Obesity and Cardiometabolic Health Risk Prevalence in Relation to Eating Habits and Nutrition Knowledge among Adolescents: Suggestions for Nutrition Education Programs and Strategies

（思春期の子どもたちにおける食習慣・栄養の知識と関連する肥満・心代謝系健康リスク：栄養教育プログラムおよび戦略の提案）

2023

Graduate School of Human Life Science

Osaka City University

Ashleigh Pencil

アシュリーペンシル

Table of Contents

List of Appendices

List of tables

List of figures

Chapter 1

Overall introduction

1.1 Introduction

Zimbabwe is a beautiful country in Southern Africa that is known for its dramatic landscapes, its diverse wildlife, and its hardworking people. Zimbabwe has a total land area of 390 000 square kilometres and a well-educated population of around 14 million people.[1]

1.2 The socio-demographic characteristics for Zimbabwe

Zimbabwe attained its independence in 1980 and based on the 2012 national census the population size was approximately 13 million people consisting of marginally more females (52%) than males.[2] A high proportion of the population consists of young people below 15 years of age (41%), and the average household size is 4.2 persons. In addition, a high proportion of the population resides in rural areas (67%), and in general, the country has a high literacy rate (96%).[3] Zimbabwe is a low-income country, ranked 150 out of 189 on the 2019 United Nations Development Programme (UNDP) Human Development Index.[4] Life expectancy at birth for men and women was 56 and 60 years, respectively. The infant mortality rate was estimated at 64 deaths per 1000 births for 2012. The rate was generally higher for males than for females. The under-five mortality rate was 84 per 1000 live births.[5,6]

In the past 15 years, Zimbabwe has experienced a humanitarian, economic, and social crisis that has been characterized by an increase in poverty and food insecurity. The nation has experienced food shortages since the 1990s at both the national and household levels.[7] This has a huge impact on children as they become more susceptible to disease, suffer cognitive impairment, have poorer educational outcomes, poor growth and have reduced economic productivity as adults.[8]

1.3 Food environment and food systems in Zimbabwe

Food environments are defined as all the foods that are available and accessible to people in the settings in which they go about their daily lives, while food systems encompass the entire range of activities, peoples, and institutions involved in the production, processing, marketing, consumption, and disposal of food.[2,9] Food environments are influenced by the food systems which supply them and vice versa. Traditionally, the majority of Zimbabweans lived in rural areas (63%), where agriculture is the main income-generating activity for 51.8% of households.[10] Smallholder agriculture in Zimbabwe is predominantly focused on staple maize production, while, in urban areas, they buy their food from supermarkets and informal markets or street food vendors.[11] To ensure household food security the focus on nutrition-sensitive agriculture is recommended based on the growing evidence of its contribution to improved nutrition outcomes in low-income countries. In addition, recently launched innovations like biofortified provitamin and orange maize and iron-rich beans have the potential to address micronutrient deficiencies in rural Zimbabwe.[12]

1.4 The double burden of malnutrition in Zimbabwe

Nutrition program in Zimbabwe addresses factors that contribute to maternal and infant malnutrition, through strengthening the capacity of district Ministry of health and child welfare (MoHCC) and health facilities to reduce malnutrition.[13] MoHCC implements programmes that include maternal health and nutrition; support to Vitamin A supplementation, promotion of optimal infant and young child feeding practices, nutrition education and awareness campaigns, community-based growth monitoring and

promotion, management and treatment of malnutrition across age-groups.[13] This is done through integrated management of acute malnutrition and targeted supplementary feeding. Zimbabwe has long suffered from high levels of chronic malnutrition among its population, which have led the government and international organisations to launch several initiatives over the years to tackle the problem.[14] However, due to nutrition transition in Zimbabwe there has been a dietary shift from traditional wholesome foods to ultra-processed foods which has led to the rise of obesity and non-communicable diseases.[15,16]

1.5 Nutrition transition in Zimbabwe

Nutrition transition refers to the changes that populations experience in quality and quantity of dietary behaviours and patterns.[17] Nutrition transition patterns are highlighted in **Figure 1**. Zimbabwe is currently in between pattern3 and 4 of nutrition transition.[10] This is characterised by the rise in diet related NCDs.[18] These changes go hand in hand with other lifestyle-related factors such as physical activity, work and family environments, and general health and socioeconomic well-being, all of which ultimately influence energy expenditure.[19] It is a common practice in Zimbabwe to have three meals per day. Breakfast mostly comprises of bread, or any other source of carbohydrates like pumpkin, sweet potato, or maize meal porridge. It is commonly believed that carbohydrate for breakfast will give enough energy until the next meal. Lunch is commonly comprised of sadza (the staple) and a vegetable like covo, rape and tsunga. Meat is normally reserved for dinner where it is served with another source of carbohydrates like sadza or rice and on serving of vegetables or a salad.

The current status of the nutrition transition in Zimbabwe is characterized by a high consumption of energy, fat, and sugary and salty foods and low intakes of dietary fiber and low physical activity level.[20] The current evidence on malnutrition in the region is mostly on issues related to undernutrition, which has been a major burden for decades, and consequently, most population-based studies have focused on maternal and childhood nutrition.[18] Urbanization, women work, and economic development are heavily influencing the dietary pattern as an indicator of the continued transition that affected adolescents.[21]

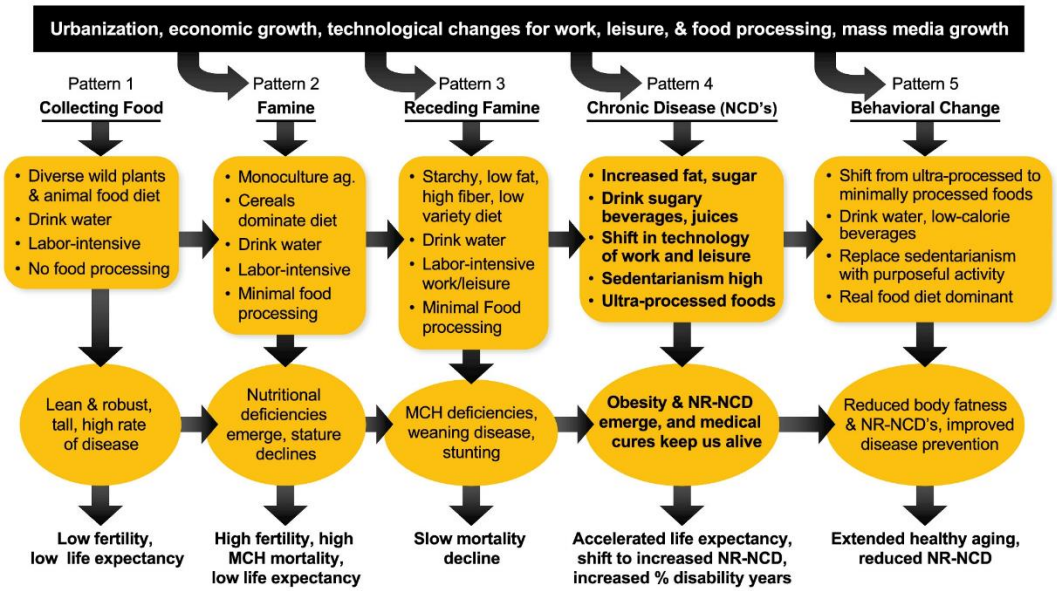


Figure 1 The nutrition transition to a state of high obesity and non-communicable disease prevalence dominated by ultra processed foods. [126]

In Zimbabwe the most important consumed foods are grains, sunflower oil, and sweeteners; they presented three-quarters of the energy intake. The diet is dense in energy and poor in micronutrients that provides overnutrition.[22] The traditional Zimbabwean diet was dependent on cereals, dried legumes, and vegetables. Currently, white bread, fast food, sweets, cakes, snacks, and processed products replaced the

traditional diet.[16] These new dietary patterns are characterized by decreased consumption of vegetables, legumes, cereals, grains, and vegetable oil, along with increased in white bread, dairy products, sugars, confectionery, added fats, fried potatoes, and fruits.[16]

1.6 Adolescent nutrition "The neglected age group"

Adolescence is a period characterized by rapid growth that is second to the first 1000 days of a child's life.[23] Although there is very limited data on adolescent nutrition indicators in Zimbabwe, there appears to be a trend indicating the presence of "multiple burden of malnutrition" particularly anaemia, undernutrition, and obesity among adolescents.[6] Unfortunately, interventions for malnutrition related diseases particularly obesity and NCDs are limited and almost non-existent in Zimbabwe. This puts adolescents at risk of diseases that can be prevented by healthy food habits.[20]

1.7 Practical implications of the Study

Zimbabwe has both established and upcoming health promotion programs.[30,13] Recently, the government launched the Zimbabwe School Health Policy (ZSHP), a guide for all public health, nutrition, sexual, and reproductive health related matters that affect students from preschool, to primary and high school.[25] In addition, the policy covers all aspects of the care and support provisions programs of all students, including the home- grown school feeding program. Interestingly, there are unique programs in Zimbabwean schools designed to combat chronic malnutrition (stunting), which has been exacerbated by food insecurity and deepening poverty, particularly among young children, pregnant women, and immune-compromised individuals.[26] However, despite the evidence of the double burden of malnutrition and the rise of obesity and

non-communicable diseases, which are mainly caused by nutrition transition, these health promotion programs are still biased towards undernutrition with limited focus on obesity and diet-related non- communicable diseases.[25,32]

Furthermore, there is limited nutrition programming in urban areas, in spite of the increasing urban nutrition challenges and growing population.[6] Our results contribute to the future health promotion programs and policies in Zimbabwe by establishing the base to address obesity issues among adolescents in urban areas including the capital city Harare, and we postulate that these findings may also be useful for other low-income countries.

1.8 The purpose of study and the structure of the thesis

The overall purpose of this study was to examine the determinants of overweight and obesity among adolescents in Harare, Zimbabwe. The purpose of Chapter 1 is to introduce the adolescent's obesity situation in urban Harare, Zimbabwe. In Zimbabwe, obesity is both an emerging health problem and a grey area, particularly among adolescents. The purpose of Chapter 2 was to gather existing studies to provide evidence of the emerging obesity problem in Zimbabwe. The purpose of Chapter 3 was to assess the prevalence of obesity, CMR, and associated determinants among in-school adolescents in Harare, Zimbabwe. The purpose of Chapter 4 was to assess obesity awareness and related factors among adolescents. A cross-sectional survey guided by the health belief model (HBM) was performed using an interviewer-administered questionnaire. The purpose of Chapter 5 was to suggest obesity awareness and intervention measures based on the scoping review and survey results. Social behavior change communication (SBCC) is the strategic use of communication approaches to

promote changes in knowledge, attitudes, norms, beliefs, and behaviors. The purpose of Chapter 6 was to provide an overall summary of the whole study and to give recommendations for future studies, nutrition education and obesity intervention programs.

Ethical considerations

This study was conducted according to the World Medical Association Declaration of Helsinki (2013). Ethical clearance was obtained from the Medical Research Council of Zimbabwe (MRCZ/A/2857) and the ethics committee of Graduate School of Human Life and Ecology, Osaka Metropolitan University (21-52). Approval was sought at the Ministry of Primary and Secondary Education (MoPSE) and the schools through a consultative engagement process. The consent for the learners to participate was obtained from the parents and/or guardians before commencement of study activities.

Chapter 2

Determinants of overweight and obesity among adolescents in Zimbabwe: A scoping review

2.1 Introduction

Obesity has been known to be a contributing factor to the development of non-communicable diseases (NCDs) which include diabetes, hypertension, and coronary heart diseases.[28] Recent evidence is indicating that obesity is now prevalent in low to medium-income countries (LMICs) and nutrition transition, economic transition, and urbanization are major driving forces behind the increase in levels of obesity in LMICs, despite the persistence of undernutrition.[29] Undernutrition and obesity may coexist in countries and even smaller communities and households, being referred to as the double burden of malnutrition.[30]

Zimbabwe has undergone a complex health and demographic transition resulting in the double burden of malnutrition.[31] Nevertheless, the high levels of undernutrition still persist in relation to the high levels of food insecurity.[4] On the other hand, a rapid nutrition transition characterized by a shift from staple foods towards an energy-dense diet is occurring alongside urbanization.[32] The changing food systems in urban areas result in easy access to ultra-processed foods and a general shift from the traditional cuisine and active lifestyles.[33] Although Zimbabwe has not been spared from these effects of obesity and associated non-communicable diseases,[34] less effort has been placed on addressing overweight and obesity especially among adolescents. Adolescents nutrition has been neglected in Zimbabwe, and this is supported by the limited data on adolescents nutrition and very few researchers have targeted this age group.[6]

WHO defines adolescents as individuals in the 10-19-year age group and “youth” as the 15-24- year age group [10]. Obesity in children and adolescents aged 5–19 years is

defined as body mass index (BMI) for- age- Z-score above +2 standard deviations, according to WHO age- and gender-specific growth reference charts.[23,40] Childhood and adolescent obesity often result from complex relationships which can be categorized at various levels based on the Socio-Ecological Model (SEM).[41,42] This model provides a framework to understand the factors that impact an individual's health.[37] The SEM in obesity research suggests that obesity is influenced by factors across multiple levels: individual and family characteristics, as well as characteristics of the home, society, region, and country.[38]

Macro-level factors including social norms, economic policies, and advertising have an indirect influence on behaviours as they provide unhealthy environments which make it difficult for individuals to adopt healthy eating behaviours that prevent overweight and obesity.[39] However, despite the rising obesity burden in low-income countries like Zimbabwe, the risk factors for overweight and obesity are still not clearly known.[40] It is therefore important to use the SEM to identify and categorize the risk factors in these low-income settings. Therefore, this review aims to summarize evidence of the determinants of obesity among adolescents in Zimbabwe using the SEM. The findings of the review will be useful in informing policy and programming decisions in the country.

2.2 Methods

This scoping review followed the five-stage review methodology proposed by Arksey and O'Malley.[41] This approach involved (1) identifying the research questions, (2) identifying relevant studies, (3) study selection, (4) charting the data, and (5) collating and summarizing the data.

2.2.1 Stage 1: Identifying the research questions

This study research questions arose from the need to identify which SEM level of adolescence obesity determinants have been studied in Zimbabwe, and to identify the gaps in literature. Furthermore, the questions intended to verify the affected population, exposure, prevalence, distribution, and the risk factors of adolescents' obesity in Zimbabwe. The main review question was: *Which SEM levels of determinants of adolescent obesity have been studied in Zimbabwe?*

2.2.2 Stage 2: Identifying relevant studies

Relevant literature on the burden of adolescents' obesity in Zimbabwe was identified through a thorough search on Google, PubMed, and Google scholar regardless of publication status (published, unpublished, press, and conference articles). However, enough relevance to answering the research questions was required. Grey areas in literature were also searched using Google as well as websites from International Organisations for example the World Health Organisation. This search was done targeting literature written between 2010 to the current search date. Specific keywords were used in the thorough search. These words included *obesity, overweight, BMI, youth, prevalence, adolescents, distribution, burden, incidence, risk factors, and Zimbabwe*. Boolean operators (and, or not) were used to combine keywords and thus broaden or narrow the search.

2.2.3 Stage 3: Study selection

A pre-set inclusion and exclusion criterion were used to screen studies for eligibility. The included studies showed evidence of studies and reports from National surveys conducted in Zimbabwe conducted from 2010-2020. These studies should have

presented evidence of the prevalence and determinants of obesity among adolescents between 10-19 years.[42] To avoid duplication, we excluded African studies with Zimbabwean data. We excluded studies with participants outside the 10-19 years age range.

2.2.4 Stage 4: Charting the data

The primary outcomes considered in this review were overweight, obesity, and central obesity. Obesity in children and adolescents aged 5-19 years is defined as body mass index (BMI) for- age- Z-score above +2 standard deviations, according to WHO age- and gender-specific growth reference charts. BMI cut points by age and sex for overweight and obesity for children age 2 to 18 correspond to adult BMI of 25 kg/m^2 (overweight) or 30 kg/m^2 (obesity).[41]

Studies were screened to identify which SEM level of childhood obesity determinants were addressed. The SEM levels of the variables analysed in each study were identified considering the description of each SEM level presented as follows, and not according to the conceptualization of such aspects made by each study. The SEM levels used in this scoping review were based on the Bronfenbrenner theory[43]: (1) the individual level that includes all factors intrinsically related with the child such as age, gender, biological and anthropometric information as well as personal beliefs and behaviours; (2) the environmental level that comprises the characteristics of parents, close relatives, and peers such as, educational level, home and school settings among others; (3) the social level which is mostly associated with the social associations, socioeconomic status religious groups or other groups that the adolescent is integrated into; (4) the

economic and government policies level, that is comprised of factors of a broader dimension such as economy, legislation and policies documentation.

2.3 Results

2.3.1 Stage 5: Collating and summarizing the data.

The results are presented in the figure and table format. **Figure 2** summarizes the number of identified papers, screened papers, and papers included in this study. While, **Table 1** shows the detailed characteristics of the selected studies including the author(s), year of publication, the aim of the study, and the percentage prevalence of obesity.

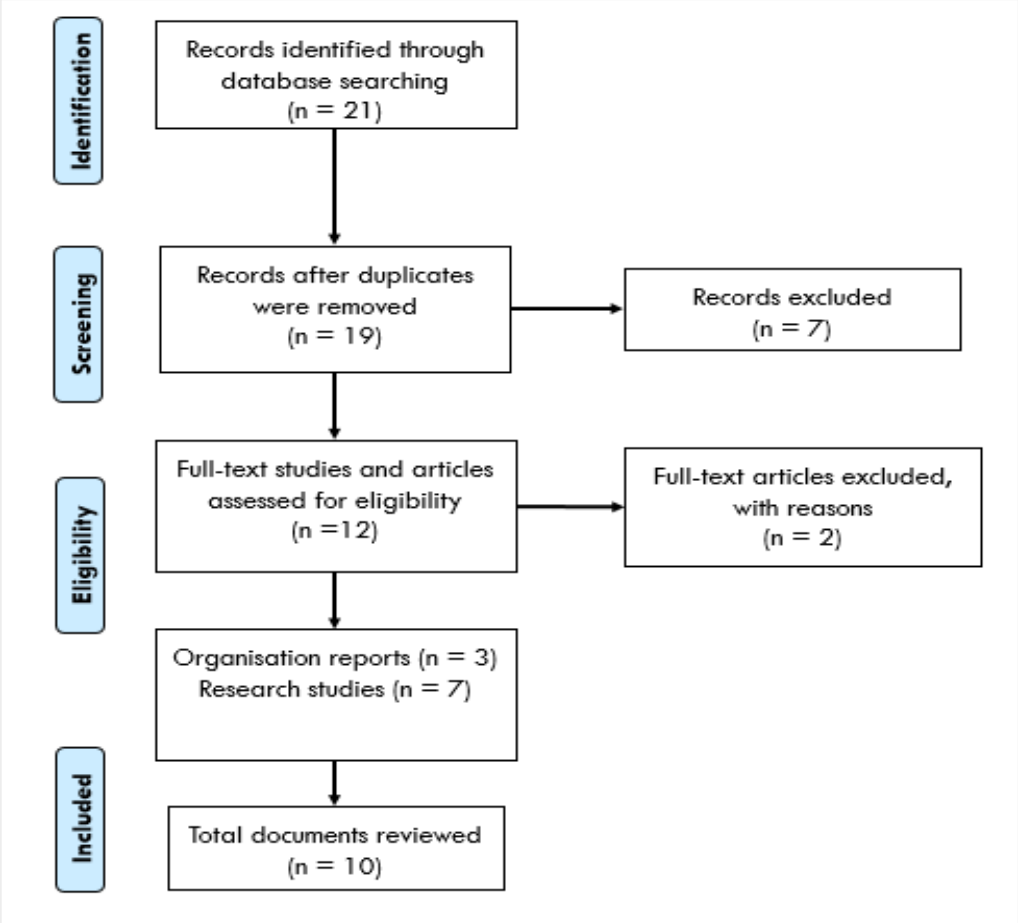


Figure 2 Flow chart showing the systematic review of the articles included in this study.

Table 2 shows the SEM levels and the respective variables discussed in the reviewed studies and a socioecological model was designed to summarize the risk factor levels (**Figure 3**).

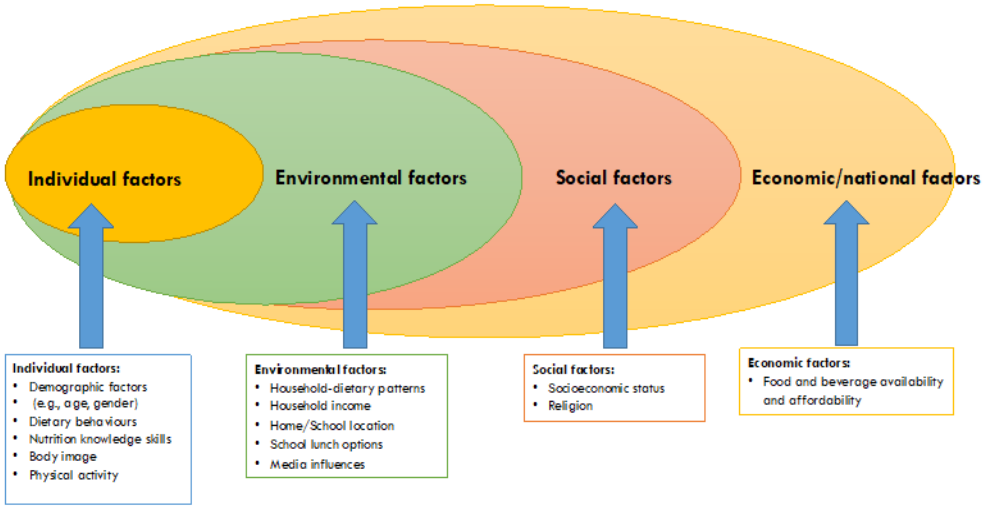


Figure 3 A socio-ecological model summarizing the risk for adolescents' obesity in Zimbabwe.

2.3.2 Characteristics of the included studies

A total of five papers and one national survey reviewed in this study included participants from both male and female adolescents (**Table 1**). Two papers and two national surveys focused on female adolescents only. None of the included studies or national surveys focused on males only. None of the studies had the specified age range of 10-19 years, however, were possible, segregated data for the targeted age range was extracted from the studies. Most of the studies were done in the urban areas and national health surveys were done in both urban and rural areas and two studies were conducted

in universities; hence it is unclear whether the participants were from a rural setting or urban setting.

The search generated 21 results and based on the eligibility criteria only ten studies were included in the review **Figure 1**. Seven studies were included because they focused on the 10-19 age range or part of the age range, and they presented evidence on the prevalence of adolescents' obesity supported by SEM factors. Three reports/articles were also included in this review. According to the data evidence presented by the reports and the studies, the evidence from the studies was easy to analyse since the data was segregated by age in most cases and SEM determinants could be extracted easily.

2.3.3 Summary of the key findings

Figure 2 shows that various authors focused on different SEM level determinants and various variables. The most studied SEM level was the individual level followed by the environmental level. None of the reviewed studies researched all the factors (individual, environmental, societal, and economic determinants of adolescent obesity in Zimbabwe. Under the individual-level factors, diet and nutrition knowledge was the most studied, and only one study researched physical activity.[3] The least studied SEM levels were the social and economic levels factors. Only one national survey briefly discussed the economic instability in Zimbabwe but further information on how this is contributing to adolescents obesity was not provided. [10]

Table 1 shows the summary of the characteristics of the eligible studies and national reports involving adolescents' obesity that were used in this review. None of the studies researched on the exact 10-19 years age range but they covered part of it.

Table 2 shows the variables discussed within each SEM level. Diet and nutritional knowledge were the most studied variables under the individual-level factors and many authors studied the association between urban or rural residence and obesity under the environmental level factors.

Table 1: Description of the selected studies and national survey involving adolescents involving adolescents' obesity.

Author(s) and year	N	Age in years	Study design and Anthropometric indicators	Aim of study	Prevalence of obesity	SE factors identified
Muderedzwa and Matsungo, 2020 [3]	368	9-14	Cross-sectional BMI	To determine the nutritional status, physical activity levels, and associated nutritional knowledge of primary school learners.	Boys- 24.1% Girls-27.3%	-Individual factors
Mangemba and San-Sabastian, 2020 [10]	8904	15-29*	Cross-sectional BMI	To determine the socioeconomic risk factors for overweight in non-pregnant women in Zimbabwe	Girls- 5.84%	-Individual factors -Environmental factors -Societal factors
Mukora-Mutseyekwa *et al.*, 2019 [44]	9066	15-19	Cross-sectional BMI	To investigate the trends and demographic, socioeconomic, and behavioural risk factors for overweight and obesity among Zimbabwean women of reproductive age.	Girls 15.5%- (2010-2011) 13.7%- (2015)	-Individual factors -Environmental factors -Societal factors
Dube, 2018 [8]	630	9-11	Cross-sectional BMI	To determine the socio-demographic and anthropometric characteristics of 9-11-year-old children in relation to their tuck-shop purchasing habits.	Boys-26.2% Girls-28.4%	-Individual factors -Environmental factors
Kambodo and Sartorious, 2018 [40]	9 90	10-12	Cross-sectional BMI and MUAC	To identify prominent risk factors for obesity, over fat, and overweight among primary school children.	Boys -7.34% Girls- 8.02%	-Individual factors -Environmental factors -Societal factors
Zimbabwe Nutrition Profile, 2018 [45][1]		12-18	Desk review BMI	To capture the Country's Nutrition Profiles the burden of malnutrition at the global, regional, subregional, and country level.	Not reported	-Economic factors
Chapoterera *et al*., 2016 [46]	283	13-19	Cross-sectional BMI	To explore the factors influencing dietary practices among adolescents in Zimbabwean schools.	11.4% both Boys and Girls	-Individual factors -Environmental factors -Social factors
Mufunda and Makuyana 2016 [34]	96	18-35*	Cross-sectional BMI	To investigate the youth's perception of obesity	13% both Boys and Girls	-Individual factors
ZDHS, 2016 [1][1]		15-19	Cross-sectional BMI	Not reported	Girls-35%	Not reported
GNR, Zimbabwe, 2020 [47][1]		5-19*	Desk review and self-evaluation	To provide information on adult, adolescent, and child diet, the burden of malnutrition, nutrition strategies and financing, and social determinants of nutrition.	6.0% both Boys and Girls	Not reported

Notes:
[1]The data was not segregated by sex

Table 2: Studies on the individual, environmental, societal, and economic determinants of adolescents' obesity in Zimbabwe.

SEM level	Variable	Key findings	References
Individual	Age	● Obesity was common in the younger adolescent age group (< 16 years) compared to the older adolescents.	[46]
	Sex/gender	● Girls are at a higher risk of obesity	[51, 50 , 30, 49]
		● There was a 4% increase in obesity over 4 years.	[44]
	Diet	● There was a positive association between the consumption of fast foods, unhealthy snacks, and obesity.	[51,50 ,1]
		● Students who carried lunch boxes to school were more likely to be obese than those who did not.	[46]
		● An inadequate dietary diversity score as a determinant of overweight.	[3]
	Nutrition knowledge	● Girls had more knowledge than boys and older adolescents were more knowledgeable than younger adolescents.	[34]
		● A knowledge gap was identified around obesity-related complications and predisposing factors.	[46]
		● Knowledgeable students were more likely to be obese than those who did not receive the information.	[3]
		● Parents were the source of information on healthy diets.	
	Physical activity	● Students who used non-active forms of transport were likely to be obese.	[3]
	Perceptions towards obesity	● Respondents said obesity was not a problem and they were not worried about it because that how they are.	[34]
		● Obesity is an ideal body weight preferred by the opposite sex.	
Environmental	Home	● There is access to fruits and vegetables at home.	[46]
		● Small household sizes (1 child) were associated with a greater risk of obesity.	[40] [1]
	School	● Students were exposed to and purchased unhealthy processed foods.	[46]
		● Students cannot buy fruits and vegetables at school.	
		● Guardians, peers, and teachers have very little influence on what students ate at school.	[1]
		● Students who frequently purchased unhealthy foods at the tuckshop were prone to obesity	
	Parent's occupations	● Formally employed parents were associated with increased odds of being overweight/obesity	[40]
	Urban or Rural settings	● Attending school or living in an urban area was associated with a greater risk of obesity.	[51,45,49,1]
Societal	Religion	● Christianity increases the rate of obesity.	[46]
	Socio-economic status	● The prevalence of overweight and obesity was associated with an increase in wealth.	[45, 52]
Economic/national		● Economic instability has led to food insecurities	[10]

2.4. Discussion

The objective of this review was to explore the determinants of overweight and obesity among adolescents in Zimbabwe utilizing the socioecological model. Available evidence has shown that individual and environmental factors have been studied the most while few studies investigated the social and economic factors in the Zimbabwean context. Some limitations were noted as follows: one of the studies targeted the specific 10-19 years adolescents age group and because of the various age ranges of the studies, analysis the data was challenging. In addition, their methodologies focused more on determining the prevalence and distribution of the rate of obesity and they did not involve research on barriers to healthy eating or the self-efficacy of the adolescents to shift to healthier diets, both of which are instruments of nutritional interventions. Considering that most of the evidence reviewed were subnational studies, new studies that investigate the determinants of adolescent obesity at the national level are warranted. Nevertheless, the limited data available on this topic remains relevant to facilitate a deeper understanding of adolescents' obesity dynamics in Zimbabwe. In the proceeding sections, we discuss the individual, environmental, societal, and policy-related factors regarding obesity for this age group.

2.4.1 Individual factors

Girls were more likely to be obese than boys in the reviewed studies.[39,50, 53] Similar results have been reported in systematic reviews which studied adolescents obesity in Sub-Saharan African studies, [54,55] and also in South African studies.[56,57] Possible reasons include different levels of physical activity between boys and girls, the adoption of a sedentary lifestyle as girls grow older, and watching television for more than three hours a day.[54] In addition, participation in physical activity and sports, both in and out of school, decreases during adolescence, particularly for girls. [55]

Concerning dietary determinants of obesity we observed that students who brought lunch boxes to school were 2.31 times more likely to be obese than those who did not.[24] In addition to packed lunches, some students are given additional money to purchase snacks at school. This means that students may be consuming more calories than they require considering that they purchase mostly energy dense nutrient deficient snacks. It is possible that the students who did not carry lunch boxes to school rely on food sold at school tuckshops or by vendors located at the entrances of most urban schools. In this case, it is the responsibility of the school to sell healthy and nutritious foods, and this highlights important policy considerations that must be made to ensure that the school food environment is nutrition friendly. In addition, most of the participants in reviewed studies preferred modern *"Western"* foods, and their choice of food was motivated by being good and tasty.[46] This agrees with available evidence from the USA which showed that the consumption of processed foods increased with time in adolescents [56] and this increased consumption of processed foods may be a result of food promotion and market targeting this age group.[57] These results are a direct cue for policymakers to introduce policies that protect children from unhealthy food marketing taking into consideration that children may not understand how marketing influences purchasing and eating habits.

Varying results were presented on the aspect of nutritional knowledge. Adolescents indicated that parents were the major source of information on healthy diets.[3] In addition, older adolescents were more knowledgeable than younger adolescents.[34] However, a knowledge gap was identified around obesity-related complications, predisposing factors, diet, and food preferences.[34] Furthermore, girls generally had higher k=nutrition knowledge scores (KNS) compared to boys.[3,30] This difference has been attributed to their dominant roles in food purchasing and preparation or lower interest in nutrition by boys.[2,62]

Interestingly, one study indicated that knowledgeable participants were prone to obesity than those who did not receive any form of nutritional education.[46] This implies that nutritional knowledge is not always translated to practice or dietary behaviour changes.[59] This makes sense considering that adolescents in most households are not responsible for making decisions on food purchases and preparation.[2] Studies have shown that involving adolescents in food preparation increases diet quality and better-eating patterns [60] and is a good way to pass down food traditions.[61] Public health programs should encourage the involvement of adolescents in food purchase, preparation, and the use of digital platforms like YouTube and Cookpad to learn new food preparation techniques and increase dietary diversity. Interestingly, the review highlighted that although adolescents had a negative perception towards obesity,[34] in most African settings, weight gain is acceptable as a sign of beauty, wealth, good health, and power.[62] This means that there is a need for intervention programs that target social norms and beliefs at the society level and body image perceptions and overall health on the individual level.

2.4.2 Environmental factors

Results showed that adolescents residing in urban settings had higher chances of becoming obese than their rural counterparts.[45] These results corroborate with other African studies which showed an association between urban settings and high BMI.[67,68] However, contrary to this finding, Ghana reported higher rates of obesity in rural settings compared to urban settings.[65]

The high rates of obesity in urban settings can be attributed to low physical activity and the use of non-active forms of transport in urban areas.[3,50] In addition, obesogenic environments (media influences, food adverts, modernization of traditional markets) which foster easy access to high-calorie food choices are equally responsible for weight gains

among urban dwellers.[50,70] . The finding that rural areas tend to have lower cases of obese adolescents is partially explained by the availability of healthier food options from "nutritional gardens" and the forests.[51,2] Whereas, in urban areas, the consumption of fruits and vegetables has declined due to the adoption of the Western diet.[39,32]

In some settings regardless of availability and affordability, healthier food options are shunned due to consumer perceptions of them being "poor people's foods", tasteless or bitter, and tedious in preparation.[2,71,72,73] To increase the consumption of healthy foods in various settings, food policies should aim to increase the affordability, accessibility, and marketing of healthy foods.[70] Furthermore, intervention programs should aim to support food heritage and the transmission of food culture from parents or knowledgeable members of the society to the adolescents.[60]

2.4.3 Social factors

Socioeconomic status (SES) and economic insecurity were hypothesized to be some of the key contributory factors to the increasing obesity prevalence and associated non-communicable diseases like diabetes mellitus and hypertension.[71] In the reviewed studies, family wealth and parental education were positively associated with obesity.[45,49] Furthermore, our review showed that low parental education and self-employment or unemployment were found to be protective against obesity.[40] This contradicts the results of recent studies which reported that adolescents from families with low socioeconomic status (SES) were exposed to poorer diets.[72] This makes sense, considering that healthy foods tend to be expensive and out of reach of lower-income households.[2,77]

Regarding obesity and religion, one study reported an association between obesity and religion where church members were more likely to be overweight.[10] This is an odd result and difficult to explain. Although there are instances where food is part of religious

gatherings, like the Seventh Day Adventist Church's vegetarian traditions.[74] Therefore, future studies are recommended to investigate the relationship between religion and obesity, particularly in adolescents.

2.4.4 Policy and economic factors

Overall, we observed that there is a gap in the study of the role of economic factors as determinants of obesity in Zimbabwe. This will have to be prioritized in future studies, including investigating the effect of economic factors and the affordability of healthy and nutrient-dense foods. However, some studies briefly mentioned that Zimbabwe has faced political and economic problems that disrupted its standing as a prosperous and resilient country.[10] This is supported by a recent situational analysis which revealed that the deepening economic crisis has causes a soaring inflation and economic instability which has threatened the country's food security by making obesogenic foods affordable.[6,79] In 2020, COVID-19 induced lockdown caused food price increases and shortages which resulted in the reduction of healthy food options in many families.[73] When the price of staples goes up, research shows that the diet proportions, quality, and budget dedicated to micronutrient-rich foods go down.[78,80] Although affluence and wealth, the effects of urbanization are mainly implicated as the reason behind the gradual rise of obesity in Zimbabwe (as suggested by this review) food insecurity may be another factor to consider at the other end of the socio-economic spectrum.[77]

It is now recognized that political will as reflected in supportive policies is responsible for creating an enabling environment to support the adoption of healthy food choices needed for policy implementation. [9] For example, Ghana restricted the supply of fatty meat in the food chain[78] and in 2016, South Africa launched the soft drinks taxation system to reduce the harm caused by consuming these beverages.[79] Australia and New Zealand banned and

restricted the marketing and selling of unhealthy foods to children[80] and in addition, the Japanese government introduced the school lunch program which reduced the percentage of overweight and obesity among Junior high school students.[81] These innovative policy actions can be adapted to deal with the emerging obesity problem among children and adolescents. The government of Zimbabwe showed interest in nutrition matters by introducing the Food and Nutrition Security Policy.[22] However, this policy primarily focuses on malnutrition and poverty eradication, however with proper emendations, it can be a powerful tool to tackle the rising issues of obesity.

2.4.5 Strength and limitations

The use of an ecological model to explore multiple risk factors for adolescents' obesity revealed the prevalence, affected gender, and distribution of adolescents' obesity in Zimbabwe. This model also revealed literature and research gaps on economic and national level factors of adolescents' obesity. Limitations included the unavailability of segregated data from some studies and national surveys which made it difficult to accurately compare the results. Nutrition education, intervention programs, and policies that are essential for the prevention and reduction of adolescents are not mentioned in the reviewed studies. Overall, the studies on adolescents' obesity in Zimbabwe are limited.

2.4.6 Conclusions

The review showed that girls are at higher risk of obesity compared to boys despite having higher nutrition knowledge scores. In both boys and girls, the rate of obesity increased with age. In addition, adolescents residing in urban settings had a higher risk of obesity than their rural-based counterparts. In this context, church-going adolescents were more likely to be overweight. While at the environmental level we found that school environments are obesogenic and congested with unhealthy foods. Interestingly, this scoping review also

revealed gaps in the literature that address the economic and national level factors and nutrition interventions and policies. Furthermore, this paper provides a useful summary of evidence to inform policy and programming decisions to reduce or reverse the effects of adolescent obesity in Zimbabwe and related settings.

2.4.7 Recommendations

1. We recommend cardiometabolic health screening for adolescents as a risk assessment measure considering the prevalence of obesity within this age group.
2. Considering that most of the evidence reviewed were subnational studies, there is a need for adolescent nutrition indicator surveys which should address gender discrepancies in BMI.
3. Lastly, we recommend future studies that explore the policy and economic determinants of obesity particularly the impact of macroeconomics on diet behaviours among adolescents in low-income settings.

Chapter 3

The prevalence and factors associated with cardiometabolic risk among urban in-school adolescents in Harare, Zimbabwe

3.1 Introduction

Adolescents are aged between 10-19 years.[23] Although this stage is seen as a healthy stage of life, risks of preventable diseases, illnesses, and conditions like obesity exist.[35] Overweight and obesity are caused by excess fat accumulation in the body which presents health risks and is commonly measured using the body mass index (BMI).[62,63] Obesity is a global public health problem that is often associated with several non-communicable diseases (NCDs) and increased cardiometabolic risk (CMR) attributable to nutrition transition and poor dietary habits.[64,65]

Low-income countries are facing an emerging problem of obesity which often co-exist with hunger, micronutrient deficiencies, and undernutrition, *"multiple burdens of malnutrition."*[86] In Africa, the prevalence of obesity among children and adolescents ranges from 5% -16.5%.[66] WHO predicts that by December 2023, 1 in 10 children or adolescents in Africa will be obese.[67] In Zimbabwe, the rate of obesity has exponentially increased over the years with prevalence ranges from 5.8%-27.3%.[10,68,3,24] Therefore, if interventions are not structured, the rate of obesity and associated NCD will increase among children and adolescents.

For instance, childhood and adolescent obesity increase the risk of diabetes mellitus, hypertension, hyperglycaemia, low high-density lipoprotein (HDL) cholesterol, and low cardio-respiratory.[86] CMR is a pattern of metabolic imbalances manifested as central obesity, hypertension, hypercholesterolemia, and hyperglycaemia.[90] The presence of any one or two of these constitutes early markers of the risk.[91] CMR and its early markers occur in adolescents; however, its magnitude has not been determined in Zimbabwe.

It is critical to estimate the magnitude and the factors associated with CMR across the life course considering that Zimbabwe is experiencing nutrition transition and rapid

urbanization.[16] Nutrition transition is a dietary shift from the consumption of wholesome and healthy foods to ultra-processed energy-dense foods. Due to modernization, eating away from home has become popular.[92] In Zimbabwe, ready-to-eat sweetened, or fried and salty foods are commonly available especially in tuck-shops near schools or on the roadside where students easily purchase these foods on the way to and from school.[8]

A recent review article concluded that adolescence is a critical stage where obesity starts to increase especially in girls in Zimbabwe.[20] Interestingly, sedentary lifestyles and the consumption of unhealthy foods are the key drivers of obesity among adolescents in urban areas.[3] Although limited studies and data exist on the factors associated with obesity and/or CMR in Zimbabwe, socio-cultural practices and the community perception that an increase in body fat "obesity" is a sign of wealth, social status, and beauty still exist.[93] As a result, there is a lack of urgency regarding CMR screening among adolescents, *"the neglected age group",* as there is still a belief that NCDs only affects adults and the elderly.[6] Essentially, there is a need for supportive policies to address the emerging obesity problem among adolescent at-risk groups in Zimbabwe to improve quality of life and prevent premature deaths.[11,15]

Therefore, the purpose of this study was to assess the prevalence of obesity, CMR, and associated determinants among in-school adolescents in Harare, Zimbabwe, and propose interventions to tackle obesity and promote healthy eating targeting the adolescents.

3.2 Methods

3.2.1 Study setting and participants

The study was carried out in Harare, the capital of Zimbabwe, lying in the northeastern part of the country. The city was founded in 1890 and has an area of 940 km^2 (371 mi^2) and a population of 15 178 979 in the 2022 census.[94] The participants were adolescents aged 14 to 19 years with signed informed consent forms and attending secondary schools in Harare.

Harare has 299 high schools with a total of 355 633 adolescents.[5] This survey yielded the protocols and results explained in chapter 3 and 4.

3.2.2 Sample size and sampling technique

The sample size was calculated using the Dobson formula[95] where Z-value = 1.96, p is the percentage of picking a choice expressed as decimal = 0.05, and c is the confidence interval = 0.95. A sample size of 437 adolescents was found to be sufficient, and with a 25% attrition adjustment, the final sample size was 380. After data cleaning and consent and consolidating the data for participants with both questionnaire data and a complete set of blood measures, 320 school adolescents successfully participated in the study. The stratified random sampling technique was used to select ten high schools from the registry of The Ministry of Primary and Secondary Education. The schools were further divided into strata based on their geographical locations and socio-economic zones (high, intermediate, and low), class level (form 2 to form 6) based on the Zimbabwean education system and age groups (14-16 years and 17-19 years). Sampling weights were then applied to adjust for gender and non-response. During recruitment, recruited participants were asked to remain in the classrooms, and the researcher provided information to all prospective participants regarding the study and its objectives, what participation would entail, including the measurement of weight and height for BMI estimation, waist and hip circumference measurements, the length and duration of the self-administered questionnaire. Prospective participants were informed that no incentive for participation would be offered, and there were no penalties for discontinuing participation. Each student could drop out of the study at any time during the administration of the questionnaire. The participants were asked to take their consent forms home for the parents/guardians to sign and after recruitment, the investigator coordinated with stuff members for them to collect the signed consent forms and the participants were given the date and time for the administration of the questionnaire within their classrooms.

Recruited participants were asked to remain in the classrooms, and they received an in-depth orientation about the study's objectives, finger prick sampling procedure, weight, and height measurements for BMI calculations, waist and hip circumference measurements, and how long it would take to fill in the self-administered questionnaire. The participants were informed that no incentive would be offered for participation, there would be no penalties for dropping out of the survey and participation in the study was for participants with sign consent forms. This survey was carried out in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008.

3.2.3 Research instruments and data collection methods

3.2.3.1. Data collection and tools

3.2.3.2 Structured questionnaire

An interviewer-administered questionnaire was used to collect data on the adolescents' socio-demographics, food habits, nutrition knowledge, and physical activity levels (PAL). The questionnaires were adapted to collect data on obesity perception (OP) scores (perceived susceptibility, severity, and benefits of obesity prevention) [96], self-efficacy and barriers to change [97], nutrition knowledge scores (NKS) [98], food habits scores (FHS) [99], and physical activity scores (PAS).[100] The final questionnaire had seven sections. Socio-demographic and anthropometry (10 questions), obesity perceptions (15 questions), self-efficacy (8 questions), barriers to change (9 questions), nutrition knowledge (20 questions), food habits (23 questions), and physical activity (7 questions).

3.2.3.3. Nutrition knowledge, food habits, and physical activity levels

Nutrition knowledge

This questionnaire was adapted from [98]. NKS was categorized as inadequate (NKS <50%) and adequate (NKS ≥50%). The instrument was a practical and easy-to-administer tool with acceptable reliability in high school students. This section had three subscales: adequate and balanced nutrition, essential nutrients, and malnutrition-related diseases. Items consists of complete sentences of correct or incorrect statements. Cronbach's alpha coefficient was 0.85 overall. Examples of nutrition knowledge questions are: *Regularly eating breakfast improves school performance and Obesity may be due to excessive fat consumption* with (true, false, and not sure) answer options.

Food habits

This questionnaire was adapted from [30]. FHS was calculated as:

$$FHs = No.of\ healthy\ responses\ x\ (\frac{23}{No.} of\ items\ completed)$$

Where inadequate was (FHS <50%) and adequate was (FHS ≥50%). This AFHC had an internal reliability of Cronbach's α=0.82. Examples of food habits questions were: *I try to ensure I eat plenty of fruit and vegetables and I often eat sweet snacks between meals?*

Physical activity

This questionnaire was adapted from.[31] Physical activity score (PAS) responses were structured in different ways according to each question, each score ranging from 1 to 4, with the maximum score assigned to the healthiest habit. The total score of the PA section was 28, this was categorized as inadequate (PAS<50%) and adequate (PAS≥50%). It had an internal reliability Cronbach's alpha 0.71. Examples of food habits questions were: *Do you usually practice any form of physical activity? and What do you prefer doing during your free time?*

3.2.3.4. Anthropometry

Height was measured to the nearest 0.1 m using the stadiometer (Leicester® Height Measure, Seca, UK). Weight was measured using an electronic bathroom weighing scale (Sunbeam, South Africa), and waist and hip circumferences using the Seca 201 measuring tape (Seca, UK). The nutritional status of the children and adolescents (5–19 years) was determined using WHO standard protocols.[101] The WHO AnthroPlus software to BMI-for-age Z-scores (BMIAZ) and Height-for-age Z-scores (HAZ). Waist circumference (WC) ≥90^{th} percentile for children and adolescents is defined as central obesity.[102] Waist hip ratio (WHR) was classified as abnormal in males if the ratio was ≥0.9 and ≥0.85 in females. Waist-to-height (WtHR) was classified as an indicator of a high risk of central obesity if the ratio was ≥0.5.[103]

3.2.3.5 Blood measures

Single-use disposable nonsterile gloves were used, and a single-use disposable lancet device was used for each participant and all tests were carried out as per the manufacturer's instructions. The adolescents cooperated and fasted overnight. Blood pressure (BP) was measured using an automated sphygmomanometer (Braun, UK). Three measurements were taken 10 minutes apart, and the average was taken as the blood pressure. Blood pressure was classified such that normal BP: was < 120/< 80 mmHg. Elevated BP: 120/< 80 to 129/ < 80 mmHg[23] Elevated BP, Stage 1 (130/80 to 139/89 mmHg) and stage 2 (≥ 140/90 mmHg).[104] Glucometers were used for the blood glucose (Accu-Answer®, LBM-01, South Africa) and rapid total cholesterol meter (Accu-Answer®, LBM-01, South Africa). Fasting blood sugar levels (mmol/L) were classified as normal (3.9 and 5.6 mmol/L), impaired glucose tolerance (5.6 to 6.9 mmol/L), and elevated (≥11 mmol/L).[105] While cholesterol was classified such that normal cholesterol is ≤170 mg/dL, moderate as >170 mg/dL and <200 mg/dL, and abnormal as ≥200 mg/dL.[106]

3.3 Results

Cardiometabolic indices (CMI) included fasting glucose (FG) and total cholesterol (TC), blood pressure (BP) and waist-to-hip ratio (WHR), and waist-to-height ratio (WtHR). Cardiometabolic health risk was categorized as low risk and high risk. Low risk was defined as the presents of any two high cardiometabolic indices and high risk was defined as the presence of three or more indices.

Table 3: Prevalence of cardiometabolic health risk across participants' demographics

Variable		Cardiometabolic health risk			P value
		Total n(%)	Low Risk n(%)	High Risk n(%)	
Gender	Male	122 (38.6)	93_a (38.6)	29_a (38.7)	0.990
	Female	194 (61.4)	148_a (61.4)	46_a (61.3)	
Age Group	14-16 years	181 (56.6)	133_a (54.5)	48_a (63.2)	0.184
	17-19 years	139 (43.4)	111_a (45.5)	28_a (36.8)	
Education level of HH	No formal education	6 (1.9)	6_a (2.5)	0_a (0.0)	0.544
	Primary education	5 (1.6)	4_a (1.6)	1_a (1.3)	
	Ordinary education	126 (39.4)	97_a (39.8)	29_a (38.2)	
	Tertiary education	183 (57.2)	137_a (56.1)	46_a (60.5)	
Employment status of HH	Formally employed	173 (54.1)	133_a (54.5)	40_a (52.6)	0.957
	Unemployed	21 (6.6)	16_a (6.6)	5_a (6.6)	
	Entrepreneur	126 (39.4)	95_a (38.9)	31_a (40.8)	
Family Structure	Both parents	211 (65.9)	166_a (68.0)	45_a (59.2)	0.159
	Single parent	58 (18.1)	38_a (15.6)	20_b (26.3)	
	Relatives/guardians	44 (13.8)	33_a (13.5)	11_a (14.5)	
	Child headed	5 (1.6)	5_a (2.0)	0_a (0.0)	
	Other	2 (0.6)	2_a (0.8)	0_a (0.0)	
Household Size	Average	273 (85.3)	207_a (84.8)	66_a (86.8)	0.666
	Above Average	47 (14.7)	37_a (15.2)	10_a (13.2)	
Place of Residence	HES	40 (12.5)	26_a (10.7)	14_a (18.4)	0.011*
	Intermediate	78 (24.4)	53_a (21.7)	25_b (32.9)	
	LES	202 (63.1)	165_a (67.6)	37_b (48.7)	

Notes: Notes: Cardiometabolic risk: Low risk <2 indices, high risk >3 indices *P-value is Pearson's Chi-squared test, in cases where cell values less than 5, Fisher's Exact test was used. Where HH= Household head. HES – high economic status, LES- low economic status. Different subscript letter and (*) indicates that the CMR categories differ significantly ($p<0.05$).

3.3.1 Socio-demographic characteristics

The summary of sociodemographic characteristics of the participants is summarized in **Table 3**. The median and IQR range for the participants was 16 (14;19) years. Most of the participants were female (61.4%, p=0.990) and in the 14-16 years age group (56.6%, p=0.184). Concerning the household heads, most attained tertiary education (57.2%) and were formally employed (54.1%). Most of the adolescents were staying with both parents (65.9%, p=0.157), within an average household size of at least 5 family members (85.3%, p=0.666), and lived in low socio-economic neighbourhoods (63.1%, p=0.011). A greater proportion of the adolescents from the LES neighbourhood were in the low-risk category (67.6%). However, overall, adolescents who were in the high-risk category were living in LES neighbourhoods (48.7%).

3.3.2 Cardiometabolic health risk by nutrition knowledge, foods habits, and physical activity levels

Table 4 shows the relationship between CMR and nutrition knowledge score (NKS), food habits, and PA. CMR was significantly associated with NKS. Most adolescents with inadequate knowledge were in the high-risk CMR category (30.3%, p=0.014). Adolescents with inadequate food habits (56%, p=0.029), particularly skipping meals (90.8%, p=0.021), were in the high-risk category and were significantly associated with CMR. Lastly, adolescents with inadequate PA were in the high-risk category and had a significant association with CMR (55.3%, p=0.034).

Table 4: The interplay between cardiometabolic health risk by nutrition knowledge, food habits, and physical activity levels

Variable		Total n(%)	Cardiometabolic health risk		P value
			Low Risk n(%)	High Risk n(%)	
Nutrition Knowledge Score	Inadequate	65 (20.3)	42_a (17.2)	23_b (30.3)	0.014*
	Adequate	255 (79.7)	202_a (82.8)	53_b (69.7)	
Malnutrition related diseases knowledge	Inadequate	175 (54.7)	131_a (53.7)	44_a (57.9)	0.520
	Adequate	145 (45.3)	113_a (46.3)	32_a (42.1)	
Essential nutrients knowledge	Inadequate	264 (82.5)	195_a (79.9)	69_b (90.8)	0.029*
	Adequate	56 (17.5)	49_a (20.1)	7_b (9.2)	
Balanced nutrition knowledge	Inadequate	233 (72.8)	170_a (69.7)	63_b (82.9)	0.024*
	Adequate	87 (27.2)	74_a (30.3)	13_b (17.1)	
Food Habits Score	Inadequate	202 (63.1)	146_a (59.8)	56_b (73.7)	0.029*
	Adequate	118 (36.9)	98_a (40.2)	20_b (26.3)	
Health Choices	Inadequate	192 (60.0)	140_a (57.4)	52_a (68.4)	0.086
	Adequate	128 (40.0)	104_a (42.6)	24_a (31.6)	
Sugars	High	151 (47.2)	113_a (46.3)	38_a (50.0)	0.574
	Low	169 (52.8)	131_a (53.7)	38_a (50.0)	
Fats	High	243 (75.9)	187_a (76.6)	56_a (73.7)	0.599
	Low	77 (24.1)	57_a (23.4)	20_a (26.3)	
Fruits and Vegetables	Low	206 (64.4)	163_a (66.8)	43_a (56.6)	0.104
	High	114 (35.6)	81_a (33.2)	33_a (43.4)	
Skipping Meals	Inadequate	262 (81.9)	193_a (79.1)	69_b (90.8)	0.021*
	Adequate	58 (18.1)	51_a (20.9)	7_b (9.2)	
Physical Activity Level	Inadequate	143 (44.7)	101_a (41.4)	42_b (55.3)	0.034*
	Adequate	177 (55.3)	143_a (58.6)	34_b (44.7)	

Notes: Cardiometabolic risk: Low risk <2 indices, high risk >3 indices. *P-value is Pearson's Chi-squared test at p=0.05. NKS (nutrition knowledge score): <50% is inadequate and ≥50% is adequate. Food habits score<5 is inadequate and ≥5 is adequate. PAL (physical activity level) adequate ≥ 60 minutes and inadequate <60 minutes. Different subscript letter and (*) indicates that the CMR categories differ significantly (p<0.05).

3.3.3 Nutrition status of the adolescents

The results of the current study (**Figure 4)** revealed that obesity affected 17.1% of adolescents with high proportions among girls compared to boys (p=0.03), while the underweight status (23.0%) was higher among boys than girls (p=0.03).

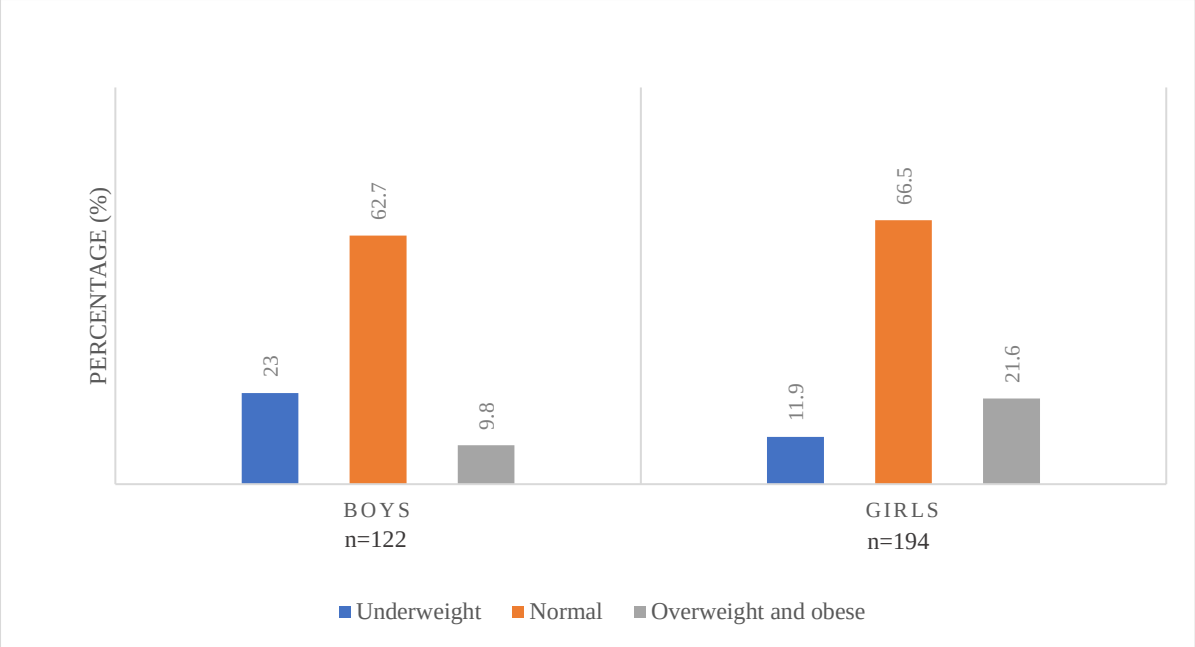


Figure 4 The distribution of nutrition status of adolescents by sex

3.3.4 Summary of the cardiometabolic indices for the adolescents

Cardiometabolic indices (CMI) were clustered with a high proportion among the 14-16-year-old age group and more pronounced in girls, i.e., overweight and obesity (21.6%, p=0.030) than WHtR (13.8%, p=0.012), TC (29.4%, p=0.023) and FG (98.9%, p=0.210). Notably, BP (58.7%, p=0.038) and WHR (18.0, p=0.0023) were more pronounced among boys **(Table 5).**

Table 5: Clustering of cardiometabolic indices among adolescents by sex and age group

Variable		Total n(%)	Gender		P value	Variable		Total n(%)	Age Group		P value
			Male n(%)	Female n(%)					14-16 years n(%)	17-19 years n(%)	
BMI	Underweight	51 (16.1)	28_a (23.0)	23_b (11.9)	0.030*	**BMI**	Underweight	52 (16.3)	37_a (20.4)	15_b (10.8)	0.064
	Normal	211 (66.8)	82_a (67.2)	129_a (66.5)			Normal	212 (66.3)	115_a (63.5)	97_a (69.8)	
	Overweight and obese	54 (17.1)	12_a (9.8)	42_b (21.6)			Overweight and obese	56 (17.5)	29_a (16.0)	27_a (19.4)	
WHtR	Low Risk	278 (89.7)	116_a (95.1)	162_b (86.2)	0.012*	**WHtR**	Low Risk	282 (89.8)	156_a (88.1)	126_a (92.0)	0.265
	High Risk	32 (10.3)	6_a (4.9)	26_b (13.8)			High Risk	32 (10.2)	21_a (11.9)	11_a (8.0)	
BP	Low risk	152 (48.7)	50_a (41.3)	102_b (53.4)	0.038*	**Blood Pressure**	Acceptable and Borderline	155 (49.1)	91_a (51.1)	64_a (46.4)	0.402
	High risk	160 (51.3)	71_a (58.7)	89_b (46.6)			High	161 (50.9)	87_a (48.9)	74_a (53.6)	
WHR	Low risk	276 (87.3)	100_a (82.0)	176_b (90.7)	0.023*	**WHR Category**	Normal	280 (87.5)	154_a (85.1)	126_a (90.6)	0.136
	High risk	40 (12.7)	22_a (18.0)	18_b (9.3)			High	40 (12.5)	27_a (14.9)	13_a (9.4)	
TC	Low risk	237 (75.0)	100_a (82.0)	137_b (70.6)	0.023*	**Cholesterol Level**	Acceptable	240 (75.0)	130_a (71.8)	110_a (79.1)	0.134
	High risk	79 (25.0)	22_a (18.0)	57_b (29.4)			Borderline and high	80 (25.0)	51_a (28.2)	29_a (20.9)	
FG	Low risk	6 (1.9)	4_a (3.4)	2_a (1.1)	0.210*	**Glucose Level**	Acceptable	6 (1.9)	3_a (1.7)	3_a (2.2)	0.999
	High risk	302 (98.1)	115_a (96.6)	187_a (98.9)			Borderline and high	306 (98.1)	170_a (98.3)	136_a (97.8)	

Notes: FG- fasting glucose, TC- total cholesterol, BP- Blood pressure, WHR- waist-hip ratio, WtHR- Waist to height ratio. Values are above cut-off points (at-risk category). WC for females, normal is <80 and risky when ≥80; for males, normal is <94 and risky when ≥94 · FG: normal is 5.6-6.9mmol/L and at risk is ≥7.2. BP: normal is ≤139/89mmHg, and at risk ≥140/90mmHg. TC: normal >170>120mg/dl and risky when >200mg/dl. WtHR: normal ratio 0.5, at risk >0.5. Different subscript letter and (*) indicates that the CMR categories differ significantly ($p<0.05$).

3.3.5 Factors associated with cardiometabolic risk among adolescents.

CMR was significantly associated with home location; HES [OR=3.09(1.29, 7.38), p= 0.011], intermediate [OR=2.16(1.08-4.30), p=0.029], inadequate nutrition knowledge score [OR=1.38(1.96-7.77), p<0.001]. Inadequate PA was also significantly associated with CMR [OR=2.28(1.25-4.15), p=0.007]; and BMI [OR=1.18(1.10-1.27), p<0.001], (**Table 6).**

Table 6: Factors associated with cardiometabolic health risk.

Variable	B	S.E.	P value	Odds Ratio (OR)	95% CI (OR)	
					Lower	Upper
Age (years)	-0.07	0.12	0.549	0.93	0.74	1.18
Formally employed	-0.49	0.31	0.121	0.62	0.33	1.14
Unemployed	0.35	0.60	0.560	1.42	0.44	4.56
Location (HES)	1.13	0.44	0.011*	3.09	1.29	7.38
Location (Intermediate)	0.77	0.35	0.029*	2.16	1.08	4.30
HH Size (<5 people)	0.32	0.42	0.451	1.38	0.60	3.15
NKS (Inadequate)	1.36	0.35	<0.001*	3.90	1.96	7.77
Food habits (Inadequate)	0.66	0.32	0.043	1.93	1.02	3.64
Physical activity (Inadequate)	0.82	0.31	0.007*	2.28	1.25	4.15
BMI (kg/(m^2))	0.17	0.04	<0.001*	1.18	1.10	1.27
Constant	-5.26	2.17	0.015	0.01		

Notes: Goodness of fit: Nagelkerke R^2 = 0.249, Hosmer and Lameshow test p=0.842 Where; HH- Household, NKS - Nutrition Knowledge Score, BMI – Body Mass Index, HES- high socioeconomic status.

3.4 Discussion

This study was designed to assess the prevalence and factors associated with CMR among in-school adolescents in Harare, Zimbabwe. Our findings show that the prevalence of obesity was (17.1%) and high CMR (24.7%) among this age group. The results showed that overweight and obesity (17.1%) with higher proportions among girls and underweight (15.9%) with higher proportions among boys. These results are in line with findings from recent Zimbabwean studies[1,3,93] and studies from other

African countries.[108,109] However, considering that 23.0% of the adolescents were underweight, our results confirm that the “double burden” of malnutrition exists in Zimbabwe. The emerging problem of obesity and associated increased CMR is postulated to be mainly driven by nutrition transition and an increasingly obesogenic environment.[23,110,112] Our findings show that a higher percentages of adolescents are consuming high fats and sugar foods and low fruits and vegetables. This is problematic particularly in school environments where adolescents can easily access more ultra processed snacks and limited fruits and vegetables. A national survey showed only 13% of adult population in Zimbabwe consumed at least 400 g per day of fruits and vegetables required by WHO.[1] Despite of the enormous benefits and existing dietary recommendations, most Zimbabwean adults not meet the daily requirements and adolescents can easily adopt the behaviour in a family setting. [21]

A recent study on adolescents obesity in Zimbabwe revealed that adolescents lack obesity awareness and it is not as serious as other health problems and conditions.[18] This shows the need to set up interventions to tackle obesity, promote PA and encourage healthy eating among adolescents utilizing community-themed social behavior change activities informed by the social-ecological model.[113,114] It has been observed that the rate of obesity is higher among girls than boys. [25,45,93] Interestingly, our study results shows that CMR risk appears to be higher in girls compared to boys as well. Furthermore, our results highlighted that boys were more underweight than girls. Similar gender biases on obesity in this age group have been reported in other African countries.[97,115] However, it is reported that boys are more obese than girls in developed countries like North America and Japan.[116,117]

Although the cause is not well understood, it can be speculated that the differences in obesity prevalence and associated CMR may be driven by societal gender perspectives on body weight, dietary habits as well as sex-related determinants, such as body composition and hormones.[116,117] This argument may be true considering that in the African context a mother is perceived to be big and curvy *"bigger is better myth"* is a reflection that the husband is taking good care of his wife.[117] In Japan, girls in higher-grade classes and young women generally want to be thin[118] due to media influences of this body ideals[119] however, in Zimbabwe girls want to be plump and curvy as they believe it makes them more attractive.[10,121] Additionally, it is a common beliefs that a plump child is healthy and a slim child is unhealthy therefore these beliefs results in parents overfeeding their children, while adolescents voluntarily overeat.[10,25] Therefore, future studies are required to explore these important societal risk factors, to perspectives from adolescents and adults on; *"What is a 'good' desirable, beautiful, impressive body?"*. Consequently, health promotion interventions for this age group should consider the array of factors that maintain these preferences.

There is a general understanding that BMI alone is not a good indicator of CMR but it will have to be coupled with other CMI.[121] To the best of our knowledge, this study is the first to assess all six CMI namely BMI, TC, FG, BP, WHR, and WtHR among adolescents in Zimbabwe. The results show some high proportions of adolescents affected with CMI thus indicating the need for early screening[122] especially in related low-income settings where regular screening is not a public health priority. A regular screening approach ensures that targeted interventions are aimed at obesity prevention and CMI control. Binary logistic regression analysis revealed that the significant factors

associated with CMR among adolescents were living in HES (affluent) neighborhoods, inadequate nutrition knowledge, low PA, and higher BMI (obesity). Our results also show that overall, CMI was higher among girls compared to boys. This gender face of CMI and CMR surely needs more research and strong advocacy for government policies which support adolescents CMR screening.

3.4.1 Place of residence and CMR

It is known that socio-economic environments have a huge influence on obesity and cardiometabolic health.[123] Our results showed that adolescents from who live in affluent suburbs and families have a higher risk CMR risk. However, in developed countries like the USA and Japan adolescents from affluent families are slimmer while the risk of obesity and CMR is high among adolescents from low income families.[125, 126] In many African countries including Zimbabwe people believe that when they earn more, they should eat more because wealth and happiness is physically shown by being fat.[93] In addition to socio-cultural beliefs, this contrast between Zimbabwe and other developed countries could be a result of nutrition transition. Zimbabwe is between stage 3 and 4 of nutrition transition[10] and is far behind most developed countries regarding health behavioural change.

Stages 3 and 4 are characterised by social and economic changes which causes receding famine and a decline in nutritional deficiencies together with a dietary shift from natural and wholesome foods to ultra processed foods resulting in the rise in obesity rate and CMR risk.[127,22] Therefore, we recommend that social behaviour change (SBCC) themed interventions for health promotion, obesity and CMR prevention in affluent

communities for adolescents and families and communities to raise obesity and CMR awareness while promoting healthy shopping and eating habits.[128,129]

3.4.2 Inadequate nutrition knowledge and CMR

Nutrition knowledge is a key element for health behavior change by providing an individual with a cognitive understanding of healthy eating habits.[129] The result contradicts a recent finding from Harare, Zimbabwe that reported that the majority of the adolescents had adequate nutrition knowledge but were obese.[89] Although it was previously reported to be adequate, it is possible that it is not always translated to practice.[20] To the best of our knowledge, our paper is the first to report that essential nutrients ($p=0.029$) and balanced diet ($p=0.024$) knowledge was lacking among urban Zimbabwean adolescents. This should help in the choice of nutrition messages targeting this age group in a country where most nutrition interventions and health promotion programs and policies are still biased toward stunting and undernutrition.[15,43] Understanding the kind of nutrition knowledge that adolescents need, and how that knowledge can be put to practice is the genesis of sustainable and effective nutrition interventions to reduce obesity and the associated CMR.[130]

3.4.3 Low physical activity and CMR

Low PA was also a significant predictor of CMR in this current study. In addition, our results showed that most adolescents with adequate PA were in the low CMR category. This supports available evidence that increased moderate-to-vigorous PA has a protective effect on weight gain and lowers CMR.[102,132,133] We recommend future studies that profile the level of PA and sedentary behaviors among adolescents.

3.4.4 Obesity, food habits, and CMR

The finding that higher BMI was a significant determinant of high CMR is understandable. It is known that obesity or fatness is a factor of poor dietary choices, low physical inactivity or sedentarism, genetics, and sociocultural influences. Notably, our finding that negative consumption patterns particularly low fruit and vegetable consumption and skipping breakfast were associated with obesity and high CMR warrants further research to understand dietary habits among adolescents from low-income countries like Zimbabwe. In an obesity perceptions study among urban adolescents in Zimbabwe it was stated that "people are obese because they don't know what's in their food."[18] Nutrition education program particularly basic knowledge in essential nutrients could prove beneficial in promoting healthy food choices by eating nutrient dense traditional and wholesome foods and less ultra processed foods. Additionally, practical nutrition education for balanced diet using Zimbabwe's food guidelines could help adolescents create healthy, balanced meals—whether served on a plate or packed in a lunch box.

3.5 Strengths and limitations

Our study adds to the limited literature on cardiometabolic risk factors and their clustering among adolescents in the Zimbabwean context. This is the first study to assess the combined cardiometabolic health risk burden by assessing all six cardiometabolic health indices. However, there were some limitations. Although the participants were asked to be in a fasting state for blood measurements, we had no means to verify compliance. In addition, we relied on the less invasive finger prick blood sampling, and we did not collect venous blood for the measurements which

provides more definitive results. We also acknowledge the potential for recall bias in the estimation of food habits and any other recall-based questions.

3.6 Conclusions

Our results show different occurrences compared to other developed countries where the prevalence of obesity and CMR appears to be higher among girls compared to boys. The significant factors associated with CMR among adolescents in this study were staying in HES (affluent) neighborhoods, inadequate nutrition knowledge, low physical activity, and higher BMI (obesity). This gender disparity of obesity and/or underweight and CMR could be explained by socio-cultural beliefs which may hinder the translation of nutrition knowledge to practice.

3.7 Recommendations

1. Obesity awareness should be assessed within this age group to determine whether adolescents are aware of obesity and CMR as diet related health risks.
2. Community based interventions to raise obesity and CMR awareness are needed to provide basic nutrition education for essential nutrients and practical education for balanced diets while promoting healthy eating habits to increase fruits and vegetable consumption to reduce the prevalence of obesity and CMR among adolescents.

Chapter 4

Nutrition status, obesity awareness and related factors among urban adolescents in Harare, Zimbabwe.

4.1 Introduction

Zimbabwe is experiencing a nutrition transition where the consumption of obesogenic foods is high in urban areas and energy-dense foods associated with western lifestyles have been adopted.[6] The causes of obesity are multifactorial including individual, environmental, and societal factors. Socio-cultural perceptions and beliefs fuel the increase in overweight and obesity.[20] In many African countries including Zimbabwe, it is commonly believed that healthy people should not be skinny as it symbolizes poverty and ill health.[5,6,7]

The perception that being overweight is a good sign of health and prosperity is accepted in Zimbabwe and other African countries like South Africa and Morocco.[4,8] In the African context, mothers are encouraged to eat more for their well-being and that of their infant after childbirth, this belief results in excessive weight gain. Furthermore, mothers/guardians often fail to recognize unhealthy weight among children and adolescents.[10] Therefore, it is important to design obesity awareness programs for adolescents, especially girls, before they become mothers.

The adolescent period is a critical time for altering physical activity, dietary patterns, and nutrition knowledge to avoid excessive weight gain.[10,11] Thus, weight management remains an important health challenge for adolescents, especially in Zimbabwe where the stigma attached to being “thin” as the labelling of thin individuals is often associated with being HIV-infected. The same stigma has also been reported in South Africa and Botswana.[8,12] Furthermore, the adolescent age group is often left out in many nutrition programs hence weight gained in childhood may continue to adolescence and adulthood.[6] Tackling obesity may require other strategies, such as

understanding the individual's perceptions of overweight and obesity.[138] Obesity perceptions are important in the field of health promotion and behaviour change as they measure awareness levels which contribute to prevention and management strategies. [139] Assessing obesity awareness among adolescents is important because obesity increases with age, furthermore, adolescence is a stage of pre-independence where eating habits like snacking after school or when hanging out with friends, skipping meals and food choices are not always monitored by their parents.[15,16] High schools in Harare enrol students aged 13-19 years.[5]

These schools do not offer school lunch therefore it is a common practice for adolescents to buy snacks at break and lunch time, and after school. It is known that when adolescents select snacks, they select based on taste over nutrition which could lead to overweight and obesity.[62] They more often choose salty, crunchy foods as snacks and sweet beverages over healthier alternatives like fruit or water.[140] More importantly, adolescents are at a greater risk of emotional eating. It is believed that during adolescence, pubertal hormones that begin to influence appetite and body weight.[142] Therefore, obesity awareness among adolescents could be an important intrinsic motivator towards making healthy food choices and eating habits.

This study was guided by the health belief model (HBM) to understand adolescents' beliefs and perceptions about obesity. In the context of obesity, HBM has three categories that lead to health behaviour change. Modifying factors (1) age, gender, body mass index (BMI), food habits, nutrition knowledge, and physical activity. Individual beliefs (2) include perceived susceptibility to obesity, perceived severity, perceived barriers to obesity prevention, and perceived self-efficacy. Action cues (3) include

obesity intervention program design and implementation. The HBM states that people's beliefs influence their health-related actions or behaviours and readiness to take action depends on the person's ability to understand their susceptibility, the severity of the threat, their ability to bring the desired change (self-efficacy), and barriers to change (if they exist). [143] It is reported that obesity misperceptions are severe in children and adolescents.[22,23]

Therefore, understanding their perceptions may increase our understanding of how they may respond to weight reduction interventions. Thus, the study assessed adolescents' perceptions on various issues related to obesity, and the factors associated with low obesity awareness among adolescents in Harare, Zimbabwe. The knowledge of adolescents' obesity awareness and perceptions contributes to the framework for obesity prevention strategies and intervention programs for adolescents and the general population. This section was derived from.[18]

4.2 Materials and Methods

4.2.1. Study design and theoretical framework

The study design and theoretical framework followed the protocol described in Chapter 3.

4.2.2. Sample size and sampling technique

A sample size of 480 adolescents was found to be sufficient, and after a 10% attrition adjustment, the final sample size was 432. This section utilized the data from the questionnaire hence the number of participants was higher than previously reported in Chapter 3.

4.2.3. Data collection and tools

4.2.3.1. Obesity awareness

Obesity awareness, measures were evaluated and categorized based on the degree to which adolescents' obesity perceptions were assessed. Multiple choice or Likert-scale questions of obesity perceptions were used to create total scores. These scores were used to categorize the obesity awareness variable such that low (OP total scores <50%) and high (OP total scores ≥50%). Obesity awareness was defined as low and high awareness using existing theoretical models and previously validated scales of illness awareness, its core domains, and psychometric properties of other health conditions.[32, 33, 34] An example of an obesity perceptions question was: *How many years does obesity shorten an individual's life expectancy?*

4.2.3.2. Self-efficacy and barriers to change

This questionnaire was adapted from.[96] Self-efficacy (SE) section aimed at estimating how each student can assume attitudes and behaviours that can improve his health status related to nutrition. The total score was 24 and was categorized as low (SE<50%) and high (SE≥50%). The barriers to change (BtC) questions assessed the knowledge and perceptions on challenges that individuals have faced or will face in trying to modify dietary eating habits. The BtC total score was 18 and was categorized as minor (BtC<50%) and major (BtC≥50%). Examples of SE and BtC questions were: *Do you think you can lose or gain weight if needed?* and *Do you know how to improve your diet?* respectively.

4.2.3.3. Nutrition knowledge, food habits, and physical activity levels

This protocol was described in Chapter 3. The instruments were a practical and easy-to-administer tool with acceptable reliability in high school students.

4.2.3.4. Anthropometry

Anthropometrical assessments were done according to the protocol in Chapter 3. Body Mass Index (BMI) was analysed using WHO *AnthroPlus*. BMI-for-age *z*- scores were categorized into underweight (<−2 SD), normal (≥−2 to ≤+1SD), overweight (≥1 to +2SD), and obese (>+2SD) and WtHR was used to assess central obesity.

4.3. Data analysis

The data was analysed using IBM SPSS Statistics for Windows v23 (IBM Corp., Armonk, NY, USA) and the normality of the data was checked using Shapiro Wilk tests and Q-Q plots. The continuous variables were transformed to categorical variables where applicable. The relationship between the categorical variables was assessed using Pearson's chi-squared test with Bonferroni adjustments, and in cases where cell counts were below five, Fisher's exact test was used. Factors associated with obesity awareness were explored with binary logistic regression analysis using the conditional backward elimination method. The choice of the model of best fit was determined by comparing the Nagelkerke R^2 and the Hosmer and Lameshow test. Variables entered in Step 1 are: *Gender, Age, Location, Education level of the household head (HH), Employment HH, BMI, self-efficacy, barriers to change, physical activity, food habits, and nutrition knowledge.*

4.4 Results

4.4.1 Sociodemographic characteristics

The sociodemographic characteristics of the participants are summarized in **Table 1.** The median and IQR range for the participants was 16 (14;19) years. Most of the participants were girls (53.2%, p=0.001) and in the 14-16 years age group (54.1%, p=0.317). Most of the adolescents came from average-sized families (84.9%, p=0.272), lived in high-density locations (59.8%, p=0.630), with both parents (66.7%, p=0.253), whose household head had tertiary education (57.2%, p=0.001) and was formally employed (53.9%. p=0.010).

4.4.2. Obesity awareness and sociodemographic characteristics

More girls than boys had low obesity awareness (67.0%, p=0.001), and more 14-16-year-old also had low obesity awareness (51.3%, p=0.317). However, there was no significant difference between the age groups. In the BMI category, 56.8% of the overweight/obese adolescents had low obesity awareness (p<0.001). The education level of HH and employment status were significantly associated with low obesity awareness. Further analysis revealed that the significance was specifically on the HH with tertiary education (35.7%, p<0.001) and formally employed (55.7%, p=0.010) respectively **(Table 7).**

Table 7: Obesity awareness across participants` sociodemographic characteristics.

Variable		Obesity awareness			
		Total	**Low**	**High**	**P-value**
		n (%)	**n (%)**	**n (%)**	
Sex	Boys	198 (46.8)	38 (33.0)	160 (51.9)	0.001*
	Girls	225 (53.2)	77 (67.0)	148 (48.1)	
Age Group	14-16 years	229 (54.1)	58 (51.3)	171 (56.8)	0.317
	17-19 years	185 (43.7)	55 (48.7)	130 (43.2)	
BMI	Underweight	41 (9.7)	26 (63.4)	15 (36.6)	0.001*
	Normal	315 (74.5)	51 (16.2)	264 (83.8)	
	Overweight/obese	67 (15.8)	38 (56.8)	29 (43.3)	
Household Size	Average	359 (84.9)	94 (81.7)	265 (86.0)	0.272
	Above Average	64 (14.8)	21 (18.3)	43 (14.0)	
Place of Residence	Low density	72 (17.0)	21 (18.3)	51 (16.6)	0.630
	Middle density	98 (23.2)	23 (20.0)	75 (24.4)	
	High density	153 (59.8)	71 (61.7)	182 (59.1)	
Family Structure	Both parents	282 (66.7)	80 (69.6)	202 (65.6)	0.253
	Single parent	79 (18.7)	16 (13.9)	63 (20.5)	
	Relatives/guardians	52 (12.3)	14 (12.2)	38 (12.3)	
	Child headed	7 (1.7)	4 (3.5)	3 (1.0)	
	Other	3 (0.4)	1 (0.9)	2 (0.6)	
Education level of HH	No formal education	19 (4.5)	12 (10.4)	7 (2.3)	0.001*
	Primary education	15 (3.5)	9 (7.8)	6 (1.9)	
	Ordinary education	147 (34.6)	41 (35.7)	106 (34.4)	
	Tertiary education	242 (57.2)	53 (46.1)	189 (61.4)	
Employment status of HH	Formally employed	228 (53.9)	64 (55.7)	164 (53.2)	0.010*
	Unemployed	23 (5.4)	12 (10.4)	11 (3.6)	
	Entrepreneur	172 (40.7)	39 (33.9)	133 (43.2)	

Notes: Obesity awareness: OP score<50% is low and OP score ≥50% is high. *P-value is Pearson's Chi-squared test, in cases where cell values are less than 5, [a] Fisher's Exact test was used. HH-Household Head. Household size: ≤5 is average and >5 is above average. Place of residence: Density describes population size.

4.4.3 Obesity perceptions overview

Figure 1 shows adolescents' perceptions of various issues related to obesity. Compared to other diseases and health-related issues like cancer, diabetes, HIV and AIDS, and alcohol and drug abuse, only 13% of the adolescents reported that obesity was an

extremely serious health issue, whereas the majority stated that obesity is a moderately serious problem (28.4%). When asked whose responsibility it was to solve the country's obesity problem most of them stated that the health insurance companies/medical aid companies (48.2%), food industries (44.9%), and only 37.4% indicated that individuals are responsible. "*People don't know how to control their weight (58.2%) and people don't have enough information about what's in their food (61.7%)"* were selected as the major causes of obesity **(Figure 1)**. The adolescents strongly favored more physical activity in schools (62.2%) compared to fast-food shops showing calorie information on the menu (29.8%) and limiting the types or amounts of food and drink people can buy (15.6%) as hypothetical solutions to overweight/obesity. Lastly, when asked to describe their current weight, only 9% acknowledged that they were overweight/obese **(Figure 5).**

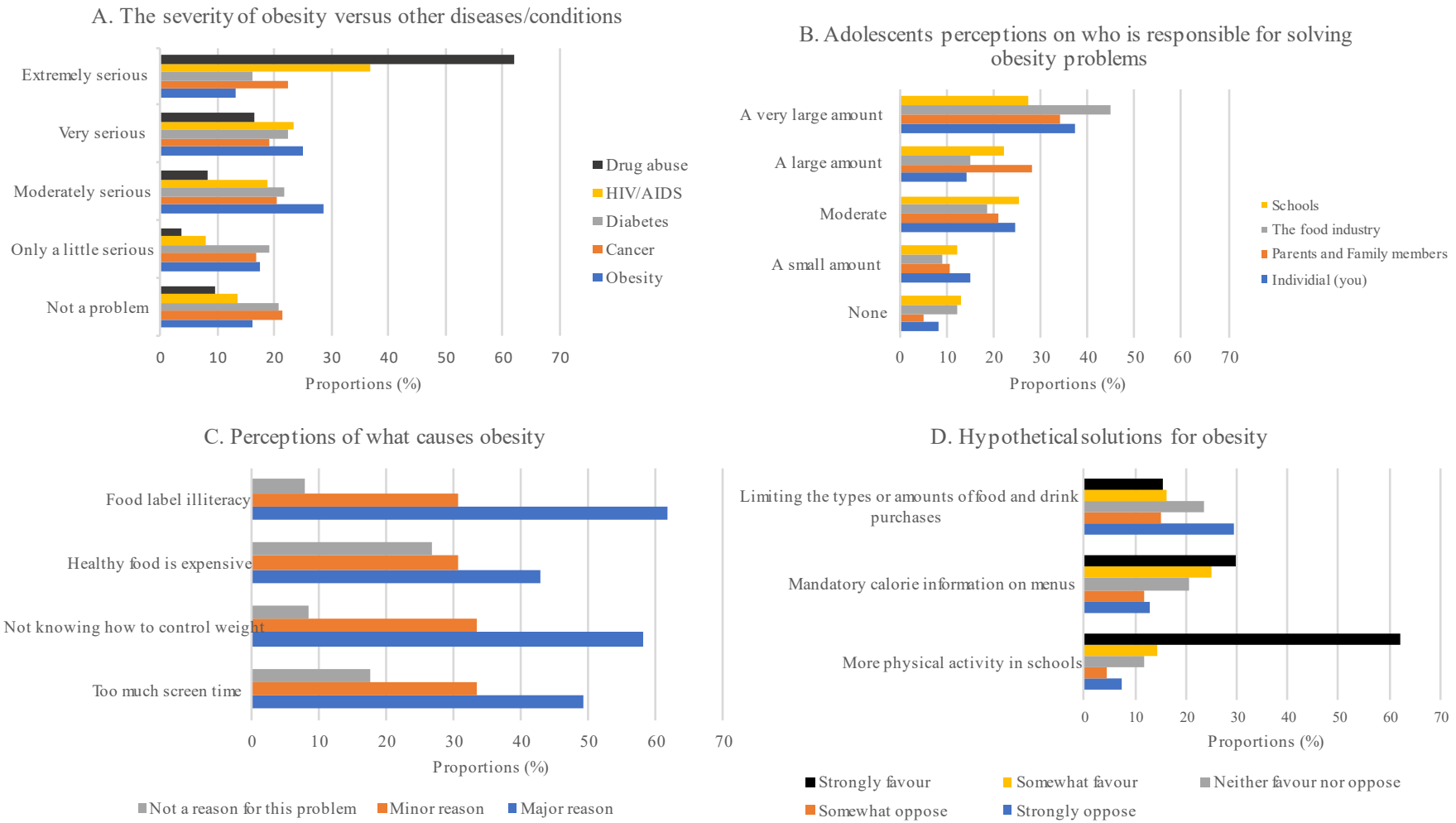


Figure 5: Adolescents perception of the seriousness of overweight and obesity problem in Zimbabwe

4.4.4 Obesity awareness and barriers to change, self-efficacy, food habits, nutrition knowledge, and physical activity

Adolescents with more BtC had low awareness compared to those with less BtC (58.3%, p=0.038, and those with low SE also had low awareness (56.5%, p=0.005). In addition, low awareness was associated with inadequate PAs (60.9%, p=0.010), inadequate FHS (61.7%, p=0.017), and inadequate NKS (53.0%, p=0.001). The results are summarized in **Table 8**.

Table 8: The interplay between obesity awareness and barriers to change, self-efficacy, food habits, nutrition knowledge, and physical activity

Variable		Obesity awareness			
		Total n (%)	Low n (%)	High n (%)	P value
BtC	Fewer	213 (50.4)	48 (41.7)	165 (53.6)	0.038*
	More	210 (49.6)	67 (58.3)	143 (46.4)	
SE	Low	192 (45.3)	65 (56.5)	127 (41.2)	0.005*
	High	231 (54.6)	50 (43.5)	181 (58.8)	
PAS	Inadequate	214 (50.6)	70 (60.9)	144 (46.8)	0.010*
	Adequate	209 (49.4)	45 (39.1)	164 (53.2)	
FHS	Inadequate	221 (52.2)	71 (61.7)	150 (48.7)	0.017*
	Adequate	202 (47.8)	44 (38.3)	158 (51.3)	
NKS	Inadequate	171 (40.4)	61 (53.0)	110 (35.7)	0.001*
	Adequate	252 (59.6)	54 (47.0)	198 (64.3)	

Notes: BtC (barriers to change score) <50%=fewer and ≥50%= more. SE (Self-efficacy score) <50%=low and ≥50% = high. PAL (physical activity level) adequate ≥ 60 minutes and inadequate <60 minutes. FHS (Food habits score) <50% is inadequate and ≥50% is adequate. NKS (nutrition knowledge score): <50% is inadequate and ≥50% is adequate. *P-value is Pearson's Chi-squared test (p<0.05).

4.4.5 Nutritional status of adolescents

An assessment of adolescents' nutrition status **(Table 9)** revealed that obesity affected 15.8% of adolescents with high proportions among girls compared to boys (p=0.002), while WHR (61.5%) was higher in boys than girls (p=0.023), and WtHR (central obesity indicator) was also higher among girls (72.0%, p= 0.005).

Variable		Gender				Obesity awareness			
		Total n (%)	Male n (%)	Female n (%)	P-value	Totals n (%)	Low n (%)	High n (%)	P-value
BMI	Underweight	41 (9.7)	20 (48.8)	21 (51.2)	0.002*	41 (9.7)	26 (63.4)	15 (36.6)	0.001*
	Normal	315 (74.5)	160 (50.8)	155 (49.2)		315 (74.5)	51 (16.2)	264 (83.8)	
	Overweight/Obese	67 (15.8)	18 (26.9)	49 (73.1)		67 (15.8)	38 (56.7)	29 (43.3)	
WHR	Normal	349 (82.5)	166 (44.7)	205 (55.3)	0.023*	371 (87.8)	99 (86.1)	272 (88.3)	0.535
	High	52 (12.3)	32 (61.5)	20 (38.5)		52 (12.2)	16 (13.9)	36 (11.7)	
WtHR	Normal	373 (88.2)	184 (49.3)	189 (50.7)	0.005*	373 (88.2)	94 (81.7)	279 (90.6)	0.012*
	High	50 (11.8)	14 (28.0)	36 (72.0)		50 (11.2)	21 (18.3)	29 (9.4)	

Table 9:Nutritional status of the adolescents by gender and obesity awareness

Notes: BMI (Body mass index) WHR- Waist hip ratio normal WHR< 0.9 and WHR 0>85, high: WHR ≥0.9 and ≥0.85 for boys and girls respectively. WtHR Waist to height ratio normal (WtHR <0.5) high (WtHR ≥ 0.5). *P-value is Pearson's Chi-squared test ($p<0.05$).

4.4.6 Factors associated with low obesity awareness among Zimbabwean adolescents

The factors associated with low obesity awareness among adolescents are presented in **Table 10**. Significant factors associated with low awareness were HH with no formal education [OR=9.41 (2.20-40.36), p=0.003] and inadequate (poor) food habits [OR=2.58 (1.33-5.01), p=0.005].

Table 10: Factors associated with low obesity awareness among Zimbabwean adolescents

Variable	B	S.E.	P-value	Odds Ratio (OR)	95% C.I. for OR	
					Lower	Upper
Boys	-0.42	0.33	0.204	0.66	0.34	1.26
Age group (14-16 years)	-0.43	0.31	0.172	0.65	0.35	1.20
Location (LDS)	0.28	0.52	0.597	1.32	0.47	3.69
HH No formal education	2.24	0.74	0.003*	9.412	2.20	40.36
Overweight and obese (BMI)	-0.26	0.55	0.614	0.76	0.26	2.21
Barriers Change (More)	0.47	0.32	0.144	1.59	0.85	2.97
Physical Activity (Inadequate)	0.39	0.33	0.227	1.48	0.78	2.80
Food Habits (Inadequate)	0.95	0.34	0.005*	2.58	1.33	5.01
NKS (Inadequate)	0.25	0.33	0.447	1.28	0.674	2.44
Constant	0.98	1.27	0.439	2.67		

Notes: Goodness of fit: Nagelkerke R^2 = 0.362, Hosmer and Lameshow test p = 0.951. OR = Odds Ratio, LDS = Low-density suburbs, HH = Household, BMI = Body Mass Index, NKS = Nutrition knowledge score.

4.5 Discussion

This study sought to assess the prevalence of overweight/obesity and factors associated with low obesity awareness among in-school adolescents in Harare, Zimbabwe. The results showed that household heads with no formal education were significantly associated with low obesity awareness among adolescents. Furthermore, inadequate (poor) food habits were also significantly associated with low obesity awareness.

Interestingly, self-efficacy (SE), and barriers to change (BtC) were not significantly associated with low obesity awareness. These results were unexpected because SE and BtC are components of the HBM which influence behavior change.[32,33] Therefore, further studies which assess adolescents SE and BtC in the context of obesity are required.

4.5.1 Prevalence of overweight/obesity and low obesity awareness

Low obesity awareness, overweight/obesity, and central obesity (high WtHR) prevalence were high and more pronounced among adolescent girls. Previous studies in Zimbabwe have also reported a high obesity rate among girls compared to boys.[34-36] Furthermore, our results are consistent with previous studies from other African countries.[37,38] Sex differences in overweight and obesity have also been reported in other countries where biology, physical activity levels, and sociocultural beliefs contribute to these differences.[39-42] However, to the best of our knowledge, our paper is the first one to link low obesity awareness and overweight/obesity prevalence both of which are more pronounced in girls in Harare. These results show the vulnerability of girls compared to boys. We suggest intervention programs specifically for girls to raise obesity awareness and inform them about the importance of maintaining a healthy weight.

4.5.2 Factors associated with low obesity awareness.

The lack of formal education of the household heads had a negative relationship with obesity awareness. This result is not surprising and agrees with previous studies which reported that education levels have a huge influence on diet-related diseases including obesity.[43,44] In an America study, an increased odds ratio in fathers' education levels

decreased the odds of their children being obese.[55] Therefore, the education levels of the parents or guardians have a bearing on the adolescents' ability to process health information. For instance, children of more educated parents were reported to be more likely to eat breakfast, more fruits and vegetables, and fewer empty calories from snacks and sweetened beverages.[46,47]

Contrary to this finding, a Zimbabwean study showed that having less educated parents with lower income was protective against overweight and obesity.[40] Proponents of this observation argue that in food-scarce environments obesity should not be a problem considering that energy-dense "fast" foods are usually unaffordable and out of reach for urban, poor households (less educated parents). Interestingly, from a socioeconomic point of view, parental education and income cannot be separated.[151] The *"wealth effect"* is a problem in many low-income countries including Zimbabwe where parents tend to buy high-calorie foods packed with sugars, salt, and fats as a means of keeping up with the socio-cultural belief that fast foods/processed foods are prestigious and traditional foods represent poverty.[4,6] Therefore, our results being contradictory, confirms the notion that the debate on education, wealth, and obesity remains controversial.

Nonetheless, health education targeting both high-income and low-income parents can have cascading benefits in raising obesity awareness and preventing obesity among children and adolescents.[151] This socioecological approach may prove effective considering that in most African settings, children do not have decision-making powers in terms of food purchase and preparation.[2] Therefore, educating parents to act as role models can motivate children to adopt healthy food habits and lifestyles.[154] We also speculate that obesity awareness and nutrition education in schools will help adolescents

to purchase and prepare healthier foods regardless of parental influence, education, and income level.

Inadequate (poor) food habits were also significantly associated with low obesity awareness among adolescents. Food habits are conscious, collective, and repetitive behaviors, which lead people to choose, eat, and use certain foods or diets, in response to economic, social, and cultural influences.[155] Poor food habits may stem from social or cultural misconceptions surrounding obesity and the failure to acknowledge its complexities.[156] In some African settings, the *"earn more eat more"* concept is characterized by overeating and overfeeding in support of the belief that being fat is a sign of wealth, health, and happiness.[93] An exploratory analysis revealed that 73% of the participants with low obesity awareness reported that they generally tried to have a healthy diet. However, the same individuals often skipped meals (93%) and did not eat fruits and vegetables (57.4%). These unhealthy eating behaviors are associated with overweight and obesity.[53,54] Furthermore, the dietary habits of adolescents in Zimbabwe requires further investigation within the context of socio-cultural beliefs and the changing food environments.[159]

4.5.3 Cross-cutting issues

Binary logistic regression revealed that there were no significant associations between low obesity awareness and nutrition knowledge, physical activity levels, BtC, and BMI. These results were unexpected because of the well-known link between obesity and poor nutrition knowledge and PA.[54,55] Further research is warranted to shed more light on this area. Interestingly, our finding that a greater proportion of girls had low obesity awareness makes sense within the wider African socio-cultural context, where

bigger women are considered more attractive by men.[5,56,57] Our results confirm this notion, where only 13.1% of adolescents thought that obesity is a problem in Zimbabwe.

The adolescents placed the responsibility to solve obesity mainly on food companies. Therefore, nutrition education interventions targeting this age group should prioritize messages which emphasise that the fight against obesity starts at an individual level. This is particularly important since some food companies usually prioritise profits over the health benefits of their products.[161] Therefore, people should make informed food decisions, understand how to read food labels and ask "*what's in this food*?" when they do not understand food labels.[162] There is growing evidence that nutrition decisions should be coupled with physical activity adjustments.[163] In Zimbabwe where physical activity education is part of the school curriculum, increasing adolescents' physical activity levels should be done through both organized and recreational sports activities.

4.5.4 Practical implications of the study

Zimbabwe has both established and upcoming health promotion programs.[63,64,65] Recently the government launched the Zimbabwe School Health Policy (ZSHP) a guide for all public health, nutrition, sexual and reproductive health related matters that affect students from preschool, primary to high school.[25] In addition, the policy covers all aspects of the care and support provisions programs of all students including the homegrown school feeding program. Interestingly, there are unique programs in Zimbabwean schools designed to combat chronic malnutrition (stunting), which has been exacerbated by food insecurity and deepening poverty particularly among young children,

pregnant women, and immune-compromised individuals.[13] However, despite the evidence of the double burden of malnutrition and the rise of obesity and non-communicable diseases, which are mainly caused by nutrition transition, these health promotion programs are still biased towards undernutrition with limited focus on obesity and diet-related non-communicable diseases.[4,39,66] Furthermore, there are limited nutrition programming in urban areas in spite of the increasing urban nutrition challenges and growing population.[164] Our results contribute to the future health promotion programs and policies in Zimbabwe by establishing the base to address obesity issues, among adolescents, in urban areas like the capital city Harare and we postulate that these findings may also be useful for other low-income countries.

4.6 Limitations of the study

Several limitations should be considered when interpreting these results. Firstly, the variables in this study were developed *post hoc* from existing surveys. Secondly, the findings are based entirely on adolescents' self-reports and perceptions. Therefore, we acknowledge the potential for recall bias in the estimation of food habits and any other recall-based questions. The samples were obtained from a single city in Zimbabwe, and future research should be conducted using study populations from multiple regions, to obtain even more accurate results than those of the present study. This study acknowledged body image concerns, however, its impact on eating behaviour was not assessed. Finally, because the study was cross-sectional, the direction of causality between the variables of interest was not determined. Nevertheless, the study also had its strengths considering that adolescent nutrition and statistics is a grey area in Zimbabwe.[3,4] The current study adds to the limited literature on overweight/obesity

prevalence and related factors among adolescents in low-income African countries like Zimbabwe.

4.7 Conclusions

This study of in-school adolescents in Harare, Zimbabwe showed obesity was prevalent and more pronounced in girls, adolescents had different obesity awareness levels, with low awareness being more pronounced in girls. They also had diverse perceptions on the complex nature of obesity in terms of causes, its seriousness, and a range of potential solutions. The findings are important for public health interventions in obesity care in Harare.

4.8 Recommendations

1. Nutrition education programs should consider obesity awareness level to address adolescents eating habits, especially among girls, while taking cognizance of the different education levels of household heads.

2. The use of mass media programs to raise more awareness of the causes of obesity, consequences, preventive measures, are recommended while hammering unhealthy socio-cultural misconceptions which aid in the increase in the rate of obesity.

Chapter 5

Recommendations for future nutrition education programmes

A Social and Behaviour Change Communication Framework for addressing the rising obesity rate among urban adolescents in Zimbabwe.

5.1 Introduction

Social and Behaviour Change Communication (SBCC) is the strategic use of communication approaches to promote changes in knowledge, attitudes, norms, beliefs, and behaviours. SBCC is grounded in theory and is evidence-based. Programs are designed based on existing data, and they follow a systematic process, analysing the problem to define barriers and motivators to change, and design a comprehensive set of tailored interventions that promote the desired behaviours. An SBCC strategy is the document that guides the design of interventions, establishing intended audiences, setting behavioural communication objectives, and determining consistent messages, materials, and activities across channels.[170,171]

5.2 Influences on behaviour

Behaviour is a complex phenomenon, influenced by factors within the individual and beyond. The Social Ecological Model (SEM) **(Figure 6)**, informed by Bronfenbrenner's 1979 seminal work, recognizes four levels of influence that interact to affect behaviour: individual, family and peer networks, community and social/structural.[167]

Individual: At this level behaviour is affected by factors within the individual. Examples include knowledge, attitudes, skills, emotions, and beliefs.[105]

Family and peer networks: At this level, individual behaviour is affected by a person's close social and family circle. This includes influence from peers, family, and social support.[166]

Community: This refers to influences from the situational context in which the individual lives and in which social relationships are nested. The characteristics of the

context are associated with risk and protective factors and include leadership, access to information, service provision, social capital, and collective efficacy.[168]

Social/Structural: This refers to the larger, macro-level environment which can either promote or deter behaviours. Examples include leadership, health systems, resources and services, policies, guidance and protocols, religious and cultural values, media and technology, gender norms and income equity.[169]

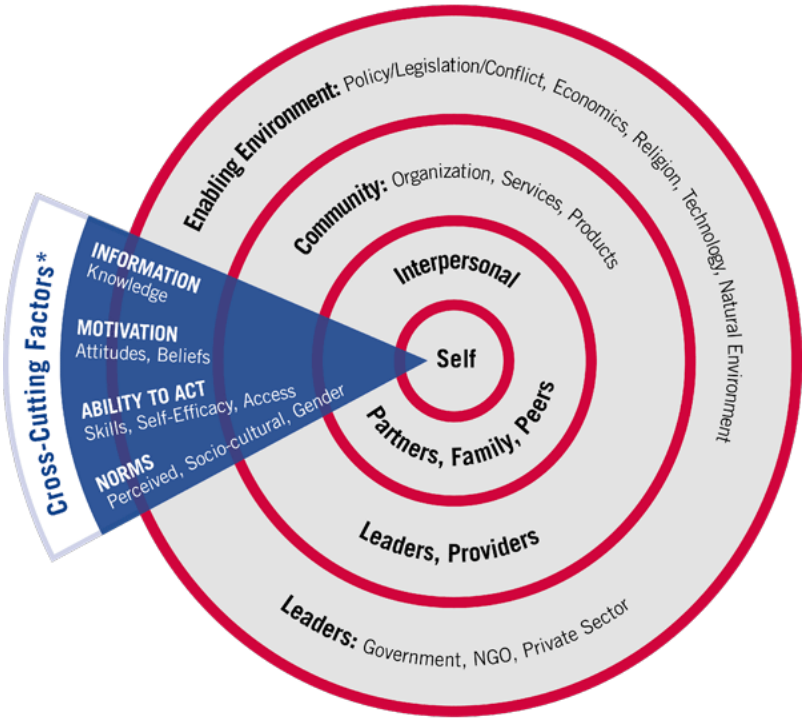


Figure 6 The socio-ecological model for change

At each of these four levels of influence there are factors that affect behaviour in positive ways (facilitators) and factors that affect behaviour in negative ways (barriers). Effective SBCC interventions should aim to develop messages and activities that influence all four levels of the SEM, maximizing the facilitators and limiting the

barriers.[170] It is important to recognize, however, that it is unlikely for one single organization to be able to operate at all four levels, as these often require different skills, strategies, and approaches. Coordination and partnerships with institutions and organization that operate at different levels are therefore necessary for a comprehensive SBCC approach.[171] The SEM was incorporated into the "Model for Change" developed by C-Change, which outlines the levels at which SBCC programs can be developed. This model originally adapted from McKee, Manoncourt, Chin and Carnegie – can be used in analysis, planning and implementation.[172]

5.3 Strategy pillars and objectives

The vision of the SBCC strategy is adopted from the Zimbabwe School Health Policy (ZSHP), a guide for all public health, nutrition, sexual, and reproductive health related matters that affect students from preschool to primary and high school which focuses on the empowerment of the students to choose wellness and live long and healthy lives.[25] Through empowerment, ownership of health is developed by inspiring the individual to choose wellness (physical, mental, and spiritual).[31] However, health is also greatly influenced by lifestyles and environments such as how people live, work, eat and drink, move, spend their leisure time, and so forth.[2] These are often beyond individual choices, having strong social, cultural, socioeconomic, policy, commercial, and environmental determinants. Also, political commitment is required at all levels of government and society. Health in all policies should enable people to choose to lead healthy lives.[18] Individual SBCC campaign behavioural objectives will need to be specifically focused on addressing the 'behavioural determinants' which support target groups to move through the "stages of change" . These describes awareness, knowledge,

perceptions and other “behavioural determinants” which are recommended to successfully address obesity and NCDs through healthy eating and increased physical activity.[172]

5.4 SBCC objectives in the Zimbabwean context

1) Raise awareness on the dangers of being overweight or obese, and risk reduction approaches.
2) To build knowledge about the sugar content in sugar sweetened beverages (SSBs) and personal risk perceptions of the health harms of high sugar and trans fats consumption and more generally poor diet on obesity.
3) To improve attitude, motivation, skills, and competencies on ► reduced consumption of unhealthy foods (those containing trans fats and sugar) that cause obesity; ► cooking and purchasing decisions; ► policies to index SSB taxes, reduce trans fats consumption and other initiatives including front of-package labelling.

SBCC Strategy overview

Figure 7 The four stages of SBCC strategic cycle. Adopted from [173]

5.5 Stepwise operational approach for SBCC campaigns

This research enabled the achievement of three steps of the SBCC campaign preparation. In the near future, the goal is to achieve the remaining 7 steps to successfully launch this campaign.

Step 1. Define and understand the problem.

The Health Problem in Zimbabwe

Despite the evidence of the double burden of malnutrition and the rise of obesity and non-communicable diseases, which are mainly caused by nutrition transition, these health promotion programs are still biased towards undernutrition with limited focus on obesity and diet-related noncommunicable diseases.[4,39,66]

Step 2. Identify campaign target groups.

Primary targets

The adolescents and youths in schools are the target groups because they need to get the message when they are young as older people are hard to change. The campaign can be flexible to include families at a community level.

Secondary targets

The church leaders can be both a target group and advocates for the strategy to encourage healthier eating habits.

Step 3. Set campaign behavioural objectives.

1) Raise obesity awareness.

   ► Set the SBCC programme agenda. This involves defining obesity as a term and explaining its characteristics. Additionally, obesity causes, risk factors and health outcomes and risks if its left unresolved should be clearly stated.

2) Build knowledge.

   ► Knowledge of the risks of obesity and NCDs and risk-prevention methods

►Knowledge of dietary and PA guidelines with a focus on: Locations of community networks, health and support services, and the need for regular visits.

3) Change attitude and perceptions.

"A big curvy body is attractive and is a sign of wealth."

►Attitudes towards the efficacy of healthy diets and PA in reducing weight and improving quality of life.

►Attitudes towards healthy body image and Body Mass Index (BMI)

►Attitudes towards existing social norms and gender roles which undermine good nutrition and PA behaviours

►Risk perceptions about the harm caused by obesity

►Capability—self-efficacy perceptions competencies, confidence, and motivation toward improved dietary behavioural changes

►Intentions towards trialling the recommended dietary and PA behaviours

1) To encourage adolescents to eating the local food and most importantly, that they should eat the right portions.
2) To build the capacity of individuals, families, and communities to make healthier choices by creating healthy environments.
3) Strengthen health systems to provide accessible, affordable, and good quality care to all people with or at risk of NCDs.

5.6 Additional steps of the SBCC campaign to be achieved in the future.

Step 4.Develop work plan and allocate resources.

Step 5.Build partnerships/coordinating mechanism.

Step 6.Build SBCC core competencies.

Step 7.Develop key messages and approaches.

Step.8Select communication and dissemination channels.

Step.9Implement the SBCC campaign.

Step.10Monitor and evaluate the campaign—advocate for finding seasons for using SBCC.

5.7 Practical implications of the SBCC in the Zimbabwean context

Overweight in children is a complex issue, requiring coordination between many individuals, organisations, and systems. One of the challenges that may be faced when implementing the SBCC is the identification of various stakeholders who will be dedicated to this cause. On the other hand, dedicated stakeholders may be identified but a new challenge will be on sourcing the funds to make this program a success. Financial assistance from the Government of Zimbabwe is not guaranteed as most government related programs are still biased towards poverty eradication and malnutrition. As mentioned throughout this study, obesity related issues are still a grey area in Zimbabwe. Therefore, SBCC is the most suitable intervention method for obesity awareness, debunking false and unhealthy obesity perceptions, and introducing health promotion at a socio-ecological level with the help of multisectoral stakeholders.

Chapter 6

General discussion and suggestions for nutrition education strategies

6.1 Summary of study procedures and key findings

This study utilized a systematic review of obesity studies done in Zimbabwe over a 10-year period from the year 2000 to 2020.[20] Additionally, a survey was done to assess the nutritional status of adolescents, cardiometabolic health risk and obesity awareness levels and factors associated with low obesity awareness.[18] Our study confirmed that that obesity studies are limited in Zimbabwe despite its rising prevalence. This is a cause for concern as this shows a neglected health concern that will potentially burden the health care system of Zimbabwe due to the rise/uncontrolled prevalence of non-communicable diseases. The study revealed that poor eating habits, social beliefs (being fat is a sign of beauty and wealth) and a poor economic status which prevents families from purchasing healthy foods like fruits and vegetables are the main drivers of an increasing rate of obesity.

The survey confirmed the prevalence of obesity among adolescents. The study further revealed that the adolescent had low obesity awareness. This was based on their perceptions towards obesity where they highlighted that obesity is not as severe as other health problems like drug abuse, diabetes etc. Low obesity awareness means that adolescents are not aware of obesity as a health problem. This belief is further strengthened by socio cultural beliefs which glorify big bodies among men and women which also affects adolescents. The fact that adolescents do not believe that the fight against obesity starts at an individual level was alarming. A greater percentage of the adolescents placed the responsibility to address obesity problems in the hands of food processing companies. This is why adolescents need to be informed that they have the sole responsibility to protect their own health by making healthy food choices.

As mentioned in this study food companies care more about their profits. Regarding the reasons why people become obese, adolescents stated that most people do not know what's in their food. This is an important topic that needs to be explored further in Zimbabwe. It is not clear whether consumers understand the food labels or whether food processing companies prepare consumer friendly and easy to understand food labels. Various study shows that most of the foods marketed as healthy are in fact unhealthy. In addition, to clear, easy to read food labels, food companies should aim for reduced fats, sugars and salts in their formulations.[161]

Low obesity awareness was associated with low parental education and poor eating habits. Parental education and income cannot be separated.[18] This may mean that parents with low incomes cannot afford healthy foods but on the other hand, this may mean that the parents are not aware of the negative impacts of unhealthy foods purely out of ignorance since most unhealthy foods are marketed as healthy. In this regard, parents need their own nutrition education programs which focuses on healthy food purchases and meal preparation even on a low budget. In Zimbabwe, adolescents are not usually involved in food purchases and meal planning and preparation.[20] Encouraging parents to involve adolescents in food purchases and preparation is a great way to expose them to food decision making at a young age.

This study also revealed that poor eating habits were significantly associated with low obesity awareness. In Zimbabwe, adolescents consume a lot of junk food simply because of the way these foods are marketed and available at low costs. Additionally, compared to healthier foods, ultra-processed foods are much cheaper which could be a reason why they are preferred.

6.2 Suggestions for Future nutrition education strategies

The fact that the obesity epidemic didn't flash over Zimbabwe like a wildfire-rather, it smouldered and then slowly grew year after year-has made it even more difficult to combat, since its causes have become so intertwined into the social, environmental, and governmental fabric. Therefore, addressing the issues on a socio-ecological level, using a multi sectoral approach may be effective.

6.3 Families

It hardly needs saying that families are one of the most important and lasting influences on the choices—health and otherwise—that children and youth make. So, when it comes to preventing excess weight gain and obesity, parents and guardians have fantastic potential to steer children in directions that lay the foundation for lifelong good health.[173] Children today live in a world that more readily promotes unhealthy eating than healthy eating and fosters sedentary activities more than physical activities. But parents can provide children with the tools and experience they need to ignore the unhealthy cues and make healthy choices. Parents can do this by creating the healthiest home food environment possible: stocking the fridge and pantry with vegetables, fruits, whole grains, and other nutritious foods; keeping to a minimum low-quality foods and drinks, like sugary soda, sweets, and super-processed foods; eating dinner together as a family; and nurturing adolescents' interest in food shopping and cooking, even gardening.[24,179]

Parents can also create a home where being active daily is the norm: walking or biking with their kids to school; planning fun, active outings with family and friends; keeping TV and other screen time low; and simply encouraging kids to go out and play. And

parents can make sure that kids regularly get enough sleep, since healthy sleep has been linked to healthy weight.[175]

6.4 Schools

One of the main avenues that schools can use to positively affect health is also one most directly in line with every school's mission: educating students. Nutrition and physical activity lessons can be woven into the curriculum-in core classroom subjects, physical education, and after-school programs-to teach skills that help students choose and maintain healthy lifestyles. In addition to teaching evidence-based nutrition and activity messages, school physical education should focus on getting students engaged in high-quality and regular activity. Schools can also promote health outside of the classroom, by surrounding students with opportunities to eat healthy and stay active. To improve nutrition, schools can implement and improve school lunch programmes which include healthier food offerings in the cafeteria and eliminate marketing of unhealthy foods. To improve activity, schools can develop safe walking and biking routes to school and can promote active recess time.

Wellness programs for faculty and staff can also be integral to improving the school environment, not only serving to boost faculty and staff health but also building school-wide enthusiasm for student-focused programs. Additionally, schools can serve as important data sources on student health. Anonymous, school-level information on markers like students' body mass index (BMI) can help educators and policymakers assess success of current programs and decide the direction of future programs.

With good evidence that school-based prevention programs can successfully-and without many added resources-help students to eat better, be more active, and achieve

healthier weights, schools are poised to become an integral part of the fight against the obesity epidemic. As with education in general, the sooner we act, the better.

6.5 Food environment

"Toxic." It's a word often used to describe the food environment in the Zimbabwe because even though the food itself is usually safe to consume, the food system makes choosing healthy food very hard and choosing unhealthy food very easy. It is truly a toxic environment that eats away at healthy lifestyles and promotes obesity.

What makes up the food environment is vast and varied, ranging from broad agricultural and communication policy-to very local issues-like worksite policies and permits for farmers' markets. To effectively combat obesity, this broad web of influence that developed over many years must begin to be disentangled, and there are numerous opportunities to do so.

Some avenues to effect change: Agriculture policy can focus on increased planting and buying of fresh fruits and vegetables. Revenue policy can focus on increasing taxes on unhealthy foods and subsidizing the cost of healthy choices. Zoning regulations can help bring supermarkets to low-income neighbourhoods and limit fast-food restaurants in areas where there are already too many. And communication policy can restrict advertising to youth about unhealthy foods, or curb stealth marketing to youth through junk food product placements on prime-time television.

The food environment often lurks silently in the background-going largely unnoticed-but it plays a major role in the food choices people make, even for the most independent-minded consumer. Whether it is small victories on the local level or large

shifts on the national level, any positive changes to the food environment can begin to shift momentum: We move away from a world that so easily promotes unhealthy eating, and toward a world where healthy eating is the default choice.

This section summarizes broad recommendations for improving the food environment, some of the recommendations are aimed at national level change, while others can be implemented at the local level.

6.6 Healthy Food and Beverage Access

It is one of the first steps toward bettering the food environment: making healthy foods and drinks more convenient and affordable. What is equally important: limiting access to high-calorie, low-nutrient foods (also known as “junk food”) and sugary drinks. Since public buildings and facilities serve people of all ages and backgrounds, setting nutrition standards for food offered in public places or purchased with tax dollars can have an especially broad impact.

1) Establish strong nutrition standards and healthy food policies for foods served at public facilities and government buildings, as well as foods purchased with government funds.
2) Make healthy foods more “available and affordable in public facilities and government buildings and restrict the availability of less-healthy foods.
3) Ensure that smaller portion-size food options are available in public facilities and government buildings.

Communities can use many strategies to make it easier for people to buy fresh, nutritious food close to home, school, and work. They can change zoning and give

incentives to lure supermarkets and farmers' markets to food deserts," or encourage corner stores to stock fruits and vegetables. They can even create healthy food zones near schools to ban the fast-food restaurants that so often tempt students to skip school meals.

6.7 Improving Food in the Neighbourhood

It remains to be seen how effective many of these strategies will be at encouraging healthy food choices, and in turn, reducing obesity rates. It is true that in the United States, for example, millions of people do not live within easy access of a supermarket, and that living in a food desert is associated in some studies with a higher risk of obesity. But some studies have not found a relationship between supermarket access and obesity, and there's no guarantee that building supermarkets will improve people's diets: while supermarkets do offer vegetables, fruits, and other healthful foods and drinks, they also sell sugary sodas, salty chips, and other junk food-and making it easier for people to buy these unhealthy foods certainly won't turn around the obesity epidemic. That's why supermarkets and food marketers need to be partners in obesity prevention and come up with innovative ways to make healthy foods more appealing and more affordable. Other strategies to encourage consumption of healthy foods, such as taxing sugar-sweetened beverages and limiting food marketing to children, may have a greater impact on food choices.

6.8 Digital technologies for promotion of healthy eating habits in teenagers

Digital technologies are innovative tools present in the lives of teenagers, with the possibility of being used for education and promotion of healthy eating, contributing to the empowerment of the subject for his/her self-care.[176] The literature points several

conditions of inadequate eating habits among teenagers and suggests the development of educational strategies that promote effective learning in health promotion, raising adolescents' awareness for a healthy eating.[181,182,183] In this sense, creative and ludic teaching resources provide adolescents with reflection and possibilities of empowering them to take care of themselves. The evidence is that adolescents, parents, and teachers consider that the use of technology can be an instrument to practice healthy habits, because it proposes fun and improvement in the teenagers' self-esteem.[179] Health problems in adolescence resulting from inadequate nutrition and sedentarism require intense and propositional educational actions.[180] Thus, the use of a digital game can encourage reflection on the importance of developing habits for the quality of life. Due to constant access and use of digital technologies by teenagers, these tools can be a means for educating this public regarding healthy habits, enabling learning and interests in the dissemination of information about the topic. The wide use of means of communication among adolescents facilitates the access to new knowledge about food and nutrition during their free time.[181]

6.10 Limitation of the overall study

The study had some limitation worth noting. The systematic review was based on a limited number of studied, and reports and other sources of information. Further limitations included the unavailability of segregated data from some studies and national surveys which made it difficult to accurately compare the results. The survey variables were developed *post hoc* from existing surveys and the findings are based entirely on adolescents' self-reports and perceptions. Therefore, we acknowledge the potential for recall bias in the estimation of food habits and any other recall-based

questions. The samples were obtained from a single city in Zimbabwe, and future research should be conducted using study populations from multiple regions, to obtain even more accurate results than those of the present study. This study acknowledged body image concerns, however, its impact on eating behaviour was not assessed. Finally, because the study was cross-sectional, the direction of causality between the variables of interest was not determined.

6.11 Strength of the overall study

The study also had its strengths considering that adolescent nutrition and statistics is a grey area in Zimbabwe. The current study adds to the limited literature on overweight/obesity prevalence and related factors among adolescents in low-income African countries like Zimbabwe. The use of an ecological model to explore multiple risk factors for adolescents' obesity revealed the prevalence, affected gender, and distribution of adolescents' obesity in Zimbabwe. This model also revealed literature and research gaps on economic and national level factors of adolescents' obesity. Furthermore, the use of the Health Belief Model revealed the need to nutrition interventions which focus on modifying factors like eating habits, parental education, and obesity perception to address the rising rate of obesity.

6.12 Conclusion

Adolescence is a critical stage where obesity starts to increase especially in girls as they graduate into adulthood. Sedentary lifestyles and the adoption of unhealthy dietary decisions appear to be exuberating this obesity problem in urban areas. School-based, family-oriented obesity prevention interventions which address gender discrepancies in eating habits and physical activity are recommended in these and related settings. Our

survey showed that adolescents had different obesity awareness levels and diverse perceptions in terms of obesity causes, and a range of potential solutions. Obesity awareness and nutrition education should address adolescents' poor eating habits while taking cognizance of the different education levels of household heads.

6.13 Recommendations:

1. Considering that most of the evidence reviewed was subnational studies, there is a need for adolescent nutrition indicator surveys which should address gender discrepancies in BMI.
2. A socioecological approach is recommended in the formulation of social behaviour change communication (SBCC) themed interventions targeting adolescents' obesity. This study already solved the first three stages of SBCC. There is need for further research work to solve the remaining 7 stages to successfully launch the SBCC for obesity prevention among adolescents.
3. Nutrition intervention programmes for girls. This study revealed that girls are a greater risk of obesity compared to boys. We recommend programs that targets girls on the topics of eating habits and body image.
4. Body image studies within the Zimbabwean context are needed to help influence healthy eating habits which lead to positive body image and healthy weight management.
5. Government policies which regulate the selling of ultra-processed foods on school grounds may help reduce the consumption of unhealthy foods. Additionally, in the absence of school lunch programs, schools can try to have

their own well established convenience stores with healthier food options and snacks.

6. The lunchbox project is a unique initiative in Zimbabwe. This project should teach adolescents and families how to make healthy and filling lunchboxes. This project can be made attractive by offering a prize to the participants of a well prepared and nutritious lunch box.
7. Lastly, we recommend future studies that explore the policy and economic determinants of obesity particularly the impact of macroeconomics on diet behaviours among adolescents in low-income settings.

Reference list

References

[1] ZDHS, “Zimbabwe Demographic and Health Survey 2015,” *Statistics (Ber).*, p. 535, 2016, [Online]. Available: http://www.zimstat.co.zw/sites/default/files/img/publications/Health/ZDHS_2015.pdf.

[2] A. Reese-Masterson and P. Murakwani, “Assessment of adolescent girl nutrition, dietary practices and roles in Zimbabwe,” *F. Exch. Emerg. Nutr. Netw. ENN*, vol. 52, no. PG-113-115, pp. 113–115, 2016, [Online]. Available: http://www.ennonline.net/fex/52/adolescentgirlnutrition.

[3] T. M. Muderedzwa and T. M. Matsungo, “Nutritional status, physical activity and associated nutrition knowledge of primary school learners,” *Nutr. Health*, vol. 26, no. 2, pp. 115–125, 2020, doi: 10.1177/0260106020910625.

[4] Tawodzera, G., Zanamwe, L., & Crush, J. (2012). The State of Food Insecurity in Harare, Zimbabwe (rep., pp. i-42). Kingston, ON and Cape Town: African Food Security Urban Network. Urban Food Security Series No. 13.G.

[5] Ministry of Primary and Secindary Education (MoPSE), “Report .2021. http://mopse.co.zw/. Accessed: 20 June 2022.

[6] T. M. Matsungo and P. Chopera, “Nutrition in contemporary Zimbabwe: a situational analysis,” *North African J. Food Nutr. Res.*, vol. 4, no. 9, pp. S25–S35, 2020, doi: 10.51745/najfnr.4.9.s25-s35.

[7] G. Tawodzera, L. Riley, and J. Crush, *The Return of Food*, no. June. 2019. Affiliation: African Food Security Urban Network (AFSUN).

https://www.researchgate.net/publication/290391333. Accessed 22 January 2021.

[8] D. Adiele, “An Unhealthy, Obesogenic Lifestyle: A Case Study of Urban Primary School Children in Kwekwe, Zimbabwe,” *Sci. J. Public Heal.*, vol. 6, no. 2, p. 35, 2018, doi: 10.11648/j.sjph.20180602.11.

[9] M. Leach, N. Nisbett, L. Cabral, J. Harris, N. Hossain, and J. Thompson, “Food politics and development,” *World Dev.*, vol. 134, p. 105024, 2020, doi: 10.1016/j.worlddev.2020.105024.

[10] N. T. Mangemba and M. San Sebastian, “Societal risk factors for overweight and obesity in women in Zimbabwe: A cross-sectional study,” *BMC Public Health*, vol. 20, no. 1, pp. 1–8, 2020, doi: 10.1186/s12889-020-8215-x.

[11] USAID/Zimbabwe, “USAID Zimbabwe Country Development Cooperation Strategy 2016-2021,” 2016. https://www.usaid.gov/zimbabwe. Accessed 8 October 2021.

[12] T. Matsungo, “Efficacy of lipid nutrient supplements on growth and micronutrient status in infants,” no. September, 2016, [Online]. Available: http://repository.nwu.ac.za/handle/10394/25536.

[13] MoHCC, “Zimbabwe National Nutrition Strategy 2014-2018,” *https//extranet.who.int/nutrition/gina/sites/default/files/ZWE 2014 Natl. Nutr. Strateg.*, p. 28, 2014.

[14] A. Viceisza, K. Aflagah, J. Abner, and K. Hippolyte, “Poverty and malnutrition in Zimbabwe: Findings from Masvingo Province,” no. January, 2020, [Online]. Available: https://pdf.usaid.gov/pdf_docs/PA00WC2R.pdf.

[15] T. Nyanhanda, L. Mwanri, and W. Mude, “Double Burden of Malnutrition: A Population Level Comparative Cross-Sectional Study across Three Sub-Saharan African Countries—Malawi, Namibia and Zimbabwe,” *Int. J. Environ. Res. Public Health*, vol. 20, no. 10, 2023, doi: 10.3390/ijerph20105860.

[16] P. Chopera, P. R. Zimunya, F. M. Mugariri, and T. M. Matsungo, “Facilitators and barriers to the consumption of traditional foods among adults in Zimbabwe,” *J. Ethn. Foods*, vol. 9, no. 1, 2022, doi: 10.1186/s42779-022-00121-y.

[17] B. M. Popkin and M. M. Slining, “New dynamics in global obesity facing low- and middle-income countries,” *Obes. Rev.*, vol. 14, no. S2, pp. 11–20, 2013, doi: 10.1111/obr.12102.

[18] Pencil, A.; Matsungo, T.M.; Hongu, N.; Hayami, N. Prevalence of Obesity and the Factors Associated with Low Obesity Awareness among Urban Adolescents in Harare, Zimbabwe. *Nutrients* **2023**, *15*, 2302. https://doi.org/10.3390/nu15102302

[19] B. M. Popkin, “The Nutrition Transition and Global Food System Dynamics: The Accelerating Speed of Change and Global Challenges We Face for Creating a Healthier Global Diet,” *Glob. food Res. Progr.*, pp. 1–53, 2017, [Online]. Available: http://apps.who.int/nutrition/topics/seminar_9June2017_presentation.pdf.

[20] A. Pencil, T. M. Matsungo, and N. Hayami, “Determinants of overweight and obesity among adolescents in Zimbabwe: A scoping review,” *North African J. Food Nutr. Res.*, vol. 5, no. 12, pp. 112–121, 2021, doi:

10.51745/najfnr.5.12.112-121.

[21] C. Murendo, D. Sango, and C. Hakuna, “Linking nutrition education and farm production diversification to fruit and vegetable consumption in Zimbabwe,” *Cogent Food Agric.*, vol. 9, no. 1, 2023, doi: 10.1080/23311932.2023.2195084.

[22] B. M. Popkin, “Nutrition Transition and the Global Diabetes Epidemic,” *Curr. Diab. Rep.*, vol. 15, no. 9, 2015, doi: 10.1007/s11892-015-0631-4.

[23] Antony Kudakwashe Chiromba, Thokozile Njini Ncube, Ismael Ngnie Teta, and Tasiana Krispin Nyadzayo, “Addressing Micronutrient Deficiencies in Zimbabwe: Achievements, Challenges and Future Actions,” *J. Heal. Sci.*, vol. 8, no. 4, pp. 116–125, 2020, doi: 10.17265/2328-7136/2020.04.002.

[24] World Health Organization, “BMI-for-age (5–19 years),” *Growth Reference data for 5-19 years*. 2016, [Online]. Available: https://www.who.int/tools/growth-reference-data-for-5to19-years/indicators/bmi-for-age.

[25] Scaling Up Nutrition In Zimbabwe Sensitisation And Self AssesSEMnt Report https://scalingupnutrition.org/resource-library/country-profiles/zimbabwe-2021-sun-country-profile. Accessed 2 January 2021/

[26] Ministry of Primary and Secondary Education, “Zimbabwe school health policy,” no. March, pp. 1–38, 2018, [Online]. Available: http://www.mopse.co.zw/sites/default/files/public/downloads/ZSHP final signed March 2018.pdf.

[27] Sisimayi, C., Mupandawana, M., Mutambwa, M., Sisimayi, T., & Njovo, H. (2021). Assessing the Multi-Dimensional Risk of Stunting Amongst Children

Under Five Years in Zimbabwe.

[28] T. Matsungo, P. Chopera, P. Tsikayi, C. Benhura, and N. G. . Mushonga, "Nutritional Status and Lifestyle characteristics of adults aged 15-49 years living in Harare, Zimbabwe," *Cent. Afr. J. Med.*, vol. 65, no. 1–3, pp. 10–14, 2019.

[29] L. Webber *et al.*, "The future burden of obesity-related diseases in the 53 WHO European-Region countries and the impact of effective interventions: A modelling study," *BMJ Open*, vol. 4, no. 7, pp. 1–8, 2014, doi: 10.1136/bmjopen-2014-004787.

[30] B. M. Popkin, P. S. Haines, and A. M. Siega-Riz, "Dietary patterns and trends in the United States: The UNC-CH approach," *Appetite*, vol. 32, no. 1, pp. 8–14, 1999, doi: 10.1006/appe.1998.0190.

[31] R. Barazzoni and G. Gortan Cappellari, "Double burden of malnutrition in persons with obesity," *Rev. Endocr. Metab. Disord.*, vol. 21, no. 3, pp. 307–313, 2020, doi: 10.1007/s11154-020-09578-1.

[32] K. K. Kidia, "The future of health in Zimbabwe," *Glob. Health Action*, vol. 11, no. 1, 2018, doi: 10.1080/16549716.2018.1496888.

[33] H. H. Vorster, A. Kruger, and B. M. Margetts, "The nutrition transition in Africa: can it be steered into a more positive direction?," *Nutrients*, vol. 3, no. 4, pp. 429–441, 2011, doi: 10.3390/nu3040429.

[34] T. Birkenholtz, *Driking Water*. 2016. Eating, Drinking: Surviving: The International Year of Global Understanding-IYGU Springer International Publishing. https://link.springer.com/chapter/10.1007/978-3-319-42468-2_3.

[35] E. Mufunda and L. Makuyana, “Obesity: A Potential Pandemic for the 21st Century among the Youths in Zimbabwe,” *J. Diabetes Mellit.*, vol. 06, no. 02, pp. 136–145, 2016, doi: 10.4236/jdm.2016.62014.

[36] WHO, *Handout for Module A Introduction*. 2018. https://www.who.int/publications/i/item/9241591269. Accessed 28 November 2022.

[37] M. De Onis, A. W. Onyango, E. Borghi, A. Siyam, C. Nishida, and J. Siekmann, “Development of a WHO growth reference for school-aged children and adolescents,” *Bull. World Health Organ.*, vol. 85, no. 9, pp. 660–667, 2007, doi: 10.2471/BLT.07.043497.

[38] M. M. C. e. Pereira, C. M. P. Padez, and H. G. da S. M. Nogueira, “Describing studies on childhood obesity determinants by Socio-Ecological Model level: a scoping review to identify gaps and provide guidance for future research,” *Int. J. Obes.*, vol. 43, no. 10, pp. 1883–1890, 2019, doi: 10.1038/s41366-019-0411-3.

[39] S. S. Hawkins, T. J. Cole, and C. Law, “An ecological systems approach to examining risk factors for early childhood overweight: Findings from the UK Millennium Cohort Study,” *J. Epidemiol. Community Health*, vol. 63, no. 2, pp. 147–155, 2009, doi: 10.1136/jech.2008.077917.

[40] V. Quick, J. Martin-Biggers, G. A. Povis, N. Hongu, J. Worobey, and C. Byrd-Bredbenner, “A socio-ecological examination of weight-related characteristics of the home environment and lifestyles of households with young children,” *Nutrients*, vol. 9, no. 6, 2017, doi: 10.3390/nu9060604.

[41] G. Kambondo and B. Sartorius, “Risk factors for obesity and overfat among primary school children in Mashonaland west province, Zimbabwe,” *Int. J. Environ. Res. Public Health*, vol. 15, no. 2, 2018, doi: 10.3390/ijerph15020249.

[42] H. Arksey and L. O’Malley, “Scoping studies: Towards a methodological framework,” *Int. J. Soc. Res. Methodol. Theory Pract.*, vol. 8, no. 1, pp. 19–32, 2005, doi: 10.1080/1364557032000119616.

[43] M. De Onis and T. Lobstein, “Defining obesity risk status in the general childhood population: Which cut-offs should we use?,” *Int. J. Pediatr. Obes.*, vol. 5, no. 6, pp. 458–460, 2010, doi: 10.3109/17477161003615583.

[44] U. Bronfenbrenner, “Toward an experimental ecology of human development.,” *Am. Psychol.*, vol. 32, no. 7, pp. 513–531, 1977, doi: 10.1037/0003-066x.32.7.513.

[45] F. Mukora-Mutseyekwa, H. Zeeb, L. Nengomasha, and N. K. Adjei, “Trends in prevalence and related risk factors of overweight and obesity among women of reproductive age in Zimbabwe, 2005–2015,” *Int. J. Environ. Res. Public Health*, vol. 16, no. 15, 2019, doi: 10.3390/ijerph16152758.

[46] Zimbabwe Nutrition Profile, 2018. https://2017-2020.usaid.gov/sites/default/files/documents/1864/Zimbabwe-Nutrition-Profile-Mar2018-508.pdf. Accessed 18 July 2022.

[47] B. Chapoterera, J. Maradzika, A. Marume, and A. Zikiti, “Determinants of Dietary Patterns and Obesity among Secondary School Adolescents in Harare, Zimbabwe, 2016,” *Int. J. Child Heal. Nutr.*, vol. 6, pp. 144–158, 2017.

[48] United Nations, Global Nutrition Report 2018 https://globalnutritionreport.org/resources/nutrition-profiles/africa/eastern-africa/zimbabwe/.Accessed 2 October 2021.

[49] Mukora-Mutseyekwa F, Zeeb H, Nengomasha L, Kofi Adjei N. Trends in Prevalence and Related Risk Factors of Overweight and Obesity among Women of Reproductive Age in Zimbabwe, 2005-2015. Int J Environ Res Public Health. 2019 Aug 2;16(15):2758. doi: 10.3390/ijerph16152758. PMID: 31382360; PMCID: PMC6695964

[50] D. Ssewanyana, A. Abubakar, A. van Baar, P. N. Mwangala, and C. R. Newton, "Perspectives on Underlying Factors for Unhealthy Diet and Sedentary Lifestyle of Adolescents at a Kenyan Coastal Setting," *Front. Public Heal.*, vol. 6, no. February, 2018, doi: 10.3389/fpubh.2018.00011.

[51] F. I. Danquah *et al.*, "Risk factors and morbidities associated with childhood obesity in sub-Saharan Africa: A systematic scoping review," *BMC Nutr.*, vol. 6, no. 1, pp. 1–14, 2020, doi: 10.1186/s40795-020-00364-5.

[52] T. Adom, A. P. Kengne, A. De Villiers, and T. Puoane, "Prevalence of overweight and obesity among African primary school learners: a systematic review and meta-analysis," *Obes. Sci. Pract.*, vol. 5, no. 5, pp. 487–502, 2019, doi: 10.1002/osp4.355.

[53] E. W. Kimani-Murage, K. Kahn, J. M. Pettifor, S. M. Tollman, K. Klipstein-GrobusC.H., and S. A. Norris, "Predictors of adolescent weight status and central obesity in rural South Africa," *Public Health Nutr.*, vol. 14, no. 6, pp. 1114–1122,

2010, doi: 10.1017/S1368980011000139.

[54] O. Otitoola, W. Oldewage-Theron, and A. Egal, “Prevalence of overweight and obesity among selected schoolchildren and adolescents in Cofimvaba, South Africa,” *South African J. Clin. Nutr.*, vol. 0, no. 0, pp. 1–6, 2020, doi: 10.1080/16070658.2020.1733305.

[55] A. S. Stierlin *et al.*, “A systematic review of determinants of sedentary behaviour in youth: A DEDIPAC-study,” *Int. J. Behav. Nutr. Phys. Act.*, vol. 12, no. 1, 2015, doi: 10.1186/s12966-015-0291-4.

[56] C. L. Ogden, M. D. Carroll, L. R. Curtin, M. M. Lamb, and K. M. Flegal, “Prevalence of high body mass index in US children and adolescents, 2007-2008,” *JAMA - J. Am. Med. Assoc.*, vol. 303, no. 3, pp. 242–249, 2010, doi: 10.1001/jama.2009.2012.

[57] L. G. Baraldi, E. Martinez Steele, D. S. Canella, and C. A. Monteiro, “Consumption of ultra-processed foods and associated sociodemographic factors in the USA between 2007 and 2012: Evidence from a nationally representative cross-sectional study,” *BMJ Open*, vol. 8, no. 3, 2018, doi: 10.1136/bmjopen-2017-020574.

[58] E. J. Boyland *et al.*, “Advertising as a cue to consume: A systematic review and meta-analysis of the effects of acute exposure to unhealthy food and nonalcoholic beverage advertising on intake in children and adults,” *Am. J. Clin. Nutr.*, vol. 103, no. 2, pp. 519–533, 2016, doi: 10.3945/ajcn.115.120022.

[59] G. A. Hendrie, J. Coveney, and D. Cox, “Exploring nutrition knowledge and the

demographic variation in knowledge levels in an Australian community sample," *Public Health Nutr.*, vol. 11, no. 12, pp. 1365–1371, 2008, doi: 10.1017/S1368980008003042.

[60] N. G. T. Mushonga, H. A. Mujuru, L. K. Nyanga, S. Nyagura, N. Musaka, and R. Dembah, "Parental knowledge, attitudes and practices regarding overweight among preschool children in rural Zimbabwe," *African J. Food, Agric. Nutr. Dev.*, vol. 17, no. 4, pp. 12775–12790, 2017, doi: 10.18697/ajfand.80.16480.

[61] B. Kowrygo, H. Górska-Warsewicz, and S. Berger, "Evaluation of eating patterns with different methods: The Polish experience," *Appetite*, vol. 32, no. 1, pp. 86–92, 1999, doi: 10.1006/appe.1998.0200.

[62] M. Y. Martin Romero and L. A. Francis, "Youth involvement in food preparation practices at home: A multi-method exploration of Latinx youth experiences and perspectives," *Appetite*, vol. 144, no. August 2019, p. 104439, 2020, doi: 10.1016/j.appet.2019.104439.

[63] C. M. Nguu-gutu, J. K. Imungi, and E. M. Ngatia, "Snacking and its effect on nutritional status of adolescents in two national high schools in Nairobi Kenya," *Issn*, vol. 30, pp. 48–59, 2014, [Online]. Available: www.iiste.org.

[64] I. O. O. Ajayi *et al.*, "Urban-rural and geographic differences in overweight and obesity in four sub-Saharan African adult populations: a multi-country cross-sectional study," *BMC Public Health*, vol. 16, no. 1, pp. 1–13, 2016, doi: 10.1186/s12889-016-3789-z.

[65] A. P. Okeyo, E. Seekoe, A. de Villiers, M. Faber, J. H. Nel, and N. P. Steyn,

"Dietary practices and adolescent obesity in secondary school learners at disadvantaged schools in south africa: Urban–rural and gender differences," *Int. J. Environ. Res. Public Health*, vol. 17, no. 16, pp. 1–18, 2020, doi: 10.3390/ijerph17165864.

[66] E. Kobia-acquah and P. K. Akowuah, "Childhood obesity and verweight in Ghana : A systematic review and meta-analysis," *J. Nutr. Metab.*, vol. 2020, 2020.

[67] M. G. Khonje and M. Qaim, "Modernization of African food retailing and (un)healthy food consumption," *Sustain.*, vol. 11, no. 16, pp. 1–18, 2019, doi: 10.3390/su11164306.

[68] E. O. Gido, O. I. Ayuya, G. Owuor, and W. Bokelmann, "Consumption intensity of leafy African indigenous vegetables: towards enhancing nutritional security in rural and urban dwellers in Kenya," *Agric. Food Econ.*, vol. 5, no. 1, pp. 0–16, 2017, doi: 10.1186/s40100-017-0082-0.

[69] M. K. Kansiime, J. Ochieng, R. Kessy, D. Karanja, D. Romney, and V. Afari-Sefa, "Changing knowledge and perceptions of African indigenous vegetables: the role of community-based nutritional outreach," *Dev. Pract.*, vol. 28, no. 4, pp. 480–493, 2018, doi: 10.1080/09614524.2018.1449814.

[70] Messina M, Duncan A, Messina V, Lynch H, Kiel J, Erdman JW Jr. The health effects of soy: A reference guide for health professionals. Front Nutr. 2022 Aug 11;9:970364. doi: 10.3389/fnut.2022.970364. PMID: 36034914; PMCID: PMC9410752.

[71] J. Bucksch *et al.*, "Adolescent obesity and related behaviours: trends and

inequalities in the WHO region 2002-2014, Observations from the Health Behaviour in School-aged Children (HBSC) WHO collaborative cross-national study," *World Heal. Organ. Reg. Off. Eur.*, vol. 130, no. 4, pp. 207–217, 2017, [Online]. Available: http://www.euro.who.int/__data/assets/pdf_file/0019/339211/WHO_ObesityReport_2017_v3.pdf.

[72] J. M. Fernández-Alvira *et al.*, "Country-specific dietary patterns and associations with socioeconomic status in European children: The IDEFICS study," *Eur. J. Clin. Nutr.*, vol. 68, no. 7, pp. 811–821, 2014, doi: 10.1038/ejcn.2014.78.

[73] J. E. Banta, J. W. Lee, G. Hodgkin, Z. Yi, A. Fanica, and J. Sabate, "The global influence of the seventh-day adventist church on diet," *Religions*, vol. 9, no. 9, pp. 1–25, 2018, doi: 10.3390/rel9090251.

[74] T. M. matsungo and P. Chopera, "Department of Nutrition, Dietetics and Food Sciences, University of Zimbabwe, P O Box MP 167, Mt Pleasant, Harare, Zimbabwe," vol. preprint, 2020, [Online]. Available: https://www.medrxiv.org/content/medrxiv/early/2020/08/01/2020.06.16.20130278.full.pdf.

[75] H. E. Bouis, P. Eozenou, and A. Rahman, "Food prices, household income, and resource allocation: Socioeconomic perspectives on their effects on dietary quality and nutritional status," *Food Nutr. Bull.*, vol. 32, no. 1 SUPPL., pp. 14–23, 2011, doi: 10.1177/15648265110321s103.

[76] World Bank Group, "An Overview of Links Between Obesity and Food Systems

Implications for The Food and Agriculture Global Practice Agena," *Food Agric. Glob. Pract.*, no. June, p. 48, 2017, [Online]. Available: http://documents.worldbank.org/curated/en/222101499437276873/pdf/117200-REVISED-WP-Obesity-Overview-Web-PUBLIC-002.pdf.

[77] A. Herforth and S. Ahmed, "The food environment, its effects on dietary consumption, and potential for measurement within agriculture-nutrition interventions," *Food Secur.*, vol. 7, no. 3, pp. 505–520, 2015, doi: 10.1007/s12571-015-0455-8.

[78] B. Adeboye, G. Bermano, and C. Rolland, "Obesity and its health impact in Africa: A systematic review," *Cardiovasc. J. Afr.*, vol. 23, no. 9, pp. 512–521, 2012, doi: 10.5830/CVJA-2012-040.

[79] A. M. Thow, R. Annan, L. Mensah, and S. N. Chowdhury, "Development, implementation and outcome of standards to restrict fatty meat in the food supply and prevent NCDs: Learning from an innovative trade/food policy in Ghana," *BMC Public Health*, vol. 14, no. 1, pp. 1–9, 2014, doi: 10.1186/1471-2458-14-249.

[80] N. Stacey, A. Tugendhaft, and K. Hofman, "Sugary beverage taxation in South Africa: Household expenditure, demand system elasticities, and policy implications," *Prev. Med. (Baltim).*, vol. 105, pp. S26–S31, 2017, doi: 10.1016/j.ypmed.2017.05.026.

[81] B. A. Swinburn, "Obesity prevention: The role of policies, laws and regulations," *Aust. New Zealand Health Policy*, vol. 5, pp. 1–7, 2008, doi: 10.1186/1743-8462-

5-12.

[82] A. Miyawaki, J. S. Lee, and Y. Kobayashi, “Impact of the school lunch program on overweight and obesity among junior high school students: A nationwide study in Japan,” *J. Public Heal. (United Kingdom)*, vol. 41, no. 2, pp. 362–370, 2019, doi: 10.1093/pubmed/fdy095.

[83] World Health Organization. BMI-for-age (5–19 years) [Internet]. Growth Reference data for 5-19 years. 2016. Available from: https://www.who.int/tools/growth-reference-data-for-5to19-years/indicators/bmi-for-age. Accessed 18 January 2023.

[84] Piedmont, “Does BMI Accurately Determine Body Fat? Piedmont Healthcare.” 2022. https://www.piedmont.org/. Accessed 2 August 2022.

[85] Cao Y, Huynh Q, Kapoor N, Jeemon P, de Mello GT, Oldenburg B et al. Associations between Dietary Patterns and Cardiometabolic Risk Factors—A Longitudinal Analysis among High-Risk Individuals for Diabetes in Kerala, India. Nutrients., vol. 14(3):662. doi: 10.3390/nu14030662Y

[86] I. K. Murni, D. C. Sulistyoningrum, R. Susilowati, M. Julia, and K. M. Dickinson, “The association between dietary intake and cardiometabolic risk factors among obese adolescents in Indonesia,” *BMC Pediatr.*, vol. 22, no. 1, pp. 1–9, 2022, doi: 10.1186/s12887-022-03341-y.

[87] M. Agirbasli, S. Cakir, S. Ozme, and G. Ciliv, “Metabolic syndrome in Turkish children and adolescents,” *Metabolism.*, vol. 55, no. 8, pp. 1002–1006, 2006, doi: 10.1016/j.metabol.2006.03.009.

[88] WHO, “Obesity rising in Africa, WHO analysis finds,” pp. 1–4, 2022, [Online]. Available: https://www.afro.who.int/news/obesity-rising-africa-who-analysis-finds. Accessed 29 September 2022.

[89] WHO, “Obesity rising in Africa,” *Reg. Off. Africa*, p. 2021, 2022, [Online]. Available: https://www.afro.who.int/news/obesity-rising-africa-who-analysis-finds. Accessed 3 February 2022.

[90] P. T. Mapfumo, T. M. Muderedzwa, and T. M. Matsungo, “Prevalence and determinants of overweight and obesity among in-school adolescents in Harare, Zimbabwe,” *North African J. Food Nutr. Res.*, vol. 6, no. 13, pp. 29–38, 2022, doi: 10.51745/najfnr.6.13.29-38.

[91] A. E. Mehairi *et al.*, “Metabolic Syndrome among Emirati Adolescents: A School-Based Study,” *PLoS One*, vol. 8, no. 2, 2013, doi: 10.1371/journal.pone.0056159.

[92] W. C. Lwabukuna and Y. Mgonda, “Early clinical markers of metabolic syndrome among secondary school adolescents in dar es salaam, tanzania,” *Tanzan. J. Health Res.*, vol. 22, no. 1, pp. 1–7, 2021, doi: 10.4314/thrb.v22i1.3.

[93] B. M. Popkin, Li. S. Adair, and S. W. Ng, “Now And Then: The Global Nutrition Transition: The Pandemic of Obesity in Developing Countries,” *Nutrients*, vol. 58, no. 1, pp. 1–10, 2017, doi: 10.1111/j.1753-4887.2011.00456.x.NOW.

[94] A. M. N. Renzaho, “Fat, rich and beautiful: Changing socio-cultural paradigms associated with obesity risk, nutritional status and refugee children from sub-Saharan Africa,” *Heal. Place*, vol. 10, no. 1, pp. 105–113, 2004, doi:

10.1016/S1353-8292(03)00051-0.

[95] UNFPA Zimbabwe, “July 2022,” *Oncology*, no. 3607, 2022, doi: 10.46883/onc.2022.3607.

[96] J. Charan and T. Biswas, “How to calculate sample size for different study designs in medical research?,” *Indian J. Psychol. Med.*, vol. 35, no. 2, pp. 121–126, 2013, doi: 10.4103/0253-7176.116232.

[97] F. Oz, R. Aydin, M. F. Onsuz, S. Metintas, and G. O. Emiral, “Development of a reliable and valid adolescence nutritional knowledge questionnaire,” *Prog. Nutr.*, vol. 18, no. 2, pp. 125–134, 2016.

[98] F. Johnson, J. Wardle, and J. Griffith, “The adolescent food habits checklist: Reliability and validity of a measure of healthy eating behaviour in adolescents,” *Eur. J. Clin. Nutr.*, vol. 56, no. 7, pp. 644–649, 2002, doi: 10.1038/sj.ejcn.1601371.

[99] D. R. Silva *et al.*, “Physical activity maintenance and metabolic risk in adolescents,” *J. Public Heal. (United Kingdom)*, vol. 40, no. 3, pp. 493–500, 2018, doi: 10.1093/pubmed/fdx077.

[100] Y. X. Zhang, “Letter to the editor: ‘International waist circumference percentile cutoffs for central obesity in children and adolescents aged 6 to 18 years,’” *J. Clin. Endocrinol. Metab.*, vol. 105, no. 12, p. 2020, 2020, doi: 10.1210/clinem/dgaa578.

[101] F. Bacopoulou, V. Efthymiou, G. Landis, A. Rentoumis, and G. P. Chrousos, “Waist circumference, waist-to-hip ratio and waist-to-height ratio reference

percentiles for abdominal obesity among Greek adolescents," *BMC Pediatr.*, vol. 15, no. 1, p. 2015, 2015, doi: 10.1186/s12887-015-0366-z.

[102] M. Riley, A. K. Hernandez, and A. L. Kuznia, "High blood pressure in children and adolescents," *Am. Fam. Physician*, vol. 98, no. 8, pp. 486–494, 2018.

[103] D. Care and S. S. Suppl, "2. Classification and diagnosis of diabetes: Standards of medical care in diabetesd2019," *Diabetes Care*, vol. 42, no. January, pp. S13–S28, 2019, doi: 10.2337/dc19-S002.

[104] Zachary T. Bloomgarden; Type 2 Diabetes in the Young: The evolving epidemic. *Diabetes Care* 1 April 2004; 27 (4): 998–1010. https://doi.org/10.2337/diacare.27.4.998.

[105] A. K. Irelosen, N. Eno Etim, and A. S. Babatunde, "Adolescent obesity: An emerging public health crisis in an urban city in South-South Nigeria," *Ann. Clin. Biomed. Res.*, vol. 2, no. 2, 2021, doi: 10.4081/acbr.2021.148.

[106] E. Nwosu *et al.*, "Trends in prevalence of overweight and obesity among South African and European adolescents: a comparative outlook," *BMC Public Health*, vol. 22, no. 1, pp. 1–13, 2022, doi: 10.1186/s12889-022-14724-2.

[107] S. Debeila, P. Modjadji, and S. Madiba, "High Prevalence of Overall Overweight/obesity and Abdominal Obesity Amongst Adolescents: An Emerging Nutritional Problem in Rural High Schools in Limpopo Province, South Africa," *African J. Prim. Heal. Care Fam. Med.*, vol. 13, no. 1, pp. 1–9, 2021, doi: 10.4102/PHCFM.V13I1.2596.

[108] A. Sanyaolu, C. Okorie, X. Qi, J. Locke, and S. Rehman, "Childhood and

Adolescent Obesity in the United States: A Public Health Concern," *Glob. Pediatr. Heal.*, vol. 6, 2019, doi: 10.1177/2333794X19891305.

[109] Shisana, O., Labadarios, D., Rehle, T., Simbayi, L., Zuma, K., Dhansay, A., Reddy, P., Parker, W., Hoosain, E., Naidoo, P., Hongoro, C., Mchiza, Z., Steyn, N.P., Dwane, N., Makoae, M., Maluleke, T., Ramlagan, S., Zungu, N., Evans, M.G., Jacobs, L., Faber,2012 "The South African national health and nutrition examination survey." pp. 1–423,

[110] S. L. Brown, "Using a social-ecological model to examine obesity interventions for children and adolescents.2011. Kinesiology.p. 264, 2011. https://doi.org/10.31274/etd-180810-2927

[111] P. Ohri-Vachaspati, D. DeLia, R. S. DeWeese, N. C. Crespo, M. Todd, and M. J. Yedidia, "The relative contribution of layers of the Social Ecological Model to childhood obesity," *Public Health Nutr.*, vol. 18, no. 11, pp. 2055–2066, 2015, doi: 10.1017/S1368980014002365.

[112] I. H. Sirikyi *et al.*, "Anthropometric indices and cardiometabolic risk factors in a Ghanaian adolescent population," *J. Pediatr. Endocrinol. Metab.*, vol. 34, no. 1, pp. 35–44, 2021, doi: 10.1515/jpem-2020-0273.

[113] B. Shah, K. Tombeau Cost, A. Fuller, C. S. Birken, and L. N. Anderson, "Sex and gender differences in childhood obesity: Contributing to the research agenda," *BMJ Nutr. Prev. Heal.*, vol. 3, no. 2, pp. 387–390, 2020, doi: 10.1136/bmjnph-2020-000074.

[114] S. X. M. Zhang Juan, Zhai Yi Feng Xiao Qi, Li Wei Rong, Lyu Yue Bin, Astell-

Burt Thomas, Zhao Peng Yu, “Gender Differences In The Prevalence Of Overweight and Obesity, Associated Behaviors, and Weight-rel.” 2018.

[115] R. Pradeilles *et al.*, “Body size preferences for women and adolescent girls living in Africa: a mixed-methods systematic review,” *Public Health Nutr.*, vol. 25, no. 3, pp. 738–759, 2022, doi: 10.1017/S1368980021000768.

[116] T. Kubo, “Common approach to childhood obesity in Japan,” *J. Pediatr. Endocrinol. Metab.*, vol. 27, no. 7–8, pp. 581–592, 2014, doi: 10.1515/jpem-2014-0047.

[117] N. Chisuwa and J. A. O’Dea, “Body image and eating disorders amongst Japanese adolescents. A review of the literature,” *Appetite*, vol. 54, no. 1, pp. 5–15, 2010, doi: 10.1016/j.appet.2009.11.008.

[118] E. Hughes, “‘I’m Supposed To Be Thick’: Managing Body Image Anxieties Among Black American Women,” *J. Black Stud.*, vol. 52, no. 3, pp. 310–330, 2021, doi: 10.1177/0021934720972440.

[119] H. Itoh *et al.*, “Metabolically healthy obesity and the risk of cardiovascular disease in the general population ― Analysis of a nationwide epidemiological database ―,” *Circ. J.*, vol. 85, no. 6, pp. 914–920, 2021, doi: 10.1253/circj.CJ-20-1040.

[120] R. C. Quinn, S. C. Campisi, B. W. McCrindle, and D. J. Korczak, “Adolescent cardiometabolic risk scores: A scoping review,” *Nutr. Metab. Cardiovasc. Dis.*, vol. 32, no. 12, pp. 2669–2676, 2022, doi: 10.1016/j.numecd.2022.08.022.

[121] S. Shantanam and MUELLER, *Physiol. Behav.*, vol. 176, no. 1, pp. 139–148,

2018, doi: 10.1016/j.gheart.2016.08.002.The.

[122] T. Templin, T. C. O. Hashiguchi, B. Thomson, J. Dieleman, and E. Bendavid, "The overweight and obesity transition from the wealthy to the poor in low- And middleincome countries: A survey of household data from 103 countries," *PLoS Med.*, vol. 16, no. 11, pp. 1–15, 2019, doi: 10.1371/journal.pmed.1002968.

[123] J. Takaya and T. Okawa, "Impact of family income on the lifestyle and physique of schoolchildren in Higashi-Osaka City, Japan," *Pediatr. Int.*, vol. 62, no. 1, pp. 74–80, 2020, doi: 10.1111/ped.14044.

[124] R. J. Chung, C. Touloumtzis, and H. Gooding, "Staying Young at Heart: Cardiovascular Disease Prevention in Adolescents and Young Adults," *Curr. Treat. Options Cardiovasc. Med.*, vol. 17, no. 12, 2015, doi: 10.1007/s11936-015-0414-x.

[125] R. Raeside, S. Partridge, A. Singleton, and J. Redfern, "Cardiovascular Disease Prevention in Adolescents: eHealth, Co-Creation, and Advocacy," *Med. Sci.*, vol. 7, no. 2, p. 34, 2019, doi: 10.3390/medsci7020034.

[126] K. S. N. Liu, J. Y. Chen, K. S. Sun, J. P. Y. Tsang, P. Ip, and C. L. K. Lam, "Adolescent Knowledge, Attitudes and Practices of Healthy Eating: Findings of Qualitative Interviews among Hong Kong Families," *Nutrients*, vol. 14, no. 14, pp. 1–18, 2022, doi: 10.3390/nu14142857.

[127] R. Vaitkeviciute, L. E. Ball, and N. Harris, "The relationship between food literacy and dietary intake in adolescents: A systematic review," *Public Health Nutr.*, vol. 18, no. 4, pp. 649–658, 2015, doi: 10.1017/S1368980014000962.

[128] J. L. Slaght *et al.*, “Physical activity and cardiometabolic health in adolescents with type 2 diabetes: A cross-sectional study,” *BMJ Open Diabetes Res. Care*, vol. 9, no. 1, pp. 1–7, 2021, doi: 10.1136/bmjdrc-2021-002134.

[129] J. Wyszyńska *et al.*, “Physical Activity in the Prevention of Childhood Obesity: The Position of the European Childhood Obesity Group and the European Academy of Pediatrics,” *Front. Pediatr.*, vol. 8, no. November, pp. 1–8, 2020, doi: 10.3389/fped.2020.535705.

[130] T. T. Kamvura, J. M. Dambi, E. Chiriseri, J. Turner, R. Verhey, and D. Chibanda, “Barriers to the provision of non-communicable disease care in Zimbabwe: a qualitative study of primary health care nurses,” *BMC Nurs.*, vol. 21, no. 1, pp. 1–12, 2022, doi: 10.1186/s12912-022-00841-1.

[131] P. Simfukwe, B. Van Wyk, and C. Swart, “Perceptions, attitudes and challenges about obesity and adopting a healthy lifestyle among health workers in Pietermaritzburg, KwaZulu-Natal province,” *African J. Prim. Heal. Care Fam. Med.*, vol. 9, no. 1, pp. 1–9, 2017, doi: 10.4102/phcfm.v9i1.1276.

[132] M. Manafe, P. K. Chelule, and S. Madiba, “The Perception of Overweight and Obesity among South African Adults: Implications for Intervention Strategies,” *Int. J. Environ. Res. Public Health*, vol. 19, no. 19, 2022, doi: 10.3390/ijerph191912335.

[133] S. Negash, C. Agyemang, T. E. Matsha, N. Peer, R. T. Erasmus, and A. P. Kengne, “Differential prevalence and associations of overweight and obesity by gender and population group among school learners in South Africa: A cross-

sectional study," *BMC Obes.*, vol. 4, no. 1, pp. 1–8, 2017, doi: 10.1186/s40608-017-0165-1.

[134] Y. Liu *et al.*, "Analysis of Related Factors of Overweight and Obesity among Secondary School Students in Chongqing, China," *Phys. Procedia*, vol. 33, pp. 104–110, 2012, doi: 10.1016/j.phpro.2012.05.036.

[135] S. K. Mmolai, "HIV/AIDS Stigma in Botswana: Implications for the Dignity of People Living With HIV/AIDS," vol. 8, no. 1, pp. 84–95, 2011.

[136] M. Mohammad Shouli, N. Mahmoud Soliman, and H. Abd El moneemElsayied, "High Risk for Obesity among Youth in West Bank /Palestine," *Egypt. J. Heal. Care*, vol. 9, no. 4, pp. 64–77, 2018, doi: 10.21608/ejhc.2018.19872.

[137] T. L. S. Visscher *et al.*, "Perceived Health Status: Is Obesity Perceived as a Risk Factor and Disease?," *Obes. Facts*, vol. 10, no. 1, pp. 52–60, 2017, doi: 10.1159/000457958.

[138] G. Savige, A. MacFarlane, K. Ball, A. Worsley, and D. Crawford, "Snacking behaviours of adolescents and their association with skipping meals," *Int. J. Behav. Nutr. Phys. Act.*, vol. 4, pp. 1–9, 2007, doi: 10.1186/1479-5868-4-36.

[139] V. Y. Feyzabadi, N. K. Mohammadi, N. Omidvar, A. Karimi-Shahanjarini, S. Nedjat, and A. Rashidian, "Factors associated with unhealthy snacks consumption among adolescents in Iran's schools," *Int. J. Heal. Policy Manag.*, vol. 6, no. 9, pp. 519–528, 2017, doi: 10.15171/ijhpm.2017.09.

[140] M. Rashighi and J. E. Harris, "乳鼠心肌提取 HHS Public Access," *Physiol.*

Behav., vol. 176, no. 3, pp. 139–148, 2017, doi: 10.1053/j.gastro.2016.08.014.CagY.

[141] L. Washburn, “Understanding the Health Belief Model,” *Univ. Tennessee*, 2020,. Available: https://extension.tennessee.edu/publications/Documents/W931-C.pdf.

[142] M. Fan, Y. Jin, and J. Khubchandani, “Overweight misperception among adolescents in the United States,” *J. Pediatr. Nurs.*, vol. 29, no. 6, pp. 536–546, 2014, doi: 10.1016/j.pedn.2014.07.009.

[143] K. S. Talamayan, A. E. Springer, S. H. Kelder, E. C. Gorospe, and K. A. Joye, “Prevalence of overweight misperception and weight control behaviors among normal weight adolescents in the United States.,” *ScientificWorldJournal.*, vol. 6, pp. 365–373, 2006, doi: 10.1100/tsw.2006.70.

[144] W. Jayawardene, S. Pinar, M. Torabi, P. Xun, and M. Özer, “Obesity perception survey among youth in Turkey: Instrument development and test-retest reliability,” *Turkish J. Med. Sci.*, vol. 49, no. 4, pp. 1228–1235, 2019, doi: 10.3906/sag-1811-56.

[145] G. Turconi, M. Celsa, C. Rezzani, G. Biino, M. A. Sartirana, and C. Roggi, “Reliability of a dietary questionnaire on food habits, eating behaviour and nutritional knowledge of adolescents,” *Eur. J. Clin. Nutr.*, vol. 57, no. 6, pp. 753–763, 2003, doi: 10.1038/sj.ejcn.1601607.

[146] X. F. Amador, D. H. Strauss, S. A. Yale, and J. M. Gorman, “Awareness of illness in schizophrenia,” *Schizophr. Bull.*, vol. 17, no. 1, pp. 113–132, 1991, doi: 10.1093/schbul/17.1.113.

[147] A. M. C. Carolyn C. Preston, “Optimal number of response categories in rating scales: reliability, validity, discriminating power, and respondent preferences,” vol. 104, p. 2000, 2000.

[148] World Health Organization (WHO), “Consideration of the evidence on childhood obesity for the Commission on Ending Childhood Obesity: Report of the Ad hoc Working Group on Science and Evidence for Ending Childhood Obesity,” *World Heal. Organ.*, p. 219, 2016.

[149] M. Saghafi-Asl, S. Aliasgharzadeh, and M. Asghari-Jafarabadi, “Factors influencing weight management behavior among college students: An application of the Health Belief Model,” *PLoS One*, vol. 15, no. 2, pp. 1–15, 2020, doi: 10.1371/journal.pone.0228058.

[150] P. Dalwood, S. Marshall, T. L. Burrows, A. McIntosh, and C. E. Collins, *Diet quality indices and their associations with health-related outcomes in children and adolescents: an updated systematic review*, vol. 19, no. 1. Nutrition Journal, 2020.

[151] C. L. Ogden *et al.*, “Prevalence of Obesity Among Youths by Household Income and Education Level of Head of Household — United States 2011–2014,” *MMWR. Morb. Mortal. Wkly. Rep.*, vol. 67, no. 6, pp. 186–189, 2018, doi: 10.15585/mmwr.mm6706a3.

[152] A. Aitsi-Selmi, T. Chandola, S. Friel, R. Nouraei, M. J. Shipley, and M. G. Marmot, “Interaction between education and household wealth on the risk of obesity in women in Egypt,” *PLoS One*, vol. 7, no. 6, pp. 4–11, 2012, doi:

10.1371/journal.pone.0039507.

[153] Y. Liu, Y. Ma, N. Jiang, S. Song, Q. Fan, and D. Wen, “Interaction between parental education and household wealth on children’s obesity risk,” *Int. J. Environ. Res. Public Health*, vol. 15, no. 8, 2018, doi: 10.3390/ijerph15081754.

[154] J. A. Wolfson, S. E. Gollust, J. Niederdeppe, and C. L. Barry, “The role of parents in public views of strategies to address childhood obesity in the United States,” *Milbank Q.*, vol. 93, no. 1, pp. 73–111, 2015, doi: 10.1111/1468-0009.12106.

[155] C. L. Barry, S. E. Gollust, E. E. McGinty, and J. Niederdeppe, “Effects of messages from a media campaign to increase public awareness of childhood obesity,” *Obesity*, vol. 22, no. 2, pp. 466–473, 2014, doi: 10.1002/oby.20570.

[156] C. R. Medina, M. B. Urbano, A. De Jesús Espinosa, and Á. T. López, “Eating habits associated with nutrition-related knowledge among university students enrolled in academic programs related to nutrition and culinary arts in puerto rico,” *Nutrients*, vol. 12, no. 5, 2020, doi: 10.3390/nu12051408.

[157] B. Loring and A. Robertson, “Obesity and Inequities,” *World Heal. Organ.*, p. 48, 2014. https://www.researchgate.net/publication/261855392_Obesity_and_inequities_Guidance for addressing inequities in overweight and obesity.

[158] A. Monzani *et al.*, “A systematic review of the association of skipping breakfast with weight and cardiometabolic risk factors in children and adolescents. What should we better investigate in the future?,” *Nutrients*, vol. 11, no. 2, pp. 1–23,

2019, doi: 10.3390/nu11020387.

[159] A. Sincovich *et al.*, “Prevalence of breakfast skipping among children and adolescents: a cross-sectional population level study,” *BMC Pediatr.*, vol. 22, no. 1, pp. 1–10, 2022, doi: 10.1186/s12887-022-03284-4.

[160] Moyo J. Obesity Emerges as Health Hazard in Cash—Strapped Zimbabwe Related News; Harare, Zimbabwe. 2021; p. 2021. [(accessed on 3 March 2023)]. Available online: https://www.aa.com.tr/en/africa/obesity-emerges-as-health-hazard-in-cash-strapped-zimbabwe/2315231.

[161] T. Tompson *et al.*, “Obesity in the United States : Public Perceptions,” *Assoc. Press. Cent. Public Aff. Res.*, no. January, pp. 1–8, 2013, [Online]. Available: http://www.apnorc.org/PDFs/Obesity/AP-NORC-Obesity-Research-Highlights.pdf.

[162] T. Hahn, “Who is to blame for the health risks of junk food : consumers or food companies ? Related programmes Join the Do Better community Business Innovation technology Global agenda,” p. 2023, 2019.

[163] P. Chopera, D. T. Chagwena, N. G. T. Mushonga, and D. T. Chagwena, “Food label reading and understanding in parts of rural and urban Zimbabwe,” *Afr. Health Sci.*, vol. 14, no. 3, pp. 576–584, 2014, doi: 10.4314/ahs.v14i3.12.

[164] Inclusive Physical Activity and Ways to Reduce Inequalities. Sports England; Leicestershire, UK: 2021. [(accessed on 20 March 2023)]. Available online: https://sportengland-production-files.s3.eu-west-2.amazonaws.com

[165] “Multi-Sectoral Nutrition Needs And Gap Analysis.”2022

https://pubdocs.worldbank.org/en/825961538777240208/pdf/Oct-3-S3-Zimbabwe-Presentation.pdf. Accessed 7 June 2023.

[166] T. Hamlets and E. Years, “Communication Guidance,”2021. https://chscp.org.uk/wp-content/uploads/2023/01/CHSCP_AnnualReport_202122.pdf. Accessed 21 May 2023.

[167] T. Turk, “Social and Behaviour Change Communication Strategy and Action Plan to Address Obesity and NCDs in Tonga 2021-2026,” no. June, 2022. https://www.researchgate.net/publication/361812333. Accessed 21 October 2022.

[168] USAID Wildlife Asia, “Social and Behavior Change Communication (SBCC) Demand Reduction Guidebook |,” no. November, pp. 35–36, 2020, [Online]. Available: https://www.fhi360.org/resource/social-and-behavior-change-communication-sbcc-demand-reduction-guidebook.

[169] Ministry of Health & Family Welfare and USAID India, *Training for Information, Education, and Communication (IEC) Officers Ministry of Health and Family Welfare Government of India*, no. September. 2013.

[170] M. Crops, “Social And Behavior Change Mercy Corps Approach.2020. https://www.hsph.harvard.edu/wp-content/uploads/sites/2187/2022/05/E-book-Jan-Andolan-For-Dissemination.pdf

[171] Social Diversity and behaviour change.2008. https://www.academia.edu/75366972/Behaviour_Change_Communication_in_Health Promotion Appropriate Practices and Promising Approaches. Accessed 22

May 2023.

[172] “Comprehensive SBCC Strategy-3-.pdf.” 2016.https://thedocs.worldbank.org/en/doc/9d945a08c69e75ccbc93912ea7f775bb-0390072021/related. Accessed 18 June 2023.

[173] V. Pal Kaur, “Social and behavior change communication,” *Int. J. Adv. Nurs. Manag.*, pp. 53–56, 2022, doi: 10.52711/2454-2652.2022.00014.

[174] J. Lanigan, L. Tee, and R. Brandreth, “Childhood obesity,” *Medicine (United Kingdom)*, vol. 47, no. 3. 2019, doi: 10.1016/j.mpmed.2018.12.007.

[175] E. Fornari, M. Brusati, and C. Maffeis, “Nutritional strategies for childhood obesity prevention,” *Life*, vol. 11, no. 6, pp. 1–15, 2021, doi: 10.3390/life11060532.

[176] N. Almutairi, S. Burns, and L. Portsmouth, “Barriers and enablers to the implementation of school-based obesity prevention strategies in Jeddah, KSA,” *Int. J. Qual. Stud. Health Well-being*, vol. 17, no. 1, 2022, doi: 10.1080/17482631.2022.2135197.

[177] D. Hargreaves *et al.*, “Strategies and interventions for healthy adolescent growth, nutrition, and development,” *Lancet*, vol. 399, no. 10320, pp. 198–210, 2022, doi: 10.1016/S0140-6736(21)01593-2.

[178] M. Fuster, R. F. Houser, E. Messer, P. Palma de Fulladolsa, H. Deman, and O. I. Bermudez, “Perceived access and actual intake of healthy diets among households in vulnerable salvadoran communities,” *J. Nutr. Educ. Behav.*, vol. 45, no. 6, pp. 713–717, 2013, doi: 10.1016/j.jneb.2013.06.002.

[179] T. Rose *et al.*, “A Systematic Review of Digital Interventions for Improving the Diet and Physical Activity Behaviors of Adolescents,” *J. Adolesc. Heal.*, vol. 61, no. 6, pp. 669–677, 2017, doi: 10.1016/j.jadohealth.2017.05.024.

[180] S. L. Holzmann, F. Dischl, H. Schafer, G. Groh, H. Hauner, and C. Holzapfel, “Digital gaming for nutritional education: A survey on preferences, motives, and needs of children and adolescents,” *JMIR Form. Res.*, vol. 3, no. 1, pp. 1–10, 2019, doi: 10.2196/10284.

[181] C. Oh, B. Carducci, T. Vaivada, and Z. A. Bhutta, “Digital Interventions for Universal Health Promotion in Children and Adolescents: A Systematic Review,” *Pediatrics*, vol. 149, no. May, 2022, doi: 10.1542/peds.2021-053852H.

[182] M. M. Chau, M. Burgermaster, and L. Mamykina, “The use of social media in nutrition interventions for adolescents and young adults—A systematic review,” *Int. J. Med. Inform.*, vol. 120, no. October, pp. 77–91, 2018, doi: 10.1016/j.ijmedinf.2018.10.001.

Acknowledgements

First and foremost, I want to thank God, for being with me. I have experienced His guidance day by day and I will keep trusting him with my future.

I would like to acknowledge and thank to the Government of Japan for awarding me the Monbukagakusho (MEXT) scholarship which enabled me to study this far. My warmest appreciation goes to Nishikawa Sensei for believing in me and supporting me as I navigated my Master's course, first time parenting, and he finally introduced me to my current Supervisors Habu Sensei and Hayami Sensei. Their guidance and advice carried me through all the stages of my PhD journey. I am also grateful to Hongu Sensei and Dr Matsungo from the University of Zimbabwe for their encouragement, support, guidance, and patience. I would also like to thank my committee members for making my defense an enjoyable moment, and for their brilliant comments and suggestions.

I would also like to give special thanks to my daughter Aretha-Gold. She was with me from day one and through the ups and downs of being born in Japan and me studying full time, she has remained the sweetest little girl I know. We have both become stronger and more resilient. Special thanks to my parents and my family for their continuous support and prayers which sustained me this far.

Finally, I want to thank myself for not giving up. I want to thank myself for all the hard work that is now paying off. I am proud of the person I have become. I am looking forward to more top tier opportunities, achievements, and celebrations. I have waited so long to pat myself in the back and say, "Well done Ashleigh Pencil, you did great!"

Appendix

Appendix 1: Survey questionnaire

Questionnaire

Please complete all the sections of the questionnaire. You must answer each item with only one choice. It is important that you complete it by yourself and do not leave any item without an answer. If you have any doubts, ask the Survey assistants. Your answers will remain anonymous, and the data collected will be used only for research.

Section A: Socio-Demographic Information

1. Name of school:……

2. Age (years) [*As at last birthday*] :…….

3. Sex:[1] Male [2] Female [3] Prefer not to say

4. Where do you stay? E.g. Kuwadzana, Westgate, Hatfield……

5. Who do you stay with?

   [1] Both parents
   [2] single parent
   [3] Relatives/Guardian
   [4] Child headed
   [5] Others specify……..

6. How many people live in the same household as you?……..

7. What is the employment status of your parents/guardians?
   [1] Formally employed
   [2] Unemployed
   [3] Business owners or Self-employed

8. What is the educational level of your parents/ guardians? [The household head]

   [1] No formal Education
   [2] Primary School
   [3] Ordinary and Advanced level
   [4] Tertiary level (College or university graduate)

Section B: Obesity Perceptions

Instructions
Please read each item carefully then, for each one circle the response that best applies to you.

1. How serious a problem is each of these health issues for adolescents in this country?
   Please choose 1 response for each problem ranging from extremely serious[5], very serious [4], moderately serious [3], only a little serious [2], and not a problem [1].

	Not a problem	**Only a little serious**	**Moderately serious**	**Very serious**	**Extremely serious**
Cancer	1	2	3	4	5
Overweight and obesity	1	2	3	4	5
Diabetes	1	2	3	4	5
Alcohol and drug abuse	1	2	3	4	5
HIV/AIDS	1	2	3	4	5

2. More people are becoming obese these days. These might be the causes. For cause each, please show if you think it is a major reason, a minor reason, or not a reason for this problem.

A) People spend too much time in front of the TV, video games, and computer screens,
[1] a major reason [2] a minor reason [3] not a reason for this problem

B) People do not know how to control their weight,
[1] a major reason [2] a minor reason [3] not a reason for this problem

C) Healthy foods are expensive,
[1] a major reason [2] a minor reason [3] not a reason for this problem

D) People don't have enough information about what's in their food,
[1] a major reason [2] a minor reason [3] not a reason for this problem

E) There are not enough safe places for people to be physically active outdoors
[1] a major reason [2] a minor reason [3] not a reason for this problem

3. Do you think one can be overweight and still be healthy?
[1] Yes [2] No

4. How much discrimination do obese people face because of their weight?
[1] A lot [2] A little [3] Some [4] Not very much [5] None

5. How many years does obesity shorten an individual's life expectancy?
[1] <5 years [2] 5–10 years [3] 11–15 years [4] 16–20 years [5] >21 years

6. Do you favour the following government policies: strongly favour [5], somewhat favour [4], neither favour nor oppose[3], somewhat oppose [2], strongly oppose[1]?

	Strongly oppose	**Somewhat oppose**	**Neither favour nor oppose**	**Somewhat favour**	**Strongly favour**
Requiring more physical activity in schools	1	2	3	4	5
Requiring take-away shops to post calorie information on menus	1	2	3	4	5
Limiting the types or amounts of foods and drinks people can buy	1	2	3	4	5

7. How much responsibility does each of the following groups have for solving the country's obesity problems?
A very large amount of responsibility [5], a large amount [4], a moderate amount [3], a small amount of responsibility [2], or no responsibility at all [1]?

	No responsibility at all	**A small amount of responsibility**	**A moderate amount**	**A large amount**	**A very large amount of responsibility**
Individual (you)	1	2	3	4	5
Parents and other family members	1	2	3	4	5
Food industry	1	2	3	4	5

Schools	1	2	3	4	5
Medical aid companies	1	2	3	4	5
The government	1	2	3	4	5
State and local governments	1	2	3	4	5
Employers	1	2	3	4	5

8. Obesity increases the risk for illnesses like diabetes, high blood pressure, sleep apnoea (a sleeping disorder where breathing repeatedly starts and stops), heart disease, and cancer. Which of the following is the most effective way to treat morbid obesity?
   [1] Exercise [2] Diet control [3] Medication [4] Surgery [5] Other

9. In general, how would you rate your overall health?
   [1] Excellent [2] Very good [3] Good [4] Fair

10. Do you personally know anybody who you would consider to be obese?
    [1] Yes [2] No

11. Which of the following best describes your current weight?
    [1] Underweight [2] Normal/healthy weight [3] Overweight [4] Obese

12. How do you feel about your current weight?
    [1] Very happy [2] Happy [3] Neither happy nor unhappy
    [4] Unhappy [5] Very unhappy

Solution perceptions- Private

13. Is it very easy, somewhat easy, neither easy nor hard, somewhat hard, or very hard to:
    a) Get to fast-food restaurants,
       [1] It is very easy [2] somewhat easy [3] neither easy nor hard
       [4] somewhat hard [5] very hard

    b) Find safe places to be physically active outdoors?
       [1] It is very easy [2] somewhat easy [3] neither easy nor hard
       [4] somewhat hard [5] very hard

14. When was your last visit with a doctor for a check-up?
    [1] <6 months ago [2] 6–12 months ago [3] 1–2 years ago [4] >2 years ago [5]Never

15. Has your doctor ever talked with you about the health risks of being or becoming overweight or obese?
    [1] Yes [2] No [3] I rarely go to the doctor

Section C: Self-efficacy

Please choose 1 answer only. Yes, no, or I don't know.

1. Do you think you can choose anything by yourself?
   [1] Yes [2] No [3] I don't know

2. Do you think you can use advice aimed at improving your well-being?
   [1] Yes [2] No [3] I don't know

3. Do you think you can change your diet if needed?

[1] Yes [2] No [3] I don't know

4. Do you think you can lose or gain weight if needed?
   [1] Yes [2] No [3] I don't know

5. Do you think you can use nutrition advice aimed at improving your dietary habits?
   [1] Yes [2] No [3] I don't know

6. Do you think you can use nutrition advice aimed at improving your health status?
   [1] Yes [2] No [3] I don't know

7. Do you think you can practice constant physical activity to improve your well-being?
   [1] Yes [2] No [3] I don't know

8. Do you think you can practice constant physical activity to improve your physical aspect?
   [1] Yes [2] No [3] I don't know

Section D: Barriers to change

Please choose 1 answer only. Either yes or no.

1. Do you have some influence on cooking food at home?
   [1] Yes [2] No

2. Do you know which foods must be avoided to reduce dietary intake of fats and cholesterol?
   [1] Yes [2] No

3. Do you know which foods must be restricted to reduce dietary intake of sugar?
   [1] Yes [2] No

4. Do you know which foods must be eaten to increase your dietary intake of fiber?
   [1] Yes [2] No

5. Do you know which benefits you could gain by eating a healthy diet?
   [1] Yes [2] No

6. Do you know how to improve your diet?
   [1] Yes [2] No

7. Do you know how much you must eat to satisfy your energy requirement?
   [1] Yes [2] No

8. Do you know how important it is not to be influenced by your friends in choosing your food?
   [1] Yes [2] No

9. Do you think that your family would support your efforts in improving your food habits?
   [1] Yes [2] No

Section E: Food habits checklist

Please circle only 1 answer. Either True or False. In some cases, there is a third option.

1. If I am having lunch away from home, I often choose a low-fat option.
   [1] True [2] False [3] I never have lunch away from home

2. I usually avoid eating fried foods.
   [1] True [2] False

3. I usually eat a dessert if there is one available.
   [1] True [2] False

4. I make sure I eat at least one serving of fruit a day.
   [1] True [2] False

5. I try to keep my overall fat intake down.
   [1] True [2] False

6. If I am buying milk, I often choose a low-fat brand.
   [1] True [2] False [3] I never buy milk

7. I avoid eating lots of sausages and burgers.
   [1] True [2] False [3] I never eat sausages or burgers

8. I often buy biscuits, donuts cream puffs, or cakes.
   [1] True [2] False

9. I try to keep my overall sugar intake down.
   [1] True [2] False

10. I make sure I eat at least one portion of vegetables or salad a day.
    [1] True [2] False

11. If I am having a dessert at home, I try to have something low in fat.
    [1] True [2] False [3] I don't eat desserts

12. I rarely eat takeaway meals.
    [1] True [2] False

13. I try to ensure I eat plenty of fruit and vegetables.
    [1] True [2] False

14. I often eat sweet snacks between meals.
    [1] True [2] False
15. I usually eat at least one serving of vegetables (excluding potatoes) or salad with my evening meal.
    [1] True [2] False

16. When I am buying a soft drink, I usually choose a diet drink e.g. diet Coke.
    [1] True [2] False [3] I never buy soft drinks

17. When I put butter or margarine on bread, I usually spread it thinly.
    [1] True [2] False [3] I never have butter or margarine on bread

18. If I have a packed lunch, I usually include some chocolate and/ or biscuits.
    [1] True [2] False [3] I never have a packed lunch

19. When I have a snack between meals, I often choose fruit.
    [1] True [2] False [3] I never eat snacks between meals

20. If I am having a dessert in a restaurant, I usually choose the healthiest one.
    [1] True [2] False [3] I never have desserts in restaurants

21. I often have cream on desserts.
    [1] True [2] False [3] I don't eat desserts

22. I eat at least three servings of fruit most days.
    [1] True [2] False

23. I generally try to have a healthy diet.
    [1] True [2] False

Please recall how often you eat/skip meals.
Circle only 1 box from Never[1], Seldom[2]Sometimes [3], Often [4], Always [5]

	Never	**Seldom**	**Sometimes**	**Often**	**Always**
24. How often do you skip breakfast?	1	2	3	4	5
25. How often do you skip lunch?	1	2	3	4	5
26. How often do you skip supper?	1	2	3	4	5
27. How often do you eat regular meals with your immediate family at home, sitting down together?	1	2	3	4	5

Section F: Nutrition knowledge

Please circle only 1 answer

Adequate and balanced nutrition.

1. Regularly eating breakfast improves school performance.
   [1] True [2] False [3] Not sure

2. Especially milk and eggs should be consumed at breakfast.
   [1] True [2] False [3] Not sure

3. We should drink 8-10 glasses of water every day.
   [1] True [2] False [3] Not sure

4. We should drink at least 2 glasses of milk every day.
   [1] True [2] False [3] Not sure

5. We should consume 5 portions of fruits and vegetables every day.
   [1] True [2] False [3] Not sure

6. Consuming bread and cereals (maize) is important for adequate and balanced nutrition.
   [1] True [2] False [3] Not sure

7. We should not consume meat more than 3 days a week.
   [1] True [2] False [3] Not sure

8. According to the nutrition expert, the amount of salt a person consumes in a day should not exceed 6 grams.
   [1] True [2] False [3] Not sure

9. Fast food (burgers, fried chips, fizzy drinks, etc) is not suitable for adequate and balanced nutrition.

[1] True [2] False [3] Not sure

Essential nutrients

10. Nutrients are divided into six groups.
[1] True [2] False [3] Not sure

11. The carbohydrate group has more energy than the fats group.
[1] True [2] False [3] Not sure

12. Fizzy drinks contain high amounts of sugar.
[1] True [2] False [3] Not sure

13. Pasta and rice are starchy foods.
[1] True [2] False [3] Not sure

14. Chicken and eggs contain a high amount of protein.
[1] True [2] False [3] Not sure

15. Sugar beans and baked beans contain a high amount of protein.
[1] True [2] False [3] Not sure

16. Nuts are an alternative to meat in terms of protein content.
[1] True [2] False [3] Not sure

17. The most reasonable act for limiting the amount of fat is consuming biscuits.
[1] True [2] False [3] Not sure

18. Bread contains a high amount of fat.
[1] True [2] False [3] Not sure

19. Meat and chicken are important sources of omega-3 fatty acids.
[1] True [2] False [3] Not sure

20. When we consume animal fat, the amount of cholesterol in the body increases.
[1] True [2] False [3] Not sure

21. Fried chips are junk food.
[1] True [2] False [3] Not sure

22. Whole-grain bread contains more vitamins and minerals than white bread.
[1] True [2] False [3] Not sure

23. Vitamins A and C can be classified as antioxidant vitamins.
[1] True [2] False [3] Not sure

24. Green pepper and oranges contain high amounts of vitamin C.
[1] True [2] False [3] Not sure

25. Cheese contains a high amount of calcium.
[1] True [2] False [3] Not sure

26. Calcium and vitamin D are important for strong bones.
[1] True [2] False [3] Not sure

27. Meat contains a high amount of salt.
[1] True [2] False [3] Not sure

28. White bread contains more fiber than whole-grain bread.
[1] True [2] False [3] Not sure

29. Peached does not contain a high amount of fibre.
[1] True [2] False [3] Not sure

Malnutrition related diseases

30. Obese people have health problems more than normal.
    [1] True [2] False [3] Not sure

31. Eating fish is a risk factor for cardiovascular diseases.
    [1] True [2] False [3] Not sure

32. Obesity may be due to excessive fat consumption.
    [1] True [2] False [3] Not sure

33. Consuming foods such as fruits and vegetables which have high amount of fibre reduce the risk of getting cancer.
    [1] True [2] False [3] Not sure

34. Reducing salt consumption does not reduce the risk of heart disease.
    [1] True [2] False [3] Not sure

35. Overusing of sugar and salt is associated with health problems such as diabetes, hypertension, and heart disease.
    [1] True [2] False [3] Not sure

36. The low consumption of fruits increases the risk of infectious diseases.
    [1] True [2] False [3] Not sure

37. Adequate and balanced nutrition decreases the risk of anemia.
    [1] True [2] False [3] Not sure

Section G: Physical activity. (This is the concluding section)

Please circle only 1 answer for each question.

1. Do you usually practice any form of physical activity?
   [1] Always during the entire year
   [2] Only in some seasons
   [3] Sometimes
   [4] Never

2. How many hours do you practice?
   [1] 1-2 hours per week
   [2] 3-4 hours per week
   [3] More than 4 hours per week
   [4] Never
3. In the last 7 days, during your physical education (PE) class, how often were you very active (playing hard, jumping, and throwing)?
   [1] Always [2] Quite often [3] Sometimes [4] Hardly [5] I don't do PE

4. The physical activity you practice at school:
   [1] Makes you feel well.
   [2] Stimulates you to practice sports even out of school
   [3] Is tiring
   [4] Is boring

5. What do you prefer doing during your free time?
   [1] Practicing a sport
   [2] Walking
   [3] Shopping

[4] Watching TV/listening to music/using the computer/reading a book

6. How many hours a day do you spend on the computer or watching TV?
   [1] 1-2 hours a day
   [2] 3-4 hours a day
   [3] 5-6 hours a day
   [4] More than 6 hours a day

7. Your lifestyle is:
   [1] Very active
   [2] Moderately active
   [3] Sedentary
   [4] Very sedentary.

Appendix 2: Ministry of Primary and Secondary Education approval letter

All communications should be addressed
to "The Secretary for Primary and
Secondary Education
Telephone: 794895/796211
Telegraphic address: "EDUCATION"
Fax: 794505

ZIMBABWE

Reference: C/426/3
Ministry of Primary and
Secondary Education
P.O Box CY 121
Causeway
HARARE
ZIMBABWE

8 November 2021

Ashleigh Pencil
Osaka City University
3-3-138 Sugimoto, Sumiyoshi-Ku
Osaka-shi 558-8585
JAPAN

Re: PERMISSION TO CARRY OUT RESEARCH IN HARARE METROPOLITAN PROVINCE: ST JOHNS; TRUST ACADEMY; SPECISS TECHNICAL; HARARE SDA; GATEWAY; DZIVARASEKWA; MORGAN; ZENGEZA 1; MABVUKU AND MT PLEASANT HIGH SCHOOLS

Reference is made to your application to carry a research in the above mentioned schools on the research title:

"THE ANALYSIS OF RELATED FACTORS OF OVERWEIGHT AND OBESITY AMONG HIGH SCHOOL STUDENTS IN HARARE, ZIMBABWE"

Permission is hereby granted. However, you are required to liaise with the Provincial Education Director Harare Province, who are responsible for the schools which you want to involve in your research. You should ensure that your research work does not disrupt the normal operations of the school. Where students are involved, parental consent is required.

You are also required to provide a copy of your final report to the Secretary for Primary and Secondary Education.

PERMANENT SECRETARY
MINISTRY OF PRIMARY AND
SECONDARY EDUCATION
09 NOV 2021
P.O. BOX CY 121, CAUSEWAY
HARARE, ZIMBABWE

T. Thabela (Mrs)
SECRETARY FOR PRIMARY AND SECONDARY EDUCATION

Appendix 3: Participants Invitation Letter to the Parents/Guardians

Osaka Metropolitan University
Graduate School of Human Life Science
558-8585
Osaka-Shi Sumiyoshi-Ku Sugimoto 3-3-138
Japan

04 April 2022

Dear Parents and Guardians

RE: INVITATION FOR YOUR CHILD TO PARTICIPATE IN AN ADOLESCENTS NUTRITION SURVEY.

The above matter refers. We are inviting your child to participate in a survey titled:

"An Analysis of the Determinants of Overweight and Obesity among High School Students in Harare, Zimbabwe"

This survey was approved by the Ministry of Primary and Secondary Education (MOPSE) and the Medical Research Council of Zimbabwe (MRCZ/A/2857). Your child has been given a consent form for you to sign as an indication of your permission for him/her to participate in this study. This document has detailed information about the study activities.

Please sign two copies of the consent form, one copy is for you to keep at home and your child should bring the other copy back to the teacher at school. As part of the survey protocol, we are kindly asking that your child skip breakfast on the survey day. We will provide a fruit and bottled water to at the end of the survey.

Thank you for your cooperation.

Yours sincerely

Ashleigh Pencil (B.Sc., M.Sc., Ph.D. candidate)
Principal Investigator
ashleighpencil@gmail.com
Tel No.0081 6-6605-2818; 0773 732 703(Hotline)

Co-investigators
Naomi Hayami, PhD, RD (Osaka University, Japan)
Nobuko Hongu, Ph.D., M.Ed., R.D., FACSM (Osaka University, Japan)
Tonderayi Matsungo B.Sc., M. Phil, PhD, RNutr (University of Zimbabwe)

Appendix 4: Informed parental consent form

RESEARCH TITLE

The Analysis of Related Factors of Overweight and Obesity among High School Students in Harare, Zimbabwe

Principal Investigator: Ashleigh Pencil, [*Ph.D. Student*]
Sipervisors(s): Dr. Naomi Hayami, Dr. Nobuko Hongu and Dr. Tonderai Matthew Matsungo [Ph.D.]
Phone number(s): +263 7 8 3530428, + 81 6-6605-2818

What you should know about this research study:

- We give you this consent so that you may read about the purpose, risks, and benefits of this research study.
- The main goal of research studies is to investigate the relationship between nutrition knowledge, practices and beliefs, physical activity, and the risk of high blood pressure, diabetes, high blood cholesterol among adolescents in Harare.
- We cannot promise that this research will benefit your child. Just like regular care, this research can have side effects that can be serious or minor.
- Your participation is voluntary, you have the right to refuse to allow your child to take part or agree for your child to take part now and change your mind later.
- Whatever you decide, it will not affect your child's regular care.
- Please review this consent form carefully. Ask any questions before you decide.

Purpose

You are being asked to allow your child to participate in a research study of **obesity (excess body fat) and** how it is connected to diet, exercise, and nutrition knowledge**.** The purpose of the study is to assess the prevalence and causes of overweight and obesity and the risk of high blood pressure, lipid, cholesterol and, glucose in school learners in Harare, Zimbabwe**.** Your child was selected as a possible participant in this study because he/she is an adolescent and

currently attending high school in Harare**.** There are approximately 500 participants in the study in Zimbabwe.

Procedures and duration

If you decide to allow your child to participate, your child will undergo an orientation program for him/her to understand the purpose of the survey and the protocols that will be followed. On the day of the survey, your child will be asked to skip breakfast and be in a fasting state. In this case fasting means that he/she should not eat or drink anything 8 hours before the survey begins. When the survey begins, to prevent the risk of COVID 19 infections, participants will have their temperature checked, it will be mandatory to wear a mask and sanitize their hands before handling any survey material. The participants will be asked to fill in a questionnaire in a quiet, comfortable, and well-ventilated room. Upon completion of the questionnaire, the participant`s height, weight, blood pressure will be measured, and finger prick blood samples will be collected. To follow standard procedure, first, the area on the finger to be pricked will be disinfected, a new lancet will be used to prick each student and a new test strip will be used to collect the blood. The blood will be analyzed immediately by an automatic lipid profile, cholesterol and glucose analyzer and the results will be recorded. The blood test strips will be discarded immediately in a biohazard container for further incineration. On the survey day, the whole procedure will take less than one hour.

Risks and discomforts

A qualified nurse will carefully collect the blood samples thus minimizing any risks associated with the procedure. A new lancet and test strip will be used on each student. The finger prick will cause a mild discomfort which should gradually disappear with time. After the procedure, there is no likelihood of serious risks or inconveniences to the child -including health, legal, economic, and psychological risks

Benefits and/or compensation

We cannot and do not guarantee or promise that your child will receive any benefits from this study.

Confidentiality

If you indicate your willingness for your child to participate in this study by signing this document, we plan to disclose the questionnaire responses, lipid, cholesterol, and glucose test results to the Universities affiliated with this research. Each participant will be assigned an

identity number which will be printed on the questionnaire. However, any information that is obtained in connection with this study that can be identified with your child will remain confidential and will be disclosed only with your, and when appropriate, your child's permission. Under some circumstances, the MRCZ and the local Institutional Review Board may need to review participants records for compliance audits.

Additional costs

No additional costs will be designated to the guardians or participants as part of this research. All the expenses for the research material will be covered by the investigators.

In the event of injury

In the event of injury resulting from your child's participation in this study, treatment will be offered by the study. You should understand that the costs of such treatment will be the study's responsibility. **In the event of injury, contact Dr. Tonderayi Matsungo (+263783530428)**

Voluntary participation

Participation in this study is voluntary. If you decide not to allow your child to participate in this study, your decision will not affect your or your child's future relations with this institution, its personnel, and associated hospitals**.** If you decide to allow your child to participate, you and your child are free to withdraw your consent and assent and discontinue participation at any time without penalty.

OFFER TO ANSWER QUESTIONS

Before you sign this form, please ask any questions on any aspect of this study that is unclear to you. You may take as much time as necessary to think it over and if you need further explanation please contact **contact Dr. Tonderayi Matsungo (+263783530428).**

Family health check list

Have you or a close family member been diagnosed of the any one of the chronic diseases listed below? Yes ☐ No ☐

If yes, please put a tick on the type of chronic disease.

Diabetes ☐

High blood pressure ☐

High cholesterol ☐

AUTHORIZATION

You are deciding whether to allow your child to participate in this study. your signature indicates that you have read and understood the information provided above, have had all your questions answered, and have decided to allow your child to participate.

_____ _____

Name of Participant/Adolescent *(please print)* Date & time

_____ _____

Signature of Parent or guardian *(please print)* Date& time

_____

Relationship to the Child

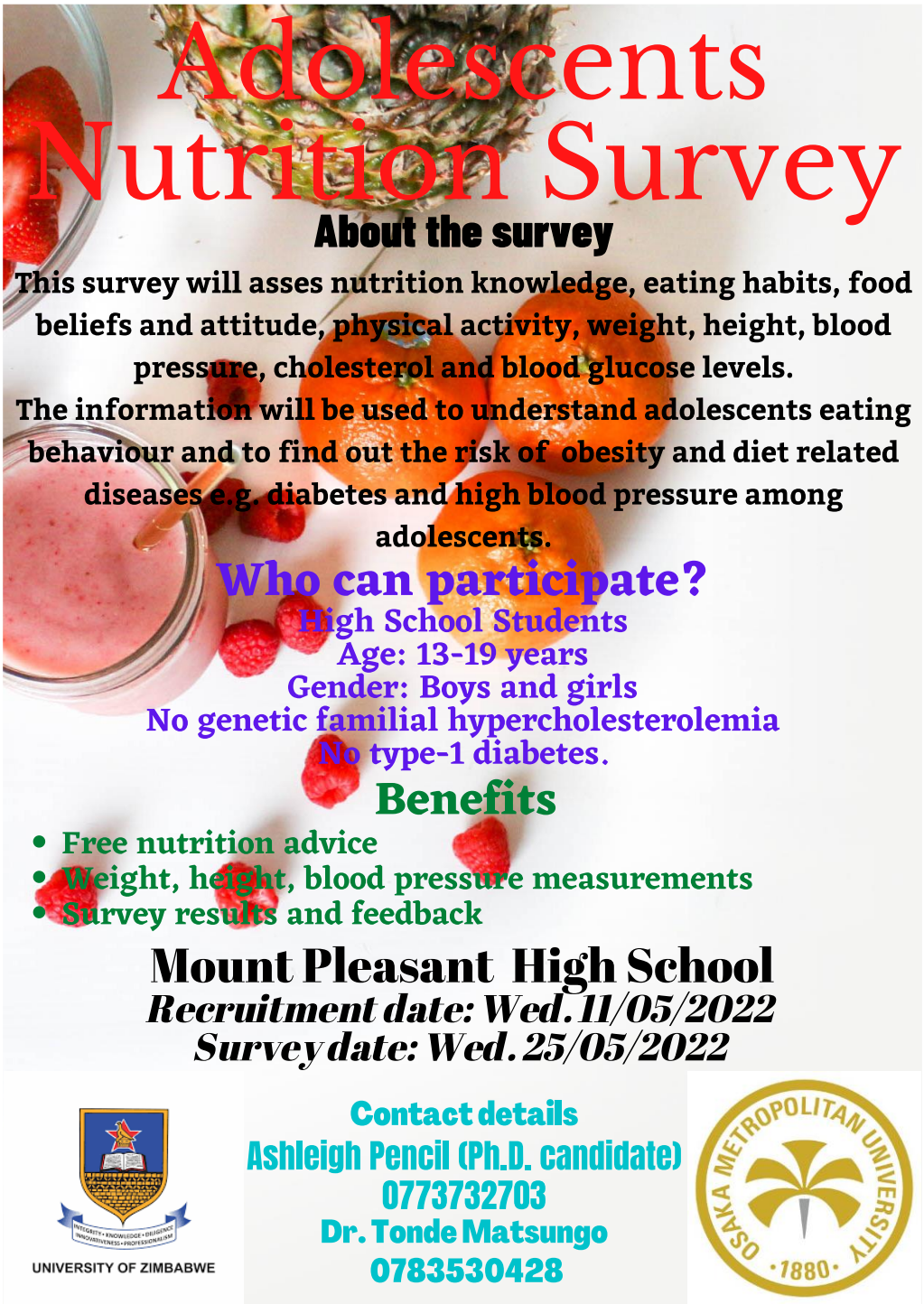
_____ _____ _____

Name of research stuff Signature Date & time

YOU WILL BE GIVEN A COPY OF THIS CONSENT FORM TO KEEP.

If you have any questions concerning this study or consent form beyond those answered by the investigator, including questions about the research, your rights as a research participant or research-related injuries; or if you feel that you have been treated unfairly and would like to talk to someone other than a member of the research team, please feel free to contact the Medical Research Council of Zimbabwe on telephone (242) 791792/791193 and 0784956128 or the following address:

Appendix 5: Sample Survey Poster



Appendix 6: Orientation SOP

Research Title: An Analysis of the Determinants of Overweight and Obesity among High School Students in Harare, Zimbabwe.

Objectives

1. To assess the nutrition knowledge, eating habits, physical activity levels, and nutritional status (BMI, Waist to height and waist-hip ratio) among school adolescents aged 13-19 years.
2. To assess their psycho-social determinants and perceptions (attitudes, beliefs, practices) on the individual's risk of obesity and its modifying factors.
3. To assess the barriers and enablers for diet modification among targeted adolescents.
4. To assess the cardiometabolic risk and co-morbidities (blood pressure, blood glucose, haemoglobin, lipid levels) among adolescents.

Purpose

Adolescent nutrition studies are very few in Zimbabwe. Adolescents are tomorrow's adults therefore it is important to invest in their health earlier. This survey will assess the eating habits, nutrition knowledge and physical activity and determine how they are all related to obesity among adolescents. Furthermore, we want to assess their attitudes and beliefs towards food to know if they will be able to change their eating behaviour where there is a need. Lastly, we want to assess the risk of diet related non communicable diseases like high blood pressure and diabetes among adolescents.

Method

- You are kindly being asked to skip breakfast on the data collection day.

1. **Finger prick blood sampling.**

   This will be used to measure the amount of blood sugar and cholesterol in your blood. Your index finger will be pricked using a new lancet, new blood sugar and cholesterol test strips will be used to test a tiny drop of your blood. After that, the nurse will cover the pricked area with a new Band-Aid. You will

experience mild discomfort on your finger; however, this discomfort will only last a few minutes.

2. **Measurements**

   Your weight, heigh, waist circumference and hip circumference will be measured and recorded. When recording your height and weight, you are being kindly asked to take off your shoes before stepping on the scales.

3. **Questionnaire**

   You will be asked to fill in a questionnaire. Before filling it out, the research assistants will explain its contents and they will be on standby to support you if you have any questions. Please fill in every section of this questionnaire and leave no blanks. The questionnaire is not test, so please be a truthful as possible and where you are not sure, ask the assistance for help. After filling in every section, take you questionnaire to the assistant who will check it for completeness.

4. **Snack time**

   Thank you for your cooperation, at this stage you have completed the survey. You can now go to the snack station and choose a fruit; pick your water bottle and you will be free to go.

5. **Consent**

   The consent form is for your parents/guardians allow you to participate in this survey. You cannot participate without their permission. After they sign, they consent form, please take it back to school and give it to your school health master within one week. If you lose your form please notify the health master immediately.

6. Questions and answer time
7. Distribution of consent
8. End by thanking the teachers and students and tell them the survey date.

Appendix 7: Recruitment SOP

What to do when you arrive at a school

- Contact the School health master

1. Greetings
2. Collect registers for forms 2-5
3. Calculate the sampling interval
4. Select the participants
5. Gather the selected participants for an orientation
6. Orientation
7. Question and answer session
8. Distribute consent forms
9. Ask the participants hand in the consent forms within 1 week

- Target age group: 14-17 years (form 2-5)
- Participants selection method: Systematic random sampling.

Calculation of sampling interval

(i)= N/n

(N= total number of students/stream)/ (n= the number of students we want per stream:12)

Example
Gateway has 3 form 2 classes with 35 students each and 3 form 5 classes with 25 students. Calculate the Sampling intervals for form 2 and form 5.

Answer

1. **Form 2**
   (i)= N/n = (3X35)/12 =105/12 = 8.75 =8

2. **Form 5**
   (i)= N/n =(3X25)/12 =75/12 = 6.25 =6

Explanation
1. In the form 2 stream, you will select every 8^{th} student on the register
2. In the form 5 stream, you will select every 6^{th} student on the register.

Appendix 8: Recruitment and survey procedure

Research Title:

An Analysis of the Determinants of Overweight and Obesity among High School Students in Harare, Zimbabwe

Objectives

1. To assess the nutrition knowledge, eating habits, physical activity levels, and nutritional status (BMI, Waist to height and waist-hip ratio) among school adolescents aged 13-19 years.
2. To assess their psycho-social determinants and perceptions (attitudes, beliefs, practices) on the individual's risk of obesity and its modifying factors.
3. To assess the barriers and enablers for diet modification among targeted adolescents.
4. To assess the cardiometabolic risk and co-morbidities (blood pressure, blood glucose, haemoglobin, lipid levels) among adolescents.

Participants' selection

- ✓ Total number of schools : 10
- ✓ Number of participants per school: 48
- ✓ Number of participants per stream: 8

Inclusion criteria

- ✓ Students enrolled in the selected schools. Schools were selected randomly by socio-economic-geographical locations.
- ✓ Age: 13-19 years
- ✓ Sex: Boys and girls
- ✓ Good physical condition on survey day

Exclusion criteria

- ✓ Students without consent forms
- ✓ Students with genetic familial hypercholesterolemia and type 1 diabetes
- ✓ Students below 13 years and over 19 years.
- ✓ Students not feeling well or have a fever on the survey day

Method

Pre- survey

1. **Selection of participants**

Participants will be selected randomly with the help of class teachers and nutrition teachers (were possible). The target is 6 students per stream and 48 students per school.

2. **Orientation**
   Participants will be given a thorough explanation of the objectives of the survey. I addition to this, a background of adolescents' nutrition will be given which will be followed by a question-and-answer session.

3. **Distribution of consent forms**
   The selected students will be given two consent forms for their parents/guardians to sign. One signed copy is for the parents/guardians to keep at home and the other copy should be handed over to the teacher in charge of managing the students in preparation for the survey. All students should hand in the signed consent forms before the survey day.

Survey day

4. **Consent forms**
   It is mandatory that the participants present their signed consent forms. Selected participants without consent forms will not be able to participate in the survey.

5. **Fasting state**
   We kindly ask that the students skip breakfast on the survey day. This helps in the collection of accurate data during blood sampling. Participants will be able to eat as soon as all the data has been collected.

6. **Anthropometric measurements**
   - ✓ Weight (kg) and height (m^2)
   - ✓ Waist and hip circumference

7. **Blood glucose, Blood Pressure, and Cholesterol measurements**
   Blood pressure will be tested using an Omron upper arm sphygmomanometer White HCR 7104. Blood samples (finger-prick blood) will be collected used for the estimation of lipid, cholesterol, and glucose levels. After the collection of blood samples using test strips, lipid analysers and glucometers will be used to analyse the samples and the test strips will be discarded immediately after the results are recorded. A registered nurse will oversee all blood samples.
8. **Questionnaire**
   The participants will be given a questionnaire to fill out. The survey stuff will explain the details of the questionnaire and they will attend to any questions the participants may have. Participants are required to completely fill out the

questionnaire and leave no blank spaces. Once they finish, the survey stuff will check the questionnaires for completeness before the participants are dismissed.

After the survey

9. **End of survey**
   After all the data has been collected the participants will be thanked and allowed to go. The survey stuff will clean up their designated area, meet the teachers in charge and Headmaster for a vote of thanks and bidding farewell.

Additions

10. **COVID 19 prevention**
    Participants are required to wear masks and sanitize their hands before and after handling survey material. We will provide masks for those may have forgotten to bring their own.

11. **Working space**
    We kindly ask for a designated working area i.e., a well-ventilated and clean classroom or hall with desk and chairs. We want to ensure the utmost comfort and safety for our participants in line with WHO COVID 19 prevention.

12. **Privacy assurance and handling of data**
    The questionnaire will be coded but we assure you that the identity of the participants will remain anonymous. The data will be stored under lock and key in a safe and secure place.

13. **Survey results and dissemination**
    The results of this survey will be distributed to the schools at a much later date when all the data analyses have been completed.

Ethics

This survey is in compliance with the Ministry of Primary and Secondary Education and the Medical Research council of Zimbabwe (MRCZ/A/2857).