthetically pleasing.

2.2.1.6 Safety from Traffic scale and Safety from Crime scale

The two scales covered the volume and speed of traffic, availability of pedestrian crossings and perceived safety from crime. Higher scores for the *Safety from Traffic scale* indicated that participants felt less safe, whereas higher scores for the *Safety from Crime scale* indicated that participants felt safer from crime. As a result, the *Safety from Crime scale* was reverse coded.

2.2.1.7 Personal safety scale

The *Personal safety scale* included: participants' perceptions regarding their interactions with fellow pedestrians as they walked in their neighbourhood, street lighting and the presence of and control of stray dogs. A higher score was associated with a greater perceived personal safety.

2.2.1.8 Stranger danger scale

Stranger danger scale was only completed by those participants with children and reflected their concerns regarding the children's safety during playtime and whom they interacted with, the closer the average scores to 4, the safer they perceived their children to be in the neighbourhoods.

2.2.2 The International Physical Activity Questionnaire (IPAQ-Long)

The long version of the International Physical Activity Questionnaire (IPAQ-long) was used to measure the participant's self-reported physical activity. The 31-item long form comprehensively assessed the frequency, duration and intensity of physical activity in the four domains of; work, household, transportation and leisure. The IPAQ computed weekly durations (minutes per week= days per week x minutes per usual day during of the previous week) for moderate to vigorous physical activity.

Walking for transportation and walking for recreational physical activity were outcome variables. Work-related physical activity was not included, as it is not typically associated with the neighbourhood built environment. Therefore, the total min/week in the domains of transport and recreation were summed to estimate overall minutes of moderate-to-vigorous physical activity (MVPA) per week. Data that were over-reported were truncated according to the IPAQ protocol (www.ipaq.ki.se).

2.2.4 Accelerometers

The Actigraph GTX3 activity monitor was used to assess physical activity objectively. Minute by minute activity counts was accumulated and collapsed into minutes spent at different physical intensities, using the Freedson cut-points across the 7 days as described by Loprinzi et al. (Loprinzi et al., 2012). These intensities included: light (counts less than 759 per minute), moderate (counts between 760 and 5724), and vigorous (counts between 5725 and 9498). The accelerometer data were collected and aggregated to one-minute epochs. Non-wear time was determined as any period of 60 minutes or more of consecutive zero counts. Only data from participants with at least 10 hours of valid wear time, on at least 4 days, were included. Counts/minutes were converted into minutes of sedentary time (≤ 100 counts/min), light, and moderate and vigorous-intensity physical activity as described by Loprinzi et al. (Loprinzi et al., 2012).

2.3 Ethical considerations

The ethical considerations for this research involving human subjects complied with the Declaration of Helsinki (2013). All procedures in the proposed study were non-invasive and largely self-report. All participants received a token of appreciation for participation in the project, in the form of a shopping or airtime voucher, to the value of ZAR100 after returning the accelerometers on the second visit. All subjects gave informed, written consent to participate. This research study was approved by the University of Cape Town Health Sciences Research Ethics committee (HREC REF 293/2016).

2.2.4 Data analysis

Descriptive analysis for the sociodemographic characteristics of all participants was computed and presented as means \pm standard deviation for continuous variables or counts and percentages for categorical variables all (all the descriptive statistics are presented in Table 2.1). In Table 2.1, the self-reported and objectively-measured MVPA were also compared

between high- and low-SES groups. Between group comparisons for normally-distributed were made using independent t-tests. Where data were not normally distributed, medians and the lower and upper quartiles were provided (Table 2.3) and non-parametric Mann-Whitney U tests (Table 2.4 for objective physical activity and Table 2.5 for reported physical activity) and regression done (Table 2.4).

To evaluate the test-retest reliability, Spearman's rho correlations between the NEWS –Africa instrument administered on the first occasion and one week later (NEWS 1 vs NEWS 2) were conducted, for each SES group and with the two-SES groups combined (Table 2.6). Further, to assess the construct validity of the NEWS-Africa, Spearman's rho correlations were calculated between environmental variables (Scales, Subscales and single items) and IPAQ measurements (Table 1.7) and objective accelerometer data (Table 8). Statistical tests were considered significant at $p < 0.05$. All data were analysed using Stat Soft ® 2014 version 13 for Windows (IBM Corp: New York).

2.4 Results

2.4.1. Descriptive Characteristics of the participants

The descriptive characteristics of the participants for whom there was complete data (N=52) are presented in Table 2.1. The participants' mean age was 41.4 ± 12.7 years in the lower-SES groups and 45.8 ± 12.7 years in the higher-SES groups. Significant differences were found for BMI ($p < 0.05$) between the two-SES groups. Of those participants in the high-SES neighbourhoods, 84% were married, compared to only 16% from the low-SES communities. Also, more than 80% of persons surveyed in the high-SES suburbs had access to at least one private motor vehicle, while only 44% of persons from low-SES neighbourhoods had similar access.

2.4.2 Objectively- measured physical activity

The median, 25th and 75th percentiles of objectively-measured physical activity are presented in Table 2.2. There were no significant differences between the two SES groups for objectively-measured light and moderate physical activity. However, time spent in vigorous physical activity was significantly higher in the high-SES groups.

2.4.3. Self-reported physical activity

The median, 25th and 75th percentiles of self-reported physical activity are presented in Table 2.3. The median time participants reported for TPA in the combined-SES was 60 min/wk with 25% reporting \leq 10 min/wk of transport-related physical activity. Self-reported leisure-time physical activity in the combined-SES groups had a median of 150 min/wk with 25% of the participants reporting \leq 40.5 min/wk of recreational physical activity. Transport-related physical activity was higher in the lower SES groups, with a median of 112.5 min/wk compared to a median of 25.0 min/wk in the Higher SES groups. Data for reported physical activity, presented in Table 2.3, indicated that participants from the lower-SES areas reported significantly greater TPA compared to those from higher-SES areas ($P < 0.05$). Conversely, participants in the higher-SES areas reported more leisure time related to physical activity than those from lower-income areas ($P < 0.05$).

Table 2.1: Descriptive statistics for participants' demographics – comparison of high and low SES groups

	N=26	N=26	N=52	p-value
	High-SES N (%)	Low-SES N (%)	Combined-SES N (%)	
Vehicle use				
None	2 (7.6)	11(42.3)	14 (53.8)	0.001* *
One or more	24 (92.4)	15 (57.3)	12 (46.2)	
Marital status				
Married / Living with partner	23 (88.4)	5(19.2)	26 (50)	0.001* *
Single	2 (7.6)	16 (64)	19 (36.5)	
Widowed	1(3.8)	4 (16)	5 (9.6)	
Level of Education.				
Completed High school	3 (11.5)	3 (12)	6 (11.5)	0.001* *
Diploma/Higher Diploma	14 (53.8)	5 (20)	19 (36.5)	
Bachelor's degree	3 (11.5)	1 (4)	4 (7.7)	
Graduate degree	6 (23.1)	0 (0)	6 (11.5)	
Age (yrs, mean, SD)	41.38 (12.7)	45.77 (10.8)	43.58 (11.9)	0.19
BMI (kg/m ² , mean, SD)	33.9 (23.0)	28.9 (23.9)	31.1 (23.34)	0.05**

* SES groups based on socio-economic parameters

** Comparisons between Low-SES High-SES mean ages, BMI. $p < 0.05$ is statistically significant.

Table 2.2: Mann-Whitney U test Comparison of objectively-measured physical activity by Low and High SES

	COMBINED-SES		LOW-SES		HIGH-SES		P Value
	N	Median (25 th ; 75 th centile)	N	Median (25 th ; 75 th centile)	N	Median (25 th ; 75 th centile)	
MPA	51	209 (118;327)	25	232 (11;353)	26	185 (130;273)	0.78
VPA	51	1 (0;5)	25	0 (0;2)	26	4 (0;11)	0.01*
MVPA	51	216 (120;327)	25	232 (114;354)	26	195 (136;274)	0.99

Descriptive statistics for demographic variables using median lower and higher quartiles.

* SES – Socioeconomic groupings (high or low)

M Median

MPA Moderate physical activity

VPA Vigorous physical activity

MVPA Moderate to vigorous physical activity

Table 2.3: Mann-Whitney U test for Reported physical activity (transport, household and leisure) by SES^a

	COMBINED-SES		LOW-SES		HIGH-SES		P Value
	N	Median (25 th ; 75 th centile)	N	Median (25 th ; 75 th centile)	N	Median (25 th ; 75 th centile)	
TPA	52	60 (10;180)	26	113 (45; 180)	26	25 (0;70)	0.78
LTPA	52	151 (41;180)	26	113 (30;180)	26	180 (100;180)	0.99
TTL PA	52	403 (248;525)	26	403 (255;540)	26	408 (240;450)	0.69

^a Descriptive statistics for demographic variables using median lower and higher quartiles.

* SES – Socioeconomic groupings (high or low)

M - Median

TPA - Transport physical activity

LPA - Leisure-time physical activity

TOT PA - Total physical activity

2.5. Test-Retest Reliability

Table 2.4 shows the test-retest reliability Spearman's correlations between the NEWS – Africa instrument administered on the first occasion and one week later (NEWS 1 vs NEWS 2), for each SES group and with the two SES groups combined. For the combined groups, 10 out of the 13 items were positively and significantly correlated, indicating good reliability of the scales.

The *Safety from Crime Scale* ($r_s=0.74$, $p=0.00$) and *Neighbourhood Surroundings scale* ($r_s=0.79$, $p=0.000$) had the highest reliability. For the lower-SES group, only 2 out of 13 items

(*Recreation scale* ($r_s = 0.53$, $p=0.01$) and *Neighbourhood surroundings scale* ($r_s = 0.39$, $p=0.05$) were positively and significantly correlated, indicating overall poorer reliability. Conversely, for the high-SES group, 12 out of 13 scales were positively and significantly correlated, and 1 item (*Access to services scale*) had poor reliability.

2.6 Construct validity for NEWS against self-reported physical activity

Table 2.5 shows the correlations between the different environmental perceptions (Scales for NEWS-Africa 1) and the self-reported physical activity questionnaire (IPAQ).

The *Safety from Traffic scale* indicated that participants were less likely to engage in Transport-related physical activity if they felt safe (TPA) ($r_s = -0.34$, $p=0.01$). Conversely, the Leisure-time physical activity (LPA) was positively associated with the *Safety from Crime scale* (feeling safer in their neighbourhood, $r_s = 0.36$, $p=0.00$). Persons who felt safe from crime, were nevertheless, less likely to engage in TPA ($r_s = -0.39$, $p=0.00$).

In the high-SES groups, the *Access to services scale* was inversely associated TPA ($r_s = -0.50$, $p=0.00$) and MVPA ($r_s = -0.50$, $p<0.00$).

2.7 Construct Validity for objectively measured physical activity

The associations between the neighbourhood environment variables and objectively measured physical activity (moderate, vigorous and total MVPA) are presented in Table 2.6 and segregated by SES (i.e. Low-SES, High-SES groups, and Combined-SES). In the combined-SES groups, none of the scales was significantly associated with total physical activity.

Participants who perceived greater access to services were less likely to accumulate MPA ($r_s = -0.29$, $p=0.03$). Participants who scored higher on personal safety ($r_s = 0.30$, $p=0.03$) and safety from crime ($r_s = 0.36$, $p= 0.00$) were more likely to accumulate VPA.

In the lower SES group, the *Recreation scale* was significantly and positively associated with VPA ($r_s = 0.42$, $p=0.03$). However, higher scores for *Neighbourhood Surroundings* were inversely associated with MPA and MVPA. In the high-SES, only the *Roads and walking paths scale* had a statistically significant association with physical activity ($r_s = -0.39$, $p=0.04$), and this was also in an unexpected direction. The participants were less likely to engage in moderate physical activity, even when they perceived proximity, good quality of

paths and alternative routes. The participants who perceived greater personal safety were more likely to engage in VPA.

Table 2.4: Test-retest reliability for NEWS 1 and NEWS 2 scales ^a

NEWS 1 Variables	Lower-SES*		Higher-SES*		Combined-SES*	
	<i>r_s</i>	p- value	<i>r_s</i>	p- value	<i>r_s</i>	p- value
Destinations 1	-0.35	0.08	-0.55	0.00**	-0.43	0.00**
Recreation 1	0.53	0.01**	0.63	0.00**	0.62	0.00**
Access to services 1	0.27	0.18	0.16	0.43	0.23	0.11
Roads and walking paths 1	-0.11	0.58	0.47	0.02**	0.22	0.12
Side walk 1	-0.12	0.55	0.66	0.00**	0.30	0.03**
Crossing 1	0.10	0.63	0.51	0.01**	0.38	0.01**
Paths Infrastructure1	-0.25	0.21	0.43	0.03**	0.13	0.37
Places for walking, cycling, playing 1	0.07	0.74	0.64	0.00**	0.48	0.00**
Neighbourhood surroundings 1	0.39	0.05**	0.65	0.00**	0.79	0.00**
Safety from Traffic 1	0.21	0.31	0.50	0.01**	0.55	0.00**
Safety from Crime 1	0.31	0.13	0.61	0.00**	0.74	0.00**
Personal safety 1	0.07	0.75	0.68	0.00**	0.39	0.00**
Stranger danger 1	-0.32	0.23	0.90	0.00**	0.51	0.01**

Test-retest reliability uses Spearman's (rho) correlation between NEWS 1 and NEWS 2 for all SES * SES groups; ** r-values are reported for only comparisons that were statistically significant at p <0.05 (the negative values for the Spearman's are indicative of test-retest reliability, a negative value is indicative of an inverse relationship between the perceived neighbourhood environment of NEWS 1 and NEWS 2).

Table 2.5: Construct validity: Spearman (rho) rank order Correlations between environmental perceptions (NEWS 1) the 7-day long IPAQ

NEWS VARIABLES	Low SES			High SES			Combined groups		
	Transport PA	Leisure PA	Total PA	Transport PA	Leisure PA	Total PA	Transport PA	Leisure PA	Total PA
Destination 1	-0.06	0.16	-0.29	-0.30	-0.23	-0.26	-0.12	-0.08	-0.26
Recreation 1	0.15	0.24	0.04	0.16	0.39	0.37	0.23	0.21	0.20
Access to services 1	-0.01	-0.20	-0.05	-0.50**	-0.11	-0.50**	-0.20	-0.15	-0.26
Roads and walking paths 1	-0.22	-0.30	-0.23	0.08	-0.02	-0.01	-0.12	-0.10	-0.14
Sidewalks 1	0.15	0.03	-0.14	0.10	0.07	0.29	0.01	0.09	0.07
Crossings 1	-0.08	0.06	0.05	0.17	0.09	0.03	-0.15	0.17	0.00
Paths infrastructure1	0.13	-0.05	0.01	-0.21	-0.10	-0.25	-0.13	0.03	-0.14
Places for walking, cycling, and playing overall mean 1	0.04	-0.11	-0.10	0.03	-0.02	0.02	-0.17	0.08	-0.08
Neighbourhood surroundings 1	0.14	-0.18	0.09	-0.35	-0.10	-0.30	-0.34**	0.15	-0.08
Safety from Traffic 1	-0.07	-0.39	-0.18	-0.34	-0.14	-0.24	-0.34**	-0.07	-0.17
Safety from Crime 1	0.14	0.37	0.24	-0.15	0.05	-0.26	-0.39**	0.36**	-0.05
Personal safety 1	0.16	-0.03	0.20	0.12	0.37	0.22	-0.05	0.27	0.18
Stranger danger 1	-0.31	-0.24	-0.15	0.04	-0.15	-0.09	-0.12	-0.08	-0.26

^a Spearman's (rho) Comparisons between self-reported physical activity (Transport, Leisure and Total MVPA) and environmental perceptions (computed scales) for NEWS1. ** r-values are reported for only comparisons that were statistically significant at p <0.05. The negative values for the Spearman's r, are indicative of an inverse relationship between the perceived neighbourhood environment and self-reported physical activity domains.

Table 2.6: Comparisons between measured physical activity (Moderate, Vigorous and MVPA) and NEWS environmental perceptions: Construct validity

NEWS 1 VARAIABLES	Low -SES*			High- SES*			Combined -SES*		
	Moderate	Vigorous	Total MVPA	Moderate	Vigorous	Total MVPA	Moderate	Vigorous	Total MVPA
Destination 1	-0.08	0.15	-0.08	0.27	-0.05	0.30	0.10	-0.01	0.11
Recreation 1	-0.05	0.42**	-0.05	0.18	-0.13	0.16	0.02	0.05	0.01
Access to services 1	-0.40**	0.11	-0.38	-0.13	-0.03	-0.05	-0.30**	0.00	-0.27
Roads and walking paths 1	-0.14	0.31	-0.15	-0.40**	0.05	-0.32	-0.24	0.13	-0.22
Sidewalks 1	0.03	0.05	0.02	-0.15	-0.10	-0.19	-0.05	0.10	-0.06
Crossings 1	-0.10	0.23	-0.10	-0.33	0.23	-0.28	-0.20	0.31**	-0.17
Paths infrastructure1	-0.05	-0.14	-0.06	-0.28	-0.28	-0.30	-0.12	-0.09	-0.11
Places for walking, cycling, and playing, overall mean 1	-0.14	0.06	-0.15	-0.18	0.01	-0.21	-0.13	0.21	-0.12
Neighbourhood surroundings 1	-0.41**	-0.38	-0.41**	0.00	0.26	0.08	-0.15	0.26	-0.10
Safety from Traffic 1	-0.16	-0.09	-0.16	-0.19	0.10	-0.12	-0.14	0.18	-0.10
Safety from Crime 1	0.14	0.10	0.15	0.23	0.13	0.24	0.06	0.36**	0.10
Personal Safety 1	-0.10	-0.04	-0.10	0.13	0.49**	0.25	-0.03	0.30**	0.02
Stranger Danger 1	-0.37	-0.44	-0.36	-0.18	0.23	-0.19	-0.15	-0.24	-0.15

^aSpearman's (rho) Comparisons between measured physical activity (Moderate, Vigorous, and MVPA) and environmental perceptions (computed scales) for NEWS1. * SES groups; ** r-values are reported for only comparisons that were statistically significant at $p < 0.05$ (the negative values for the spearman's are indicative of an inverse relationship between the perceived neighbourhood environment and objective physical activity domains) (construct validity).

2. 8 Discussion of Results and Conclusion

The present study examined the reliability and construct validity of the NEWS-Africa instrument in an urban African setting, specifically in high- and low-income settings. The NEWS–Africa is a survey instrument that has been developed as a means to assess the perceived attributes of the built environment in relation to physical activity, adapted for African countries (Oyeyemi et al., 2016). Test-retest of the NEWS–Africa was measured for each SES group and the combined groups. For the combined-SES, the test-retest reliability indicated good reliability with 11 out of the 13 scales of the NEWS-Africa being significantly and positively correlated, the Spearman's correlations ranged from ($r_s = 0.30, p=0.03$ to $r_s = 0.79, p<0.001$). This is in line with the NEWS-Africa study (Oyeyemi et al., 2016) in which over 95% of all NEWS-Africa items, Scales and Sub-scales showed evidence of “excellent” (ICCs > 0.75 for 7 scales) or “good” (ICCs=0.60 to 0.74 for 6 scales) reliability. 7 of the 13 (53.8 %) of the computed scales demonstrating "excellent" agreement and the other 6 having "good" agreement. In the Oyeyemi study, none of the items or scales demonstrated "poor" reliability (ICCs <0.40) (Oyeyemi et al., 2016).

However, in the lower-SES group in the present study, only 2 out of 13 scales were shown to be reliably reported compared to the higher-SES group with 11/13 scales being positively and significantly correlated. To better understand this discrepancy, we consider the definition of reliability. Smith (2008) notes that reliability can be contextualised in different ways, one of which is test-retest reliability. The magnitude of test-retest agreement and sources of error may be due to biological variability, instrumentation, an error by the tester, as well as systematic error, such as bias from learning effects. All of which may cause differences in scores/reliability.

The differences in reliability in the present study may have been due to factors such as recall, or differences in educational attainment, habitual tendencies, and little or no access to the various destinations in the previous weeks, or actual changes within the built environment from one week to the next. Cortina, 1993, highlights that many factors can prevent measurements from being repeated correctly and that a particular aspect of reliability depends on particular error-producing factors that one seeks to identify. (Cortina, 1993).

The *Destinations scale* is only repeatable in the higher-SES group. While many studies show positive associations with physical activity in relation to proximity of destinations and for example, easy access to parks (Jáuregui, Pratt, et al., 2016)(Sugiyama et al., 2014)(Hallal et al., 2010), the perception of proximity to destinations in the present study seems to be different on the second administration in the low-SES groups. Another possible explanation for the discrepancy between the results in the computed scales between the low- and high-SES groups, may be sensitisation. The participants might have been sensitised about the destinations they might otherwise have been unaware of, on answering the same question twice. Golafshani, 2003. (Golafshani, 2003) have highlighted that employing the test-retest method of research has a pitfall as it may sensitise the respondent to the subject matter and thereby influence the responses given. Sensitisation in the present study may have affected the reliability outcomes as 11/13 had reliability in the Combined-SES, 12/13 the high-SES and only 2/13 in the low-SES. The results suggest that as a result of completing a test survey respondents many may have become more sensitised to physical characteristics of their neighbourhood and noticed aspects of the environment in their neighbourhood that they may not have been aware of or accustomed to thereby producing a different response on the test survey, resulting into lower reliabilities.

The *Stranger danger scale* had little to no variance in the low SES group on second administration indicating that all the subjects felt safe. One possible explanation for this may be that people in the low-SES area are more “accommodating” about what is safe for them, and are more inured to the general crime and insecurity that is endemic and more pronounced in the low-SES areas of South Africa (City of Cape Town, 2006). Furthermore, the socioeconomically disadvantaged are more likely than the advantaged to walk for transport and may therefore be exposed or experience negative aspects of their neighborhood (for example sparse neighborhood greenery, fewer interesting things to see , more crime) resulting in a greater consistency and reproducibility of their responses (Turrell et al., 2009). Turrell et al. (2009) further suggests that a chance occurrence can also explain higher reliabilities for crime and safety during the week.

The lower reliability coefficient in the various groups could also be accounted for by the subjective and changeable nature of their neighbourhood surroundings, for example, the level of traffic may change during day due to road closures or public disturbances (Turrell et al., 2011). One study highlights that even trained auditors had difficulty assessing neighbourhood

aesthetics, presumably because of the nature of the constructs as they subjective (Pikora et al., 2002).

2.8.1 Construct validity of the reported physical activity

Most environmental scales in this study including *Recreation, Roads and walking paths, Crossings, Personal Safety, Stranger Danger* were not significantly related to walking for transport, which was similar to the construct validity in the NEWS–Africa study (Oyeyemi et al., 2017), but is contrasted with the literature from outside of Africa, such as China (Cerin et al., 2007) and countries in Europe and Americas (Cerin et al., 2013). The failure to demonstrate construct validity in this study for the various scales may be due, in part, to the differences in income levels that significantly affect pedestrian behaviours (Kim et al., 2016) and the availability of services. These differences impact on whether or not individuals travel or need access to services by foot, which involves walking for utilitarian purposes (Cerin et al., 2011) and therefore, may result in a ‘disconnect’ between the perceived environment and physical activity levels.

This study revealed that only three scales were related to walking for transport. These were; *Neighbourhood surroundings, Safety form Traffic* and *Safety from Crime*. *Safety from Traffic* and *Safety from Crime* scales were in the opposite direction Perceived Safety from Traffic and perceived Safety from crime were associated with less transport-related physical activity, and this differed from the Nigerian study (Oyeyemi et al., 2013) which showed that all significant correlations were in the expected direction except for the Neighbourhood Aesthetics.

The results of the *Neighbourhood aesthetics scale (Neighbourhood surroundings scale)* in this study is in the same direction as the Nigerian study and revealed that the more the respondents found the neighbourhood aesthetically pleasing, the less transport-related physical activity they engaged in. The explanatory factors for the negative relationship between Neighbourhood Surroundings and transport-related physical activity were gender and income status implying that women respondents from low SES areas did less transport-related physical activity compared to the men.

The findings in the current study are of particular importance, as they suggest a difference in expectation of respondents as regards traffic safety and crime. The possibility could be the people from higher-SES are more demanding about what is safe for them as indicated by

Oyeyemi et al., (Oyeyemi et al., 2013) in the Nigerian study or it could also reflect the general high crime rate in the Western Cape (City of Cape Town, 2006).

2.8.2 Construct validity of the objectively measured physical activity

In the combined-SES group in the present study, the *Access to services, Sidewalks, Neighbourhood surroundings, Safety from Traffic and Safety from Crime scales* were not related to total MVPA. The overall construct validity ranged from -0.41 to 0.36 indicating poor to moderate validity.

Previous studies have found associations that are fairly consistent, with perceived traffic safety, neighbourhood aesthetics, convenience of facilities for walking, accessibility of destinations associated with higher physical activity (Arango et al., 2013). The limited evidence from low-income and middle-income countries has demonstrated that perceived access to recreation facilities, density of exercise facilities and urbanisation are positively associated with physical activity (Bauman et al., 2012) while the association between safety (e.g. crime and traffic) and physical activity are less consistent (Bauman et al., 2012).

Orstad et al. (Orstad et al., 2017) highlight that a number of review of studies have documented associations between perceived and objective built environment and various physical activity outcomes, however, they state that current evidence does not discern whether perceived or objective environment variables more consistently predict physical activity. They, therefore, did a study to synthesise evidence on agreement on agreement between perceived and objective neighbourhood environmental measures, and whether demographic, psychosocial, behavioural and/or environmental factors explain the level of agreement between these measures. The second aim was to examine evidence on associations between comparable perceived and objective neighbourhood environmental variables and physical activity. The overall results of their study revealed a low to moderate agreement between perceived and objective environmental variables and a few factors that were consistently associated with the level of agreement.

Their review underscores that perceived and environmental measures may be less comparable than their definitions suggest and the low agreement may suggest that perceived measures have not yet fully been developed to reflect the objectively measured environment adequately. They further suggest that perceived and objective measures cannot closely approximate one another and should not be used interchangeably because they may capture

different sources of variability in behaviour. They, therefore, caution against concluding objectively measured neighbourhood environmental attributes based on perceived measures and vice-versa. Koohsari (2014) (Koohsari et al., 2014), point out that it may be unsound to assume that a match between the perceived and the objectively measured environment is a requisite for physical activity behaviour. Orstad (Orstad et al., 2017), therefore recommend that future physical activity research should examine how perceptions of neighbourhoods form, how they can best be defined and how they differ among individuals and groups, and how the objectively measured environment influences them.

The explanatory variables for the differences in these SES groups in the present study range from vehicle ownership to the proximity of outdoor recreation and sports fields. (Orstad et al., 2017) highlight that there are socioeconomic inequalities, cultural aspects, and other contextual differences in the environment (crime rates, poor access to physical activity facilities and public transportation predominantly made by buses) unique to low and middle-income countries, where physical activity is used for utilitarian, rather than recreational purpose. Wang et al. (Wang et al., 2015) concluded that urban parks appear inequitably distributed within cities, especially with communities of lower SES and people of colour having inferior geographic access to parks thereby constraining the frequency of park use. (Wang et al., 2015). The research highlighted a link between a non-physical attribute, such as cultural similarity, contributing to urban park accessibility with results indicating that park accessibility consists of physical and socio-personal dimensions hence underscoring the theme of environmental and social justice.

For a country such as South Africa, the effect of environmental and social injustice still plagues the society post-1994 and may account for the differences between these SES groups. Although previous research shows otherwise, there is an empirical study in Melbourne, Australia confirmed that urban residents of lower income were more likely to have mismatches between their perceptions of the perceived environment and objective measures (Ball et al., 2008).

2.8.3 Strengths and limitations

The present study has fundamental limitations to note. Conducting the study among residents of one neighbourhood type or as part of a convenience sample (in terms of them attending the same church within the same community) may restrict environmental variability. Restricted variability could, in turn, underestimate the strengths of environmental-physical activity

associations in environmental studies (Adams et al., 2013; Oyeyemi et al., 2013; Van Dyck et al., 2012; Sallis et al., 2009). The small sample size may reduce the generalizability of the findings (Oyeyemi et al., 2013) and the ability to detect true differences.

The present study had key strengths to note. The present study can be used as a basis of comparison with the psychometric evaluation of the NEWS-Africa in the 7 African nations (South Africa, Mozambique, Cameroon, Nigeria, Ghana, Kenya and Uganda). It is also the first of its kind to compare physical activity levels objectively and subjectively against the perceived built environment, and across different income settings, in a South African context, which brings variation to environmental studies.

In conclusion, this study showed that the NEWS-Africa had low to moderate reliability in the low-SES group for both self reported and objective physical activity, whereas it was higher in the high-SES group and when the groups were combined-SES. Construct validity for objective physical activity in the combined-SES group in the present study showed that *Access to services, Sidewalks, Neighbourhood surroundings, Safety from Traffic and Safety from Crime scales* were not related to total MVPA. The overall construct validity ranged from -0.41 to 0.36 indicating poor to moderate validity. This was possibly due to differences in utilitarian compared to volitional or leisure time activity, access to a motor vehicle etc. between groups. One way of confirming if there is a relationship between attributes of the built environment and physical activity is to use 'ground-truthing'. To our knowledge, a "ground truthing" study of neighbourhood "walkability" has not been conducted in Africa. We believe this is important in better understanding the impact of environmental attributes on utilitarian, and leisure-time physical activity in order to structure interventions and to address issues of environmental justice. Geographical Information System (GIS) can be used to objectively measure features of the built environment that may influence adult physical activity, an important determinant of chronic disease (Pikora et al., 2002).

These findings are particularly important for health promotion in Sub-Saharan Africa. Lee et al., (Lee et al., 2012b) highlight that understanding the environmental correlates of physical activity is a priority that could lead to better strategies to prevent further declines in physical activity in the region. Further evaluation of the NEWS-Africa is needed in other countries that could lead to evidence-based recommendations for creating better designed and safer communities that make cities in Africa more "walkable".

CHAPTER THREE

GROUND TRUTHING: PERCEIVED VS OBJECTIVELY-MEASURED BUILT ENVIRONMENT ATTRIBUTES IN SOUTH AFRICAN COMMUNITIES

3.0 INTRODUCTION

In the previous chapter, we examined the reliability and construct validity of the NEWS-Africa instrument in an urban African setting, specifically in high- and low-income neighbourhoods. The results showed that the NEWS-Africa had evidence of low to moderate reliability in the low-SES group, whereas it was higher in the high-SES group and when groups were combined. Differences in construct validity between groups may have been related, at least in part, to differences in the purpose of activity. One means of comparing the perceived environment to the actual built environment is through ground truthing. Ground-truthing involves a systematic and direct observation of various attributes of the built environment. In the case of physical activity, this may include: road networks, land use, destinations, aesthetics, recreational facilities and sporting venues, community centres and shopping destinations, traffic safety, and lighting. To our knowledge, a "ground truthing" study of neighbourhood "walkability" has not been conducted in Africa that contrasts the "lived experience" of the neighbourhood built environment against objectively-measured attributes and to identify the factors that shape any inconsistencies in these measures and addresses issues of environmental justice. South Africa, as a nation has vast inequalities (high GINI coefficient) and therefore ground-truthing the built environment in relation to incidental, utilitarian, and leisure-time physical activity, may provide insights to better understand the ecological and environmental barriers to participation in physical activity, to address issues of social justice.

Charreire et al. (Charreire et al., 2014) address the importance of capturing both the objective and subjective assessments of environmental attributes. In other words, it is essential to understand "how those who inhabit the environment perceive it". The extent to which objective measures and subjective measures of the neighbourhood environment overlap or complement each other in influencing the level of physical activity has not been widely

researched (Nyunt et al., 2015). Furthermore, previous studies have actually shown a poor level of agreement between the perceived and objective measures of the built environment (Michael et al., 2006), (McGinn et al., 2007).

A recent ground-truthing study concerning the six attributes of neighbourhood walkability was conducted in 14 countries from the IPEN network, including cities in New Zealand, Hong Kong, China, and several European cities, Mexico City, Brazil, Colombia and the United States. This multi-country study identified urban environmental attributes that accounted for significant differences in physical activity, including net residential density, public transport density and park density. This combination of environmental features generally explained more variation in physical activity than individual variables, such as intersection density, suggesting that comprehensive approaches were needed to design physical activity-supportive neighbourhoods.

One of the recommendations from their study was to expand the research to low-income countries in which associations between urban environment and physical activity have not been previously assessed, to develop objective measures for environmental attributes relevant to physical activity like sidewalks, pedestrian zones, bicycle facilities and factors affecting intersection quality such as: crosswalks, pedestrian signals and traffic calming.

With the above recommendation in mind, this study aimed to:

- Broaden the research on associations between the built environment and physical activity, by examining walkability constructs and subscales of the NEWS-Africa instrument, utilising ground-truthing and remote-sensing technology (Geographic Information Systems, GIS) in an urban South African setting.
- Examine the extent to which socioeconomic status of communities influences these associations.

3.1 Methodology

3.1.1 Study setting and sample size

As in the previous chapter, we reported on the reliability and construct validity of the NEWS-Africa instrument of the 52 participants recruited from four suburbs in Cape Town. The suburbs were both low (Khayelitsha, Langa) and high income (Table view, Pinelands).

3.1.2 Geographic Information Systems (GIS)

Buffer size and Type

Using Geographic Information Systems (GIS) (ArcGIS version 10.51), we identified the available physical activity facilities which included; sporting venues, recreational centres and parks within each residential buffer. The source of the point data was the City of Cape Town 2011 census. Radial buffers (500m, 1000m and 1600m) were established (Hanibuchi et al., 2011) around the street intersection closest to each participant's home address, distances that corresponded to 5-7 min (500m), 10-12 min (1000m) and 15-18 (1600m) minutes walking time for persons traveling on foot.

The methodology used was based on Adams et al. (Adams et al., 2014), who employed the individual-level street network buffer-based GIS measures. The advantage of using this approach was that it placed the participants within the neighbourhood and captured destinations that participants could access from the road network. As a result, this method has merits compared to an administrative boundary approach of defining neighbourhoods (Adams et al., 2014).

3.1.3 Walkability measures using GIS

3.1.3.1 Walkability

A walkability index was computed as the sum of Z scores for net residential density, land use mix and diversity, and intersection density (Adams et al., 2014). The walkability index was adapted from (Frank et al., 2010) and calculated as:

$$\text{Walkability} = ((2 * z\text{-intersection density}) + (z\text{-net residential density}) + (z\text{-retail floor area}) + (z\text{-land use mix})).$$

It differed from the original measure as the retail floor area ratios were not available, but (Adams et al., 2014) captured the two main theoretical constructs of walkability, proximity and connectivity (Frank et al., 2010).

3.1.3.2. Net Residential Density

Net residential density was computed as the number of dwellings (numerator) divided by the land area dedicated to residential use, within the three buffers (Adams et al., 2014). The

residential density was computed for each buffer in each of the suburbs ((dwelling count/residential area)*1,000,000).

3.1.3.3. Street connectivity

In this chapter (Adams et al., 2014), street connectivity was operationalised as intersection density. This was defined as the ratio of the number of intersections within each participant's buffer (numerator) divided by the total buffer area. Previous papers (Frank et al., 2005) (Sallis et al., 2004) have established intersection density as a measure of route directness, which captures the ability to move to and from destinations in a direct pathway.

An intersection in this study was defined as a point where three or more segments intersected after removal of limited access roads and pseudo intersection nodes (Adams et al., 2014). All streets in Cape Town were merged and cut out to fit the buffers in the four suburbs, the street connections were then set to point, and the points were joined in the buffers and aggregated to get each intersection in all the buffers. The intersection density was computed as ((intersection count/buffer area)*1000,000).

3.1.3.4. Land-use Mix and Diversity

Four land uses were computed; residential, retail-combined, civic/institutional and others. Parcel data was used to quantify the land uses. Land-use mix was calculated using an entropy equation (Song et al., 2013) to score the area based on these four land use types (Adams et al., 2014).

Table 3.1a: Descriptive properties of Land use mix by community

Neighbourhood	Land area of community (m ²)	Population density (persons/m ²)	Land- use types			
			Residential % Mean (SD)	Retail combined % Mean (SD)	Civic % Mean SD	Other Mean (SD)
Khayelitsha	38.70 km ²	10,120 persons/km ²	18.8 (7.5)	1.7 (1.6)	8.0 (4.2)	71.5 (12.3)
Langa	3.09 km ²	16,958 persons/km ²	32.7 (5.0)	5.2 (2.8)	12.1 (2.4)	50.0 (8.6)
Table view	6.14 km ²	2,800 persons/km ²	57.8 (16.0)	5.1 (3.0)	15.8 (6.4)	21.3 (15.7)
Pinelands	5.86 km ²	2,400 persons/km ²	54.1 (7.6)	4.4 (4.1)	11.3 (3.3)	30.1 (7.7)

The area of the four land uses was summed up and later divided by each land use to get the portion of land use for each buffer (land use/sum of land use types)*100. (Table 3.1a)

3.1.3.5. Public Transport density

For this study, all bus stops, Integrated Rapid Transit System stops, and railway stops were documented in each buffer zone. Public transport density was computed as the number of public transport stops divided by buffer area (transport stops/transport zones)*1,000,000. (Kerr et al., 2013).

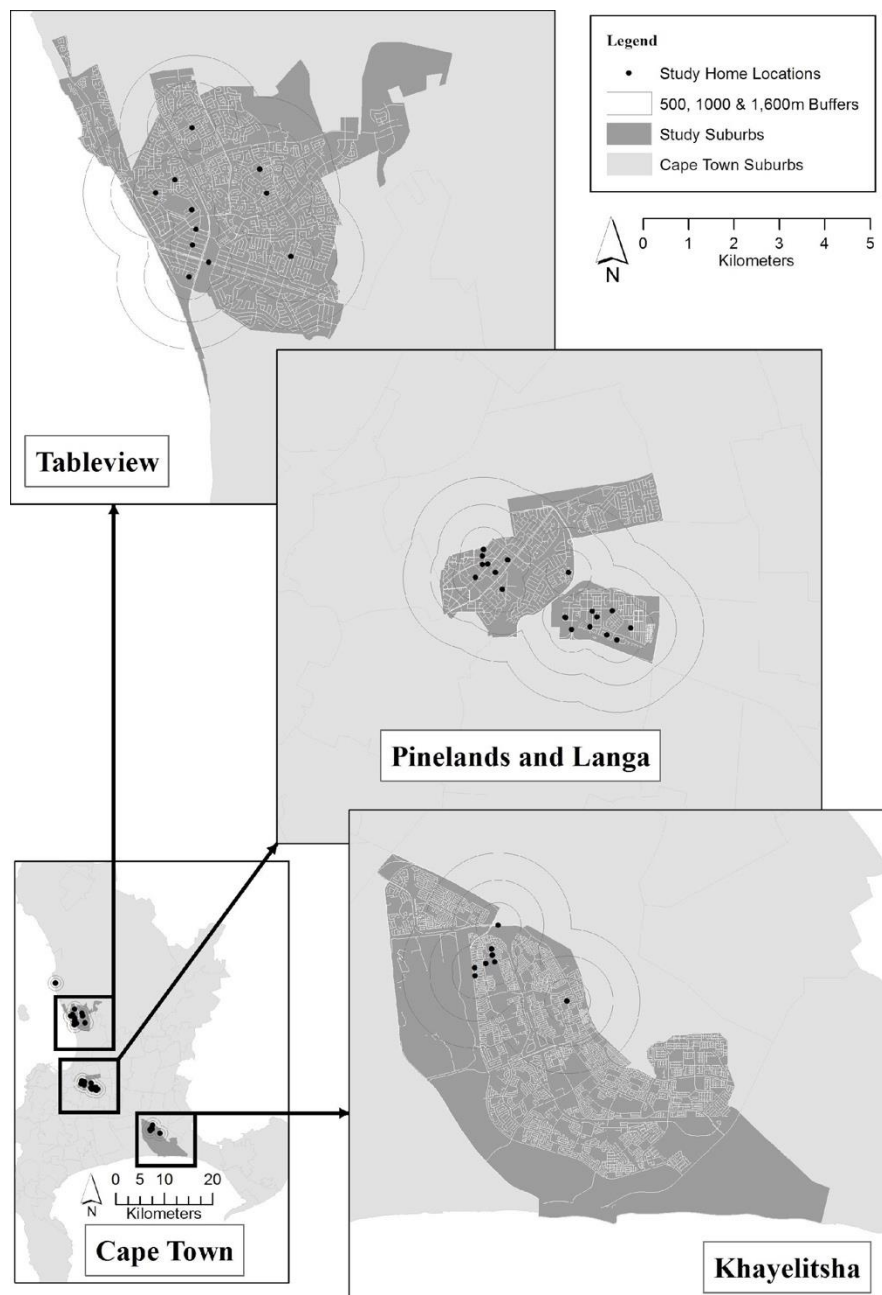


Figure 3: An overview of Intersection density in the four study suburbs

3.2 Analyses

We correlated the perceived distances (in minutes of walking on an ordinal scale) between the NEWS-Africa survey for: Places of worship/ Faith centres, Workplaces or Schools, Health Clinics/Hospitals, Sports fields/Courts/Other outdoor recreation spaces, Public bus or train stops/Closest transport, against those same measures determined using GIS. We used Spearman's rho rank order correlations for selected NEWS-Africa scales vs geocoded variables.

We also correlated the parameters that comprised the GIS measured walkability index against the perceived attributes of the built environment (NEWS-Africa subscales) in the (1000m buffer). The sample was divided into four groups using a median split using the GIS-measured walkability index (Low-SES/Low walkable, High-SES/ Low walkable, Low-SES/High walkable, High-SES/High walkable). Perceived neighbourhood variables (including estimated walking distances or proximity to destinations, and the various walkability subscales), were compared between groups using Kruskal-Wallis non-parametric ANOVA. All data were analysed using Statistica (Stat Soft ® 2014 version 13 for Windows (IBM Corp: New York).

3.3 Ethical considerations

As in the previous chapter, this research study was approved by the University of Cape Town Health Sciences Research Ethics committee (HREC REF 293/2016).

3.4 Results

In Table 3.1a and Table 3.1b, we present the % contribution of the various components of Land Use Mix, including residential, retail, civic and other (which is poorly defined and in some cases, includes public open space, green space, blocked roads and special zones for subdivisions or future development) across the 4 communities. As can be seen, in the two high-SES neighbourhoods, residential land use was significantly higher than in the low-SES communities, despite a much higher population density in these communities, whereas unspecified use was higher in the low-SES groups.

In Table 3.2, we present the median (and 25th and 75th percentiles) of the GIS variables that comprise the construct of walkability (Land Use Mix, Residential Density, Intersection Density) and Transport density for the two combined SES groups.

Table 3.1b. Components of Land Use Mix by Low- and High SES groups

Components of Land Use	Low- SES		High-SES		P-values
	Valid N	Median (25th and 75th percentile)	Valid N	Median (25th and 75th percentile)	
Residential (%)	25	28.3 (19.7; 31.6)	26	58.7 (51.91; 66.4)	0.001**
Retail combined (%)	25	2.9 (1.4; 5.8)	26	2.9 (2.6;6.3)	0.190
Civic (%)	25	10.4 (7.7; 13.1)	26	12.5 (9.8; 15.8)	0.010**
Other^ (%)	25	56.8 (49.4; 71.3)	26	25.1 (15.4; 32.7)	0.001**

^ Other: public open space, green space, blocked roads and special zones

** p<0.001

We demonstrated that Intersection density (p=0.04) and Residential density (p=0.001) were significantly higher in the low-SES areas combined to the high-SES neighbourhoods. (P= 0.04).

Table 3.2: GIS measures of walkability and Transport Hub density between low- and high-SES groups

GIS VARIABLES	Low SES		High SES		P-Value
	N	Median (25 th ; 75 th centile)	N	Median (25 th ; 75 th centile)	
Land-use mix (0-1)	25	0.9 (0.7; 1.0)	26	0.9 (0.9; 1.0)	0.15
Intersection Density (counts per m ²)	25	53.8 (41.7;74.5)	26	41.7 (36.9;46.8)	0.04**
Residential density (units per m ²)	25	3699.5 (2718.0; 4537.9)	26	715.2 (624.9; 1169.3)	0.001**
Transport density (units per m ²)	25	6.0 (0.3; 10.2)	26	7.3 (6.0;12.7)	0.11

^a Descriptive statistics for GIS derived measured variables demographic variables using median lower and higher quartiles. Non-parametric comparison (Kruskal Wallis) and t-test to ascertain the significant difference

3.4.1. Perceptions of proximity compared to objectively measured distances in high- and low-SES neighbourhoods.

We correlated the perceived distances (in minutes of walking on an ordinal scale) between the neighbourhood NEWS-Africa survey for: Places of worship/ Faith centres, Workplaces or Schools, Health Clinics/Hospitals, Sports fields/Courts/Other outdoor recreation spaces, Public bus or train stops/Closest transport to those same measures determined using GIS.

People living in high-SES neighbourhoods perceived sports fields and places of worship to be further away than they actually were ($r_s = -0.60, p=0.00$ and $r_s = -0.50, p=0.01$, respectively) and people in the low-SES and combined SES groups perceived Public bus/ train stop to be nearer than they actually were ($r_s = -0.50, p=0.00$).

3.4.2 The relationship between the GIS measured walkability index parameters and the perceived built environment in the 1000m buffer

Table 3.4 shows the relationship between the parameters of GIS measured walkability index and the perceived attributes of the built environment (NEWS-Africa subscales) in the (1000 m buffers). Six of the 14 scales of the NEWS-Africa questionnaire were significantly correlated to GIS measured walkability index parameters in the low-, high – and combined-SES.

Table 3.3: NEWS-Africa scales vs Geocoded variables ^a

NEWS Scales /Vs Geocoded Locations	Combined-SES*	Low –SES	High- SES
	r coefficient		
Health clinic /Hospital vs Nearest Hospital	-0.2	0.3	-0.4
Place of worship /Faith centre vs Nearest worship	-0.3	0.0	-0.5**
Other indoor recreation facilities vs Nearest recreational hub	-0.1	0.2	0.2
Your workplace/school vs Nearest workplace/ schools	0.0	-0.2	0.2
Sports field /court vs Nearest sports ground	-0.4**	-0.1	-0.6**
Public bus/ train stop vs Nearest Transport	-0.5**	-0.5**	-0.3

^a Spearman’s rank order correlations for selected NEWS-Africa scales vs Geocoded variables. ** r-values are reported for only comparisons that were statistically significant at $p < 0.05$.

In the combined-SES, 5 scales were significantly correlated to GIS measured walkability index parameters. These included; *The Roads and walking paths scale* , *Places for walking, cycling playing (overall mean)*, *Neighbourhood surroundings scale* , *Safety from Crime scale*, *Personal safety scale*, *Stranger danger scale*.

The *Roads and walking paths scale* ($r_s = 0.3, p=0.04$) *scale* ($r_s = 0.3, p=0.01$) was positively associated with the GIS-measured walkability parameter Intersection density. When we considered GIS-measured Land use mix, 3 of the NEWS –Africa scales were correlated (The scales including *Places for walking, cycling, and playing overall scale* ($r_s = 0.3, p=0.02$), and

Neighbourhood surroundings ($r_s = 0.3$, $p=0.01$), were positively associated, respectively). Conversely, *Stranger danger* was inversely correlated ($r_s = -0.6$, $p=0.00$).

In the low-SES, 4 scales were significantly correlated to GIS measured walkability parameters. These include; *Destinations scale*, *The Roads and walking paths scale*, *Safety from Crime scale* and *Personal safety scale*. Intersection density measured with GIS was significantly and negatively associated with the *Destinations scale* ($r_s = -0.5$, $p=0.02$), and positively associated with *Safety from Crime scale* ($r_s = 0.4$, $p=0.04$) while Residential density measured by GIS was significantly and negatively related to *Personal safety* ($r_s = -0.5$, $p=0.00$). Only one NEWS-Africa scale; *Roads and walking paths scale* in the high-SES was significantly correlated to GIS measured walkability parameters.

Table 3.4: Correlations of GIS measured walkability index parameters and the perceived built environment in 1000m*

GIS WALKABILITY INDEX PARAMETERS	PERCEIVED BUILT ENVIRONMENT (NEWS Africa Scale)						
	Destinations	Roads and Paths	Places for walking, cycling, playing	Neighbourhood surroundings	Safety from Crime	Personal safety	Stranger danger
1000 m buffer Combined –SES							
Walkability (Overall)	-0.1	0.3**	0.0	0.2	0.1	0.1	-0.4**
Land-use mix	0.0	0.2	0.3**	0.3**	0.2	0.2	-0.6**
Intersection density	-0.2	0.3**	0.0	0.1	0.1	0.2	0.0
Residential density	-0.2	0.3	-0.1	-0.3**	-0.4**	-0.4**	0.3
Transport density	0.1	0.1	0.0	0.1	0.2	0.0	-0.2
1000 m buffer Low-SES							
Walkability (Overall)	-0.2	0.3	0.1	-0.2	0.0	-0.2	-0.3
Land-use mix	-0.2	0.4**	0.3	-0.1	-0.1	0.0	-0.4
Intersection density	-0.5**	0.3	0.0	0.0	0.4**	0.3	0.0
Residential density	-0.1	0.0	-0.1	-0.2	-0.2	-0.5**	-0.2
Transport density	0.3	0.1	-0.1	-0.1	-0.1	-0.4	0.0
1000 m buffer High-SES							
Walkability	-0.2	0.1	0.3	0.2	0.0	0.0	-0.1
Land -use mix	-0.2	0.0	0.0	-0.1	-0.3	0.2	-0.1
Intersection density	-0.3	-0.1	0.2	0.0	0.1	-0.1	0.0
Residential density	0.2	-0.4**	-0.2	0.2	0.2	0.0	-0.2
Transport density	-0.1	0.2	0.3	0.1	-0.1	-0.1	0.0

^a Spearman's (rho) correlations of GIS measured walkability index parameters and the perceived built environment in 1000m*. ** r-values are reported for only comparisons that were statistically significant at $p < 0.05$.

3.4.2 The NEWS Africa survey and in groups according to SES and GIS-measured walkability

We examined the scores for the perceived attributes of the built environment from the NEWS-Africa subscales in the 4 groups. These results are presented in Table 3.5. There was a significant difference in scores for *Places for walking, cycling, and playing* overall scale in the Low-SES/Low walkable vs High-SES/ Low walkable (Overall p = 0.008) groups, indicating the differences were due to SES differences but not walkability. *The Neighbourhood surroundings* scale, representing the perceived neighbourhood aesthetics, was significantly lower in the Low-SES/Low walkable community when compared to Low-SES/ High walkable and both High-SES groups. However, this sub-scale did not differ between High-SES groups, irrespective of walkability.

Table 3.5: Comparisons of NEWS sub-scales by SES-Walkability Status (High-Low SES & Low-High Walkability) ^a

	Low-SES/ Low w*	High-SES/ Low w*	Low-SES/ High w*	High-SES/ High w*	P values**
	1	2	3	4	
NEWS 1 SUB-SCALE	Median (lower and upper interquartile range) ^Y				
Places for walking, cycling, & playing (Overall Mean)	2.7 (2.4; 2.8)	3.1 (2.8;3.4)	2.8 (2.2; 2.9)	2.8 (2.7;3.2)	Overall p = 0.008 1 vs 2 = 0.000
Neighbourhood surroundings	2.3 (1.8; 3.0)	3.5 (3.1;3.8)	2.1(1.8;2.8)	3.9 (3.6;3.9)	Overall p = 0.00 1vs 4 = 0.000; 2vs 3 = 0.033 3 vs 4 = 0.000
Safety from Traffic	1.8(1.0;2.6)	2.6 (2.2;3)	1.0 (1.0;2)	2.8 (2;3)	Overall p=0.000 2 vs 3=0.003; 3 vs 4= 0.0002
Safety from Crime	1.3 (1.3;1.5)	3.0 (2.8;3.5)	1.0 (1.0;1.5)	3.0 (2.5;3.3)	Overall p= 0.000 1vs 2 = 0.001; 1vs 4 = 0.000 2 vs 3 = 0.000; 3 vs 4 = 0.002
Personal safety	2.7 (2.3, 3.0)	2.7 (2.7;3.0)	2.7 (2.7;3.0)	3.3 (2.7;3.3)	Overall p= 0.012 3vs 4=0.0146
Stranger danger	4.0 (4.0;4.0)	3.0 (2.0,4.0)	3.3 (3.0,4.0)	2.5 (1.8,3.2)	Overall p = 0.004; 1 vs 4 = 0.004

^a Kruskal-Wallis tests were used to present the multiple comparisons between NEWS Sub-scale and SES-W

* w-walkability

** p-values are reported for only comparisons that were statistically significant - p-value<0.05 (N/B: 1 vs 4 – means low-SES-Low Walkability category vs. High SES-High Walkability categories).

^Y Figures presented on the table are based on median, lower and upper interquartile ranges.

The *Safety from Traffic* scale was significantly lower in the Low-SES, High walkable group, compared to both High-SES groups, with residents in both High-SES communities reporting a higher perception of safety from traffic. With respect to the *Safety from Crime* scale,

persons from Low-SES groups felt significantly less safe than their High-SES counterparts, again irrespective of walkability (Overall $P= 0.000$). In terms of *Personal safety*, this subscale only differed between the High-SES and Low-SES, High walkable groups (Overall $P= 0.012$). *The Stranger danger* scale was only significantly different between the extremes of Low-SES, Low walkable and High-SES, High walkable groups (Overall $P = 0.004$).

3.5 Discussion and conclusion

In broadening the research on associations between the built environment and physical activity, this study explored some aspects of the NEWS-Africa scale utilising ground-truthing and remote-sensing technology (Geographic Information Systems (GIS) in an urban South African setting.

3.5.1. Perceptions of proximity compared to objectively measured distances in high-and low-SES communities

There is limited evidence concerning the factors that influence an individual's ability to accurately report on the features that are present in their neighbourhood (Leslie et al., 2005). In the present study, the only significant correlations we found, were in fact, in the opposite direction of what we expected. For example, people in the high-SES, perceived sports fields and places of worship to be further away than they actually were ($r_s= -0.60$ and $r_s= -0.50$, respectively, $P< 0.05$), whereas, people in the low-SES and combined-SES perceived Public bus/ train stop to be nearer than they actually were ($r_s =-0.50$, $P< 0.5$). We, therefore, postulated various factors to explain these significant differences including; salience, utility, choice and effects of the past socio-political environment in South Africa.

Residents in the high-SES are more accustomed to driving and using private cars (Sugiyama et al., 2017) to get to their various destinations and may therefore not be aware or sensitized to the distance they would have to cover if they walked on foot. On the other hand, the people in low-SES have limited access to private motor vehicles, and therefore generally rely on public transport to get to and from places.

Current studies reveal that the frequency of transportation is related to the proximity of destinations (Adams et al., 2009; Cerin et al., 2007; Frank et al., 2007). Adams et al. (Adams et al., 2009), note that destinations may be recalled more accurately because of their utility and salience and further note that destinations allow for real transactions to take place such as purchases and use of facilities, thereby presenting an opportunity to interact. It is therefore

likely for one who walks to specific destinations to be able to recall its location and distance from home more accurately than someone who takes motorised transport.

In a large, diverse sample of adults, Adams et al. (2009) compared 22 items from the NEWS, along with four composite measures of NEWS items to 10 physical environmental characteristics determined by GIS data for each neighbourhood. The neighbourhood was operationalised as the 1-mile (1600m) street network buffer around participants' residences. The GIS measures of the built environment included the percent of commercial and institutional land uses, number of schools, colleges and recreational facilities, parks, transit stops and trees, land topography and traffic congestion.

Three types of analyses were done in the study: 1) Correlations between the NEWS items or indices (ordinal scale) and objective variables, 2) A sensitivity analysis between different NEWS walking distance cut-points (dichotomous scale) and objective variables), 3) Pearson's (r) were used for comparisons between continuous or ordinal variables and Spearman's rho because some objective variables had non-normal distributions. To test for the sensitivity of different walking distances cut-points, the original 5-point NEWS response scale for land-use mix diversity (section B) was dichotomised to determine the presence of a facility within the 10-, 20- or 30 minutes' walk. The study revealed that, compared with a 10 and 30-minute walking distance, the self-reported 20-minute walking distance to destinations generally had the strongest correlations with GIS measures.

In correlations between self-reported (NEWS) and corresponding objective physical environmental variables, their study reported that almost all items correlated significantly with the objective measures. The strongest individual correlations between self-reported and objective measures were found for the bus, and trolley stops ($r = -.35$), recreational centres ($r = -.20$) and all correlations were in the expected direction. They, therefore, hypothesised that participants who had more significant exposure to their neighbourhoods would have a higher concordance between self-reported and GIS measures. Although their study provided concurrent validity, it highlights that only physically active adults may be knowledgeable about their neighbourhood characteristics.

Compared to the present study their study used 15 items from the land-use mix diversity section and the present study compared only six, the similar items from both studies in the land –use mix diversity section (section B) were schools, bus/trolley stop, recreation centre and gym/fitness centre and all correlations were higher for participants' self-reports of

proximity to destinations. The present study showed that people in the high-SES, perceived sports fields and places of worship to be further away than they actually were ($r_s = -0.60$ and $r_s = -0.50$, respectively, $P < 0.05$) and people in the low-SES and combined-SES perceived Public bus/ train stop to be nearer than they actually were ($r_s = -0.50$, $P < 0.5$). The present study, unlike their study, did not stratify participants according to physical activity levels, and the study did not adjust for income levels as we did in the present study.

Studies suggest that the past structural inequalities of apartheid have rendered transit and transportation difficult and complicated to a broader South African context, especially in a Cape Town setting. Turok, (Turok, 2002) in South Africa, explains that the three most important structural elements of the cities are employment, housing and transport connections between them and these are critical in determining how efficiently and equitably cities function because they are critical resources for the poor. Access to these amenities has a significant effect on living standards and is competitively sought after.

Our findings show that the people in the low-SES and combined SES perceived Public bus/ train stops to be nearer than they actually were and this underscores the inequities between SES communities as there is an underlying reason and implication for this perception. Guither and Weinstock, (Gauthier & Weinstock, 2010) reveal that Cape Town's My Citi bus system has an intention to correct the apartheid planning that has put citizens of colour at a disadvantage. My Citi or Integrated Rapid Transit system was developed in 2008 and launched in May 2001 in the form of Bus Rapid Transit (BRT) trunk (central station and route) and feeder services (Bartels et al., 2016). What began as inner city and airport services coupled with specific routes on the corridor between the inner city and a northern middle-income suburb has expanded over time, and this relatively new bus system seeks to create a system that tries to correct the past structural inequalities of apartheid (Gauthier & Weinstock, 2010).

3.5.2. The relationship between the GIS measured walkability index parameters and the perceived built environment in the 1000 m buffers

In an analysis of four US metropolitan areas, Duncan et al. (Duncan et al., 2011) used 400, 800 and 1600 m street network buffers and GIS data to measure multiple objective indicators of neighbourhood walkability. Their results showed many significant moderate correlations between the walk scores and the GIS neighbourhood walkability indicators such as

destinations, intersection density ($P < 0.05$). The magnitude of the correlations in their study varied by the GIS indicator of neighbourhood walkability and the correlations generally became stronger with a larger spatial scale. Their study employed 400, and 800 m buffers as they were considered proximal neighbourhood environment for the youth and 1600 m buffer equivalent to one mile proximal to adults and aligned with the walk score algorithm. Similar to their study, the correlations (overall walkability and intersection density) of the combined-SES in the present study, became stronger as the buffers increased from 500m to 1000m but only the 1000m data is presented. While their data was divided according to top metropolitan cities (urban and suburban and involved youth and adults, the present study divided the data based on SES, and it was in one region Cape Town (divided into four different suburbs).

In our present study, Residential density measured with GIS in the 1000m buffer was inversely related to the *Roads and walking paths scale* in the high- SES. In the low-SES, Residential density measured by GIS was also inversely related to Personal Safety scale. The current study contrasts with Glazier et al. (Glazier et al., 2014). In their study, they found that both residential density and availability of walkable destinations had strong, consistent associations with active transport. High residential density and available destinations tended to co-exist spatially. Similarly, so few areas had high density without multiple destinations and vice-versa. High density and many walkable destinations had robust associations. The results from this study (Glazier et al., 2014), suggest that either destinations or density can be used on their own as a measure of walkability. (Glazier et al., 2014). As mentioned earlier, the reason for this difference may be due to the environmental justice encompassing the past structural inequalities of apartheid have rendered transit and transportation difficult and complicated to a broader South African context complex, especially in a Cape Town setting. Turok, (Turok, 2002) in South Africa explains that the three most important structural elements of the cities are employment, housing and transport connections between them and these are critical in determining how efficiently and equitably cities function because they are critical resources for the poor.

In the present study, Intersection density was positively associated with *Roads and walking paths scale* in the combined –SES but not in the low- and high –SES, *Places for walking cycling, playing and overall mean* were not associated with Intersection density in all of the SES groups. Some researchers (Frank et al., 2005)(Sallis et al., 2003) have established

intersection density as a measure of route directness which captures the ability to move to and from destinations in a direct pathway. Therefore, the ability to move to and from destinations by a direct route was positively associated with physical activity. Previous studies that have reported on intersection density (as an objective measure of perceived street connectivity), have highlighted that intersection density was associated with walking (Saelens et al., 2012), but not with cycling (Sallis et al., 2013). In the present study, we failed to show these correlations, which may be due, in part, to differences in infrastructure regarding roads and intersections, than studies from Europe or North America. Alternatively, people in the low-SES use the informal routes irrespective of the set structures put in place because they are overcrowded with high density of slum settlements without any planned open spaces such as parks or playgrounds or people in low-SES formal places like parks, green spaces are destroyed to make way for housing and infrastructure (Adlakha et al., 2017).

The *Neighbourhood surroundings scale* in the present study had a positive association with the land use mix and a negative association with residential density when groups were combined. In the low-come groups, intersection density was associated with greater safety from crime, whereas residential density was inversely associated with personal safety. A previous study by Mackenbach (Mackenbach et al., 2016), explored why residents of socioeconomically deprived neighbourhoods have less favourable perceptions of their neighbourhood environment compared to the wealthy neighbours. They further examined individual and contextual correlates of socio-economic inequalities in neighbourhood perceptions across five urban regions of Europe. Their study provided evidence that socioeconomic differences in neighbourhood perceptions are associated with objective neighbourhood measures.

The work of Boyko (2017) informs this discussion. He suggested that the interpretation, for example, of urban density may be very context specific. In our study, for example, although the actual total scores for Land Use Mix were not different, between groups the proportion of land use allocated to residential vs “other” (poorly defined and includes public open space, green space, blocked roads and special zones for subdivisions or future development) were very different. He posits that urban density, and perhaps more broadly, the built environment, should be conceptualised, not only quantitatively, but considering the quality, in relation to expectations and community-identified needs and perceptions.

3.5.3. Perceptions of the built environment (walkability) in high- and low-SES

In a bid to further understand the associations, this study determined if the perceptions of the built environment differed in high-SES vs low-SES communities when divided by walkability. This study showed that; *Places for walking, cycling, and playing overall mean, Neighbourhood surroundings, Safety from Traffic, Safety from Crime, Personal safety and Stranger danger* all had significant differences when the neighbourhoods were divided according to SES and walkability. The respondents of high-SES perceived better sidewalks, roads and paths and street connectivity compared to the low-SES.

Compared to people in high-SES, those with a lower-SES are more likely to perceive their neighbourhood as unattractive and unsafe, which in turn may be related to low levels of physical activity. Sugiyama et al. (2017) highlight that persons living in high SES communities people may prefer to walk in their neighbourhoods, with fewer safety concerns from crime and traffic.

Kamphuis et al. (Kamphuis et al., 2010), showed that agreement between objective and perceived environmental factors is often found to be low and underscore that it is questionable to what extent creating supportive neighbourhoods would change neighbourhood perceptions. They carried out a study in the Netherlands (Eindhoven) with a sample of just over 800 people, from 14 neighbourhoods. They investigated the extent to which five domains of objective features could explain socio-economic variations in perceived neighbourhood unattractiveness and unsafety, that is: Design, Traffic safety, social safety, aesthetics and destinations) and to what extent these factors such as perceived social neighbourhood environment and psycho-social characteristics contributed to this explanation. They reveal that unfavourable neighbourhood perceptions of low socioeconomic groups partly reflected on their actual less aesthetic and less safe neighbourhoods.

The differences in *Safety from Crime, Personal safety and Stranger danger* perceptions in the current study may be due to the fact that people in the low-SES area may be more "accommodating" about what is safe for them and have become accustomed to the general crime and insecurity that seems to be pronounced in the South African low-SES areas (City of Cape Town, 2006). This is corroborated by Manaliyo, (Manaliyo, 2014) in which he shows that residents in Khayelitsha recognise that the crime rates are high, frequent and unpredictable. However, he argues that poverty and unemployment have rendered some of

the residents into a hopeless situation, which leads to the overall high crime rate and the perception of normalcy which may be associated with it.

Crime is a well-recognised barrier to physical activity, particularly in low-income neighbourhoods (Adlakha et al., 2015) and our current study yielded associations between perceptions regarding crime, SES, and walkability. Studies previously have also produced inconsistent associations between crime and neighbourhood perceptions and SES. This suggests that the impact of perceived safety from crime on walking and other forms of physical activity needs further investigation (Ding et al., 2013) (Foster & Giles-Corti, 2008).

Ding et al., (2013) (Ding et al., 2013), highlight that the effects of perceived crime and physical activity, the built environment are complex, for example, times of occurrence, people's perceptions, response coping mechanisms. All of these factors may influence the respondent's perceptions. Objective measures of crime and better-specified models should be used in future studies to understand crime and physical activity associations, especially in fast-growing African urban cities.

The differences in the *Safety from Traffic scale* in the present African study are of importance, as they suggest a difference in the expectations of respondents, as regards traffic safety and safety from crime. The possibility could be the people from higher-SES are more demanding about what is safe for them as indicated by Oyeyemi et al., in the Nigerian study (Oyeyemi et al., 2013), or it could also reflect the general high crime rate in Western Cape (City of Cape Town, 2006). Lemanski (2004) addresses the spatial implications of fear of crime in Cape Town and terms it "new apartheid". South African statistics point to alarming increases in crime over the years. She notes that although the statistics are considered unreliable, they reflect some extent the reporting of crimes and the public perception of it. The attempts to mitigate this fear have resulted in the creation of fortified enclaves and withdrawal from public spaces. She notes that although the more extreme manifestations are restricted to affluent areas, the levels of residential protection have increased among all groups similar to other parts of the world and this "architecture of fear" has resulted into growing danger within the public domain and increasing polarisation of social groups. She argues that this trend has perpetuated the social divisions that were inherent in the apartheid state into the post-apartheid context with a fear of crime being used as a justification for a predominantly racist fear of difference.

Strengths and limitations

The present study has critical limitations to note, these include; the method of recruitment, small sample size, which have been highlighted in the previous chapter.

An additional limitation in this chapter is the definition used for street network, which may not correspond with the participants' perceptions of the boundaries of their own neighbourhoods. Participants may consider their neighbourhoods further or closer than the set boundaries, especially after they are asked the same question for different items. Adams et al. (Adams et al., 2009) underscore that the NEWS prefacing items in the land-use mix access (e.g. 10-15) minutes' walk from one's home may attenuate the observed relationships for other items.

The strengths of the present study include; being the first study in the region to compare neighbourhood environmental perceptions and objectively measured attributes of the built environment related to walkability. To our knowledge, a “ground truthing” study of neighbourhood “walkability” has not been conducted in Africa, we believe this is important in better understanding the impact of environmental attributes on; incidental, utilitarian, and leisure-time physical activity in order to structure interventions, and to address issues of environmental justice. Geographical Information System (GIS) can be used to objectively measure features of the built environment that may influence adult physical activity, an essential determinant of chronic disease (Pikora et al., 2002).

3.7 Recommendations

These findings are particularly significant for health promotion in Sub-Saharan Africa. Lee et al., (Lee et al., 2012b) highlight that understanding the environmental correlates of physical activity is a priority that could lead to better strategies to prevent further declines in physical activity in the region and have implications for policies and strategies that lie outside the health sector.

From an African and South African perspective, we may be able to adapt and implement strategies used in other African cities and nations, including some of the examples below.

An initiative in Tanzania carried out community participation in for the conservation of open public spaces. This was a problem both in formal and informal settlements and helped raise awareness among the public. As a result, the communities took active steps to participate in the conservation of the open spaces on condition that the efforts and resources were channelled appropriately (Hassan, 2015).

Daniel (Daniel, 2018) described co-creating open public spaces in three African cities: Accra in Ghana, Kampala in Uganda, and Niamey in Niger, as mentioned previously. This process involved: community engagement, capacity building, awareness-raising, infrastructure changes and policy and the projects have increased awareness about the importance of public spaces, increased park usage, increased trust in the respective communities with government officials.

Rwanda has implemented twice-monthly car-free days in the city of Kigali, involving public servants and the general public with high government support (presidential participation including time allocated for government workers). This encourages mass sports and exercise participation along dedicated routes and has been sustainable since 2016 (Ntwari, 2016). In so doing, Kigali has become an exercise hub once every week, the physical activities begin at 15:00 local time and extend till evening, with government employees required to participate. Some ministerial institutions have gone a step further and monitor the activities of the civil servants unless excused by their direct supervisors (Ntwari, 2016). This programme has not been independently evaluated, and may have mixed results, as the aspect of choice to engage in safe and enjoyable physical activity may be compromised.

Dar es Salaam introduced the very first Bus Rapid Transit System in Africa, known as DART, which has substantively reduced commuting times, traffic accidents and commuting costs. These efforts are being replicated in other African cities. (Scruggs, 2018).

The challenges in implementing these are seen from the ever-increasing urban informal settlements, especially from a Cape Town perspective.

Venter (Venter, 2013), in their study reviewed the recent experience in South Africa with the implementation of Bus Rapid Transit and reveals that the most important lesson in the minibus-taxi experience from a South African perspective was that “transformation from an informal public transport industry to a formal industry, operating within the quality frameworks offered by the government is not likely achievable via a heavy-handed, top-down regulatory approach.” However, they concluded that the Bus Rapid transit is potentially a strong instrument in achieving government strategic goals for equitable public transport.

Further evaluation of the NEWS-Africa in other African nations may lead to more locally relevant and evidence-based recommendations for creating better designed and safer communities, which will encourage public participation in safe and enjoyable physical activity and greater environmental justice for commuters in the African region. However, Baldock et al. (Baldock et al., 2018) also highlight that it is essential to know whether the actual (objectively measured) accessibility of neighborhood resources is related to health behaviours and outcomes, as resources that are not perceived to be accessible are less likely to be utilised. In this regard, LMICs and Africa as a continent has limited relevant data (Oyeyemi et al., 2013), coupled with lack of reliable census data in most African countries. These gaps in evidence are fundamental challenges for policymakers and other stakeholders, as they are needed for the development of appropriate policies and actions.

As shown through the thesis, research from LMICs has revealed social norms and prejudices against PA, for example, for bicycling. Car owners in some countries represent a higher social status/ standing. There is less car ownership in LMICs compared to developed countries especially among women in low-income groups. Walking, coupled with bicycling, therefore, becomes the norm for them as a means of commuting. With respect to this, the built environment may not necessarily have as measurable an impact on physical activity used for non-motorised transport, simply through lack of choice. This may lead to a failure of recognition by government officials and urban planners, of the need to address these issues as a matter of priority.

The role of local government in addressing environmental justice to promote physical activity, in particular for promoting the development and use of public space, is: “1) as a funder help in sustainability, equity and resilience, 2) as a regulator, to develop policies on public space, defend public space and balance competing and conflicting interests, avoid speculation of public spaces and collaborate with other spheres of Government, 3) as an implementer and facilitator, promote the need for inclusive, safe and quality public spaces (Ntwari, 2016).

For researchers, especially in future studies, measuring social and cultural environments especially in the LMICs, will aid in understanding their impact/role in enhancing or inhibiting PA. Analyses that include variables from multiple levels of ecological models would be more powerful in explaining human behaviour. An example would be in our study to increase and diversify the sample size to include subjects of all walks of life (our research was limited to residents of the same neighbourhood type as they attended the same church within the same community and this may have restricted environmental variability).

We would also increase the domains measured especially the self –report PA, we concentrated on Leisure-PA and Transport-PA, the inclusion of Job-related and Home-related PA would add in more context and explain more the human behaviour. As regards the ground-truthing, we would ground truth all aspects of the NEWS-Africa to add more context and also compare two regions, for example, Western Cape and Eastern Cape which would help in understanding and measuring two different social and cultural environments.

CHAPTER FOUR

THE RELATIONSHIP BETWEEN PHYSICAL ACTIVITY AND OBJECTIVELY-MEASURED ATTRIBUTES OF THE BUILT ENVIRONMENT

4.0 Introduction

In the previous chapter, we examined the associations between the measured and perceived attributes of the built environment, in relation to walkability and suitability for physical activity. We validated some aspects of the NEWS-Africa scale by utilising ground-truthing and remote-sensing technology in an urban South African setting (South Africa). We also examined the extent to which built environmental attributes associated with walkability, from the NEWS-Africa survey, corresponded to actual GIS-measured walkability, across high- and low-income communities.

The relationships between the perceived built environment and walkability, based on the NEWS-Africa survey and geocoded variables that comprise the walkability index, were found to be relatively weak, particularly in the low SES communities. For example, there was a significant difference in scores for *Places for walking, cycling, and playing overall mean*, in the Low-SES/Low walkable vs High-SES/Low walkable (overall $P=0.008$) indicating differences were largely due to SES differences. However, the *Neighbourhood surroundings* scale representing neighbourhood aesthetics was significantly lower in the Low-SES/Low walkable group when compared to Low-SES/High walkable group, as well as both High-SES groups.

The question that remains to be answered is whether or not the objectively-measured attributes of the built environment are associated with either self-reported or device-measured physical activity. Furthermore, we are interested in whether these relationships, should they exist, differ in high- and low-income settings, or by domains of activity.

There are a limited number of studies which have interrogated these relationships (Michael et al., 2006),(McGinn et al., 2007), One such study, by Nynt et al., (Nyunt et al., 2015), examined associations of subjective vs objective measures of neighbourhood environment with transportation physical activity of community-dwelling older persons in Singapore. They used a modified NEWS and GIS measures of residential density, street connectivity,

land use mix, and public park density within a 500m buffer. Using structural equation modelling, they examined the association between subjective and objective measures of the built environment (independent variables) with transportation physical activity (dependent variables). The environmental attributes included: eight subjective measures of neighbourhood environment (*residential density, street connectivity, infrastructure, aesthetics, land use mix access, land use mix diversity, traffic safety and crime safety*) and two GIS indices (walkability and accessibility). Accessibility Index in the study was measured and assessed by walking to 30 types of community service and amenity destinations to which proximity could plausibly encourage residents to walk more for leisure or transport. Eighteen individual zones were assessed by multiplying sum of the building weight within each zone and the residential density: Accessibility index = building weight within each zone zone x residential density).

The subjective measures of residential density, street connectivity, land use mix diversity and aesthetic environment and the objective measure of Accessibility Index had positively significant independent associations with transportation physical activity, after adjusting for demographics, socio-economic and health status. The study underscored that subjective and objective measures are non-overlapping measures that complement each other in providing information on the impact of built environment characteristics on physical activity. For the elderly, living in a high-density urban neighbourhood, with well-connected streets, diversity of land use mix, in close proximity to amenities and facilities and with an aesthetically pleasing environment, was associated with higher frequency of walking for transportation purposes.

Irrespective of the above, studies that regard objective and subjective measures of the built environment, including the attributes of walkability such as land use mix, and proximity to home, street or network connectivity, population density, pedestrian infrastructure, aesthetics and safety have only been realised in high-income countries. Middle- and low-income countries have limited or no studies where both objective and subjective measures have incorporated measures of the built environment.

The previous chapter showed discordance between perceived and measured walkability using GIS. The current study, therefore, aims to examine the relationship between self-reported and device-measured physical activity and objectively-measured attributes of the built environment and the walkability index, measured using GIS (500 and 1000m buffers).

4.2 Methodology

4.2.1 Study setting and Sample size

As in the previous chapter, we report on the results of the 52 participants recruited from four suburbs in Cape Town. The sample was divided into four groups using a median split for the GIS-measured walkability index (in 1000m buffer) and by neighbourhood income level (Low-SES/Low walkable (n=11), High-SES/ High walkable (n=13), Low-SES/High walkable (n=13), High-SES/High (n=13)). GIS-measured attributes that comprise the measure of walkability these neighbourhoods met the definitions of walkability/SES quadrants (Kerr et al., 2013). Approval for the study was granted the University of Cape Town Ethics committee.

4.2.2 Subjective physical activity

As in the previous chapter, the long version of the International Physical Activity Questionnaire (IPAQ-long) was used to measure the participant's self-reported physical activity. The 31-item long form comprehensively assessed the frequency, duration and intensity of physical activity in the four domains of; work, household, transportation and leisure. The IPAQ is used to compute the weekly dose of both moderate and vigorous physical activity (minutes per week= days per week x minutes per usual day during of the previous week).

For this study, we specifically examined walking or cycling for transportation and walking and physical activity for recreation. Work-related physical activity was not included, as it is not typically associated with the neighbourhood built environment. Therefore, the total min/week in the domains of transport and recreation were summed to estimate overall minutes of self-reported, moderate-to-vigorous physical activity (MVPA) per week. Data that were over-reported were truncated according to the IPAQ protocol (www.ipaq.ki.se).

4.2.3 Device-measured physical activity

As elaborated in the previous chapter, participants were fitted with accelerometers (Actigraph GT3X, Firmware 3:2:1, Actigraph, Pensacola, USA) worn on an elastic belt around their waist. They were asked to wear them for 7 days, and only to remove them when bathing or when they went to bed at night. Data were downloaded and analysed using Actilife 6:10:4 software (ActiGraph, Pensacola, USA).

The Actigraph GTX3 activity monitor was used to assess physical activity objectively. Minute by minute activity counts was accumulated and collapsed into minutes spent at different physical intensities, using the Freedson cut-points across the 7 days as described by Loprinzi et al. (Loprinzi et al., 2012). These intensities included: light (counts less than 759 per minute), moderate (counts between 760 and 5724), and vigorous (counts between 5725 and 9498). The accelerometer data were collected and aggregated to one-minute epochs. Non-wear time was determined as any period of 60 minutes or more of consecutive zero counts. Only data from participants with at least 10 hours of valid wear time, on at least 4 days, were included. Counts/minutes were converted into minutes of sedentary time (≤ 100 counts/min), light, moderate and vigorous-intensity physical activity as described by Loprinzi et al. (Loprinzi et al., 2012).

4.2.4 Measured built environment (GIS)

This paper follows the methods developed by Adams et al. (Adams et al., 2014), which employed the individual-level street network buffer- based GIS measures (The protocols and measures are discussed in length in the previous chapter. The advantage of using an individual-level street network approach was that it placed the participants amid a neighbourhood and captured destinations that participants could access from the road network. As a result, this method has merits compared to an administrative boundary approach of defining neighbourhoods (Adams et al., 2014).

4.2.5 Ethical considerations.

As in the previous chapters, this research study was approved by the University of Cape Town Health Sciences Research Ethics committee (HREC REF 293/2016).

4.3 Statistical analysis

In the previous chapters, the descriptive analyses for all participants are presented as means \pm standard deviations, counts and percentages, or medians and lower and upper quartiles (depending on whether or not the data were binary, or non-normally distributed).

Also as noted in the previous chapter, the sample was divided into four groups using a median split for the walkability index (Low-SES/Low walkable, High-SES/ High walkable, Low-SES/High walkable, High-SES/High). GIS-measured attributes that comprise the measure of walkability were calculated for the 1000m buffer zones surrounding the

participants' street address. Spearman's rho correlations were calculated between the reported physical activity for transport and recreation (IPAQ), as well as device-measured physical activity, and GIS measures of walkability. A Kruskal-Wallis test was used to compare self-reported and objectively measured physical activity in the 4 groups, according to SES and Walkability. Statistical tests were considered significant at $p < 0.05$. All data were analysed using Stat Soft ® 2014 version 13 for Windows (IBM Corp: New York).

4.4 Results.

4.4.1 Self-reported and device-measured physical activity and GIS walkability

There was no relationship between any self-reported physical activity and GIS measured attributes of walkability in 1000m buffers. In Table 4.2, data on objectively measured (GIS) walkability and device-measured physical activity and SES categories (low and high) are compared for 1000m buffers, using Spearman's rho coefficient. In the low SES groups, only intersection density in the 1000m buffer was statistically and inversely associated with device-measured moderate-vigorous physical activity. In the high SES groups, results were similar. However, for these groups, intersection density in the 1000m buffer was statistically and inversely associated with device-measured vigorous physical activity, only. When groups were combined, the inverse relationship between intersection density and physical activity persisted. In the 1000-m buffer, intersection density was inversely associated with both moderate ($r_s = 0.29$, $P < 0.05$) and moderate-to-vigorous physical activity ($r_s = 0.31$, $P < 0.05$).

4.4.2 Perceived vs objective physical activity (MPVA) and GIS walkability when apportioned by income

There was a significant difference in self-reported physical activity in the domain of transport with High-SES/Low walkable vs. Low-SES/ High walkable (Overall $p = 0.013$) as reported in Table 4.3. Residents in the Low-SES/High walkable neighbourhoods reported more transport-related physical activity compared to High-SES/Low walkable.

There was a significant difference in device-measured, vigorous physical activity only, between the Low-SES/Low walkable vs High-SES/Low walkable groups ($P < 0.04$).

Table 4.1: GIS –measured walkability and self-report physical activity in the 1000 m buffers

SES*	Low-SES*			High –SES			Combined-SES		
Self-reported physical activity domains →	Transport physical activity truncated	Leisure physical activity Truncated	Total PA Truncated	Transport physical activity truncated	Leisure physical activity Truncated	Total PA Truncated	Transport physical activity truncated	Leisure physical activity Truncated	Total PA Truncated
GIS–measured walkability and self-report physical activity in the 1000 m buffer									
r (Spearman’s rho) a									
GIS Measured ↓									
Overall Walkability	0.22	0.39	0.22	0.05	-0.12	-0.15	0.07	0.16	0.05
Land use Mix	0.07	0.20	0.14	-0.11	-0.14	-0.08	-0.13	0.06	-0.03
Intersection Density	0.10	0.22	0.17	-0.03	-0.28	-0.31	-0.01	0.03	-0.04
Residential Density	0.01	-0.14	-0.19	-0.09	-0.19	-0.16	0.11	-0.26	-0.12
Transport Density	0.26	0.32	0.12	0.02	-0.06	-0.11	0.05	0.10	-0.01

^a Spearman’s (rho) correlations tests were used to present comparisons between GIS–measured walkability and self-report physical activity in the 1000 m buffers

* SES groups

** r-values are reported for only comparisons that were statistically significant at p <0.05.

Table 4.2. GIS-measured walkability and device-measured physical activity in the 1000 m buffers

SES*	Low-SES*			High -SES			Combined -SES		
Device measured physical activity (min/wk) →	Moderate	Vigorous	Total MVPA	Moderate	Vigorous	Total MVPA	Moderate	Vigorous	Total MVPA
GIS –measured walkability and device-measured physical activity in the 1000 m buffers									
	r (Spearman’s rho) ^a								
GIS Measured ↓									
Overall Walkability	-0.13	0.14	-0.13	-0.09	-0.10	-0.10	-0.13	0.04	-0.13
Land use Mix	0.03	0.22	0.03	-0.08	0.07	-0.09	0.05	0.24	0.04
Intersection Density	-0.30	-0.16	-0.31 **	-0.09	-0.39**	-0.19	-0.29**	-0.20	-0.31**
Residential Density	-0.15	-0.09	-0.15	-0.21	0.04	-0.16	-0.18	-0.10	-0.18
Transport Density	-0.09	0.27	-0.08	-0.14	0.09	-0.11	-0.10	0.18	-0.09

Spearman’s (rho) correlations tests were used to present comparisons between GIS –measured walkability and objective physical activity in the 1000 m buffer

* SES groups

** r-values are reported for only comparisons that were statistically significant at p <0.05.

Table 4.3: Comparisons of self-reported and device-measured physical activity by SES-Walkability Status (High-Low SES & Low-High Walkability) ^a

NEWS 1 SUB-SCALE	Low-SES/ Low w*	High-SES/ Low w*	Low-SES/ High w*	High-SES/ High w*	P values**
SES-Walkability Group (SES-W) Categories→	1	2	3	4	
Median (lower and upper interquartile range) ^Y					
Self-reported physical activity (IPAQ)					
Transport physical activity (min/wk)	75 (30; 120)	20 (00;70)	180 (45; 180)	30 (0.0;75)	Overall p = 0.013** 2 vs 3 = 0.024**
Recreation physical activity (min/wk)	100(20; 180)	180 (120;180)	120(60;180)	180 (100;180)	Overall p = 0.24
Median (lower and upper interquartile range) ^Y					
Device-measure (Accelerometer)					
Vigorous physical activity (min/wk)	0.0 (0.0; 1.0)	4.0 (2.0;11)	0.0 (0.0;7.0)	1.0 (00;5.0)	Overall p = 0.034** 1 vs 2 = 0.039**
Moderate to vigorous activity (min/wk)	264(114;354)	239 (169,323)	155 (67,383)	164 (136;,271)	Overall p=0.639

^a Kruskal-Wallis tests were used to present the multiple comparisons between self-reported physical activity, measured physical activity and SES-W

* w-walkability

** P-values are reported for only comparisons that were statistically significant - p-value<0.05 (N/B: 1 vs 4 – means low-SES-Low Walkability category vs. High SES-High Walkability categories).

^Y Figures presented on the table are based on median, lower and upper interquartile ranges.

4. 5 Conclusion and Recommendations

This current study examined the differences in self-reported physical activity (transport and leisure domains) and measured physical activity (MVPA) when groups were apportioned according to income and GIS measured walkability in the 1000m buffers. There was no relationship between self-reported physical activity and walkability (or the components of walkability, measured using GIS), irrespective of income level. Conversely, the measured physical activity for all groups was inversely associated with intersection density.

Gebel et al. (Gebel et al., 2009), examined the characteristics of adults who are resident in objectively identified, high walkability neighbourhoods but whose perceptions of neighbourhood attributes are not concordant with these objective attributes. Neighbourhood built environment characteristics related to walkability (dwelling density, intersection density, land use mix, and net retail area) were determined objectively using GIS. The results of the study highlighted that adults with a lower educational attainment and lower incomes, or who were less physically active were less likely to recognise these attributes. The findings for this study highlighted a potential for physical activity promotion and to develop strategies to address these non-concordant perceptions, especially among those who live in high

walkable environments but perceive them to be low and also among the socially disadvantaged and are less active.

We also showed differences in transport-related, self-report physical activity, but only between the High SES/Low walkable and Low SES/High walkable groups. Previous studies have established that adults walk more for transportation in walkable neighbourhoods (Heath et al., 2006). In the current study, the walkability–walking for transport association was weaker for respondents in low –SES than the high-SES in the 1000m buffer. This finding is important and is similar to those from Sallis et al., Thorton et al., (Sallis et al., 2009 ; Thorton et al., 2016), and elegantly summarised in a review by Adkins et al. (Adkins et al., 2017). These researchers suggests that low-income SES respondents may not experience all the benefits of living in a walkable neighbourhood unless other needs are met. In addition, these findings highlight the differences in utilitarian physical activity (such as walking for transport) and leisure time or volitional activity, based on choice.

For measured physical activity in the present study, Importantly, the results generally show a mismatch between perceived and objectively assessed access to physical activity supportive environments in local neighbourhoods. Compared to the results in chapter two, there was also a mismatch between the perceived and objectively assessed physical activity domains in the neighbourhoods, as none of the NEWS-Africa 1 scales was significantly associated with total physical activity.

While few studies have examined the agreement between perceived and objective measures of the physical environment, the present findings are consistent with other findings (Ball et al., 2008). A vast majority of literature has focused on examining associations between aspects of the built environment and modes of choice (Broberg et al., 2015; Dalton et al., 2013; Ding et al., 2014). These studies generally support the relationship between physical activity and the physical environment based on 3 key elements of the physical environment: greater proximity to retail destinations (Cerin et al., 2007; Chow et al., 2010; Forsyth et al., 2008), high connectivity (Deforche et al., 2010; Sugiyama et al., 2012) and land use mix (Saelens et al., 2003; Sallis et al, 2004).

The current study examined the associations between 4 elements including Land use mix, Intersection density, Residential density and transport density and highlighted that intersection density had significant, but inverse associations with physical activity. Therefore, in our settings, walkability may involve the creation of less intersection density, and more space (Turrell et al., 2013). The modification of the built environment to create “walkable built environments” in low-SES, may require a better understanding of the user needs and expectations, as well as upstream influencing factor that may impact more broadly, on persona safety (Boyko 2017). This may help to reduce the SES inequalities with respect to participation in physical activity, while embedding solutions within the “lived experience” of the community.

Based on GIS and other measures, it is possible that not all socioeconomic groups benefit equally from “walkable built environments” (Sallis et al., 2009). Studies that have examined the influence of built environment on active transport for different socio-economic groups have obtained mixed results (Kerr et al., 2006; Sallis et al., 2009; Van Dyck et al., 2010; Thorton et al., 2016). Steinmetz & Kestens (Steinmetz & Kestens, 2015) suggest that the equivocal nature of these findings could be due to the way the built environment measures were determined. They point out that studies which examined the built environment in residential settings and ignore non-residential destinations could explain some of these differences. They suggest that built environment features along the entirety of the spatial trajectory, from origin and destination may have the potential to influence Active transport mode of choice. In their study, they again show that the built environment has a weaker association with the active transportation of those from low- SES neighbourhoods.

4.5.1 Strengths and limitations

A strength of the present study was the design to recruit participants from four different neighbourhoods in an urban South African setting including Langa, Pinelands, Khayelitsha and Table View and all were in the urban metropole. These neighbourhoods differed in demographic composition. Langa and Khayelitsha represented two primarily low socioeconomic status (SES) townships, whereas Pinelands and Table View represented suburbs of a higher SES. The other strength included the use of accelerometers and GIS to objectively assess physical activity and use of IPAQ to assess physical activity for multiple

purposes, using walkability defined by GIS and income and utilisation of valid measures. The present study is one of the first in Africa.

This study also has some limitations and these were highlighted in the previous chapter including ; convenient sampling, limited geographic variability, construct validity restricted to only NEWS-Africa 1. Therefore, the findings may in this study not be generalizable to the entire disadvantaged communities in Africa.

4.5.2. Recommendation

Importantly, the results of the current study generally show a mismatch between perceived and objectively assessed access to physical activity supportive environments in local neighbourhoods, when groups were apportioned according to income and GIS walkability (1000m buffers). Therefore, the changes in the built environment may have a broader population-level impact. The findings are significant especially given the high social disparities that face South Africa (Stats SA, 2017). It therefore pre-emptly that low-income SES respondents may not experience all the benefits of living in a walkable neighbourhood unless other needs such as access employment, health care services are met.

4.5.3 Conclusion

In conclusion, this present study found a modest and inverse association between device-measured physical activity and GIS-measured intersection density and this therefore suggests that when doing PA for leisure (objectively measured MVPA). Intersection density is a deterrent. However, transport related activity is not affected by GIS measured walkability.

There is therefore a need to examine further the agreement between objective and further measures with a modification of the built environment (Sallis et al., 2009). Moreover, there is a need to consider the constraints to physical activity, in low SES groups, irrespective of the built environment, in order to address social and environmental justice in the promotion of physical activity, at a population level.

CHAPTER 5

DISCUSSION AND RECOMMENDATIONS

5.0 Introduction and review of main findings

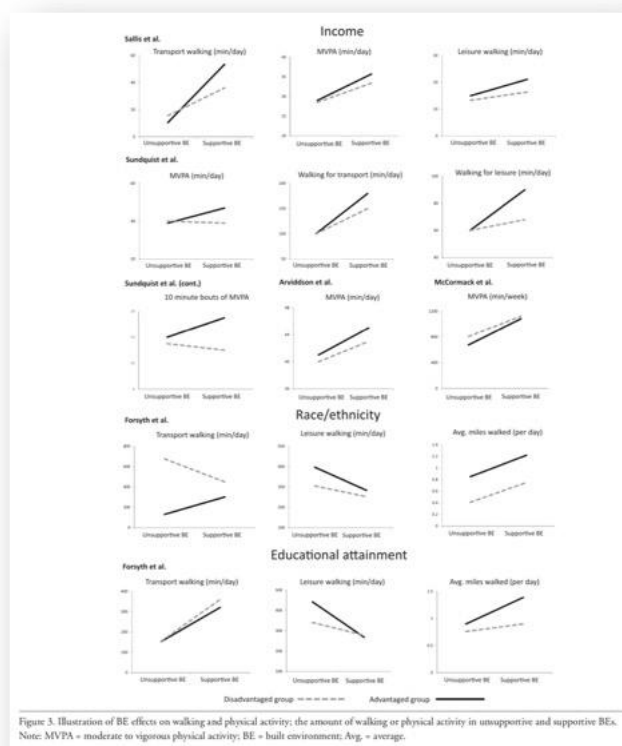
As indicated earlier in the thesis, the burden of physical inactivity is heavy in the nation of South Africa, along with an increasing prevalence of chronic diseases (Mayosi et al., 2009). The positive effects of physical activity on health and quality of life provide a strong justification to prioritise the promotion of regular physical activity, as part of a comprehensive strategy to reduce non-communicable diseases (NCDs). This can best be achieved by routine surveillance of physical activity and by making an assessment of the environmental barriers and socio-ecological constraints for physical activity, as potential targets for population-based interventions, often lacking in low and middle-income countries (Bauman et al., 2012). The ecological model (Figure 1) provides a framework to understand these interventions based on a premise of healthy behaviours being shaped at both individual and community level, coupled with strategies targeting the built environment and policies (Oyeyemi et al., 2013a).

This model (Figure 1) has provided a foundational base for examining the correlates of physical activity and other behaviours that can impact on overall physical activity of populations over time. For the present study, the focus was on two significant correlates (or determinants) of physical activity namely, socio-economic status (SES) and perceived and/or objectively measured attributes of the built environment. In particular, we were interested in the interaction between these two factors.

Initially, in this study (Chapter 2), we interrogated the reliability and construct validity of the NEWS-Africa instrument in an urban South African setting, specifically in high- and low-income neighbourhoods. In general, we found good overall reliability in those individuals living in high-income neighbourhoods, whereas we found poor test-retest reliability in the low-income groups. We posited that one possible explanation for these differences was actual week-on-week differences in traffic and crime, for example, in low-income neighbourhoods (Turrell et al., 2009). Another possible explanation might be actual week-on-week differences in exposures to the built environment, based on changes in routine or the availability of episodic work (Turrell et al., 2011).

We examined construct validity, which in this study, was measured using the first administration of NEWS-Africa against self-report transport and leisure time physical activity domains, as well as device-measured physical activity. We found no association between self-report domains of physical activity and NEWS-Africa sub-scales in the low-SES groups, and an inverse association between transport-related activity and the *Access to Services* sub-scale in the high-SES groups. With greater statistical power and more variability (groups combined), we found that there was, in fact, an inverse association between transport-related physical activity and *Safety from crime*, *Safety from traffic* and *Neighbourhood surroundings*, suggesting that much of transport-related physical activity, when reported, would be utilitarian and not volitional. This corroborates Oyeyemi's findings (Oyeyemi et al., 2017), but contrasts with the literature from outside of Africa, such as in countries in Europe and Americas (Cerin et al., 2013). These findings are also aligned with two recent studies using the NEWS instrument and active commuting in Chennai, India and Cuernavaca, Mexico (Adlakha et al., 2018, Jáuregui et al., 2017), which differ from associations found in high-income settings and countries.

Further to this, Adkins et al. (Adkins et al., 2017) recently published a narrative review, in which they questioned the traditional and expected associations between the built environment and the construct of “walkability” as defined by bulk of the existing literature.



They described a weaker and often inverse association between the built environment and walking (for transport and leisure) as well as overall physical activity, in disadvantaged groups compared to their more advantaged counterparts (See Figure 3, extracted from Adkins et al., 2017).

Similarly, when we compared *Access to services* to moderate and total device-measured MVPA, the

relationship was inverse in the low-SES group, along with *Neighbourhood surroundings*. Whereas, in the high SES group and when groups were combined, *Personal Safety and Safety from Crime* were positively associated with vigorous activity in the high-SES groups and overall. We interpret vigorous activity in this context, as a proxy for recreational physical activity.

In summary, our results suggest that construct validity for NEWS-Africa, based on actual or reported physical activity against as a measure of the perceived built environment for “walkability”, may have less utility in low-SES settings, where utilitarian, particularly transport-related activity, may involve little choice. In Chapter 3, we explored walkability constructs and subscales of the NEWS-Africa instrument against what might be considered comparable measures of the built environment, measured using GIS or ‘ground-truthing’. We were specifically interested in the extent to which the SES of communities may influence these associations.

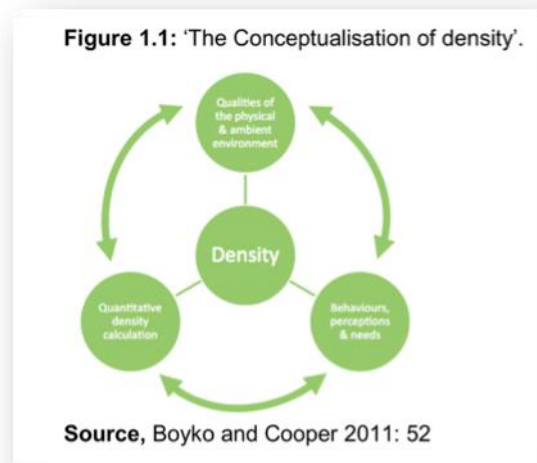
Our first finding was that persons from high-income settings perceived places of worship and sports fields to be further from their homes than when actually measured. Conversely, persons living in low-income communities perceived public transport stops to be closer than they were. We interpreted these results to suggest that high-income persons likely drove to these destinations, whereas low -income persons were inured to the distance to public transport stops, because they were accustomed to the distance based on frequency of use (Jáuregui et al., 2016).

When we considered the NEWS-subscales of walkability in high- and low-income settings, using the GIS-coded “walkability” index, differences in the perceptions in the built environment were always shown between low- and high-SES groups, irrespective of measured walkability. And within in comparable high- and low- income, high walkable communities, for example, scores for *Stranger danger* were higher, and *Safety from crime* were lower in the low-SES, high walkable group. The picture that emerges is one of inequity, and lack of environmental justice. In addition, it suggests that attributes such as residential density or intersection density may have a different interpretation, with respect to walkability, than the original intent when used in high-income country settings.

For example, studies in high-income countries and the Global North associated a higher residential density with greater walkability (Christiansen et al., 2016). However, recently Lu et al. (2017) presented data from Hong Kong, on the GIS- attributes of walkability (the 3 D’s

or density, diversity and design). Investigators found no association between street connectivity or land use mix, with self-reported walking for leisure or transport. Moreover, population density (a slightly different measure than residential density) was associated with walking for transport and leisure only in the low density range, whereas density was negatively associated with walking for leisure in high density areas. These authors suggested that *“the association between original 3D's and walking may vary in different urban contexts... policy or planning strategy—using three D's to promote physical activity—may be ineffective or even counterproductive in large and already dense cities...”*.

The urban design constructs such as residential density in an extreme urban context may, in fact, reflect overcrowding. In a recent book, *Design for Health* (2017), Boyko describe sthe various conflicting information associated with health outcomes and urban density. In some cases, urban density and socioeconomic disadvantage have been associated with a lower quality of life, greater psychological stress and less social interaction. However, there are other examples of urban density, depending on infrastructure, available programmes and the “quality” within that space, which show greater social interaction, and overall better well being amongst residents (see Figure 1.1 below, extracted from Boyko CT, which was cited from a previous publication, Boyko and Cooper 2011).



In our study, there was a more than 4-fold difference in density between our low- and high-SES groups, and large differences in the ill-defined “other” category. Despite this. Residential density comprised a larger proportion of the space in the high SES communities than any other land-use category. Therefore, it is clear that using Land-Use Mix as a stand-alone category to predict walkability, without a larger social context (including quality of the land use, and the needs of the community, as well as mitigating factors such as crime) is likely to lead to different interpretations, in low- and high-SES communities. This is likely to

be further exacerbated by the long-standing social and geospatial inequities which were part of the South African apartheid legacy.

Thirdly, we investigated the differences in the self-reported physical activity (domains) and device-measured physical activity (MVPA), when groups were divided according to income and GIS-measured walkability in the 1000m buffers. This allowed us to compare the actual vs perceived barriers to physical activity, within and across different income levels and domains. We discovered that there was no relationship between any self-reported physical activity and GIS measured attributes of walkability in 1000m buffers. In the low SES groups, only intersection density in the 1000m buffer was statistically and inversely associated with device-measured moderate-vigorous physical activity. In the high SES groups, results were similar. However, for these groups, intersection density in the 1000m buffer was statistically and inversely associated with device-measured vigorous physical activity, only. When groups were combined, the inverse relationship between intersection density and physical activity persisted.

These results speak to the previous discussion concerning urban density, and highlight the importance of considering both volitional and utilitarian purposes underlying physical activity, the level of car dependency of a community, and issues of the quality of what comprises the urban space, against the needs of the inhabitants and their perceptions (Boyko 2017). Adkins et al., (2017) provide a conceptual framework showing factors that contribute to weaker built environment (BE) effects on walking and physical activity (PA) among disadvantaged groups. We further discussed this framework, below as it applies to these results, and have adapted it for our study.

5.1 Conceptualized model for the study findings.

The key findings of this study are visualised in the conceptual framework in Figure 4, adapted from Adkins et al. (Adkins et al., 2017). Overall, three key findings stand out of this study. i) There was no relationship between any self-reported physical activity and GIS-measured walkability index parameters, irrespective of income level/ ii) Out of the four walkability parameters (land-use mix, residential, transport, and intersection density) only intersection density correlated with measured physical activity, and was inverse for total MVPA in the low SES groups, inverse for Vigorous PA in high SES groups, and inverse for MVPA for the combined groups. iii) When adjusted for income levels, overall, there was a

significant difference in the self-reported physical activity in the domain of transport with High-SES/Low walkable vs. Low-SES/ High walkable, whereas the device-measured VPA was significant in the Low-SES/Low walkable vs High-SES/Low walkable groups. Specifically, residents in the Low-SES/High walkable neighbourhoods reported more transport-related physical activity compared to High-SES/Low walkable as highlighted in the conceptual model.

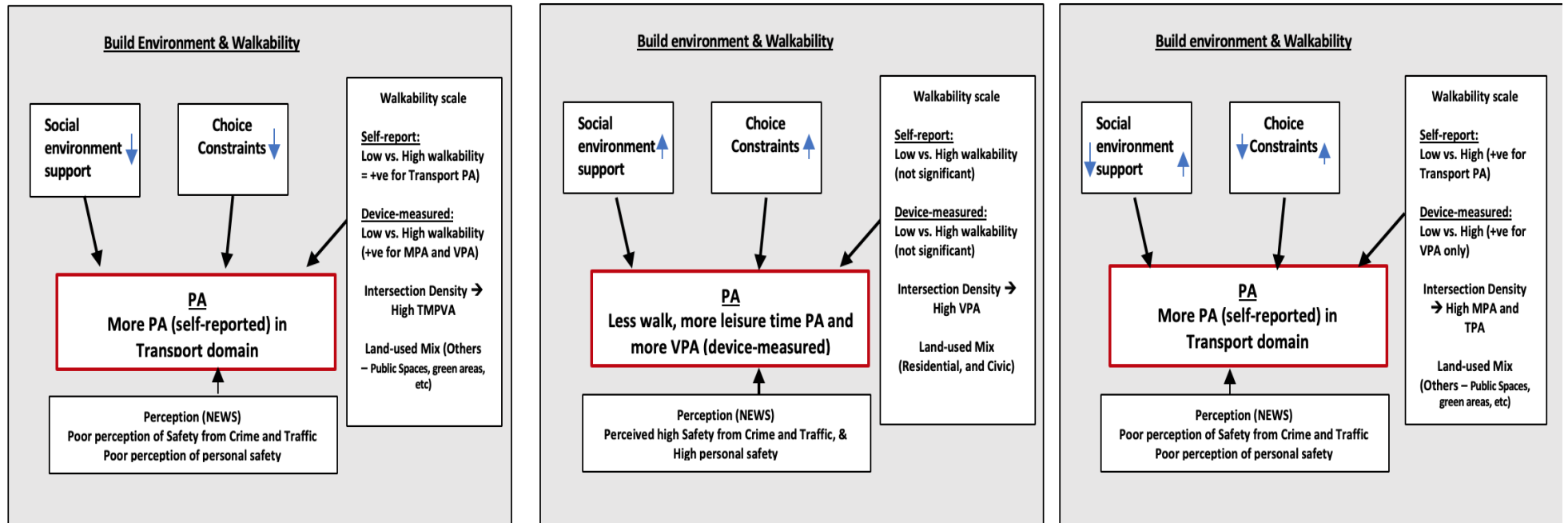
The differences in these findings can be partially explained by the measures used for walkability. Our current study calculated the Land-use mix, using an entropy equation (Song et al., 2013) to score the area based on these four land use types (Adams et al., 2014). It differed from the original index as it used land use area measures instead of floor area measures and “retail floor area ratios”, as these data were not available in the South African context. This adapted version of land use-mix, although not the most precise in calculation, still underscores the main theoretical constructs of walkability (proximity and connectivity (Adams et al., 2014)). The current study is similar to the IPEN study of International neighbourhood variation by Adams et al.(Adams et al., 2014), which maximized within-city variation in net-residential density, land use-mix and intersection density and therefore the walkability index values should be able to reflect the maximum ranges within each community that would translate into cities in other countries in addition to directly comparing with other countries at country level, thereby highlighting true between country variation.

The diagram below suggests that even when the built environment is unsupportive for physical activity, low SES communities participate in more transport-related physical activity. We make the assumption, based on car ownership and economic constraints, that this is not based on choice. Those individuals from high SES communities participate in more vigorous activity, even when they perceive the environment to be unsupportive. We assume that this is because they might be engaged in fitness-related or leisure time activity, in destinations beyond their local community. The model by Adkins et al., (2017) and our own data support the need for local consultation, and a better understanding of what comprises a “walkable” community and what informs or mitigates the choice constraint of low SES communities for physical activity in order to “level the playing fields”.

Low SES Communities - Unsupported BE

High SES Communities - Unsupported BE

Combined SES (Overall)



PA: Physical Activity; TMPVA: Total moderate to vigorous PA; VPA: Vigorous PA; MPA: Moderate PA; TPA: Total PA

Figure 5: Conceptual model showing factors that significantly influenced self-reported PA (Leisure and Transport) and device-measured PA (adapted from (Adkins et al ., 2017)

5.2 Overall study strength, limitation and recommendations

5.2.1 Study strengths

The present study was undertaken in communities of different SES and resource-poor settings in South Africa, and therefore can be used as a basis of comparisons with the psychometric evaluation of the NEWS-Africa in the 7 African nations (South Africa, Mozambique, Cameroon, Nigeria, Ghana, Kenya and Uganda).

Many studies have explored physical activity levels objectively and subjectively but this study was the first to do it with GIS measured walkability and also in high- and low-SES, which brings variation to environmental studies. The ground-truthing aspect also added to the methodology further explored the factors that influence an individual's ability to accurately report about the features that are present in their neighbourhood.

5.2.2 Study limitations

The present study has some limitations which are important considerations in the interpretation of the results these are highlighted in the previous chapters (chapter 2 section 2.8.3 and chapter 4; section 4.5.1), including: The method of recruitment, limited sample size, restricted geographical variability, the cross-sectional design of the study. All which may have restricted environmental variability, could in turn underestimate the strengths of environmental-physical activity associations (Adams et al., 2013; Oyeyemi et al., 2013; Van Dyck et al., 2012; Sallis et al., 2009).

5.2.3. Recommendations

The findings in the current study are of particular importance, as they suggest a difference in expectation of respondents as regards their environment and highlight a need for social justice. Population-level strategies that can impact on the socio-economic, psychosocial, and health-care related issues among households in the resource-poor settings needs to be commission to address aspects of inclusion, health equity and socio-economic deprivation.

Crime is a well-recognised barrier to physical activity, particularly in low-income neighbourhoods (Adlakha et al., 2015) and our current study indicated associations between perceptions regarding crime, SES, and walkability. Studies previously have also produced inconsistent associations between crime and neighbourhood perceptions and SES. This suggests that the impact of perceived safety from crime on walking and other forms of

physical activity needs further investigation (Ding et al., 2013; Foster & Giles-Corti, 2008). For a country such as South Africa, the effect of environmental and social injustice still plagues the society post-1994 and may account for the differences between these SES groups. Although previous research shows otherwise, there is an empirical study in Melbourne, Australia confirmed that urban residents of lower income were more likely to have mismatches between their perceptions of the perceived environment and objective measures (Ball et al., 2008).

The findings in the present study are particularly significant for health promotion in Sub-Saharan Africa. Lee et al., (Lee et al., 2012b) highlight that understanding the environmental correlates of physical activity is a priority that could lead to better strategies to prevent further declines in physical activity in the region. Further evaluation of the NEWS-Africa is needed in other countries that could lead to evidence-based recommendations for creating better designed and safer communities, that improve access to safe and enjoyable opportunities in the African region.

5.3 Overall Conclusions

The overall results of the current study across all chapters generally show a mismatch between perceived and objectively assessed built environment, particularly in low-income communities. Furthermore, in low-SES communities, we failed to show the expected relationships between attributes of the built environment and physical activity, suggesting that physical activity in these communities is more utilitarian in nature, and as such, may not be as influenced by aspect of the built environment.

In summary, the environment (including crime rates, poor access to physical activity facilities and public transportation predominantly made by buses) are unique to these setlow and middle-income countries, where physical activity is used for utilitarian, rather than recreational purposes. This study stemmed from the need to broaden research on the relationship between the built environment and physical activity, considering walkability constructs. What these findings suggest is that the definition of the construct of walkability be re-examined, in relation to low SES settings.

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APPENDIX 1



“PERCEIVED NEIGHBOURHOOD WALKABILITY” AND PHYSICAL ACTIVITY IN FOUR URBAN SETTINGS: A RESEARCH STUDY

PARTICIPANT INFORMATION

Who are we and what is this project about?

We are field researchers, representing the Division of Exercise Science and Sports Medicine, in the Department of Human Biology, in the Faculty of Health Sciences, at the University of Cape Town. You are receiving this invitation, as part of a community or church group, in one of four suburban areas in Cape Town, including: Langa, Table view, Khayelitsha, or Durbanville.

You have been invited to participate in a project in which we hope to get a better understanding about the way in which the neighbourhood environment may impact, both positively and negatively, on levels of physical activity, in getting to and from places, as well as physical activity for recreation and/or health. We have chosen groups who meet already regularly, firstly so that it does not involve additional travel for you. We have chosen different neighbourhoods, and so that it adds sufficient variety to our results, to gain understanding.

If I choose to participate, what is expected of me?

On your first visit, we will be asking questions concerning your levels of physical activity, your current health status, some questions concerning your age, education and work experience, and some questions about your neighbourhood. The questions about your neighbourhood refer to the estimated walking distance to various types of destinations (post office, school, transport stations, shopping, medical services, etc.), some questions

concerning neighbourhood appearance and safety, or “walkability”. All of these questions should not take more than 30 minutes to answer.

Should you decide to volunteer, we will also be asking you to wear a small plastic device on a belt around your waist for 7 days or until your next meeting. This device counts the number of steps that you take, and all of your movement while you are wearing the device. From this, we can determine the number of minutes that you spend each day in light, moderate and vigorous activity.

Finally, we will ask for the nearest street intersection to your home (not your home address). We will use this intersection as a landmark, and using mapping software programmes, we will be able to determine levels of crime, traffic safety, and access to certain amenities. By using your street intersection, instead of your address, your privacy will be maintained.

On your second meeting, one week later, we will collect the step counter device and repeat only the questions concerning your neighbourhood. This helps us to determine if the questionnaire is reliable.

Thank you for your consideration in participating in this project.

Are there any benefits or risks in taking part in this project?

There are no direct benefits to you personally in taking part in this project. We will be sharing the overall results with participants. However, there are also no risks to your health or well-being in taking part in the project. Completing the questionnaires will take about 30 minutes of your time, and the step counting device and questionnaires will be administered and fitted on a day in which you are already meeting, to save travel time and inconvenience. On return of the step counting device, and completion of the neighbourhood questionnaire for the second time, you will be presented with a shopping voucher or cell phone voucher for R100, as a token of appreciation for your participation.

Will my information be protected and remain confidential? With whom will the results of this project be shared?

The information that you provide in the questionnaires will remain confidential, along with the measured levels of physical activity from the step counting device. Once you have signed consent, and agreed to participate in the study, you will be given a study number, and your

results will be stored separately to your name. Also, we will not use your street address to map your neighbourhood, but simply the nearest street intersection, which will also protect your privacy.

The overall results of this study will be used to prepare a report and manuscript to share with other researchers, and policy makers, so that they may be informed about the way in which the neighbourhood environment may impact on opportunities for physical activity. You will never be identified, nor your community or church group, by name, in any report or document.

Am I obliged to participate or remain in the study?

You may choose to take part in this study or you may choose not to take part. If you choose to participate in the project, you have the right to withdraw at any stage.

What if I have any questions or concerns?

If you have any queries or questions regarding the research study or your rights as a participant, please feel free to contact any the following people to share your concerns or answer your questions.

Professor Vicki Lambert.....021 650 4571, 082-3126890

(Project leader, Supervisor)

Moses Isiagi..... 072 408 6239 (Student investigator)

Associate Professor Mark Blockman, Chair of the Health Science Faculty Research Ethics Committee, Old Main Building of Groote Schuur Hospital, Floor E52, Room 23, Observatory, 7925. Phone: 021-406 6496

APPENDIX 2



“PERCEIVED NEIGHBOURHOOD WALKABILITY” AND PHYSICAL ACTIVITY IN FOUR URBAN SETTINGS: A RESEARCH STUDY

PARTICIPANT WRITTEN CONSENT

INFORMED CONSENT

The study has been described to me in language that I understand and I freely and voluntarily agree to participate. My questions about the study have been answered. I understand that my identity will not be disclosed and that I may withdraw from the study without giving a reason at any time and this will not negatively affect me in any way.

Participant’s name.....

Participant’s signature.....

Date.....

Witness Signature.....

APPENDIX 3



**“PERCEIVED NEIGHBOURHOOD WALKABILITY” AND PHYSICAL ACTIVITY
IN FOUR URBAN SETTINGS: A RESEARCH STUDY**

STREET ADDRESS QUESTIONNAIRE

1. Please indicate the nearest street corner address to your home

.....
.....
.....

2. Please indicate the Name and address of your place of worship

.....
.....
.....

3. Please indicate the Name and address of the place that you most frequently shop for your family groceries

.....
.....
.....

4. Please indicate the Name and address of the medical practice or clinic that you and your family members attend, when you have health concerns.

.....
.....

5. Please indicate the Name and address of your place of employment.

.....
.....
.....

6. How do you travel to work (please tick appropriate box)

Bus/Taxi

Train

Car

Bicycle

Walk

7.If you have a child, provide the name and street address of the school that they attend

.....
.....
.....

8. How does your child travel to school (please tick appropriate box)

Bus/Taxi

Train

Car

Bicycle

Walk



APPENDIX 4

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

LONG LAST 7 DAYS SELF-ADMINISTERED FORMAT

FOR USE WITH YOUNG AND MIDDLE-AGED ADULTS (15-69 years)

The International Physical Activity Questionnaires (IPAQ) comprises a set of 4 questionnaires. Long (5 activity domains asked independently) and short (4 generic items) versions for use by either telephone or self-administered methods are available. The purpose of the questionnaires is to provide common instruments that can be used to obtain internationally comparable data on health-related physical activity.

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** and **moderate** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal.

PART 1: JOB-RELATED PHYSICAL ACTIVITY

The first section is about your work. This includes paid jobs, farming, volunteer work, course work, and any other unpaid work that you did outside your home. Do not include unpaid work you might do around your home, like housework, yard work, general maintenance, and caring for your family. These are asked in Part 3.

1. Do you currently have a job or do any unpaid work outside your home?

Yes

No → **Skip to PART 2: TRANSPORTATION**

The next questions are about all the physical activity you did in the **last 7 days** as part of your paid or unpaid work. This does not include traveling to and from work.

2. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, heavy construction, or climbing upstairs **as part of your work**? Think about only those physical activities that you did for at least 10 minutes at a time.

_____ **Days per week**

No vigorous job-related physical activity → **Skip to question 4**

3. How much time did you usually spend on one of those days doing **vigorous** physical activities as part of your work?

_____ hours per day

_____ minutes per day

4. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads **as part of your work**? Please do not include walking.

_____ days per week

No moderate job-related physical activity

➔ *Skip to question 6*

5. How much time did you usually spend on one of those days doing **moderate** physical activities as part of your work?

_____ **hours per day**

_____ **minutes per day**

6. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time

as part of your work? Please do not count any walking you did to travel to or from work.

_____ **days per week**

No job-related walking

➔ ***Skip to PART 2: TRANSPORTATION***

7. How much time did you usually spend on one of those days **walking** as part of your work?

_____ **hours per day**

_____ **minutes per day**

PART 2: TRANSPORTATION PHYSICAL ACTIVITY

These questions are about how you travelled from place to place, including to places like work, stores, movies, and so on.

8. During the **last 7 days**, on how many days did you **travel in a motor vehicle** like a train, bus, car, or tram?

_____ **days per week**

No traveling in a motor vehicle **➔** *Skip to question 10*

9. How much time did you usually spend on one of those days **traveling** in a train, bus, car, tram, or other kind of motor vehicle?

_____ **hours per day**

_____ **minutes per day**

Now think only about the **bicycling** and **walking** you might have done to travel to and from work, to do errands, or to go from place to place.

10. During the **last 7 days**, on how many days did you **bicycle** for at least 10 minutes at a time to go **from place to place**?

_____ **days per week**

No bicycling from place to place **➔** *Skip to question 12*

11. How much time did you usually spend on one of those days to **bicycle** from place to place?

_____ hours per day

_____ minutes per day

12. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time to go **from place to place**?

_____ days per week

No walking from place to place
HOUSEWORK, HOUSE

➔ **Skip to PART 3:
MAINTENANCE, AND
CARING FOR FAMILY**

13. How much time did you usually spend on one of those days **walking** from place to place?

_____ hours per day

_____ minutes per day

PART 3: HOUSEWORK, HOUSE MAINTENANCE, AND CARING FOR FAMILY

This section is about some of the physical activities you might have done in the **last 7 days** in and around your home, like housework, gardening, yard work, general maintenance work, and caring for your family.

14. Think about only those physical activities that you did for at least 10 minutes at a time.

During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, chopping wood, shovelling snow, or digging **in the garden or yard**?

_____ **days per week**

No vigorous activity in garden or yard **➔ Skip to question 16**

15. How much time did you usually spend on one of those days doing **vigorous** physical activities in the garden or yard?

_____ **hours per day**

_____ **minutes per day**

16. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** activities like carrying light loads, sweeping, washing windows, and raking **in the garden or yard**?

_____ **days per week**

No moderate activity in garden or yard **➔ Skip to question 18**

17. How much time did you usually spend on one of those days doing **moderate** physical activities in the garden or yard?

_____ **hours per day**

_____ **minutes per day**

18. Once again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** activities like carrying light loads, washing windows, scrubbing floors and sweeping **inside your home**?

_____ **days per week**

No moderate activity inside home **➔ Skip to PART 4:**
RECREATION, SPORT AND LEISURE-TIME PHYSICAL ACTIVITY

19. How much time did you usually spend on one of those days doing **moderate** physical activities inside your home?

_____ **hours per day**

_____ **minutes per day**

PART 4: RECREATION, SPORT, AND LEISURE-TIME PHYSICAL ACTIVITY

This section is about all the physical activities that you did in the **last 7 days** solely for recreation, sport, exercise or leisure. Please do not include any activities you have already mentioned.

20. Not counting any walking you have already mentioned, during the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time **in your leisure time**?

_____ **days per week**

No walking in leisure time

➔ *Skip to question 22*

21. How much time did you usually spend on one of those days **walking** in your leisure time?

_____ **hours per day**

_____ **minutes per day**

22. Think about only those physical activities that you did for at least 10 minutes at a time.

During the **last 7 days**, on how many days did you do **vigorous** physical activities like aerobics, running, fast bicycling, or fast swimming **in your leisure time**?

_____ **days per week**

No vigorous activity in leisure time

➔ *Skip to question 24*

23. How much time did you usually spend on one of those days doing **vigorous** physical activities in your leisure time?

_____ **hours per day**

_____ **minutes per day**

24. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** physical activities like bicycling at a regular pace, swimming at a regular pace, and doubles tennis **in your leisure time**?

_____ **days per week**

No moderate activity in leisure time ➔ ***Skip to PART 5: TIME***
SPENT SITTING

25. How much time did you usually spend on one of those days doing **moderate** physical activities in your leisure time?

_____ **hours per day**

_____ **minutes per day**

PART 5: TIME SPENT SITTING

The last questions are about the time you spend sitting while at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading or sitting or lying down to watch television. Do not include any time spent sitting in a motor vehicle that you have already told me about.

26. During the **last 7 days**, how much time did you usually spend **sitting** on a **weekday**?

_____ **hours per day**

_____ **minutes per day**

27. During the **last 7 days**, how much time did you usually spend **sitting** on a **weekend day**?

_____ **hours per day**

_____ **minutes per day**

This is the end of the questionnaire, thank you for participating.

APPENDIX 5



NEWS-AFRICA SURVEY

This questionnaire has been used all over the world to understand more about where people live and how this may impact their ability and willingness to walk, move about, and play. This version has been adapted for use in sub-Saharan Africa countries for people aged 12-100 years. *Not all questions may apply to you*, but please try to answer all questions to the best of your ability.

SECTION A: DEMOGRAPHIC INFORMATION

Please respond to these questions about yourself.

1. What is your age? _____ (years old)

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

3. What is your marital status?
 1. Married
 2. Living with partner
 3. Single
 4. Widowed/divorced/separated
 5. Not applicable for youth 17 and younger

4. What is your highest level of education?
 1. No formal schooling
 2. Primary school

3. Some high school
4. Completed high school
5. Diploma/Higher Diploma
6. Bachelor's degree
7. Graduate (Masters/PhD)/professional degree

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

1. None
2. One
3. Two
4. Three or more

6. How often do you use personal or private motorized transport (cars, trucks, motorcycles/bikes, tricycles) in a week? This can be your vehicle or someone else's, but not public transport.

1. Not at all or Less than once a week
2. A few times a week
3. Most days of the week
4. Everyday

7. What is the **COMBINED** monthly income for your household? *Modify as needed to reflect specific income cut-points in your country*

1. Less than \$200 (Less than R2 001)
2. Between \$200-599
3. Between \$600-999
4. between \$1,000-\$1,999
5. between \$2,000-\$3,000
6. between \$3,000-\$5,000
7. More than \$5,000

8. How many adults (aged 18 and above) live in your household most of the time? ____ adults

9. How many youth (aged 0-17 years) live in your household most of the time? _____ youth
10. How long have you lived in your present address (house)? _____ years and _____ months
11. What is your height: _____ Metres *modify as needed to reflect the desired unit of measurement.*
12. What is your weight: _____ Kg *modify as needed to reflect the desired unit of measurement.*

SECTION B: QUESTIONS ABOUT YOUR NEIGHBOURHOOD

*We would like to find out more information about what you perceive or think and how you feel about your neighbourhood. By neighbourhood we mean **ALL** the area that you could walk to in **10-15 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 neighbourhood.*



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

1. What is the main type of housing in your immediate neighbourhood?
 1. Very few residential buildings/dwellings within 2-5 min walk of my house
 2. Detached or semi-detached single-family houses with space/garden
 3. Attached (row) housing, apartment blocks/flats or multi-family housing with 2-5 stories.
 4. Multiple apartment blocks/flats of 6 stories or more, with large spaces between buildings.
 5. Multiple apartment blocks/flats of 6 stories or more, with very little space between buildings.
 6. Very densely packed small houses (1-story homes, including informal settlements and slums)



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 to get from your house to the nearest places or locations listed below if you walked to them? 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 Don't know

Example: gas/petrol station

1. _____ 2. _____ 3. ✓ _____ 4. _____ 5. _____ 8. _____

1. kiosk/corner store

small grocery 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 8. _____

2. supermarket 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 8. _____

3. fruit/vegetable market (food market) 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 8. _____

4. fast food restaurant 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 8. _____

5. non-fast food restaurant 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 8. _____

6. pub or bar 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 8. _____

7. cinema/theater 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 8. _____

8. place of worship/faith centre(church, mosque, shrine) 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 8. _____

9. computer/cell phone kiosks
Places for internet or phone calls 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 8. _____

10. library 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 8. _____

1-5 min 6-10 min 11-20 min 21-30 min 31+ min Don't know

11. Any school 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 8. _____

12. your work place or your school (if a student) 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 8. _____

13. book store (book shop) 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 8. _____
14. health care clinic/hospital 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 8. _____
15. pharmacy/chemist 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 8. _____
16. salon/barber shop (hair dresser) 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 8. _____
17. clothing store (tailoring/fashion/designer shop) 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 8. _____
18. electronics shop 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 8. _____
19. public bus or train stop 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 8. _____
20. taxi or motorbike stop 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 8. _____
21. sports field or court for basketball, soccer, tennis, etc 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 8. _____
22. other outdoor recreation space (park, open space, informal play/recreation area) 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 8. _____
23. other indoor recreation facilities (recreation center, gymnasium, health or fitness center) 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 8. _____
24. dance or martial arts classes (karate) 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 8. _____
25. 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. _____
26. farm (crop planting/animal herding) 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 8. _____
27. places for hunting/collecting firewood. 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 8. _____



Please circle the answer that best applies to you and your neighbourhood. Within easy walking distance means 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 centre, gym, health or 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 palace, village square, church/worship places etc.) within easy distance of my house.

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



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

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 or less)

1	2	3	4	5
strongly disagree	somewhat disagree	somewhat agree	strongly agree	Not applicable (few official roads)

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 every time)

1	2	3	4	5
strongly disagree	somewhat disagree	somewhat agree	strongly agree	Not applicable (few official roads)

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

4. 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

5. Some roads (official routes) 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





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	5
strongly	somewhat	somewhat	strongly	Not applicable
disagree	disagree	agree	agree	(few official roads)

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

1	2	3	4	5
Strongly	somewhat	somewhat	strongly	Not applicable
Disagree	disagree	agree	agree	(no sidewalks)

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

1	2	3	4	5
Strongly	somewhat	somewhat	strongly	Not applicable
Disagree	disagree	agree	agree	(no sidewalks)

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

1	2	3	4	5
strongly	somewhat	somewhat	strongly	Not applicable
disagree	disagree	agree	agree	(no sidewalks)

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

1	2	3	4	5
strongly	somewhat	somewhat	strongly	Not applicable
disagree	disagree	agree	agree	(no sidewalks/roads)

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

1	2	3	4	5
strongly	somewhat	somewhat	strongly	Not applicable
disagree	disagree	agree	agree	(few official roads)

7. There are curb ramps (decline or smooth grades) that go from sidewalk level to road level at road crossings (intersections/junctions) in my neighbourhood to assist the elderly or wheel chair/prams users

1	2	3	4	5
strongly	somewhat	somewhat	strongly	Not applicable
disagree	disagree	agree	agree	(no sidewalks)

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	5
strongly disagree	somewhat disagree	somewhat agree	strongly agree	Not applicable (few official roads)

9. The roads in my neighbourhood are well lit (adequate functioning street lights) at night.

1	2	3	4	5
strongly disagree	somewhat disagree	somewhat agree	strongly agree	Not applicable (few official roads)

10. There are informal places (walk/foot paths) for people to walk in my neighbourhood.

1	2	3	4	5
strongly disagree	somewhat disagree	somewhat agree	strongly agree	Not applicable (few informal routes)

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

1	2	3	4	5
strongly disagree	somewhat disagree	somewhat agree	strongly agree	Not applicable (few informal routes)

12. In my neighbourhood/area there are busy roads that are dangerous to cross.

1	2	3	4	5
strongly disagree	somewhat disagree	somewhat agree	strongly agree	Not applicable (few official roads)

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

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





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

1. There are trees along the roads/paths in my neighbourhood.

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

2. My neighbourhood is clean and free of litter, garbage or stagnant water.

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

3. My neighbourhood is free from bad smells and odors.

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

4. There are beautiful natural sights/views in my neighbourhood.

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

5. There are attractive buildings/houses in my neighbourhood.

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

6. My neighbourhood is generally free of unpleasant noises like highways, factories, trains, bars, music/record studios, nightclubs/discotheques etc.

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

7. 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

8. 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



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

1. There is so much traffic along nearby roads that it is difficult or unpleasant to walk or play in my neighbourhood.

1	2	3	4	5
strongly disagree	somewhat disagree	somewhat agree	strongly agree	Not applicable (few official roads)

2. The speed of traffic on most nearby roads in my neighbourhood is usually slow

1	2	3	4	5
strongly disagree	somewhat disagree	somewhat agree	strongly agree	Not applicable (few official roads)

3. Most drivers exceed the speed limits (drive very fast) in my neighbourhood.

1	2	3	4	5
strongly disagree	somewhat disagree	somewhat agree	strongly agree	Not applicable (few official roads)

4. Walking or playing is dangerous in my neighbourhood because of careless or aggressive driving.

1	2	3	4	5
strongly disagree	somewhat disagree	somewhat agree	strongly agree	Not applicable (few official roads)

5. It could be dangerous to ride on bicycle in or near my neighbourhood because of speed of traffic.

1	2	3	4	5
strongly disagree	somewhat disagree	somewhat agree	strongly agree	Not applicable (few official roads)

H. Safety from crime

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

1. There is a lot of crime in my neighbourhood.

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

2. There is too much crime in my neighbourhood 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, 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. Additional individual items (Single Items)

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

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

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.

1. 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

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 of them being taken or hurt by a stranger.

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

3. 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

4. I am worried about letting my child play or walk in my neighbourhood and local streets because I am afraid of them being injured by a car.

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

If you are 17 years or younger, please answer these questions:

1. I am worried about playing or being outside alone or with friends around my house (e.g. yard, driveway, apartment common area), because I am afraid of being taken or hurt by a stranger.

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

2. I am worried about playing or walking alone or with friends in my neighbourhood and local streets because I am afraid of being taken or hurt by a stranger.

1
strongly
disagree

2
somewhat
disagree

3
somewhat
agree

4
strongly
agree

3. I am worried about being alone or with friends in a local or nearby park because I am afraid of being taken or hurt by a stranger

1
strongly
disagree

2
somewhat
disagree

3
somewhat
agree

4
strongly
agree

4. I am worried about playing or walking in my neighbourhood and local streets because I am afraid of being injured by a car.

1
strongly
disagree

2
somewhat
disagree

3
somewhat
agree

4
strongly
agree

THANK YOU AND WE APPRECIATE YOUR HELP IN COMPLETING THE LONG QUESTIONNAIRE



“PERCEIVED NEIGHBOURHOOD WALKABILITY” AND PHYSICAL ACTIVITY IN FOUR URBAN SETTINGS: A RESEARCH STUDY

IMVUME EBHALIWEYO YOMTHABATHI NXAXHEBA

IMVUME LWAZI

Izifundo/ uphando lucacisiwe kum ngolwimi endiliqondayo yaye ndiyavuma ngokuzithandela nangokukhululekileyo ukuthabatha inxaxheba. Imibuzo yam malunga nezifundo / nophando iphendulwe .Ndiyaqonda isazisi sam asiyiku papashwa kwaye ndivumelekile ukurhoxa kuphando ngaphandle kokunika isizathu nangeliphi na ilixa kwaye oku akuyi kundichaphaza ngandlela itenxileyo nangayiphina indlela.

Igama lomthathi nxaxheba

Tyikitya

Umhla

Kutyikitya ingqina.....

NEWS-AFRICA SURVEY-TRANSLATED

This questionnaire has been used all over the world to understand more about where people live and how this may impact their ability and willingness to walk, move about, and play. This version has been adapted for use in sub-Saharan Africa countries for people aged 12-100 years. *Not all questions may apply to you*, but please try to answer all questions to the best of your ability. Le mibuzo isetyenziswe kwilizwe lonke ukuqonda ngokubanzi malunga nokuba abantu bahlala phi yaye oku kunokbachaphazela njani ekukwazini kunye naseku kuthakazeleleniukuhamba, ukuzula nokudlala. Oluxwebhu lwamkelwe ukuba lsetyenziswe kumazwe akumazantsi e Afrika kubantu abakwiminyaka 12-100 lwe minyaka. Ayikuba yiyo yonke imibuzo eyakuhambelana nawe, kodwa nceda zama kangoko unako.

SECTION A: DEMOGRAPHIC INFORMATION Icandelo A:

Please respond to these questions about yourself. Nceda phendula le mibuzo imalunga nawe,

1. What is your age? _____(years old) 1. Mingaphi iminyaka yakho?

2. What is your sex? 2. Sesiphi isini sakho?

1. Male 1.
Uyindoda
2. Female2.
Ungumfazi

3. What is your marital status? 3. Sithini isimo sakho somtshato?

1. Married/ utshatile
2. Living with partner/ uyahlalisana
3. Single/ awutshatanga
4. Widowed/divorced/separated/ubhujelwe/uqhawule umtshato/ nisohlukene
5. Not applicable for youth 17 and younger akuhambelani nolutsha oluna 17 nangaphantsi ngeminyaka.

4. What is your highest level of education? Leliphi ibanga lakho eliphezulu le mfundo?

1. No formal schooling/ akukho mfundo iyephi
2. Primary school /amabanga aphantsi
3. some high school/ amanye amabanga aphakamileyo
4. Completed high school/ gqibile amabanga aphakamileyo esikolo
5. Diploma/Higher Diploma I Diploma/ i Diploma ephezulu
6. Bachelor's degree
7. Graduate (Masters/PhD)/professional degree

5. How many functioning motorized transport/vehicles (cars, trucks, motorcycles/bikes, tricycles) are available for use in your household? Zingaphi izithuthi ezisebenzayo ezikhoyo kwi khaya lakho ()

1. None azikho
2. One inye
3. Two zimbini
4. Three or more zintathu nanga

phezulu

6. How often do you use personal or private motorized transport (cars, trucks, motorcycles/bikes, tricycles) in a week? This can be your vehicle or someone else's, but not public transport. Kukangaphi apho usebenzisa isithuthi sakho okanye sabucala() evekini? Esi isengaba sisithuthi sakho okanye esomnye umntu , kodwa hayi isithuthi sika wonke.

1. Not at all or Less than once a week
hayi konke okanye ngaphantsi
kwesinye nge veki,
2. A few times a week amaxeshana
abalekayo nge veki
3. Most days of the week intsuku ezisisixa
evekini
 Everyday yonke imihla
- 4.

7. What is the **COMBINED** monthly income for your household? *Modify as needed to reflect specific income cut-points in your countryuthini umrholo wenyanga ekhayeni lakho.*

1. Less than \$200 ungaphantsi kwe 2000
2. Between \$200-599 uphakathi kwe
3. Between \$600-999 uphakathi kwe
4. Between \$1,000-\$1,999 uphakathi kwe -
5. Between \$2,000-\$3,000 uphakathi kwe
6. Between \$3,000-\$5,0000 uphakathi kwe
7. More than \$5,000 ungaphezulu kwe

8. How many adults (aged 18 and above) live in your household most of the time? _____ adults Bangaphi abantu abadala(kwiminyaka 18 nangaphezulu) abahlala ekhayeni lakho amaxesha amaninzi? -----

9. How many youth (aged 0-17 years) live in your household most of the time? _____ youth Bangaphi abantu abalulutsha (ubudala buka 0-17 iminyaka) abahlala ekhayeni lakho amaxesha amaninzi? -----

10. How long have you lived in your present address (house)? _____ years and _____ months kukudala kangakanani uhlala kule dilesi(indlu)? ----- iminyaka kunye ne ----- nyaanga

11. What is your height: _____ Metres *modify as needed to reflect the desired unit of measurement. Buthini ubude bakho: -----*

12. What is your weight: _____ Kg *modify as needed to reflect the desired unit of measurement. Buthini ubunzima bakho -----*

SECTION B: QUESTIONS ABOUT YOUR NEIGHBOURHOOD ICANDELO b: I mibuzo ngendawo yakho yokuhlala

We would like to find out more information about what you perceive or think and how you feel about your neighbourhood. By neighbourhood we mean **ALL** the area that you could walk to in **10-15 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 neighbourhood. Singathanda ukufumana ulwazi ngokubanzi malunga nokuba uzibona njani izinto okanye ucinga njani kunye nemvakalelo zakho malunga nesimo sendawo yakho. Xa sithetha nge simo sendawo sithetha zonke ingingqi onokuhamba nge nyawo kuzo kwimizuzu elishumi ukuya kwelishumi elinesihlanu 10-15 ukusuka endlwini yakho (kumgama ongange khilomitha enye okanye isiqingatha semayile yendlu yakho). Nceda bonisa impendulo echaza ngcono wena nesimo sendawo yakho.



A. Indidi zezindlu/ amakhaya kwingingqi yakho

Please put a check mark (✓) in the box beside the answer that best applies to you and your neighbourhood (please select only one answer). Nceda beka isiboniso kwi bokisi engakwi mpendulo ecacisa ngcono wena kunye nengingqi yakho (nceda khetha impendulo ibenye)

2. What is the main type of housing in your immediate neighbourhood?
- Very few residential buildings/dwellings within 2-5 min walk of my house imizi embalwa/ izakhiwo eziku mgama onokuthatha imizuzu emebini ukuya kwe mihlanu ukuhamba...
 - Detached or semi-detached single-family houses with space/garden Imizi yosapho ezimeleyo enomhlaba / igadi
 - Attached (row) housing, apartment blocks/flats or multi-family housing with 2-5 stories. Izindlu ezidibeneyo (umqolo),I flethi/I aphathimenti okanye izindlu zentsaphoo nge ntsapho ezina 2-5 ukubheka phezulu.
 - Multiple apartment blocks/flats of 6 stories or more, with large spaces between buildings. Ii flethi eziphindaphindeneyo , isithandathu 6 ukubheka phezulu nokunyuka, ezine bala phakathi kwe zakhiwo.
 - Multiple apartment blocks/flats of 6 stories or more, with very little space between buildings. Iiflet eziphindeneyo isithandathu 6 okanye ngaphezulu, ezinomhlaba omncinci phakathi kwezakhiwo.

6. Very densely packed small houses (1-story homes, including informal settlements and slums) Izindlu ezicukenezo ezincinci (indlu enye, kuquka amatyotyombe nembacu)



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. **Nceda cinga nge ndawo oya kuyo ukusuka endlwini yakho amaxa amaninzi, kwaye mingaphi imizuzu oyithathayo? Ukunga ngokuba lingakanani ithuba olithathayo ukuya kule ndawo lingakunceda kwimibuzo elandelayo .** *Approximately how long would it take to get from your house to the nearest places or locations listed below if you walked to them? Please put only one check mark (√) for each business or facility.* **Xa uqikelela ingaba lithuba elingakanani oyakulithatha ukusuka endlwini yakho ukuya kwindawo ekufutshane okanye location ebeliweyo apha nge zantsi ukuba uhamba ngenyawo ukuya kuzo? Nceda beka isiboniso sibesinye kushishino okanye kwi Facility.**

	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	Don't know
example: umzekelo: gas/petrol station 8.____	1. ____	2. ____	3. <input checked="" type="checkbox"/>	4. ____	5. ____	
1. kiosk/corner store small grocery isikroxoxo 8.____	1. ____	2. ____	3. ____	4. ____	5. ____	
2. supermarket ivenkile ezinkulu 8.____	1. ____	2. ____	3. ____	4. ____	5. ____	
3. fruit/vegetable market (food market) imaket yeziqhamo/ nemifuno 8.____	1. ____	2. ____	3. ____	4. ____	5. ____	8.____
4. fast food restaurant 8.____ Ivenkile yokutya okukhawulezayo	1. ____	2. ____	3. ____	4. ____	5. ____	
5. non-fast food Restaurant I 8.____	1. ____	2. ____	3. ____	4. ____	5. ____	8.____
6. pub or bar Indawo yotywala 8.____	1. ____	2. ____	3. ____	4. ____	5. ____	8.____
7. cinema/theater 8.____	1. ____	2. ____	3. ____	4. ____	5. ____	8.____

Indawo yemiboniso bhanya-

8. place of worship/faith centre(church, mosque, shrine)
indawo yokhonza

1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 8. _____

9. computer/cell phone kiosks
8. _____

1. _____ 2. _____ 3. _____ 4. _____ 5. _____

Places for internet or phone calls
Indawo ze khomputha/ cell

10. library
8. _____
Ithala lencwadi

1. _____ 2. _____ 3. _____ 4. _____ 5. _____

11. Any school
Isikolo noba sesiphi8. _____

1. _____ 2. _____ 3. _____ 4. _____ 5. _____

12. your work place or your school (if a student)
Indawo yakho yomsebenzi or isikolo sakho (ukuba ngu mntwana wesikolo)

1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 8. _____

13. book store (book shop)
8. _____ ivenkile yencwadi

1. _____ 2. _____ 3. _____ 4. _____ 5. _____

14. health care clinic/hospital
8. _____
Isebe lezonyango i klinikhi/ isibhedlele

1. _____ 2. _____ 3. _____ 4. _____ 5. _____

15. pharmacy/chemist
I khemest

1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 8. _____

1-5 min 6-10 min 11-20 min 20-30 min 30+ min Don't

know

16. salon/barber shop
8. _____
(hair dresser)
Indawo yenelwe

1. _____ 2. _____ 3. _____ 4. _____ 5. _____

17. clothing store
(tailoring/fashion/designer shop)
Ivenkile yempahla

1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 8. _____

18. electronics shop
Ivenkile yento zombane

1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 8. _____

19. public bus or train stop
Stop se bhasi okanye se treyini

1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 8. _____

20. taxi or motorbike stop
Istophu se taxi okanye yesi thuthu

1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 8. _____

21. sports field or court for basketball, soccer, tennis, etc
Ibala le midlalookanye

1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 8. _____

22. other outdoor recreation space

1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 8. _____

(park, open space, informal play/recreation area)

Amanye amabala emidlalo yaphandle (I paki,

23. other indoor recreation facilities 1. _____ 2. _____ 3. _____ 4. _____ 5. _ 8._
(recreation center, gymnasium, health or fitness center)

24. dance or martial arts classes 1. _____ 2. _____ 3. _____ 4. _____ 5. _ 8._
(karate)

Indawo yomdaniso okanye

25. tap/well water, pond, river 1. _____ 2. _____ 3. _____ 4. _____ 5. _ 8._
or stream for fresh water (if plumbing is in house, choose "1-5" minutes)
Amanzi e tephu/amanzi equal, umlambo ichibi (ukuba amanzi atsaliwe endlwini, khetha 1-5 min)

26. farm 1. _____ 2. _____ 3. _____ 4. _____ 5. _ 8._
(crop planting/animal herding)
iFama(ezolimo/ imfuyo)

27. places for hunting/ 1. _____ 2. _____ 3. _____ 4. _____ 5. _ 8._
collecting firewood.

Indawo yokuzingela/ yokuchola inkuni,



ukufikelela kwi nkonzo nakwi

Please circle the answer that best applies to you and your neighbourhood. Within easy walking distance means within a 10-15 minute walk from your house. Nceda biyela impendulo echaza kangoko kuwe nange ngingqi yakho. Kungama ohambeka ngokulula ,kutsho ukuthi kwi mizuzu elishumi ukuya kwelishumi elinesihlanu ukuhamba ukusuka kwindlu yakho.

1. Stores (shops) are within easy walking distance of my house. I venkile zikumgama ohambeka lula kwindlu yam.

1	2	3	4
strongly	somewhat andivumi nje		somewhat ndivuma njee
strongly			
disagree			
andivumelani kwaphela		disagree	agree
ndivumelana			agree

2. There are many places to go, such as food markets and restaurants, within easy walking distance of my house. Zininzi indawo zokuya , ezifana nee marike zokutya ne ndawo zokutyela, ezikumgama ekulula ukuhamba ukusuka kwindlu yam

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

3. It is easy to walk to a transit/transport stop (bus, taxi, motorbike, tricycle, train) from my house. Kulula ukuhamba ukuya kwindawo yokulindela izithuthi () ukusuka endlwini yam.

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. Kulula ukuya kwindawo zemidlalo yophandle okanye kumabala kawonke wonke () ukusuka endlwini yam.

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, gym, health or fitness center) from my house. Kulula ukuya kwindawo zemidlalo yangaphakathi () ukusuka endlwini yam.

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. Indawo ekufunyanwa izinto ezibalulekileyo, ezifana na manzi kunye neenkuni, zikumgama ohambekayo nge nyawo ukusuka endlwini yam.

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

7. There are gathering places (community center, king palace, village square, church/worship places etc.) within easy distance of my house. Zikhona indawo zembizo(iholo yoluntu, ibhotwe /ikomkhulu, inkonzo nezinye..)

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



Indlela nee ndledlana zokuhamba

Please circle the answer that best applies to you and your neighbourhood. Nceda biyela impendulo emayela nawe ne ngingqi yakho.

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 or less)

2	3	4	5	1
strongly disagree	somewhat disagree	somewhat agree	strongly agree	Not applicable (few official roads)

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 every time.) Zininzi(zintathu okanye ngaphezulu) ezinye indlela (ezise mthethweni) ukuya nokusuka kwindawo nge ndawo kwi ngingqi yam. (Andinyanzele ukuhamba ngendlela enye onke amaxa.)

1	2	3	4	5
strongly disagree	somewhat disagree	somewhat agree	strongly agree	Not applicable (few official roads)

3. There are many (3 or more) unofficial routes (walking/foot paths) connecting places in my area. Zininzi indlela (zintathu okanye ngaphezulu) ezingekho mthethweni (indledlana zenyawo) ezidibanisa indawo kwi ngingqi yam.

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

4. There are many (3 or more) shortcuts such as foot paths between roads (official routes) in my area. Zininzi () ezinqumlayo ezifana nendledlalana zenyawo phakathi kwendlela (ezisemthethweni) kwi ngingqi yam.

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

5. Some roads (official routes) or walking/foot paths (unofficial routes) in my area are blocked by gates or barriers. Ezinye indlela(ezise mthethweni) okanye indlela zenyawo(indlela ezingekho mthethweni) ezikwi ngingqi zithintelwe nge Gate.

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



Indawo zoku hamba, nokukhwela I bhayisekile

Please circle the answer that best applies to you and your neighbourhood. Nceda biyela impendulo ehambelana nawe nengingqi yakho

1. There are formally provided sidewalks (pedestrian pavements) on most of the roads (official routes) in my neighbourhood. Kukho indlela ezakhiweyo ezilungiselelwe ukuhamba nge nyawo (ipavumente yabahambi) kwinglela eziliqela (kwindlela ezise mthethweni) kwi ngingqi yam.

1	2	3	4	5
strongly disagree	somewhat disagree	somewhat agree	strongly agree	Not applicable (few official roads)

2. The sidewalks in my neighbourhood are well maintained (paved, even, and not a lot of cracks). Indawo zokuhamba ezikumacala endlela kwi ngingqi zikhathalelwe ziyalungiswa ()

1	2	3	4	5
strongly disagree	somewhat disagree	somewhat agree	strongly agree	Not applicable (no sidewalks)

3. The sidewalks in my neighbourhood are often blocked by merchandise, construction materials, parked cars, gardens/lawns/barricades. Indawo zokuhamba ezikumacala endlele kwingingqi yam zithintelekile ngenxa yabathengisi, into zokusebenza ukwakha, imoto ezisemacaleni,igadi/ingca etyaliweyoibharikhedi.

1	2	3	4	5
strongly disagree	somewhat disagree	somewhat agree	strongly agree	Not applicable (no sidewalks)

4. Sidewalks are separated from the road (vehicle traffic) in my neighbourhood by parked cars or dedicated parking bays/curbs. Indlela yomhambi nge nyawo esecaleni yohlulwe (kwindlela yezithuthi) nge zithuthi ezi mileyo okanye nge ndawo yokuzimisa elungiselweyo kwingingqi yam.

1	2	3	4	5
strongly disagree	somewhat disagree	somewhat agree	strongly agree	Not applicable (no sidewalks)

5. There is a grass/dirt strip that separates the roads from the sidewalks in my neighbourhood. Kukho ingca/ nezinto ezimdaka ezahlula indlela kumacala endlala okuhamba ngenyawo kwi ngingqi yam.

1	2	3	4	5
strongly disagree	somewhat disagree	somewhat agree	strongly agree	Not applicable (no sidewalks/roads)

6. There are signals or crosswalks/zebra crossings to help walkers cross the busy roads in my neighbourhood. Kukho isignals okanye indawo zokuwela ukunceda umhambi nge nyawo ukuwela umgaqo oxakekileyo kwingingqi yam.

1	2	3	4	5
strongly disagree	somewhat disagree	somewhat agree	strongly agree	Not applicable (few official roads)

7. There are curb ramps (decline or smooth grades) that go from sidewalk level to road level at road crossings (intersections/junctions) in my neighbourhood to assist the elderly or wheel chair/prams users Kukho I curb rempu () ezisuka kumgangatho wecala lwendlela lokuhamba ngenyawo kwindawo zokuwela indlela(ekudibaneni kweendlela) kwi ngingqi yam ukunceda abantu abadala okanye abahamba ngesitulo samavili /abasebenzisa iprem.

1	2	3	4	5
strongly	somewhat	somewhat	strongly	Not applicable

disagree disagree agree agree (no sidewalks)

8. There is enough time for people on foot to cross the road at crossing points/junctions with traffic lights, signals or robots. Kukho Ixesha elaneleyo labantu abahamba nge nyawo kwindawo zoku wela /kwi junctions ezi nezibane ezilawula izithuthi, iziboniso okanye irobotsi.

1	2	3	4	5
strongly disagree	somewhat disagree	somewhat agree	strongly agree	Not applicable (few official roads)

9. The roads in my neighbourhood are well lit (adequate functioning street lights) at night. Indlela engingqini yam ziyakha kakuhle(zinezibane zezitalato ezi Sebenza ngokwaneleyo) ebusuku.

1	2	3	4	5
strongly disagree	somewhat disagree	somewhat agree	strongly agree	Not applicable (few official roads)

10. There are informal places (walk/foot paths) for people to walk in my neighbourhood. Kukho indawo zokunqumla ezingokhiwanga ukulungiselela abantu bahambe kwingingqi yam.

1	2	3	4	5
strongly disagree	somewhat disagree	somewhat agree	strongly agree	Not applicable (few informal routes)

11. The walk/foot paths in my neighbourhood are generally of good quality (few potholes, ditches, un-evenness, stones, obstructions), so it is not difficult to walk there. Indawo zokunqumla kwi ngingqi yam zikumgangatho olungeleyo gabalala(imingxunya imbalwa, ditches, ukungalingani, amatye, nezithinteli), ngoko akukho nzima ukuhamba khona.

1	2	3	4	5
strongly disagree	somewhat disagree	somewhat agree	strongly agree	Not applicable (few informal routes)

12. In my neighbourhood/area there are busy roads that are dangerous to cross. Kwi ngingqi/eriya yam kukho indlela ezixakekileyo ezenza kube yingozi ukuwela.

1	2	3	4	5
strongly disagree	somewhat disagree	somewhat agree	strongly agree	Not applicable (few official roads)

13. There are designated or marked places to bicycle, such as separate paths or trails, or shared use paths for cycles and pedestrians in or near my neighbourhood. Kukho indawo ezakhelwe okanye ezibonakalisiweyo zokuhamba ibhayisekile, ezinjenge ndledlana esecaleni okanye indledlana eyabelwe ukunyawuza (bhayisekile) kunye nabantu kwingingqi yam.

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



okungqonge ingingqi

Please circle the answer that best applies to you and your neighbourhood. nceda biyela impendulo echaza ngokungcono wena kunye nengingqi yakho.

1. There are trees along the roads/paths in my neighbourhood. Kukho imithi ecaleni kwe ndlela/indledlana kwi ngingqi yam.

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

2. My neighbourhood is clean and free of litter, garbage or stagnant water. Ingqi yam icocekile yaye abukho ubumdaka, inkunkuma okanye amanzi amileyo.

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

3. My neighbourhood is free from bad smells and odors. Akukho mavumba mabi engingqini yam.

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

4. There are beautiful natural sights/views in my neighbourhood. Kukho ubuhle bendalo kwi ngingqi yam/umbono omhle kwi ngingqi yam.

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

5. There are attractive buildings/houses in my neighbourhood. Kukho izakhiwo/izindlu ezinomtsalane kwingingqi yam.

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

6. My neighbourhood is generally free of unpleasant noises like highways, factories, trains, bars, music/record studios, nightclubs/discotheques etc. Ingingqi yam ikhululekile kwingxolo engammandanga njengeka hola wendlela, I factories, ololiwe, I bhari, umculo, indawo yoku shicilela umculo, I club yasebusuku/ I disko Nezinye.

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

7. My neighbourhood is generally free of noticeable pollution and dust, such as from traffic or factories. Ingingqi yam ikhululekile kungcoliseko gabalala ne dast, njengo ngcoliseka olwenziwa zizithuthi okanye I factories.

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

8. There are many pleasant natural sounds in my neighbourhood such as from birds. Kukho ingxelo enintsi eyolisayo yendalo kwingingqi yam njengeye ntaka.

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



Ukukhuseleka kwizithuthi

Please circle the answer that best applies to you and your neighbourhood. **Biyela impendulo echaza wena nengingqi yakho ngoku ngcono.**

1. There is so much traffic along nearby roads that it is difficult or unpleasant to walk or play in my neighbourhood. Kukho izithuthi ezininzi ngakwi ndlela ezikufutshane ezenza kube nzima okanye kunga yolisi ukuhamba okanye ukudlala kwingingqi yam.

1	2	3	4	5
strongly disagree	somewhat disagree	somewhat agree	strongly agree	Not applicable (few official roads)

2. The speed of traffic on most nearby roads in my neighbourhood is usually slow Isantya sezithuthi kwindlela eziliqela ezikufutshane kwingingqi yam njengesiqhelo siphantsi.

1	2	3	4	5
strongly disagree	somewhat disagree	somewhat agree	strongly agree	Not applicable (few official roads)

3. Most drivers exceed the speed limits (drive very fast) in my neighbourhood. Abaqhubi abanintsi bayawugqitha umlinganiselo wesantya (bayabalekisa) kwi ngingqi yam.

1	2	3	4	5
strongly disagree	somewhat disagree	somewhat agree	strongly agree	Not applicable (few official roads)

4. Walking or playing is dangerous in my neighbourhood because of careless or aggressive driving. Ukuhamba okanye ukudlala kuyingozi kwingingqi yam ngenxa yokuqhuba ngokungathali nakakubi.

1	2	3	4	5
strongly disagree	somewhat disagree	somewhat agree	strongly agree	Not applicable (few official roads)

5. It could be dangerous to ride on bicycle in or near my neighbourhood because of speed of traffic. Kungaba yingozi ukukhweka I bhayisekile kufuphi okanye kwi ngingqi yam ngenxa yesantya sezithuthi.

1	2	3	4	5
strongly disagree	somewhat disagree	somewhat agree	strongly agree	Not applicable (few official roads)

H. Safety from crime Ukhuseleko kulwaphulo mthetho

Please circle the answer that best applies to you and your neighbourhood. **Nceda biyela impendulo echaza ngcono wena ne ngingqi yakho.**

1. There is a lot of crime in my neighbourhood. Kukho ubundlobongela obuninzi kwingingqi yam.

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

2. There is too much crime in my neighbourhood to go outside for walks or play during the day. Kukho ubundlobongela obuninzi kwingingqi yam ukuya phandle okanye ukuhamba okanye ukudlala ngexesha lase mini.

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. Kukho ulwaphulo mthethooluninzi kwi ngingqi yam ukuba ndiphumele ngaphandle uya hamba okanye ukuya kudlala ebusuku.

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

4. There are groups of people or gangs (rascals, hooligans, thugs) in my neighbourhood who make me feel threatened when I go out. Kukho iqela labantu okanye lemigewu (rscals, hooligans, thugs) kwi ngingqi yam ezindenza ndizive ndinoloyiko xa ndiphuma.

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

If you are a parent with a child 17 years old or below, please answer these questions:

1. 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. Ndinexhala ukuvumela umntwana wam adlale okanye abe ngaphandle yedwa okanye nabahlobo ngase ndlwini yam(umz eyadini, drive way,), ngoba ndinoloyiko lokuba athathwe okanye alinyazwe ngabantu abangaziwayo.

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

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 of them being taken or hurt by a stranger. Ndinexhala ukuvumela umntwana wam adlale okanye ahambe yedwa okanye nabahlobo kwingingqi yam nakwi zitalato zokuhlala ngoba ndiyoyika bathathwe okanye balinyazwe ngabantu abangaziwayo.

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

3. 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. Ndinexhala ukuvumela umntwana wam abeyedwa okanye nabahlobo kwi paki ekufutshane yase kuhlaleni ngoba ndinoloyiko lokuba athathwe okanye onzakaliswe ngumntu ongaziwayo.

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

disagree	disagree	agree	agree
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4. I am worried about letting my child play or walk in my neighbourhood and local streets because I am afraid of them being injured by a car. Ndinexhala ukuvumela umntwana wam ukudlala okanye ahambe kwi ngingqi yam nakwi zitalato zasekuhlaleni ngokuba ndoyikisela onzakaliswe zimoto.

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

If you are 17 years or younger, please answer these questions: Ukuba uneminyaka eyi17 okanye umncinci, nceda phendula le buzo :

1. I am worried about playing or being outside alone or with friends around my house (e.g. yard, driveway, apartment common area), because I am afraid of being taken or hurt by a stranger.ndixhalabile nge phandle okanye ngokuba phandle yedwa okanye nabahlobo around endlwini yam(umz.yard, driveway,apartment common area) , kuba ndisoyika uba athathwe okanye onzakaliswe

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

2. I am worried about playing or walking alone or with friends in my neighbourhood and local streets because I am afraid of being taken or hurt by a stranger. Ndinexhala ngoku dlala okanye ukuhamba yedwa okanye nabohlobo kwingingqi yam nakwi zitalalto zase kuhlaleni, ngokuba ndinoloyiko lokubiwa okanye ndonzakaliswe ngumntu ongaziwayo.

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

3. I am worried about being alone or with friends in a local or nearby park because I am afraid of being taken or hurt by a stranger Ndinexhala lokuba ndedwa okanye nezihlobo kwi park ekufutshane ndoyika ukuba ndibiwe okanye ndonzakaliswe ngumntu ongaziwayo.

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

4. I am worried about playing or walking in my neighbourhood and local streets because I am afraid of being injured by a car.Ndinexhala lokudlala okanye ukuhamba kwingingqi yam nakwizitalato zasekuhlaleningokuba ndinoloyiko loku limazwa zizithuthi.

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

I. Additional individual items (Single Items) Izinto ezongezelelweyo

*Please circle the answer that best applies to you and your neighbourhood. **Nceda biyela impendulo yakho echaza wena nengingqi yakho ngcono.***

1. I see and I can talk to people when I am walking in my neighbourhood. Ndiyabona kwaye ndingathetha nabantu xa ndihamba kwi ngingqi yam.

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. Kukho izinja ezingenabanikazi okanye izilwanyana eziyingozi ezindayikisayo kwingingqi yam.

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

THANK YOU AND WE APPRECIATE YOUR HELP IN COMPLETING THE LONG QUESTIONNAIRE Enkosi siyabulela ngokusinceda ekugcwaliseni oluxwebhu.