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The Prevalence and Factors Associated With Cardiometabolic Risk Among Urban in-School Adolescents in Harare, Zimbabwe

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ABSTRACT *Background:* Obesity and cardiometabolic health risks (CMR) an emerging health problem in Zimbabwe. Nutrition education for adolescents plays a pivotal role in preventing both obesity and CMR. *Objective:* To assess the prevalence and factors associated with CMR among adolescents in Harare, Zimbabwe. *Method:* A cross-sectional survey using a questionnaire was carried out with 320 in-school adolescents. Blood measures for blood pressure (BP), glucose (FG), and total cholesterol (TC) were assessed using standard methods, and body mass index (BMI), and waist-to-hip ratio (WHR), waist-to-height ratio (WtHR) were calculated. Pearson`s Chi-square and binary logistic regression were used to test for associations and explored factors associated with CMR ($p < 0.05$). *Results:* The median and IQR range age for the participants was 16 (14;19) years. The prevalence of obesity was 17.1% and CMR was 24.7%, both of which were higher among girls compared to boys. CMR was significantly associated with living in high economic status (HES) neighbourhoods [OR = 3.09(1.29, 7.38), p = 0.011], inadequate nutrition knowledge score [OR = 1.38(1.96-7.77), p < 0.001], inadequate physical activity [OR = 2.28(1.25-4.15), p = 0.007] and increased BMI [OR = 1.18(1.10-1.27), p < 0.001]. *Conclusions:* The prevalence of obesity and high CMR appears to be higher among girls compared to boys, particularly from affluent neighborhoods. This gender disparity could be due to socio-cultural beliefs which may hinder the translation of nutrition knowledge to practice. Therefore, community-based nutrition interventions to raise obesity and CMR awareness are needed to improve nutrition knowledge while promoting healthy eating habits to increase fruit and vegetable consumption to reduce the prevalence of obesity and CMR among adolescents.
Keywords: Obesity, adolescents, diabetes, hypertension, CMR, Zimbabwe

INTRODUCTION

Adolescents are aged between 10-19 years (1). Although this stage is seen as a healthy stage of life, risks of preventable diseases, illnesses, and conditions like obesity exist (2). Overweight and obesity are caused by excess fat accumulation in the body which presents health risks (3) and is commonly measured using the body mass index (BMI) (4, 5). Obesity is a global public health problem that is often associated with several non-communicable diseases (NCDs) and increased cardio metabolic risk (CMR) attributable to nutrition transition and poor dietary habits (6-8),.

Low-income countries are facing an emerging problem of obesity which often co-exists with hunger, micronutrient deficiencies, and undernutrition, *"multiple burdens of malnutrition."*(9) In Africa, the prevalence of obesity among children and adolescents ranges from 5% to 16.5% (10, 11). In Zimbabwe, the rate of obesity has exponentially increased over the years with prevalence ranging from 5.8% to 27.3% (12-15). CMR is a pattern of metabolic imbalances manifested as central obesity, hypertension, hypercholesterolemia, and hyperglycaemia (16, 17). The presence of any one or two of these constitutes early markers of the risk (18). 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 (19). 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 (20). 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 (21).

Interestingly, sedentary lifestyles and the consumption of unhealthy foods are the key drivers of obesity among adolescents in urban areas (14). Although limited studies and data exist on the factors associated with obesity and/or CMR in Zimbabwe, socio-cultural practices and community perceptions that an increase in body fat "obesity" is a sign of wealth, social status, and beauty still exist (22). As a result, there is a lack of urgency regarding CMR screening among adolescents, *"the neglected age*

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group", as there is still a belief that CMR only affects adults and the elderly (23). Therefore, the purpose of this study was to assess the prevalence of obesity, CMR, and associated determinants among in-school adolescents and to propose interventions to tackle obesity and promote healthy dietary behaviors among adolescents in Harare, Zimbabwe. and propose interventions to tackle obesity and promote healthy eating targeting the adolescents.

METHODS

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 (24). 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 (25).

Sample size and sampling technique

The sample size was calculated using the Dobson formula (26) 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, 320 school adolescents successfully participated in the study. A 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 locations and socio-economic zones, class level (form 2 to form 6) based on the Zimbabwean education system, and age groups (14–16 years and 17–19 years). 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 signed consent forms. Three hundred and twenty (320) participants were successfully enrolled in this study and on the survey day, a team of research assistants and one nurse were always present during the administration and blood sampling. 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.

Research instruments and data collection methods

Structured questionnaire: An interviewer-administered questionnaire was used to collect demographic data, food habits, nutrition knowledge, and information on physical activity (PA). The final questionnaire had four sections. Socio-demographic and anthropometry (10 questions), nutrition knowledge (20 questions), food habits (23 questions), and physical activity (7 questions). The questionnaire was adapted and scored as follows:

Nutrition Knowledge: This questionnaire was adapted from (27) and was categorized as inadequate (NKS <50%) or adequate (NKS ≥50%). The instrument was a practical and easy-to-administer tool with acceptable reliability among high school students. This section had three subscales: adequate and balanced nutrition, essential nutrients, and malnutrition-related diseases and the questions consisted of complete sentences of correct or incorrect statements. The Cronbach's alpha coefficient was 0.85 overall. An example of the nutrition knowledge question was, "We should drink at least 8-10 glasses of water every day" with (true, false, and not sure) answer options.

Food habits: This questionnaire was adapted from (28) and it had an internal reliability of Cronbach's α = 0.82. The FHS was calculated as follows:

FHS = No. of healthy responses × (23 No. of items completed)

Inadequate was (FHS < 50%) and adequate was (FHS ≥ 50%). An example of a food habits question was, "I try to ensure I eat plenty of fruit and vegetables."

Physical activity: This questionnaire was adapted from(29) and the physical activity score (PAS) responses were structured in different ways according to each question. The total score of the PA section was categorized as inadequate (PAS < 50%) or adequate (PAS ≥ 50%). It had an internal reliability Cronbach's alpha of 0.71. An example of a physical activity question was, "Do you usually practice any form of physical activity?"

Anthropometry: Height was measured to the nearest 0.1 m using the stadiometer (Leceister® Height Measure, Seca, UK), weight was measured using an electronic bathroom weighing scale (Sunbeam, South Africa), and waist and hip circumferences using the non-elastic tape measure, (Goldfish, UK). The nutritional status of the participants was determined using WHO standard protocols for children 5–19 years (30). Body Mass Index (BMI), kg/(m^2) was converted to *z*-scores 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). While waist circumference (WC) ≥90th

percentile for children and adolescents is defined as abdominal obesity (31). Waist hip ratio (WHR) was classified as abnormal in males if the ratio was ≥0.9 and ≥0.85 in females. Waist-to-height (WHtR) was classified as at high risk of abdominal obesity if the ratio was ≥0.5 (32).

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 mm Hg. Elevated BP: 120/< 80 to 129/ < 80 mm Hg (30) Elevated BP, Stage 1 (130/80 to 139/89 mmHg) and Stage 2 (≥ 140/90 mmHg) (33). 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) (34). 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 (35).

RESULTS

Cardiometabolic indices (CMI) included fasting glucose (FG) and total cholesterol (TC), blood pressure (BP) 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 presence of any two high cardiometabolic indices and high risk was defined as the presence of three or more indices.

Table 1: Prevalence of cardiometabolic health risk across participants' demographics

		Cardiometabolic health risk			
Variable		**Total n (%)**	**Low Risk n (%)**	**High Risk n (%)**	***p*-value**
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: 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).

Socio-demographic characteristics

The summary of 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 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%).

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

Table 2 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 2: The interplay between cardiometabolic health risk by nutrition knowledge, food habits, and physical activity levels

		Cardiometabolic health risk			
Variable		**Total n (%)**	**Low Risk n (%)**	**High Risk n (%)**	***p*-value**
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) is adequate at≥ 60 minutes and inadequate at <60 minutes. Different subscript letter and (*) indicates that the CMR categories differ significantly (p<0.05).

Nutrition status of the adolescents

The results of the current study (**Figure 1)** revealed that obesity affected 17.1% of adolescents with high proportions among girls compared to boys (p=0.030), while the underweight status (23.0%) was higher among boys than girls (p=0.030)

Summary of the cardiometabolic indices for 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 3).**

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 food habits score [OR= 0.66(1.02-3.64), p = 0.043, inadequate nutrition knowledge score [OR = 1.36(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 4).**

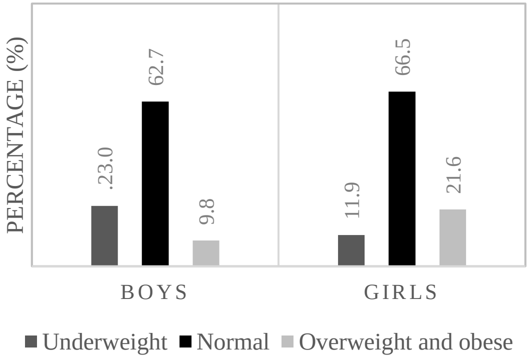

Figure 1: The distribution of nutrition status of adolescents by sex

Table 3: Clustering of cardiometabolic indices among adolescents by sex and age group

		Gender						Age Group			
Variable		**Total n (%)**	**Male n (%)**	**Female n (%)**	***p*-value**	**Variable**		**Total n (%)**	**14-16 years n (%)**	**17-19 years n (%)**	***p*-value**
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)	
WtHR	**Low Risk**	278 (89.7)	116_a (95.1)	162_b (86.2)	**0.012***	**WtHR**	**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***	**BP**	**Low risk**	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 risk**	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)		**WHR**	**Low risk**	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)	**0.023***		**High risk**	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***	**TC**	**Low risk**	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)			**High risk**	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	**FG**	**Low risk**	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)			**High risk**	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).

Table 4. 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.

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, (13, 14, 36) and studies from other African countries (37, 38).

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 (39-42). Our findings show that higher percentages of adolescents are consuming high-fat 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 the adult population in Zimbabwe consumed at least 400 g per day of fruits and vegetables recommended by WHO (36). Despite the enormous benefits and existing dietary recommendations, most Zimbabwean adults do not meet the daily requirements and adolescents can easily adopt the behaviour in a family setting (43).

A recent study on adolescent obesity in Zimbabwe revealed that adolescents lack obesity awareness and it is not as serious as other health problems and conditions (44). 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 (44, 45). It has been observed that the rate of obesity is higher among girls than boys (13,46, 47). However, the finding that CMR risk appears to be higher in girls compared to boys as well is a cause for concern as this could indicate problematic dietary behaviours within this sex. On the contrary, it is reported that boys are more obese than girls in developed countries like North America and Japan (49, 50). 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. Hormonal fluctuation particularly women across the lifespan influence appetite and body fat distribution (48, 49). 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 (51). In Japan, girls in higher-grade classes and young women generally want to be thin (52) due to media influences on this body ideal (53) however, in Zimbabwe girls want to be plump and curvy as they believe it makes them more attractive (12, 51). Additionally, it is a common belief that a plump child is healthy, and a slim child is unhealthy. Therefore these beliefs result in parents overfeeding their children, while adolescents voluntarily overeat (12, 44). 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 take into account the array of factors that maintain these preferences.

Place of residence and CMR: It is known that socioeconomic environments have a huge influence on obesity and cardiometabolic health (57). Our results showed that adolescents who live in affluent suburbs and families have a higher 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 (58, 59). In many African countries including Zimbabwe, people believe that when they earn more, they should eat more because wealth and happiness are physically shown by being fat (22). In addition to socio-cultural beliefs, this contrast between Zimbabwe and other developed countries could be a result of the nutrition transition. Zimbabwe is between stages 3 and 4 of the nutrition transition, (12) and is far behind most developed countries regarding health behavioural change. Stages 3 and 4 are characterised by social and economic changes which cause 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 (60, 61). 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 raise obesity and CMR awareness while promoting healthy shopping and eating habits (57, 58).

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 (64). The result contradicts a recent finding from Harare, Zimbabwe that reported that the majority of the adolescents had adequate nutrition knowledge but were obese (13). Although it was previously reported to be adequate, it is possible that it is not always translated into practice (15). 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 were 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 into practice is the genesis of sustainable and effective nutrition interventions to reduce obesity and the associated CMR (65).

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 sedentaryism, 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” (44). Nutrition education programs 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 a 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. It is anticipated that these findings will enable dieticians and nutritionists in Zimbabwe to consider obesity and CMR as health threats and plan nutrition activities accordingly.

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 fast 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.

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. 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. 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). Therefore, 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 fruit and vegetable consumption. These strategies should help to reduce the prevalence of obesity and CMR among adolescents.

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CONFLICTS OF INTEREST (COI)

The authors have no conflicts of interest to disclose.

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