Examining Lifestyle Behaviours and Weight Status of Primary Schoolchildren: Using Mozambique to Explore the Data Gaps in Low- and Middle-Income Countries

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Abstract

The emergency of malnutrition, in all of its forms, and physical inactivity among children and adolescents as serious public health challenges, especially in resource-limited low- and middle-income countries is concerning and requires attention. Data on the prevalence of unhealthy weight status and levels of physical inactivity among children and adolescents in these low- and middle-income countries are limited, not systematically collected nor are they well documented. Accurate prevalence estimates, and an informed understanding of the relationships among movement behaviours and weight status of children and adolescents, are required to facilitate evidence-informed interventions and public health policies in these countries.

The main purposes of this dissertation were to examine relationships between lifestyle behaviours and weight status among primary schoolchildren in Mozambique; compare body mass indices and movement behaviours of Mozambican schoolchildren to those of children from other countries; and use these findings to highlight important data gaps that exist in low- and middle-income countries. First, the Active Healthy Kids Global Alliance's Report Card development methodology was used to conduct thorough narrative literature searches, identify data gaps and research needs which subsequently informed research questions and primary data collection. A published protocol that was developed for the multinational cross-sectional International Study of Childhood Obesity, Lifestyle and the Environment was adopted and used for primary data collection among urban and rural schoolchildren in Mozambique (n=683), to facilitate data comparability. Anthropometric (weight, height, percent body fat, bioelectric impedance, mid-upper-arm circumference, waist-circumference) and accelerometry (nocturnal sleep, sedentary time, various intensities of physical activity) data were objectively measured by

trained personnel. Data about lifestyle behaviours (diet and movement behaviours), demographics and environmental (home, neighbourhood, school) factors associated with child weight status were collected using context-adapted questionnaires. As part of this dissertation, six manuscripts were developed and submitted for publication in peer-reviewed scientific journals.

Overall, the narrative literature searches revealed a dearth of information about prevalences of unhealthy weight status, and key lifestyle behaviours among children and adolescents in low- and middle-income countries. Results from data collected in Mozambique showed overweight/obesity to be an emerging public health concern, especially among urban children (11.4%), while thinness still persists and is more prevalent among rural schoolchildren (6.3%). Moderate- to vigorous-intensity physical activity, active transport and mother's body mass index were found to be important modifiable correlates of weight status for Mozambican children. Distinct differences in the prevalences and correlates of lifestyle behaviours (sleep and physical activity) were observed between urban and rural children in Mozambique. The findings showed that mean moderate- to vigorous-intensity physical activity was lower (82.9±29.5 minutes/day) among urban compared to rural Mozambican children (96.7±31.8 minutes/day). Compared to children from 12 other countries, on average, children from Mozambique had lower body mass indices, higher daily moderate- to vigorous-intensity physical activity, lower daily sedentary time and comparable sleep duration. For example, rural Mozambican children had lower mean BMI z-scores (-0.5±0.9) than the rest of the sample (0.4±1.3), 46 more minutes of daily moderate- to vigorous-intensity physical activity, and 99 less minutes of daily sedentary time than the other children. Furthermore, linear distributions of study site-specific body mass index (positive),

minutes of daily moderate- to vigorous-intensity physical activity (negative), and daily sedentary time (positive) by country human development index were observed. Compared to others, children from the urban Mozambican site closely resembled those from Nairobi Kenya on body mass index and movement behaviours, whereas those from rural Mozambique were distinctly different from the rest of the sample on many indicators.

Findings from this dissertation highlight the importance of including participants from low, medium, high, and very high-income countries in multinational studies investigating contextual and environmental factors related to childhood weight status. The findings revealed important differences between urban and rural children supporting the need to include both in study samples and especially in low- and middle-income countries where the majority of people live in rural areas. Finally, findings from this dissertation have demonstrated that despite the reported global progress in the availability of data about obesity and related factors among children and adolescents, gaps still exist and need to be filled in low- and middle-income countries.

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Chapter 4.6

Table 1: Methods and instruments used to assess overall physical activity; abbreviations: GSHS = global school-based student health survey; N/A = not available.

List of abbreviations

%BF:	Percent Body Fat
AHKGA:	Active Healthy Kids Global Alliance
ANOVA:	Analysis of Variance
BCPE:	Box-Cox Power Exponential
BIA:	Bioelectrical Impedance Analysis
BMI:	Body Mass Index
CCHS:	Canadian Community Health Survey
CDC:	Centers for Disease Control and Prevention
CHEO:	Children's Hospital of Eastern Ontario
CHMS:	Canadian Health Measures Survey
CI:	Confidence Interval
CIHR:	Canadian Institutes of Health Research
CSEP:	Canadian Society for Exercise Physiology
DDFM=KR:	Denominator degrees of freedom = Kenwardroger
DXA:	Dual-energy X-Ray Absorptiometry
EFT:	Ecological Systems Theory
FFQ:	Food Frequency Questionnaire
GHO:	Global Health Observatory
GPS:	Global Positioning System
GSHS:	Global School-based Student Health Survey
HALO:	Healthy Active Living and Obesity
HANES:	Health and Nutrition Examination Survey

HBSC:	Health Behaviour in School-aged Children
HDI:	Human Development Index
HELENA-CSS:	Healthy Lifestyle in Europe by Nutrition in Adolescence Cross-Sectional Study (HELENA-CSS)
HES:	Health Examination Survey
HICs:	High-Income Countries
ICC:	Intraclass Correlation Coefficient
IDRC:	International Development Research Centre
I-FFQ:	ISCOLE Food Frequency Questionnaire
IOTF:	International Obesity Task Force
ISCOLE:	International Study of Childhood Obesity, Lifestyle and the Environment
kcal:	Kilocalories
LICs:	Low-Income Countries
LMICs:	Low-and Middle-Income Countries
LMS:	Lambda-mu-sigma
MAR:	Missing at random
MCAR:	Missing completely at random
METs:	Metabolic equivalents
MICE:	Multiple Imputation by Chained Equations
MNAR:	Missing Not at Random
MUAC:	Mid-Upper-Arm Circumference
MVPA:	Moderate- to Vigorous-Intensity Physical Activity

NCDs:	Non-communicable Diseases
NSF:	National Sleep Foundation
PA:	Physical Activity
OR:	Odds Ratios
PBRC:	Pennington Biomedical Research Center
RCWG	Report Card Working Group
SB:	Sedentary Behaviour
SBRN:	Sedentary Behaviour Research Network
SD:	Standard Deviation
SDGs:	Sustainable Development Goals
SES:	Socioeconomic Status
SSHS:	School Sleep Habits Survey
ST:	Screen Time
TV:	Television
UN:	United Nations
UNICEF:	United Nations Children's Fund
VIF:	Variation inflation factors
WC:	Waist Circumference
WHO:	World Health Organization
YRBS:	Youth Risk Behavior Survey
YSS:	Youth Smoking Survey

Preface

This thesis dissertation evolved from my passion and interest in contributing, albeit in small ways, to the collection of high-quality research data in my native Zimbabwe specifically, and Africa in general. First, having been gone from Zimbabwe so long, I needed to acquaint myself with the research needs of Zimbabwe with regard to the prevalences of weight status and associated lifestyle behaviours of children and youth. After reviewing several key literature sources and substantive conversations with my supervisor in the Fall of 2015, my work began with identifying key stakeholders in Zimbabwe and forming a working group that has since developed two Report Cards on the physical activity of children and youth in Zimbabwe under my leadership. This phase helped to identify data gaps and the research needs in the area of my interest. As I prepared for primary data collection, the political environment in Zimbabwe deteriorated, making it impractical and unsafe to proceed in a timely fashion. Recognizing the need to move data collection elsewhere, and understanding the similarities in culture, contexts and research needs between Zimbabwe and Mozambique, in 2016, my supervisor and I, approached a research group in Mozambique led by Dr. Antonio Prista who enthusiastically accepted to host data collection for my dissertation project. Once the logistics of where and when data collection would occur were in place, I applied for, and received a doctoral research award to support data collection needs through the International Development Research Centre. I also received matching funds from my supervisor's research resources. Dr. Peter Katzmarzyk, Dr. Mark Tremblay (my supervisor) and I set out for Maputo, Mozambique (May 2017) to train research assistants. I also received a three-year CIHR doctoral fellowship (salary support) for allied health workers (May 2017) which allowed me to remain in Mozambique where I led, coordinated and participated in all aspects of data collection, and data entry. In completing this

dissertation, I have had assistance from many collaborators and researchers whose support is appropriately acknowledged in this document

Chapter 1: Introduction

Industrialization, accelerated economic growth, and rapid social change in many low- and middle-income countries (LMICs) has led to a 'dual burden of disease as populations in these countries face concurrent threats from traditional (e.g., undernutrition, unsafe water, poor sanitation) and modern (e.g., physical inactivity, overweight and obesity) health risks.[1,2] The World Health Organization (WHO)'s[2] current estimates rank underweight as the leading risk factor for death among young children in low-income countries (LICs). Globally, physical inactivity[3] (6%) and overweight and obesity (5%) rank as the fourth and fifth leading risk factors for death.[2] The emergency of malnutrition, in all of its forms[4], and physical inactivity [3,5] among children and youth as serious public health challenges, especially in resource-limited LMICs, is concerning. Despite recent evidence of global progress[6], data on the prevalences of unhealthy weight status (underweight, overweight, obesity) and levels of physical inactivity among children and youth in LMICs are limited and not systematically collected nor well documented.[6,7] However, accurate prevalence estimates, consistent surveillance systems and a better understanding of the intricate relationships among physical activity (PA) behaviours and weight status, are required to facilitate evidence-informed interventions and public health policies. Evidence from mostly high-income countries (HICs) show that PA can be negatively affected by childhood obesity, and that PA behaviours across the life-course can be heavily influenced by childhood experience.[8,9] Thus, the overall aim of this dissertation was to identify and address data gaps related to prevalences of, and the relationships among lifestyle behaviours and weight status among Mozambican primary schoolchildren.

Dissertation overview and rationale

The main purposes of this dissertation were to: a) examine relationships between lifestyle behaviours and weight status among primary schoolchildren in Mozambique; b) compare body mass indices and movement behaviors of Mozambican schoolchildren to those of children from 12 other countries; and c) highlight important data gaps in LMICs. The ongoing lifestyle (PA, nutritional)[1,4,10] and overweight/obesity[11] transitions occurring in LMICs, is an inevitable, unintended consequence of economic development. In sub-Saharan Africa, data are limited and are of less robust quality to accurately describe prevalences and relationships among weight status and key lifestyle behaviours for children and youth. With the important roles that PA,[12] diet,[13] sleep,[14] and sedentary behaviours (SB)[15,16] play in the prevention and management of non-communicable diseases (NCDs) it is imperative to study and understand any potential relationships. Moreover, the recent International Study of Childhood Obesity, Lifestyle and the Environment (ISCOLE) showed that results from Kenya (the only LIC in the study) were very different from those of the other countries on many indicators, raising questions as to whether it was just an outlier or if results from this country were indicative of its lower Human Development Index (HDI) status. Furthermore, the ISCOLE sample was drawn from urban and peri-urban areas without rural representation, which is an important limitation especially in LMICs, where the majority of the population lives in rural areas. Mozambique, a similarly low income country, with very limited data,[17,18] and undergoing rapid urbanization due to significant rural to urban migration,[19] offered a great opportunity to provide additional and comparable data, while overcoming important data gaps within the country.

Objectives

The specific objectives of this dissertation were to:

1. Conduct thorough narrative searches of relevant literature on childhood weight status and lifestyle behaviours, consult and enlist key stakeholders, and identify data gaps in Zimbabwe and Mozambique;
2. Describe the prevalence, and identify important lifestyle and environmental correlates of objectively measured weight status among urban and rural Mozambican schoolchildren;
3. Compare and contrast the prevalence and correlates of adherence to movement guidelines among urban and rural schoolchildren in Mozambique;
4. Describe differences or similarities in body mass index and movement behaviours among schoolchildren from 13 countries across a continuum of HDIs;
5. Summarize Report Card indicators of PA among children and youth and explore data gaps from nine LMICs.

Research questions

The objectives listed above were designed to answer the following research questions:

1. What is the weight status of children and youth, and how much data about their weight status and lifestyle behaviours are available in Zimbabwe and Mozambique?
2. What are the levels and correlates of weight status and lifestyle behaviours in a sample of urban and rural Mozambican primary schoolchildren?
3. Are there similarities or differences in the proportion of schoolchildren meeting the recommended 24-hour movement guidelines between urban and rural schoolchildren in Mozambique?

4. What are the differences or similarities in body mass index and movement behaviours for schoolchildren from 13 countries across a continuum of HDIs?
5. What are the data gaps and are they similar across nine LMICs?

Hypotheses

The main hypothesis of this study was that unhealthy behaviours (e.g., physical inactivity, excessive recreational screen time, shorter sleep duration, unhealthy diet) and related environmental factors (e.g., number of family cars, socioeconomic status (SES), opportunities for PA at school, school food policies) would be related to undesirable child weight status (undernutrition or overweight/obesity) among Mozambican schoolchildren. An additional hypothesis was that the relationships of lifestyle and environmental factors with weight status would differ per area of residence (e.g., urban, rural), and SES. Lastly, it was anticipated that results from Mozambique would closely resemble those from Kenya while differing from those of high and very-HICs in ISCOLE.[20]

Dissertation organization

This dissertation is organized following the criteria prescribed by the University of Ottawa. **Chapter 1** provides the context, overview and rationale for the dissertation. **Chapter 2** presents a brief but detailed review of the relevant literature. **Chapter 3** summarizes the overall methodology used to answer the specific research questions posed for the dissertation project. **Chapter 4** presents the results of the dissertation project, and is organized in manuscript format. Because the conception and development of this dissertation occurred in two distinct but related phases, the manuscripts are arranged in a sequence that demonstrates that reality, and shows the

necessary changes that were made prospectively as the dissertation project progressed. The **first phase** of the dissertation involved a thorough search for all available data, contacting key stakeholders/experts, and identifying data gaps about key lifestyle behaviours and weight status of Zimbabwean children and youth.

The thorough search for data, which led to the development of two Report Cards (2016, 2018),[21,22] necessitated the identification and involvement of key stakeholders and researchers who were familiar with the state of literature in Zimbabwe. The *first* and *second* manuscripts included in this dissertation as **Chapters 4.1 and 4.2** respectively, "Results from Zimbabwe's 2016 Report Card on Physical Activity for Children and Youth" and "Results from Zimbabwe's 2018 Report Card on Physical Activity for Children and Youth" derive from results of the literature searches and are narrative syntheses describing key indicators of PA among children and youth in Zimbabwe. These two manuscripts helped to identify important data gaps, and highlighted areas for further research. Once data gaps and research needs were identified, preparation for the second (data collection) phase of the dissertation commenced. It was during this period that it became apparent that the project would not be feasible in Zimbabwe given the unexpected rapid deterioration in political stability and the uncertainty about the potential to successfully collect good-quality data in a timely and safe fashion. Following extensive consultations, contingency planning, including reviewing literature from countries within the region that have similar contexts and cultures to Zimbabwe, feasibility reassessments necessitated changing the data collection site to a different country. Similar data gaps and research needs were identified in neighbouring Mozambique, and thus the dissertation project refocused on Mozambique.

The **second phase** of the dissertation research project involved primary data collection in Maputo (urban), and Macia district (rural) in Mozambique. Training and certification of research assistants was conducted prior to commencing data collection. To enable international comparisons, data were collected following the published ISCOLE protocol.[20] The *third* manuscript, included in this dissertation as **Chapter 4.3** "Prevalence and correlates of objectively measured weight status among urban and rural Mozambican schoolchildren: a cross-sectional study", presents prevalence estimates and correlates of objectively measured thinness and overweight/obesity for children and youth in Mozambique. Manuscript *four*, included as **Chapter 4.4** "Prevalence and correlates of adherence to movement guidelines among urban and rural children in Mozambique: a cross-sectional study", compared prevalences and correlates of adherence to movement guidelines between urban and rural schoolchildren in Mozambique.

Manuscript *five* "Body mass index and movement behaviors among schoolchildren from 13 countries across a continuum of human development indices: a multinational cross-sectional study", describes the distribution of body mass index, weight status and movement behaviours (sleep duration, sedentary time, moderate-vigorous physical activity) for the Mozambican and participants from the other twelve ISCOLE countries, and is presented as **Chapter 4.5**. Manuscript *six* "Indicators of physical activity among children and youth in nine countries with low and medium human development indices: A Global Matrix 3.0 paper", included as **Chapter 4.6**, completes the series of articles in this dissertation and summarizes the results of Report Cards of PA of children and youth from nine LMICs. **Chapter 5** concludes the dissertation and provides a global summary of the results from each manuscript, presents strengths and limitations of the dissertation, and provides recommendations for future research.

Conceptual framework

To untangle the potential influence of the various modifiable factors contributing to unhealthy childhood weight status, such as children's dietary and activity patterns, parenting practices, and their environments, this dissertation was guided by the modified socioecological model of childhood overweight and obesity.[23] Davison and Birch[23] used the Ecological Systems Theory (EST)[23,24] as a framework for developing the modified socioecological model of predictors of childhood overweight. The EST conceptualizes human development from an interactive contextual perspective and highlights the importance of considering the context(s), or ecological niche, in which a person is located in order to understand the emergence of a particular characteristic.[23] Thus, the socioecological model acknowledges the complex inter-relationships between individuals and their environments. The modified socio-ecological model of childhood obesity[23] (**Figure 1**), graphically depicts the ecological theory of a specific health behaviour or outcome such as unhealthy weight status and illustrates how the health and well-being of an individual is influenced by many factors that interact at both the macro-level and micro-level environment.[25] The selection and application of a socioecological model for this dissertation was informed by the suitability of its domains for addressing key questions posed in this study. The socioecological model was especially suitable for this dissertation because it overcomes some of the limitations of individual-level models which tend to overlook immediate or proximal social contexts.[26]

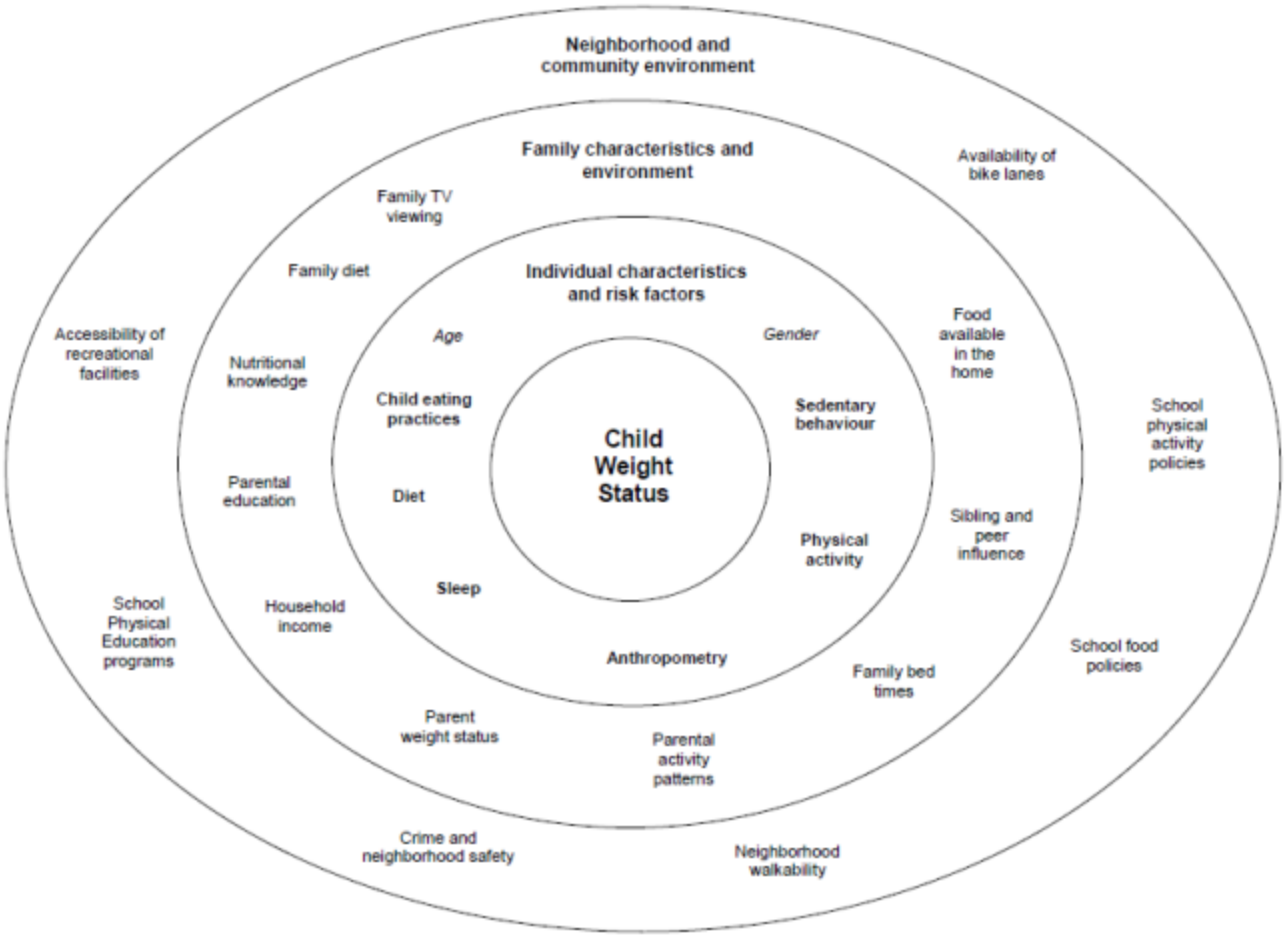

Figure 1: Modified ecological model of predictors of childhood weight status: Adapted from Davison & Birch. (2001). Obesity Reviews; 2: 159-171. Reproduced with permission.

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Chapter 2: Review of literature

Public health surveillance

Public health surveillance is defined as the consistent, regular collection, evaluation, and interpretation of outcome-specific data used for planning, and implementation of public health practices.[1] Such surveillance (e.g., WHO STEPwise framework) can "serve as an early warning system for impending public health emergencies; document the impact of an intervention, or track progress towards specified goals; and monitor and clarify the epidemiology of health problems, to allow priorities to be set and to inform public health policy and strategies".[1] A brief description of the global surveillance mechanisms and measurement for each of weight status, PA, SB, sleep and dietary patterns, is discussed separately for these variables. Examples of well-established international surveillance systems for PA, SB, diet and more recently sleep, among children and youth include the Global School-based Student Health Survey (GSHS)[2] conducted mostly in LMICs, and the Health Behaviour in School-aged Children (HBSC)[3] survey administered in 48 European and North American countries.

Weight status

Throughout this dissertation, a child's weight category (thinness, normal weight, overweight, obesity) referred to as *weight status* hereafter, will be defined using the WHO's Body Mass Index (BMI)-for-age (5-19 years) classifications.[4,5] For children and adolescents, classifications of weight status using BMI is complicated,[6] and must be made using sex-and age-adjusted z-scores to account for normal growth.[7] A BMI z-score is the BMI of a child transformed into a scale comprising the number of standard deviation (SD) units it is away from the mean of the referent population of the same sex and age.[7] There is no single, universal reference or standard

to assess weight status for children and adolescents. In the absence of locally constructed references, one of three international references is typically used: the International Obesity Task Force (IOTF) 2012 reference,[8] the Centers for Disease Control and Prevention (CDC) 2000 reference,[9] or the WHO 2007 reference for children aged 5-19 years.[5]

The IOTF cut-offs[8] are based on nationally representative data from six countries (the UK, USA, Netherlands, Brazil, Singapore, Hong Kong) for children and youth ages 2 to 18 years. These data were collected between 1963 and 1993. The age- and sex-specific BMI distribution were summarized using the Lambda-Mu-Sigma (LMS)[10] method, and they link BMI values at the age of 18 years to child centiles, which were averaged across the six countries.[8] The United States uses CDC BMI-for-age charts[9] which were developed using cross-sectional data from five national health surveys for children and adolescents aged 2 to 20 years. A series of these cross-sectional surveys were conducted at various time-periods between 1963 and 1994. Smoothed curves for major percentiles were generated using parametric and non-parametric regression procedures prior to being approximated at the transformation stage, using a modified LMS estimation procedure.[9] The WHO BMI-for-age growth references for 5-19-year-old children[5] were developed from 3 merged datasets (Health Examination Survey (HES) Cycle II (6–11 years) and Cycle III (12–17 years) and Health and Nutrition Examination Survey (HANES) Cycle I (birth to 74 years)). The Box-Cox Power Exponential (BCPE)[11] method with curve smoothing was used to construct the curves.[5]

The WHO classifications define thinness as having a BMI z-score that is (<-2 SD), overweight (> + 1 SD) and obesity (> +2 SD) from the median of the reference sample for 5-19-year

children.[4,5] The three categories (thinness, overweight, obesity) which classify being below or above what is considered to be normal weight, will be referred to in this dissertation as *unhealthy weight status*. The choice to apply WHO cut-offs[4,5] for 5-19-year old children and adolescents was made because similar cut-offs were used for the ISCOLE[12] and have also been previously used in studies with similar samples elsewhere.[13] Evidence shows that unhealthy weight status in childhood or adolescence is associated with adverse health outcomes throughout the life-course.[13]

Overweight and/or obesity

Prevalence estimates from the WHO show that childhood and adolescent obesity is increasing globally.[14] Some,[15–17] but not all,[18] studies in HICs report a recent plateau in childhood obesity prevalence, suggesting levelling off in increases that had been documented over the past four decades.[19] Although plateaued in HICs albeit at high levels,[13] the obesity prevalence among children and youth in lower SES groups still remains high.[17] Moreover, in LMICs, childhood obesity is reportedly increasing[20] and at a more rapid pace than it did in HICs.[19,21] In 2010, self-reported survey data obtained from 144 countries showed that 35 million children in LMICs were either overweight or obese.[22] In 2014, globally, an estimated 41 million children under the age of 5 years were classified as being overweight or obese, of which 48% and 25% were living in Asia and Africa respectively.[23] A recent study estimated that "in just 40 years the number of school-age children and adolescents with obesity has risen more than 10-fold, from 11 million to 124 million".[13]

Meanwhile, the WHO's Commission on Ending Childhood Obesity reported that in Africa alone, the number of overweight or obese children had almost doubled from approximately 5.4 million in 1990 to 10.3 million in 2014.[14] In 2016, it was estimated that 43 million (33%) children aged 5-19 years in Africa, were living with either overweight or obesity.[24] Collectively, these statistics suggest that in absolute numbers, today, there are more obese children living in LMICs than in HICs.[14,20,21] Specific to Mozambique, a study by dos Santos and colleagues[25] in 2014 examined secular trends in growth and nutritional status for 8-15 year old children and adolescents and found significant positive linear trends in overweight/obesity (1.6% to 11.0%) among boys, and (6.9% to 20.3%) among girls from 1992 to 2012. In 2015, the reported combined overweight and obesity prevalences in the same sample were 7.5% for boys and 21.0% for girls.[26]

Many LMICs, especially those in sub-Saharan Africa, are still in the 'age of pestilence and famine' of the epidemiological transition[27] due to significantly high levels of infectious diseases, lower respiratory tract infections, malaria, diarrheal diseases, and tuberculosis.[28] Thus, adding the negative effects of NCDs to the infectious, enteral, and other parasitic diseases[28] is likely to put an unbearable burden onto the meagre resources of already stressed economies. Research shows that obesity (itself classified as a disease)[29,30] tracks closely from childhood to adulthood[31–35] and is associated with an increased risk of several other chronic diseases including coronary artery disease, stroke, and type II diabetes mellitus.[23] Childhood obesity has also been linked to premature death,[36] decreased productivity in adulthood,[37] permanent negative imprints on adult health,[35] and adds to the economic burden of countries due to related direct and indirect health care costs.[37,38] In light of the foregoing, the WHO has declared childhood obesity "one of the most serious public health challenges of the 21st century".[39]

Thinness

In epidemiologic research, underweight, defined as weight-for-age <-2 SD below the median for children aged 5 years or younger,[5] and thinness (BMI-for-age <-2 SD below the median) for children and youth aged 5-19 years old[5,40] can be erroneously interchanged. Because data for this dissertation were collected on 9-11 year-old children, most of the description of undernutrition will appropriately use and focus on thinness as opposed to underweight. Although it has been declining for decades, the prevalence of undernutrition (underweight, wasting, stunting, thinness), is still high in LMICs.[41] In 2017, approximately 150.8 million children under the age of five were reported to be stunted and 38% of them lived in Africa.[42] In fact, the United Nations Children's Education Fund (UNICEF) estimated that in Africa, the prevalence of stunting for children under the age of five had actually increased by 17% from 50.4 million in 2000 to 59 million in 2017.[42] Globally, it is reported that there are more thin children and youth than there are those who are overweight or obese, and that the burden seems to be increasingly concentrated in south Asia and central, east and west Africa.[13] In 2016, the global prevalence of thinness among 5-19-year-old children and youth was 10.5%.[40] Thinness was highest in south-east Asia (22.5%), and lowest in the Americas (1.6%), while it was 7.8% in Africa.[40] Self-reported data from 40 LMICs[43] showed a 7.6% prevalence of thinness among 12-18 year-old adolescent girls. The 2016 data from the Global Health Observatory (GHO) indicated that the prevalence of thinness among 5-19 year-old Mozambican children and youth was below the global average at 3.5%.[40]

These statistics demonstrate that although global estimates seem to consistently show a steady decline,[13,40] thinness still persists among children and youth in LMICs. Thus, attempts to assess,

understand, and manage childhood obesity in these settings need to concurrently occur with similar efforts to address thinness. To this end, the second goal of the United Nations' (UN) Sustainable Development Goals (SDGs) to "end hunger, achieve food security and improve nutrition and promote sustainable agriculture"[44] recognizes the importance of addressing undernutrition because it is known to impede physical growth, and is a significant contributor to infant and child mortality.[45]

Undernutrition is also linked to poor adult health, is associated with poor cognitive and motor development, has negative consequences for work productivity, and ultimately perpetuates poverty.[45,46] In addition, and more specifically, thinness among children and adolescents is associated with higher risk of infectious diseases, adverse pregnancy outcomes including maternal mortality, delivery complications, preterm birth, and intrauterine growth retardation for girls of childbearing age.[13,45] Accordingly, context-specific, culturally-sensitive monitoring and surveillance of weight status (thinness, normal weight, overweight, obesity) and related behaviours are imperative.

Lifestyle behaviours

Defining physical activity

Defined as "any bodily movement produced by skeletal muscles that results in energy expenditure",[47] PA is a behaviour that is complex[48] and can be influenced by many interdependent factors.[49] For children and youth, PA can be structured (e.g., leisure sport, physical education classes, regular exercise routine)[50] or unstructured (e.g., active outdoor or indoor play).[51] Regular PA among children and youth is associated with physical, psychosocial

and cognitive wellbeing, decreased adiposity,[52,53] improved academic achievement,[54] and brain health and development.[55]

Measurement and surveillance of physical activity for children and youth

PA can either be objectively (directly) measured or subjectively (self or proxy) reported. Objective measures of PA include but are not limited to those based on oxygen uptake,[56,57] heart rate monitoring, and motion sensors such as accelerometers or pedometers.[57,58] Subjectively, PA can either be quantitatively or qualitatively measured through interviews, questionnaires or surveys, and diaries.[59] PA of a specified past period (e.g., the previous week) is either self-reported by the child, or reported by a proxy (e.g., parent, guardian).[60] Often, the goal in measuring PA is to estimate energy expenditure attributable to participation in specific intensities of PA (e.g., light, moderate, vigorous). Although objective methods provide more valid estimates of PA, they can be costly,[59] require a certain level of expertise, and are more intrusive and time consuming.[57] On the other hand, although known to be less valid, and tend to overestimate vigorous PA levels,[59] subjective measures can be practical, enabling the collection of large amounts of data at low costs and provide detailed characterizations of the activity.[57] Good PA surveillance systems must balance the trade-off between the validity and feasibility of measures, and in many cases need to have some combination of both objective and subjective measures.[57] Because of limited resources, the majority of surveillance data on levels of PA among children and youth that are available in most LMICs are obtained through subjective methods.

Physical activity guidelines for children and youth

For improving cardiorespiratory and muscular fitness, bone health, cardiovascular and metabolic health biomarkers and to reduce symptoms of anxiety and depression, the WHO[61] recommends that 5-17 year-old children and youth should accumulate at least 60 minutes of daily moderate- to vigorous-intensity physical activity (MVPA) that should consist of mostly aerobic PA, including vigorous-intensity activities and activities that strengthen muscle and bone at least three times per week.[61] The WHO further recommends that amounts of PA that are greater than 60 minutes per day provide additional health benefits.[61]

Prevalence of physical inactivity among children and youth

According to a study by Kohl et al,[62] physical inactivity, defined as "an insufficient physical activity level to meet present physical activity recommendations",[63] among children and youth has reached pandemic levels worldwide. In 2010, self-reported data from the WHO GHO[64] showed that 81% of adolescents between the ages of 11-17 years, did not meet the recommended daily minimum of 60 minutes of MVPA. Adolescent girls (84%) were less active than boys (78%).[64] Self-reported data collected from 10 European countries between 2009 and 2012 showed that only 17.9% of boys and 10.7% of the girls were meeting the WHO guidelines of daily MVPA.[65] Furthermore, in 2018, the overall grade for overall PA in a synthesis of data from 49 countries including 9 LMICs, conducted as part of the global matrix of PA among children and youth aged 5-17 years, was a 'D',[66] which translates to an estimated 27-33% meeting the WHO recommended guidelines. The most recent synthesis of PA surveillance data from Mozambique[67] conducted in 2016 showed that children and youth aged 5-17 years had a grade of 'C' for the overall PA indicator, which translates to an estimated 47- 53% meeting the

recommended guidelines. Overall, there is clear evidence of insufficient levels of PA among children and youth which varies by sex and geographical location.

Defining sedentary behaviour

The Sedentary Behavior Research Network (SBRN) defines SB as "any waking behaviour characterized by an energy expenditure ≤1.5 metabolic equivalents (METs), while in a sitting, reclining or lying posture".[63] Total sedentary time can be further broken down into specific SBs such as reading, playing quietly, watching television (TV), using the computer, social SB, or playing video games.[68] Some sedentary pursuits are inevitable necessities (e.g. classroom sitting), while others such as recreational screen time (total amount of time spent watching television, playing video games, or using the computer or other screen-equipped device for any recreational purpose during leisure time)[69] can and should be minimized.[51] There is a plethora of evidence showing deleterious effects of too much recreational screen time (ST) among children and youth and linking it to negative outcomes.[70] For example, higher duration of TV viewing was found to be associated with unfavourable body composition and higher clustered cardiometabolic risk scores; increased video gaming was associated with poor social conduct; and higher durations of reading and doing homework were associated with higher academic achievement.[71] Furthermore, systematic review evidence showed that increased ST was associated with more hyperactivity/inattention problems and internalizing problems.[72]

Measurement and surveillance of sedentary behaviours among children and youth

Similar to PA, SB can either be objectively (directly) measured or subjectively (self or proxy) reported.[71,73] Objective measures of SB include wearable monitors (e.g., accelerometers,

inclinometers) which are the most commonly used,[74] wearable cameras, OpenBeacons, global positioning systems (GPS),[75] or direct observation including video.[76,77] Subjectively, SB can be measured by self or proxy report and diaries.[71,73,78] The limitations of accelerometers (inability to distinguish between sitting and stationary standing), inclinometers (inability to provide information on the modality of sedentary behaviour),[79] self- and proxy-report (error, recall bias),[78] leads most researchers to concurrently use both objective and subjective measures.[78] To acknowledge the compositional nature [80,81]and the codependency of movement behaviours which occur on a continuum,[82] within the finite 24-hour period,[51,81], recent surveillance efforts have concurrently monitored movement behaviours.

Sedentary behaviour guidelines for children and youth

Currently, there are no quantitative guidelines for total SB; however, some countries have developed and adopted guidelines for daily recreational ST as one dimension of SB. In those jurisdictions and countries, no more than 2 hours per day of recreational ST is recommended for apparently healthy children and youth aged 5-17 years, including limiting sitting for extended periods.[51]

Prevalence of sedentary behaviours among children and youth

Estimates from the 2007-2009 Canadian Health Measures Survey (CHMS) showed that 6-19 year-old Canadian children and youth spend 8.6 hours (62%) of their waking hours in sedentary pursuits.[83] Results from the 2014 Canadian HBSC survey showed that "only 1 in 10 adolescents adhered to sedentary behaviour guidelines of less than 2 hours per day of screen time for recreational purposes".[84] Objective (accelerometry) findings from a systematic review published

in 2011[85] showed that 2-18 year-old children and youth engaged in 3-8 hours of SB per day. In addition, a 2014 study[78] reported that North American children and youth spend between 40% and 60% of their waking hours engaging in SB. Findings from a systematic synthesis of data from 49 countries[66] showed that the average grade for SB was a 'D+' which translates to 34-39% of 5-17 year-old children and youth from these countries meeting the recommended ≤2 hours of SB per day. Results from the Mozambique 2016 Report Card on physical activity of children and adolescents showed that less than 20% (grade 'F') of the 5-17 year-old children and youth met the recommended SB guidelines.[67]

Defining sleep health

Healthy sleep has been described as combinations of adequate sleep duration, good sleep quality, regular sleep timing, sustained alertness during waking hours and the absence of sleep disorders.[86] Each dimension of sleep (e.g., duration, quality, timing, consistency) is associated with various but not uniform health outcomes.[86] Inadequate sleep patterns (e.g., short sleep duration, poor sleep quality, late bedtimes)[87] have been linked to day-time tiredness and have been shown to be negatively associated with health indicators such as body composition, emotional regulation, growth, cognition, academic achievement, and quality of life.[88] Modernity (e.g., artificial lighting, late-night ST, caffeine use, absent bedtime rules)[89] is implicated in the secular decline in sleep duration for children and youth that has been observed over the past few decades.[90]

Measurement and surveillance of sleep among children and youth

Sleep can be measured objectively (e.g., polysomnography, actigraphy) or subjectively through self- or proxy-report (questionnaires, sleep logs).[88,91] Components of sleep health such as duration, timing, and efficiency can be objectively measured while other aspects of sleep quality are more suitably measured by self- or proxy report. To date, sleep diaries and questionnaires have been the measures of choice due to the impracticality and expense of population level surveillance of sleep using objective methods such as accelerometry.[91] Unlike PA and SB, surveillance of sleep health among children and youth has only been done infrequently. Developed in 1994, the School Sleep Habits Survey (SSHS)[92,93] is believed to be the most widely used surveillance measure for sleep among children and youth.[91] The HBSC survey in Canada first included sleep health questions for adolescents on the 2014 survey.[84]The CDC compiles sleep duration data from the Youth Risk Behavior Survey (YRBS) for American middle and high school students.[94] These surveillance measures have been most widely used in North America and Europe.

Sleep duration guidelines for children and youth

The National Sleep Foundation[95] (NSF) recommends that 6-13 year-old children should get 9 to 11 hours of sleep per night. For 14-17 year-old youth, it is recommended that they should sleep between 8 and 10 hours per night. The Canadian 24-Hour Movement Guidelines[51] generally conform to the NSF sleep duration guidelines[95] but include 5 year-olds (because primary school starts at 5 years old in Canada) to the younger age group and adds the caveats "uninterrupted sleep", "with consistent bed and wake up times" to the guidelines.

Prevalence of sleep duration among children and youth

A secular trend of rapid and consistent declines in children's sleep duration over time has been reported.[90,96] A systematic review of data dating from 1905 to 2008 from 20 countries reporting on 690,747 children and youth aged 5-18 years old found an overall decline in sleep duration of 0.76 minutes per year over a century.[96] Meanwhile, a representative sample of American youth aged 12-19 years were 30% less likely to report sleeping for 7 or more hours per night in 2012 compared to 1991.[90] A study by Twenge et al[97] found that in 2015, compared to 2009, adolescents in the US "were 16-17% more likely to report sleeping less than 7 hours a night on most nights, with an increase in short sleep duration after 2011- 2013". Self-reported sleep duration from the 2015 YRBS showed that 57.8% of middle school students and 72.7% of high school students did not meet the recommended nightly sleep hours.[98] Furthermore, in a study relying on a nationally representative sample of 10-17 year-old Canadian school-children, published in 2016, Chaput and Janssen[99] found that 31% of 10-13 year-olds and 26% of 14-17 year-olds did not meet the recommended amount of sleep per night. According to results from the 2014 HBSC survey, 64-78% of Canadian boys and 65-82% of girls aged 11-17 years met the recommended nightly sleep duration guidelines.[84] Results of a multinational study with sites in 12 countries showed that 41.6% of 9-11 year old children met the sleep duration recommendations.[100] Australia (75.8%) and Portugal (18.1%) had the highest and lowest adherence rates respectively.[100] Together, the results of these studies suggests that today's children and youth are getting fewer hours of sleep per night, thus are at an increased risk of the inadequate sleep-related consequences.

Defining dietary patterns

Dietary patterns can be defined generally as "the overall diet; the foods, food groups, and nutrients included; their combination and variety; and the frequency and quantity with which they are habitually consumed".[101,102] Diet is a significant determinant of child health and overall NCD risk.[103–105] Current research suggests that the consumption of diets rich in fruits, vegetables, whole grains, dairy, seafood, legumes, and nuts; moderate in alcohol; lower in red and processed meats; and low in sugar-sweetened foods and drinks[106,107] is beneficial for health. The association between poor diets and various chronic diseases is hotly debated[108,109] and controversial,[110] despite evidence showing that even modest positive dietary changes can improve child undernutrition[45,111] and lead to meaningful reductions in NCD and all-cause mortality risk.[112,113] Moreover, there is some evidence demonstrating that poor diets can have negative health impacts.[114] For example, high fat intake is linked to risk for high blood lipids, whereas high sodium intake is associated with a risk for high blood pressure,[104,115] and high consumption of added sugars has been implicated in cardiovascular disease[106] and diabetes risk.[116] Globalization, the ongoing nutrition transition, and the accompanying shifts from traditional to westernized diets, are now universally exposing children and youth, including those living in LMICs, to highly processed, energy dense, and obesogenic diets.[117,118]

Measurement and surveillance of dietary patterns among children and youth

Dietary intake or food consumption can be objectively measured through direct observation (duplicate diet approach, food consumption record),[119] use of dietary biomarkers,[120] or by subjective measures (diet/food record, 24-hour recall, food frequency questionnaire (FFQ)).[120] To overcome inherent errors in subjective measures, researchers "often integrate sub-studies for

the validation and calibration of the questionnaires and/or administer a combination of different assessment methods (e.g. administration of different questionnaires and assessment of biomarker levels)".[120] In addition and more broadly, data-driven (identifying eating patterns that do not reflect guidelines or knowledge about optimal eating patterns)[121] or theory-driven (dietary index score based on theoretical assumptions),[102] methods can be used to identify dietary patterns. Although ideally, dietary data surveillance should be harmonized, systematically collected at the individual level, and be representative, this is rarely the case due to limited expertise and resources, and other country-specific challenges.[122] Because of these limitations, global surveillance frequently relies on crude national estimates of food balance sheets or expenditure data (e.g., household consumption and expenditure surveys) which limits comparability of dietary habits and thus, negatively impacts overall quality and reliability of these data.[122]

Prevalence of poor dietary patterns among children and youth

The 2010 study on the Global Burden of Disease attributed 4.9 million and 1.8 million deaths worldwide to diets that were low in fruits and vegetables, respectively.[104] In Canada, data obtained from the 2012-2013 Youth Smoking Survey (YSS) showed that only 10% of 11-17 year-old adolescents were meeting the recommended amount of daily fruit and vegetable consumption.[123] Meanwhile, data from the annual Canadian Community Health Survey (CCHS) showed a significant decline in daily fruit and vegetable consumption from 5.3 to 5.2 servings per day ($p < .0001$) among 12-18 year old children and youth in 2007 and 2014, respectively.[124] Furthermore, self-reported data from the 2002 HBSC survey, showed that 67% and 70.5% of 11, 13, and 15-year-old Danish adolescents consumed lower than recommended fruit and vegetables, respectively. Results from the Healthy Lifestyle in Europe by Nutrition in Adolescence Cross-

Sectional Study (HELENA-CSS) showed that only 30% of boys and 35% of girls aged 12.5-15 years met the recommended amounts of fruit and vegetable consumption.[125] In the same study, Diethelm et al[125] concluded that in general, adolescents were consuming unhealthier diets because they ate "less than half of the recommended amount of fruit and vegetables and less than two-thirds of the recommended amount of milk (and milk products), but consume much more meat (and meat products) and oils, fats and sweets than recommended".

Dietary guidelines for children and youth

In 2012, the WHO published guidelines for recommended amounts of daily salt intake for adults (a reduction to <2 g/day sodium (5 g/day salt) in adults) and children (adjusted downward from that recommended for adults based on the energy requirements of children relative to those of adults).[126] Current WHO guidelines recommend that free sugars should not constitute 10% of total energy intake, and a further reduction to below 5% of daily intake is believed to provide additional benefits.[127] Canada's most recent dietary guidelines,[128] which incorporate wide ranging scientific evidence including systematic reviews, recommends that individuals should habitually "eat a variety of healthy foods each day". The guidelines specifically recommend to: eat plenty of vegetables and fruits, whole grain foods and protein foods, often choosing plant based-protein; limiting highly processed foods or eating only small amounts and less often; making water the drink of choice; preparing meals and snacks using ingredients that have little to no added sodium, sugars or saturated fats; using food labels and being conscious that food marketing has can potentially influence choices.[128] Canada's current dietary guidelines do not prescribe specific proportions or numerical recommendations of portions.

Lifestyle transitions

Epidemiologic and lifestyle transition

According to Omran,[129] the theory of epidemiologic transition "focuses on the complex change in patterns of health and disease, and the interactions between these patterns and their demographic, economic and sociologic determinants and consequences". The epidemiologic transition parallels demographic and technological transitions and is characterized by the displacement of communicable diseases with NCDs as primary causes of morbidity and mortality.[129] As the transition occurs, lifestyle behaviours such as habitual physical labour and active transportation are replaced by an increased reliance on motorized transportation and sedentary behaviours,[130] while traditional diets are replaced with diets high in fats and sugars,[21] especially in urban areas.[131] A systematic analysis for the global burden of disease of all global deaths in 2015 showing an increase in deaths attributable to NCDs compared to a significant decrease in those caused by communicable and other diseases, provides evidence of an ongoing epidemiologic transition.[132]

Results from recent systematic reviews showed evidence of lifestyle transitions (decreased PA and increased SB),[133] and increased overweight and obesity among children in sub-Saharan Africa.[134] The concept of a physical activity transition was first introduced by Katzmarzyk and Mason in 2009.[27] In 2011, Abrahams et al[131] reported that many countries in sub-Saharan Africa were undergoing a nutrition transition, demonstrated by a shift from the traditional and native diets (high in complex carbohydrates and fiber) to a reliance on western diet (high in fat, refined carbohydrates, sugar, and cholesterol). Contrary to the observed transitions in weight status,[133] PA,[27] and diet,[131] findings from a study using data from sites in 12 countries did not find

evidence of epidemiological transitions in sleep patterns among 10-year old children.[135] Sub-Saharan Africa, the only region in the world where the burden of infectious disease still outweighs that of NCDs,[136] is undergoing the contemporary or delayed epidemiologic transition,[129] as both communicable and NCDs are concurrently major public health problems.[137]

Double burden of malnutrition

The double burden of malnutrition[21,138] is characterized by the coexistence of undernutrition (e.g., wasting, stunting, underweight, and thinness) along with overweight, obesity or diet-related NCDs, within individuals, households and populations, across the life-course.[139] For example, a child could be both stunted and obese; a single household might have an undernourished and thin child while his/her parent(s) may be overweight; or the coexistence of high rates of undernutrition and overweight within the same community.[139] The double burden of malnutrition is driven by the nutrition,[45,118] epidemiological,[129] and demographic transitions.[139] Globalization, industrialization and rapid economic growth,[118] with the accompanying rural to urban migration have accelerated lifestyle transitions (e.g., decreased habitual PA)[138] in many LMICs,[138] resulting in intra- as opposed to inter-generational changes in diet quality and quantity for individuals and populations.[118,139] The presence of the double burden of malnutrition calls for double-duty action plans[140] that prioritize dealing with both under- and over-nutrition in public health programs. Although there is evidence of the double burden of malnutrition among Mozambican children,[25] the data are scarce, less robust and non-representative to meaningfully inform interventions or public health policies.

International Study of Childhood Obesity, Lifestyle and the Environment

This dissertation was partly informed by results from the ISCOLE,[12] a cross-sectional, multinational study designed to examine relationships between lifestyle behaviours and obesity among children in urban/peri-urban areas at sites from 12 countries (Australia, Brazil, Canada, China, Colombia, Finland, India, Kenya, Portugal, South Africa, the United Kingdom and the United States of America). The countries differed in several SES indicators across a continuum of HDI and Gini indices.[12] Detailed descriptions of the design and methods for ISCOLE have been published.[12] Briefly, in the ISCOLE, the primary sampling frame was schools which were stratified by an indicator of SES to maximize variability among the recruited schools.[12] The secondary sampling frame was classrooms most likely to have children with minimum variability from age 10 years. A standardized and published protocol[12] was used to collect data across all sites, and all study personnel underwent rigorous training and certification before and continuously during data collection to ensure data quality and standardization across sites. Data collection for the ISCOLE occurred between September 2011 and December 2013. At each study site, data were collected during the school year. All children within the targeted grade level in a sampled school were eligible to participate; hence, the sample included 9-11-year-old children. Based on *a priori* sample-size calculations[12] (**Appendix A**), each site aimed to recruit a sex-balanced sample of at least 500 children.

As part of ISCOLE, Broyles and colleagues[140] reported that obesity prevalence, body fat percentage and BMI z-score among both boys and girls increased linearly with higher family income in countries at lower levels of development (e.g., lower HDI) while the opposite was true in countries at higher levels of development, consistent with the model of the epidemiologic

transition. Barreira et al,[141] reported the possibility of an epidemiological transition in physical activity (i.e., lower levels of MVPA were observed at opposite levels of household income, at different HDI percentiles). In addition, Chaput et al.[142] reported differences in associations between sleep patterns and physical activity in low vs. HICs and recommended more studies in LMICs to understand these lifestyle behaviours in specific cultural contexts. Furthermore, Larouche and collaborators[143] showed variations in active school transportation and commute times between children from HICs vs. LMICs. Collectively, these results suggest that LMICs may be fundamentally different from HICs; thus, successful interventions in HICs should not necessarily be adopted in LMICs. The results also highlight the need for current, reliable, and valid data on anthropometric and lifestyle behaviours in children from these understudied LMICs.

Research and data gaps

The systematic searches initiated as part of the first phase of this dissertation revealed a paucity of data on key lifestyle and weight status variables for Zimbabwean and Mozambican school children. Furthermore, although multi-national and diverse across HDI measures, the sample for the ISCOLE was drawn from mostly middle, high, and very-HICs. Although the lack of, and need for, robust surveillance data especially in LICs has been universally identified as an urgent priority,[62,122] only one country (Kenya) in the ISCOLE was classified as low-income.[12] Curiously, findings from the ISCOLE showed Kenya's results to be very different from those of the other countries on many indicators, raising questions as to whether it was just an outlier or if results from this country were affected by its lower HDI status. In addition, the ISCOLE sample was drawn from urban and peri-urban neighborhoods only, without any rural representation, thereby limiting generalizability of findings.

Furthermore, the disproportionate urbanization in HICs and lack of rural samples in ISCOLE may distort findings across countries at different HDIs. Results from the ISCOLE demonstrated the presence of an epidemiological transition in PA and dietary patterns and showed a strong relationship between childhood obesity and SES which was differentially related to each country's HDI.[140] Additionally, the main variable of interest for ISCOLE was obesity, despite having sites in LMICs whose populations may be dually affected by both obesity and undernutrition. Thus, with a non-representative convenient sample from one LIC, and no rural representation, accurately interpreting ISCOLE results from Kenya either as an outlier or genuinely different from other countries due to its low HDI has been challenging. Mozambique, a similar LIC in sub-Saharan Africa with a lower HDI (0.44) than that of Kenya (0.59),[144] and undergoing rapid urbanization and lifestyle transitions,[25] offered a great opportunity to provide additional and comparable data, while overcoming important data gaps within the country. Currently, there are limited published data[67,145] from which to provide accurate prevalence estimates of childhood weight status, PA, SB, sleep and dietary patterns among school-aged children in Mozambique.

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Chapter 3: Overview of the general methodology

Summary and justification of methodology

The overall methodology applied for this dissertation is divided into two parts. The first part describes the methodology for developing Report Cards as part of the Global Matrix on PA of children and youth.[1–3] The methodology for developing Report Cards was applied to fulfil objectives 1 and 5 of the dissertation. The second part describes the methodology used for primary data collection and addresses dissertation objectives 2 to 4, and was partially informed by the protocol used for the ISCOLE.[4] Detailed descriptions of manuscript-specific methodological approaches are contained in each of the manuscripts developed as part of the dissertation and are presented in subsections of chapter 4.

Methodology for developing Report Cards

Led by the Active Healthy Kids Global Alliance (AHKGA),[5] the global matrix on PA of children and youth initiatives[1–3] grew out of the international concern over the childhood physical inactivity pandemic.[6] The global matrix initiative was modelled after, and expanded, the Active Healthy Kids Canada Report Card initiative.[7,8] Since the inaugural 2014 summit in Toronto, Canada where the Global Matrix 1.0 was released,[1] two more editions (Global Matrix 2.0, Bangkok, Thailand 2016; Global Matrix 3.0, Adelaide, Australia 2018)[2,3] of the global matrix initiative have been held. To participate, individual countries express interest, are invited to join, and commit to following a harmonized process, adhering to standardized protocols of gathering and appraising the best available country-specific data.[2,3] First, nationally representative teams comprised of researchers, policy makers and representatives of the not-for-profit sector are assembled. The teams then follow a systematic and transparent data gathering process, use

standardized benchmarks (**Appendix B**) and a grading rubric (**Appendix C**) to appraise the best available data, culminating in a country-specific Report Card of grades on specified common indicators of PA.[3] Throughout the approximately eighteen month Report Card development process, the AHKGA Executive Committee provided guidance[5] to all participating countries via monthly e-blasts, assigned mentors and provided technical support. For the Global Matrix 3.0,[3] a scientific sub-committee audited the justifications of each country's grades.

Methodology for primary data collection

This was a cross-sectional study conducted in one urban centre (Maputo) and one rural district (Macia) in Mozambique involving a sex-balanced sample of 9-11 year-old primary schoolchildren. For the urban centre, the sampling frame was a list of all public schools in Maputo, provided by the Ministry of Education in Mozambique. The list was then stratified by school-district (used as a proxy of neighborhood SES) and from each school-district at least three schools were selected. If a school declined to participate, another school in the same school-district was randomly selected and approached. Once schools had consented to participate, students in grades four and five (likely to have participants closest to age 10) were targeted for recruitment into the study. Overall, ten schools were selected in the urban centre, with an average of 33 students participating per school. For the rural district, the sampling frame was a list of schools conveniently selected and provided by the rural district education office. Due to unique circumstances in rural Mozambique, where student progression in school does not always correspond to chronological age, potential study participants (age 9-11-years) were identified and recruited with the help of the school administrator, and not by specifically targeting certain

grades within the school. Due to this flexibility, only seven schools, with an average of 50 study participants per school, were recruited.

Sample size determination

The sample size calculation for the ISCOLE[4] (**Appendix A**) was used to partially guide and inform the sample size requirements for the current study. Assuming 1) that participants would be recruited in clusters with an average of 25 students per school,[4] 2) approximately 5.3% difference in obesity prevalence between urban[4] and rural[9] school-aged children and 3) at least 80% power, a total of 444 participants for both urban and rural locations (222 each) was required. To account for the cluster sampling, a design effect of 1.3 was estimated[4] resulting in a required sample size of 578 and anticipating approximately 10% of participants to have invalid and/ or incomplete data, a recruitment target of 650 students was required. A total of 334 urban and 350 rural students were recruited to make a combined sample of 684 participants.

Research sequence

Ethics applications

Prior to study commencement, ethics approvals were sought and obtained (February-April, 2017) from the Children's Hospital of Eastern Ontario (CHEO) Research Ethics Board (**Appendix D**), the University of Ottawa Research Ethics Board (**Appendix E**), and the Ministry of Health, National Bioethics Committee for Health, Mozambique (English, **Appendix F;** Portuguese, **Appendix G**). Written informed consent (detailing risks/benefits of participating and the ability to voluntarily withdraw at any stage of the research) was obtained from parents or legal guardians. As was done in the ISCOLE,[4] children who were ineligible due to their age, but

interested to participate and were in the classes selected for the study, were allowed (but none elected) to participate, and their data would have been excluded from the final analyses. To ensure confidentiality, only an assigned number (matched to the name in a separate and secure file) was used to identify each participant. All hard copies of research data were locked in a secure space at the Universidade Pedagógica. Data analysis was performed at an aggregate level and any sub-groups with less than 5 participants were suppressed to prevent unintentional or indirect breach of privacy/confidentiality.

Research staff training

To ensure good quality and uniform data collection, research staff underwent structured training that was specifically designed for the ISCOLE protocol.[4] The two-day training covered key components of the protocol including familiarization with measurement instruments, measurement protocols, data collection procedures, data capture and entry procedures, how to handle errors, and the administration of questionnaires. Aspiring research staff were provided with study material for each of the modules ahead of their training. The modules were then presented in a classroom setting after which the research staff wrote and had to successfully pass examinations of each of the six training modules. In addition, research staff also practically engaged in mock data collection exercises and had to demonstrate acceptable ability to follow the data collection protocols before being certified. Training and certification of research staff was conducted once prior to commencement of data collection and refresher training was provided periodically throughout data collection as was required.

Data collection

To minimize the potential effects of seasonality, data collection occurred throughout the school year, between August-November 2017 and February-May 2018. Body composition (BMI, %BF, waist circumference (WC), mid-upper arm circumference (MUAC)) and lifestyle behaviours (PA, SB, sleep) were objectively measured as per the ISCOLE protocol.[4] Dietary patterns, environmental factors, and demographic information were self-reported or obtained through parental/guardian-report. For comparison purposes, as was done in the ISCOLE,[4] the objectively measured movement behaviours (PA, SB, sleep) were further assessed using self-reported questionnaires. The dissertation project received funding ($20,000) for data collection and subsistence from the International Development Research Centre (IDRC) and this was matched by the Healthy Active Living and Obesity Research Group at the Children's Hospital of Eastern Ontario Research Institute.

Measures

Measurement of body composition

Anthropometrics (standing and sitting heights, body weight, %BF, WC, MUAC) were objectively measured by trained staff during an in-school visit using standardized procedures.[4] Standing height (participant as upright as possible, without shoes, head in the Frankfort plane, at the end of inhalation), was measured in duplicate to the nearest 0.1 cm,[4] using a Seca 213 portable stadiometer (Seca corporation, Hamburg, Germany).[10] The head is considered to be in the Frankfort plane when the horizontal line from the notch above the ear canal (the tragion) to the lower border of the orbit of the eye is parallel to the floor and perpendicular to the vertical backboard. Sitting height (participant sitting on a level platform of known height, head in the

Frankfort plane, at the end of inhalation with legs hanging freely and arms resting on the thighs) was measured in duplicate to the nearest 0.1 cm,[4] using a Seca 213 portable stadiometer (Seca corporation, Hamburg, Germany).[10] After removal of all outer clothing and shoes, and pocket contents emptied, participants' body weight (to the nearest 0.1 kg), and %BF (to the nearest 0.1%), [4] was measured, in duplicate, using a portable Tanita SC-240 Body Composition Analyzer (Tanita, Arlington Heights, IL, USA).[11] Given the cross-sectional nature of the dissertation project, the method of Mirwald and colleagues[12] was used to estimate biological maturation, as was done for the ISCOLE,[4] to predict years from peak height velocity, or the "maturity offset" from age, sex, sitting height, stature and body mass. BMI (kg/m^2) was calculated from the objectively measured weight and height. After BMI was calculated, it was used to determine z-scores based on the sex- and age-adjusted reference curves developed by the WHO for children and youth.[13]

WC was measured (to the nearest 0.1 cm) directly on the skin, at the mid-point between the top of the iliac crest and the lower-rib margin, using a non-elastic tape after normal exhalation.[4] MUAC was measured at the midpoint between the acromion process and the olecranon process of a bare right arm, which was relaxed by the participant's side.[4] Each measurement for body composition (height, weight, %BF, WC, MUAC) was repeated and the average of the two measurements was used for analyses. A third measurement was made if the first two were greater than 0.5 cm or 0.5 kg apart and the average of the closest two was used for analyses. All anthropometric measurements were recorded in real time, on a standard data collection sheet (**Appendix H**) and were later checked as a quality control mechanism.

Measurement of physical activity, sedentary behaviours, and sleep

Participation in light, moderate and vigorous PA, SB and sleep was objectively measured using the ActiGraph GT3X+ accelerometer (ActiGraph LLC, Pensacola, FL, USA).[14] The accelerometer was attached to an elastic belt and worn lying on the right iliac crest at the mid-axillary line for seven consecutive days (excluding an initial familiarization day and the morning of the final day). Participants were encouraged to wear the accelerometer 24-hours per day, only being removed for water-based activities. Four days with at least 10 hours of wear time per day including at least 1 weekend day were considered the minimal amount of acceptable accelerometer data. "Nocturnal sleep duration was estimated from the accelerometry data using 60-second epochs and a fully automated algorithm for 24-hour waist-worn accelerometers that was validated for ISCOLE".[15] The beginning of a sleep period was identified as the first 5 consecutive minutes of sleep, and the end of a sleep period was identified as the first 10 or 20 consecutive minutes of wake time, depending on the time of day. A sleep period was only identified when at least 160 minutes had elapsed between its beginning and end, and sleep periods could contain an unlimited number of non-consecutive wake minutes.

The data collection team demonstrated how to properly wear accelerometers before handing them to participants. Wearing the accelerometer for seven consecutive days has been shown to yield reliable PA and sedentary time data,[16] and the 24-hour protocol has previously been demonstrated to improve wear-time compliance, produce valid awake wear-time counts, and also to provide information about children's total sleep episode time.[17] Non-wear time within a day was considered 20 consecutive minutes of '0' activity counts while awake.[15] After the exclusion of total sleep time and the awake non-wear time, total SB and the various intensities of PA were

determined using cut-points developed by Evenson et al.[18] Based on these cut-points, SB was defined as ≤ 25 activity counts per 15 seconds, light PA (≥ 26 to < 574 activity counts per 15 seconds), moderate PA (≥ 574 to < 1003 activity counts per 15 seconds) and vigorous PA (≥ 1003 activity counts per 15 seconds).[18] As was done in the ISCOLE, various intensities of PA and SB were also examined using the cut-points of Treuth et al.[19] On the final day of data collection, research staff collected all accelerometers and verified the data for completeness using the ActiLife software (ActiGraph, Penscola, FL, USA) version 6.5.4.

Measurement of dietary patterns

As was done in ISCOLE,[4] a food frequency questionnaire adapted from the HBSC Survey[20] was used to examine participants' 'usual' consumption of different food groups. The 23-item ISCOLE Food Frequency Questionnaire (I-FFQ) (administered as part of the diet and lifestyle questionnaire) has seven response categories as follows: never, less than once per week, once per week, 2–4 days per week, 5–6 days per week, once a day/every day, and more than once a day. Reliability (r = 0.52–0.82) of a 15-item version of this FFQ has previously been demonstrated for ranking the frequency of consumption of food items in children.[21] When assessed for reliability at sites in three countries (USA, Colombia , Finland) for the ISCOLE, the I-FFQ demonstrated moderate reliability (intraclass correlation coefficients (ICC): ranged from 0.37 to 0.78)) and gross misclassification of all food items was < 5%.[22]

Questionnaires

All questionnaires for this study were developed for the ISCOLE, have been culturally adapted, and were successfully used in the ISCOLE.[4] The questionnaires were forward and backward

translated from English to Portuguese. The Diet and Lifestyle Questionnaire (**Appendix I**), assessing food consumption/dietary patterns, PA, ST, active transport use, active outdoor play, and sleep patterns was completed by participants during a school visit by research staff. Research staff were trained to administer the questionnaire in a standardized manner to minimize bias and a provision was made to administer the questionnaire by interview for participants with low levels of literacy.[4] A Demographic and Family Health Questionnaire (**Appendix J**) capturing information about the child's basic demographic information, ethnicity, health history, family income, parental anthropometry and educational levels was completed by the participants' parents/guardians. A Neighborhood and Home Environment Questionnaire (**Appendix K**) was used to capture information on parental perceptions of the built environment, home food and PA environment, and the neighbourhood safety, cohesion and social environment.

For the urban sub-sample, the demographic and family health and the neighborhood and home environment questionnaires were completed by parents/guardians at home and brought in the next day by the study participants. In cases where the parents did not complete the questionnaires on time, or they were incomplete, follow-up phone calls were made by two research staff, who were trained to conduct telephone interviews. Due to high levels of illiteracy and other logistical concerns, parental/guardian questionnaires for the rural sub-sample were completed at the school where parents were invited for in-person interviews. The School Environment Questionnaire (**Appendix L**), completed by a designated school administrator, was used to assess the school food and PA environment, school facilities and equipment for PA, and policies and practices to promote healthy eating and PA. Details on the development and adaptations of each of these questionnaires are provided elsewhere.[4] All four questionnaires were forward and backward

translated (**Appendices M-P**) as necessary to accommodate the local language needs. Adaptations to specific items and examples on questions were necessary to account for cultural and contextual variations unique to Mozambique.

Validity of measurement instruments

Accelerometers

Validity of an instrument is the degree to which it measures what it purports to measure.[23] An instrument is valid only to the extent that it's scores allows for accurate inferences to be made for a specific purpose (e.g., measuring movement behaviours) with a specific group of subjects (e.g., 10-year-old children). There are generally three categories of instrument validity (i.e., construct, content, and criterion).[23] For the purposes of this dissertation, the validity of an ActiGraph GT3X+ accelerometer is considered to be the degree to which it could accurately measure the movement behaviours (PA, SB, sleep) of 10-year-old children. The validity of accelerometers in measuring movement behaviours is dependent on various components including, but not limited to, the protocol applied (e.g., number of acceptable consecutive wear days), epoch length, definition of acceptable daily wear and non-wear time, and cut-points used to determine time spent in different movement behaviours. Because of no consensus, several predictions equations and cut-points[18,19,24–27] have been validated and are used in measuring movement behaviours of children. For this dissertation, the cut-points developed by Evenson et al.[18] which were validated for children were used. Cut-points developed by Treuth et al[19] were also used to determine various intensities of PA as was done in the ISCOLE.[4]

Tanita SC-240 body composition analyzer

The use of bioelectrical impedance analysis (BIA) scales for assessing body composition has been recommended for field studies because it is safe, practical and inexpensive.[28] A review by Bohm and Heitmann[29] that included 55 studies found BIA-estimated BF% to be directly and closely related to various health outcomes, and concluded that BIA was a valid method for predicting body composition in healthy subjects.[29] When compared to dual-energy x-ray absorptiometry (DXA), the Tanita SC-240 body composition analyzer demonstrated acceptable accuracy in estimating body weight and %BF for a sample of 5-18 American children and adolescents.[30] However, the Tanita SC-240 body composition analyzer underestimated %BF compared to DXA among Caucasian boys and girls but not for African-American boys and girls, although the difference was small.[30] Other studies have also reported significant differences in estimates of %BF between DXA and BIA scales.[31,32]

Analytic approach

Descriptive and summary statistics

Specific statistical analyses for each of the manuscripts presented in chapter 4 that were developed as part of this dissertation are described in detail in the methods section of each of those manuscripts. In general, however, descriptive and summary statistics included means and standard deviations for continuous variables and frequencies and percentages for categorical variables. For normally distributed data, group differences were determined using unpaired t-tests (2 groups, e.g., sex differences) and ANOVA (multiple groups, e.g., different PA intensities) for continuous variables; and Chi-square tests for categorical variables or equivalent non-parametric tests for data that were non-normal.

Inferential analyses

Correlational analyses were used to assess the nature of relationships among country-specific grades for the core indicators of movement behaviours and select global indices and descriptors. General linear models, including covariate-adjusted models, were used to assess associations among lifestyle and environmental factors and weight status of the study participants. Associations between categorical dependent and independent variables were estimated in terms of odds ratios using generalized linear mixed models (SAS PROC GLIMMIX). Associations between continuous dependent and independent variables were estimated using linear mixed models (SAS PROC MIXED). Interaction effects were tested for sex to determine if boys and girls could be combined in our analyses. Because there were no significant sex interactions in the associations between key predictors and dependent variables, results for boys and girls were pooled for presentation. Results from analyses were also compared to the existing ISCOLE dataset,[4] collected previously using similar methodology. The level of statistical significance was defined as $p < 0.05$, with appropriate corrections for multiple tests as was required.

Due to a systematic error (ActiLife software installed on a laptop that was set to North American Eastern Standard Time which is 6 hours behind Maputo time), all accelerometers from the first 8 urban schools (n=261) were erroneously initialized for 06:00 local time. In order to prevent loss of usable data, six hours of zero-activity data were appended to the front end of these files. These hours do appear as sleep and allow the algorithm to begin, but since they are not part of a noon-to-noon full night's sleep, they were not included in any of the sleep summaries.

Dealing with missing data

Missing data is "is a universal measurement problem that threatens the integrity of study results by calling into question the interpretation, reliability, and generalizability of the findings".[34] This is because study participants with missing data may significantly differ from those with complete data on key variables,[35] which "can introduce bias and challenge the interpretation of study findings"[34] if not dealt with appropriately. Historically, the standard approach to missing data has been to delete them.[36] The process that is believed to have generated the missing data is called the missing data mechanism and it "describes the possible relationships between measured variables and the probability of missing data".[37] According to Rubin (1976), these mechanisms generally fall into one of three categories.[38] Data can be referred to as being missing completely at random (MCAR), missing at random (MAR), or missing not at random (MNAR).[38] Data are said to be: MCAR "if the probability of being missing is the same for all cases", MAR "if the probability of being missing is the same only within groups defined by the observed data", or MNAR "if neither MCAR nor MAR holds".[36] Most modern methods of dealing with missing data (e.g. ad hoc methods, direct maximum likelihood, multiple imputation) assume that the data are at least MAR. Overall, in the present study, 15% of the participants were missing data on parental education and 22% had insufficient accelerometry data. To minimize loss of information, and potentially biasing the results due to excluding missing cases,[34] multiple imputation by chained equations (MICE) was applied[36] using the R statistical Package, "mice".[39] Missing values were multiply imputed (50 datasets) under the MAR assumptions, which were tested using recursive partitioning analysis,[40] the Little MCAR's test,[41] and missing patterns analyses.[36]

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Chapter 4: Results

Chapter 4.1**:** Results from Zimbabwe's 2016 Report Card on Physical Activity for Children and Youth

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Article Preface: This article addresses objective 1 "To conduct thorough searches of relevant literature on childhood weight status and lifestyle behaviours, consult and enlist key stakeholders, and identify data gaps in Zimbabwe and Mozambique", for this dissertation. I am the primary (first) author on this article. In consultation with my supervisor, I conceived of the idea of the manuscript, drafted the manuscript, submitted it for publication, and addressed reviewer comments. All co-authors participated in gathering the data, edited the manuscript for content, and approved the final version of the manuscript before it was submitted for peer review. As a narrative literature search, there were no applications for ethical approvals for this article because it relied on secondary data.

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Human Kinetics
ORIGINAL RESEARCH

Results From Zimbabwe's 2016 Report Card on Physical Activity for Children and Youth

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Background: The report card was a synthesis of the best available evidence on the performance of Zimbabwean children and youth on key physical activity (PA) indicators. The aim of this article was to summarize the results from the 2016 Zimbabwe Report Card. **Methods:** The Report Card Working Group gathered and synthesized the best available evidence, met, discussed and assigned grades to 10 indicators based on the Active Healthy Kids Global Alliance global matrix grading system. **Results:** The indicators were graded as follows: overall PA (*C+*), organized sport participation (*B*), active play (*D+*), active transportation (*A-*), sedentary behaviors (*B*), school (*D*), family and peers (*Incomplete*), community and the built environment (*F*), government (*D*) and nongovernmental organizations (*Incomplete*). **Conclusions:** Although the majority of children used active transport, played organized sports and engaged in acceptable levels of PA, most of them did not meet the recommended hours of unstructured/unorganized play per day. At present, there are limited data to accurately inform the Zimbabwe Report Card therefore studies employing robust research designs with representative samples are needed. Zimbabwe also needs to prioritize policies and investments that promote greater and safe participation in PA among children and youth.

Keywords: advocacy, stakeholder engagement, health, policy, sedentary

Research evidence shows that obesity, physical inactivity, and sedentary behaviors among children and youth are increasing globally.[1,2] Recently, the World Health Organization (WHO) reported that in Africa, overweight or obesity among children and youth had nearly doubled, from an estimated 5.4 million in 1990 to 10.3 million in 2014.[1] Physical inactivity and sedentary behaviors are associated with childhood obesity[3] and are known independent risk factors of noncommunicable diseases (NCDs).[4–6] At present, there are limited reliable prevalence estimates for childhood obesity, physical inactivity, and sedentary behaviors among children and youth in Zimbabwe. The lack of nationally representative data or studies using robust measures means that research evidence is limited to support the development of effective strategies to combat the prevalence of noncommunicable diseases.

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The 2016 Zimbabwean Report Card on Physical Activity (PA) for Children and Youth summarizes current evidence and can be used as a knowledge translation and advocacy tool to engage and inform stakeholders while promoting overall PA among Zimbabwean children and youth. Grades ranging from *A* to *F* or *incomplete* (*INC*) on each key indicator of PA were assigned based on best available data. Modeled after the Active Healthy Kids Global Alliance (www.activehealthykids.org) global matrix grading system,[7,8] the 2016 Zimbabwean Report Card was the first comprehensive assessment of key indicators of PA and related behaviors among Zimbabwean children and youth. The purpose of this article was to summarize the methods used and results from Zimbabwe's Report Card on PA for Children and Youth.

Methods

The 2016 Zimbabwean Report Card was developed through a collaborative and iterative process, including extensive electronic correspondence and virtual and in-person meetings. A representative Report Card Working Group (RCWG; Table 1) was comprised of 5 academic professors and university lecturers, 1 member from a nongovernmental organization, 4 PhD students, and 1 representative from the Ministry of Primary and Secondary Education. Members of the RCWG identified and reviewed the best available literature (published and unpublished, graduate student theses, policy documents, and syllabi, etc.) on PA among Zimbabwean children and youth without limits to the year of study or publication. Studies included for grading the evidence for the 2016 Report Card were published or conducted between 2003 and 2015. The first author (TM) summarized the available data according to each indicator in a spreadsheet and a second member (DM) reviewed it independently. A mentor with experience developing Report Cards (MST)

Table 1 Composition of the Zimbabwe Report Card Working Group

Name	Institution	Designation
Mr. T Manyanga	Children's Hospital of Eastern Ontario, Research Institute, Healthy Active Living and Obesity Group	PhD Student
Mr. D Makaza	National University of Science and Technology, Department of Sports Science and Coaching	Lecturer/PhD student
Mrs. Carol Mahachi	University of Zimbabwe, Department of Physiology	Lecturer/PhD student
Mr. TF Mlalazi	National University of Science and Technology, Department of Sports Science and Coaching	Lecturer
Dr. P Makoni	National University of Science and Technology, Department of Innovative Science	Professor
Mr. D Mandaza	Ministry of Primary and Secondary Education	Government Ministry representative
Mr. E Tapera	National University of Science and Technology, Department of Sports Science and Coaching	Lecturer
Mrs. SH Rutsate	National University of Science and Technology, Department of Sports Science and Coaching	Department Chairperson
Mr. V Masocha	Bindura University of Science Education, Sports Science Department	Lecturer/PhD student
Dr. N Munyonga	Public Service Medical Aid Society (PSMAS)/Zimbabwe Olympic Committee (ZOC)	NGO Representative
Mr. B Khumalo	National University of Science and Technology, Department of Sports Science and Coaching	Lecturer
Dr. MS Tremblay	Children's Hospital of Eastern Ontario, Research Institute, Healthy Active Living and Obesity Group	Professor/Mentor
Dr. V Onywera	Kenyatta University, Department of Recreation Management and Exercise Science	Professor/Mentor

Table 2 Report Card Grading Rubric

Grade	Definition	Benchmark
A	We are succeeding with a large majority of children and youth	81–100%
B	We are succeeding with well over half of children and youth	61–80%
C	We are succeeding with about half of children and youth	41–60%
D	We are succeeding with less than half, but some, children and youth	21–40%
F	We are succeeding with very few children and youth	0–20%
INC	Incomplete. At the present time there is not enough information available for grading	–

Note. Developed by Active Healthy Kids Canada for the Active Healthy Kids Canada Report Card on Physical activity for Children and Youth.[8]

supervised the development of the spreadsheet for completeness before it was shared with all members of the RCWG. Each member individually reviewed the summary and assigned grades to each of the 10 key indicators following the rubric outlined in Table 2. To be consistent with report cards from other countries, the indicators used were (1) Overall PA, (2) Organized Sports Participation, (3) Active Play, (4) Active Transportation, (5) Sedentary Behavior, (6) Family and Peer Influence, (7) School, (8) Community and Built Environment, and (9) Government Strategies, Policies, and Investments. Nongovernmental organization strategies, policies, and investments was also added as an additional indicator. Once received by the lead author, the grades from individual members were compiled into a single table, verified by the mentor, and compared. Where grades differed, the inconsistencies were noted and discussed during a virtual meeting until consensus was reached. To maximize the potential for great impact, the RCWG decided to target one of the weakest and most likely modifiable indicators or related behaviors as the cover story for the 2016 Zimbabwe Report Card. More details on procedures and the long form of the Report Card can be accessed at www.activehealthykidszimbabwe.com.

Results

Table 3 presents the grades assigned to each indicator for the 2016 Zimbabwean Report Card. The cover page (Figure 1) of the Report Card shows an image of Zimbabwean children engaging in active play to demonstrate its importance in promoting overall PA.

Overall PA Level: C+

Data informing the grade for overall PA were obtained from 2 studies,[9,10] each with nonrepresentative samples. A little more than one-half (59%) of Zimbabwean children and youth 8 to 16 years of age (n = 4402)[9] met the recommended 60 minutes of moderate-to-vigorous intensity physical activity (MVPA) with variation based on area of residence, type of school attended, and sex [boys (64.1%) accrued more PA than girls (55%)]. More children attending schools in rural areas (63.2%) met the recommended daily minutes of MVPA compared with 58% in urban school children.[9] A study[10] (n = 320) of 3- to 5-year-old preschoolers found that approximately 68% engaged in average or high PA, although there was no mention/

Table 3 Grades According to Physical Activity Indicator in Zimbabwe's 2016 Report Card on Physical Activity for Children and Youth

Category	Indicator	Grades
Physical Activity	Overall physical activity level	*C+*
	Organized sport participation	*B*
	Active play	*D+*
	Active transportation	*A-*
Sedentary Behavior	Screen-based and nonscreen based behaviors	*B*
School	Infrastructure, policy, and programs	*D*
Family and Peers	Support and behavior	*INC*
Community and Built Environment	Infrastructure, policy, programs, safety	*F*
Government	Strategies and investments	*D*
Nongovernmental	Strategies and investments	*INC*

Note. The grade for each indicator is based on the percentage of children and youth meeting a defined benchmark.[7,8] The (±) signs were added to indicate that the grade was awarded based on evidence at the extreme end of the defined benchmark, or when variation by gender, area or residence or age spanned the extreme ends of 2 grades.[7]

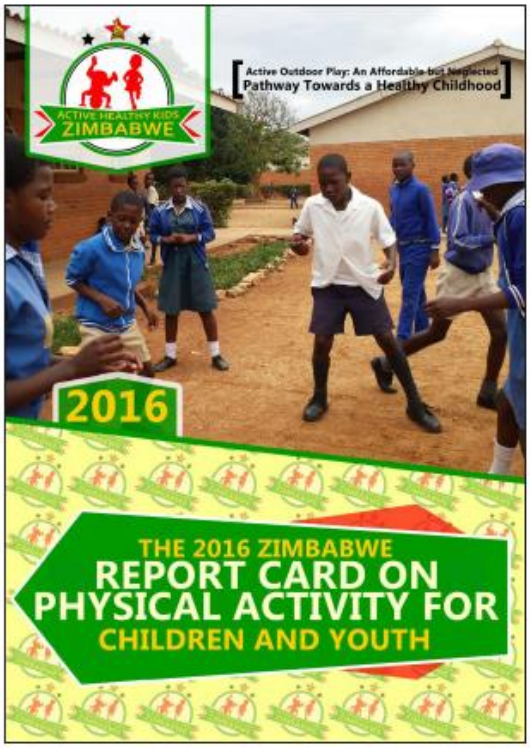

Figure 1 — Front cover of the Zimbabwe's 2016 Report Card on Physical Activity for Children and Youth.

definition of what average or high PA meant. Given the stated variations mostly near the top end of the *C* grade, and the inconsistent cut-points for recommended daily PA, a grade of *C+* was awarded for this indicator.

Organized Sport Participation: *B*

A recent survey[9] (n = 4402) reported that 67.2% of 8- to 16-year-old children participated in organized sports (eg, swimming, tennis, soccer), while another smaller study[11] (n = 91) found that a group of healthy controls participated in an average of 2.5 ±0.9 hours of organized sports per day. Based on these data and expert opinion, participation in organized sports was graded *B*.

Active Play: *D+*

Approximately one-half (49%) of Zimbabwean children and youth reported spending less than 1 hour playing outside before or after school, 13% reported not playing outside at all, and only 35% reported engaging in active play for at least 1 hour per day.[9] More boys (41%) than girls (29%) spent more than 1 hour playing outside before or after school.[9] A slightly higher (48%) proportion of older children (≥13 years) spent more than 1 hour playing outside compared with 46% of children younger than 13 years old.[9] Based on these data and consensus of the RCWG, the indicator was graded *D+*.

Active Transportation: *A-*

The majority (over 80%) of Zimbabwean children and youth used active rather than motorized transport to school.[9,12] The evidence showed some small variation by province of residence, rural vs. urban areas, sex, and age. Use of active transport by province was lowest among children and youth in Harare (77%) and highest in Manicaland (83%).[12] The proportion of boys walking to and from school was lower (79%) compared with girls (82%).[9] Use of active transport was lower (78%) among urban and higher (88%) among rural children and youth.[9] As expected, a greater percentage (82%) of older (≥13 years old) youth used active transport than younger children (<13 years old; 80%).[9] A surprising 33% of children living in urban areas—and overall 41% of girls and 32% of boys—preferred to be driven to school if they had a choice.[9] Given the noted variation ranging from *B+* in Harare province to an *A* in rural areas, the consensus was to award the indicator an *A-*.

Sedentary Behavior: *B*

The available data show that overall approximately 75% of Zimbabwean children and youth spend the recommended ≤ 2 hours per day[13] in sedentary behaviors.[9] About 15% of children and youth reported watching 5 or more hours of television the previous day. Electronic video games (23%) and watching television (26%) were the most common sedentary behaviors reported among Zimbabwean children and youth.[9] As expected, the majority of children and youth from rural areas reported not having watched television at all the previous day.[9] Based on these data, the indicator was graded *B*.

Family and Peers: *INC*

Although anecdotal evidence seems to suggest that Zimbabwean children and youth's PA, sedentary behavior, or sport participation is influenced by their families and peers, the evidence was insufficient to assign a definite grade for this indicator. Research documenting who influences children and youth, and how much they do so, is needed to better inform future grade assignment for this indicator.

School: *D*

The Ministry of Primary and Secondary Education is mandated by the government to promote the teaching and examination of Physical Education (PE) through national syllabi for both primary[14] and secondary education.[15,16] In addition, PE is one of the requirements and is an examinable subject at all teachers' colleges including public universities in Zimbabwe. The Ministry, through its national, provincial, and district education officers, administers, and monitors national examinations. However, there is no evidence of systematic surveillance of adherence at the school level. The consensus among RCWG members was that PE is often not prioritized in schools and that PE teachers are the first to be pulled for other duties at schools. This is consistent with other African countries.[17] The expert group noted that there was room for improvement in infrastructure development and implementation of school PA policies. While polices/syllabi exist, they are not always implemented. Because of this policy–implementation disconnect, the consensus of the RCWG was to award a *D* for the School indicator.

Community and the Built Environment: *F*

Although no objective data were available for grading this indicator, there was consensus among RCWG experts that it should be awarded an *F* grade. The opinion was based on the fact that despite the existence of public parks and infrastructure for recreation mostly in urban areas, little effort goes into maintaining them or ensuring that they are safe. Most of these facilities were in derelict and unsafe conditions and local municipal authorities do not seem to prioritize their upkeep. Furthermore, no municipalities/communities reported that they have policies promoting PA nor were there sidewalks, trails, paths, etc. specifically geared toward promoting PA as specified by the benchmark.[7] There is need for research to accurately assess and evaluate the availability of public facilities to encourage and enable children to be active and also evaluate the proportion of children and youth who use these facilities.

Government Strategies and Investments: *D*

The government of Zimbabwe, through the Ministry of Sports and Recreation, has put in place a draft national policy,[18] yet to be officially adopted, to mandate and promote sports participation among children and youth. The policy is well delineated with a 5-year implementation plan; however, there is no evidence of resource allocation or investments to ensure its successful implementation. Priorities set by the Sports and Recreation Commission,[19] which was established by statutory law in 1991 and tasked to promote organized sport participation, are still to be met. Consensus among members of the RCWG was that significant steps toward implementation and specific funding initiatives were still needed, thus this indicator was graded *D*. There is need for more evidence of government commitment through direct resource allocation for policy and intervention strategies as well as careful monitoring and evaluation.

Nongovernmental Strategies and Investments: *INC*

Although this indicator is not part of the global matrix, it was added to the 2016 Zimbabwean Report Card because of its relevance to Zimbabwe. Currently, there is no independent organization to coordinate and advocate for active healthy living among children and youth in Zimbabwe. Only 1 corporation, Nestle Zimbabwe,[20] partners with the National Association of Primary School Headmasters with the Nestle Kids Athletics Physical Activity Program to promote active healthy living among primary school-children. However, given the concern surrounding corporate sponsorship of healthy active living programs, an independent not-for-profit organization (eg, Active Healthy Kids Zimbabwe) that can advocate and engage stakeholders is needed. Without such a not-for-profit organization and no data available, an *Incomplete* grade was awarded. There is a need for the strengthening of stakeholder networks by forming a national organization which will gather evidence and advocate for policies and interventions that promote active healthy living among children and youth.

Discussion

Collectively, the results of the 2016 Zimbabwean Report Card clearly demonstrate a dearth of quality research evidence and thus the need for valid and reliable data and robust surveillance methods to adequately assess and monitor Zimbabwean children and youth's healthy active living behaviors. The best way to communicate the monitoring and systematic reporting of PA levels among children and youth is to use valid and reliable research evidence and effective knowledge translation tools (eg, the Report Card).[21] The limited available evidence shows that most Zimbabwean children and youth are using active transport, but only a little more than one-half are reporting meeting the recommended 60 minutes of daily MVPA. Evidence also shows that the majority of children and youth are not engaging in habitual out-of-school active play. This is concerning given that active play may be the best option for being physically active, especially for children from low-income families in urban areas, because it does not require a lot of effort or financial resources. It is plausible to speculate that this may be related to safety concerns. Strategies to encourage more habitual out-of-school play should include deliberate efforts and messaging to remind parents and children that play is not only an important part of childhood, but that it also has health benefits.

Given that more than one-third of children and youth (41% girls and 32% boys) are living in urban areas—41% of girls and 32% of boys, overall, preferred motorized to active transport[9]—their use

of active transport may just be reflective of the unavailability of active transport means and not necessarily a lack of awareness of its benefits for health. Preference of motorized transportation among children and youth, especially in urban areas, is troubling in light of the rapid urbanization occurring in Zimbabwe, and may be an indication of how it is associated with 'status' or 'affluence' and thus more preferable. A concerted effort and consistent messaging is needed to ensure that Zimbabwean children and youth continue to see PA as an enjoyable and integral part of their lifestyle and heritage. The development of a national policy and syllabi that makes physical education (PE) mandatory in primary and secondary schools is promising, but there is room for improvement in terms of direct resource allocation and investments to ensure the successful implementation of these policies. Moving forward, schools can support PE teachers by not pulling them from their primary role whenever there is another 'important' activity elsewhere.

Results from the 2016 Zimbabwean Report Card are comparable to those recently reported from other countries in sub-Saharan Africa. Similar to the 2014 Report Card results[7] from Mozambique, Kenya, and Nigeria, which all graded *B* on active transportation, Zimbabwean children and youth fared well with an *A*- grade, contrary to many high-income countries who graded *C* or lower.[7] Zimbabwean children performed slightly better on organized sports participation (*B*) than Ghana, Kenya, and South Africa (*C*), but had a lower grade (*D*+) on active play compared with Kenya, Mozambique, and Nigeria (*C* to *C*-).[7] Perhaps reflective of the influence of better development and availability of resources, the Community and the Built Environment indicator was low for Zimbabwe (*F*) and other African countries: Ghana (*D*), South Africa (*D*), Mozambique (*F*), Nigeria (*INC*), and Kenya (*INC*), whereas high-income countries (Australia, Canada, England, Finland, Ireland, Scotland, and the United States of America) had higher (*A*- or *B*) grades.[7]

Strengths and Limitations

There are several important limitations in the present manuscript worth noting. First, only a handful of mostly unpublished studies provided the data used for the 2016 Zimbabwean Report Card. Second, most of the studies did not use robust measures, were cross-sectional, and used self-reported data. Third, we did not limit our data searches to only recent studies, and as such the Report Card includes data that do not represent only recent estimates. Fourth, all the samples in the included studies were conveniently recruited and not nationally representative, therefore there is a need for caution when interpreting the presented results. Fifth, there was inconsistent reporting and different cut-points and measurement criteria making for difficult comparison among studies. Furthermore, children younger than 6 years old were underrepresented because only 1 study[10] reporting on early years contributed data for the Report Card. Despite these limitations, this initial Report Card effort served to consolidate the existing evidence, bring together researchers and stakeholders from across Zimbabwe with an interest in PA for children and youth, identify specific areas of research need, serve as a catalyst for future research, and inspire efforts to create Active Healthy Kids Zimbabwe.

Conclusions

The 2016 Zimbabwean Report Card clearly demonstrates a dearth of information about key PA indicators among children and youth in Zimbabwe. Evidence from the limited data available shows that although most Zimbabwean children used active transport, engaged in organized sports, and did not spend too much time in sedentary behaviors, their PA levels are generally lower than desired. Due to lack of opportunities, safe areas, programs, and investments, Zimbabwean children may be at risk of becoming increasingly physically inactive and sedentary, putting them at a higher risk for NCDs early in their adulthood. Overall, the results suggest a need for robust research, strong advocacy and stakeholder engagement, as well as policies that prioritize healthy active living among Zimbabwean children and youth.

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Chapter 4.2**:** Results from Zimbabwe's 2018 Report Card on Physical Activity for Children and Youth

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Article Preface: Similar to the article in chapter 4.1, this article also addresses objective 1 "To conduct thorough searches of relevant literature on childhood weight status and lifestyle behaviours, consult and enlist key stakeholders, and identify data gaps in Zimbabwe and Mozambique", for this dissertation. I am the primary (first) author on this article. In consultation with my supervisor, I conceived of the idea of the manuscript, drafted the manuscript, submitted it for publication, and addressed reviewer comments. All co-authors participated in gathering the data, edited the manuscript for content, and approved the final version of the manuscript before it was submitted for peer review. As a narrative literature search, there were no applications for ethical approvals for this article because it relied on secondary data.

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Human Kinetics
BRIEF REPORT

Results from Zimbabwe's 2018 Report Card on Physical Activity for Children and Youth

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Introduction

Physical inactivity, the fourth leading cause of death worldwide,[1] and childhood obesity[2] are increasing globally. In low-income countries like Zimbabwe, childhood obesity often co-exists with undernutrition (underweight, wasting, stunting), resulting in an emerging "double burden of malnutrition".[2] However, there is limited data to accurately assess the extent of these problems among Zimbabwean children.[3] To better understand and help reduce the unhealthy acceleration of these public health challenges, Zimbabwe is participating in the Global Matrix initiative,[4] involving 49 countries. This paper summarizes results of Zimbabwe's 2018 Report Card on the physical activity and nutritional status among 5-17 year old children and youth.

Methods

The 2018 Report Card summarizes data for 10 core physical activity indicators, common to the Global Matrix 3.0 (Overall Physical Activity, Organized Sport and Physical Activity, Active Play, Active Transportation, Sedentary Behaviours, Physical Fitness, Family and Peers, School, Community and Environment, and Government) and two additional indicators (Nutrition and Non-Government). Each of the 12 indicators can be grouped into 1 of 3 categories: Daily Behaviors (Overall PA, Organized Sport and Physical Activity, Active Play, Active Transportation, Physical Fitness, Sedentary Behaviors, Nutrition), Settings and Sources of Influence (Family and Peers, School, Community and Environment), and Strategies and Investments (Government, Non-government).

Data from published, and unpublished studies, and policy documents (with no limits to year-of-publication), reporting on physical activity and related behaviors for 5-17-year-old children were gathered and summarized into a bibliography and an excel spreadsheet. Benchmarks provided by Active Healthy Kids Global Alliance[5] were used by members of the Report Card Working Group comprising national experts working in various sectors of physical activity viz: academia, government and non-government, to individually assign grades for each indicator. Grades for individual members were collated, and discrepancies noted. The grades for each indicator were converted to a numerical value using a common score. Discrepancies among members' grades were reconciled and the median score was selected for the final grade.

Results and Discussion

Similar to findings from the 2016 Zimbabwe Report Card[4] and also to those from countries with comparable Human

Figure 1 — Zimbabwe's 2018 Report Card cover.

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Table 1 Grades and rationales for Zimbabwe's 2018 Report Card

Indicator	Grade	Rationale
Overall Physical Activity	C+	A combination of expert opinion as well as data from two unpublished studies informed grade assignment for this indicator. A little over half (59%) of Zimbabwean children and youth met the recommended 60 minutes of daily moderate-to-vigorous physical activity
Organized Sport and Physical Activity Participation	B	Two studies, (1 published and 1 unpublished) provided data to inform grading of this indicator. The data showed that approximately 67% of children and youth participated in organized sport. Some experts on our panel queried the lack of information on the type of sports and time spent in organized sporting activities.
Active Play	D+	Only one study, as well as expert opinion informed the grade assignment for this indicator. While the majority (47%) of children reported spending less than an hour playing outside, only 35% indicated that they spend more than 1 hour playing outside before and after school. Given these data and expert opinion, this indicator was allocated the grade of D+.
Active Transportation	A-	Two studies informed the grade for this indicator. The grade did not change from our previous Report Card because there were no new data since then. Over 80% of children and youth did use active transport to and from school, but there was some variation between boys and girls as well as between rural and urban areas. The proportion of boys walking to and from school was lower (79%) compared with girls (82%). Use of active transport was lower (78%) among urban and higher (88%) among rural school children and youth.
Sedentary Behaviours	B	Only one unpublished study informed grade assignment for this indicator. This grade did not change from the 2016 Report Card largely because the data used to inform it have not changed since then. There was considerable debate among experts over what; some argued were unreported high levels of sedentary behaviors among children. Overall approximately 75% of Zimbabwean children and youth spend the recommended ≤ 2 hours per day engaged in recreational screen time. About 15% of children and youth reported watching 5 or more hours of television the previous day.
Physical Fitness	Incomplete	Lack of expert opinion as well as insufficient data to accurately assign a grade for this indicator led us to conclude that an Incomplete grade would be more appropriate.
Family and Peers	Incomplete	Similar to the 2016, Report Card, lack of expert opinion as well as insufficient data to accurately assign a grade for this indicator led us to conclude that an Incomplete grade would be more appropriate.
School	C	The primary and secondary schools curricula in Zimbabwe mandate the examination of physical education. There are dedicated time slots (as is the case with other subjects) throughout the week at all levels of primary and secondary education. In addition, physical education is taught and examined as a separate subject at all Institutions of higher education where school teachers are trained.
Community and Environment	D	There is some evidence of infrastructure resuscitation, including a draft policy document, adopted by the government of Zimbabwe in 2016 that prioritizes community recreational activities and spaces in some neighborhoods. Given this level of commitment and progress, but with little concrete evidence of implementation, the Report Card Working Group awarded a D for this indicator.
Government	C-	Through the Ministries of: Health & Child Welfare; Sports and Recreation; and Primary and Secondary Schools, the Government of Zimbabwe has developed and now begun implementing policies that are meant to increase physical activity among children and youth. All three ministries have promulgated 5-year strategic plans, with some evidence of allocation of funding to implement the policies. The new school curriculum which mandates and makes physical education examinable has now been implemented in primary through to secondary school. The school health policy, In addition to the policy documents, expert opinion was unanimous that there has been practical progress for this grade to improve from the D we assigned to it two years ago.

Development Index,[6] results from the 2018 Report Card show that in general, indicators for daily behaviours had higher grades, compared to the indicators for settings and sources of influence. Grades for overall Physical Activity, Organized Sport and Physical Activity, Active Play, Active Transportation, and Sedentary Behaviours, remained unchanged from the 2016 Report Card, owing to unavailability of new data. Grades for School (C), Community and Environment (D), and Government (C-), improved largely due to policy implementations and commitments made to promoting physical activity[7,8] and nutritional status[9] among Zimbabwean children and youth. Community infrastructure resuscitation,[10] and allocation of financial resources were noted as important steps targeting physical activity among children and youth. There was insufficient evidence to accurately assign grades for Physical Fitness and Family and Peers. Two additional indicators, Nutritional Status (B) and Non-Government (INC) were added because of their importance to the Zimbabwean context. The acknowledgement by the Government of Zimbabwe, that malnutrition in all of its forms[9] is a national public health concern, provides an opportunity for strong advocacy and stakeholder engagement, in support and promotion of improved physical activity and nutrition among Zimbabwean children and youth. Grades assigned, and rationales for each indicator are presented in the Table 1. The cover page (Figure 1) of the Report Card shows an image of the measurement of nutritional status for Zimbabwean children.

Conclusion

There are limited and mostly unpublished data on physical activity levels among Zimbabwean children. Overall physical activity levels for Zimbabwean children are lower than desired. Robust research using nationally representative samples, consistent advocacy and stakeholder engagement, including policies that prioritize healthy active living among Zimbabwean children and youth is needed.

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Chapter 4.3: Prevalence and correlates of objectively measured weight status among urban and rural Mozambican primary schoolchildren: a cross-sectional study

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Key Words: Thinness, overweight/obesity, correlates, multiple imputation, low-middle-income countries

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This manuscript was written for submission as an original article to *PLOS ONE* and appears in its submitted format.

Article Preface: This article addresses objective 2 "To describe the prevalence, and identify important lifestyle and environmental correlates of objectively measured weight status among urban and rural Mozambican schoolchildren", for this dissertation. I am the primary (first) author on this article. In consultation with my supervisor, I conceived of the idea of the manuscript, drafted the manuscript, cleaned and analyzed the data, and submitted the final version for publication. All co-authors contributed significantly and met the International Committee of Medical Journal Editors guidelines for authorship. They all edited the manuscript for content, and approved the final version of the manuscript before it was submitted for peer review. Ethics approvals (refer to Appendices D-F) for the data used in this article were obtained from the relevant authorities prior to data collection.

Abstract

Background: The coexistence of undernutrition (thinness) and overnutrition (overweight/obesity) among children and adolescents is a public health concern in low-middle-income countries. Accurate prevalence estimates of thinness and overweight/obesity among children and adolescents are unavailable in many low-middle-income countries due to lack of data. Here we describe the prevalences and examine correlates of objectively measured weight status among urban and rural schoolchildren in Mozambique.

Methods: A cross-sectional study design was applied to recruit 9-11-year-old schoolchildren (n=683) from 17 urban and rural primary schools in Mozambique. Body mass index (BMI) was computed from objectively measured height and weight and participants' weight categories were determined using the World Health Organization cut-points. Actigraph GT3X + accelerometers were worn 24 hours per day for 7 days to assess movement behaviours. Multilevel multivariable modelling was conducted to estimate odds ratios and confidence intervals.

Results: Combined prevalence of overweight/obesity (11.4%) was significantly higher among urban participants compared to rural participants (5.7%; χ^2 =7.1; p=0.008). Conversely, thinness was more prevalent among rural (6.3%) compared to urban (4.2%) participants. Passive school commute, not meeting daily moderate- to vigorous-intensity physical activity (MVPA) guidelines, and mother's BMI >25 kg/m^2 were associated with overweight/obesity while one or more functional cars at home, mother's BMI >25 kg/m^2 and older age were associated with thinness in the present sample. The proportion of total variance in the prevalences of obesity and/or thinness occurring at the school level was 8.7% and 8.3%, respectively.

Conclusion: Prevalences of thinness, overweight/obesity and other key variables differ between urban and rural schoolchildren in Mozambique. MVPA, active transport and mother's BMI are

important modifiable correlates of weight status among Mozambican schoolchildren. Results from this study demonstrate important differences between urban and rural schoolchildren that should not be ignored when designing research projects, formulating public health strategies, and interpreting findings.

Background

Prevalence estimates from the World Health Organization (WHO) show that childhood obesity is increasing globally (1). Although some studies in high-income countries (HICs) have reported a recent plateau (2,3), obesity levels remain high among all children and youth (3). Moreover, in low-middle-income countries (LMICs), childhood obesity is reportedly increasing (4), and at a much faster pace than it did in HICs (5,6). Obesity is linked to numerous non-communicable diseases (NCDs), (1) is known to track from childhood to adulthood (7,8) and is associated with a higher risk of premature mortality (9). In LMICs, undernutrition (underweight/thinness, wasting, stunting) also still persists. Undernutrition is linked to health consequences such as suboptimal adult health, poor cognitive and motor development, and has negative consequences for work productivity, thus ultimately perpetuating poverty (10,11). The coexistence of undernutrition and overnutrition (overweight, obesity), commonly referred to as the double burden of malnutrition (6,12), is challenging for LMICs that still face high prevalences of infectious diseases (13). Recently, the WHO declared childhood obesity as one of the greatest challenges of the 21st century, announcing that ending it was a top priority (1). However, many LMICs face the double burden of communicable diseases and NCDs (14), and have limited resources to enable them to adequately address these competing public health priorities.

Despite the well-known differences in lifestyle behaviours between urban and rural populations (15,16), there is limited available evidence in LMICs where research is still mostly based on urban and non-representative samples. Relying on this evidence alone to inform public health policies or to design interventions may be ill-informed and inappropriate. Furthermore, behavioural and environmental factors (e.g. home or school environments) that may be associated with the weight status of schoolchildren in LMICs such as Mozambique are not well documented. The most recent synthesis of data on key indicators of physical activity among Mozambican children and youth identified addressing the absence of such evidence as an urgent priority (17). Not surprisingly, this lack of data is most apparent in the rural areas of Mozambique.

In the present study, multilevel multivariable models were used to examine the prevalence and correlates of objectively measured weight status among urban and rural schoolchildren in Mozambique. We hypothesized that the prevalence of unhealthy weight status (thinness, overweight/obese) would significantly differ between urban and rural schoolchildren. We further hypothesized that the correlates of thinness or overweight/obesity would also be different between urban and rural schoolchildren.

Methods

Study design and participants: Participants (9-11 year-old primary schoolchildren) for this cross-sectional study (n = 683) were recruited from 10 urban (Maputo, stratified by socioeconomic status) and 7 rural (Macia district) schools in Mozambique. At least three urban schools were randomly recruited from each of three districts, using a list provided by the Ministry of Education to maximize variability in levels of neighborhood socioeconomic status (SES). Rural schools were purposively recruited from a list

provided by the district education office. One urban school declined to participate after being approached and was replaced by another school from the same district. Participants whose parents provided consent and were between ages 9 and11 years old were included in the study. We followed the published protocol and methodology used in the International Study of Childhood Obesity, Lifestyle and the Environment (ISCOLE) (18). Data were collected between August 2017 and May 2018. We adhered to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for cross-sectional studies.

Ethics approvals: Prior to data collection, ethical approvals were received from the Children's Hospital of Eastern Ontario Research Ethics Board (#17/59X), the University of Ottawa Research Ethics Board (#A05-17-02), and the Mozambique National Bioethics Committee for Health (#151/CNBS/17). Written informed consent was obtained from parents or legal guardians before including participants in this study. For parents/guardians with low levels of literacy, research assistants who were fluent in Portuguese (the official language), and the native language (Xangana), read and explained the contents of consent forms. In developing this study, we adhered to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for cross-sectional studies (19).

Measures

Anthropometric measurements: Participants' standing height was measured to the nearest 0.1 cm by trained and certified research staff using a Seca 213 portable stadiometer (Seca Corporation, Hamburg, Germany). With the participant standing as erect as possible and with their head in the Frankfort horizontal plane, measurements were recorded at the end of a deep inhalation. The participant's body weight was measured to the nearest 0.5 kg using a portable

Tanita Body Composition Analyzer (SC-240, Illinois, USA) after all outer clothing, heavy pocket items, shoes, and socks were removed. All measurements were done in duplicate, and a third measurement was taken if the first two were more than 0.1 cm (height), or 0.5 kg (body weight) apart. The average of the closest two measurements was used for analyses. BMI (kg/m^2) was derived from standing height and body weight, and converted to BMI z-scores using sex- and age-adjusted growth references developed by the WHO for 5-19 year-old children and youth (20,21). The WHO defined cut-points were applied to classify participants as being thin (BMI z-scores < -2 standard deviations [SD]), healthy weight (BMI z-scores between -2 and +1 SD), overweight (BMI z-scores > +1 to +2 SD), or obese (BMI z-scores > +2 SD) (21,20).

Movement behavior measurements: Actigraph GT3X+ accelerometers were used to objectively measure nocturnal sleep, total sedentary time, and physical activity. The accelerometers were attached to an elastic belt and worn lying flat on the right hip, for seven consecutive days plus an initial familiarization day. To improve compliance, a 24-hour protocol was implemented, encouraging participants to wear the accelerometer at all times except during water based activities (22). An algorithm was used to identify total nocturnal sleep time and an additional algorithm was used to identify periods of awake non-wear time (any sequence of ≥20 consecutive minutes of 0 activity counts) (23). Data were collected at a sampling rate of 80 Hz, downloaded in 1-second epochs with the low-frequency extension filter using the ActiLife software version 6.5.4 (ActiGraph LLC, Pensacola, FL, USA). Data were subsequently aggregated to 15- and 60-second epochs for summarizing physical activity and nocturnal sleep, respectively. After accounting for the total nocturnal sleep and awake non-wear time (23), all remaining minutes were classified as awake-wear time. Participants with ≥10 hours of wear time

per day on at least 4 days including 1 weekend day were considered to have sufficient physical activity data. Cut-points developed by Evenson et al. (24). were used to quantify sedentary time (≤25 counts), light physical activity (LPA) (26-573 counts), moderate physical activity (574–1002 counts) and vigorous physical activity (≥1003 counts) per 15-second epochs.

Questionnaires: Participants were asked to complete a *Diet and Lifestyle Questionnaire* related to their dietary intake, physical activity, sedentary behaviours and sleep patterns, in the presence of research staff during a school visit. Parents/guardians completed a *Demographic and Health Questionnaire* which captured the participant's health history; parental education, number of siblings, parental weight and height, household income; and home food environment information. Parents/guardians also completed a *Neighbourhood Environment Questionnaire* which captured information about parental perceptions of their neighborhoods' social, built, food and physical activity environment. A school administrator completed the *School Environment Questionnaire* capturing information about the participants' school characteristics, policies and practices that could potentially influence participants' healthy eating and physical activity behaviours. Questionnaires were translated from English to Portuguese and Xangana and specific items were adapted to reflect local contexts. Complete questionnaires are available elsewhere (18).

Covariates: In line with previous ISCOLE publications, participants' sex and age, and the highest level of parental education (a proxy of SES) were used as covariates in all multivariable models because of the plausibility of confounding.

Sample size: Sample size calculations were partially guided by those done for ISCOLE (18). Assuming: 1) that participants would be recruited in clusters with an average of 25 students per school; 2) approximately 5.3% difference in obesity prevalence between urban (6.8%) (ref. 18) and rural (1.5%) (ref. 25) primary schoolchildren; and 3) at least 80% power, a total of 444 participants for both urban and rural (222 each) would be required. To account for the cluster sampling, we estimated a design effect of 1.3, resulting in a required sample size of 578; and anticipating approximately 10% of participants to have invalid and/or incomplete data, the recruitment target was 650 students.

Treatment of missing data: Overall, 103 participants (15%) were missing data on the highest level of parental education and 149 participants (22%) had insufficient accelerometry data. Participants with missing data did not significantly differ in mean age (mean difference =0.02; p=0.7), BMI z-scores (mean difference=-0.13; p=0.10) or sex (chi-square=1.31; p=0.3). The proportion of participants missing data on the highest level of parental education did not differ from those with complete data (p=0.7). To minimize loss of information, and potentially biasing the results due to excluding missing cases (26), multiple imputation by chained equations (MICE) was applied (27) using the R statistical Package, "mice"(28). Missing values were multiply imputed (50 datasets) under the Missing at Random (MAR) assumptions (27). Before assuming that data were MAR, model-based recursive partitioning analysis (29), the Little MCAR's test (30), and missing patterns analyses were performed (27).

Statistical Analyses: Statistical analyses were computed using SAS 9.4 (SAS Institute Inc., North Carolina, USA) and R (version 3.5.2; The R Foundation for Statistical Computing,

Vienna, Austria). Descriptive characteristics of participants were summarized using means (SD) or frequencies (percentages) as appropriate. Unpaired t-tests and chi-square tests (χ^2) were used to examine potential differences between participants attending urban versus rural schools. Multilevel multivariable logit models (PROC GLIMMIX) accounting for clustering at the school level were used to determine the correlates of participants' weight status (thinness versus non-thin or overweight/obese versus non-overweight/obese). Schools were treated as random effects in all models. Potential correlates of thinness or overweight/obesity were selected *a priori*, based on previous literature (31–35) and the modified socioecological model proposed by Davison & Birch (36). Table 1 presents the list of potential correlates and how they were used in the analyses. First, each potential correlate was included in univariable models and those that were at least marginally ($p < 0.10$) statistically significant were retained for use in the multivariable models. This less-strict criterion was applied for univariable analyses to prevent the potential exclusion of important variables (37). Potential correlates that remained marginally statistically significant ($p<0.10$) from the univariable analyses were entered in final models including all variables and covariates. Variables that were statistically significant ($p<0.05$) in the final models were considered to be correlates of overweight/obesity or thinness.

INSERT TABLE 1 HERE

For intercept estimates to be more meaningful, all continuous variables were grand mean centered prior to estimating the models. Denominator degrees of freedom, were calculated using the Kenward Roger approximation (DDFM = KR) (38). Variance tolerance inflation factors (VIF) were applied to test for multicollinearity in multivariable models (39). Unless stated (i.e.

VIFs > 5), no problems regarding multicollinearity were identified. Covariance parameter estimates from an unconditional model (i.e., a model with the dependent variable only) were used to compute Intraclass Correlation Coefficients (ICC) indicating how much of the total variance in the prevalences of obesity or thinness was attributed to individuals (level 1) or schools (level 2).

Sensitivity analyses were conducted to compare univariable results from imputed data sets to those from complete case analyses, and results were similar. Because the results from complete case analysis and multiply imputed data analyses were similar, the imputed data were used for final analyses to maximize data utilization. Unbalanced weight status (i.e. low prevalence of obesity among rural participants) within the models made it impractical to separately estimate models for rural and urban sub-samples. However, because of important descriptive differences between the two sub-samples, density curves for key variables were plotted. In addition, the location of school (rural or urban) was added to multivariable models as an additional covariate.

Results

Table 2 presents the descriptive characteristics of the participants with complete data, stratified by rural or urban school location. The whole sample (52.9% girls) had a mean age of 10.1 ± 0.8 years, and BMI z-score of -0.4 ± 1.0. Apart from sex (χ^2 = 0.8; p=0.4), all other descriptive characteristics (age, BMI z-scores, weight status, levels of parental education) were statistically significantly different between urban and rural participants. The ICC obtained from unconditional multilevel models showed that the proportion of total variance in the prevalences of obesity or thinness occurring at the school level was 8.7% and 8.3% respectively. The

remaining proportion of variability in each of overweight/obesity or thinness was explained by individual or other unmeasured factors. Combined prevalence of overweight/obesity (11.4%) was significantly higher among urban participants compared to rural participants (5.7%; χ^2 =7.1; p=0.008). Conversely, thinness was more prevalent among rural (6.3%) compared to urban (4.2%) participants. More boys (6.8%) than girls (3.9%) were thin. Virtually all rural schoolchildren (98.3%) reported that they actively commuted to school while 69.1% of urban schoolchildren used active transport. Rural schoolchildren had an average of 19 more minutes of LPA, and 24 more minutes of moderate- to vigorous- intensity physical activity (MVPA) per day than those attending urban schools.

INSERT TABLE 2 HERE

Density curves presented in Figure 1 compare BMI z-scores (panel A), sedentary time (SED) (panel B), LPA (panel C), and MVPA (panel D) between participants from urban and rural schools and illustrate distinct differences. Tables 3 and 4 separately present the odds ratios for the relationships between overweight/obesity, and thinness and each of their potential correlates. Of the 33 potential correlates, 10 had a marginal ($p < 0.10$) statistically significant association with overweight/obesity and five were significantly associated with thinness in the univariable analyses. Most (passive commute to school, not meeting MVPA guidelines, higher recreational screen time, frequent consumption of fast food, frequent consumption of fast food while watching TV, mother's BMI >25 kg/m^2, father works ≥15 hours/week, one or more cars at home, urban school) were positively associated with overweight/obesity while having three or more siblings was the only variable inversely associated with overweight/obesity. Frequent

consumption of fast food, mother's BMI >25 kg/m^2, and having one or more cars at home were inversely associated with thinness while being male and an older participant were positively associated with being thin.

INSERT FIGURE 1 HERE

INSERT TABLES 3 AND 4 HERE

Table 5 presents results of the final multivariable models that included all marginally statistically significant variables from univariable analyses and the covariates. Three variables (passive commute to school, not meeting daily MVPA guidelines, and having a mother with BMI >25 kg/m^2) were associated with increased odds of being overweight/obese. Having one or more functional cars at the home (inverse), mother's BMI >25 kg/m^2 (inverse) and being an older participant (positive) were associated with, and were identified as correlates of thinness. Mother's BMI >25 kg/m^2 (inversely related to thinness and positively related to overweight/obesity) was the only variable that remained significant for both thinness and overweight/obesity in final multivariable regression models. As shown in supplementary files, Figure S1, density curves for BMI z-scores, SED, and LPA are not very different between boys and girls while boys have higher MVPA than girls. Figures S2 and S3 present density curves that compare similar variables and confirm the differences in key variables for urban and rural boys and girls separately.

INSERT TABLE 5 HERE

Discussion

This study examined the prevalence and correlates of thinness or overweight/obesity among urban and rural schoolchildren in Mozambique. The results indicate that overweight/obesity is higher among urban, while thinness is higher among rural, schoolchildren. With the exception of one variable (mother's BMI), our findings show different correlates for thinness and overweight/obesity. Passive commuting to school, not meeting daily MVPA guidelines and having a mother with overweight/obesity are statistically significant correlates of overweight /obesity. Having one or more cars at home, mother's BMI >25 kg/m^2, and older age are statistically significant correlates of thinness. Results from this study illustrate distinct differences in key variables between urban and rural Mozambican primary schoolchildren. The emergence of obesity and the persistence of thinness as serious public health concerns among children and adolescents in LMICs necessitate prioritizing effective and evidence-informed prevention and management strategies.

The presence of both thinness and overweight/obesity in this study validates the need to consider examining both forms of malnutrition when designing studies in samples such as the present one. The present findings confirm results from previous studies (6,10,25,40,41) that document the existence of the dual burden of malnutrition among children and adolescents in LMICs. While prudent for public health strategies to appropriately continue focusing on undernutrition, present and previous findings (40) show that overweight/obesity, especially among urban Mozambican schoolchildren is increasing, and needs attention. Finding a high prevalence of overweight/obesity among urban Mozambican schoolchildren and thinness among rural schoolchildren supports our primary hypothesis. These findings are comparable to those reported

by Gomes et al. (16), albeit in an adult sample and demonstrate important differences between urban and rural populations in Mozambique. These key differences must be considered, and should compel researchers to include rural participants in similar studies conducted in LMICs such as Mozambique, that still have large proportions of the population living in the rural areas. Consistent with our findings, Nhantumbo et al (42) previously reported a higher prevalence of undernutrition and negligible overweight status in a sample of rural Mozambican children and adolescents. These results suggest that public health strategies should be dually focused and aim to address thinness and overweight/obesity separately for rural and urban schoolchildren.

MVPA (34) and active transport (43,44) are important lifestyle correlates of obesity among children. In previous multinational studies involving LMICs and HICs, objectively measured low MVPA has been consistently shown to be associated with obesity (34,45,46). Consistent with results from a previous Mozambican (47) and other international studies (45,46), our findings presented in Figure S1 show that boys accumulate more minutes of daily MVPA than girls. These present findings further support the robustness of MVPA as an important correlate of obesity in many different contexts. Previous results for active transportation are equivocal (43,48), suggesting that its association with obesity may be context-specific or may be related to the limitations of self-reported data.

Findings from the present study identifying both active transport and high MVPA as protective correlates for obesity among schoolchildren suggest that promoting these lifestyle behaviours as effective and less expensive strategies for active healthy living, especially in resource-limited LMICs may yield positive public health outcomes. However, it is also plausible (because the

cross-sectional design cannot establish temporality), that it is indeed the overweight/obesity status that may be driving the lower MVPA or passive transport commute among participants with obesity. Higher proportions of active school commuters and more MVPA minutes among rural schoolchildren than those from urban schools suggest ongoing physical activity transitions (49) among urban-dwellers in Mozambique and demonstrates the overall importance of utilitarian physical activity. Although low prevalence of overweight/obesity among rural participants made it impractical to estimate separate models for rural and urban schoolchildren, descriptive results presented in density curves support our secondary hypothesis and further corroborates the need to include rural and urban participants in future studies.

High maternal BMI was the only significant correlate, though in opposite directions, for both overweight/obesity and thinness in the present study. This finding showing that higher maternal BMI was positively and negatively associated with overweight/obesity and thinness, respectively, is consistent with findings from previous studies (50,51) and may be indicative of the important role that mothers play in shaping lifestyle choices for their children, especially in the context of LMICs. Having one or more functional cars at home might have been a good proxy for family affluence, hence its significant inverse relationship with thinness in the present study. Unlike overweight/obesity, thinness among children in LMICs may be driven by higher-order risk factors, e.g. poverty or food security which were not measured in the present study. Future studies among populations in similar settings may need to consider measuring the potential influences of such variables.

This study has several limitations, including its cross-sectional design which precludes inferences about causation. Relationships found, are limited to the list of included correlates and we also cannot exclude the potential confounding effects of unmeasured variables. The study sample is non-representative, and for several variables, relied on self-reported data obtained by questionnaires whose validity in this context, especially for the rural population, is not known. There were substantial data missing on key variables which necessitated the application of multiple imputations with potential biases that may have been introduced. However, comparative analyses between complete data cases and imputed datasets do not support this potential limitation. We used BMI z-score cut-points developed from a different reference population which may have resulted in inadvertently over or underestimating prevalences of thinness or overweight/obesity. Nonetheless, this study has important strengths that include the recruitment of a relatively large sample involving both urban and rural participants. We objectively measured anthropometry and movement behaviours, and followed a rigorous and standardized study protocol. For example, research staff were trained and certified prior to data collection. Finally, our multilevel analyses accounted for the hierarchical nature of these data.

Conclusion

Prevalences of thinness and overweight/obesity and other key variables (SED, LPA, MVPA, active transport) differed between urban and rural schoolchildren in Mozambique. Active transport and MVPA were statistically significant correlates of overweight/obesity while having one or more functional cars at home and being older were significant correlates for thinness. High maternal BMI was a significant correlate for both thinness (negative) and obesity (positive) albeit in opposing directions. Results from this study demonstrate important differences between

urban and rural schoolchildren that should not be ignored when designing research projects, formulating public health strategies, and interpreting findings.

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Author Contributions

TM and MST conceived this paper with input from JDB, PTK, AP, EFM, LD, and J-PC. TM, EFM, and JDB cleaned and analysed the data with input from MST, AP, J-PC, LD, and PTK. TM developed the final version of the manuscript and MST, JDB, AP, EFM, J-PC, LD, and PTK provided significant edits and approved the final manuscript.

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Table 1: Potential correlates of objectively measured thinness or overweight/obesity		
Variable	Method of measurement	Use in analysis
Individual characteristics		
Sex	Parent-reported	Binary variable: male or female (covariate)
Age	Parent-reported	Continuous (covariate)
School commute (mode of transport to and from school for main part of the journey)	Participant-reported	Re-coded as a dichotomous variable: active (walking, bicycle/rollerblade/skateboard/scooter), or passive (bus/train/ boat, car/motorcycle/moped)
Total sedentary time	Accelerometer measured	Continuous
Light-intensity physical activity	Accelerometer measured	Continuous
Moderate-to-vigorous-intensity physical activity	Accelerometer measured	Continuous: re-coded as dichotomous (< 60 minutes per day) or (≥60 minutes per day)
Sleep duration	Accelerometer measured	Continuous
Recreational screen time	Participant-reported	Continuous
Outdoor play time (before school, after school, weekend)	Participant-reported	Continuous
Recreational screen time	Participant-reported	Dichotomous: (≤ 2 hours of recreational screen time) or (> 2 hours of recreational screen time) per day
Participation in sports	Participant-reported	Dichotomous: (Did not participate in sporting activities) or (participated in sporting activities) in the past year
Health-related quality of life	Participant-reported	Dichotomous: (poor, fair) or (good, very good, excellent)
Consumption of breakfast	Participant-reported	Dichotomous: (eats breakfast ≤ 6 days per week) or (eats breakfast daily)
Consumption of fruits	Participant-reported	Dichotomous: (eats fruits ≤ 3 days per week) or (eats fruits 4 or more days per week)
Consumption of vegetables	Participant-reported	Dichotomous: (eats vegetables ≤ 3 days per week) or (eats vegetables 4 or more days per week)
Consumption of fast-food	Participant-reported	Dichotomous: (eats fast food ≤ 3 times per week) or (eats fast food > 3 times per week)
Consumption of fried food	Participant-reported	Dichotomous: (eats fried food ≤ 3 times per week) or (eats fried food > 3 times per week)
Consumption of fries	Participant-reported	Dichotomous: (eats fries ≤ 3 times per week) or (eats fries > 3 times per week)
Consumption of fast food while watching television	Participant-reported	Dichotomous (Does not eat fast food while watching television) or (eats fast food while watching television at least once per week)
Characteristics of participant's parents/legal guardians		
Mother's BMI	Parent-reported	Continuous: re-coded as dichotomous <25 or ≥25 kg/m^2
Father's BMI	Parent-reported	Continuous: re-coded as dichotomous <25 or ≥25 kg/m^2
Parental level of education	Parent-reported	Re-coded as highest level of parental education (covariate): <high school, high school/some college, or bachelor's/graduate degree

Mother's work status	Parent-reported	Continuous: re-coded as dichotomous (≤15 hours/week) or (>15 hours/week)
Father's work status	Parent-reported	Continuous: recoded as dichotomous (≤15 hours/week) or (>15 hours/week)
Home Environment		
Number of televisions in the house	Parent-reported	Re-coded as categorical: 0 or 1 or ≥2
Number of functional cars at home	Parent-reported	Re-coded as categorical: 0 or 1 or ≥2
Number of siblings for participant	Parent-reported	Continuous: recoded as dichotomous ≤2 or ≥3
Number of residents at home	Parent-reported	Continuous: recoded as dichotomous; ≤3 or≥4
Neighborhood Environment		
Crime rate in the neighbourhood	Parent-reported	Re-coded as binary: "disagreed/strongly disagreed", and "agreed/strongly agreed"
Trust people in the community	Parent-reported	Re-coded as binary: "disagreed/strongly disagreed", and "agreed/strongly agreed"
School Environment		
School location	School-Administrator-reported	Binary: urban or rural
Physical activity policies	School-Administrator-reported	Binary: yes/no
Healthy eating policies	School-Administrator-reported	Binary: yes/no
BMI: Body Mass Index		

Table 2: Descriptive characteristics					
Continuous variables	**Mean (SD)**				
	Total sample	**Urban**	**Rural**	**t-value**	**p-value**
Age (years)	10.1 (0.8)	10.2 (0.8)	10.1 (0.8)	2.5	0.01*
BMI z-score	-0.4 (1.0)	-0.2 (1.0)	-0.5 (0.9)	3.3	0.001*
Categorical variables	**N (%)**			**Chi-Square**	**p-value**
Sex (% female)	683 (52.9)	333 (54.7)	350 (51.1)	0.8	0.4
Weight Categories					
Thinness	36 (5.3)	14 (4.2)	22 (6.3)	8.7	0.03*
Normal Weight	589 (86.2)	281 (84.4)	308 (88.0)		
Overweight	46 (6.7)	29 (8.7)	17 (4.9)		
Obese	12 (1.8)	9 (2.7)	3 (0.9)		
Parents did not complete high school	431 (74.3)	172 (62.1)	259 (85.5)	48.8	<.0001*
Parents completed high school, some college	111 (19.1)	71 (25.6)	40 (13.2)		
Parents completed bachelors or higher degree	38 (6.6)	34 (12.3)	4 (1.3)		
Data are presented for participants with complete data. SD: Standard Deviation; BMI: Body Mass Index; *= statistically significant					

Table 3: Univariate correlates of overweight/obesity					
Variables	**Estimate**	**SE**	**Odds Ratio**	**Confidence limits**	**p-value**
Individual characteristics					
Sex	-0.11	0.28	1.12	0.64– 1.93	0.7
Age	0.32	0.20	1.38	0.94 – 2.03	0.1
Passive commute to school	1.21	0.34	3.37	1.72 – 6.60	**0.0006***
Total sedentary time	0.00	0.00	1.00	1.00 – 1.00	0.8
Light-intensity physical activity	0.00	0.00	1.00	0.99 – 1.00	0.7
Not meeting daily MVPA guidelines	1.00	0.38	2.71	1.29 – 5.73	**0.009***
Sleep duration	-0.00	0.00	1.00	0.99 – 1.01	0.4
Recreational screen time	0.15	0.06	1.16	1.03 – 1.30	**0.01***
Outdoor playtime	-0.02	0.10	0.98	0.81 – 1.18	0.8
Non-participation in sports	0.43	0.34	1.54	0.79 – 3.00	0.2
Poor health-related quality of life	0.27	0.33	1.30	0.68 – 2.49	0.4
Frequent consumption of breakfast	-0.01	0.36	0.99	0.49 – 1.99	0.9
Frequent consumption of fruits	0.34	0.29	1.42	0.79 – 2.52	0.2
Frequent consumption of vegetables	-0.03	0.31	0.97	0.52 – 1.79	0.9
Frequent consumption of fast-food	0.82	0.32	2.27	1.22 – 4.24	**0.01***
Frequent consumption of fried food	0.34	0.29	1.41	0.80 – 2.50	0.2
Frequent consumption of fast food while watching television	0.73	0.31	2.08	1.12 – 3.84	**0.02***
Characteristics of participant's parents/legal guardians					
Mother's BMI >25 kg/m^2	1.41	0.39	4.10	1.92 - 8.75	**0.0003***
Father's BMI >25 kg/m^2	0.17	0.29	1.18	0.66 – 2.11	0.6
Higher level of parental education	-0.50	0.30	1.65	0.90 – 2.99	0.1
Mother works ≥15 hours/week	0.36	0.30	1.44	0.80 – 2.59	0.2
Father works ≥15 hours/week	0.72	0.31	2.05	1.11 – 3.77	**0.02***
Home Environment					
> number of televisions in the house	0.09	0.32	1.08	0.59 – 2.00	0.8
> number of functional cars at home	0.50	0.29	1.64	0.93 – 2.93	**0.09***
> number of siblings for participant	-0.53	0.28	0.59	0.34 – 1.03	**0.06***
> number of residents at home	-0.34	0.30	0.70	0.39 – 1.27	0.2
Neighborhood Environment					
Crime rate in the neighbourhood	0.33	0.31	1.38	0.76 – 2.52	0.3
Trust people in the community	0.19	0.29	1.21	0.69 – 2.13	0.5
School Environment					
School location	0.74	0.37	0.48	0.21 – 1.04	**0.06***
No physical activity policies	0.31	0.41	1.37	0.57 – 3.30	0.4
No healthy eating policies	0.09	0.41	1.10	0.46 – 2.63	0.8
MVPA: moderate- to vigorous-intensity physical activity; BMI: body mass index; *: statistically significant					

Table 4: Univariate correlates of thinness					
Variables	**Estimate**	**SE**	**Odds Ratio**	**Confidence limits**	**p-value**
Individual characteristics					
Sex	0.64	0.35	0.53	0.26 – 1.06	**0.07***
Age	0.52	0.24	1.69	1.05 – 2.70	**0.03***
Passive commute to school	-0.31	0.59	0.73	0.23 – 2.33	0.6
Total sedentary time	0.00	0.00	1.00	0.99 – 1.01	0.6
Light-intensity physical activity	-0.00	0.00	1.00	0.99 – 1.00	0.4
Not meeting daily MVPA guidelines	0.66	0.53	1.93	0.68 – 5.44	0.2
Sleep duration	-0.00	0.00	1.00	0.99 – 1.01	0.5
Recreational screen time	-0.13	0.09	0.88	0.74 – 1.04	0.1
Outdoor playtime	-0.07	0.13	0.94	0.72 – 1.21	0.6
Non-participation in sports	0.17	0.43	1.18	0.51 – 2.73	0.7
Poor health-related quality of life	-0.21	0.47	0.81	0.32 – 2.05	0.7
Frequent consumption of breakfast	-0.53	0.39	0.59	0.27 – 1.26	0.2
Frequent consumption of fruits	-0.30	0.39	0.73	0.34 – 1.60	0.4
Frequent consumption of vegetables	-0.57	0.47	0.56	0.22 – 1.42	0.2
Frequent consumption of fast-food	-1.04	0.63	0.35	0.10 – 1.21	**0.09***
Frequent consumption of fried food	0.06	0.38	1.06	0.50 – 2.25	0.9
Frequent consumption of fast food while watching television	-0.29	0.42	0.75	0.32 – 1.72	0.5
Characteristics of participant's parents/legal guardians					
Mother's BMI >25 kg/m^2	-0.93	0.36	0.39	0.20 – 0.80	**0.009***
Father's BMI >25 kg/m^2	0.46	0.38	1.59	0.75 – 3.32	0.2
Higher level of parental education	-0.24	0.41	1.27	0.57 – 2.85	0.5
Mother works ≥15 hours/week	0.08	0.39	1.08	0.50 – 2.33	0.8
Father works ≥15 hours/week	0.27	0.37	1.31	0.64 – 2.70	0.5
Home Environment					
> number of televisions in the house	-0.39	0.39	0.68	0.31 – 1.48	0.3
> number of functional cars at home	-0.88	0.38	0.42	0.20 – 0.87	**0.02***
> number of siblings for participant	-0.11	0.36	0.90	0.44 – 1.83	0.8
> number of residents at home	-0.16	0.36	0.85	0.43 – 1.71	0.7
Neighborhood Environment					
Crime rate in the neighbourhood	-0.00	0.37	0.99	0.48 – 2.04	0.9
Trust people in the community	0.45	0.36	1.57	0.78 – 3.15	0.2
School Environment					
School location	-0.37	0.46	1.45	0.56 – 3.77	0.4
No physical activity policies	-0.38	0.49	0.68	0.25 – 1.86	0.4
No healthy eating policies	0.15	0.46	1.16	0.44 – 3.05	0.8
MVPA: moderate- to vigorous-intensity physical activity; BMI: body mass index; *: statistically significant					

Table 5: Final Multivariable Models					
Variables	**Estimate**	**SE**	**Odds Ratio**	**Confidence limits**	**p-value**
Correlates of overweight/obesity					
Passive commute to school	0.86	0.38	2.36	1.11– 5.00	**0.03***
Not meeting daily MVPA guidelines	0.98	0.43	2.68	1.15 – 6.18	**0.02***
Recreational screen time	0.05	0.07	1.06	0.92 – 1.21	0.4
Frequent consumption of fast-food	0.65	0.38	1.92	0.92 – 4.02	0.08
Frequent consumption of fast food while watching television	0.48	0.42	1.61	0.74– 3.65	0.3
Mother's BMI >25 kg/m^2	1.61	0.40	4.94	2.26 – 10.94	**<.0001***
Father works ≥15 hours/week	0.54	0.33	1.72	0.90 – 3.28	0.1
> number of siblings for participant	-0.50	0.30	0.61	0.34 – 1.10	0.1
School location	0.46	0.50	1.59	0.58 – 4.32	0.4
Sex	-0.06	0.31	1.06	0.58 – 1.92	0.9
Age	0.40	0.21	1.50	0.99 – 2.28	0.06
Higher level of parental education	0.00	0.31	0.99	0.51 – 1.92	0.9
Correlates of thinness					
Mother's BMI >25 kg/m^2	-1.13	0.37	0.33	0.16 – 0.68	**0.003***
> number of functional cars at home	-1.18	0.42	0.30	0.14 – 0.70	**0.005***
Frequent consumption of fast-food	-1.00	0.67	0.37	0.10 – 1.36	0.1
School location	0.72	0.53	2.02	0.68 – 6.01	0.2
Sex	0.70	0.37	0.50	0.24 – 1.02	0.06
Age	0.56	0.25	1.75	1.06 – 2.87	**0.03***
Higher level of parental education	-0.20	0.45	1.23	0.51 – 2.94	0.6
MVPA: moderate- to vigorous-intensity physical activity; BMI: body mass index; SES: Socioeconomic status; *: statistically significant Models were adjusted for age, sex, SES, school location					

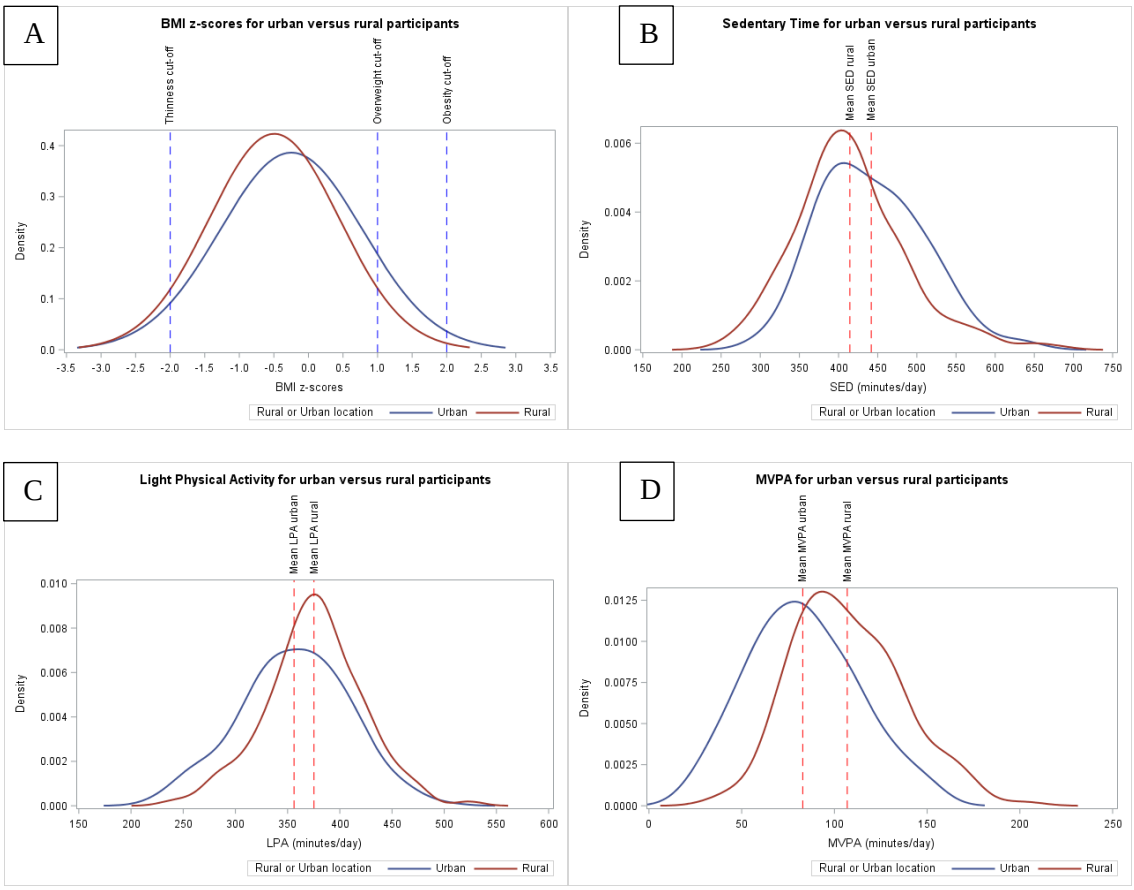

Figure 1: Density curves based on complete cases, comparing body mass index z-scores (A), total sedentary time (B), light physical activity (C), and moderate-vigorous-physical activity (D), between urban and rural participants. BMI = Body Mass Index; SED = Total Sedentary Time; LPA = Light Physical Activity; MVPA = Moderate- to Vigorous- Intensity Physical Activity

Chapter 4.4: Prevalence and correlates of adherence to movement guidelines among urban and rural children in Mozambique: a cross-sectional study

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Key Words: 24-hour movement guidelines, correlates, urban/rural comparison, Moderate- to vigorous-intensity physical activity, sleep, recreational screen time.

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Article Preface: This article addresses objective 3 "To compare and contrast the prevalence and correlates of adherence to movement guidelines among urban and rural schoolchildren in Mozambique", for this dissertation. I am the primary (first) author on this article. In consultation with my supervisor, I conceived of the idea of the manuscript, drafted the manuscript, cleaned and analyzed the data, and submitted the final version for publication. All co-authors contributed significantly and met the International Committee of Medical Journal Editors guidelines for authorship. They all edited the manuscript for content, and approved the final version of the manuscript before it was submitted for peer review. Ethics approvals (refer to Appendices D-F) for the data used in this article were obtained from the relevant authorities prior to data collection.

Abstract

Background: Insufficient physical activity, short sleep duration, and excessive recreational screen time are increasing globally. In many low-middle-income countries there is little available evidence to accurately describe these movement behaviours among children and adolescents. Furthermore, representative samples from LMICs that include both urban and rural dwelling respondents are lacking, despite the large proportion of rural dwelling people in these countries. In this study, we compared the prevalence of meeting 24-hour movement guidelines and examined correlates of meeting the guidelines in a sample of urban and rural Mozambican schoolchildren.

Methods: This cross-sectional study of 9-11 year-old children (n=683) recruited participants from 10 urban and 7 rural schools in Mozambique. Moderate- to vigorous-intensity physical activity (MVPA) and sleep duration were measured by waist-worn Actigraph GT3X+ accelerometers. Accelerometers were worn 24 hours/day for up to eight days. Recreational screen time was self-reported. Multilevel multivariable logit models were used to determine the correlates of movement behaviours. Meeting 24-hour movement guidelines was defined as ≥60 min/day of MVPA, ≤2 h/day of recreational screen time, and between 9 and 11 hours/night of sleep.

Results: More rural (17.7%) than urban (3.6%) children met all three 24-hour movement guidelines. Mean MVPA was lower (82.9±29.5 minutes/day) among urban than rural children (96.7±31.8 minutes/day). Rural children had longer sleep duration (8.9±0.7 hours/night) and shorter recreational screen time (2.7±1.9 hours/day) than their urban counterparts (8.7±0.9 hours/night and 5.0±2.3 hours/day respectively). Parental education (OR: 0.37; CI: 0.16–0.87),

school location (OR: 0.21; CI: 0.09–0.52), and outdoor time (OR: 0.67; CI: 0.53–0.85) were significant correlates of meeting all three 24-hour movement guidelines.

Conclusions: Prevalence and correlates of meeting movement guidelines differed between urban and rural schoolchildren in Mozambique. On average, both groups had higher daily MVPA minutes, shorter sleep duration, and higher recreational screen time than the 24-hour movement guidelines recommend. These findings differ from those from high-income countries and highlight the need to sample from both urban and rural areas.

Introduction

Insufficient physical activity (PA),[1] short sleep duration,[2] and excessive recreational screen time (ST)[3] among children and adolescents are reaching alarming levels globally. In 2010, self-reported data from the Global Health Observatory showed that 81% of 11-17 year-old adolescents did not accumulate the recommended ≥60 minutes of daily moderate- to vigorous-intensity physical activity (MVPA).[4] A recent review showed that overall, 5-18 year-old children and adolescents from 20 countries have been losing an average of 0.76 minutes of sleep/year over the past century,[2] although the evidence for secular trends is mixed, conflicting and limited.[5] Evidence has also shown that 2-18 year-old children and adolescents spent 3-8 hours in ST/day,[3] while another review showed that 5-18 year-olds spent 51% of their off-school time in ST.[6] The unfavourable pattern in 24-hour movement behaviours (i.e., shorter sleep, low levels of MVPA, high ST) may be related to the ongoing PA transition,[7] and modernity.[8]

Insufficient PA, inadequate sleep duration, and excessive ST have been linked with a higher risk of childhood obesity, cardiovascular disease, metabolic syndrome, type 2 diabetes mellitus, and all-cause mortality in adulthood.[9–12] Surveillance mechanisms for the prevention and identification of those most at risk for the health consequences associated with suboptimal MVPA or sleep includes national[13,14] and global[15,16] 24-hour movement guidelines for children and youth. Although there are currently no quantitative guidelines for total sedentary behaviours, some countries have developed and adopted guidelines for maximum daily ST (≤2 hours) as one dimension of sedentary behaviour.[13,14] There has been growing interest in understanding patterns and the potential relationships between 24-hour movement behaviours and health indicators,[13,17,18] but most of the available evidence is based on studies from high-income

countries. In many low-middle-income countries (LMICs) there is little available evidence to accurately describe patterns of movement behaviours among children and adolescents.[19] Furthermore, representative samples from LMICs that include both urban and rural dwelling respondents are lacking, despite the large proportion of rural dwelling people in these countries.[20] For example, in Mozambique the little available objective evidence[21] documenting the prevalence of movement behaviours does not compare urban and rural children despite the well-known differences in their lifestyles. The relative lack of current and robust evidence on movement behaviours was identified as an urgent priority in the most recent synthesis[22] of available data in Mozambique and highlighted in the recent World Health Organization Global Action Plan for Physical Activity.[23]

The purpose of the present study was to 1) compare the prevalence of urban and rural schoolchildren meeting 24-hour movement guidelines and 2) examine correlates of meeting the 24-hour movement guidelines in a sample of urban and rural Mozambican children. We hypothesized that children attending rural schools would accumulate more minutes of MVPA, have longer sleep duration and less ST compared to those from urban schools and that correlates of movement behaviours would differ between urban and rural children.

Methods

Study design and participants: Participants (9-11 year-old primary schoolchildren) for this cross-sectional study (n = 683) were recruited from 10 urban (Maputo, stratified by socioeconomic status) and 7 rural (Macia district) schools in Mozambique. At least three urban schools were randomly recruited from each of three districts, using a list provided by the Ministry of Education to maximize variability in levels of neighborhood socioeconomic status (SES). Rural schools

were purposively recruited from a list provided by the district education office. One urban school declined to participate after being approached and was replaced by another school from the same district. Participants whose parents provided consent and were between ages 9 and11 years old were included in the study. We followed the published protocol and methodology used in the International Study of Childhood Obesity, Lifestyle and the Environment (ISCOLE).[24] Data were collected between August 2017 and May 2018. We adhered to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for cross-sectional studies.

24-Hour Movement Guidelines for Children and Youth: 24-Hour Movement Guidelines for Children and Youth[13,14] recommend that within a 24-hour period, children and youth should accumulate at least 60 minutes of MVPA, engage in no more than 2 hours of ST, and obtain uninterrupted sleep of 9 to 11 hours per night. For the present study, participants were classified as meeting the overall guidelines if they met all three recommendations.

Measurement of movement behaviours

Sleep and MVPA: Actigraph GT3X+ accelerometers were used to objectively measure nocturnal sleep, and PA. The accelerometers were attached to an elastic belt and worn over the right hip, for seven consecutive days plus an initial familiarization day. To improve compliance, a 24-hour protocol was implemented, encouraging participants to wear the accelerometer at all times except during water-based activities.[26] An algorithm was used to identify total nocturnal sleep time and an additional algorithm was used to identify periods of awake non-wear time (any sequence of $\geq$20 consecutive minutes of 0 activity counts).[27] Data were collected at a sampling rate of 80 Hz, downloaded in 1-second epochs with the low-frequency extension filter using the ActiLife software version 6.5.4 (ActiGraph LLC, Pensacola, FL, USA). Data were subsequently

aggregated to 15- and 60-second epochs for summarizing PA and nocturnal sleep, respectively. After accounting for the total nocturnal sleep and awake non-wear time,[27] all remaining minutes were classified as awake-wear time. Participants with ≥10 hours of wear time/day on at least 4 days including 1 weekend day were considered to have sufficient PA data. Cut-points developed by Evenson et al.[28] were used to quantify MVPA (≥574 counts/15-seconds). Sleep duration and MVPA were dichotomized as those who did not meet the sleep duration guideline (<9 hours/night vs. meeting 9 to 11 hours/night) and not meeting the MVPA guideline (<60 minutes/day vs. meeting ≥60 minutes/day).

Recreational screen time: A *Demographic and Lifestyle Questionnaire* with questions derived from the U.S Youth Risk Behaviour Surveillance System was used to obtain data on ST. Participants were asked the following questions: 1) on a school day, how many hours did you watch TV; 2) on a school day, how many hours did you play video or computer games or use a computer for something that was not school; 3) on a weekend day, how many hours did you watch TV; or 4) on a weekend day, how many hours did you play video or computer games or use a computer for something that was not school work? Response options were: did not watch TV, ≤ 1hour of TV, 2 hours, 3 hours, 4 hours, and ≥5 hours of TV. A weighted mean score of hours of daily ST was calculated as follows: [(hours of TV on weekdays x 5) + (hours of TV on weekend days x 2) + (hours of video games and computers on weekdays x 5) + (hours of video games and computers on weekend days x 2)]/7. Quantifying ST using self-reported methods has been shown to have acceptable reliability and validity in children.[29] ST was dichotomized as those who did not meet the ST guideline (>2 hours/day) versus those who met the guidelines (≤2hours/day).

Covariates: Participants' sex and age, highest level of parental education (a proxy of socioeconomic status), and school location were used as covariates in all multivariable models because of the plausibility of confounding.

Treatment of missing data: Overall, 103 participants (15%) were missing data on parental education and 149 participants (22%) had insufficient accelerometry data. Participants with missing data did not significantly differ in mean age (mean difference=0.02 years; p=0.7), or sex (chi-square=1.31; p=0.3). The proportion of participants missing data on the highest level of parental education did not differ from those with complete data (p=0.7). To minimize loss of information, and potentially biasing the results due to excluding missing cases,[30] multiple imputation by chained equations (MICE) was applied[31] using the R statistical Package, "mice".[32] Missing values were multiply imputed (50 datasets) under the Missing At Random (MAR) assumptions,[31] which were tested using recursive partitioning analysis,[33] the Little MCAR's test,[34] and missing patterns analyses.[31]

Statistical Analyses: Statistical analyses were computed using SAS 9.4 (SAS Institute Inc., North Carolina, USA) and R (version 3.5.2; The R Foundation for Statistical Computing, Vienna, Austria). Descriptive characteristics of participants were summarized using means (SD) or frequencies (percentages) as appropriate. Unpaired t-tests and chi-square tests (χ^2) were used to examine potential differences between participants attending urban versus rural schools. Multilevel multivariable logit models (PROC GLIMMIX) accounting for clustering at the school level were used to determine the correlates of meeting MVPA, sleep, ST, and MVPA + sleep + ST guidelines (0, no; 1, yes). Schools were treated as random effects in all models. For intercept

estimates to be more meaningful, all continuous predictors were grand mean centered prior to estimating the models. Denominator degrees of freedom pertaining to fixed effects were calculated using the Kenward Roger approximation (DDFM = KR).[35] Variance tolerance inflation factors (VIF) were applied to test for multicollinearity in multivariable models.[36] Unless stated (i.e. VIFs > 10), no problems regarding multicollinearity were identified. Potential correlates were selected *a priori*, based on availability and previous literature.[37–41] Table 1 presents the list of the potential correlates and how they were used in the analyses. First, each potential correlate was included in univariable models and those that were at least marginally ($p < 0.10$) statistically significant were retained for use in the multivariable models. This less-strict criterion was applied for univariable analyses to prevent the potential exclusion of important variables. Potential correlates that remained marginally statistically significant ($p<0.10$) from the univariable analyses were entered in final models including all variables and covariates. Variables that were statistically significant ($p<0.05$) in the final models were considered to be correlates of meeting movement guidelines.

INSERT TABLE 1 HERE

Results

Table 2 presents descriptive characteristics of participants with complete data, stratified by urban and rural school location. Participants (52.9% girls) had a mean age of 10.1±0.8 years. The mean MVPA minutes/day for both urban (82.9±29.5), and rural (96.7±31.8) children, were above the recommended 60 minutes/day. Average sleep duration was lower and average daily ST was higher than the recommended amounts for both groups. There were statistically significant differences for all descriptive characteristics between urban and rural participants except sex (χ^2

= 0.8; p=0.4). Figure 1A shows that more rural (17.7%) compared to urban (3.6%) participants (Figure 1B) met all three 24-hour movement guidelines. Figure 1C illustrates that only 10.8% of the entire sample met all three of the 24-hour movement guidelines, while 5% did not meet any of the recommended guidelines.

INSERT TABLE 2 HERE

INSERT FIGURE 1 HERE

Table 3 presents univariable correlates of meeting each of the three movement behaviours plus all of them combined. In the univariable analyses, four potential correlates had a marginal ($p < 0.10$) statistically significant association with meeting the MVPA guideline, eight correlates for meeting the ST guideline, and one each for the sleep duration guideline and all three 24-hour movement guidelines. Results from multivariable analyses (Table 4) show that participants from urban schools were much less likely to meet the MVPA (OR: 0.19; CI: 0.07–0.52), ST (OR: 0.34; CI: 0.12–0.93), or all three 24-hour movement guidelines (OR: 0.21; CI: 0.09–0.52) than their rural counterparts. Older children (OR: 0.75; CI: 0.59–0.95) had lower odds of meeting the sleep duration guideline. Participants who engaged in sports (OR: 0.47; CI: 0.29–0.78) were less likely to meet the ST guideline and those reporting longer outdoor time (OR: 0.62: CI: 0.51–0.75) had lower odds of meeting the ST or all three 24-hour movement guidelines (OR: 0.67; CI: 0.53–0.86).

INSERT TABLE 3 HERE

INSERT TABLE 4 HERE

Discussion

Results from this study revealed distinct differences in prevalences of meeting movement guidelines and related correlates between urban and rural children in Mozambique. To the best of our knowledge, this is the first study to compare accelerometer measured movement behaviours between urban and rural children in Mozambique. The observed differences in the prevalences and correlates of movement guideline adherence between urban and rural children supports our primary hypothesis and underscores the importance of including both groups for research and surveillance, especially in sub-Saharan Africa where the majority of the population still live in rural areas.[20] Sex (OR: 4.18; CI: 2.08–8.41, MVPA), school location (OR: 0.21; CI: 0.09–0.52, all three 24-hour movement guidelines) and parental education (OR: 0.37; CI: 0.16–0.87, for all three 24-hour movement guidelines) had medium to large effect sizes,[42] suggesting moderate- to strong associations with adherence to movement behaviours.

The higher levels of MVPA among children in the present study differs from previous reports in high-income countries[1,43,44] but supports the results reported by Prista et al[21] albeit from a sample of only rural Mozambican children, and demonstrates the key role that household, or utilitarian PA may be playing in these contexts. These findings merit discussing, debating and exploring public health messaging that encourages maintaining the high levels of MVPA for better health benefits. Furthermore, it may be useful for planners to include items that capture the various domains of PA (including utilitarian PA) when designing surveillance measurement instruments, enabling researchers to quantify and better characterize these sub-categories. The higher odds of boys than girls meeting MVPA guidelines is consistent with previously reported results from both high-income countries and LMICs,[45–47] suggesting that it is not unique to one region or

country, and may call for the need to deliberately evaluate the real or perceived contextual and cultural barriers to the equitable participation in MVPA for girls.

The fact that more rural children are adhering to movement guidelines than their urban counterparts may be related to the ongoing PA transition.[7] Accelerometer data obtained by Ojiambo et al. showed higher MVPA and lower sedentary behaviour among rural compared to urban Kenyan adolescents.[47] Systematic review evidence of studies from sub-Saharan Africa showed that children living in urban areas were more likely to engage in lower levels of PA, and higher sedentary behaviour than their rural counterparts.[48] Furthermore, an examination of secular trends in habitual PA in the city of Maputo, Mozambique revealed a general negative trend between 1992 and 2012[49] and cited decreased household chores associated with economic and social transitions as likely contributing to the trend. Collectively, these results suggest that the urban environment itself (e.g. lack of walkability, reduced need for habitual PA, and safety concerns) may be detrimental to a healthy active childhood.

Consequences of urbanization (e.g. passive transportation) and modernity (e.g. availability of more screens) may be reducing the opportunities for habitual PA and increasing chances for sedentary pursuits among urban dwellers in Mozambique. Conversely, opportunities for engaging in utilitarian PA is likely preserved in rural areas where availability of space, lack of artificial lighting and less access to screens and may be helping children to attain more MVPA, longer sleep duration and have less ST. This observation is supported by our finding showing that only 1.4% of the rural participants failed to meet any guideline compared to 8.7% of the urban participants. In addition, our findings are consistent with results from previous research

among children and youth elsewhere in Africa.[46–48] Movement behaviours for children and adolescents in our sample may also be influenced by other factors such as family affluence. For example, our results showed that children whose parents reported that they had ≥2 functional cars at home or those who reported frequent consumption of fast-food while watching TV, (both potential proxies of family affluence) had lower odds of meeting movement guidelines. Self-reported participation in sports and outdoor time had counterintuitive associations with adherence to the ST guideline and all three 24-hour movement guidelines. It is possible that participants either over or underestimated times spent in these activities given the subjective nature of the instruments used, and the potential for social desirability and other associated biases. Alternatively, it is plausible that participants that could afford to participate in sports and have ample outdoor time in this context may be more affluent with less requirements for household and other chores, and are more likely to also afford ST opportunities.

Our finding showing average ST being higher than the recommended ≤ 2 hours/day among both urban and rural children supports results from previous studies,[3,6] and may be indicative of the current pervasiveness of ST among children worldwide, even for those in LMICs, thus similarly exposing them to the associated health-related risks.[50,51] Average sleep duration for the present sample (8.8±0.8 hours/night) was shorter than the recommended 9-11 hours/night, but compares well to that reported for the whole ISCOLE sample (8.8±0.9),[52] which was obtained using a similar protocol.[27] Although these findings only represent a snapshot in time, they add to the growing body of evidence[2,8] suggesting secular trends for shorter sleep duration, albeit the mixed and conflicting evidence.[2,53] Alternatively, shorter sleep duration may be inevitable in this population where school start times are generally early, and rural children may need to first

complete household chores, walk long distances to school thus necessitating early wake up times. Given the higher average ST and shorter average sleep duration for the urban versus rural participants, it is plausible that modernity,[8] and urbanization may be contributing to these findings.

The limitations of this study include its cross-sectional design which precludes inferences about directionality or causation. Associations found are limited to the list of available correlates and we also cannot exclude the potential confounding effects of unmeasured variables. Our sample is not necessarily representative, and for several variables, relied on self-reported data obtained by instruments whose validity and meaning in this context, especially for the rural population, has not been assessed. Because of missing data on key variables, multiple imputation was applied with potential of introducing bias. However, comparative analyses between complete data cases and imputed datasets do not support this potential limitation. Nonetheless, this study has important strengths that include our recruitment of a relatively large sample with both urban and rural participants. We objectively measured movement behaviours, and followed a rigorous and standardized study protocol. For example, research staff were trained and certified prior to data collection. Finally, our multilevel analyses accounted for the hierarchical nature of these data.

Conclusion and future directions

The prevalence of meeting movement guidelines and related correlates differed between urban and rural children. On average, both groups had higher daily MVPA minutes, shorter sleep duration, and higher ST than recommended in the 24-hour movement guidelines. It is important for future research to account for the environmental, contextual and cultural factors unique to

LMICs and to urban and rural living. Further, public health messages should be tailored in these areas to promote and preserve higher MVPA, longer sleep duration, and less ST as the preferable way of life. Such a message could emphasize the additional benefits associated with exceeding the thresholds for MVPA given in the 24-hour movement guidelines. Our study provides data that can be used to inform local policies and strategies and can serve as evidence supporting the need to include both rural and urban samples in studies and surveillance efforts, particularly in Africa.

List of abbreviations

BMI: Body mass index

CI: Confidence Interval

CIHR: Canadian Institutes of Health Research

DDFM=KR: Denominator degrees of freedom = Kenwardroger

ICC: Intraclass correlation coefficient

IDRC: International Development Research Centre

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

LMICs: Low-middle-income countries

MAR: Missing at random

MCAR: Missing Completely at Random

MICE: Multiple imputation by chained equations

MVPA: Moderate- to vigorous-intensity physical activity

NCDs: Non-communicable diseases

OR: Odds Ratios

PA: Physical Activity

ST: Recreational Screen Time

SD: Standard deviation

STROBE: Strengthening the Reporting of Observational Studies in Epidemiology

VIF: Variation inflation factors

WHO: World Health Organization

Declarations

Ethics approval and consent to participate: Ethical approvals were received from the Children's Hospital of Eastern Ontario Research Ethics Board (#17/59X), University of Ottawa Research Ethics Board (#A05-17-02), and Mozambique National Bioethics Committee for Health (#151/CNBS/17) before data collection commenced. Written informed consent was obtained from parents/guardians before including participants. For parents/guardians with low levels of literacy, research assistants read and explained the contents of consent forms in Portuguese or Xangana.

Consent for Publication: Not applicable

Availability of data and material: The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing Interests: The authors declare that they have no competing interests.

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Authors' contributions: TM and MST conceived this paper with input from JDB, J-PC, PTK, and AP. TM, and JDB analysed the data with input from MST, AP, PTK, and J-PC. TM developed the final version of the manuscript and MST, JDB, AP, J-PC, and PTK provided significant edits and approved the final manuscript.

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Table 1: Potential correlates of meeting movement guidelines.		
Variable	**Method of measurement**	**Use in analysis**
Potential correlates common to MVPA, Sleep duration, and ST.		
Sex	Parent-reported	Binary variable: male or female (covariate)
Age	Parent-reported	Continuous (covariate)
BMI z-score	Objectively measured	Continuous
School commute (mode of transport to and from school for main part of the journey)	Participant-reported	Re-coded as dichotomous: active (walking, bicycle / rollerblade / skateboard / scooter), or passive (bus / train / boat / car / motorcycle / moped)
Outdoor time (before school, after school, weekend)	Participant-reported	Continuous
Participation in sports	Participant-reported	Re-coded as dichotomous: (did not participate in sporting activities) or (participated in sporting activities) in the past year
Self-perceived health	Participant-reported	Re-coded as dichotomous: (poor, fair) or (good, very good, excellent)
Parental level of education	Parent-reported	Re-coded as highest level of parental education (covariate): <high school, high school/some college, or bachelor's/graduate degree
Mother's work status	Parent-reported	Continuous: re-coded as dichotomous (≤15 hours/week) or (>15 hours/week)
Father's work status	Parent-reported	Continuous: recoded as dichotomous (≤15 hours/week) or (>15 hours/week)
School location	School-Administrator-reported	Binary: urban or rural (covariate)
Number of televisions in the house	Parent-reported	Continuous: re-coded as categorical: 0 or 1 or ≥2
Number of functional cars at home	Parent-reported	Continuous: re-coded as categorical: 0 or 1 or ≥2
Number of siblings for participant	Parent-reported	Continuous: recoded as dichotomous ≤2 or ≥3
Crime rate in the neighbourhood	Parent-reported	Re-coded as dichotomous: "disagreed/strongly disagreed", and "agreed/strongly agreed"
Trust people in the community	Parent-reported	Re-coded as dichotomous: "disagreed/strongly disagreed", and "agreed/strongly agreed"
Correlates specific to MVPA		
School physical activity policies	School-Administrator-reported	Binary: yes/no

Mother's BMI	Parent-reported	Continuous: re-coded as dichotomous <25 or ≥25
Father's BMI	Parent-reported	Continuous: re-coded as dichotomous <25 or ≥25
Sleep duration	Accelerometer measured	Continuous
Recreational screen time	Participant-reported	Continuous
Correlates specific to Sleep duration		
Recreational screen time	Participant-reported	Continuous
Moderate-to-vigorous-intensity physical activity	Accelerometer measured	Continuous: re-coded as dichotomous (< 60 minutes per day) or (≥60 minutes per day)
Correlates specific to ST		
Sleep duration	Accelerometer measured	Continuous
MVPA	Accelerometer measured	Continuous: re-coded as dichotomous (< 60 minutes per day) or (≥60 minutes per day)
Consumption of fast-food	Participant-reported	Re-coded as dichotomous: (eats fast food ≤ 3 times per week) or (eats fast food > 3 times per week)
Consumption of fried food	Participant-reported	Re-coded as dichotomous: (eats fried food ≤ 3 times per week) or (eats fried food > 3 times per week)
Consumption of fast food while watching television	Participant-reported	Re-coded as dichotomous: (does not eat fast food while watching television) or (eats fast food while watching television at least once per week)
BMI: Body Mass Index; MVPA: moderate- to vigorous-intensity physical activity; ST: recreational screen time.		

Table 2: Descriptive characteristics.					
Continuous variables	**Mean (SD)**				
	Total sample (n= 683)	**Urban (n= 333)**	**Rural (n= 350)**	**t-value**	**p-value**
Age (years)	10.1 (0.8)	10.2 (0.8)	10.1 (0.8)	2.5	0.01*
MVPA (minutes/day)	96.7 (31.8)	82.9 (29.5)	106.9 (29.5)	-9.3	<.0001*
Sleep duration (hours/day)	8.8 (0.8)	8.7 (0.9)	8.9 (0.7)	-2.5	0.01*
ST score (hours/day)	3.8 (2.4)	5.0 (2.3)	2.7 (1.9)	14.1	<.0001*
Categorical variables	**N (%)**			**chi-square**	**p-value**
Sex (% female)	683 (52.9)	333 (54.7)	350 (51.1)	0.8	0.4
MVPA (% meeting recommendations)	534 (89.0)	228 (77.2)	306 (97.7)	56.0	<.0001*
Sleep duration (% meeting recommendations)	530 (39.3)	227 (33.5)	303 (43.6)	5.5	0.02*
ST (% meeting recommendations)	662 (24.2)	318 (8.2)	344 (40.0)	85.4	<.0001*
Parents did not complete high school	431 (74.3)	172 (62.1)	259 (85.5)	48.8	<.0001*
Parents completed high school, some college	111 (19.1)	71 (25.6)	40 (13.2)		
Parents completed bachelors or higher degree	38 (6.6)	34 (12.3)	4 (1.3)		

Data are presented for participants with complete data.
SD: standard deviation; MVPA: moderate- to vigorous-intensity physical activity; ST: recreational screen time.
Meeting the recommendations is defined as ≥60 min/day for MVPA, ≤2 h/day for ST, and between 9 and 11 hours per night for sleep.
*= statistically significant at $p < 0.05$.

Table 3: Univariable correlates of meeting MVPA, sleep duration, ST and combination of all three Movement Guidelines (n=683).					
Variables	**Estimate**	**SE**	**Odds Ratio**	**95% CI**	**p-value**
Meeting MVPA Guideline					
Commute to school (ref: passive)	-0.54	0.36	0.58	0.29 – 1.18	0.13
BMI z-score	-0.18	0.14	0.83	0.64 – 1.09	0.18
Outdoor time	0.16	0.10	1.18	0.96 – 1.44	0.12
Participation in sports (ref: did not participate)	0.44	0.38	1.56	0.73 – 3.30	0.25
Self-perceived health (ref: poor/fair)	0.67	0.33	**1.95**	**1.02 – 3.71**	**0.04**
Mother works (ref: < 15 hours/week)	0.52	0.33	1.68	0.88 – 3.22	0.12
Father works (ref: < 15 hours/week)	-0.74	0.33	**0.48**	**0.25 – 0.91**	**0.03**
Televisions in the house (ref: <1)	-0.68	0.31	**0.50**	**0.27 – 0.96**	**0.04**
Functional cars at home (ref: <2)	-0.89	0.31	**0.41**	**0.23 – 0.76**	**0.004**
Number of siblings (ref: ≤2)	-0.02	0.29	0.98	0.55 – 1.74	0.95
Crime rate in the neighbourhood (ref: crime not a problem)	-0.44	0.30	0.65	0.36 – 1.17	0.15
Trust people in the community (ref: do not trust)	-0.08	0.30	0.92	0.51 – 1.66	0.78
School physical activity policies (ref: not present)	-0.14	0.73	0.87	0.18 – 4.22	0.86
Mother's BMI (ref< 25 kg/m^2)	0.28	0.29	1.32	0.74 – 2.36	0.34
Father's BMI (ref< 25 kg/m^2)	-0.36	0.31	0.70	0.38 – 1.27	0.24
Sleep duration	-0.00	0.00	1.00	0.99 – 1.01	0.81
ST (ref: not meeting)	0.00	0.06	1.01	0.89 – 1.14	0.93
Meeting Sleep duration Guideline					
Commute to school (ref: passive)	0.11	0.27	1.12	0.65 – 1.91	0.67
BMI z-score	0.11	0.09	1.12	0.95 – 1.32	0.19
Outdoor time	0.00	0.06	1.00	0.89 – 1.12	0.99
Participation in sports (ref: did not participate)	0.50	0.23	**1.66**	**1.05 – 2.60**	**0.03**
Self-perceived health (ref: poor/fair)	0.16	0.21	1.17	0.77 – 1.78	0.45
Mother works (ref: < 15 hours/week)	0.00	0.19	1.00	0.69 – 1.45	0.99
Father works (ref: < 15 hours/week)	-0.07	0.18	0.93	0.66 – 1.32	0.70
Televisions in the house (ref: <1)	-0.10	0.20	0.90	0.61 – 1.34	0.61
Functional cars at home (ref: <2)	-0.09	0.19	0.91	0.63 – 1.32	0.62
Number of siblings (ref: ≤2)	0.04	0.17	1.04	0.74 – 1.46	0.83
Crime rate in the neighbourhood (ref: crime not a problem)	0.00	0.18	1.00	0.70 – 1.42	0.98
Trust people in the community (ref: do not trust)	-0.13	0.18	0.88	0.62 – 1.24	0.46
MVPA (ref: not meeting)	-0.31	0.30	0.73	0.40 – 1.33	0.30
ST (ref: not meeting)	-0.03	0.04	0.97	0.90 – 1.05	0.45
Meeting ST Guideline					
Commute to school (ref: passive)	-0.73	0.43	**0.48**	**0.21 – 1.11**	**0.09**

BMI z-score	-0.00	0.10	1.00	0.82 – 1.22	0.98
Outdoor time	-0.50	0.09	**0.61**	**0.51 – 0.73**	**<.0001**
Participation in sports (ref: did not participate)	-0.67	0.23	**0.51**	**0.32 – 0.81**	**0.004**
Self-perceived health (ref: poor/fair)	-0.28	0.24	0.75	0.47 – 1.21	0.24
Mother works (ref: < 15 hours/week)	-0.13	0.23	0.88	0.56 – 1.38	0.57
Father works (ref: < 15 hours/week)	-0.19	0.21	0.83	0.55 – 1.25	0.37
Televisions in the house (ref: <1)	-0.34	0.26	0.71	0.43 – 1.18	0.18
Functional cars at home (ref: <2)	-0.66	0.24	**0.52**	**0.32 – 83**	**0.006**
Number of siblings (ref: ≤2)	-0.28	0.21	0.75	0.50 – 1.14	0.18
Crime rate in the neighbourhood (ref: crime not a problem)	-0.38	0.22	**0.68**	**0.45 – 1.05**	**0.08**
Trust people in the community (ref: do not trust)	0.41	0.21	**1.51**	**1.00 – 2.28**	**0.05**
Sleep duration	0.00	0.00	1.00	0.99 – 1.00	0.73
MVPA (ref: not meeting)	0.83	0.55	2.29	0.78 – 6.73	0.13
Consumption of fast-food (ref: < 3 times per week)	-0.36	0.32	0.70	0.37 – 1.30	0.26
Consumption of fried food (ref: < 3 times per week)	-0.51	0.22	**0.60**	**0.38 – 0.94**	**0.03**
Consumption of fast food while watching television (ref: < 3 times per week)	-0.94	0.29	**0.39**	**0.22 – 0.68**	**0.001**
Meeting all three 24-Hour Movement Guidelines					
Commute to school (ref: passive)	-0.70	0.61	0.50	0.15 – 1.66	0.25
BMI z-score	0.03	0.13	1.03	0.79 – 1.35	0.81
Outdoor time	-0.39	0.12	**0.68**	**0.53 – 0.86**	**0.002**
Participation in sports (ref: did not participate)	-0.36	0.30	0.70	0.38 – 1.27	0.24
Self-perceived health (ref: poor/fair)	-0.13	0.32	0.87	0.46 – 1.65	0.68
Mother works (ref: < 15 hours/week)	0.10	0.31	1.10	0.60 – 2.04	0.76
Father works (ref: < 15 hours/week)	0.09	0.28	1.10	0.64 – 1.90	0.73
Televisions in the house (ref: <1)	0.21	0.34	1.24	0.64 – 2.43	0.52
Functional cars at home (ref: <2)	-0.12	0.31	0.89	0.48 – 1.65	0.71
Number of siblings (ref: ≤2)	-0.26	0.29	0.77	0.44 – 1.35	0.36
Crime rate in the neighbourhood (ref: crime not a problem)	-0.49	0.30	0.61	0.34 – 1.10	0.10
Trust people in the community (ref: do not trust)	0.18	0.28	1.20	0.69 – 2.07	0.52

Data are presented from imputed datasets.
MVPA: moderate- to vigorous-intensity physical activity; BMI: body mass index; ST: screen time; SE: standard error; CI: confidence interval.
Bold indicates marginally statistically significant correlates at $p < 0.10$.
Meeting the 24-hour movement guidelines is defined as ≥60 min/day for MVPA, ≤2 h/day for ST, and between 9 and 11 hours per night for sleep duration.

Table 4: Multivariable correlates of meeting MVPA, sleep duration, ST and combination of all three Movement Guidelines (n = 683).					
Variables	**Estimate**	**SE**	**Odds Ratio**	**95% CI**	**p-value**
Meeting MVPA Guideline					
Age	-0.39	0.24	0.68	0.42 – 1.09	0.10
Sex (ref: girls)	1.43	0.36	**4.18**	**2.08 – 8.41**	**<.0001***
Parental education (ref: <high school, high school/some college)	-0.35	0.33	0.71	0.37 – 1.35	0.29
School location (ref: rural)	-1.69	0.50	**0.19**	**0.07 – 0.52**	**0.002***
Self-perceived health (ref: poor healthy)	0.54	0.35	1.72	0.87 – 3.40	0.12
Father works (ref: < 15 hours/week)	-0.66	0.35	0.51	0.26 – 1.02	0.06
Televisions in the house (ref: <1)	-0.14	0.36	0.87	0.43 – 1.76	0.70
Functional cars at home (ref: <2)	-0.59	0.34	0.56	0.28 – 1.09	0.09
Meeting Sleep Duration Guideline					
Age	-0.29	0.12	**0.75**	**0.59 – 0.95**	**0.02***
Sex (ref: girls)	0.08	0.17	1.08	0.78 – 1.51	0.62
Parental education (<high school, high school/some college)	-0.13	0.21	0.88	0.59 – 1.32	0.54
School location (ref: rural)	-0.38	0.40	0.68	0.29 – 1.59	0.35
Participation in sports (ref: did not participate)	0.55	0.23	**1.74**	**1.10 – 2.76**	**0.02***
Meeting ST Guideline					
Age	-0.03	0.14	0.97	0.75 – 1.27	0.84
Sex (ref: girls)	-0.25	0.21	0.78	0.52 – 1.17	0.22
Parental education (<high school, high school/some college)	-1.08	0.32	**0.34**	**0.18 – 0.64**	**0.0008***
School location (ref: rural)	-1.10	0.49	**0.34**	**0.12 – 0.93**	**0.04***
Commute to school (ref: passive)	-0.05	0.47	0.95	0.38 – 2.40	0.91
Outdoor time	-0.48	0.10	**0.62**	**0.51- 0.75**	**<.0001***
Participation in sports (ref: did not participate)	-0.74	0.25	**0.47**	**0.29 – 0.78**	**0.003***
Functional cars at home (ref: < 2)	-0.62	0.27	**0.54**	**0.32 – 0.92**	**0.02***
Crime rate in the neighbourhood (ref: crime not a problem)	-0.43	0.23	0.65	0.41 – 1.03	0.07
Trust people in the community (ref: do not trust)	0.34	0.23	1.41	0.90 – 2.20	0.13
Consumption of fried food (ref: < 3 times per week)	-0.32	0.25	0.73	0.45 – 1.19	0.20
Consumption of fast food while watching television (ref: < 3 times per week)	-0.68	032	**0.50**	**0.27 – 0.96**	**0.04***
Meeting all three 24-Hour Movement Guidelines					
Age	-0.31	0.17	0.74	0.53 – 1.02	0.07
Sex (ref: girls)	0.07	0.26	1.08	0.64 – 1.80	0.78

Parental education (<high school, high school/some college)	-0.99	0.44	**0.37**	**0.16 – 0.87**	**0.03***
School location (ref: rural)	-1.55	0.43	**0.21**	**0.09 – 0.52**	**0.002***
Outdoor time	-0.40	0.12	**0.67**	**0.53 – 0.86**	**0.001***

Data are presented from imputed datasets.
MVPA: moderate- to vigorous-intensity physical activity; ST: recreational screen time; SE: standard error; CI: confidence interval; SES: socioeconomic status.
*: statistically significant at $p < 0.05$.
Models were adjusted for age, sex, SES, and school location.
Meeting the 24-hour movement guidelines is defined as ≥60 min/day for MVPA, ≤2 h/day for ST, and between 9 and 11 hours per night for sleep duration.

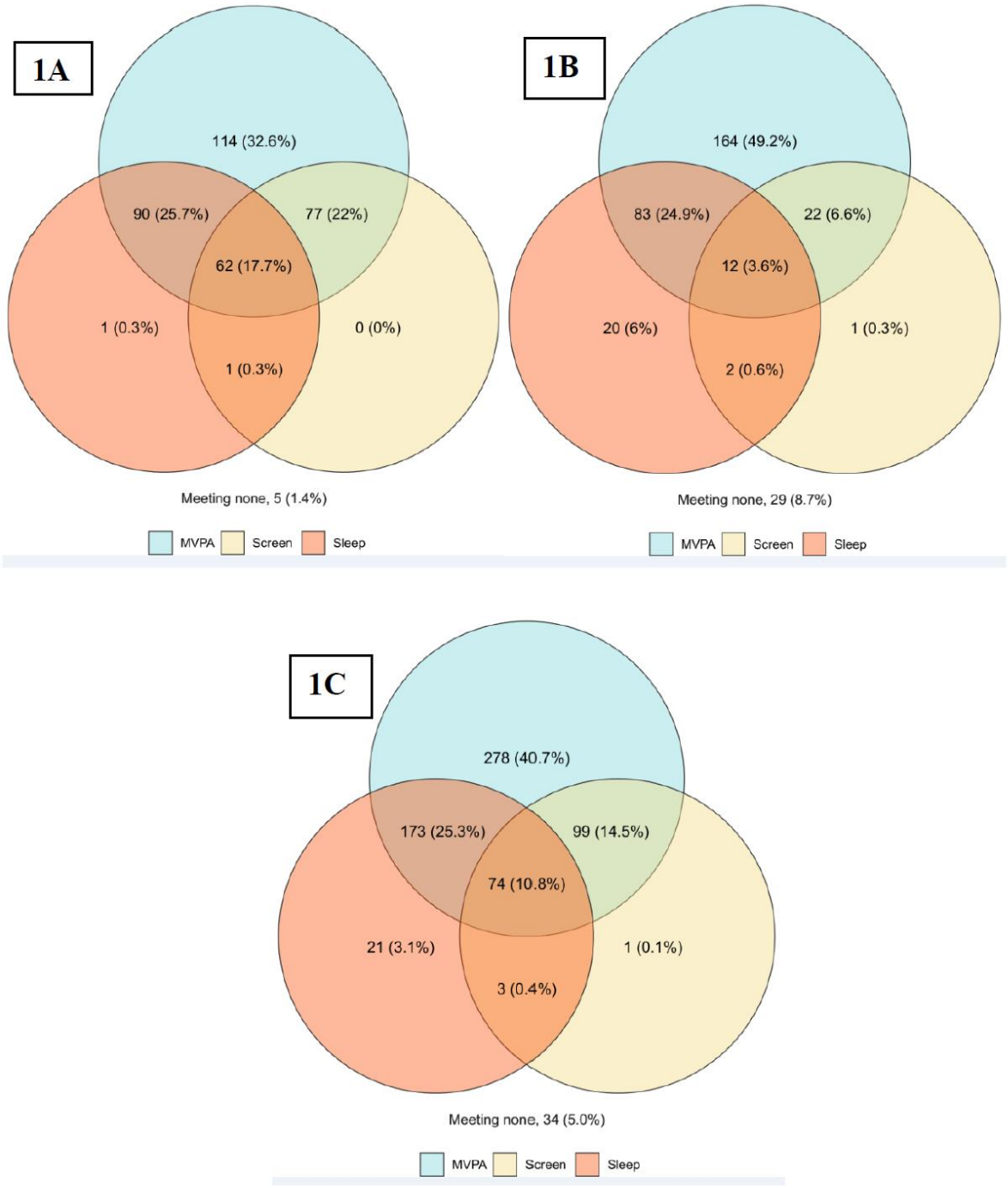

Figure1 (n=683): Venn diagrams showing the number and proportion of participants meeting no guidelines, the moderate-to-vigorous physical activity (MVPA), recreational screen time (screen), and sleep duration recommendations, and various combinations of the recommendations for the rural participants (panel 1A), urban participants (panel 1B), and the whole sample (panel 1C).

Chapter 4.5: Body mass index and movement behaviors among schoolchildren from 13 countries across a continuum of human development indices: a multinational cross-sectional study

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Article Preface: This article addresses objective 4 "To describe differences or similarities in body mass index and movement behaviours among schoolchildren from 13 countries across a continuum of HDIs", for this dissertation. I am the primary (first) author on this article. In consultation with my supervisor, I conceived of the idea of the manuscript, drafted the manuscript, cleaned and analyzed the data, and submitted the final version for publication. All co-authors contributed significantly and met the International Committee of Medical Journal Editors guidelines for authorship. They all edited the manuscript for content and approved the final version of the manuscript before it was submitted for peer review. Ethics approvals (refer to Appendices D-F) for the data used in this article were obtained from the relevant authorities prior to data collection.

Abstract

Background: The current study describes the distribution of body mass index and movement behaviors among schoolchildren from 13 countries across a continuum of human development.

Methods: Data were from a multinational cross-sectional study of 9-11 year-old children (n=8055) recruited from 276 schools in 13 countries. Body mass index (BMI) was derived from objectively measured heights and weights. Moderate- to vigorous physical activity (MVPA), sedentary time (SED) and sleep duration were assessed by waist-worn Actigraph GT3X+ accelerometers worn 24 hours/day for up to eight days. Linear models were used to describe the distribution of mean BMI z-scores, MVPA, SED and sleep duration among sites across varying HDIs.

Results: Mean MVPA, SED, and sleep duration were 63.1±27.3 minutes/day, 508.7±72.4 minutes/day, and 8.8±0.9 hours/night, respectively. Overall, 2.1% of the sample were thin, 19.5% overweight, and 11.7% were obese. Density curves for urban children (BMI z-scores, SED) and boys (MVPA) showed significantly higher daily mean values compared to rural children and girls, respectively. Mean BMI z-scores were positively associated (β=0.02; p=0.004) with HDI, mean daily MVPA minutes were negatively associated (β=-0.38; p=0.025) with HDI and mean SED time was positively associated with HDI (β=1.18; p=0.049) whereas no significant association (β=0.01; p=0.29) was observed between sleep duration and HDI.

Conclusion: Findings from this study show distinct differences in BMI z-scores and movement behavior profiles between urban and rural children. Mean BMI z-scores, MVPA and SED differed by country HDI. These findings support the need to include participants from rural and urban areas in study samples.

Introduction

The increase in the prevalence of childhood obesity worldwide has prompted the World Health Organization (WHO) to declare it an important priority for the 21st century.[1] Although evidence from high-income countries suggests that there may be a plateau in childhood obesity,[2–4] prevalences remain high in many countries.[2] In low- and middle-income countries (LMICs), where underweight/thinness still persists,[5,6] childhood obesity is reported to be rapidly increasing,[7,8] creating a double burden of malnutrition.[6,9] Meanwhile, rapid urbanization, and the accompanying rural-urban migration[10,11] may be exacerbating the physical activity transition[12] (i.e., a change from high physical activity lifestyles to more sedentary and less active lifestyles over time), due to the decrease in utilitarian/chore-based physical activity. Research evidence shows that today's children and adolescents are not accumulating the recommended amount of daily physical activity.[13] Given its global, multifaceted and urgent nature, examining the relationships between childhood obesity and associated lifestyle factors implores a multinational approach.

It is against this background that the International Study of Childhood Obesity, Lifestyle and the Environment (ISCOLE)[14], a multinational cross-sectional study that sought to investigate and understand context-specific lifestyle and environmental factors associated with the global childhood obesity crisis, was developed. Although multinational with 12 countries at different levels of human development, ISCOLE included only one low-income country (Kenya), and recruited participants from urban and peri-urban areas with no rural representation. Including participants from rural areas in multinational studies involving LMICs is especially important because the majority of people in these countries live in rural areas.[15] Based on the 2011 Human Development Index (HDI) data provided by the United Nations Development Program,[16]

countries with HDIs ≤0.732 are considered to be LMICs and those with higher HDIs are classified as high-income countries (HIC) or very high-income countries (VHICs).

LMICs may have unique characteristics or contexts that fundamentally differ from HICs and VHICs. For example, as part of ISCOLE, Chaput et al.,[17,18] Barreira et al,[19] and Broyles et al.[20] reported differences in key variables between LMICs and HICs/VIHCs. Chaput et al.[17] reported stronger associations between sleep patterns and moderate- to vigorous-intensity physical activity (MVPA), and sedentary time (SED) for children in HICs/VHICs compared to those in LMICs. Barreira et al,[19] reported the possibility of an epidemiological transition in physical activity (i.e., lower levels of MVPA were observed at opposite levels of household income at different HDI percentiles). Broyles et al.[20] found positive associations between obesity and household income levels for participants from sites with lower HDI and negative associations for sites with high HDI. Chaput et al.[18] found that obesity was associated with greater MVPA inequality in HIC/VHICs while it was associated with lower MVPA inequality in LMICs. Furthermore, findings from ISCOLE also showed Kenya's results (e.g., higher daily MVPA,[18] significantly lower percent body fat among girls[21]) to be different on some key indicators, raising questions as to whether it was a reflection of contextual factors that are unique to low-income countries generally, or a peculiarity for Kenya specifically. The absence of rural participants, whose lifestyles and risk of obesity may be different from urban dwellers,[22] was identified as a limitation of ISCOLE, and included as an important recommendation for future studies.[23]

The present study helps to address this limitation by including data obtained from rural participants in Mozambique and adds another low-income country to the ISCOLE dataset. Here

we describe the distribution of body mass index (BMI) and movement behaviors (sleep duration, SED, MVPA) among schoolchildren from 13 countries across a continuum of HDIs.

Methods

Study design and setting: Data for this study were partly from the ISCOLE dataset.[14] ISCOLE was a cross-sectional, multinational study involving twelve countries (Australia, Brazil, Canada, China, Colombia, Finland, India, Kenya, Portugal, South Africa, the United Kingdom and the United States of America). These countries ranged from low (0.509; Kenya) to very high HDI (0.929; Australia). ISCOLE recruited a sex-balanced sample of 9-11 year-old schoolchildren from 256 primary schools. Data collection for ISCOLE occurred between September 2011 and December 2013. Recruited schools were used as the primary sampling framework. Detailed descriptions of the methods and study protocol have been reported previously.[14] For the present analyses, the ISCOLE dataset was merged with data collected between August 2017 to May 2018 from urban and rural schoolchildren in Mozambique. Data collection in Mozambique followed the same study protocol as ISCOLE.[14] For the Mozambican sample, seventeen (10 urban and 7 rural) schools were recruited.

Participants: Based on *a priori* sample size calculations,[14] each study site in ISCOLE aimed to recruit at least 500 children. Because of the addition of a rural/urban comparison, the target sample size was 650 children in Mozambique. Both ISCOLE (n=7372) and the Mozambique (n=683) study sites exceeded recruitment targets. Of the 8055 children in the whole sample, 6665 remained in the present analytic dataset after excluding participants without valid accelerometry (n=1359) and BMI (n=31) data. Participants with missing data had significantly higher BMI z-scores (t=-2.8; p=0.005), mean sleep duration (t=-5.9; p<0.0001), but not MVPA minutes (t=-

0.5; p=0.62), than those with complete data. Ethical approval for ISCOLE was received from the Pennington Biomedical Research Center Institutional Review Board, as well as from relevant research ethics boards from each study site before data collection commenced. Written informed consent was obtained from parents/guardians and where required, child assent was sought from the children before participation. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for cross-sectional studies were adhered to for the current study.[24]

Measurements

Anthropometry: Participants' standing height was measured to the nearest 0.1 cm by trained and certified research staff, using a Seca 213 portable stadiometer (Seca Corporation, Hamburg, Germany). With the participant standing as erect as possible and with their head in the Frankfort horizontal plane, measurements were recorded at the end of a deep inhalation. Participants' body weight was measured to the nearest 0.1 kg using a portable Tanita Body Composition Analyzer (SC-240, Illinois, USA) after all outer clothing, heavy pocket items, shoes, and socks were removed. All measurements were done in duplicate, and a third measurement was taken if the first two were more than 0.5 cm (height), or 0.5 kg (body weight) apart. The average of the closest two measurements was used for analyses. BMI (kg/m^2) was derived from standing height and body weight, and converted to BMI z-scores using an algorithm informed by an LMS model and sex- and age-adjusted growth references developed by the WHO for 5-19 year-old children and youth.[25,26] The WHO defined cut-points were applied to classify participants as being thin (BMI z-scores < -2 standard deviations [SD]), healthy weight (BMI z-scores between -2 and +1 SD), overweight (BMI z-scores > +1 to +2 SD), or obese (BMI z-scores > +2 SD).[25,26]

Movement behaviors: Actigraph GT3X+ accelerometers were used to objectively measure nocturnal sleep, total SED, and physical activity. The accelerometers were attached to an elastic belt and worn lying flat on the right hip for seven consecutive days plus an initial familiarization day. To improve compliance, a 24-hour protocol was implemented, encouraging participants to wear the accelerometer at all times except during water-based activities.[27] An algorithm was used to identify total nocturnal sleep time and an additional algorithm was used to identify periods of awake non-wear time (any sequence of ≥20 consecutive minutes of 0 activity counts).[28] Data were collected at a sampling rate of 80 Hz, downloaded in 1-second epochs with the low-frequency extension filter using the ActiLife software version 6.5.4 (ActiGraph LLC, Pensacola, FL, USA). Data were subsequently aggregated to 15- and 60-second epochs for summarizing physical activity and nocturnal sleep, respectively. After accounting for the total nocturnal sleep and awake non-wear time,[28] all remaining minutes were classified as awake-wear time. Participants with ≥10 hours of wear time per day on at least 4 days including at least 1 weekend day were considered to have sufficient physical activity data. Cut-points developed by Evenson et al.[29] were used to quantify SED (≤25 counts), light physical activity (LPA) (26-573 counts), moderate physical activity (574–1002 counts) and vigorous physical activity (≥1003 counts) per 15-second epoch.

Country Human Development Index: HDI values[16] for 2011 and 2017 were used for the ISCOLE and Mozambican study sites respectively, to be consistent with when data used in the current study were collected.

Statistical Analyses: Analyses were computed using SAS 9.4 (SAS Institute Inc., North Carolina, USA) and RStudio (version 1.1.463; RStudio, Boston, United States). Descriptive characteristics of participants were summarized using means (SD) or frequencies (percentages)

as appropriate. To illustrate potential differences in BMI z-scores, MVPA, SED and sleep duration between urban vs. rural, boys vs. girls, and LMICs (Mozambique, Kenya, India, China, South Africa, Colombia, Brazil) vs. HICs/VHICs (Portugal, Finland, United Kingdom, Canada, United States of America, Australia), density curves were generated. Scatter plots with lines of best fit based on linear models with 95% confidence intervals for the lines of best fit were used to display the distribution of study site-specific mean BMI z-score, MVPA, SED and sleep duration by HDI.

Results

Table 1 presents the descriptive characteristics of participants with complete data, stratified by study site. The whole sample (54.7% girls) had a mean age of 10.4±0.6 years, and BMI z-score of 0.4±1.3. For the total sample, mean MVPA, SED, and sleep duration were 63.1±27.3 minutes/day, 508.7±72.4 minutes/day, and 8.8±0.9 hours/night, respectively. On average, children from rural Mozambique had 46 more minutes of MVPA, and 99 less minutes of SED per day than those from urban and peri-urban areas. Overall, 2.1% of the sample were thin, 19.5% overweight, and 11.7% were classified as obese. The prevalence of thinness ranged from lowest among Portuguese children (0.3%) to highest (6.3%) among the rural Mozambican children. Obesity was highest among children from China (24.4%) and lowest among rural Mozambican children (1.0%).

INSERT TABLE 1 HERE

Figure 1 presents density curves comparing mean BMI z-scores for urban vs. rural children (A), boys vs. girls (B), and children from LMICs vs. those from HICs and VHICs (C). Figure 1A shows that mean BMI z-scores for urban children were almost one unit higher than those for

their rural counterparts (mean difference [MD]=0.95; t=-16.6; p<0.001). Figure 1B shows that boys had significantly higher mean BMI z-scores than girls (MD=0.14; t=4.37; p<0.0001). Children from HICs/VHICs had significantly higher mean BMI z-scores (MD=0.31; t = -10.10; p < 0.0001) than those from LMICs (1C). As shown in Figure 2, there was a statistically significant difference in mean daily MVPA minutes between children from urban and rural areas (MD=46.01; t=26.69; p<0.0001) (A) and boys vs. girls (MD=17.57; t = 27.15; p < 0.0001) (B). The density curves show that on average children from LMICs had more daily mean MVPA minutes than those from HICs/VHICs (MD=5.23; t = 8.04; p < 0.0001). Daily SED was higher among urban compared to rural children (MD=99.34; t = -23.9; p < 0.0001) (Figure 3A), girls compared to boys (MD=17.02; t = -9.58; p < 0.0001) (Figure 3B) and for children from HICs/VHICs vs those from LMICs (MD=19.98; t = -11.49; p < 0.0001) (Figure 3C). There were no significant differences in sleep duration (Figure 4A) between urban vs. rural children (MD=3.52; t = 1.40; p < 0.16). Girls had significantly longer sleep duration than boys (MD=7.55; t = -5.89; p < 0.0001) (Figure 4B), and children from HICs/VHICs had longer average sleep durations compared to those from LMICs (MD=7.98; t = -6.07; p < 0.0001) (Figure 4C).

INSERT FIGURE 1 HERE

INSERT FIGURE 2 HERE

INSERT FIGURE 3 HERE

INSERT FIGURE 4 HERE

Figure 5 shows that in general, site-specific mean BMI z-scores were positively associated (β=0.02; p=0.004) with HDI (A). Site-specific mean daily MVPA minutes were negatively (β=-

0.38; p=0.025) associated with HDI (B). Site-specific mean SED time (C) was positively associated with HDI (β=1.18; p=0.049) whereas no significant association (β=0.01; p=0.29) was observed between site-specific sleep duration and HDI (D).

INSERT FIGURE 5 HERE

Discussion

The main purpose of this study was to describe the distribution of BMI z-scores and movement behaviours (sleep, SED, MVPA) among schoolchildren across a continuum of HDIs. We compared children from rural vs. urban areas, boys vs. girls, and those from LMICs vs. HIC/VHICs. To the best of our knowledge, this is the first multinational study of childhood weight status and associated movement behaviors in children that relied on a similar protocol and participants from countries across a wide continuum of HDIs, including a rural sub-sample from the Mozambique site. Findings from this study showed distinct differences in mean BMI z-scores, SED, and MVPA between urban and rural children but not sleep duration. Results also demonstrated linear distributions of mean BMI z-scores, MVPA, and SED by country HDI, but again not for sleep duration. Furthermore, obesity prevalences tended to be generally higher among children from countries with higher HDI and thinness was highest among rural Mozambican children and generally higher for countries with lower HDI.

The relationships between site-specific mean BMI z-scores, SED, MVPA and HDI found in this study are consistent with the epidemiologic transition theory (i.e., changes across levels of

countries' development in shifting patterns of morbidity and mortality from predominantly infectious disease causes to chronic non-communicable diseases).[30] Our research group has previously reported such epidemiologic transition patterning in the relationships between childhood obesity and household income,[20] physical activity and socioeconomic status,[19] but not for sleep duration and socioeconomic status.[31] The impact of accelerated epidemiologic transitions for childhood adiposity, and physical activity may be excessively burdensome, especially in LMICs, where infectious and other enteral diseases are still prevalent,[32] and resources to adequately address the dual burden of both communicable and non-communicable diseases may be unavailable.[33] A previous multinational study showed higher deaths related to cardiovascular events in low-income countries despite their low-risk burden,[34] suggesting that as epidemiologic transitions progress, cardiovascular events related to obesity will only add to the already stressed health care systems in these countries. Results from the current and other previous studies[33,35] provide evidence for governments and policy makers of LMICs, and international organizations to prioritize interventions and policy strategies designed to manage epidemiological and lifestyle transitions.

The lack of discernible patterns in the site-specific sleep durations by HDIs observed in this study is consistent with our previous study[31] which showed no evidence of epidemiological transition in the relationship between sleep duration and socioeconomic status. Sleep duration can be affected by many factors including bedtimes,[36] wake-up times,[37] availability and excessive use of screens in the bedroom,[38,39] artificial light,[40] length of daylight,[41] and other contextual or cultural factors. The need for early wake-up times to accommodate household chores (e.g. in rural areas), early school start times,[37] and longer school commute times in LMICs as contributors to shorter sleep duration, may offset the effects of late bedtimes, artificial

lighting or availability of screens in bedrooms for sleep duration among children in HIC/VHICs. Therefore, it is plausible to speculate that potential epidemiological transition patterning by country-specific HDI that might be observed may be diminished, given that these factors may differential affect sleep duration among children in LMICs vs HICs/VHICs. It may be prudent for public health messages emphasizing the importance of adequate sleep duration for children to target context-specific factors rather than providing generic or 'one-size fits all' prescriptions.

The distinct differences in characteristics (e.g., lower average BMI z-scores, lower mean minutes of daily SED, higher average daily MVPA minutes) of children from rural Mozambique compared to the rest of the sample supports findings from previous single-country studies[22,42,43] with similar samples. These findings demonstrate that urban and rural populations may be fundamentally different in key characteristics, supporting the importance of accounting for these differences in study designs and policy strategies. Previous studies in VHICs reported differences albeit not in uniform directions for physical activity, SED, and obesity prevalence between urban and rural children, suggesting that the differences observed in the current study may not be unique to rural vs urban children in LMICs. For example, Katzmarzyk and Mason[12] reported higher pedometer-derived step counts for rural-dwelling Old-Order Amish[44] than Canadian children.[45] Aristides et al.[46] reported differences in MVPA, and SED between rural and urban Portuguese adolescents. Roxane et al.[47] found differences in obesity and physical activity levels between urban and rural schoolchildren in Iowa, USA. Together, these findings should motivate researchers to include both rural and urban children in studies of a similar nature.

The present study should be interpreted in light of the following key limitations. First, the cross-sectional study design precludes any inferences about causation. Second, site-specific samples were not designed to be nationally representative, thus limiting the generalizability of the results.

Third, the exclusion of participants with missing data might have inadvertently biased the results. Finally, due to the narrow age range (9-11 year-old), results from this study cannot be extrapolated to other age groups. However, this study has several strengths. An important strength is the multinational nature of the sample, from countries at various levels of HDIs with diverse cultures and contexts, providing results that can help to inform interventions or policy initiatives. The inclusion of rural children for the Mozambican site provided data that helped to address a previously identified and important research need. The use of a standardized and rigorous measurement protocol, robust data quality assurance procedures, and the training and certification of research staff ensured that the data collected at all sites were of high quality. Finally, all anthropometric[23] and accelerometry[23,27] data were directly measured.

In conclusion, findings from this study demonstrate that children from rural areas have distinctly different BMI z-scores and movement behavior profiles from their urban counterparts. Mean BMI z-scores, MVPA and SED also differed by country HDI. These findings support the need to plan for, and include participants from rural and urban areas in research studies investigating associations between child weight status and lifestyle factors such as movement behaviors. Furthermore, multinational studies examining similar indicators should consider including countries that vary in cultures, contexts and levels of HDI.

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collection, management, analysis, interpretation of the data, decision to publish or preparation of this manuscript. Authors had full control of all primary data.

Competing interests: The authors declare that they have no competing interests.

Authors' contributions: TM and MST conceived this paper with input from JDB, J-PC, MG, EFM, PTK, and AP. TM, and JDB analysed the data with input from MST, J-PC, MG, EFM, PTK, and AP. TM developed the final version of the manuscript and MST, JDB, EFM, MG, AP, J-PC, and PTK provided significant edits, interpreted the results, and approved the final manuscript for submission.

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Table 1: Descriptive characteristics of the study sample from highest to lowest HDI (n=6665)								
Study Site	N (%girls)	HDI 2011	Age (years)	BMI z-score	MVPA Minutes/day	SED Minutes/day	Sleep duration hours/night	Obesity (%)
Australia (Adelaide)	452 (53.8)	0.929	10.7 (0.4)	0.6 (1.1)	65.8 (23.1)	479.5 (60.0)	9.4 (0.7)	10.6
Canada (Ottawa)	507 (59.0)	0.910	10.5 (0.4)	0.4 (1.2)	58.4 (19.4)	512.6 (61.3)	9.1 (0.8)	12.2
USA (Baton Rouge)	464 (58.8)	0.908	9.9 (0.6)	0.7 (1.3)	50.0 (18.9)	521.3 (62.0)	8.9 (0.9)	17.7
UK (Bath and NE Somerset)	414 (56.3)	0.863	10.9 (0.4)	0.4 (1.1)	63.8 (22.9)	502.8 (56.3)	9.5 (0.7)	9.4
Finland (Helsinki, Espoo and Vantaa)	461 (54.7)	0.882	10.5 (0.4)	0.3 (1.0)	70.1 (26.8)	532.5 (65.9)	8.5 (0.9)	6.1
Portugal (Porto)	639 (57.1)	0.809	10.4 (0.3)	0.9 (1.1)	55.7 (21.5)	555.0 (58.6)	8.3 (0.9)	16.7
Brazil (São Paulo)	479 (51.4)	0.718	10.5 (0.5)	0.9 (1.4)	59.4 (26.3)	501.7 (67.6)	8.6 (0.8)	21.9
China (Tianjin)	467 (48.4)	0.687	9.9 (0.5)	0.7 (1.5)	44.7 (15.7)	569.5 (65.8)	8.8 (0.6)	24.4
Colombia (Bogotá)	822 (51.0)	0.710	10.5 (0.5)	0.2 (1.0)	68.2 (24.9)	502.3 (66.1)	8.8 (0.8)	5.6
South Africa (Cape Town)	456 (61.0)	0.619	10.3 (0.7)	0.3 (1.3)	65.0 (25.7)	488.2 (64.3)	9.2 (0.7)	11.0
India (Bangalore)	532 (54.7)	0.547	10.4 (0.5)	0.2 (1.4)	48.9 (21.2)	517.2 (65.6)	8.6 (0.7)	10.7
Kenya (Nairobi)	460 (54.6)	0.509	10.2 (0.7)	-0.0 (1.2)	72.0 (31.3)	496.5 (65.1)	8.6 (0.9)	6.7
Mozambique (Urban: Maputo)	211 (55.5)	0.437*	10.2 (0.7)	-0.3 (1.1)	82.4 (30.0)	444.3 (67.9)	8.7 (0.8)	2.8
Mozambique (Rural: Macia)	301 (50.8)	0.437*	10.0 (0.9)	-0.5 (0.9)	107.0 (29.4)	413.8 (70.7)	8.9 (0.7)	1.0

HDI: human development index; BMI: body mass index; MVPA: moderate- to vigorous-intensity physical activity; SED: sedentary time.
Data are presented as mean (standard deviation) or proportions (%).
Data are presented for participants with complete data.
*HDI values for Mozambique are derived from 2017 data to be consistent with when the study data were collected.

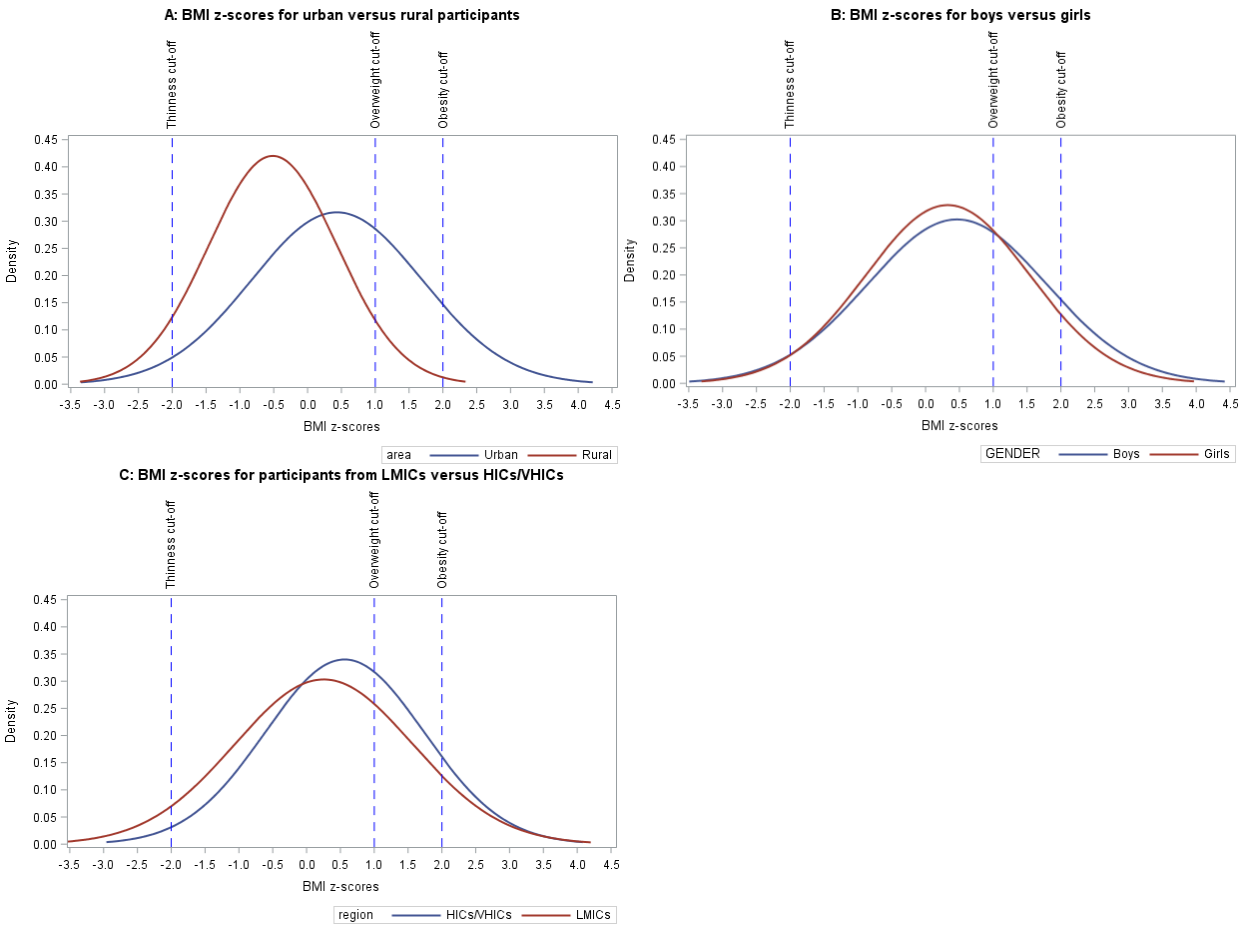

Figure 1: Density curves based on participants with complete data comparing body mass index z-scores between urban and rural participants (A); boys and girls (B); participants from LMICs and HCIs/VHICs (C). BMI = Body Mass Index; LMICs= Low- and Middle-Income Countries; HICs = High-Income-Countries; VHCIs = Very-High-Income-Countries

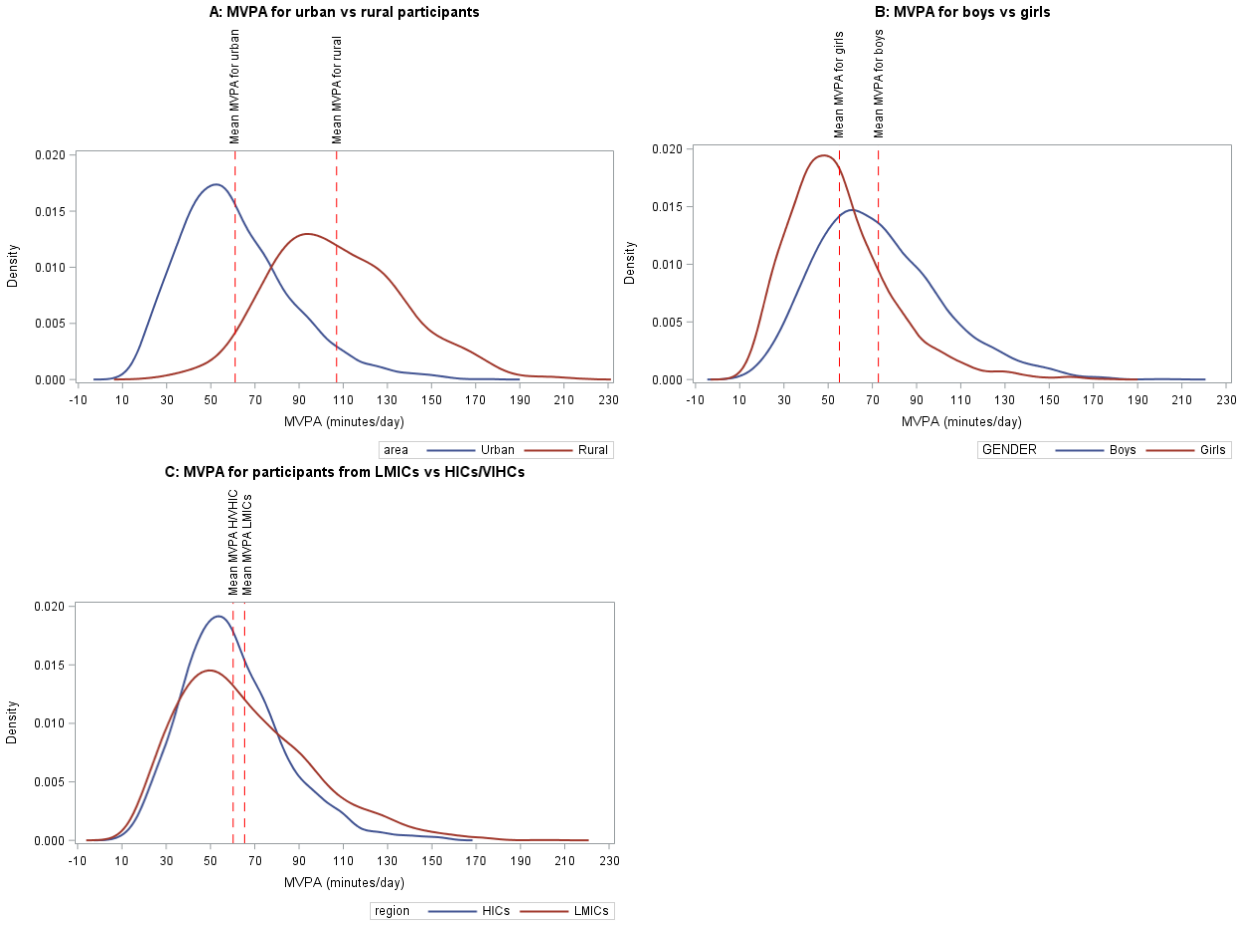

Figure 2: Density curves based on participants with complete data comparing MVPA between urban and rural participants (A); boys and girls (B); participants from LMICs and HCIs. MVPA = Moderate- to Vigorous-Intensity Physical Activity; LMICs= Low- and Middle-Income Countries; HICs = High-Income-Countries; VHCIs = Very-High-Income-Countries; H/VHIC = High-Income-Countries/Very-High-Income-Countries

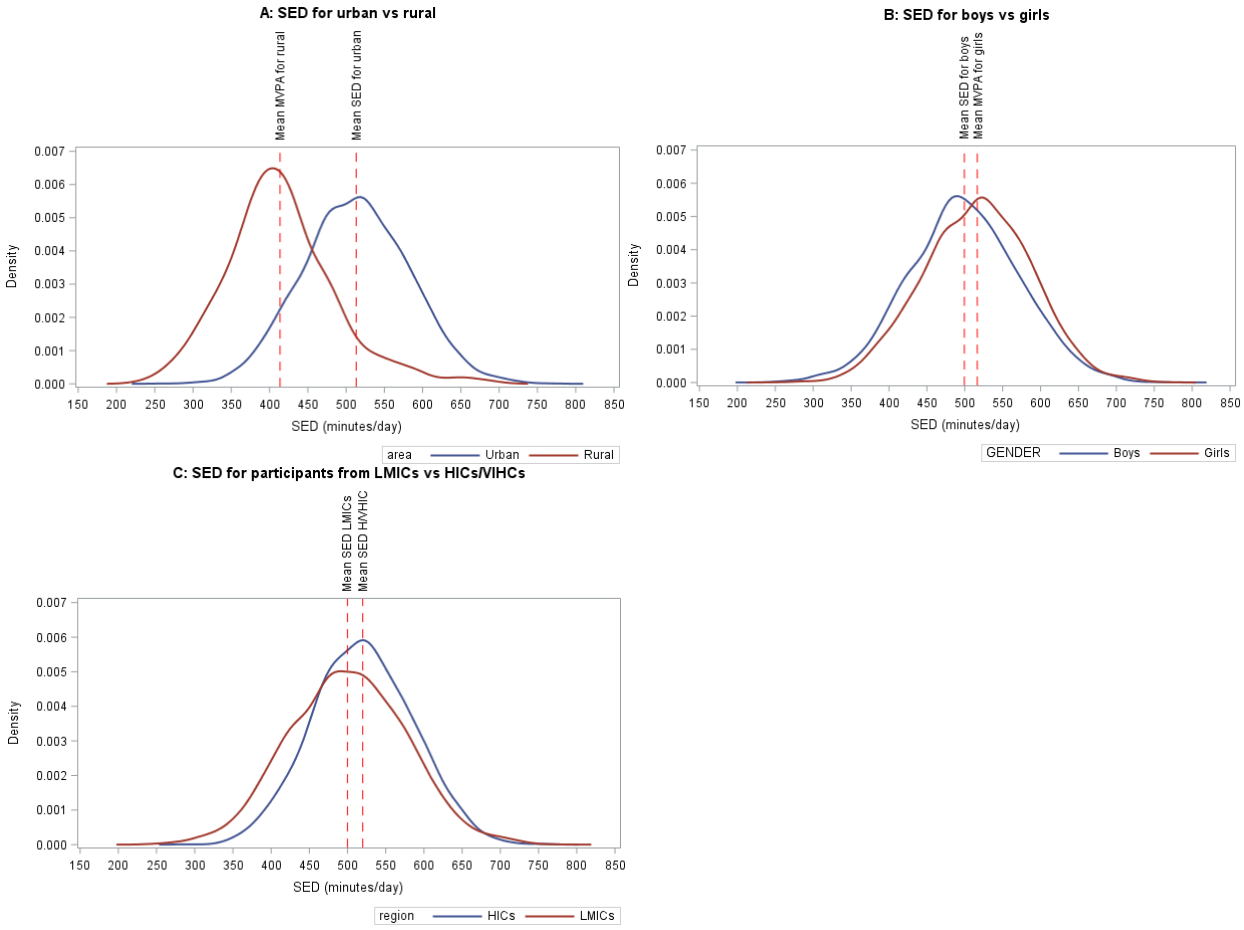

Figure 3: Density curves based on participants with complete data comparing SED between urban and rural participants (A); boys and girls (B); participants from LMICs and HCIs. SED = Sedentary Time; LMICs= Low- and Middle-Income Countries; HICs = High-Income-Countries; VHCIs = Very-High-Income-Countries H/VHIC = High-Income-Countries/Very-High-Income-Countries

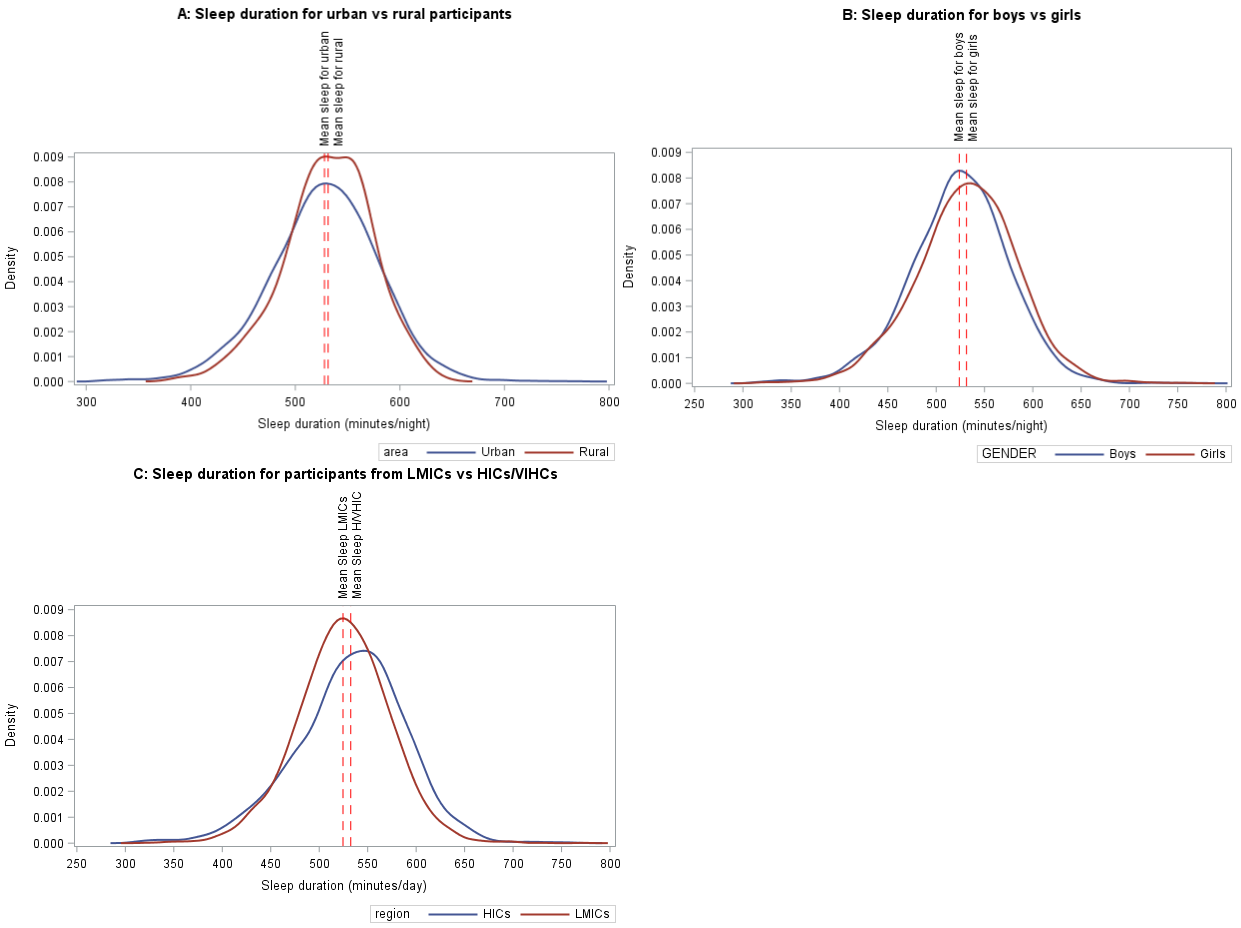

Figure 4: Density curves based on participants with complete data comparing sleep duration between urban and rural participants (A); boys and girls (B); participants from LMICs and HCIs. LMICs= Low- and Middle-Income Countries; HICs = High-Income-Countries; VHCIs = Very-High-Income-Countries H/VHIC = High-Income-Countries/ Very-High-Income-Countries

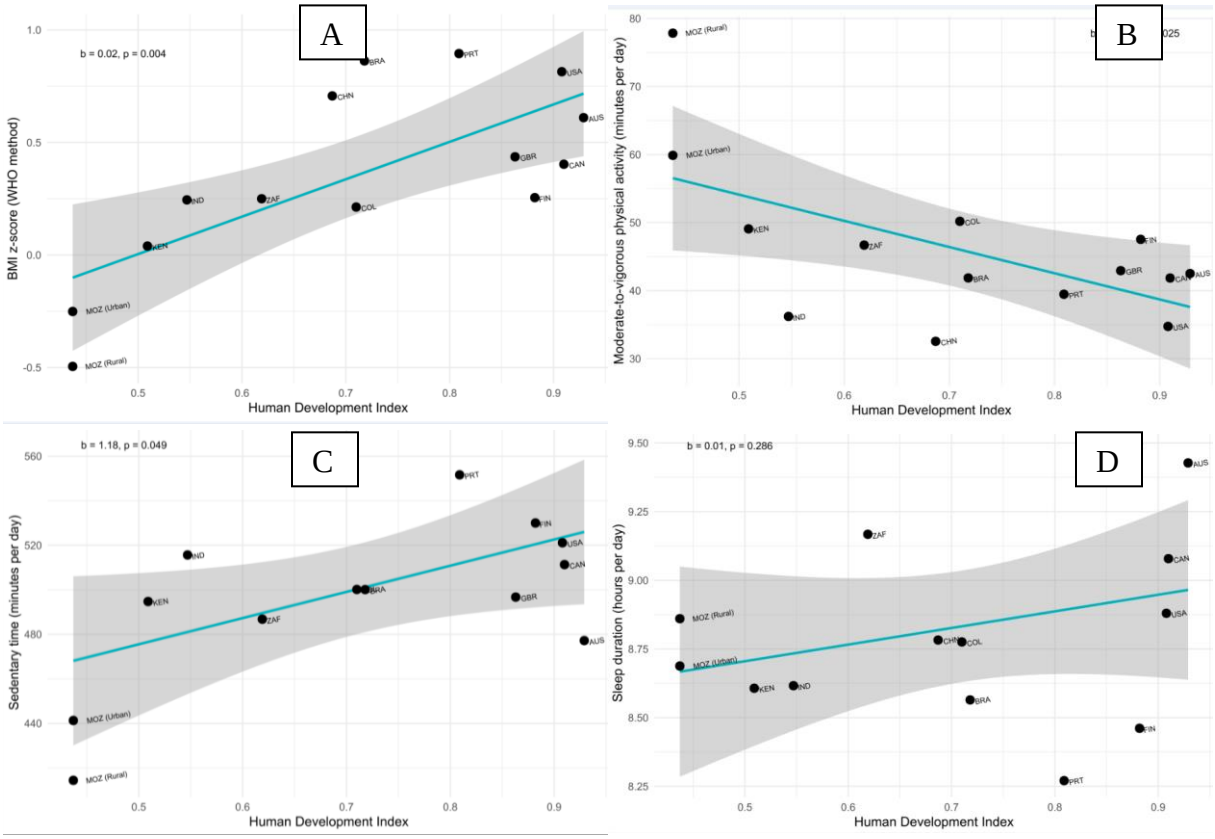

Figure 5: Scatter plots with lines of best fit (95% confidence interval) showing the distribution of study site-specific mean: BMI z-scores (A); MVPA (B); SED (C); sleep duration (D) by HDI.
Shaded area represents the 95% confidence intervals for the lines of best fit.
BMI: body mass index; MVPA: moderate- to vigorous-intensity physical activity; SED: sedentary time; HDI: human development index; WHO method: World Health Organization sex- age adjusted BMI z-score classification method; MOZ (rural): Mozambique rural; MOZ (urban): Mozambique urban; KEN: Kenya; IND: India; ZAF: South Africa; COL: Colombia; CHN: China; BRA: Brazil; FIN: Finland; GBR: United Kingdom; PRT: Portugal; CAN: Canada; AUS: Australia; USA: United States of America.

Chapter 4.6: Indicators of Physical Activity among Children and Youth in Nine Countries with Low and Medium Human Development Indices: A Global Matrix 3.0 Paper

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Article Preface: This article addresses objective 5 "To summarize the indicators of PA among children and youth and explore data gaps in nine LMICs", for this dissertation. I am the primary (first) author on this article. In consultation with my supervisor, I conceived of the idea of the manuscript, drafted the manuscript, cleaned and analyzed the data, submitted the final version for publication, addressed reviewer comments and edits. All co-authors contributed significantly and met the International Committee of Medical Journal Editors guidelines for authorship. They all edited the manuscript for content, and approved the final version of the manuscript before it was submitted for peer review. There were no applications for ethical approvals for this article because it relied on data from country-specific Report Cards already in the public domain.

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Human Kinetics
ORIGINAL RESEARCH

Indicators of Physical Activity Among Children and Youth in 9 Countries With Low to Medium Human Development Indices: A Global Matrix 3.0 Paper

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Background: This study compares results of physical activity report cards from 9 countries with low to medium human development indices, participating in the Global Matrix 3.0 initiative. **Methods**: Country-specific report cards were informed by relevant data and government policy documents, reporting on 10 core indicators of physical activity for children and youth. Data were synthesized by report card working groups following a harmonized process. Grade assignments for each indicator utilized a standard grading rubric. Indicators were grouped into one of 2 categories: daily behaviors and settings and sources of influence. Descriptive statistics (average grades) were computed after letter grades were converted into interval variables. Spearman's rank correlation coefficients were calculated for all correlation analyses. **Results**: Mean grades for daily behaviors were higher (C) than those for settings and sources of influence (D+). Twenty-nine out of the possible 90 grades were assigned an incomplete. There were moderate to strong positive and negative relationships between different global indices and overall physical activity, organized sport and physical activity, active play, family, community and environment, and government. **Conclusions**: Findings demonstrate an urgent need for high-quality data at the country level in order to better characterize the physical activity levels of children and youth in countries with low to medium human development indices.

Keywords: active living, policy, daily physical activity behaviors, settings and sources of influence

Evidence from studies conducted mainly in countries with high or very high human development indices (HDIs) show that regular physical activity among children and youth is associated with physical, psychosocial, and cognitive well-being,[1] decreased adiposity,[2,3] improved academic achievement,[1,4] and brain health and development.[5] Despite these known benefits, a significant proportion of children and adolescents do not accumulate the recommended amount of daily physical activity.[6,7] Rhodes et al[6] reported that 4 out of 5 adolescents between the ages of 11 and 17 did not meet the recommended daily minimum of 60 minutes of moderate- to vigorous-intensity physical activity. Furthermore, both insufficient physical activity and sedentary behaviors[8] among children and youth have been increasing globally.[7,9]

Sedentary behaviors[10–12] and insufficient physical activity[2,3] in children and youth pose a significant public health challenge, because these behaviors are independently associated with noncommunicable diseases in adulthood.[13] In addition, insufficient physical activity is currently the fourth leading risk factor for mortality globally.[14] Many countries with low to medium HDIs are undergoing industrialization and economic growth along with rural to urban migration; these factors have led to the unintended consequences of rapid urbanization and densely populated cities. The United Nations estimates that within the next few decades, the largest and fastest growth in urban populations will be in Africa and Asia, places that currently remain mostly rural.[15] High population density in cities, particularly in low-income neighborhoods, often reduces walkability.[16] In addition, urbanization itself,[17] and the accompanying increase in motorized transportation[7] use in densely populated cities,[18] may decrease the amount of daily utilitarian or habitual physical activity.[8]

Promoting physical activity and reducing both insufficient physical activity and sedentary behaviors are important for promoting child health. In the context of the ongoing physical activity transition (the behavioral shift from traditionally active to more industrialized and sedentary lifestyles),[8,14,19,20] global strategies

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(eg, sustainable development goals[21] and the World Health Organization global action plan on physical activity 2018–2030[22]) that identify specific indicators of progress and global interventions, including strategies for countries at different levels of human development that have unique contexts, cultures, challenges, and opportunities, may be needed to prevent accelerated physical activity transitions.[23]

To better understand and develop global strategies for curbing insufficient physical activity among children and youth, reducing sedentary behaviors, and encouraging more active lifestyles, the Active Healthy Kids Global Alliance (AHKGA: www.activehealthykids.org) has advocated for and developed a harmonized approach to data synthesis.[23–25] This initiative facilitates the development of report cards[26] on indicators of child and youth physical activity in countries that participate in the global matrix initiatives.[23,24] However, documented variation in physical activity and other lifestyle behaviors across regions and cultures[23,24] and a lack of data regarding the extent of or levels of inequalities in and determinants of movement behaviors among children and youth[27] in many countries with low to medium HDIs continue to make it challenging to draw meaningful global comparisons or conclusions.

Previous studies[18,28] have reported variations in physical activity and active transportation patterns, respectively, in low-income versus high-income countries, suggesting that there may be a need for distinct strategies and priorities in different regions or countries. As such, strategies that group countries with similar challenges and/or priorities into clusters by common indicators such as the HDI[29] or Gini coefficient[29] (a measure of income distribution within a population and an indicator of income inequality, where 0 represents perfect income equality [ie, everyone has the same income] and 1 corresponds to perfect income inequality [ie, one person has all the income while everyone else has zero income]), may lead to an improved understanding of the extent of insufficient physical activity among children and youth. Ultimately, this knowledge can be applied to develop strategies and leverage policies to increase opportunities for and access to safe and enjoyable physical activity. This knowledge may also help to identify priority areas for research and surveillance of activity behaviors in countries with low to medium HDIs, which could further support pragmatic and context-specific strategies to promote active lifestyles among children and youth. This study combines report card results from 9 self-selected countries with low to medium HDIs that agreed and registered to participate in the Global Matrix 3.0 initiative. The main objective of this study was to compare the synthesized data on 10 physical activity indicators for children and youth from Bangladesh, Botswana, Ethiopia, Ghana, India, Nepal, Nigeria, South Africa, and Zimbabwe.

Methods

The 9 participating countries representing low to medium HDIs identified national experts working in various sectors of physical activity and formed country-specific report card working groups that were responsible for rigorous and transparent data and information gathering. Each participating country was assigned an experienced report card mentor, familiar with that country's context. In addition, participating countries received monthly e-blasts from the AHKGA that detailed steps and timelines of the report card development process throughout the year preceding the official launch of the Global Matrix 3.0.

Strategies to gather data included manual or hand searches, online literature searches, and systematic or narrative reviews to obtain the best available peer-reviewed evidence, reporting on the various indicators of physical activity for children and youth ages 5 to 17. In addition, unpublished research (eg, dissertations and theses, government reports) and policy documents were actively sought and gathered through engagement with local stakeholders. These data and information were aggregated and consolidated into report cards following a harmonized process.[23,24,26]

Ten core indicators for the Global Matrix 3.0 (overall physical activity, organized sport and physical activity, active play, active transportation, sedentary behaviors, physical fitness, family and peers, school, community and environment, and government) were used to develop each country-specific report card. For the purposes of analyses, 9 indicators (excluding physical fitness) were grouped into 1 of 2 categories: daily behaviors (overall physical activity, organized sport and physical activity, active play, active transportation, and sedentary behaviors) and settings and sources of influence (family and peers, school, community and environment, and government). Grades (A = excellent to F = failing) were assigned to each indicator using a standardized grading rubric and participating countries adhered to the same benchmarks for grade assignment.[25] In cases in which data were insufficient to accurately assign a grade, an incomplete was assigned to that indicator.

Although the quality, quantity, and sources of data varied, the report card working groups in each of the 9 countries followed a similar process of appraising, aggregating, consolidating, and harmonizing the total available evidence, discussing discrepancies and reaching consensus before assigning a grade for each indicator. Assigned grades and justifications were submitted to and audited by the scientific subcommittee of the AHKGA. As an example of how indicators were graded, Table 1 presents the methods, instruments, and sample sizes of the studies used to evaluate the overall physical activity indicator. In addition to an abstract and a poster presented at the launch of the Global Matrix 3.0, participating countries consolidated their results into short-form and long-form report cards and were encouraged to develop and publish country-specific manuscripts based on their findings. Furthermore, participating countries had the latitude to include additional indicator(s) that were specific to their context in their report cards. A companion article[25] published in this issue of *The Journal of Physical Activity and Health* provides a detailed description of the methods used by each of the participating countries. In addition, summary papers for each of the participating countries' report cards[30–38] are included in this issue and provide additional details of data sources.

Descriptive statistics (average grade and SD) were computed after converting categorical variables (letter grades) to interval variables (eg, A+ = 15, A = 14, A− = 13, D = 5, D− = 4, F = 2). Once converted to interval variables, scores for each group of indicators (overall, daily behaviors, settings, and sources of influence) were calculated by summing the relevant interval data. Incomplete grades were removed and the scores were reweighted accordingly. Letter grades (categorical variables) were grouped into 4 levels (A–B, C, D–F, and no grade). The categories were then used to rank countries by letter grade/score and category level in scatter plots. For all correlation analyses among the 10 core indicators and global indices and descriptors (HDI, Gini coefficient, gender inequality, mean years of schooling, public health expenditure,[29] and improved drinking water coverage[39]), Spearman's rank correlation coefficients were calculated. Rule of thumb cutoffs[40,41] were applied to define weak, moderate, and strong correlations. Pairwise deletion was used to treat missing data

Table 1 Methods and Instruments Used to Assess Overall Physical Activity

Country	Method(s)	Instrument used	Age group	Sample size(s)
Bangladesh	Subjective	Self-administered questionnaire—GSHS	13–17	2989
Botswana	Subjective	Literature search, gray literature, and anecdotal information	9–18	N/A
Ethiopia	Subjective	Literature, policy documents, and expert interviews	5–17	N/A
Ghana	Subjective	Literature search, focus group interviews on indicators and benchmarks, policy implementation guidelines, and expert opinions	9–15	N/A
India	Objective	Accelerometer	9–11	1002
	Objective	Accelerometer and self-administered questionnaire	12–17	324
	Subjective	Self-administered questionnaire	6–19	27,972
	Subjective	Interviewer-administered questionnaire	3–15	2734
	Subjective	Interviewer-administered questionnaire	8–21	325
Nepal	Subjective	Questionnaire	15–19	241
Nigeria	Subjective	Researcher-administered semistructured questionnaire	3–18	1760
	Subjective	Self-administered questionnaire—Health Risk Behavior Questionnaire	10–21	348
South Africa	Objective	Accelerometer	9–11	453
	Subjective	Self-administered questionnaire	8–14	7348
	Subjective	Self-administered questionnaire	13–14	239
	Subjective	Self-administered questionnaire	8–12	832
Zimbabwe	Subjective	Self-administered questionnaire	8–16	4402
	Subjective	Self-administered questionnaire-GSHS	13–15	5665
Total sample(s)				56,634

Abbreviations: GSHS, global school-based student health survey; N/A, not available.

(incomplete grades). All statistical analyses were performed using R (version 3.4.1; The R Foundation for Statistical Computing, Vienna, Austria). To extend base R, several packages were loaded, including corrplot,[42] ggplot2,[43] UpSetR,[44] and VIM.[45]

Results

Table 2 presents the sociodemographic information of the 9 countries with low to medium HDIs participating in the Global Matrix 3.0 initiative (6 sub-Saharan African and 3 Asian countries), with HDIs[29] ranging from 0.448 (Ethiopia) to 0.698 (Botswana). These countries represent a combined total population of approximately 1.9 billion, with India accounting for 1.3 billion people.[46] Botswana (4 people/km^2) is the least densely populated of the 9 countries, whereas Bangladesh (1252 people/km^2) is the most densely populated of the 9 countries.[47] The physical activity grades for the 10 core indicators, organized by country in alphabetical order, are presented in Table 3. Active transportation is the only core indicator that was assigned a grade by all 9 countries. Physical fitness, which was not a core indicator for the first 2 Global Matrix initiatives,[20,21] was assigned incomplete grades in all countries except India (grade F). Except for sedentary behaviors (grade range A– to F) and family and peers (grade range A to F), there was a relatively narrow spread in grades for all the indicators (overall physical activity C+ to D, organized sport and physical activity B to D, active play B to D–, active transportation A– to C, school C to D–, community and environment C– to F, and government B to D) across the 9 countries.

Grade counts, number of incomplete grades, and mean letter grades for each core indicator are presented in Table 4. In general, the mean grades for daily behaviors were higher (C) than the mean grades for settings and sources of influence (D+), and the overall mean grade for all indicators was a C–. Active transportation and sedentary behaviors had the highest mean grade (C+), while physical fitness had the lowest (F). Figure 1 provides a comparison of the frequency of letter grades for daily behaviors versus the settings and sources of influence for the 9 countries. The results show that letter grade C (19.8%) was the most frequent for daily behaviors, while INC (13.6%), closely followed by C and D (12.3%), were the most frequent grades for settings and sources of influence. Twenty-nine (32.2%) of the possible 90 grades were assigned as incomplete. A matrix-based plot of incomplete grades is shown in Figure 2. Ethiopia had only 1 incomplete grade; the other 8 countries had at least 2 or more incomplete grades. Three countries (Bangladesh, Botswana, and Nepal) had at least 5 incomplete grades each. Organized sport and physical activity, physical fitness, and family and peers were graded incomplete in at least 4 countries.

Table 5 presents results of the correlation analyses among the core indicators and some key global indices and descriptors for economic development and health. The findings show mostly weak negative and positive relationships among the global indices (HDI, Gini coefficient, improved drinking water coverage, gender inequality index, public health expenditure, and mean years of schooling) and active transportation, sedentary behaviors, and the school indicators. There were moderate to strong[40,41] relationships among global indices with overall physical activity, organized sport and physical activity, active play, family, community and environment, and government. The Gini coefficient[29] had a statistically significant positive (0.70) and negative (–0.83) relationship with overall physical activity and active play, respectively. Public health expenditure[29] had a statistically significant negative (–0.87) relationship with the community and environment indicator. Mean years of schooling[29] had statistically significant positive (0.71) and negative (–0.83) relationships with overall physical activity and active play, respectively. Country-specific infant mortality rate[48] had a statistically significant negative relationship with sedentary

Table 2 Sociodemographic Information of Countries With Low to Medium HDIs in the Global Matrix 3.0

Country	HDI	Life expectancy at birth	Infant mortality rate	Under 5 mortality rate	Expected years of schooling	Mean years of schooling	GNI per capita	Public health expenditure, % of GDP	Improved drinking water coverage, %	GII	Gini coefficient, %	Urban population, %	Population	Population density (no. of people/km^2)
Bangladesh	0.579	72	29.7	36.3	10.2	5.2	3341	3.7	81	0.52	32.1	34.28	161,669,751	1252
Botswana	0.698	71.7	33.9	42.1	11.8	11.9	14,663	5.1	96	435	60.5	57.44	2,291,661	4
Ethiopia	0.448	64.6	42.6	61.3	8.4	2.6	1523	4.7	44	0.499	33.2	19.47	104,957,438	102
Ghana	0.579	61.5	36.2	61	11.5	6.9	3839	4.8	86	0.547	42.8	54.04	28,833,629	124
India	0.624	68.3	42.4	45.2	11.7	6.3	5663	3.9	92	0.53	35.2	32.75	1,339,180,127	445
Nepal	0.558	70.25	29.6	36.1	12.2	4.1	2337	5.4	89	0.497	32.8	18.62	29,304,998	202
Nigeria	0.527	53.1	69.0	108	10	6	5443	5.3	58	N/A	43	47.78	190,886,311	204
South Africa	0.666	57.7	35.5	44.1	13	10.3	12,087	8.5	91	0.394	63.4	64.8	56,717,156	46
Zimbabwe	0.516	59.2	42	59.9	10.3	7.7	1588	N/A	80	0.54	43.2	32.28	16,529,904	42

Abbreviations: GDP, gross domestic product; GII, gender inequality index; GNI, gross national income; HDI, human development index; N/A, not available.

Table 3 Report Card Grades for Countries With Low to Medium HDIs: Global Matrix 3.0

Country	Overall physical activity	Organized sport and physical activity	Active play	Active transportation	Sedentary behaviors	Physical fitness	Family and peers	School	Community and environment	Government
Bangladesh	C–	INC	INC	C–	A–	INC	INC	INC	INC	C–
Botswana	INC	INC	D–	C	B–	INC	INC	C–	INC	C
Ethiopia	D	C	B	C	F	INC	F	D	F	D
Ghana	C	C+	B–	C+	INC	INC	F	D	D+	D
India	D	INC	C–	B–	C–	F	D	INC	D	D
Nepal	D+	INC	INC	A–	B+	INC	A	INC	C–	INC
Nigeria	C	C–	C	B	B–	INC	INC	C–	INC	B
South Africa	C	D	INC	C	INC	INC	C–	D–	C–	C
Zimbabwe	C+	B	D+	A–	B	INC	INC	C	D	C–

Abbreviations: HDIs, human development indices; INC, incomplete grade.

Table 4 Grade Counts and Mean Letter Grades for Core Indicators

Core indicator	Grade count	Incomplete grades	Mean number grade	SD	Mean letter grade
Overall physical activity	8	1	7	1.5	C–
Organized sport and physical activity	5	4	8	2.2	C
Active play	6	3	7.7	2.6	C–
Active transportation	9	0	9.7	2.2	C+
Sedentary behaviors	7	2	9.3	3.7	C+
Physical fitness	1	8	2	NA	F
Family and peers	5	4	6	4.9	D+
School	6	3	6	1.5	D+
Community and environment	6	3	5.3	1.9	D
Government	8	1	7	2.1	C–
Behavioral indicators	9	0	8.3	1.3	C
Setting and sources of influence indicators	9	0	6.7	2.1	D+
All indicators	9	0	7.6	1.6	C–

Note: Physical fitness was not included in the behavioral indicators cluster. There are no missing grades for the bottom 3 rows because these scores were adjusted for missing grades.

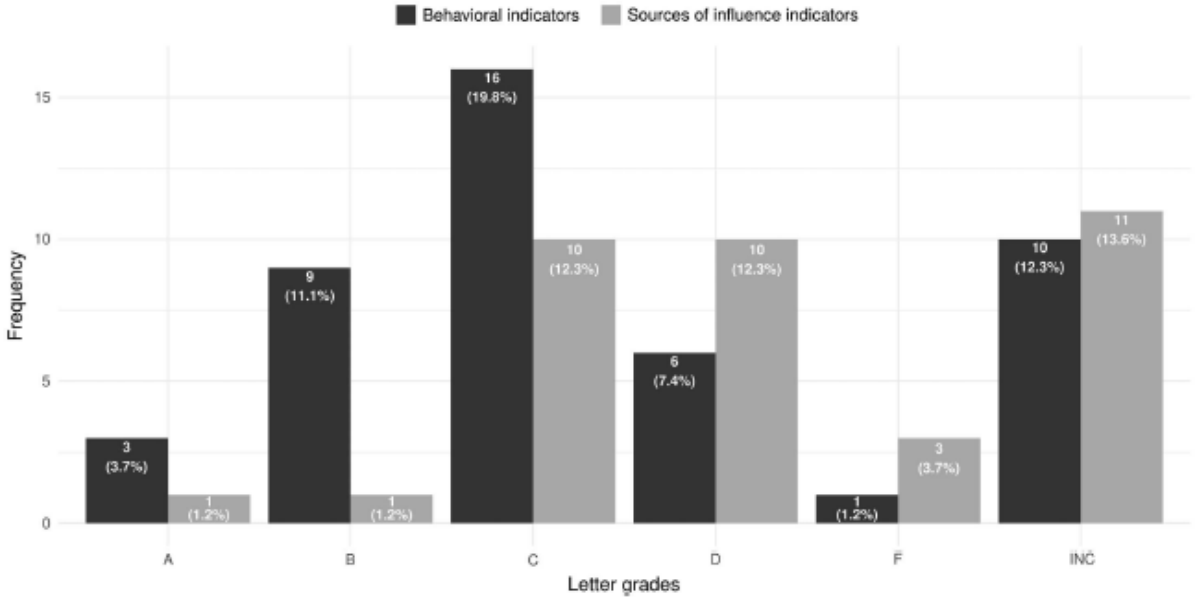

Figure 1 — Frequency of each letter grade for behavioral and settings and sources of influence indicators. INC indicates incomplete grade.

behavior (–0.85). Similarly, the under-five mortality rate[48] had a statistically significant negative relationship with the family and peers indicator (–0.97).

Discussion

Findings from this study provide a broad examination of grades assigned to 10 indicators of physical activity among children and youth from 9 countries with low to medium HDIs that participated in the Global Matrix 3.0 initiative.[25] Although significant effort was made to standardize and gather the best country-specific data, our findings are limited to the overall quality of data and the number of indicators that were examined and assigned grades. As such, caution is needed in interpreting these results. Although the 9 countries included in this study are spread across Africa and Asia, with diverse cultural and geographical contexts within and between them, the narrow spread and similar clustering of grades for most indicators (Table 3) suggest that these countries have comparable challenges, such as a surge in inactive lifestyles among children and youth. The findings point toward a need for increased

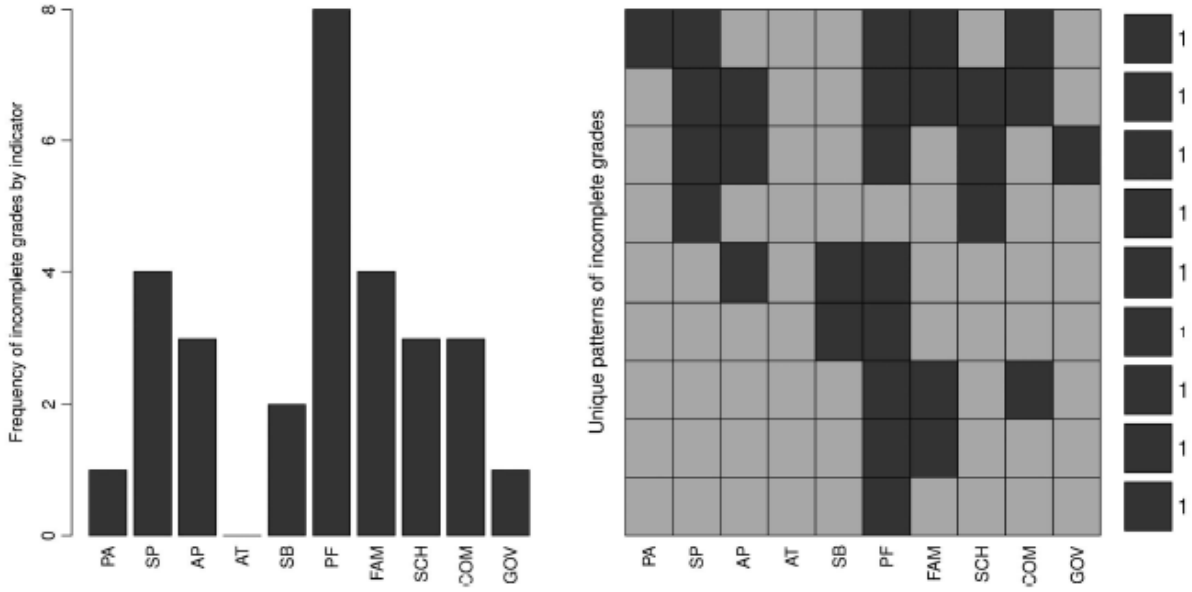

Figure 2 — Matrix-based plot of incomplete grades. Note: In the plot to the right of the figure, dark gray cells represent missing grades. AP indicates active play; AT, active transportation; COM, community and environment; FAM, family and peers; GOV, government; PA, physical activity; PF, physical fitness; SB, sedentary behaviors; SCH, school; SP, organized sport and physical activity.

Table 5 Correlation Matrix (Spearman's Rank Correlation Coefficients) of Mean Physical Activity Grades by Global Indices and Descriptors

	Core indicators								
Sociodemographic index/descriptor	**PA**	**SP**	**AP**	**AT**	**SB**	**FAM**	**SCH**	**COM**	**GOV**
Human development index[29]	–0.02	–0.5	–0.6	–0.41	0.18	0.31	–0.21	0.62	0.29
Gini coefficient[29]	**0.70**	–0.3	**–0.83**	0.06	–0.36	0.21	0	0.18	0.62
Improved drinking water coverage[39]	–0.16	–0.2	–0.71	–0.11	0.20	0.56	–0.12	0.53	0.06
Gender inequality index[29]	0.29	0.8	0.3	0.37	0.03	–0.72	0.41	–0.44	–0.66
Public health expenditure[29]	0.51	–0.8	–0.2	0.41	0.06	0.56	–0.11	**0.87**	0.67
Mean years of schooling[29]	**0.71**	–0.1	**–0.83**	–0.06	0.02	0.15	0.09	0.44	0.38
Infant mortality rate[48]	–0.03	–0.3	0.54	–0.14	**–0.85**	–0.21	–0.59	–0.26	–0.29
Under 5 mortality rate[48]	0.18	0	0.77	0.16	–0.65	**–0.97**	0.02	–0.79	–0.11
Urban population[49]	0.49	–0.5	–0.43	–0.48	–0.02	–0.21	–0.41	0.26	0.56

Abbreviations: AP, active play; AT, active transportation; COM, community and environment; FAM, family and peers; GOV, government; PA, physical activity; SB, sedentary behaviors; SCH, school; SP, organized sport and physical activity. Note: Correlation coefficients in bold show statistically significant ($P < .05$) moderate to very strong[40,41] (negative or positive) relationships between a specific indicator and an index/descriptor. Physical fitness was removed from this analysis due to a majority (8/9) of incomplete grades. Pairwise deletion was used to treat missing data.

knowledge exchange and collaboration between countries to develop common goals and strategies to address insufficient physical activity and increased sedentary behaviors among children and youth. This observation is in line with a recommendation made in the Lancet physical activity series[50] to promote capacity building, workforce training, and intersectoral approaches for physical activity research.

Active transportation was the only indicator assigned a grade by all 9 countries. In resource-limited countries, focusing on the promotion and preservation of behaviors such as active transportation may be the most practical and achievable means to improve physical activity among children and youth. In most of the participating countries, active transportation is still a necessary part of life for most children and youth. The argument for promoting active transportation is supported by the observation that, in general, grades for daily physical activity behaviors were higher than those for settings and sources of influence. Promoting the benefits of active transportation should be weighed against the unintended safety risks of potential harm to pedestrians and cyclists, especially in less walkable urban areas.[7] Although strong and well-designed settings and sources of influence may be preferred, especially given their reported influence on children's participation

in physical activity,[51] the lack of resources, political will,[52] as well as competing priorities, are a reality that cannot be easily addressed in most countries with low-to-medium HDIs. Moreover, having strong and supportive settings and sources of influence does not guarantee increased physical activity participation, as demonstrated by results from the Global Matrix 2.0,[23] which showed lower levels of overall physical activity among children and youth from countries such as Belgium,[53] Sweden,[54] and Denmark,[55] which have very supportive infrastructure.

Findings from the analyses of this study also demonstrate a dearth of data in the participating countries, which has been previously reported[7,56] for most of the indicators, and we present results that are mainly descriptive and correlational; thus, interpretations need to be made with caution. The information in Table 1 presents the common, objective data limitations that are unique to most countries with low to medium HDIs.[1,27] Except for South Africa and India (2 medium HDI countries with some accelerometer data), the other 7 countries relied on subjective data and/or expert opinions to evaluate overall physical activity. Such reliance on subjective data, which are known to be prone to recall and other biases,[57] may impact the accuracy of the reported results. Furthermore, over one-third of the indicators could not be assigned grades due to the unavailability or insufficiency of relevant data. Such data gaps and the preponderant reliance on subjective measures demands urgent action to invest in objective research in countries with low to medium HDIs.[27] This would be a critical step in providing empirical evidence in order to facilitate not only consistent global comparisons and accurate trends over time but also to inform evidence-based policies. The need to prioritize and strengthen systematic surveillance of the core indicators of physical activity among children and youth in countries with low to medium HDIs is further demonstrated by the fact that 8 out of the 9 participating countries could not assign a grade for physical fitness, a simple and cost-effective assessment,[58] due to lack of data.

Accurately interpreting the findings from the present correlation analyses is challenging because of the potential influence of many mechanisms and/or factors that may confound the relationships. A study[59] among American adults found that state-level income inequality was associated with increased risk of sedentary behavior. Whether or not these findings are generalizable to other countries with low to medium HDIs requires further investigation. Mechanisms through which income inequality may affect overall physical activity or sedentary behavior include its relationship with depression,[60,61] which in turn is reportedly associated with decreased participation in physical activity[60] and increased sedentary behavior among adolescents[62,63] and adults.[59] Income inequality has also been found to be associated with depressive symptoms among adolescent girls.[64] Similar to the Global Matrix 2.0 findings,[23] a recent study[65] found that an increased Gini coefficient was associated with decreased participation in physical activity. Another study of 76 countries[20] showed a positive association between physical inactivity and HDI (ie, countries' physical inactivity increased in tandem with an increasing HDI). Contrary to Dumith et al's[20] findings, a study of 47 countries (mostly low-middle-income countries),[66] reported an inverse relationship between HDI and physical inactivity, indicating that as human development increased, physical inactivity decreased. Findings from this study show a negligible (−0.02) relationship between HDI and grades for overall physical activity, suggesting that there is no relationship between the two. The negligible relationship found in this study may be due to the narrow variance in the HDIs of the participating countries, deliberately selected to create a more homogenous sample. These conflicting results may also be due to differences in the composition of samples, highlighting the possible need to further explore these relationships using larger and more diverse samples of countries.

The significantly positive relationships between grades for overall physical activity and the Gini coefficient, overall physical activity and mean years of schooling, and community and environment with public health expenditure, and the significantly negative relationships between active play and Gini coefficient, and active play and mean years of schooling need to be interpreted with caution. First, the sample of countries included in this study (n = 9) is very small. Second, missing data were treated using pairwise deletion under the missing at random assumption. Third, data to compute the Gini coefficient, the mean years of schooling, and public health expenditure,[29] were from 2016, while country-specific data and evidence used to assign grades may have been obtained from different years. Fourth, the present correlation analyses did not account for potential confounders. Furthermore, the quality, sources, and quantity of the data informing the grades varied from country to country. Active play among children and youth can be culture and context specific; given the inevitable cultural and contextual variability among the included countries, the significant correlational results should be interpreted with caution. In addition, given the reported relationships between income inequality and sedentary behavior[59] and physical activity,[65] the negligible to weak relationships observed among sedentary behaviors and the indices and descriptors may be spurious. Alternatively, these findings may suggest that recreational screen time is low in countries with low to medium HDIs, or that the weak relationships observed may be emblematic of the weaknesses in the measurement of sedentary behaviors.

Some studies from high-income countries have reported inverse relationships between income inequality and general health,[67,68] physical activity,[69] and leisure-time physical activities.[70] Furthermore, Tomkinson et al[71] reported a strong inverse relationship between cardiorespiratory fitness and the Gini coefficient in 18 mostly high-income countries. However, care should be taken not to overgeneralize based on these findings given the need for research to determine if such results can replicated using samples from countries with low-medium HDIs. The strong positive relationship between the Gini coefficient and overall physical activity in the present analyses is in contrast to findings by Elgar et al[69] and the Global Matrix 2.0,[23] which showed negative relationships between these two, indicating that higher national income inequality is related to less physical activity among adolescents. The explanation for these differences may lie in differences in measurement methodologies or contexts. Alternatively, our findings may be subject to the ecological fallacy (ie, we cannot attribute findings observed at the population level to an individual).[20] However, our findings might also reflect the substantial needs-based physical activity[72] (eg, household chores, farming, and active transportation) among the low-income families who are the majority in countries with low to medium HDIs; in such environments, opportunities for active play may be few, deemed a luxury, and may possibly be unsafe.

Higher grades for daily behaviors for countries with low to medium HDIs participating in the Global Matrix 3.0 is comparable with results for low- to medium-income countries[73–78] that participated in the 2016 Global Matrix 2.0 initiative.[23] These findings demonstrate that, although there may be ongoing physical activity transitions[8,19] in countries with low to medium HDIs, there may still be an opportunity to reduce the transition acceleration. To this

end, it may be reasonable to employ the common global[79,80] and/or regional[81] strategies that have been proposed and other recommendations,[50,56] including those for improving grades from initiatives such as the Global Matrix,[23–25] in the fight against insufficient physical activity among children and youth. Perhaps it is time to capitalize on the momentum created by such a collective search for practical and realistic solutions. Therefore, investing resources in initiatives such as the Global Matrix[23,24] and the recent push for 24-hour movement guidelines for the early years,[82,83] including those currently being developed by the World Health Organization, the United Kingdom, and South Africa,[27] should be vigorously pursued. For example, organizations such as the African Physical Activity Network[81] and the AHKGA, must be empowered to act either as conduits or as the primary drivers of collaborative efforts among academics, researchers, and policymakers in their respective regions.

Strengths and Limitations

The strengths of this study include providing the most comprehensive assessment of physical activity levels among children and youth in the 9 participating countries with low to medium HDIs. Grade assignments for the core indicators were informed by the best available data from each of the participating countries, gathered and synthesized using a transparent and harmonized approach. The Global Matrix 3.0 initiative and the development of this study provided an opportunity for cross-fertilization of ideas from academics, researchers, and policymakers alike, and the possibility to generate common strategies to address the insufficient physical activity epidemic among children and youth in countries with low to medium HDIs. However, there are some key limitations that are important to mention. The quality and quantity of data varied significantly across the countries. Due to insufficient data, many indicators could not be assigned grades, which limits the comparisons and inferences that can be made. The composition and expertise of the country-specific report card working groups varied. This study only includes data from 9 countries with low to medium HDIs, and as such, may not be representative of all other countries with similar challenges and opportunities.

Conclusions

This study provides a comprehensive assessment of physical activity and related behaviors among children and youth and the settings and sources of influence in 9 countries with low to medium HDIs participating in the Global Matrix 3.0 initiative. The study provides clear evidence that there is a need for high quality, nationally representative data at the country and regional level in order to better understand the levels of physical activity in countries with low to medium HDIs. Findings from the present analyses show that most of the 9 participating countries had higher grades for behavioral indicators despite having lower grades for indicators of settings and sources of influence, suggesting that favorable community environments may not be the only driver of increased physical activity levels. Findings also show that, in general, levels of physical activity among children and youth in the 9 countries with low to medium HDIs are lower than desired. The lack of objective data and the overall low quality of the data among the participating countries presents collaborative research opportunities for the AHKGA and other organizations to develop strategies to collectively address the existing data gaps.

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Chapter 5: General Discussion

The main purposes of this dissertation were to examine relationships between lifestyle behaviours and weight status among primary schoolchildren in Mozambique; compare body mass indices and movement behaviours of Mozambican school children to those of children from other countries; and use these findings to highlight important data gaps that exist in LMICs. The dissertation was developed in two distinct but related phases: 1) thorough narrative literature searches were conducted to identify data gaps and research needs, and 2) primary data collection was conducted on schoolchildren in urban and rural areas in Mozambique. Five specific objectives were developed, and six studies conducted to help achieve the purposes of this dissertation. The modified socioecological model of childhood weight status[1] provided the conceptual framework that guided this research. The modified socioecological model of childhood weight status acknowledges the complex inter-relationships between an individual's characteristics (e.g., age, sex, lifestyle behaviours) and their environments (e.g., home, neighborhood, school). This chapter summarizes and interprets key results from the six studies conducted as part of this dissertation within the socioecological model of childhood weight status.

Summary and interpretation of key results by objective

Objective 1: To conduct thorough narrative searches of relevant literature on childhood weight status and lifestyle behaviours, consult and enlist key stakeholders, and identify data gaps in Zimbabwe and Mozambique.

Overall, the narrative literature searches revealed a dearth of information on prevalences of unhealthy weight status, and key lifestyle behaviours among children and adolescents in

Zimbabwe and Mozambique. The lack of data found in the literature searches is consistent with previous reports,[2–5] and calls for deliberate and sustained efforts from researchers and policy-makers to prioritize addressing these important data gaps. Results from data collected as part of this dissertation can be used to inform some of the data gaps.

Objective 2: To describe the prevalence, and identify important lifestyle and environmental correlates of objectively measured weight status among urban and rural Mozambican schoolchildren.

Results from data addressing this objective showed overweight/obesity to be an emerging public health concern, especially among urban children (11.4%), while thinness which is more prevalent among rural schoolchildren (6.3%) still persists. Although lower than the previously reported prevalences of overweight/obesity in other African[6] and HICs,[7] these results should serve as a call to action, especially for the urban Mozambican schoolchildren whose environment (e.g., lack of walkability, reduced need for habitual PA, and safety concerns) may exacerbate the increases in unhealthy weight status, a PA transition and the associated increased risk for NCDs. The presence of both thinness and overweight/obesity among urban and rural children is consistent with previous reports[8,9] on the existence of a dual burden of malnutrition in LMICs. These findings validate the need to prioritize both forms of malnutrition, albeit with different emphasis, focusing on overweight/obesity in urban and on underweight/thinness in rural areas of LMICs.

Passive school commute, not meeting daily MVPA guidelines (**child risk factors**), and mother's BMI >25 kg/m^2 (**family characteristic**) were associated with overweight/obesity while one or

more functional cars at home (**home environment**), mother's BMI >25 kg/m^2 (**family characteristic**) and older age (**child characteristic**) were associated with thinness in this study. The relationship found between these variables and childhood weight status supports the application of the socioecological model of childhood weight status[1] for this dissertation work. The fact that MVPA, active transport and mother's BMI were found to be important modifiable correlates of childhood weight status suggests that promoting positive changes in lifestyle behaviours could be effective strategies for healthy active living in LMICs. The proportion of total variance in the prevalences of obesity and/or thinness occurring at the school level was 8.7% and 8.3%, respectively, suggesting that the school environment is also an important correlate of child weight status. As proposed in the socioecological model - that the community environment is an important determinant of childhood weight status[1] - rural schoolchildren were found to have an average of 19 more minutes of LPA, and 24 more minutes of MVPA per day than those attending urban schools.

Objective 3: To compare and contrast the prevalence and correlates of adherence to movement guidelines among urban and rural schoolchildren in Mozambique.

Results from the article to address this objective showed that more rural (17.7%) than urban (3.6%) children met all three 24-hour movement guidelines.[10,11] Mean MVPA was lower (82.9±29.5 minutes/day) among urban than rural children (96.7±31.8 minutes/day). Rural children reported longer sleep duration (8.9±0.7 hours/night) and less recreational screen time (2.7±1.9 hours/day) than their urban counterparts (8.7±0.9 hours/night and 5.0±2.3 hours/day, respectively). Distinct differences in the prevalences and correlates of lifestyle behaviours (sleep and physical activity) were observed between urban and rural children in Mozambique.

Interpreted in the context of similar differences observed in previous studies,[12–14] these findings suggest that urban and rural populations may be fundamentally different in key behavioural characteristics, supporting the importance of accounting for these differences in study designs and policy strategies. Parental education (OR: 0.37; CI: 0.16–0.87), school location (OR: 0.21; CI: 0.09–0.52), and outdoor time (OR: 0.67; CI: 0.53–0.85) were significant correlates of meeting all three 24-hour movement guidelines and is consistent with the determinants of weight status such as child risk factors, family characteristics, and community characteristics identified in the modified socioecological model of childhood weight status.[1]

Objective 4: To describe differences or similarities in body mass index and movement behaviours among schoolchildren from 13 countries across a continuum of HDIs.

Compared to children from 12 other countries, on average, children from Mozambique had lower BMIs, higher daily MVPA, lower daily sedentary time and comparable sleep duration. For example, rural Mozambican children had lower mean BMI z-scores (-0.5±0.9) than the rest of the sample (0.4±1.3), 46 more minutes of daily MVPA, and 99 less minutes of daily sedentary time than the other children. Furthermore, linear distributions of study site-specific mean BMI (positive), minutes of daily MVPA (negative), and daily sedentary time (positive) by country human development index were observed. Collectively, these findings are consistent with the epidemiologic transition theory[15], which has been previously reported by our research group in the relationships between childhood obesity and household income,[7] physical activity and socioeconomic status,[16] but not for sleep duration and socioeconomic status.[17] Compared to others, children from the urban Mozambican site closely resembled those from Nairobi Kenya on BMI and movement behaviours, whereas those from rural Mozambique were distinctly different

from the rest of the sample on many indicators suggesting that unique contextual factors for LMICs in general, or family SES specifically, may be more important drivers of the observed differences.

Objective 5: To summarize Report Card indicators of PA among children and youth and explore data gaps from nine LMICs.

A comparison of Report Card grades for ten common indicators of physical activity among children and youth from nine countries with low to medium HDIs revealed an urgent need for high quality data in these countries. Of the possible ninety grades (ten for each of nine countries), twenty-nine (32%) were assigned incomplete grades owing to lack of data. Although the nine countries (Bangladesh, Botswana, Ethiopia, Ghana, India, Nepal, Nigeria, South Africa, Zimbabwe) are culturally and geographically diverse, the similar clustering of their grades suggests that they have comparable challenges.

Summary of limitations and strengths

Limitations

This research has several important limitations including its cross-sectional design which precludes inferences about causation. Relationships found between dependent and independent variables are limited to the list of included correlates and the potential for residual confounding cannot be excluded. The rural schools were neither randomly selected nor were there expansive, deliberate stratification strategies based on other weighting of key characteristics, thus the study sample was not necessarily representative, and for several variables, relied on self-reported data obtained by questionnaires whose validity, especially in the rural context, is not known. There

were substantial missing data on key variables which necessitated the application of multiple imputation with potential biases that may have been introduced in specific studies for this research. However, comparative analyses between complete data cases and imputed datasets do not support this potential limitation.

Strengths

This research has important strengths that include the recruitment of a relatively large sample with both urban and rural participants. Many key variables (e.g., body composition, movement behaviours) were objectively measured, and a rigorous and standardized study protocol was followed. For example, research staff were trained and certified prior to data collection. For studies involving primary data collection, the use of multilevel analyses accounted for the hierarchical nature of the data. For one study, the multinational nature of the sample, from countries at various levels of HDIs with diverse cultures and contexts, provided results that could help to inform global interventions or policy initiatives. Finally, following the Active Healthy Kids Global Alliance's Report Card development methodology to conduct thorough narrative literature searches, identify data gaps and research needs helped to obtain results that are internationally comparable.

Knowledge translation approach

The knowledge translation strategy for this dissertation work included submissions of articles for publication in peer-reviewed journals, presentations at local and international conferences and scientific symposia. The two articles developed from the thorough searches of literature: *Results from Zimbabwe's 2016 Report Card on Physical Activity for Children and Youth,* and *Results*

from Zimbabwe's 2018 Report Card on Physical Activity for Children and Youth were separately published in the Journal of Physical Activity and Health. Each of the articles was derived from Report Cards which provided specific policy recommendations that were disseminated to the related Government Ministries in Zimbabwe. Results of the literature searches were also presented at the 6th International Congress on Physical Activity and Public Health (Bangkok, Thailand, 2016) and the Movement to Move Conference (Adelaide, Australia, 2018). Results from preliminary analyses of data collected for this dissertation were presented at a scientific symposium in Maputo, Mozambique, and at the International Conference on Physical Activity, Sport and Health for Development in Africa (IC-PASHDA) (Accra, Ghana, 2018).

The article *Prevalence and correlates of objectively measured weight status among urban and rural Mozambican schoolchildren: a cross-sectional study* was submitted for publication consideration and is currently under review in the PLOS ONE journal. The article *Prevalence and correlates of adherence to movement guidelines among urban and rural children in Mozambique: a cross-sectional study* was submitted and is under peer-review (revisions requested) at the International Journal of Behavioral Nutrition and Physical Activity. Two abstracts derived from this work were submitted and were accepted for presentation at the Canadian Society of Exercise Physiology conference (Kelowna, Canada, 2019). The article *Body mass index and movement behaviors among schoolchildren from 13 countries across a continuum of human development indices: a multinational cross-sectional study*, has been accepted for publication in the American Journal of Human Biology. An abstract from this study was submitted for presentation at the Active Living Research Conference (Florida, USA, 2019). The article: *Indicators of physical activity among children and youth in nine countries with low*

and medium human development indices: A Global Matrix 3.0 paper was published in the Journal of Physical Activity and Health and some of the work was presented at a scientific symposium in Adelaide Australia. Other work related to the dissertation has been presented at the annual Graduate Student Research Day (University of Ottawa, 2019), International Society of Behavioral Nutrition and Physical Activity conference (Prague, Czech Republic, 2019), and at the Canadian Student Health Research Forum (Winnipeg, Canada, 2019).

Recommendations and future directions

Although specific recommendations are presented in chapters 4.1 – 4.6 of this dissertation, it is important to provide broad research and policy priorities for the future. First, there is a need for reliable, systematic and consistent surveillance protocols for childhood weight status and associated lifestyle factors in LMICs. Such protocols could help direct the collection of the urgently needed robust and nationally representative data from samples that include urban and rural participants in many LMICs. For sustainability and ownership, there is a need for country-specific and regional capacity-building efforts to be led by researchers and other stakeholders from LMICs. There is need for multinational studies that follow standardized and rigorous data collection protocols and involve samples from culturally, geographically, and economically diverse countries. There is need for continued reliability and validity assessments, and appropriate context-specific modifications/adaptations of measurement instruments. In addition, future work should expand on the findings from this dissertation which was mostly hypothesis generating and cross-sectional in nature and add longitudinal or intervention studies that could help to establish temporality and causality between weight status and lifestyle behaviours. Such work would benefit from the application of additionally robust analytical approaches that can

better account for proximal causes, and explore the potential effects of intermediate[18] or latent variables,[19,20] including but not limited to formal mediation analysis[18] and / or structural equation modelling.[19,21] These approaches (e.g., structural equation modelling and mediation analysis) which, although deemed unnecessary in this dissertation because of the cross-sectional nature of the data precluding any causal inferences to be made, are better suited to deal with the lurking potential of latent or intermediate variables. Finally, given the identified similarities in the challenges and opportunities in LMICs, there may be merit in deliberate efforts to establish collaborative networks, and the designing of evidence-informed interventions that account for universal or unique contextual factors.

Conclusion

The emergence of obesity and the persistence of thinness as serious public health concerns among children and adolescents in LMICs necessitate prioritizing effective and evidence-informed prevention and management strategies. Findings from this dissertation highlight the importance of including participants from low, medium, high, and very high-income countries in multinational studies investigating contextual and environmental factors related to childhood weight status and related movement behaviours. The findings also revealed important differences between urban and rural children supporting the need to include both in study samples and especially in LMICs where the majority of people live in rural areas. Finally, findings from this dissertation have demonstrated that despite the reported global progress in the availability of data about obesity and related factors among children and adolescents, important gaps still exist and need to be filled in LMICs.

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Appendices

Appendix A: ISCOLE sample size and power calculations

Description: Sample size calculations for ISCOLE

In order to estimate sample size requirements for the ISCOLE, a regression model was developed to predict BMI from objectively monitored physical activity (accelerometer-determined activity counts/day) and self-reported caloric consumption (kcal/day) among 10-year olds in the 2005/2006 U.S. National Health and Nutrition Examination Survey. Based on estimates gleaned from the regression model, the sample size was determined under the following assumptions: 1) 10-year old students would be sampled in school clusters with an average of 25 students per school, 2) the 5% significance level was desirable, and 3) at least 90% power was required to detect as significant a predictor that explains 3% of the variability in BMI. It was determined that a site-specific minimum of 350 students would achieve a minimum power of 91%. Because the students were to be sampled in clusters by schools, a design effect of 1.3, estimated from Williamson et al. [2012], was applied to produce a required sample size of 455. To further allow for students who may fail to provide valid and /or complete data, the enrollment target for each site was set at 500 students, within a target of at least 20 schools. The total sample size of approximately 6000 children across twelve countries should provide excellent power for detecting meaningful significant contributions to the hypothesized multi-level model.

Appendix B: Global Matrix 3.0 Indicators and Benchmarks

Global Matrix Indicators and Benchmarks Used to Guide the Grade Assignment Process

Indicator	Benchmark
Overall Physical Activity	% of children and youth who meet the Global Recommendations on Physical Activity for Health, which recommend that children and youth accumulate at least 60 min of moderate- to vigorous-intensity physical activity per day on average. Or % of children and youth meeting the guidelines on at least 4 d a week (when an average cannot be estimated).
Organized Sport and Physical Activity	% of children and youth who participate in organized sport and/or physical activity programs.
Active Play	% of children and youth who engage in unstructured/unorganized active play at any intensity for more than 2 hours a day. % of children and youth who report being outdoors for more than 2 hours a day.
Active Transportation	% of children and youth who use active transportation to get to and from places (e.g., school, park, mall, friend's house).
Sedentary Behaviours	% of children and youth who meet the Canadian Sedentary Behaviour Guidelines (5- to 17-y-olds: no more than 2 hours of recreational screen time per day). Note: the Guidelines currently provide a time limit recommendation for screen-related pursuits, but not for nonscreen-related pursuits.
Physical Fitness	Average percentile achieved on certain physical fitness indicators based on the normative values published by Tomkinson et al.[1]
Family and Peers	% of family members (e.g., parents, guardians) who facilitate physical activity and sport opportunities for their children (e.g., volunteering, coaching, driving, paying for membership fees and equipment). % of parents who meet the Global Recommendations on Physical Activity for Health, which recommend that adults accumulate at least 150 min of moderate-intensity aerobic physical activity throughout the week or do at least 75 min of vigorous-intensity aerobic physical activity throughout the week or an equivalent combination of moderate- and vigorous intensity physical activity. % of family members (e.g., parents, guardians) who are physically active with their kids. % of children and youth with friends and peers who encourage and support them to be physically active. % of children and youth who encourage and support their friends and peers to be physically active.
School	% of schools with active school policies (e.g., daily physical education (PE), daily physical activity, recess, "everyone plays" approach, bike racks at school, traffic calming on school property, outdoor time). % of schools where the majority (≥80%) of students are taught by a PE specialist. % of schools where the majority (≥80%) of students are offered the mandated amount of PE (for the given state/territory/region/country). % of schools that offer physical activity opportunities (excluding PE) to the majority (>80%) of their students.

	% of parents who report their children and youth have access to physical activity opportunities at school in addition to PE classes. % of schools with students who have regular access to facilities and equipment that support physical activity (e.g., gymnasium, outdoor playgrounds, sporting fields, multipurpose space for physical activity, equipment in good condition).
Community and Environment	% of children or parents who perceive their community/municipality is doing a good job at promoting physical activity (e.g., variety, location, cost, quality). % of communities/municipalities that report they have policies promoting physical activity. % of communities/municipalities that report they have infrastructure (e.g., sidewalks, trails, paths, bike lanes) specifically geared toward promoting physical activity. % of children or parents who report having facilities, programs, parks, and playgrounds available to them in their community. % of children or parents who report living in a safe neighborhood where they can be physically active. %of children or parents who report having well-maintained facilities, parks, and playgrounds in their community that are safe to use.
Government	Evidence of leadership and commitment in providing physical activity opportunities for all children and youth. Allocated funds and resources for the implementation of physical activity promotion strategies and initiatives for all children and youth. Demonstrated progress through the key stages of public policy making (i.e., policy agenda, policy formation, policy implementation, policy evaluation and decisions about the future).

Reference

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Appendix C: Global Matrix Grading Rubric

Grade	Interpretation	Corresponding number for analysis
A+	94%-100%	15
A	We are succeeding with a large majority of children and youth (87%-93%)	14
A-	80%-86%	13
B+	74%-79%	12
B	We are succeeding with well over half of children and youth (67%-73%)	11
B-	60%-66%	10
C+	54%-59%	9
C	We are succeeding with about half of children and youth (47%-53%)	8
C-	40%-46%	7
D+	34%-39%	6
D	We are succeeding with less than half but some children and youth (27%-33%)	5
D-	20-26%	4
F	We are succeeding with very few children and youth (<20%)	2
INC	Incomplete ─ insufficient or inadequate information to assign a grade	No grade

Appendix D: Research Ethics Boards Approval – CHEO

CHEO Research Ethics Board
Approval - Delegated Review

Principal Investigator: Dr. Mark Tremblay
REB Protocol No: 17/59X
Romeo File No: 20170166
Other Study No:_____
Project Title: CHEOREB# 17/59X - Relationships between lifestyle behaviours and weight status in Mozambican children: a search to understand lifestyle transitions in a developing country
Primary Affiliation: HALO\HALO
Protocol Status: Active
Approval Date*: April 26, 2017
Valid Until:** April 15, 2018
Annual Renewal Submission Deadline:15 February 2018

Documents Reviewed & Approved:

Document Name	Comments	Version Date
Other Document	Appendix Q: verbal instructions to participants	received 03/22/2017
Investigator Response	Investigator response to REB feedback letter-ISCOLE MZ study	2017/04/21
Protocol	Protocol clean-ISCOLE MZ study	2017/04/20
Other Document	Appendix S-ISCOLE MZ study	2017/04/20
Other Document	Appendix R-ISCOLE MZ study	2017/04/20
Other Document	Appendix P-ISCOLE MZ study	2017/04/20
Other Document	Appendix O-ISCOLE MZ study	2017/04/20

Other Document	Appendix N-ISCOLE MZ study	2017/04/20
Other Document	Appendix M-ISCOLE MZ study	2017/04/20
Other Document	Appendix L-ISCOLE MZ study	2017/04/20
Other Document	Appendices I-K-ISCOLE MZ study	2017/04/20
Other Document	Appendix H-ISCOLE MZ study	2017/04/20
Other Document	Appendix G-ISCOLE MZ study	2017/04/20
Other Document	Appendix F-ISCOLE MZ study	2017/04/20
Other Document	Appendix E-ISCOLE MZ study	2017/04/20
Other Document	Appendix D_2-ISCOLE MZ study	2017/04/20
Other Document	Appendix D_1-ISCOLE MZ study	2017/04/20
Other Document	Appendix C-ISCOLE MZ study	2017/04/20
Other Document	Appendix B-ISCOLE MZ study	2017/04/20
Other Document	Appendix A-ISCOLE MZ study	2017/04/20
Consent Form	Consent form (School Administration)) clean-ISCOLE MZ study	2017/04/19
Consent Form	Consent form (Parent) clean-ISCOLE MZ study	2017/04/20
Assent Form	Assent form clean-ISCOLE MZ study	2017/04/19

This is to notify you that the Children's Hospital of Eastern Ontario Research Ethics Board has granted approval to the above named research study on the date noted above. Your project was reviewed under the delegated review stream, which is reserved for projects that involve no more than minimal risk to human subjects.

Final approval is granted for the above noted study, with the understanding that the investigator agrees to comply with the following requirements:

1. The investigator must conduct the study in compliance with the protocol and any additional conditions set out by the Board.
2. The investigator is responsible for complying with all applicable guidelines and regulations regarding human research ethics conduct, as applicable to the research project.
3. Approval for studies that include an investigational device(s) is contingent upon the investigator securing an Investigational Testing Authorization notice from Health Canada.

4. Investigators must submit an annual renewal report to the REB 30 days prior to the expiration date stated above.
5. The investigator must not implement any deviation from, or changes to, the protocol, consents or assents without the approval of the REB.
6. The investigator must, prior to use, submit to the Board changes to the study documentation, e.g., changes to the informed consent letters, recruitment materials.
7. Investigators must provide the Board with French versions of the consent form, unless a waiver has been granted. An interpreter should be offered to participants as required or at the request of the participant throughout the course of research.
8. The investigator must promptly report to the REB all unexpected and untoward occurrences (including the loss or theft of study data and other such privacy breaches).
9. Investigators must notify the REB of any study closures (closed to accrual, temporary, premature or permanent).
10. Investigators must submit a final report at the conclusion of the study.

Should you have any questions or concerns, please do not hesitate to contact the Research Ethics Board Office at 613-737-7600 ext. 3350 or 2128.

Regards,

Richard Carpentier, PhD
Chair, Research Ethics Board
Président, Comité d'éthique de la recherche

*The final approval date for initial delegated study applications approved with or without modifications will be the date the REB has determined that the conditions of approval have been satisfied.

**The expiry date of REB approval for initial study application that required no modifications will be as follows:

- If the date of review and approval was **on or before** the 15th of the month, the expiry date will be the 15th of the month prior to the date of review and approval by the Chair and/or delegate *in the following year*;
- If the date of review and approval was **after** the 15th the expiry date will be the 15th of the month in which the date of review and approval by the REB *in the following year*.

The expiry date of REB approval for initial study applications that **require modifications** will be as follows:

- If the initial feedback was sent **on or before** the 15th of the month, the expiry date will be the 15th of the month prior to the date the letter of REB feedback is issued to the investigator(s) *in the following year*;
- If the initial feedback was sent **after** the 15th the expiry date will be the 15th of the month in which the feedback was sent *in the following year*.

Appendix E: Research Ethics Boards Approval – UOttawa

Université d'Ottawa University of Ottawa

Bureau d'éthique et d'intégrité de la recherche Office of Research Ethics and Integrity

May 15th, 2017

Mark Tremblay
Senior Scientist
HALO
CHEO Research Institute
mtremblay@cheo.on.ca

Taru Manyanga
PhD Student
School of Epidemiology
University of Ottawa
tmanyanga@cheo.on.ca

Co-Investigators: Antonio Prista
Jean-Philippe Chaput, CHEO
Peter Katzmarzyk
Kevin Belanger, CHEO

Re: U of O Ethics file no. A05-17-02 – "Relationships between lifestyle behaviours and weight status in Mozambican children: a search to understand lifestyle transitions in a developing country"

Dear Dr. Tremblay, Mr. Manyanga and colleagues,

Thank you for the protocol documents and Certificates of Approval from the CHEO REB (# 17/59X) for your project named above.

This is to confirm that, in accordance with the agreement between the University of Ottawa and CHEO REB, the University of Ottawa has authorized this board to act as Board of Record for the review and oversight of research involving human subjects conducted at or through the hospital.

We remind you of your obligation to:

- Follow all procedures of the CHEO REB including reporting and renewal procedures;
- Submit to the authority of the CHEO REB and that you are subject to CHEO REB requirements, including, without limitation, the requirement to modify or stop the research on demand of the CHEO REB.

If you have any questions, please contact our ethics office at 562-5387.

Sincerely yours,

[redacted]

Catherine Paquet
Director
Office of Research Ethics and Integrity

550, rue Cumberland 550 Cumberland Street
Ottawa (Ontario) K1N 6N5 Canada Ottawa, Ontario K1N 6N5 Canada
(613) 562-5387 • Téléc./Fax (613) 562-5338

Appendix F: Research Ethics Boards Approval – Mozambique (English)

REPUBLIC OF MOZAMBIQUE

MINISTERY OF HEALTH

NATIONAL BIOETHICS COMMITTEE FOR HEALTH

IRB00002657

Ref: 151 / CNBS / 17

Date May 08, 2017

Subject: Decision of the National Bioethics Committee for Health (CNBS) for the study "Relationship between lifestyle behaviors and weight status in Mozambican children"

The National Bioethics Committee for Health (CNBS) analyzed the corrections made in the study protocol entitled "***Relationship between lifestyle behaviors and weight status in Mozambican children***", registration number: 01 / CNBS / 2017, according to the requirements of the Declaration of Helsinki.
Since there are no ethical issues noted, to prevent the performance of the study, the CNBS gives its due approval of the following documents:

- Study protocol (version 03)
- Informed consent (version 03)
- Data collection instruments (version 02)

However, the CNBS reports that:

1. Any changes to be made to the protocol, including its annexes, must be submitted to the CNBS for approval.
2. This approval does not replace the administrative authorization.
3. There has been no declaration of conflicts of interest by any of the CNBS members.
4. The approval will be valid for one year, ending on May 8, 2018. Researchers shall submit the request for renewal of the approval one month before the expiration of the term.
5. Researchers are advised to keep CNBS informed of the course of the study.
6. The updated list of CNBS members is available at the secretariat of the Committee.

Without further ado, our most cordial greetings

The President of CNBS

[redacted]

João Fernando Lima Schwalbach

Appendix G: Research Ethics Boards Approval – Mozambique (Portuguese)

REPÚBLICA DE MOÇAMBIQUE

MINISTÉRIO DA SAÚDE
COMITÉ NACIONAL DE BIOÉTICA PARA A SAÚDE
IRB00002657

Exmo Senhor
Prof. Doutor António Prista
Universidade Pedagógica

Ref: 151/CNBS/17 **Data 08 de Maio de 2017**

Assunto: Parecer do Comité Nacional de Bioética para Saúde (CNBS) sobre o estudo: "*Relationship between lifestyle behaviours and weight status in Mozambican children*"

O Comité Nacional de Bioética para Saúde (CNBS) analisou as correcções efectuadas no protocolo de estudo intitulado: "***Relationship between lifestyle behaviours and weight status in Mozambican children***"
Registado no CNBS com o número 01/CNBS/2017, conforme os requisitos da Declaração de Helsínquia.
Não havendo nenhum inconveniente de ordem ética que impeça a realização do estudo, o CNBS dá a sua devida aprovação aos seguintes documentos:

- Protocolo de estudo (*versão 03)*
- Consentimento informado *(versão 03)*
- Instrumentos de recolha de dados *(versão 02)*

Todavia, o CNBS informa que:

1- Qualquer alteração a ser introduzida no protocolo, incluindo os seus anexos deve ser submetida ao CNBS para aprovação.
2- A presente aprovação não substitui a autorização administrativa.
3- Não houve declaração de conflitos de interesse por nenhum dos membros do CNBS.
4- A aprovação terá a validade de um ano, terminando esta a 08 de Maio de 2018. Os investigadores deverão submeter o pedido de renovação da aprovação um mês antes de terminar o prazo.
5- Recomenda-se aos investigadores que mantenham o CNBS informado do decurso do estudo.
6- A lista actualizada dos membros do CNBS esta disponível na secretaria do Comité.

Sem mais do momento, as nossas mais cordiais saudações.

[redacted]
Dr. João Fernando Lima Schwalbach

ENDEREÇO:
MINISTÉRIO DA SAÚDE
C. POSTAL 264
Av. Eduardo Mondlane/Salvador Allende
MAPUTO – MOÇAMBIQUE

Telefones: 430814/427131(4)
Telex: 6-239 MISAU MO
FAX: 258 (1) 426547
258 (1) 33320

Appendix H: Anthropometric Data Collection Sheet

Participant ID (attach label here)	Technician Initials ☐☐☐ Date ☐☐ / ☐☐☐ / ☐☐☐☐ Day Month Year

APPENDIX H: Anthropometric Data Collection Form

1. Standing Height

1. ⌊_⌋⌊_⌋⌊_⌋.⌊_⌋ cm
2. ⌊_⌋⌊_⌋⌊_⌋.⌊_⌋ cm
3. ⌊_⌋⌊_⌋⌊_⌋.⌊_⌋ cm

2. Sitting Height

Table/Box Height:

1. ⌊_⌋⌊_⌋⌊_⌋.⌊_⌋ cm

Total Sitting Height:

1. ⌊_⌋⌊_⌋⌊_⌋.⌊_⌋ cm
2. ⌊_⌋⌊_⌋⌊_⌋.⌊_⌋ cm
3. ⌊_⌋⌊_⌋⌊_⌋.⌊_⌋ cm

☐ **Check if PT could not remove head attire for height measurements**

3. Mid-Upper-Arm Circumference

1. ⌊_⌋⌊_⌋⌊_⌋.⌊_⌋ cm
2. ⌊_⌋⌊_⌋⌊_⌋.⌊_⌋ cm
3. ⌊_⌋⌊_⌋⌊_⌋.⌊_⌋ cm

4. Waist Circumference

1. ⌊_⌋⌊_⌋⌊_⌋.⌊_⌋ cm
2. ⌊_⌋⌊_⌋⌊_⌋.⌊_⌋ cm
3. ⌊_⌋⌊_⌋⌊_⌋.⌊_⌋ cm

5. Weight

1. ⌊_⌋⌊_⌋⌊_⌋.⌊_⌋ kg
2. ⌊_⌋⌊_⌋⌊_⌋.⌊_⌋ kg
3. ⌊_⌋⌊_⌋⌊_⌋.⌊_⌋ kg

6. Body Fat

1. ⌊_⌋⌊_⌋.⌊_⌋ %
2. ⌊_⌋⌊_⌋.⌊_⌋ %
3. ⌊_⌋⌊_⌋.⌊_⌋ %

7. Impedance

1. ⌊_⌋⌊_⌋⌊_⌋.⌊_⌋ Ω
2. ⌊_⌋⌊_⌋⌊_⌋.⌊_⌋ Ω
3. ⌊_⌋⌊_⌋⌊_⌋.⌊_⌋ Ω

☐ **Check if PT is wearing socks/hosiery for weight and body fat measurements**

ISCOLE QUALITY CONTROL (QC) and DATA ENTRY:

QC Staff Initials: Date: / /

Data Entry Staff Initials: _____ Date: _____/_____/_____

Appendix I: Diet and Lifestyle Questionnaire (English)

Participant ID
(attach label here)

Technician Initials ☐☐☐

Date ☐☐ / ☐☐☐ / ☐☐☐☐
Day Month Year

ISCOLE Mozambique Diet and Lifestyle Questionnaire

Please read every question carefully. What answer comes to your mind first?
Choose the box that fits your answer best and fill it in.

Remember: This is not a test so there are no wrong answers. It is important that you answer all the questions and that we can see your marks clearly.

You do not have to show your answers to anybody. Also, nobody who knows you will look at your questionnaire once you have finished it.

For the questions on this page, please tell about what you did *last week*.

1. On a school day, how many hours did you watch TV?
   ☐ I did not watch TV on school days ☐ < 1 hour ☐ 1 hour ☐ 2 hours ☐ 3 hours ☐ 4 hours ☐ 5 or more hours

2. On a school day, how many hours did you play video or computer games or use a computer for something that was not school work?
   ☐ I did not play video/computer games or use a computer other than for school work on school days ☐ < 1 hour ☐ 1 hour ☐ 2 hours ☐ 3 hours ☐ 4 hours ☐ 5 or more hours

3. On a school day how much time did you spend outside **before** school?
   ☐ < 1 hour ☐ 1 hour ☐ 2 hours ☐ 3 hours ☐ 4 hours ☐ 5 or more hours

4. On a school day how much time did you spend outside **after** school before bedtime?
   ☐ < 1 hour ☐ 1 hour ☐ 2 hours ☐ 3 hours ☐ 4 hours ☐ 5 or more hours

5. On a weekend day, how many hours did you watch TV?
   ☐ I did not watch TV on weekend days ☐ < 1 hour ☐ 1 hour ☐ 2 hours ☐ 3 hours ☐ 4 hours ☐ 5 or more hours

6. On a weekend day, how many hours did you play video or computer games or use a computer for something that was not school work?
   ☐ I did not play video/computer games or use a computer other than for school work on the weekend ☐ < 1 hour ☐ 1 hour ☐ 2 hours ☐ 3 hours ☐ 4 hours ☐ 5 or more hours

ISCOLE MOZAMBIQUE QUALITY CONTROL (QC) and DATA ENTRY:

QC Staff Initials: _____ Date: _____ / _____ / _____

Data Entry Staff Initials: _____ Date: _____ / _____ / _____

Participant ID (attach label here)	Technician Initials ☐☐☐ Date ☐☐/☐☐☐/☐☐☐☐ Day / Month / Year

7. On a weekend day, how much time did you spend outside?
   ☐ < 1 hour ☐ 1 hour ☐ 2 hours ☐ 3 hours ☐ 4 hours ☐ 5 or more hours

8. In the last week you were in school, on how many days did you go to physical education (PE) classes?
   ☐ 0 days ☐ 1 day ☐ 2 days ☐ 3 days ☐ 4 days ☐ 5 days

9. In the last week you were in school, the **MAIN** part of your journey to school was by:
   ☐ Walking or running
   ☐ bicycle, roller-blade, skateboard or scooter
   ☐ bus, train, kombi/commuter omnibus
   ☐ car, motorcycle or moped
   ☐ other _____

10. In the last week you were in school, **HOW LONG** did it take you to travel to school?
    ☐ < 5 minutes ☐ 5 - 15 minutes ☐ 16 - 30 minutes ☐ 31 minutes to 1 hour ☐ >1 hour

11. What is the distance between your home and your school?
    ☐ < 500M ☐ 500M - 1KM ☐ 1.1KM- 3KM ☐ 3.1KM – 5KM ☐ > 5KM

12. During the past year (12 months), did you do any of these activities? (Tick all that apply)
    ☐ sports teams ☐ dance / martial arts class ☐ art / music class ☐ none of these

13. During the past week (7 days), on how many days were you physically active for a total of at least 60 minutes per day? (all the time you spent in activities that increased your heart rate and made you breathe hard)
    ☐ 0 days ☐ 1 day ☐ 2 days ☐ 3 days ☐ 4 days ☐ 5 days ☐ 6 days ☐ 7 days

14. During the past week, what time have you usually turned out the light/candle/lamp and gone to sleep on school days?
    ☐☐:☐☐ AM / PM (circle AM or PM)

15. During the past week, at what time have you usually woken up in the morning on school days?
    ☐☐:☐☐ AM / PM (circle AM or PM)

16. During the past week, what time have you usually turned out the light/candle/lamp and gone to sleep on weekend days?
    ☐☐:☐☐ AM / PM (circle AM or PM)

17. During the past week, at what time have you usually woken up in the morning on weekend days?
    ☐☐:☐☐ AM / PM (circle AM or PM)

ISCOLE MOZAMBIQUE QUALITY CONTROL (QC) and DATA ENTRY:

QC Staff Initials: _____ Date: _____/_____/_____

Data Entry Staff Initials: _____ Date: _____/_____/_____

Participant ID (attach label here)	Technician Initials ☐☐☐ Date ☐☐ / ☐☐☐ / ☐☐☐☐ Day Month Year

18. During the past week, how would you rate your sleep **quality** overall (how **well** you sleep)?

☐ very good ☐ fairly good ☐ fairly bad ☐ very bad

19. During the past week, how would you rate your sleep **quantity** overall (how **much** you sleep)?

☐ very good ☐ fairly good ☐ fairly bad ☐ very bad

20. Do you have a television in your bedroom/room where you sleep?

☐ Yes ☐ No

ISCOLE MOZAMBIQUE QUALITY CONTROL (QC) and DATA ENTRY:

QC Staff Initials: _____ Date: _____ / _____ / _____

Data Entry Staff Initials: _____ Date: _____ / _____ / _____

Participant ID (attach label here)	Technician Initials ☐☐☐ Date ☐☐ / ☐☐☐ / ☐☐☐☐ Day Month Year

21. How many times do you usually eat . . . ? (Please mark only one box for each line)

	Never	Less than once a week	Once a week	2 - 4 days a week	5 - 6 days a week	Once a day, every day	Every day, more than once
Fruits	☐	☐	☐	☐	☐	☐	☐
Vegetables	☐	☐	☐	☐	☐	☐	☐
Sweets (candy/chocolate)	☐	☐	☐	☐	☐	☐	☐
Regular cola or soft drinks that contain sugar	☐	☐	☐	☐	☐	☐	☐
Cake, pastries, or donuts	☐	☐	☐	☐	☐	☐	☐
Diet cola or diet soft drinks	☐	☐	☐	☐	☐	☐	☐
Potato chips/crisps	☐	☐	☐	☐	☐	☐	☐
French fries/chips	☐	☐	☐	☐	☐	☐	☐
Dark green vegetables (broccoli, spinach, etc.)	☐	☐	☐	☐	☐	☐	☐
Orange vegetables (carrots, squash, sweet potato, etc.)	☐	☐	☐	☐	☐	☐	☐
Fruit juice	☐	☐	☐	☐	☐	☐	☐
Low fat milk (1%,2%, skim)	☐	☐	☐	☐	☐	☐	☐
Whole milk (homogenized)	☐	☐	☐	☐	☐	☐	☐
Cheese	☐	☐	☐	☐	☐	☐	☐
Other milk products (yogurt, chocolate milk, pudding, etc.)	☐	☐	☐	☐	☐	☐	☐
Whole grain bread or cereal (oatmeal, muesli, etc.)	☐	☐	☐	☐	☐	☐	☐
Meat alternatives (beans, lentils, tofu, eggs, peanut butter, etc.)	☐	☐	☐	☐	☐	☐	☐
Energy drinks (Red Bull, Rock Star, Guru, etc.)	☐	☐	☐	☐	☐	☐	☐
Sports drinks (Gatorade, Powerade, etc.)	☐	☐	☐	☐	☐	☐	☐
Fish	☐	☐	☐	☐	☐	☐	☐
Ice cream	☐	☐	☐	☐	☐	☐	☐
Fried food such as chicken wings, chicken fingers, etc.	☐	☐	☐	☐	☐	☐	☐
Fast foods such as pizza, hamburgers, etc.	☐	☐	☐	☐	☐	☐	☐

ISCOLE MOZAMBIQUE QUALITY CONTROL (QC) and DATA ENTRY:

QC Staff Initials: _____ Date: _____ / _____ / _____

Data Entry Staff Initials: _____ Date: _____ / _____ / _____

Participant ID (attach label here)	Technician Initials ☐☐☐ Date ☐☐/☐☐☐/☐☐☐☐ Day Month Year

22. How many times do you usually eat the following food items **while watching television**?

	Never	Less than once a week	Once a week	2 - 4 days a week	5 - 6 days a week	Once a day, every day	Every day, more than once
Potato chips/crisps or peanuts	☐	☐	☐	☐	☐	☐	☐
Fried food such as chicken wings, chicken fingers, french fries, etc.	☐	☐	☐	☐	☐	☐	☐
Cookies, biscuits, chocolate or candy bars	☐	☐	☐	☐	☐	☐	☐
Ice cream	☐	☐	☐	☐	☐	☐	☐
Fast foods such as pizza, hamburgers, etc.	☐	☐	☐	☐	☐	☐	☐
Fruits or vegetables	☐	☐	☐	☐	☐	☐	☐

23. How often do you usually have **breakfast** (more than a glass of milk or fruit juice)? Mark one box for weekdays and one box for weekend.

Weekdays

- ☐ I never have breakfast on weekdays
- ☐ One day
- ☐ Two days
- ☐ Three days
- ☐ Four days
- ☐ Five days

Weekend

- ☐ I never have breakfast on the weekend
- ☐ I usually have breakfast on only one day of the weekend (Saturday OR Sunday)
- ☐ I usually have breakfast on both weekend days (Saturday AND Sunday)

24. Does your school serve school lunches?

☐ Yes ☐ No

25. In the last week you were in school, about **how many times a week** did you eat a school lunch?

☐ 0 days ☐ 1 day ☐ 2 days ☐ 3 days ☐ 4 days ☐ 5 days

26. During the past week, how many meals (breakfast, lunch or dinner) did you get that were **prepared away from home** in places such as restaurants, fast food places, food stands, grocery stores or vending machines? (please do not include meals provided as part of school breakfast or school lunch)

☐☐ meals

27. In general, how would you say your health is?

☐ excellent ☐ very good ☐ good ☐ fair ☐ poor

Thank you! ☺

ISCOLE MOZAMBIQUE QUALITY CONTROL (QC) and DATA ENTRY:

QC Staff Initials: _____ Date: _____/_____/_____

Data Entry Staff Initials: _____ Date: _____/_____/_____

Appendix J: Demographic and Family Health Questionnaire (English)

Participant ID (attach label here)	Technician Initials ☐☐☐ Date ☐☐ / ☐☐☐ / ☐☐☐☐ Day Month Year

ISCOLE Mozambique Demographic and Family Health Questionnaire

A. GENERAL INFORMATION

Child's Name:

Last First Middle

Name of Child's School:

Parent's or Guardian's Name:

Last First Middle

Home Address:

Street Address or P.O. Box Apt. # Town or City

Nearest Cross-Street to Home:

Phone Number: ( )

Area Code

How long have you lived at the current address? _____years and _____months

B. DEMOGRAPHICS OF CHILD

Birth date _____/_____/_____ Age _____years Gender: ☐ Male ☐ Female
dd/mmm/yyyy
Example: 02/Jun/2017

ISCOLE MOZAMBIQUE QUALITY CONTROL (QC) and DATA ENTRY:

QC Staff Initials: _____ Date: _____ / _____ / _____

Data Entry Staff Initials: _____ Date: _____ / _____ / _____

Participant ID (attach label here)	Technician Initials ☐☐☐ Date ☐☐ / ☐☐☐ / ☐☐☐☐ Day Month Year

Ethnicity[1]:

- ☐ White
- ☐ Black
- ☐ Asian
- ☐ East Indian
- ☐ Mixed raced/Coloured
- ☐ Don't know
- ☐ Other _____

In what country was the child born? _____

How many biological brothers and sisters does the child have?_____

What are their ages? _____yrs _____yrs _____yrs _____yrs _____yrs
_____yrs _____yrs _____yrs _____yrs _____yrs

C. HEALTH HISTORY OF CHILD

1. Birth Weight: _____kg & _____grams OR _____lbs &____oz Birth Length: ____cm OR ____inches

2. Length of Pregnancy: _____weeks OR _____months

3. Did mother develop gestational diabetes during pregnancy with **THIS** child? ☐ Yes No ☐

4. Fed breast milk? ☐ Yes ☐ No If No, please skip to question 5.

Age when **COMPLETELY** stopped being fed breast milk: _____months

Age when **FIRST** fed formula: _____months

5. Age when **COMPLETELY** stopped drinking formula: _____months

D. FAMILY DEMOGRAPHICS AND HEALTH

[1] The researchers are interested in learning about the ethnicity of your child because several studies show that individuals from various parts of the world present a different susceptibility to weight gain. The question is not intended to discriminate any child on the basis of ethnicity. Your answer will be used in the scientific analyses, only to be able to look into this important issue on a preventive standpoint. If you do not want to answer a question (but remember all answers are kept private and confidential) please draw a line through the question and mark it "'PM", meaning Permanently Missing.

ISCOLE MOZAMBIQUE QUALITY CONTROL (QC) and DATA ENTRY:

QC Staff Initials: _____ Date: _____/_____/_____

Data Entry Staff Initials: _____ Date: _____/_____/_____

Participant ID (attach label here)	Technician Initials ☐☐☐ Date ☐☐ / ☐☐☐ / ☐☐☐☐ Day Month Year

6. What is the marital status of the child's parents?

- ☐ Married
- ☐ Divorced or separated
- ☐ Never married
- ☐ Widowed parent

7. How many people live in your household (at this address)? ____

7a. Who lives with the child **at this address** (check all that apply)?

- ☐ Biological Mother
- ☐ Biological Father
- ☐ Adoptive Mother
- ☐ Adoptive Father
- ☐ Step Mother
- ☐ Step Father
- ☐ Brother(s) or Sister(s)
- ☐ Grandparent(s)
- ☐ Other Relative(s)
- ☐ Friend(s)
- ☐ Legal Guardian(s)
- ☐ OTHER

8. What is the **COMBINED** monthly (yearly) income for your household (before taxes)?

- ☐ Less than minimum wage 1
- ☐ Between minimum wages 1 and 2
- ☐ Between minimum wages 3 and 5
- ☐ Between minimum wages 5 and 10
- ☐ Between minimum wages 10 and 20
- ☐ More than minimum wages 20
- ☐ Unable to Quantify

9. How many functioning motorized vehicles (car, truck, motorcycle, moped, etc.) are available for use at your house?

- ☐ 0
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

ISCOLE MOZAMBIQUE QUALITY CONTROL (QC) and DATA ENTRY:

QC Staff Initials: _____ Date: _____ / _____ / _____

Data Entry Staff Initials: _____ Date: _____ / _____ / _____

Participant ID (attach label here)	Technician Initials ☐☐☐ Date ☐☐/☐☐☐/☐☐☐☐ Day Month Year

10. How many television sets are in your household?

- ☐ 0
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

11. What best describes your type of television service for the **primary** television in the house?

- ☐ No television
- ☐ Antenna only
- ☐ Basic cable
- ☐ Cable + premium channel(s)
- ☐ Satellite dish
- ☐ Other
- ☐ Don't know

12. What best describes your type of internet service?

- ☐ No internet access
- ☐ Dial-up modem
- ☐ DSL modem
- ☐ Cable modem
- ☐ Other
- ☐ Don't know

13. What is the **MOTHER'S** highest level of education completed?

- ☐ Less than high/secondary school
- ☐ Some high/ secondary school
- ☐ Ordinary/Advanced level certificate
- ☐ Diploma/Certificate or 1-3 years of college
- ☐ Bachelor's degree
- ☐ Postgraduate (Master's or PhD)/professional degree

14. How many hours per week does the **MOTHER** work <u>outside</u> the home?

- ☐ None
- ☐ Less than 15 hours/week
- ☐ Part-time (15-35 hours per week)
- ☐ Full time (36+ hours per week)

ISCOLE MOZAMBIQUE QUALITY CONTROL (QC) and DATA ENTRY:

QC Staff Initials: _____ Date: _____ / _____ / _____

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Participant ID (attach label here)	Technician Initials ☐☐☐ Date ☐☐/☐☐☐/☐☐☐☐ Day Month Year

15. What is the **FATHER'S** highest level of education completed?

- ☐ Less than high/secondary school
- ☐ Some high/secondary school
- ☐ Ordinary/Advanced level certificate
- ☐ Diploma/Certificate or 1-3 years of college
- ☐ Bachelor's degree
- ☐ Postgraduate (Master's or PhD)/professional degree

16. How many hours per week does the **FATHER** work outside the home?

- ☐ None
- ☐ Less than 15 hours/week
- ☐ Part-time (15-35 hours per week)
- ☐ Full time (36+ hours per week)

17. Is this child adopted? ☐ Yes ☐ No

18. Please answer the following questions with regard to the child's **BIOLOGICAL MOTHER** (if she is pregnant, please report the pre-pregnancy weight):

Current height: _____cm **or** _____feet and _____inches Current weight: _____kg **or** _____lbs

Current Age: _____ years

Age at child's birth: ____ years

☐ Biological Mother's information cannot be estimated or is not known

19. Please answer the following questions with regard to the child's **BIOLOGICAL FATHER:**

Current height: _____cm **or** _____feet and _____inches Current weight: _____kg **or** _____lbs

Current age: _____ years

☐ Biological Father's information cannot be estimated or is not known

ISCOLE MOZAMBIQUE QUALITY CONTROL (QC) and DATA ENTRY:

QC Staff Initials: _____ Date: _____ / _____ / _____

Data Entry Staff Initials: _____ Date: _____ / _____ / _____

Appendix K: Neighborhood and Home Environment Questionnaire (English)

Participant ID (attach label here)	Technician Initials ☐☐☐ Date ☐☐/☐☐☐/☐☐☐☐ Day Month Year

ISCOLE Mozambique Neighbourhood & Home Environment Questionnaire

Where "child" is mentioned, please respond only about the child who is participating in this study. Be as accurate as you can. There are no right or wrong answers. All information is strictly confidential.

A. NEIGHBOURHOOD/VILLAGE COHESION

Do you agree or disagree with the following statements?	Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree
1. People around my neighbourhood/village are willing to help their neighbours.	O	O	O	O	O
2. This is a close-knit neighbourhood/village.	O	O	O	O	O
3. People in my neighbourhood/village can be trusted.	O	O	O	O	O
4. People in my neighbourhood/village generally don't get along with each other.	O	O	O	O	O
5. People in my neighbourhood/village do not share the same values, attitudes or beliefs.	O	O	O	O	O

B. NEIGHBOURS AND FRIENDS

1. Think about the neighbourhood/village or area in which you live. In general, how well do you feel you know your neighbours?

Not at all	Just a little	Moderately well	Extremely well
O	O	O	O

2. About how often do you talk to or visit with your immediate neighbours (people in the 10-20 households that live closest to you)?

Never	Once a year or less	Several times a year	Once a month	Several times a month	Several times a week	Almost every day
O	O	O	O	O	O	O

ISCOLE MOZAMBIQUE QUALITY CONTROL (QC) and DATA ENTRY:

QC Staff Initials: Date: / /

Data Entry Staff Initials: _____ Date: _____/_____/_____

Participant ID
(attach label here)

Technician Initials ☐☐☐

Date ☐☐ / ☐☐☐ / ☐☐☐☐
Day Month Year

C. NEIGHBOURHOOD/VILLAGE RESPONSE

For the following statements, please mark how likely a neighbour would respond to, or take action in the following situations:	Very unlikely	Unlikely	Neither likely nor unlikely	Likely	Very likely
1. If a group of neighbourhood/village children were skipping school and hanging out on a street corner, how likely is it that your neighbours would do something about it?	O	O	O	O	O
2. If some children were spray-painting graffiti on a local building, how likely is it that your neighbours would do something about it?	O	O	O	O	O
3. If a child was showing disrespect to an adult, how likely is it that people in your neighbourhood would scold that child?	O	O	O	O	O
4. If there was a fight in front of your house and someone was being beaten or threatened, how likely is it that your neighbours would break it up?	O	O	O	O	O
5. Suppose that because of budget cuts the fire department's station closest to your home was going to be closed down by the city. How likely is it that neighbourhood residents would organize to try to do something to keep the fire station open?	O	O	O	O	O

D. FOODS IN THE HOME

How often are the following foods/drinks available in your home?	Never	Rarely	Sometimes	Often	Always
1. Chocolate candy	O	O	O	O	O
2. Other candy/sweets	O	O	O	O	O
3. Raw fruit (e.g., apples, oranges)	O	O	O	O	O
4. Cakes, brownies, muffins or cookies/biscuits	O	O	O	O	O
5. Regular chips/crisps or crackers	O	O	O	O	O
6. Baked chips, low-fat crackers, pretzels	O	O	O	O	O
7. Raw vegetables (e.g., carrots)	O	O	O	O	O
8. 100% fruit juice	O	O	O	O	O
9. Juice drinks (e.g., Sunny delight)	O	O	O	O	O
10. Regular soft drinks with sugar	O	O	O	O	O
11. Diet or sugar free soft drinks	O	O	O	O	O
12. Sports drinks (e.g., Gatorade)	O	O	O	O	O
13. Fruit roll-ups or other dried fruit	O	O	O	O	O
14. Regular or 2% milk	O	O	O	O	O
15. 1% or fat-free milk	O	O	O	O	O
16. Sweetened breakfast cereal	O	O	O	O	O
17. Unsweetened breakfast cereal	O	O	O	O	O

ISCOLE MOZAMBIQUE QUALITY CONTROL (QC) and DATA ENTRY:

QC Staff Initials: Date: / /

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Participant ID (attach label here)	Technician Initials ☐☐☐ Date ☐☐/☐☐☐/☐☐☐☐ Day Month Year

E. WHERE YOU SHOP OR BUY GROCERIES

When you, or the main food shopper in your home, go food shopping, how often do you go to each of these types of stores?	Never	Rarely	Sometimes	Often	Always
1. Large supermarket or discount warehouse	O	O	O	O	O
2. Small to medium food store	O	O	O	O	O
3. Convenience store	O	O	O	O	O
4. Farmer's market/produce stand	O	O	O	O	O
5. Other, specify: _____	O	O	O	O	O

F. STORE ACCESS

Please indicate whether the following statements are true of the store <u>where you usually buy groceries</u>.	Yes	No	Not applicable
1. Close to location of my employment	O	O	O
2. Close to my child's school	O	O	O
3. Close to my home	O	O	O

G. FOOD SHOPPING

The following questions apply to the store where you usually buy groceries.	Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree
1. Low-fat foods cost too much.	O	O	O	O	O
2. There is a large selection of fresh fruits and vegetables.	O	O	O	O	O
3. There is a large selection of low-fat products available.	O	O	O	O	O
4. The condition of fresh fruits and vegetables is poor.	O	O	O	O	O
5. Fruits and vegetables cost too much.	O	O	O	O	O

H. YOUR CHILD'S ELECTRONICS

Please indicate whether the following are <u>in your child's bedroom</u>.	Yes	No
1. TV	O	O
2. Computer	O	O
3. Video game system (non-hand held; Playstation, Xbox, etc.)	O	O
Does your child have the following items for his/her own use?		
4. Cell phone or 2-way radio	O	O
5. Hand-held videogame players (Game Boy, Sony PSP, etc.)	O	O
6. Music systems (Ipod, stereo, radio, etc.)	O	O

ISCOLE MOZAMBIQUE QUALITY CONTROL (QC) and DATA ENTRY:

QC Staff Initials: Date: / /

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Participant ID (attach label here)	Technician Initials ☐☐☐ Date ☐☐/☐☐☐/☐☐☐☐ Day Month Year

For the next two questions, please think about your child's activities over the *past year*.

I. PLAY EQUIPMENT

How often during the past year has your child used these items at or around home (or in a common apartment area)?	Not available (Don't have)	Available but never use	Once a month or less	Once every other week	Once a week or more
1. Bike	○	○	○	○	○
2. Basketball hoop	○	○	○	○	○
3. Jump rope	○	○	○	○	○
4. Active video games (e.g., with dance pad, Wii, etc)	○	○	○	○	○
5. Sports equipment (like ball, racquets, bats, sticks)	○	○	○	○	○
6. Swimming pool	○	○	○	○	○
7. Roller skates, skateboard, scooter	○	○	○	○	○
8. Fixed play equipment (e.g., swing set, playhouse, jungle gym)	○	○	○	○	○

J. PLACES FOR YOUR CHILD'S PHYSICAL ACTIVITY

How often during the past year has your child been <u>physically active</u> (including active play) in the following places?	Never	Once a month or less	Once every other week	Once a week	2 or 3 times/ week	4 times/ week or more
1. Inside your home	○	○	○	○	○	○
2. In your yard or common area or in your driveway	○	○	○	○	○	○
3. At a neighbour's house, yard, or driveway	○	○	○	○	○	○
4. In a local street, sidewalk, or vacant lot/field	○	○	○	○	○	○
5. Indoor recreation or exercise facility (public or private; e.g., YMCA/Boys & Girls Club)	○	○	○	○	○	○
6. Beach, lake, river, or creek	○	○	○	○	○	○
7. Bike/hiking/walking trails, paths	○	○	○	○	○	○
8. Basketball court	○	○	○	○	○	○
9. Other playing fields/courts (like skating rink/arena, football, softball, tennis, soccer)	○	○	○	○	○	○
10. Small public park or playground	○	○	○	○	○	○
11. Large public park	○	○	○	○	○	○
12. Public open space that is not a park	○	○	○	○	○	○
13. School grounds (during non-school hours)	○	○	○	○	○	○

ISCOLE MOZAMBIQUE QUALITY CONTROL (QC) and DATA ENTRY:

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Participant ID (attach label here)	Technician Initials ☐☐☐ Date ☐☐ / ☐☐☐ / ☐☐☐☐ Day Month Year

K. GETTING AROUND IN YOUR NEIGHBOURHOOD/VILLAGE

Please select the answer that best applies to you and your neighbourhood/village. Within walking distance means within a 10-15 minute walk from your home.

	Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
1. There are shops, stores, markets, and places to buy things I need within easy walking distance of my home/house.	O	O	O	O
2. There is a bus, subway, or train stop within walking distance from my home.	O	O	O	O
3. There are sidewalks on most streets.	O	O	O	O
4. There are NOT many dead end streets.	O	O	O	O
5. There are many different routes for getting from place to place.	O	O	O	O
6. There is a high crime rate.	O	O	O	O
7. The speed of traffic on most streets is usually slow (50km/h or less).	O	O	O	O
8. Most drivers go faster than the posted speed limits.	O	O	O	O
9. There are many interesting things to look at while walking in my neighbourhood.	O	O	O	O
10. The traffic makes it difficult or unpleasant for my child to walk.	O	O	O	O
11. Streets have good lighting at night.	O	O	O	O
12. There are crosswalks and signals on busy streets.	O	O	O	O
13. There are many places to go within easy walking distance of my home.	O	O	O	O
14. I'm afraid of my child being taken or hurt by a stranger on local streets.	O	O	O	O
15. I'm afraid of my child being taken or hurt by a stranger in my yard, driveway, or common area.	O	O	O	O
16. I'm afraid of my child being taken or hurt by a stranger in a local park.	O	O	O	O
17. I'm afraid of my child being taken or hurt by a known "bad" person (adult or child) in my neighbourhood.	O	O	O	O

ISCOLE MOZAMBIQUE QUALITY CONTROL (QC) and DATA ENTRY:

QC Staff Initials: Date: / /

Data Entry Staff Initials: _____ Date: _____/_____/_____

Participant ID (attach label here)	Technician Initials ☐☐☐ Date ☐☐ / ☐☐☐ / ☐☐☐☐ Day Month Year

L. DISTANCE TO LOCATIONS

About how long would it take <u>you</u> to walk from your home to the nearest places listed below? Please select the time it would take you to walk to each place, regardless of whether you/your child go there.

	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	Don't know
1. Convenience/corner store/small grocery store/bodega	O	O	O	O	O	O
2. Supermarket	O	O	O	O	O	O
3. Fast food restaurant	O	O	O	O	O	O
4. Non-fast food restaurant	O	O	O	O	O	O
5. Indoor recreation or exercise facility (public or private; e.g., YMCA/Boys & Girls Club)	O	O	O	O	O	O
6. Beach, lake, river, or creek	O	O	O	O	O	O
7. Bike/hiking/walking trails, paths	O	O	O	O	O	O
8. Basketball court (including half-court)	O	O	O	O	O	O
9. Other playing fields/courts (like skating rink/arena, soccer, football, softball, tennis, skate park, etc.)	O	O	O	O	O	O
10. Small public park	O	O	O	O	O	O
11. Large public park	O	O	O	O	O	O
12. Public playground with equipment	O	O	O	O	O	O
13. School with recreation facilities open to the public	O	O	O	O	O	O

M. FAMILY

During a typical week, how often do you or another adult in the household:

	Never	1-2 days	3-4 days	5-6 days	Every day
1. Watch your child participate in physical activity or sports	O	O	O	O	O
2. Encourage your child to do sports or physical activity	O	O	O	O	O
3. Provide transport to a place where your child can do physical activity or play sports	O	O	O	O	O
4. Do a physical activity or play sports with your child	O	O	O	O	O

ISCOLE MOZAMBIQUE QUALITY CONTROL (QC) and DATA ENTRY:

QC Staff Initials: Date: / /

Data Entry Staff Initials: _____ Date: _____/_____/_____

Appendix L : School Environment Questionnaire (English)

School Name:
(write in print below)
_____

Technician Initials ☐☐☐
Date ☐☐/☐☐☐/☐☐☐☐
Dav Month Year

ISCOLE Mozambique School Environment Questionnaire

A. SCHOOL CHARACTERISTICS

1. **What is your position at this school?** ☐ Principal ☐ Vice Principal ☐ Teacher ☐ Other:_____
2. **What is the total number of students in your school?** (Please estimate) _____ students
3. **What is the total number of teachers (full time equivalents) in your school?** (Please estimate) _____ teachers
4. **What grades are taught at your school?** _____ to _____
5. **How many days (excluding holidays) do your students attend school during the academic school year?** _____

B. POLICIES AND PRACTICES

For the following section, "policies" refers to any mandates issued by the province, the local school board, or any other agency, including policies developed by your school, that affects your school environment and that have been officially adopted by your school or district. This section also asks about practices (what your students and staff are allowed to do on a regular basis) that you might follow to promote the health and well-being of students.

6. **Does your school have written policies or practices concerning physical activity?**
   - ☐ **Yes**, existing written policies
   - ☐ **Yes**, written policies still under development
   - ☐ **Yes**, practices
   - ☐ No
   - ☐ N/A
7. **Does your school have written policies or practices concerning healthy eating?**
   - ☐ **Yes**, existing written policies
   - ☐ **Yes**, written policies still under development
   - ☐ **Yes**, practices
   - ☐ No
   - ☐ N/A
8. **Does your school have a committee that oversees or offers guidance on the development of policies and practices concerning physical activity and healthy eating at your school (e.g., health action team, school health or wellness council)?**
   - ☐ **Yes**, both physical activity and healthy eating
   - ☐ **Yes**, physical activity only
   - ☐ **Yes**, healthy eating only
   - ☐ No

ISCOLE MOZAMBIQUE QUALITY CONTROL (QC) and DATA ENTRY:

QC Staff Initials: Date: / /

Data Entry Staff Initials: _____ Date: _____/_____/_____

School Name: (write in print below)	Technician Initials ☐☐☐ Date ☐☐/☐☐☐/☐☐☐☐ Day Month Year

C. PHYSICAL ACTIVITY

9. What percent of students participate in the following extracurricular activities offered by your school?
(Please estimate)

		Not available	*Less than 10%*	*10-24%*	*25-49%*	*50%+*
a.	Varsity/interschool athletics	☐	☐	☐	☐	☐
b.	Intramural athletics or physical activity clubs (including dance)	☐	☐	☐	☐	☐
c.	Academic/hobby clubs (e.g., chess, astronomy)	☐	☐	☐	☐	☐
d.	Arts-based clubs (e.g., drama, music, photography)	☐	☐	☐	☐	☐

10. Does your school offer late bus/transportation service to students who participate in extracurricular activities?

Yes ☐ No ☐

11. From the following list, please indicate which sports are offered in your interschool or intramural athletics programs available to students in grades 4 and 5:

a. Not applicable, school does not offer interschool or intramural athletics to students in grades 4 and 5 ☐

	Varsity/ Interschool	*Intramural*		*Varsity/ Interschool*	*Intramural*
b. Basketball	☐	☐	j. Gymnastics	☐	☐
c. Volleyball	☐	☐	k. Wrestling	☐	☐
d. Soccer	☐	☐	l. Track & Field	☐	☐
e. Football	☐	☐	m. Badminton	☐	☐
f. Baseball/softball	☐	☐	n. Swimming	☐	☐
g. Rugby	☐	☐	o. Skiing	☐	☐
h. Ice Hockey	☐	☐	p. Ultimate Frisbee	☐	☐
i. Lacrosse	☐	☐	q. Other	☐	☐

For the following questions, please consider students in grades 4 and 5 when answering.

12. How many breaks of 15 to 29 minutes do students in grades 4 and 5 have in a day?

☐ zero ☐ 1 ☐ 2 ☐ 3 or more

13. How many breaks of 30 minutes or more do students in grades 4 and 5 have in a day?

☐ zero ☐ 1 ☐ 2 ☐ 3 or more

ISCOLE MOZAMBIQUE QUALITY CONTROL (QC) and DATA ENTRY:

QC Staff Initials: Date: / /

Data Entry Staff Initials: _____ Date: _____/_____/_____

School Name: (write in print below) _____	Technician Initials ☐☐☐ Date ☐☐ / ☐☐☐ / ☐☐☐☐ Day Month Year

14. How much class time is mandated by your province to be allotted to physical education (PE)/Daily Physical Activity (DPA) for students in grades 4 and 5?

_____ **Physical Education minutes per** *[check the box indicating the time unit]* **week** ☐ **day** ☐

☐ No specific amount is mandated

_____ **Daily Physical Activity minutes per** *[check the box indicating the time unit]* **week** ☐ **day** ☐

☐ No specific amount is mandated

15. Compared to the class time allotted to physical education (PE)/Daily Physical Activity (DPA) for grades 4 and 5 as mandated by your province, do students in grades 4 and 5 in your school receive on average:

☐ Less than the mandated amount
☐ Approximately the mandated amount
☐ More than the mandated amount
☐ No specific amount is mandated

16. To the best of your knowledge, how well do each of the following statements characterize your school?

	A lot	*Some*	*Very little*	*Not at all*	*Don't know*
a. We use physical activity as a reward	☐	☐	☐	☐	☐
b. We promote physical activity during or as part of special events	☐	☐	☐	☐	☐
c. We integrate physical activity into other curriculum areas	☐	☐	☐	☐	☐
d. We use physical activity as a punishment for bad behavior (e.g., withholding recess, administering push-ups or laps).	☐	☐	☐	☐	☐

17. Does your school promote *active transportation* to and from school in any of the following ways?

	Yes	*No*	*Don't know*
a. Identify safe routes to use for walking and cycling to and from school (e.g., with signs, in newsletters, etc.)	☐	☐	☐
b. Provide crossing guards at intersections to encourage safe walk-to-school routes	☐	☐	☐
c. Designate a 'car free zone' to provide safe walking areas around the school	☐	☐	☐
d. Allow students to bring bicycles on school property	☐	☐	☐

ISCOLE MOZAMBIQUE QUALITY CONTROL (QC) and DATA ENTRY:

QC Staff Initials: Date: / /

Data Entry Staff Initials: _____ Date: _____/_____/_____

School Name: (write in print below)	Technician Initials ☐☐☐ Date ☐☐/☐☐☐/☐☐☐☐ Day Month Year

		Yes	No	Don't know
e.	Allow students to bring small wheel vehicles (e.g., rollerblades, scooters, skateboards) on school property	☐	☐	☐
f.	Encourage the use of helmets and safety gear for those who use bicycles and small wheel vehicles to get to school	☐	☐	☐
g.	Organize occasional 'walk to school days' , walking clubs, or programs like 'walking school buses' (where parents or older students walk around the neighbourhood and pick up walkers at designated points)	☐	☐	☐

D. SCHOOL FACILITIES

18. Do the majority of students at your school have regular access to any of the following during school hours*?
*During school hours means from the first bell to the last bell, including both instructional and non-instructional time (e.g lunch).

		Yes, on grounds only	Yes, off grounds only	Yes, both on and off grounds	No	Don't know
a.	Gymnasium	☐	☐	☐	☐	☐
b.	Other large room suitable for physical activity (e.g., auditorium, cafeteria, dance studio)	☐	☐	☐	☐	☐
c.	Fitness room for aerobic and/or strength training	☐	☐	☐	☐	☐
d.	Running track	☐	☐	☐	☐	☐
e.	Outdoor sports field (e.g., football or soccer)	☐	☐	☐	☐	☐
f.	Outdoor paved area (e.g., tennis courts, basketball courts, any paved area that can be used for active games like skipping or hopscotch)	☐	☐	☐	☐	☐
g.	Skating rink/arena	☐	☐	☐	☐	☐
h.	Indoor swimming pool	☐	☐	☐	☐	☐
i.	Secure change room lockers available for use during physical activity	☐	☐	☐	☐	☐
j.	Change rooms available for use before and after physical activity	☐	☐	☐	☐	☐
k.	Showers available for use before or after physical activity	☐	☐	☐	☐	☐
l.	Bicycle racks	☐	☐	☐	☐	☐
m.	**If yes**, are the racks in a secure area to avoid theft?	☐	☐	☐	☐	☐
n.	Grassy playground area	☐	☐	☐	☐	☐
o.	Playground equipment (e.g., climbing structures, swings)	☐	☐	☐	☐	☐
p.	Art room	☐	☐	☐	☐	☐
q.	Music room	☐	☐	☐	☐	☐

ISCOLE MOZAMBIQUE QUALITY CONTROL (QC) and DATA ENTRY:

QC Staff Initials: Date: / /

Data Entry Staff Initials: _____ Date: _____/_____/_____

School Name: **(write in print below)** _____	**Technician Initials** ☐☐☐ **Date** ☐☐ / ☐☐☐ / ☐☐☐☐ Dav Month Year

19. Do students have access to the following facilities where they can buy foods or drinks?

	Yes	*No*
a. Cafeteria	☐	☐
b. School shop	☐	☐
c. Shops/fast food restaurants close to school	☐	☐
d. Candy and potato chips vending machine	☐	☐
e. Drinks vending machine (e.g., coke, soft drinks, orange juice)	☐	☐
f. Milk vending machine/ milk program (e.g., milk, chocolate milk)	☐	☐

20. *Outside of school hours, does your school permit regular student access to the following?**
**Outside of school hours means before and/or after school, evenings and weekends. Student access may occur via school-led, community-led or informal use.*

	Yes	*No*	*Don't know*	*N/A*
a. Gymnasium	☐	☐	☐	☐
b. Indoor facilities	☐	☐	☐	☐
c. Outdoor facilities (e.g., playing fields, paved activity areas, baseball diamond)	☐	☐	☐	☐
d. Equipment (e.g., basketballs)	☐	☐	☐	☐

21. *Outside of school hours, does your school allow community groups to use the school facilities?**
**Outside of school hours means before and/or after school, evenings and weekends.*

Yes ☐ No ☐ Don't know ☐

ISCOLE MOZAMBIQUE QUALITY CONTROL (QC) and DATA ENTRY:	
QC Staff Initials:	Date: / /
Data Entry Staff Initials: _____	Date: _____/_____/_____

School Name: **(write in print below)** _____	**Technician Initials** ☐☐☐ **Date** ☐☐ / ☐☐☐ / ☐☐☐☐ Day Month Year

E. HEALTHY EATING

22. Does your school provide any of the following to promote the sale of healthy food? (Check all that apply)

	Cafeteria	*Snack bar/ School shop*	*Vending machine(s)*
a. Healthy food choices at a reasonable/subsidized price	☐	☐	☐
b. Healthy eating promotional materials (e.g., posters)	☐	☐	☐
c. Daily healthy eating specials	☐	☐	☐
d. Healthy eating cafeteria program (e.g., Eat Smart or independent program)	☐	☐	☐

23. Does your school ensure that all students, regardless of ability to pay, have access to fruits and vegetables?

☐ Yes, entire school year
☐ Yes, occasional/short term
☐ No

24. Does your school offer any of the following? (Check all that apply)

☐ Cooking classes
☐ Gardening (e.g., growing produce)
☐ Field trips to farms/farmers' markets
☐ Media literacy on special topics related to healthy eating (e.g., body image, eating disorders)
☐ Field trips to the local grocery store

25. During the past 12 months, did your school initiate/continue any of the following activities/programs at your school?

	Yes	*No*	*N/A*
a. Offered healthy food choices during breakfast program	☐	☐	☐
b. Offered healthy food choices during lunch program	☐	☐	☐
c. Offered healthy food choices in the cafeteria(s)	☐	☐	☐
d. Offered healthy food choices in the snack bar/school shop(s)	☐	☐	☐
e. Offered healthy food choices in the vending machine(s)	☐	☐	☐
f. Organized Nutrition Month activities	☐	☐	☐
g. Stopped the sale of junk food	☐	☐	☐
h. Held junk food free days	☐	☐	☐
i. Stopped the sale of sugar-sweetened beverages	☐	☐	☐

ISCOLE MOZAMBIQUE QUALITY CONTROL (QC) and DATA ENTRY:

QC Staff Initials: Date: / /

Data Entry Staff Initials: _____ Date: _____/_____/_____

School Name: **(write in print below)** _____	**Technician Initials** ☐☐☐ **Date** ☐☐ / ☐☐☐ / ☐☐☐☐ Dav Month Year

26. During the past 12 months, have any of the following items been sold as part of fundraising for any school organization?

	Yes	*No*	*N/A*
a. Chocolate candy	☐	☐	☐
b. Other candy	☐	☐	☐
c. Other junk food (e.g., popcorn)	☐	☐	☐
d. Soft drinks or fruit drinks that are not 100% juice	☐	☐	☐
e. Sports drinks	☐	☐	☐
f. Cookies, crackers, cakes, pastries, or other baked goods that are not low in fat	☐	☐	☐
g. Fruits or vegetables	☐	☐	☐
h. 100% fruit juice or vegetable juice	☐	☐	☐
i. Low-fat cookies/biscuits, crackers, cakes, pastries, or other low-fat baked goods	☐	☐	☐

F. NEIGHBOURHOOD/COMMUNITY

27. How much of a problem are the following in the neighbourhood where this school is located?

	Major problem	*Moderate problem*	*Minor problem*	*Not a problem*	*I don't know*
a. Tensions based on racial, ethnic, or religious differences	☐	☐	☐	☐	☐
b. Garbage, litter, or broken glass in the street or road, on the sidewalks, or in yards	☐	☐	☐	☐	☐
c. Selling or using drugs or excessive drinking in public	☐	☐	☐	☐	☐
d. Gangs	☐	☐	☐	☐	☐
e. Heavy traffic	☐	☐	☐	☐	☐
f. Vacant or shabby houses and buildings	☐	☐	☐	☐	☐
g. Crime in the neighbourhood	☐	☐	☐	☐	☐

ISCOLE MOZAMBIQUE QUALITY CONTROL (QC) and DATA ENTRY:

QC Staff Initials: Date: / /

Data Entry Staff Initials: _____ Date: _____/_____/_____

Appendix M: Diet and Lifestyle Questionnaire (Portuguese)

ID Participante (Anexar etiqueta aqui)	Iniciais do técnico ☐☐☐ Data ☐☐/☐☐☐/☐☐☐☐ Dia Mês Ano

Appendix L : Questionário sobre Dieta Alimentar e Estilo de Vida

Por favor, lê cada questão cuidadosamente. Qual é a resposta que vem, em primeiro lugar, à tua mente? Escolheo ☐ que melhor se encaixa na tua resposta e marca com um X.

Lembra-te: Isto não é um teste, portanto não há respostas erradas. É importante que respondas a todas as questões com marcações claras.

Não precisas mostrar as tuas respostas a ninguém. Além disso, ninguém que conheças olhará para teu questionário, uma vez que o tenhas terminado.

Nas questões desta páginaresponde, por favor,o que fizeste na semana passada.

1. Num dos teus dias de escola, quantas horas assististe televisão (TV)?

   ☐Não assisti TV ☐ menos de 1 hora ☐ 1 hora ☐ 2 horas ☐ 3 horas ☐ 4 horas
   ☐ 5 ou mais horas nos dias de semana em que vou à escola

2. Num dos teus dias de escola, quantas horas jogaste vídeo-games, jogos no computador ou utilizaste o computador para algo que não tenha sido trabalho escolar?

   ☐Não joguei, nem utilizei computador ☐ menos de 1 hora ☐ 1 hora ☐ 2 horas ☐ 3 horas
   ☐ 4 horas ☐5 ou mais horas

3. Num dos teus dias de escola, quanto tempo gastaste em actividades fora de casa **antes** de ir para escola?

   ☐ menos de 1 hora ☐ 1 hora ☐ 2 horas ☐ 3 horas ☐ 4 horas ☐ 5 ou mais horas

4. Num dos teus dias de escola, quanto tempo gastaste em actividades fora de casa **depois** de chegares da escola e antes de te deitares?

   ☐ menos de 1 hora ☐ 1 hora ☐ 2 horas ☐ 3 horas ☐ 4 horas ☐ 5 ou mais horas

5. Num dos dias do final de semana, quantas horas assististe a televisão?

   ☐Não assisti a televisão ☐ menos de 1 hora ☐ 1 hora ☐ 2 horas ☐ 3 horas ☐ 4 horas☐
   5 ou mais horas no final de semana

6. Num dos dias do final de semana, quantas horas jogaste vídeo-game, jogos de computador ou utilizaste o computador para algo que não tenha sido trabalho escolar?

   ☐Não joguei, nem utilizei computador ☐ menos de 1 hora ☐ 1 hora ☐ 2 horas
   ☐3 horas ☐ 4 horas ☐ 5 ou mais horas

7. Num dos dias do final de semana, quanto tempo gastaste em actividades fora de casa?

   ☐ menso de 1 hora ☐ 1 hora ☐ 2 horas ☐ 3 horas ☐ 4 horas ☐ 5 ou mais horas

ISCOLE CONTROLE DE QUALIDADE (CQ) E ENTRADA DE DADOS:

CQ - Iniciais do Staff: _____ Data: _____ / _____ / _____

Entrada de dados - Iniciais do Staff: _____ Data: _____ /_____ / _____

ID Participante (Anexar etiqueta aqui)	**Iniciais do técnico** ☐☐☐ **Data** ☐☐/☐☐☐/☐☐☐☐ Dia Mês Ano

8. Na última semana em que foste à escola, quantos dias tiveste aulas de Educação Física?

☐ 0 dias ☐ 1 dia ☐ 2 dias ☐ 3 dias ☐ 4 dias ☐ 5 dias

9. Na última semana que foste à escola, a parte PRINCIPAL do teu trajecto foi feita:

☐ Caminhando (a pé)
☐ Bicicleta, patins, skate
☐ Machimbombo ou chapa
☐ Carro ou motorizada
☐ Outro meio de transporte_____

10. Na última semana em que estiveste na escola, quanto tempo gastaste para chegar à escola?

☐ menos de 5 minutos ☐ 5 - 15 minutos ☐ 16 - 30 minutos ☐ 31 minutos a 1 hora
☐ mais de 1 hora

11. Qula é a distância da sua casa até à escola?

☐ menos de 500M ☐500M - 1KM ☐ 1.1KM- 3KM ☐ 3.1KM – 5KM ☐ mais de 5KM

12. Durante o último ano (12 meses), praticaste alguma das seguintes modalidades?(Marca todas que praticaste)

☐desportos colectivos ☐dança/artes marciais ☐arte/música clássica ☐nenhuma das actividades

13. Durante a última semana (7 dias), quantos dias estiveste fisicamente activo durante pelo menos 60 minutos por dia? (todo o tempo que gastaste em actividades que aumentaram os batimentos de teu coração e tornaram a tua respiração mais difícil).

☐ 0 dias ☐ 1 dia ☐ 2 dia ☐ 3 dias ☐ 4 dias ☐ 5 dias ☐ 6 dias ☐ 7 dias

14. Durante a última semana, nos dias de escola a que horas, foste dormir?

☐☐:☐☐

15. Durante a última semana, nos dias de escola, a que horas, habitualmente, te levantaste pela manhã?

☐☐:☐☐

16. Durante a última semana, no final de semana, a que horas, habitualmente,foste dormir?

☐☐:☐☐

ISCOLE CONTROLE DE QUALIDADE (CQ) E ENTRADA DE DADOS:

CQ - Iniciais do Staff: _____ Data: _____ / _____ / _____

Entrada de dados - Iniciais do Staff: _____ Data: _____ /_____ / _____

ID Participante (Anexar etiqueta aqui)	Iniciais do técnico ☐☐☐ Data ☐☐/☐☐☐/☐☐☐☐ Dia Mês Ano

17. Durante a <u>última semana</u>, no final de semana, a que horas, habitualmente, te levantaste pela manhã?

☐☐:☐☐

18. Durante a <u>última semana</u>, como avaliarias a qualidade do teu sono (O quão bem dormiste)?

☐ muito bom ☐ razoavelmente bom ☐ razoavelmente mau ☐ muito mau

19. Durante a <u>última semana</u>, como avaliarias a quantidade de teu sono (Quantas horas dormiste)?

☐ muito bom ☐ razoavelmente bom ☐ razoavelmente mau ☐ muito mau

20. Tens um aparelho de televisão no teu quarto?

☐ Sim ☐ Não

21. Usualmente, quantas vezes comes os seguintes alimentos? Por favor, marca com um X somente uma resposta em cada linha.

	Nunca	Menos de uma vez por semana	Uma vez por semana	2-4 dias por semana	5-6 dias por semana	Todos os dias, uma vez ao dia	Todos os dias, mais de uma vez
Frutas							
Vegetais							
Doces/chocolates							
Refrigerantes (que contêm açúcar)							
Bolos, ou pastéis							
Refrigerantes sem açúcar (coca diet, ..)							
Batata frita em pacote							
Batatas fritas							
Vegetais verde-escuros (brócolos, espinafre, etc.)							
Vegetais cor de laranja (cenoura, abóbora, batata-doce, etc.)							
Sumo de frutas							
Leite magro							
Leite meio gordo							
Leite gordo							
Queijo							
Outros derivados do leite (iogurte, leite com chocolate, pudim, etc.)							
Pães ou cereais (aveia, muesli, etc.)							

ISCOLE CONTROLE DE QUALIDADE (CQ) E ENTRADA DE DADOS:

CQ - Iniciais do Staff: _____ Data: _____ / _____ / _____

Entrada de dados - Iniciais do Staff: _____ Data: _____ /_____ / _____

ID Participante
(Anexar etiqueta aqui)

Iniciais do técnico

Data ___/___/___
Dia Mês Ano

Alternativas à carne (feijão, lentilha, tofu, ovos, etc.)							
Bebidas energéticas (red bull, etc.)							
Bebidas desportivas (Gatorade, Powerade,							
Peixe							
Gelados							
Fritos (bolinhos de bacalhau, rissóis, panados, etc.)							
Comidas gordurosas (pizza, hamburgers, etc.)							

22. Normalmente, quantas vezes consomes os seguintes alimentos enquanto vês televisão?

	Nunca	Menos de uma vez por semana	Uma vez por semana	2-4 dias por semana	5-6 dias por semana	Uma vez ao dia, todos os dias	Todos os dias, mais de uma vez
Batata frita em pacote							
Fritos (bolinhos de bacalhau, rissóis, etc.)							
Bolachas, biscoitos, barras de chocolates ou doces.							
Gelados							
Comidas gordurosas (pizza, hamburgers, panados, etc.)							
Frutas ou frutas Frutas/Vegetais							

23. Com que frequência tomas o mata-bicho? Marca uma respostas para os **dias de semana** e uma resposta para **final de semana**.

Dias de semana (Segunda a sexta-feira)

- ☐ Nunca
- ☐ 1 dia
- ☐ 2 dias
- ☐ 3 dias
- ☐ 4 dias
- ☐ 5 dias

Final de semana (sábado e domingo)

- ☐ Nunca
- ☐ Tomo o mata-bicho somente num dos dias do fim de semana (sábado **OU** domingo)
- ☐ Tomo o mata-bicho em ambos os dias (sábado **E** domingo).

ISCOLE CONTROLE DE QUALIDADE (CQ) E ENTRADA DE DADOS:

CQ - Iniciais do Staff: _____ Data: _____ / _____ / _____

Entrada de dados - Iniciais do Staff: _____ Data: _____ /_____ / _____

ID Participante
(Anexar etiqueta aqui)

Iniciais do técnico ☐☐☐

Data ☐☐/☐☐☐/☐☐☐☐
Dia Mês Ano

24. A tua escola serve almoços?

☐Sim ☐Não

25. Na última semana em que estiveste na escola, quantas vezes comeste na escola (almoço servido pela escola)?

☐ 0 dias ☐ 1 dia ☐ 2 dias ☐ 3 dias ☐ 4 dias ☐ 5 dias

26. Durante a última semana, quantas refeições consumiste (mata-bicho, almoço, jantar) preparadas fora de tua casa em lugares como restaurantes, pizzaria, mercearias? (por favor, não inclua refeições feitas na escola, como o mata-bicho e o almoço)

☐☐ refeições

27. Em termos gerais, dirias que a tua saúde é?

☐ excelente ☐ muito boa ☐ boa ☐ razoável ☐ mau

Obrigado!

ISCOLE CONTROLE DE QUALIDADE (CQ) E ENTRADA DE DADOS:

CQ - Iniciais do Staff: _____ Data: _____ / _____ / _____

Entrada de dados - Iniciais do Staff: _____ Data: _____ /_____ / _____

Appendix N: Demographic and Family Health Questionnaire (Portuguese)

ID Participante (anexar etiqueta aqui)	Iniciais do Técnico ☐☐☐ Data ☐☐/☐☐☐/☐☐☐☐ Dia (Mês / Ano)

Appendix M: ISCOLE QUESTIONÁRIO DE ASPECTOS DEMOGRÁFICOS E DE SAÚDE FAMILIAR

A. INFORMAÇÕES GERAIS

Nome da criança:

Apelido Primeiro Nome Nomes no Meio

Nome da Escola da criança:

Nome dos Pais ou Encarregado de Educação:

Apelido Primeiro Nome Nomes no Meio

Morada:

Pontos de referência do local onde vive:

Número de Telefone: ( ) e-mail:

Há quanto tempo vive na morada actual?_____anos_____meses

B. DEMOGRAFIA DA CRIANÇA

Data de Nascimento ____/_____ /_____ Idade _____anos Sexo: ☐ Masc.Fem. ☐
dia / mês / ano
Exemplo: 02/Junho/2011

Língua Materna _____

Em que país é que a criança nasceu? _____

Quantos irmãos e irmãs biológicos tem a criança? _____

Que idades têm? ____anos ____anos ____anos ____anos ____anos

ISCOLE CONTROLE DE QUALIDADE (CQ) e ENTRADA DOS DADOS:

Iniciais do Staff CQ: _____ Data: _____ / _____ / _____

Iniciais Staff Entrada dos Dados: _____ Data: _____/_____/_____

ID Participante
(anexar etiqueta aqui)

Iniciais do Técnico ☐☐☐

Data ☐☐/☐☐☐/☐☐☐☐ Dia
Mês Ano

C. HISTÓRICO DE SAÚDE DA CRIANÇA

1.Peso ao nascer: _____kg Comprimento ao nascer: ____cm

2.Tempo de Gestação: _____semanas ou meses

3.A mãe desenvolveu diabetes gestacional durante a gravidez **DESTA** criança? ☐Sim ☐Não

4.Alimentada com leite materno? ☐ Sim ☐ Não Se respondeu não, por favor, passe para a questão 5.

Idade em que deixou **COMPLETAMENTE** de consumir leite materno: ____meses

Idade que consumiu pela **PRIMEIRA VEZ** leite em pó: _____meses

5.Idade em que deixou, **COMPLETAMENTE,** de consumir leite não materno: _____meses

C. DEMOGRAFIA E SAÚDE FAMILIAR

6.Qual o estado civil dos pais da criança?

- ☐ Casados
- ☐ Divorciados ou Separados
- ☐ Nunca se casaram
- ☐ Pais viúvos

7.Quantas pessoas vivem em sua casa(na morada que indicou)?_____

7a. Quem vive com a criança nesta morada(indique, por favor, todos os casos)?

- ☐ Mãe Biológica
- ☐ Pai Biológico
- ☐ Mãe Adoptiva
- ☐ Pai Adoptivo
- ☐ Madrasta
- ☐ Padrasto
- ☐ Irmão(s) ou Irmã(s)
- ☐ Avôs/Avós
- ☐ Outros Parentes
- ☐ Amigo(s)
- ☐ Encarregado de Educação
- ☐ Outro

8.Qual é o rendimento anual **CONJUNTO** da família (sem impostos)?

- ☐ Menos de 1 salário minimo
- ☐ Entre 1 a 2 salarios minimos
- ☐ Entre 3 a 5 salarios minomos
- ☐ Entre 5 a 10 salarios minmos
- ☐ Entre 10 a 20 salarios minimos
- ☐ Mais de 20 salarios minimos
- ☐ Não se conseguiu apurar

ISCOLE CONTROLE DE QUALIDADE (CQ) e ENTRADA DOS DADOS:

Iniciais do Staff CQ: _____ Data: _____ / _____ / _____

Iniciais Staff Entrada dos Dados: _____ Data: _____ / _____ / _____

ID Participante (anexar etiqueta aqui)	Iniciais do Técnico ☐☐☐ Data ☐☐/☐☐☐/☐☐☐☐ Dia Mês Ano

9.Quantos veículos motorizados (carro, carrinha, motocicleta, etc.) estão disponíveis para uso em sua casa?

- ☐ 0
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 ou mais

10. Quantos aparelhos de televisão tem em sua casa?

- ☐ 0
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 oumais

11. Como descreve, melhor, o seu serviço de transmissão de sinal para a televisão **principal** da casa??

- ☐ Não tem televisão
- ☐ Apenas antena
- ☐ TV acabo pacote básica
- ☐ TV a cabo + canal(is) premium
- ☐ Satélite
- ☐ Outro
- ☐ Nãosei

12. Como melhor descreveria o seu serviço de internet?

- ☐ Não tenho acesso a internet
- ☐ Por celular
- ☐ Por antena
- ☐ Por Modem a cabo
- ☐ Outro
- ☐ Não sei

ISCOLE CONTROLE DE QUALIDADE (CQ) e ENTRADA DOS DADOS:

Iniciais do Staff CQ: _____ Data: _____/_____/_____

Iniciais Staff Entrada dos Dados: _____ Data: _____/_____/_____

ID Participante (anexar etiqueta aqui)	Iniciais do Técnico ☐☐☐ Data ☐☐/☐☐☐/☐☐☐☐ Dia Mês Ano

13. Qual o maior grau de escolaridade obtido pela **MÃE**?

- ☐ Básico (1ª à 7ª classe)
- ☐ Ensino secundário geral (8ª à 12ª classe)
- ☐ Ensino técnico
- ☐ Curso profissionalizante
- ☐ Bacharelato
- ☐ Licenciatura
- ☐ Mestrado ou Doutoramento

14. Quantas horas por semana é que a **MÃE** trabalha fora de casa?

- ☐ Nenhuma
- ☐ Menos de 15 horas/semana
- ☐ Tempo parcial (15-35 horas por semana)
- ☐ Tempo total (36+ horas por semana)

15. Qual o maior grau de escolaridade da **PAI**?

- ☐ Básico (1ª à 7ª classe)
- ☐ Ensino secundário geral (8ª à 12ª classe)
- ☐ Ensino técnico
- ☐ Curso profissionalizante
- ☐ Bacharelato
- ☐ Licenciatura
- ☐ Mestrado ou Doutoramento

16. Quantas horas por semana é que o**PAI** trabalha fora de casa?

- ☐ Nenhuma
- ☐ Menos de 15 horas/semana
- ☐ Tempo parcial (15-35 horas por semana)
- ☐ Tempo total (36+ horas por semana

17. A criança é adoptada? Sim ☐ Não ☐

18. Por favor, responda as questões seguintes relativas à **MÃE BIOLÓGICA** da criança:

Altura actual: _____cm Peso actual: _____kg

Idade actual: _____ anos

Idade quando nasceu a criança: ____ anos

☐ Informação da Mãe Biológica não pode ser estimada ou não é conhecida

ISCOLE CONTROLE DE QUALIDADE (CQ) e ENTRADA DOS DADOS:

Iniciais do Staff CQ: _____ Data: _____/_____/_____

Iniciais Staff Entrada dos Dados: _____ Data: _____/_____/_____

ID Participante (anexar etiqueta aqui)	**Iniciais do Técnico** ☐☐☐ **Data** ☐☐/☐☐☐/☐☐☐☐ Dia Mês Ano

19. Por favor, responda as questões seguintes relativas ao **PAI BIOLÓGICO** da criança:

Altura actual: _____cm Peso actual: _____kg

Idade actual: _____ anos

☐ Informação do Pai Biológico não pode ser estimada ou não é conhecida

ISCOLE CONTROLE DE QUALIDADE (CQ) e ENTRADA DOS DADOS:

Iniciais do Staff CQ: _____ Data: _____ / _____ / _____

Iniciais Staff Entrada dos Dados: _____ Data: _____/_____/_____

Appendix O: Neighbourhood and Home Environment Questionnaire (Portuguese)

ID Participante (anexar etiqueta aqui)	Iniciais do Técnico ☐☐☐ Data ☐☐ / ☐☐☐ / ☐☐☐☐ Dia Mês Ano

Appendix N: QUESTIONÁRIO ACERCA DA VIZINHANÇA E DO AMBIENTE FAMILIAR

Quando for mencionando "criança", por favor responda apenas sobre o filho ou filha que está a participar neste estudo. Seja o mais claro possível. Não há respostas certas ou erradas. Toda informação é estritamente confidencial.

A. COESÃO DA VIZINHANÇA

Concorda ou discorda das seguintes afirmações?	Discordo plenamente	Discordo parcialmente	Indiferente	Concordo parcialmente	Concordo plenamente
1. As pessoas da minha vizinhança estão dispostas a ajudar os vizinhos.	○	○	○	○	○
2. Esta é uma vizinhança muito unida.	○	○	○	○	○
3. As pessoas da minha vizinhança podem ser confiáveis.	○	○	○	○	○
4. As pessoas da minha vizinhança geralmente não se dão bem umas com as outras.	○	○	○	○	○
5. As pessoas da minha vizinhança não partilham os mesmos valores, atitudes ou crenças.	○	○	○	○	○

B. VIZINHOS E AMIGOS

1. Pense na sua vizinhança ou área em que vive. Em geral, o que sente ou conhece dos seus vizinhos?

Nada	Pouco	Mais ou menos bem	Muito bem
○	○	○	○

2. Com que frequência visita ou conversa com seus vizinhos mais próximos (pessoas das 10-20 famílias que vivem mais próximas de si)?

Nunca	Uma vez por ano ou menos	Várias vezes por ano	Uma vez por mês	Várias vezes por mês	Várias vezes por semana	Quase todos os dias
○	○	○	○	○	○	○

C. REACÇÃO DA VIZINHANÇA

Das seguintes afirmações, assinale, por favor, a probabilidade de resposta ou acção de um vizinho às seguintes situações:	Muito improvável	Improvável	Nem provável ou improvável	Provável	Muito provável
1. Se um grupo de crianças da vizinhança faltar às aulas e passar o tempo na sua rua, qual a probabilidade dos seus vizinhos tomarem alguma atitude relativamente a isto?	○	○	○	○	○
2. Se alguma criança estivesse a pintar uma parede (p.e., com grafitis) de um edifício da sua rua, qual a probabilidade dos seus vizinhos tomarem alguma atitude relativamente a isto?	○	○	○	○	○

ISCOLE CONTROLE DE QUALIDADE (CQ) e ENTRADA DOS DADOS:

Iniciais do Staff CQ:: _____ Data: _____ / _____ / _____

Iniciais Staff Entrada dos Dados: _____ Data: _____ / _____ / _____

ID Participante (anexar etiqueta aqui)	Iniciais do Técnico ☐☐☐ Data ☐☐/☐☐☐/☐☐☐☐ Dia Mês Ano

3. Se uma criança mostrar falta de respeito para com um adulto, qual a probabilidade dos seus vizinhos tomarem alguma atitude relativamente a isto?	○	○	○	○	○
4. Se houvesse uma discussão em frente da sua casa e alguém estivesse a ser ameaçado ou agredido, qual a probabilidade dos seus vizinhos tentarem resolver o assunto?	○	○	○	○	○
5. Suponha que devido a cortes orçamentais, o centro de saúde mai próximo da sua casa era encerrado. Qual a probabilidade dos residentes se organizarem para evitar o encerramento?	○	○	○	○	○

D. ALIMENTAÇÃO EM CASA

Com que frequência os seguintes alimentos/bebidas estão disponíveis em sua casa?	Nunca	Raramente	Às vezes	Frequentemente	Sempre
1. Doces de chocolate	○	○	○	○	○
2. Outros doces	○	○	○	○	○
3. Fruta (ex.: maças, laranjas)	○	○	○	○	○
4. Bolos, *brownies*, *muffins*.	○	○	○	○	○
5. Batatas fritas ou biscoitos	○	○	○	○	○
6. Batatas assadas, biscoitos com baixo teor em gordura, salgados	○	○	○	○	○
7. Vegetais crus (ex.: cenouras)	○	○	○	○	○
8. Sumo de fruta natural	○	○	○	○	○
9. Sumos (ex.: *Sunny delight*)	○	○	○	○	○
10. Refrigerantes com açúcar	○	○	○	○	○
11. Refrigerantes dietéticos ou sem açúcar	○	○	○	○	○
12. Bebidas desportivas (ex.: *Gatorade*)	○	○	○	○	○
13. Frutos secos	○	○	○	○	○
14. Leite gordo ou meio-gordo	○	○	○	○	○
15. Leite magro	○	○	○	○	○
16. Cereais matinais com açúcar	○	○	○	○	○
17. Cereais matinais sem açúcar	○	○	○	○	○

E. ONDE FAZ AS SUAS COMPRAS

Com que freqüência vai, ou a pessoa responsável pelas compras na sua casa, a este tipo de estabelecimentos?	Nunca	Raramente	Às vezes	Frequentemente	Sempre
1. Hipermercados ou armazéns com descontos	○	○	○	○	○
2. Supermercados	○	○	○	○	○
3. Loja de conveniência	○	○	○	○	○
4. Feiras	○	○	○	○	○
5. Outros, especificar: _____	○	○	○	○	○

F. ACESSO A LOJAS

ISCOLE CONTROLE DE QUALIDADE (CQ) e ENTRADA DOS DADOS:

Iniciais do Staff CQ:: _____ Data: _____ / _____ / _____

Iniciais Staff Entrada dos Dados: _____ Data: _____ / _____ / _____

ID Participante (anexar etiqueta aqui)	Iniciais do Técnico ☐☐☐ Data ☐☐ / ☐☐☐ / ☐☐☐☐ Dia Mês Ano

Por favor indique se as seguintes afirmações são verdadeiras acerca do estabelecimento onde usualmente compra alimentos.	Sim	Não	Não se aplica
1. Próximo do meu local de trabalho	○	○	○
2. Próximo da escola dos meus filhos	○	○	○
3. Próximo da minha casa	○	○	○

G. COMPRA DE ALIMENTOS

As questões seguintes aplicam-se ao estabelecimento onde normalmente compra os seus alimentos.	Discordo plenamente	Discordo parcialmente	Indiferente	Concordo parcialmente	Concordo plenamente
1. Alimentos com baixo teor em gordura são muito caros.	○	○	○	○	○
2. Há uma grande variedade de frutas e vegetais frescos.	○	○	○	○	○
3. Há uma grande variedade de produtos com baixo teor em gordura disponíveis.	○	○	○	○	○
4. As frutas e os vegetais frescos são de fraca qualidade.	○	○	○	○	○
5. Frutas e vegetais são muito caros.	○	○	○	○	○

H. APARELHOS ELECTRÓNICOS DO SEU/SUA FILHO(A)

Por favor indique se os seguintes aparelhos eletrónicos existem no quarto do seu filho.	Sim	Não
1. TV	○	○
2. Computador	○	○
3. Consola de jogos (*Nintendo, Nintendo Wii, Playstation, Playstation move, Xbox*, etc.)	○	○
O seu/sua filho(a) tem os seguinte aparelhos para uso pessoal?		
4. Telemóvel	○	○
5. Consola de jogos portátil (*Game Boy, PSP*, etc.)	○	○
6. Aparelhos de Música (Ipod, MP3, MP4 radio *stereo*, etc.)	○	○

Para responder às duas questões seguintes pense, por favor, nas actividades que o seu(sua) filho(a) realizou ao longo do *ano passado*.

I. EQUIPAMENTOS DE LAZER

Com que frequência, durante o ano passado, o(a) seu/sua filho(a) utilizou os seguintes itens em casa ou ao redor da casa (ou em uma área comum do edifício/condomínio)?	Não disponível (Não tem)	Disponível mas nunca utiliza	Uma vez por mês ou menos	Uma vez a cada duas semanas	Uma vez por semana ou mais
1. Bicicleta	○	○	○	○	○
2. Cestos de basquetebol	○	○	○	○	○
3. Cordas para saltar	○	○	○	○	○
4. Consolas de Jogos controladas com movimentos do corpo (ex.: *Wii*, etc)	○	○	○	○	○

ISCOLE CONTROLE DE QUALIDADE (CQ) e ENTRADA DOS DADOS:

Iniciais do Staff CQ:: _____ Data: _____ / _____ / _____

Iniciais Staff Entrada dos Dados: _____ Data: _____ / _____ / _____

ID Participante (anexar etiqueta aqui)	Iniciais do Técnico ☐☐☐ Data ☐☐ / ☐☐☐ / ☐☐☐☐ Dia Mês Ano

5. Equipamentos desportivos (como bolas, raquetes, etc.)	○	○	○	○	○
6. Piscina	○	○	○	○	○
7. Patins, *skate*, *scooter*	○	○	○	○	○
8. Equipamentos de lazer fixos (ex.: baloiços, etc.)	○	○	○	○	○

J. LOCAIS PARA A ACTIVIDADE FÍSICA DO(A) SEU/SUA FILHO(A)

Com que frequência, durante o ano passado, o(a) seu/sua filho(a) foi <u>fisicamente activo</u> (incluindo com consolas de jogo controladas por movimentos do corpo) nos seguintes locais?	Nunca	Uma vez por mês ou menos	Uma vez a cada duas semanas	Uma vez por semana	2 ou 3 vezes por semana	4 ou mais vezes por semana
1. Dentro de casa	○	○	○	○	○	○
2. No seu quintal, na área comum do seu condomínio ou na sua garagem	○	○	○	○	○	○
3. Na casa, quintal ou garagem do vizinho	○	○	○	○	○	○
4. Na rua, passeio ou descampado	○	○	○	○	○	○
5. Pavilhões desportivos (público ou privado)	○	○	○	○	○	○
6. Praia, lago, rio ou riacho	○	○	○	○	○	○
7. Trilhos para caminhar ou andar de bicicleta	○	○	○	○	○	○
8. Campo de basquetebol	○	○	○	○	○	○
9. Outros campos ou pavilhões (p.e.,futebol, tênis, etc.)	○	○	○	○	○	○
10. Pequenos parques públicos ou recreios	○	○	○	○	○	○
11. Grandes parques públicos	○	○	○	○	○	○
12. Espaços públicos abertos que não sejam parques	○	○	○	○	○	○
13. Escola (fora do horário das aulas)	○	○	○	○	○	○

K. CAMINHAR NA SUA ÁREA DE RESIDÊNCIA

Por favor seleccione a resposta que melhor se aplica a si e à sua área de residência. "Curta distância" significa caminhar entre 10-15 minutos a partir da sua casa.

	Discordo plenamente	Discordo parcialmente	Concordo parcialmente	Concordo plenamente
1. Há lojas, supermercados e estabelecimentos para comprar as coisas que preciso a uma curta distância da minha casa.	○	○	○	○
2. Há paragens de autocarro, chapa ou de comboio a uma curta distância da minha casa.	○	○	○	○
3. Há passeios na maioria das ruas.	○	○	○	○
4. Não há muitas ruas sem saída.	○	○	○	○
5. Há muitos percursos diferentes para ir de um local a outro.	○	○	○	○
6. Há uma alta taxa de criminalidade.	○	○	○	○

ISCOLE CONTROLE DE QUALIDADE (CQ) e ENTRADA DOS DADOS:

Iniciais do Staff CQ:: _____ Data: _____ / _____ / _____

Iniciais Staff Entrada dos Dados: _____ Data: _____ / _____ / _____

ID Participante (anexar etiqueta aqui)	Iniciais do Técnico Data ___/___/___ Dia / Mês / Ano			
7. A velocidade do tráfego na maioria das ruas é geralmente lento (50km/h ou menos).	O	O	O	O
8. A maioria dos condutores conduz acima do limite de velocidade.	O	O	O	O
9. Há muitas coisas interessantes para observar durante uma caminhada na minha área de residência.	O	O	O	O
10. O trânsito torna difícil ou desagradável o meu filho caminhar.	O	O	O	O
11. As ruas são bem iluminadas à noite.	O	O	O	O
12. Há passadeiras e sinais luminosos em ruas movimentadas.	O	O	O	O
13. Há muitos locais a visitar a uma curta distância da minha casa.	O	O	O	O
14. Tenho medo que o(a) meu/minha filho(a) seja raptado(a) ou ferido(a) por um estranho nas ruas da cidade.	O	O	O	O
15. Tenho medo que o(a) meu/minha filho(a) seja raptado(a) ou ferido(a) por um estranho no meu quintal, garagem ou área comum do condomínio.	O	O	O	O
16. Tenho medo que o(a) meu/minha filho(a) seja raptado(a) ou ferido(a) em parques públicos.	O	O	O	O
17. Tenho medo que o(a) meu/minha filho(a) seja raptado(a) ou ferido(a) por uma má pessoa conhecida (adulto ou criança) na minha vizinhança.	O	O	O	O

L. DISTÂNCIA PARA LOCAIS

Quanto tempo demora, a pé, da sua casa até aos locais mais próximos abaixo indicados? Por favor, seleccione o tempo que demora a ir a pé para cada um dos locais, independentemente de ser habitual deslocar-se [ou o(a) seu(sua) filho(a)] até lá.

	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	Não sei
1. Loja de conveniência/mercearia/mercado	O	O	O	O	O	O
2. Supermercado	O	O	O	O	O	O
3. Restaurante tipo *fast food*	O	O	O	O	O	O
4. Restaurante (não de *fast food*)	O	O	O	O	O	O
5. Pavilhão desportivo (público ou privado)	O	O	O	O	O	O
6. Praia, lago, rio, riacho	O	O	O	O	O	O
7. Trilhas para caminhar ou andar de bicicleta	O	O	O	O	O	O
8. Campo de basquetebol (incluindo meio-campo)	O	O	O	O	O	O
9. Campos ou pavilhões para outros desportos (p.e., futebol, ténis, parque de *skate*, voleibol, etc.)	O	O	O	O	O	O
10. Pequenos parques públicos	O	O	O	O	O	O

ISCOLE CONTROLE DE QUALIDADE (CQ) e ENTRADA DOS DADOS:

Iniciais do Staff CQ:: _____ Data: _____/_____/_____

Iniciais Staff Entrada dos Dados: _____ Data: _____/_____/_____

ID Participante (anexar etiqueta aqui)	Iniciais do Técnico ☐☐☐ Data ☐☐/☐☐☐/☐☐☐☐ Dia Mês Ano

11. Grandes parques públicos	○	○	○	○	○	○
12. Recreio público com equipamentos	○	○	○	○	○	○
13. Escola com instalações de lazer abertas ao púbico	○	○	○	○	○	○

M. FAMÍLIA

Durante uma semana típica, com que frequência você ou outro adulto na casa:

	Nunca	1-2 dias	3-4 dias	5-6 dias	Todos os dias
1. Vê o(a) seu/sua filho(a) participar em actividades físicas ou desportivas	○	○	○	○	○
2. Encoraja o(a) seu/sua filho(a) a fazer desporto ou actividade física	○	○	○	○	○
3. Transporta o(a) seu/sua filho(a) até o local onde ele pode fazer actividade física ou desporto	○	○	○	○	○
4. Faz actividade física ou desporto com o(a) seu/sua filho(a)	○	○	○	○	○

ISCOLE CONTROLE DE QUALIDADE (CQ) e ENTRADA DOS DADOS:

Iniciais do Staff CQ:: _____ Data: _____ / _____ / _____

Iniciais Staff Entrada dos Dados: _____ Data: _____ / _____ / _____

Appendix P: School Environment Questionnaire (Portuguese)

Appendix O: QUESTIONÁRIO ACERCA DO AMBIENTE ESCOLAR

A. CARACTERÍSTICAS DA ESCOLA

1. Qual o cargo que desempenha na escola? ☐ Director ☐ Director Adjunto ☐ Professor ☐ Outra_____

2. Qual é o número total de alunos na sua escola? _____ alunos

3. Qual é o número total de professors (que trabalham a tempo inteiro) na sua escola? _____ professores

4. Quais os ciclos de ensino da sua escola? _____ a _____

5. Durante o ano lectivo (excluindo feriados), qual e a estimativa do número de dias do ano escolar?_____

B. POLÍTICAS E PRÁTICAS

Na secção seguinte, o termo "políticas" refere-se a qualquer mandato emitido pelo Estado, conselho escolar local, ou qualquer outra agência governamental, incluindo políticas desenvolvidas pela sua escola ou (distrito/zona), que afecte o seu ambiente escolar e que foram oficialmente adoptada pela sua escola ou zona. Esta secção também tem perguntas sobre as práticas (o que os alunos e funcionários estão autorizados a fazer, regularmente) que servem para promover a saúde e o bem-estar dos estudantes e que são organizadas pela escola.

6. A sua escola tem documentação escrita sobre políticas ou práticas relativas à actividade física?

- ☐ **Sim**, existem políticas escritas
- ☐ **Sim**, existem políticas em desenvolvimento
- ☐ **Sim**, práticas
- ☐ Não
- ☐ Não se aplica

7. A sua escola tem documentação escrita sobre políticas ou práticas relativas a alimentação saudável?

- ☐ **Sim**, existem políticas escritas
- ☐ **Sim**, existem políticas em desenvolvimento
- ☐ **Sim**, práticas
- ☐ Não
- ☐ Não se aplica

8. A sua escola tem algum comité ou grupo que supervisiona ou oferece orientação acerca do desenvolvimento de políticas e práticas relativas à actividade física e alimentação saudável (por exemplo, uma equipa de saúde e acção, saúde escolar)?

- ☐ **Sim**, de actividade física e alimentação saudável
- ☐ **Sim**, somente sobre actividade física
- ☐ **Sim**, somente sobre alimentação saudável
- ☐ Não

C. ACTIVIDADE FÍSICA/PRÁTICA DESPORTIVA

9. Qual a percentagem de alunos que participa nas seguintes actividades extracurriculares oferecidas por sua escola?

(Por favor, estime)

		Não disponível	*Menos que 10%*	*10-24%*	*25-49%*	*50%+*
a.	Práticas desportivas entre escolas	☐	☐	☐	☐	☐
b.	Práticas desportivas intramuros ou clubes de actividade física (incluindo actividades de dança)	☐	☐	☐	☐	☐
c.	Clubes de lazer/hobby (por exemplo, xadrez)	☐	☐	☐	☐	☐
d.	Clubes de artes (por exemplo, teatro, música, fotografia)	☐	☐	☐	☐	☐

10. A sua escola oferece serviços de transporte/autocarros para os estudantes que participam das actividades extracurriculares?

Sim ☐ Não ☐

11. Da lista seguinte, indique, por favor, que desportos são praticados pelos alunos do 5º ano nos programas de Educação Física (intramuros) e Desporto Escolar (interescolas):

a. Não aplicável, a escola não oferece actividades intramuros ou interescolas para os estudantes do 5º ano ☐

	Interescolas	*Intramuros*		*Interescolas*	*Intramuros*
b. Basquetebol	☐	☐	j. Ginástica	☐	☐
c. Voleibol	☐	☐	k. Desportos de combate	☐	☐
d. Futebol de 11	☐	☐	l. Atletismo	☐	☐
e. Andebol	☐	☐	m. Badminton	☐	☐
f. Beisebol	☐	☐	n. Natação	☐	☐
g. Rugby	☐	☐	o. Escalada	☐	☐
h. Ténis	☐	☐	p. Futebol de salão	☐	☐
i. Ping-pong	☐	☐	q. Outros	☐	☐

Nas questões seguintes considere, somente, os alunos do 5º ano.

12. Quantos intervalos de 15 a 29 minutos é que os alunos têm por dia?

☐ zero ☐ 1 ☐ 2 ☐ 3 ou mais

13. Quantos intervalos de 30 minutos é que os alunos têm por dia?

☐ zero ☐ 1 ☐ 2 ☐ 3 ou mais

14. Quanto tempo de aula é atribuída pelo Ministério da Educação à disciplina de Educação Física (EF)/Actividade Física Diária (AFD) para os alunos do 5º ano?

_____ minutos por *[marque a caixa que indica a unidade de tempo]* **semana** ☐ **dia** ☐

☐ Não é atribuída uma quantidade específica de tempo

15. Quando se compara o tempo atribuído pelo Ministério da Educação à disciplina de Educação Física /Actividade Física Diária, os alunos da sua escola recebem, em média:

☐ Menos que a quantidade de tempo mandatado
☐ Aproximadamente ao mandatado
☐ Mais que o tempo mandatado
☐ Nenhum tempo específico é mandatado

16. Como qualificaria as seguintes afirmações em termos caracterizadores da sua escola?

	Muito	*Mais ou menos*	*Muito Pouco*	*De modo nenhum*	*Não sei*
a. Nós usamos a actividade física como recompensa	☐	☐	☐	☐	☐
b. Nós promovemos a actividade física durante/ou como parte de eventos especiais	☐	☐	☐	☐	☐
c. Nós integramos a actividade física em outras areas curriculares	☐	☐	☐	☐	☐
d. Nós usamos a actividade física como punição por mau comportamento	☐	☐	☐	☐	☐

17. Será que a sua escola tem programas conjuntos com a Câmara Municipal, Junta de Freguesia ou Polícia para promover o transporte activo para ir e vir da escola em qualquer uma das seguintes formas?

	Sim	*Não*	*Não sei*
a. Identifica percursos seguros para caminhadar e andar de bicicleta no trajecto de ida e volta da escola (por exemplo, com sinais, em boletins informativos, etc.)	☐	☐	☐
b. Providencia controlos nos cruzamentos para incentivar percursos mais seguros à volta da escola	☐	☐	☐
c. Designa uma "área livre de carros" para providenciar áreas seguras de caminhada à volta da escola	☐	☐	☐
d. Permite que os alunos tragam bicicletas para a escola	☐	☐	☐
e. Permite que os estudantes tragam equipamentos de pequenas rodas (por exemplo, patins, skates) para a escola	☐	☐	☐
f. Incentiva o uso de capacetes e equipamentos de segurança para aqueles que utilizam bicicletas e equipamentos de pequenas rodas para irem para a escola	☐	☐	☐
g. Organiza eventos do tipo "caminhar até a escola", têm clube de caminhada ou programas como "caminhar-autocarro-escola", em que os pais e alunos mais velhos caminham pela vizinhnça e "embarcam/apanham" os alunos em pontos designados.	☐	☐	☐

D. EQUIPAMENTOS DA ESCOLA

18. Durante o tempo escolar a maioria dos alunos, da sua escola, tem acesso regular a qualquer um dos itens abaixo referenciados*? *O tempo escolar compreende o primeiro toque do 1º tempo até o último, incluindo o tempo de aulas e de recreio (por exemplo, almoço).

	Sim, na escola	*Sim, fora da escola*	*Sim, dentro e fora da escola*	*Não*	*Não sei*
a. Ginásio	☐	☐	☐	☐	☐
b. Outra sala grande adequada para a realização de actividades físicas (por exemplo, auditório, cafeteria, estúdio de dança)	☐	☐	☐	☐	☐
c. Sala de fitness para aeróbica e/ou treino de musculação	☐	☐	☐	☐	☐
d. Pista de atletismo	☐	☐	☐	☐	☐
e. Campo para a prática de desportos ao ar livre (por exemplo, futebol)	☐	☐	☐	☐	☐
f. Área pavimentada ao ar livre (por exemplo, campos de ténis, basquetebol, ou outros jogos)	☐	☐	☐	☐	☐
g. Área de patinagem	☐	☐	☐	☐	☐
h. Piscina interior	☐	☐	☐	☐	☐
i. Balneários seguros disponíveis para serem utilizados durante as actividades físicas	☐	☐	☐	☐	☐
j. Balneários disponíveis para serem utilizados antes e após as actividades físicas	☐	☐	☐	☐	☐
k. Duche disponível para o uso antes e depois da actividade física	☐	☐	☐	☐	☐
l. Local de estacionamento de bicicletas	☐	☐	☐	☐	☐
m. **Se sim**,estão situados em áreas seguras para evitar roubos?	☐	☐	☐	☐	☐
n. Área lúdica em relva	☐	☐	☐	☐	☐
o. Equipamentos lúdicos (por exemplo, estruturas de trepar, baloiços)	☐	☐	☐	☐	☐
p. Sala de arte	☐	☐	☐	☐	☐
q. Sala de música	☐	☐	☐	☐	☐

19. Os alunos têm acesso a equipamentos para comprar comidas e bebidas?

	Sim	*Não*
a. Cafeteria	☐	☐
b. Cantina	☐	☐
c. Lojas/restaurantes de *fast food* perto da escola	☐	☐
d. Máquinas de vender doces e batatas fritas	☐	☐
e. Máquina de vender bebidas (por exemplo, Cola, refrigerantes, sumo de laranja)	☐	☐
f. Máquina de vender leite e seus derivados (por exemplo, leite, leite achocolatado)	☐	☐

20. *Fora do período escolar*, a sua escola permite que os alunos tenham acesso aos seguintes locais?*
** Fora do periodo escolar significa antes e/ou depois da escola, noites e finais de semana. O acesso dos alunos pode ocorrer desporto escolar, clubes desportivos ou uso informal.*

	Sim	*Não*	*Não sei*	*N/A*
a. Ginásio	☐	☐	☐	☐
b. Instalações internas	☐	☐	☐	☐
c. Instalações ao ar livre (por exemplo, campos de jogos, áreas de actividades pavimentadas)	☐	☐	☐	☐
d. Equipamentos (por exemplo, bolas de basquetebol)	☐	☐	☐	☐

21. *Fora do periodo escolar*, é permitido o uso das instalações da escola?*
**Fora do período escolar significa antes e/ou após a escola, noites e finais de semana.*

Sim ☐ Não ☐ Não sei ☐

E. ALIMENTAÇÃO SAUDÁVEL

22. A sua escola fornece qualquer um dos seguintes itens para promover a venda de alimentos saudáveis?
(Marque todas que se apliquem)

	Cafeteria	*Bar/ Cantina*	*Máquina de venda*
a. Comida saudável por um preço razoável/subsidiado	☐	☐	☐
b. Materiais promocionais sobre alimentação saudável (por exemplo, posters)	☐	☐	☐
c. Preços especiais para pratos do dia saudáveis	☐	☐	☐
d. Programas de alimentação saudável no bufete (por exemplo, coma de forma inteligente)	☐	☐	☐

23. A sua escola assegura que todos os alunos, independentemente dos rendimentos das famílias, tenham acesso a frutas e vegetais?

☐ Sim, durante todo o ano lectivo
☐ Sim, ocasionalmente/em curto prazo
☐ Não

24. A sua escola oferece algum dos seguintes itens? (Marque todos que se apliquem)

☐ Aulas de culinária
☐ Criação de pequenas hortas ecológicas
☐ Visitas de estudo para locais produtores de alimentos
☐ Campanhas sobre tópicos especiais relacionados com alimentação saudável (por exemplo, imagem corporal, desordens alimentares)
☐ Visitas de estudo a supermercados e grande superfícies nos sectores de alimentação.

25. Durante os últimos 12 meses, sua escola iniciou/continuou alguma das seguintes actividades/programas?

	Sim	Não	N/A
a. Ofereceu opções de alimentação saudável ao pequeno-almoço	☐	☐	☐
b. Ofereceu opções de alimentação saudável ao almoço	☐	☐	☐
c. Ofereceu opções de alimentação saudável cafeterias	☐	☐	☐
d. Ofereceu opções de alimentação saudável no bar da escola	☐	☐	☐
e. Ofereceu opções de alimentação saudável nas máquinas de venda	☐	☐	☐
f. Organizou actividades mensais acerca da nutrição e alimentação saudável	☐	☐	☐
g. Parou a venda de *fast foods*	☐	☐	☐
h. Dias de alimentação saudável	☐	☐	☐
i. Parou a venda de bebidas com açúcar	☐	☐	☐

26. Durante os últimos 12 meses foi vendido algum dos seguintes itens com o propósito de angariação de fundos por um qualquer grupo da escola?

	Sim	Não	N/A
a. Doces de chocolate	☐	☐	☐
b. Outros doces	☐	☐	☐
c. Outros tipos de "comidas plásticas" (por exemplo, pipocas)	☐	☐	☐
d. Refrigerantes ou sumos de frutas que não são 100% naturais	☐	☐	☐
e. Bebidas desportivas	☐	☐	☐
f. Biscoitos, bolachas, bolos, doces, ou outros produtos de panificação que não são pobres em gordura	☐	☐	☐
g. Frutas ou vegetais	☐	☐	☐
h. Sumos de fruta ou sumo de vegetais 100% naturais	☐	☐	☐
i. Bolos, biscoitos, bolachas e doces de baixo teor em gordura, ou outros assados de baixo teor de gordura	☐	☐	☐

F. VIZINHANÇA/COMMUNIDADE

27. Será que as situações seguintes são problemáticas na vizinhança de inserção da escola?

	Maior problema	Problema moderado	Problema menor	Não é problema	Não sei
a. Tensões com base em diferenças raciais, étnicas ou religiosas	☐	☐	☐	☐	☐
b. Lixo ou vidro quebrado na rua ou estrada, nos passeios ou em quintais	☐	☐	☐	☐	☐
c. Venda ou uso de drogas ou bebida em excesso em público	☐	☐	☐	☐	☐
d. Grupos de marginais	☐	☐	☐	☐	☐
e. Tráfego intenso	☐	☐	☐	☐	☐

f.	Casas vazias e edifícios	☐	☐	☐	☐	☐
g.	Criminalidade na vizinhança	☐	☐	☐	☐	☐

Appendix Q: Addendum incorporating examiners' suggested post defense corrections

Methodology specific to the 2016 and 2018 Zimbabwe Report Card development

In addition to the general Report Card development methodology described in chapter 3 of this dissertation, this section elaborates on some nuances that were specific to the Zimbabwe Report Cards. Both the 2016 and 2018 Zimbabwe Report Cards were developed through a collaborative and iterative process including extensive electronic correspondence, virtual and in-person meetings. A representative Report Card Working Group (RCWG) comprising academic professors and university lecturers, a member from a non-governmental organization, senior PhD students, and a representative from the Ministry of Primary and Secondary Education was established through a snowball method. Once assembled, and after a series of emails to establish ground rules and to ensure that the team was national in scope and comprised of most Zimbabwean experts in the field, members of the RCWG were each asked to identify and forward all available literature (published and unpublished, graduate student theses, policy documents and syllabi, etc.) on PA among Zimbabwean children and youth without limits to the year of study or publication. All studies and reports included to facilitate grading of the best available evidence for the 2016 and 2018 Report Cards were published or conducted between 2003 and 2017.

For both Report Cards, I was responsible for collating and summarizing the available data according to each indicator onto a spreadsheet. A second member (the co-leader of the RCWG) reviewed the spreadsheet independently to ensure that all the studies and reports were accounted for. A mentor with experience developing Report Cards (Professor MS. Tremblay) supervised the development of the spreadsheet for completeness before it was shared with all members of

the RCWG. During a virtual meeting to discuss the process of grade assignment, the team reviewed the benchmarks and grading rubric using examples of how to award grades. Following the meeting, members were each given a copy of the benchmarks and grading rubric as well as the spreadsheet of data. Each member then individually reviewed the summary and assigned grades to each of the key indicators following the benchmarks and grading rubric as prescribed by the AHKGA (see appendices B and C) and discussed during the virtual meeting. After each member had completed independently assigning grades to each indicator, they forwarded their grades to me, and I compiled them into a single table, and the grades were verified by the mentor and compared. Where grades differed between or among members, the inconsistencies were noted and discussed during a virtual meeting until consensus was reached. Such discussions relied on communally discussing the available evidence as well as sharing expert knowledge. A final grade would only be reached by unanimous consent.

Although the process of developing the Zimbabwe Report Cards was comprehensive, transparent and adhered to the protocol prescribed by the AHKGA, there are several important limitations mostly due to the quality or absence of data that are worth noting. First, only a handful of mostly unpublished studies provided the data used for the Zimbabwe Report Cards. Second, most of the studies did not use robust measures, were cross-sectional and used self-reported data. Third, we did not limit our data searches to only recent studies, and as such the Report Cards include data that do not represent only recent estimates. Fourth, all the samples in the included studies were not randomly selected and not nationally representative, therefore there is a need for caution when interpreting the results in manuscripts one and two which are presented as chapters 4.1, and 4.2 in this dissertation. Fifth, there was inconsistent reporting, different cut-points and

measurement criteria making for difficult comparison among studies. However, despite these limitations, these Report Cards grades were critical knowledge translation tools, which served to consolidate the existing evidence, bring together researchers and stakeholders from across Zimbabwe with an interest in PA for children and youth, identified specific areas of research need, served as a catalyst for future research, and inspired efforts to create Active Healthy Kids Zimbabwe.

Dealing with missing data on key variables in this dissertation

Missing data is a common measurement problem that is known to threaten the veracity of study results by calling into question the interpretation, reliability, and generalizability of the findings. Study participants with missing data may significantly differ from those with complete data on key variables, which can introduce bias and challenge the interpretation of study findings if not dealt with appropriately. Overall, 15% of the participants recruited for this dissertation were missing data on level of parental education and 22% had insufficient accelerometry data. The proportion of participants missing data on each of the remaining variables used in this dissertation was below 10%. To minimize loss of information, and potentially biasing the results by excluding missing cases, multiple imputation was applied. Missing values were multiply imputed (50 datasets) under the MAR assumptions, which were tested using recursive partitioning analysis, the Little MCAR's test, and missing patterns analyses. Sensitivity analyses were conducted to compare univariable results from imputed data sets to those from complete case analyses, and results were similar. Because the results from complete case analysis and multiply imputed data analyses were similar, the imputed data were used for final analyses to maximize data utilization. Unbalanced cells for the dependent variables within the models made

it impractical to separately estimate models for rural and urban sub-samples. However, because of important descriptive differences between the two sub-samples, the location of school (rural or urban) was added to multivariable models as an additional covariate.