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Nutritional status and dietary habits of urban and peri-urban primary school children (10-13 years) in Tanzania: A comparative study between public and private schools

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Abstract

This study determined overweight and obesity prevalence and its association with dietary habits in primary school children in Ilala and Mkuranga Districts, Tanzania. A comparative cross-sectional survey was carried out among 406 school children (10-13 years). Indices such as weight, height, mid-upper arm circumference, and body composition were measured. Body Mass Index-for-age-related Z-scores were computed using the World Health Organization's AnthroPlus™ software to classify children's nutrition status according to the defined cut-off values. A structured questionnaire collected dietary habits data. Descriptive, non-parametric methods and regression were used for analysis. A combined prevalence of overweight and obesity was 22.6%, significantly higher in private than in public schools (32.4% vs. 14.8%, $p<0.001$). Prevalence of thinness was 3.9% and stunting was 10.1%. It is clear that medians for body mass index for age ($p=0.002$), percentage body fat ($p<0.001$), and mid-upper arm circumference ($p<0.001$) were significantly higher in private schools than in public schools. Girls also had higher median BMI-for-age ($p=0.021$), percentage body fat ($p<0.001$), and mid-upper arm circumference (0.006) than boys. Consumption of fruits, vegetables, and milk was relatively low in all participants. Intake of cereal foods and sugary snacks among boys and low preference for fruit among girls was associated with high median BMI-for-age ($p<0.05$). The prevalence of overweight and obesity among school children is high. Median BMI-for-age was associated with selected dietary habits. Context-specific school-based interventions are fundamental in reducing the prevalence of overweight/obesity and modifying the dietary habits of school children after formulating policy options.

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Introduction

Overweight and obesity in children is currently considered to be a significant public health problem (Mosha and Fungo, 2010; Adom *et al.,* 2019) which has exponentially increased worldwide in recent decades (Peltzer and Pengpid, 2011; Frignani *et al.,* 2015; Corvalán *et al.,* 2017). Despite the heavy burden of under-nutrition, overweight and obesity rates are increasing, causing double burden threats in developing countries (Mekonnen *et al.,* 2018). Prior studies in Tanzania have indicated an increase in overweight and obesity prevalence among primary school children rising from around 5% to more than 20% between 2010 and 2016 (Mosha and Fungo, 2010; Muhihi *et al.,* 2013; Mwaikambo, 2015; Pangani *et al.,* 2016). However, evidence is limited in terms of dietary factors contributing to this rise, and nationally representative data among school children is lacking. Available national data shows an increase in the prevalence of overweight and obesity in the study regions among women of reproductive age. In Dar-es-Salaam the prevalence was 24.6%, and 24.0%, for overweight and obesity, respectively, and in Pwani the prevalence was 26.0% for overweight and 17.1% for obesity. The levels are above the national average of 20.2% overweight and 11.5% obesity (Tanzania National Nutrition Survey, 2018). This observation may translate into a similar trend among children living in the respective districts and regions. Given that large numbers of food vendors were found in Dar-es-Salaam city, including school premises and 80% of school children purchased food from these vendors (Marras, 2018). The risk of being overweight or obese is due to increasing exposure to the consumption of unhealthy foods.

Findings from studies in Tanzania were obtained using different diagnostic criteria and different age groupings, including children below ten years, thus making a comparison of prevalence difficult. Most studies used body mass index (BMI) as the leading indicator to define the prevalence of overweight and obesity in children, seldom linking them with dietary habits. This study used several indicators to classify overweight and obesity and to associate nutrition status with selected dietary habits, namely BMI-for-age, percentage body fat, and mid-upper arm circumference (MUAC).

In children and adolescents, BMI is age- and gender-specific, which is often referred to as BMI-for-age. It is calculated by dividing body weight in kilograms (kg) by height in meters squared (m^2) like in adults, but it is expressed in percentiles or Z-scores (Adesina *et al.,* 2012). These percentiles and Z-scores express a child's BMI in relation to other children of the same gender and age. However, BMI-for-age cannot separate other parameters, such as lean mass, bone mass, and fat mass (Papandreou *et al.,* 2010; Laurson *et al.,* 2011); hence, other tools like bioelectric impedance analysis (BIA) can be used to assess body fat in children. The BIA analysis is low cost, easy to use, convenient, and is more feasible to access than other complex methods (Papandreou *et al.,* 2010; Laurson *et al.,* 2011). The BIA has shown the same reliability compared to an expensive method like dual-energy X-ray absorption (DXA) (Marques-Vidal *et al.,* 2008). We also acknowledge the use of Deuterium Dilution Isotope in BMI determination (IAEA, 2010), which was not used in the current study. MUAC is a simple to use, inexpensive and non-invasive method. It helps study indicators of nutritional status across different age groups (Jeyakumar *et al.,* 2013) and can be applied in large populations (Mogendi *et al.*, 2015). Nevertheless, it measures mainly muscle mass and lacks reproducibility (Craig *et al.,* 2014).

Obesity is caused by a change in behavioral and environmental factors, including increased intake of high energy-dense diets (Hebestreit *et al.,* 2012; Joy *et al.,* 2017) and sedentary lifestyle associated with reduced physical activity (Hanandita and Tampubolon, 2015). High energy-giving foods and sweet drinks are readily available in the school environment (Vargas *et al.,* 2013). They can promote consumption by school children since they can increase perceived hunger (Neeley, 2011). Dietary habits of public and private school children may vary due to availability and accessibility of foods, therefore comparing their dietary behaviors may shed light on proposing measures to improve their eating habits.

Many studies have defined obesity as an excessive increase in body fat which may be linked to the occurrence of dietary-related chronic diseases (Musa *et al.,* 2012; Mohammed and Vuvor, 2012; Wamba *et al.,* 2013; Mekonnen *et al.,* 2018) which, in the past, were exclusively observed in adults and developed countries (Rao *et al.,* 2016; Ulbricht *et al.,* 2018).

The comorbidities include type 2 diabetes, insulin resistance, hypertension, dyslipidemia, breathing problems, and fatty liver diseases (Papandreou *et al.,* 2010; Naeeni *et al.*, 2014). In addition, psychologically, obese children potentially face harassment, teasing, and stigma from their peers and communities around them (Rankin *et al.,* 2016).

There is limited information on dietary habits and their influence on overweight and obesity among school children in Tanzania. Therefore, this study aimed at determining overweight and obesity prevalence in selected urban and peri-urban public and private schools in Tanzania and compared BMI-for-age against dietary habits of school-aged children from 10 to 13 years. Specifically, as it is hypothesized that school children are increasingly overweight/obese as a result of poor dietary habits. The public schools are owned by the government; in these schools, pupils are sponsored by the government of Tanzania, whereas private are schools belong to individuals or companies. In these schools, parents are responsible for paying school fees and all other school requirements (Lassibille and Tan, 2001).

Methodology

Study location

The study was conducted in Ilala District, Dar-es-Salaam Region, and Mkuranga District, Pwani Region. These regions were selected due to the previously reported high prevalence of overweight and obesity in the adult population (Tanzania National Nutrition Survey, 2018). Dar-es-Salaam is the largest city in Tanzania, with a population of 6.37 million in 2019 (https://www.macrotrends.net/cities/22894/dar-es-salaam/population) and Ilala district had 1.2 million inhabitants by the year 2012 (National Bureau of Statistics, 2013). The Indian Ocean borders it to the east and Pwani region to the South, West, and North. Pwani Region has a population of 1.1 million, with Mkuranga district having 222,921 inhabitants (National Bureau of Statistics, 2013). The Lindi region borders the region to the South, the Morogoro region to the West, Tanga region to the North. To the East, it is bordered by the Dar-es-Salaam region and the Indian Ocean. Major economic activities of the two areas include business, manufacturing companies, farming, livestock keeping, and fishing (National Bureau of Statistics, 2013).

Study design, population, and sampling procedure

A cross-sectional study was conducted between July and September 2019. All children between the ages of 10 and 13 years attending schools in selected wards within the selected districts were eligible for the study. Children with physical and mental disabilities, known chronic diseases like diabetes, and already on weight management programs were excluded from the study. A summary of the sampling procedure is presented in Fig. 1. Briefly, random sampling was used to select two wards in Ilala District, while in Mkuranga District, two wards were purposively selected based on their peri-urban characteristics. Stratified random sampling was used to choose a total of eight public and private schools, four schools per district, two schools per ward (1 public, 1 private). Due to the inadequate number of children in private schools in Mkuranga Ward another private school was added to obtain a desirable sample size.

Sample size determination

The sample size was estimated using the WHO STEPwise Manual (2005). $n=Z^2P(1-P)/e^2$

Where; n = desired sample, Z = level of confidence (1.96) corresponding to 95% CI, P = baseline level of indicators (proportion of target population was 50% since no previous data which reflect reality), e =

margin of error (recommended 0.05). Therefore n = $(1.96)^2 * 0.5(1-0.5)/(0.05)^2 = 384$. Adjusting for design effect of 1.0 and for non-response rate (10%) = 0.9, Therefore 384*1.0/0.9 = 426.6. A sample size of 427 children was obtained. By using a table of random numbers, a desired number of children were chosen from each of the 9 schools.

Pre-testing and Interviews

A comprehensive, structured questionnaire was developed to collect information from respondents, namely, demographic information of parents and school children, anthropometric and body composition assessments of children, and dietary habits. The questionnaire was written in English and translated to Swahili, a predominant local language for participants. Before data collection, two research assistants were trained on questionnaire administration and taking body measurements. The questionnaire was pre-tested in other schools which had similar characteristics to study schools. The questionnaire was modified for clarification by adding some information on demographic characteristics, dietary habits and modifying the codes. Face-to-face interviews were conducted with parents who provided information on demographic characteristics, such as the age of the child, marital status, occupation, ward of residence, and maternal education level. Children provided information on their grade/class, dietary habits and participated in anthropometric measurements. Interviews and measurements were performed during break times to avoid class interruption.

Anthropometric assessment

Weight was measured using a weighing scale (Digital SECA™). Without shoes and with minimum clothes, children stepped onto a zero-calibrated weighing scale, and weight was read and recorded to the nearest 0.1 kg. Height was measured by a SECA™ mechanical stadiometer platform placed on a flat surface. Without shoes, children stood with their back, heels, buttocks, shoulders, and occiput touching the height board/stadiometer and hands hanging freely at the sides. The headpiece was then slowly lowered over the head of the child, and height was read and recorded to the nearest 0.1 cm. BMI-for-age (computed from weight and height data) and height-for-age were analyzed using the WHO's AnthroPlus software to determine the nutritional status of school children. The WHO Growth Reference (2007) for children aged 5-19 years classifies children above +1SD as overweight, which is equivalent to 25 kg/m^2 cut-off for adults, and above +2SD (29.7 kg/m^2) as obese, which is close to adult's cut-off of ≥ 30.0 kg/m^2 (De Onis *et al.*, 2007). In the AnthroPlus™ manual severe stunting is considered when HAZ-score is <-3SD and moderate stunting when HAZ-score is between >-3SD and <-2SD (WHO 2009). MUAC was measured using non-stretchable tape. The mid-point between the tip of the scapula and elbow was found and used as a center for circumference measurement. The child's left arm was allowed to hang freely at the side, then MUAC was measured and recorded to the nearest 0.1 cm. Body fat mass was measured by a Bio-electric Impedance Analyzer (TANITA™-BF-350, America). In this instrument, the child's age, sex, and height were entered before the impedance measure. A single foot-to-foot BIA device was used and a drop of saline solution was regularly added to maintain the accuracy of the device. Without shoes and socks, children stood over the device with the feet directed into BIA foot sensors to ensure optimal contact. Percentage body fat was captured and then recorded. The device was zeroed before and after each measurement. The cut-off value (25% for boys and 30% for girls) has been used to define obesity in children (Marques-Vidal *et al.,* 2008).

Dietary habits of school children

A structured and validated food habits questionnaire adapted from Jezewska-Zychowicz *et al.* (2017) was used to collect information on the dietary habits of school children. Questions included were; the number of meals per day; main staple and relish (relish is a prepared side dish/food, mostly spiced food item from animal or vegetable source which serves to enhance palatability of staple) preferred most; preference to fruits and vegetables, snacks consumption; frequency of consumption of foods;

foods preferred during school hours, and the number of times of eating during school hours. Other questions were on eating patterns such as eating with other family members and while watching television. For further analysis, food varieties, such as fruits, vegetables, and snacks, were grouped to obtain one variable for each group. For example, fruits were recorded into one variable, which combined the most preferred fruits, such as mangoes, oranges, avocado, ripe banana, watermelon, and pineapple. The most preferred green leafy vegetables were recorded into labels of sweet potato leaves, spinach, amaranths, pumpkin leaves, and cassava leaves. Furthermore, most consumed foods at school were recorded into cereal foods; comprised of stiff porridge (a maize meal product in the African diet), rice and spiced rice (*pilau*), fried foods/snacks combined of fried cassava, potato samosa, and *kachori* (a deep-fried mashed round and colored potato ball). Sugary snacks were recorded as cookies, biscuits, cakes, soda, ice cream, and tea/coffee, and salty snacks as (i.e., potato/banana crips and popcorn). Frequencies of food consumption were computed as one of three categories, "did not consume", "consumed one to three times a week", or "consumed four or more times a week". Food types were computed into categories of "did not consume," "consumed 1 or less, "consumed 1-3 or 2-3 types," and "consumed 3-4 food types."

Data analysis

Statistical Package and Service Solution (SPSS)™ Version 20 was used to perform all analyses. Descriptive statistics (i.e., frequencies, percentages, medians, mean, and standard deviation) were used to describe sample characteristics (gender, age, type of school, education level, marital status, parent's occupation) and compute mean intake of fruits, vegetables, and snacks. The Chi-square test was used to find out if there is any association between demographic characteristics and nutrition status among public and private schools children. The distribution of BMI-for-age data (dependent variable) was skewed (Shapiro-Wilk test $p<0.05$), thus, the non-parametric test Kruskal-Wallis for comparison of more than two group categories and Mann-Whitney U-test for comparison of two group categories were used to associate BMI-for-age with dietary habits (independent variables). Other skewed continuous variables were age, weight, MUAC, and percentage body fat. With non-parametric tests, median values are presented instead of mean values except for height values. BMI-for-age was categorized as thinness=1, normal=2, overweight=3, and obese and severe obese=4 (as classified under Table 3). Height-for-age was categorized into severe stunting=1, moderate stunting=2, and normal height=3. Similarly gender (male=1, female=2) and type of school (public=1 and private=2) were categorized. Pearson's correlation coefficient was used to associate median BMI-for-age, median percentage body fat, and median MUAC. Multivariable binary logistic regression was further used to associate overweight and obesity with selected dietary habits. BMI-for-age was further dichotomized into 1=non-overweight/obese and 2=overweight/obese (dependent variable) and dietary habits variables were considered as independent variables. Univariate analysis was performed to assess the association between each of the independent variables and being overweight/obese. Independent variables (dietary habits) that showed a probability value of <0.30 in the univariate analysis were entered into a regression model. Three tertiles were made for dietary habits; did not consume", "consumed one to three times a week", or "consumed four or more times a week". Food types were computed into categories of "did not consume," "consumed 1 or less, "consumed 1-3 or 2-3 types," and "consumed 3-4 food types." Furthermore, in each regression model, the first dietary habits were considered as a reference category. The significance level was considered at $p<0.05$.

Results

Socio-demographic characteristics of parents/guardians

Socio-demographic information was collected from 406 child-parent/guardians pairs (response rate was 95%): 189 parents/guardians from Ilala and 217 from Mkuranga districts; and 224 were from public schools and 182 from private schools.

Table 1. Socio-demographic characteristics of parents/guardians of study children.

Parameter	Total sample	Parents from public schools n (%)	Parents from private schools n (%)	p-value
	N=406	224 (55.2)	182 (44.8)	
Maternal education level				<0.001
Never went to school	16 (4.0)	15 (6.7)	1 (0.6)	
Primary school	185 (45.6)	143 (64.1)	42 (23.1)	
Secondary school	95 (23.5)	47 (21.0)	48 (26.4)	
College/university	109 (26.9)	18 (8.1)	91 (50.0)	
Marital status				<0.001
Never married	7 (1.8)	5 (2.3)	2 (1.1)	
Married	298 (74.7)	141 (64.7)	157 (86.7)	
Separated	18 (4.5)	17 (7.8)	1 (0.6)	
Divorced	39 (9.8)	30 (13.8)	9 (5.0)	
Widowed	19 (4.7)	14 (6.4)	5 (2.8)	
Cohabitating	18 (4.5)	11 (5.0)	7 (3.9)	
Occupation of mother				<0.001
Employed (formal/informal)	114 (28.1)	20 (9.1)	90 (49.5)	
Self-employed	163 (40.2)	108 (49.3)	55 (30.2)	
Farmer	18 (4.4)	17 (7.8)	1 (0.6)	
Business	43 (10.6)	27 (12.3)	16 (8.8)	
Homemaker	50 (12.4)	34 (15.5)	16 (8.8)	
Not applicable	17 (4.2)	13 (5.9)	4 (2.2)	
Family size				0.015
1-4 people	116 (28.6)	75 (33.5)	41 (22.5)	
Above 4 people	290 (71.4)	149 (66.5)	141 (77.5)	

p-values are from Chi-square test for comparison between groups.

All of the demographic variables (Table 1) differed significantly between parents/guardians of school children in public and private schools ($p<0.05$). The majority of mothers from public schools had primary school education, while a big proportion of mothers from private schools had attained higher education. Most parents (86.3%) of private school children were married. Nearly half of the mothers from private school children were employed in formal or informal sectors while 48.2% of mothers of children in public school were self-employed.

Median anthropometric measurements by gender and type of school and their correlations

A total sample had 188 (46.3%) boys and 218 (53.7%) girls with a median age of 12 years. Boys had higher median values for age and higher mean height than girls. Girls had higher median values for MUAC, percentage body fat, and BMI-for-age than boys. There was no difference in median weight values between boys and girls. Children from private schools had higher median values for weight, MUAC, percentage body fat, and BMI-for-age, and mean height than their counterparts in public schools ($p<0.001$). Using the cut-off value of 30% and 25% for girls and boys, respectively, the percentage of body fat was higher in girls (14.2%) than in boys (11.2%) (Results not shown in the table). In the Ilala district (urban), 15.5% of girls had a percentage body fat that exceeded the cut-off value of 30% for obesity, and 12.8% of boys had a body fat percentage that exceeded the cut-off value of 25% for obesity.

In Mkuranga district (peri-urban), 13% of girls and 9.8% of boys had higher values for body fat. There was a positive and strong association between BMI-for-age and percentage body fat ($r=0.811$, $p<0.001$), BMI-for-age and MUAC ($r=0.878$, $p<0.001$), and percentage body fat (r=0.811, p<0.001), BMI-for-age and MUAC (r=0.878, p<0.001), and percentage body fat and MUAC (r=0.820, p<0.001) (results not shown in the table). The correlation coefficient for BMI-for-age, MUAC, and percentage body was significant at level 0.01 after adjusting for the age and gender of children.

Table 3 shows the distribution of BMI-for-age and height-for-age based on school type. The overall prevalence of overweight and obesity was 14.5% and 8.1%, respectively. Children in private schools had a significantly higher prevalence of overweight and obesity compared to children in public schools (p<0.001). The overall prevalence of thinness in the general sample was 3.9%. Children in public schools were significantly thinner than children in private schools p<0.001). The proportion of children with normal weight was higher in public school children than in private schools. The prevalence did not differ between districts (urban and peri-urban) and between gender (p>0.05).

Table 2. Comparison of anthropometric measurements by gender and school type.

Parameter[1]	Overall n=406	Gender			Public n=224	Private n=182	
		Boys	Girls	p-value			p-value
Age (years)	12	12	11	0.006	12	11	<0.001
Weight (kg)	36.7	35.5	37	0.381	34.7	39.2	<0.001
Height (cm)[2]	143.6±7.9	144.5±8.3	142.9±7.6	0.049	142.4±8.0	145.2±7.7	0.001
MUAC (cm)	21.2	20.6	21.5	0.006	20.6	22.4	<0.001
Body fat (%)	16.1	12.4	19.4	<0.001	14.6	18.4	<0.001
BMI (kg/m^2)	17.5	18.1	17.8	0.021	17.1	18.1	0.002

[1]All values are medians except for height [2]Mean ± standard deviation.

The general prevalence of stunting in school children was 10.1% of which 1.0% of children were severely stunted. Most children from both public and private schools had the normal height for their ages. Children in public schools were found to be more moderately or severely stunted than children in private schools (p=0.003). No significant gender and district differences in the prevalence of stunting were observed in this study (p>0.05).

Eating patterns of school children

Generally, the majority (70%) of children from both public and private schools had 3-4 meals per day (data not shown in the table), although some (15.6%) children from public schools had 1-2 meals a day and 25.8% of children in private schools had 5-6 meals a day (p<0.001). During school days, the frequency of consumption of foods by many children (70% in public and 68% in private) was two or more times a day. Foods mostly consumed at public schools were potato samosa, fried cassava, and kachori and in private schools, the most consumed foods were rice and beans. More than half of the children (57%) in public schools ate together with other family members. In comparison, 43% of children from private schools ate less often with other family members and the difference between public and private schools was significant (p<0.001). More children from private schools (48.4%) vs. public (36%) preferred to eat while watching television (p=0.013). The most preferred foods during television viewing by both children included rice, ugali, and chips. Other foods like popcorn, biscuits, cakes, sweets and soft drinks were least preferred. However, the study found no associations between the eating patterns and BMI-for-age (p>0.05).

Preference and consumption frequencies of mostly liked fruits, vegetables, and snacks

The distribution of children by preference and consumption frequencies of mostly liked fruits, vegetables, and snacks are shown in Table 4. More than half of school children from public and private schools preferred mangoes and oranges more than other fruits. Likewise, the most preferred dark green leafy vegetables by public school children were sweet potato leaves (>70%), and private schools preferred mostly spinach (>60%). Amaranths were almost equally preferred by both groups. In terms of snacks, many children in public schools preferred fried snacks such as potato samosa, fried cassava, and kachori. Children from private schools preferred mostly sugary snacks such as soda/carbonated drinks, ice cream, and cookies, biscuits, cakes. Other snacks were moderately preferred. Preference for milk or yogurt was relatively lower in public schools (12%) than in private schools (29%).

Regarding consumption frequencies, daily consumption of fruits was < 20% and vegetables ≤ 10% in both public and private schools. A large proportion of children in both groups consumed fruits and vegetables less than once a week. In terms of snacks, children in public schools had a higher daily frequency of consumption of potato samosa and fried cassava compared to children in private schools. Likewise, children in private schools had a higher daily consumption of soda/carbonated drinks and sugared tea; meanwhile, many of them consumed cookies, biscuits, and cakes 1-3 times per week. Daily consumption of milk was low in both groups (<2% in public and 11% in private). Many children in both groups consumed milk less than once a week.

The mean intake of fruits and vegetables was ≥ four times a week with an average of ≤ one fruit and ≤ one vegetable servings per day in both public and private schools.

Table 3. Nutritional status of public and private school children.

Variable	BMI-for-age[1] n(%)					Height-for-age[2] n(%)			
	Thinness	Normal	Over- weight	Obese	p-value	Severe stunting	Moderate stunting	Normal	p-value
Public schools n=224	10(4.5)	181(80.8)	23(10.3)	10(4.5)	<0.001	4(1.8)	29(13.0)	191(85.2)	0.003
Private schools n=182	6(3.3)	117(64.3)	36(19.8)	23(12.6)		0(0.0)	8(4.4)	174(95.6)	
Total =406	16(3.9)	298(73.4)	59(14.5)	33(8.1)		4(1.0)	37(9.1)	365(89.9)	

[1]BMI-for-age Z-scores classification: Thinness =<-3SD to -2SD; Normal =>-2SD to +1SD; Overweight= >+1SD to <+2SD; Obese= >+2SD to +3SD; Severe obese= >+3SD. p-values are from Chi-square test for comparison between groups.

[2]Height-for-age Z-scores classification; severe stunting-HAZ-score:<-3SD; moderate stunting:>-3SD to -2SD; normal height: <-2SD to <+2SD; p-values are from Chi-square test for comparison between groups.

The mean intake of sugary snacks was more than four times per week in private school children with an average of > one snack a day and 1-3 times a week in public school children with the average intake of < one snack a day.

The mean intake of fried snacks was ≥ four times per week with an average of more than one snack a day, while for private schools, the mean intake was 1-3 times a week with an average intake of less than one snack a day. The preference and consumption frequency of main staple and relish are presented in Fig. 2.

The most preferred staple by both public and private school children (>55%) was rice. Stiff porridge (33%) was mostly preferred by public school children. Chips and other staples were least preferred (Figure 2). Regarding relish, public school children preferred more beans (27%) and children in private schools preferred more chicken (29%). Fish and beef were equally preferred (around 20%). Green vegetables and other relish were least preferred. The daily consumption frequency of rice was 18% and 20% for public and private schools, respectively. Public school children had a higher daily consumption of stiff porridge than children in private schools. Daily consumption of beans was slightly higher than beef, chicken, and green vegetables in both groups. However, children in public schools had a slightly higher (4%) daily consumption of fish than children in private schools (1.1%).

Table 4. Comparison of preference and consumption frequencies of mostly liked fruits, vegetables and snacks among public and private school children.

Food item	% Preference		% Frequency of consumption							
	Yes		Daily		4-6 times/week		1-3 times/week		< once/week	
	Publ. n=224	Priv. n=182	Publ. n=224	Priv. n=182	Publ. n=224	Priv. n=182	Publ. n=224	Priv. n= 182	Publ. n=224	Priv. n=182
Fruits										
Mangoes	65.2	59.9	12.9	7.7	15.2	14.3	37.1	37.9	34.8	40.1
Oranges	54.2	51.1	16.5	17.0	14.7	14.8	23.7	19.2	45.1	48.9
Banana	29.9	40.1	9.4	4.9	5.8	7.7	14.7	14.3	70.1	59.9
Water melon	21.0	30.2	5.8	7.1	4.0	8.2	11.2	14.8	79.0	69.8
Green vegetables										
Sweet potato leaves	73.2	58.2	8.9	4.9	29.8	17.6	37.5	35.7	26.8	41.8
Spinach	55.8	68.1	6.3	13.7	19.6	18.1	29.9	36.3	44.2	31.9
Amaranths	55.4	57.7	5.4	11.0	13.4	14.3	36.6	32.4	44.6	42.3
Pumpkin leaves	20.1	13.7	1.8	2.7	6.3	2.7	12.1	8.2	79.9	86.3
Snacks										
Soda/carbonated drinks	26.8	52.9	8.0	14.8	5.8	7.1	12.9	30.2	73.2	47.8
Ice cream	24.6	38.5	6.7	7.1	5.4	6.6	12.5	24.7	75.4	61.5
Potato samosa	68.3	47.8	38.4	18.1	12.9	8.8	17.0	20.9	31.7	52.2
Fried cassava	57.1	15.4	40.6	5.5	7.6	4.4	8.9	5.5	42.9	84.6
Kachori	35.7	18.1	10.7	6.0	8.9	1.6	16.1	10.4	64.3	81.9
Milk/yoghurt	11.6	28.6	1.8	11.0	3.6	7.1	6.3	10.4	88.4	71.4
Sugared tea/coffee	17.4	33.5	12.8	27.5	2.2	3.3	3.1	2.7	82.6	66.5
Cookies, biscuits, cakes	25.0	53.8	5.8	6.6	3.6	8.8	15.6	38.5	75.0	46.2

Publ=public school; Priv= private school.

Association between nutritional status and dietary habits of school children

The current study could not find an association (Table 5) between the type of school (public and private) and all dietary habits variables (all $p>0.05$). Significant differences were found in gender. Boys who consumed more cereal foods had higher median BMI-for-age than non-cereal eaters ($p<0.05$). Furthermore, boys who consumed less fried foods had a higher median BMI for age than consumers of fried foods. Likewise, boys who consumed milk/yogurt had a higher BMI-for-age value than non-milk consumers. Again, in boys, increased frequency of consumption of sugary snacks to more than four times a week was associated with high median BMI-for-age. In girls, less fruit intake was associated with high median BMI-for-age ($p<0.05$). Surprisingly, a higher frequency of consumption of fried snacks was associated with low median BMI-for-age in girls. Other dietary habit variables did not associate with median BMI-for-age in all participants ($p>0.05$).

Table 6 shows an association between overweight and obesity with selected dietary habits by multivariable binary logistic regression. In univariate analysis, crude odds ratios for consuming more cereal foods at school, fried foods/snacks at school and away, and intake of milk were significantly associated with overweight and obesity. In multivariate analysis (final model), after adjusting for other factors, only the intake of fried foods/snacks was significantly associated with overweight and obesity ($p<0.05$).

Discussion

This study aimed to determine the prevalence of overweight and obesity in public and private school children, examine their dietary habits, and assess the association between dietary habits and body mass index for age.

Table 5. Association between nutrition status and dietary habits of school children by type of school and gender.

Characteristics/food intake		Public n=224	Private n=182	Boys n=187	Girls n=219
		Median BMI-for-age	Median BMI-for-age	Median BMI-for-age	Median BMI-for-age
Number of meals/day	1-2	16.9	17.9	17.0	17.1
	3-4	17.2	18.1	17.0	18.3
	5-6	16.5	17.8	17.7	17.1
Cereal foods eaten at school	Eat None	17.1	19.4	16.6†	17.7
	Eat 1	17.2	17.6	17.2	17.7
	Eat 2-3	-	18.2	18.0	18.3
Fried foods/snacks eaten at school	Eat None	16.8	17.7	17.9†	18.3
	Eat 1	17.4	18.1	16.4	18.4
	Eat 2-3	17.1	18.2	16.6	17.4
Sugary snacks	Eat none	16.9	17.5	16.6	18.1
	Eat 1-2	17.1	18.2	17.2	17.7
	Eat 3-4	17.2	18.3	17.5	18.3
Milk/yoghurt	Yes	16.9	18.2	17.8†	17.7
	No	17.1	17.7	16.9	17.9
Eating together with others	More often	17.2	18.1	17.2	18.0
	Sometimes	16.7	17.7	16.8	17.7
	Less often	16.6	18.3	17.2	18.2
Eating while watching Tv	Yes	17.1	18.1	17.4	18.1
	No	17.1	18.0	17.0	17.7
Eating preferred vegetable	Eat ≤1	17.1	17.7	17.1	17.7
	Eat 2-3	17.1	18.1	17.1	18.0
Eating preferred fruits	Eat ≤1	18.5	17.5	16.4	20.2†
	Eat 2-3	17.0	18.1	17.1	17.7
FFQ of sugary snacks	Not consumed	16.9	17.5	16.6†	18.1
	1-3 x /week	16.8	18.2	17.0	17.3
	≥ 4 x/week	17.2	18.1	17.5	17.5
FFQ of fried snacks	Not consumed	16.8	17.7	17.1	17.7†
	1-3x/week	17.5	18.3	17.4	19.1
	≥ 4x/week	17.1	17.7	16.9	17.4
FFQ preferred fruits	Not consumed	17.2	26.0	16.9	23.6
	1-3 x/week	17.3	17.6	16.4	19.5
	≥ 4 x/week	17.1	18.1	17.1	17.7
FFQ preferred vegetables	Not consumed	17.6	17.4	16.9	17.9
	1-3x/week	18.1	18.9	18.5	18.6
	≥ 4x/week	17.1	18.1	17.1	17.1

†indicates significant.

The BMI-for-age, percentage body fat, and MUAC correlated significantly with overweight and obesity in girls and private schools. Two studies (Mosha and Fungo 2010; Ulbricht *et al.,* 2018) also reported higher body fat percentages in girls than in boys.

This may be related to the propensity of girls to accumulate more fat mass than fat-free mass during the pubertal stage, which is a period accompanied by rapid growth and fat deposition (Mosha and Fungo, 2010; Umar *et al.,* 2018). Gender difference in body fat composition was also reported by de Pádua Cintra *et al.* (2013), which described boys gaining more muscle mass while girls are gaining more fat mass.

The MUAC, which is also used for screening acute malnutrition, was associated with higher BMI-for-age and higher percentage body fat. This means, in obesity studies, MUAC can also be used to detect over-nutrition, although cut-offs values for school children need to be established. However, a single cut-off value of 25% for boys and 30% for girls has been used in one study to define overweight and obesity in school children (Marques-Vidal *et al.,* 2008).

A study by Craig *et al.* (2014) in South African school children and adolescents revealed that MUAC was an effective tool in measuring over-nutrition.

Table 6. Logistic regression analysis of selected dietary habits variables and overweight/obesity among school children (n=406).

Characteristics/food intake		Crude OR[a]	95% CI	p-value	Adjusted OR[b]	95% CI	p-value
Cereal foods eaten at school	Eat None	Ref			NA		
	Eat 1	2.2	0.8-5.6	0.11			
	Eat 2-3	2.8	1.7-4.6	≤0.001*			
Fried foods/snacks eaten at school	Eat None	Ref			Ref		
	Eat 1	0.4	0.2-0.8	0.007*	0.4	0.2-0.8	0.013*
	Eat 2-3	0.3	0.2-0.5	≤0.001*	0.3	0.4-1.1	≤0.001*
Sugary snacks	Eat none	Ref			NA		
	Eat 1-2	1.7	0.9-3.1	0.10			
	Eat 3-4	1.7	0.8-3.6	0.15			
Milk/yoghurt	No	Ref			NA		
	Yes	1.7	1.0-2.9	0.04*			
Eating while watching TV	No	Ref			NA		
	Yes	0.6	0.4-1.0	0.06			
Eating preferred fruits	Eat ≤1	Ref			NA		
	Eat 2-3	1.8	0.9-3.7	0.09			
FFQ of sugary snacks	Not consumed	Ref			NA		
	1-3x/week	1.5	0.8-3.2	0.24			
	≥ 4 x/week	1.8	0.9-3.3	0.07			
FFQ preferred fruits	Not consumed	Ref			NA		
	1-3x/week	0.33	0.8-1.4	0.13			
	≥ 4 x/week	0.34	0.1-1.1	0.08			

OR, odds ratio; CI, confidence interval; FFQ, frequency of consumption; *indicates significant.

[a]Crude odds ratios also included age, gender, school type, number of meals, number of preferred vegetables, number of sugary snacks, FFQ of fried foods/snacks, FFQ of preferred vegetables with no significant association with overweight and obesity.

[b]Odds ratios have been adjusted for age, gender, school type, number of meals per day, school food cereals, number of sugary snacks, intake of milk, eating while watching television, frequencies of consumption of sugary snacks, fried foods/snacks, preferred fruits, preferred vegetables.

Findings from the current study showed a high prevalence of overweight and obesity in school children. The overall prevalence of overweight and obesity was 22.6% which is higher than what was reported in previous studies in Tanzania (Mosha and Fungo, 2010; Muhihi *et al.,* 2013; Mwaikambo *et al.,* 2015), but it is similar to 22.6% as reported by Pangani *et al.* (2016). Children from private schools had a higher prevalence of overweight and obesity than children in public schools, which may also relate to the high education level of their mothers and mothers' employment status which also may have contributed to differences in eating patterns among the two groups. The obesity prevalence of above 20% is similar to reports from Ghana (Annan-Assare *et al.*, 2017), Uganda (Chebet *et al.,* 2015), Egypt (Taha and Marawan, 2015), and Latin America (Corvalán *et al.,* 2017). Our findings are consistent with studies done on school-age children. Studies by Kyallo *et al.* (2013) in Kenya, Pangani *et al.* (2016) in Tanzania, and Adom *et al.* (2019) in Ghana showed that attendance at private schools was linked to high social-economic status (SES), thus a driving force of overweight and obesity among school children.

Other studies also linked overweight and obesity in children to maternal employment (Adom *et al.,* 2019), high education level of mothers (Maddah and Nikooyeh (2009), and inadequate outdoor space for physical activities (Umar *et al.,* 2018).

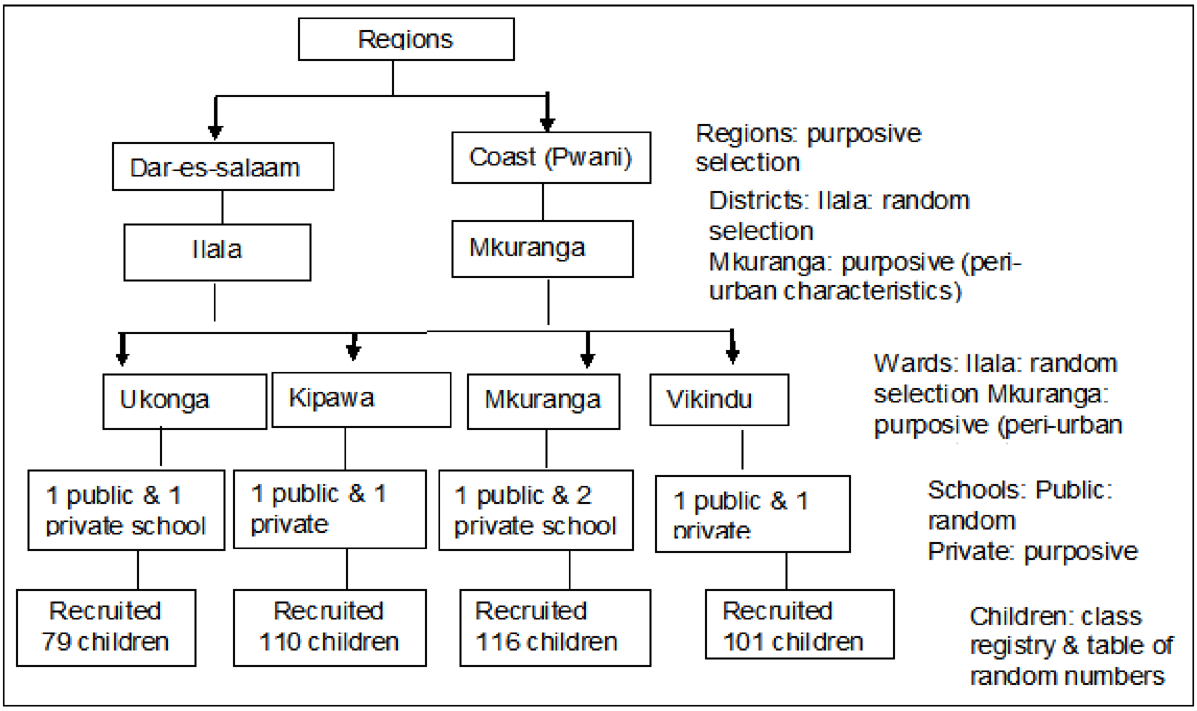
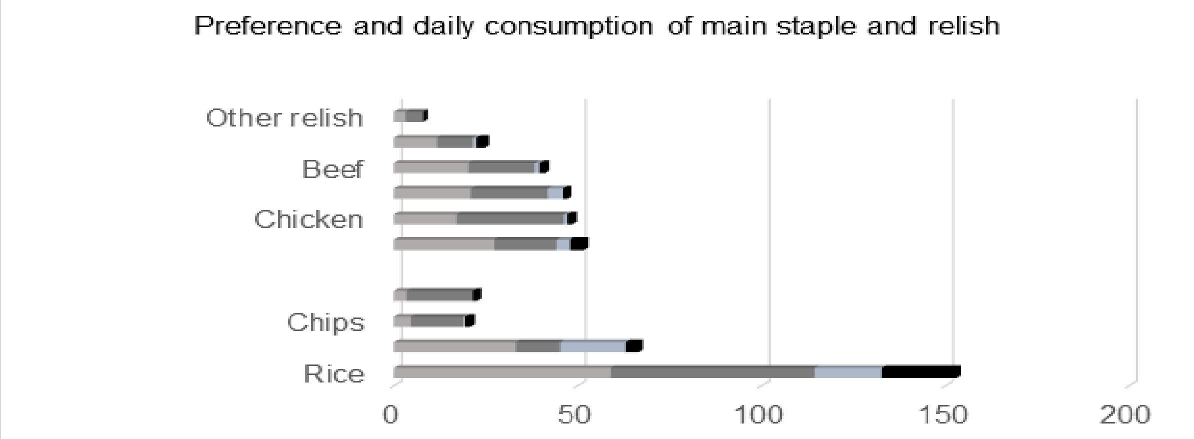


Fig. 1. Sampling procedure of study participants.

The current study found no significant difference in the prevalence of overweight and obesity between boys and girls ($p>0.05$), indicating that boys and girls are equally affected. This finding is in contrast with studies among Saudi Arabian school children (El-Mouzan *et al.,* 2010; Collison *et al.,* 2010) and Nigerian school children (Musa *et al.,* 2012), which found that boys were more obese than girls while girls were more likely to be overweight. However, the reason for this variance could not be substantially explained and needed further investigation. Other studies found that girls were significantly more obese than boys (Adesina *et al.,* 2012; Ene-Obong *et al.,* 2012; Mohammed and Vuvor, 2012; Wamba *et al.,* 2013 Baard, and McKersie, 2014; Annan-Asare *et al.,* 2017; Umar *et al.,* 2018). Again, in the African context, females having a large body sizes are regarded as prestigious and a symbol of wealth. Hence, girls do not bother to lose weight and tend to participate less in vigorous physical activities. Based on the literature, other reasons for the differences in overweight and obesity could be due to differences in the age group of children under investigation and area of residence (rural versus urban). However, our study found no difference in the prevalence of overweight and obesity in the two districts (one in urban and the other in peri-urban), which may be attributable to the geographic proximity of these two districts. Thus they are likely to share numerous social, geographical, and economic attributes.

The findings of this study also showed some degree of undernutrition. Children from public schools were significantly thinner and more stunted than children from private schools. This can be associated with the low education levels of mothers in public schools, which could affect their dietary intake. To some extent, these findings may explain the existence of the double burden of malnutrition among school children wherein both undernutrition (example stunting) and over-nutrition (example, overweight) occur together in the same population (FAO, 2006). This was observed in other studies in South Africa (Puckree *et al.,* 2011; Modjadji and Madiba, 2019) and the rates of undernutrition were higher in rural than urban areas.
The current study identified a reasonable preference for fruits and vegetables among public and private school children, but their frequency of consumption was below recommendations. Fruits such as mangoes and oranges were mainly preferred compared to other fruits, probably because they are readily available and accessible on the school premises. Less preferred

fruits such as avocado and pineapple are not available on school premises and they are also likely to be affected by seasonality. Sweet potato leaves was a mostly preferred vegetable by public school children as it was reported to be more available at home. Private school children preferred spinach and amaranths because they were frequently served during lunch. WHO recommends an intake of five portions (400g) of fruits and vegetables per day, equivalent to ≥ 2 servings of fruits and ≥ 3 servings of vegetables per day to reduce the risk of dietary-related conditions (Okop *et al.,* 2019; Ziaei *et al.,* 2019). However, in the current study, intake of fruits and vegetables on average was less than one serving a day. Some studies (Peltzer and Pengpid, 2010; Peltzer and Pengpid, 2012) conducted in seven African and five Asian countries revealed related results showing intake of fruits and vegetables among adolescents was low (less than once a day). In addition, intake of fruits and vegetables at least three times a week was associated with lower BMI in school children (Wall *et al.,* 2018). Furthermore, our results showed that milk intake by school children was also low but lower in public school children than in private school children.



	Rice	Stiff porridge	Chips	Other staples		Beans	Chicken	Fish	Beef	Green Vegetables	Other relish
Preference Public	58.9	33	4.5	3.4		27.2	17	21	20.1	11.6	3.1
Preference Private	55.5	12.2	14.3	18.1		17	29.1	20.9	18.1	9.9	4.9
Daily consumption Public	18.3	17.9	0.4	0		3.6	0.9	4	1.3	0.9	0
Daily consumption Private	20.3	3.3	1.7	1.1		3.8	1.6	1.1	1.6	2.2	0

Fig. 2. Preference and consumption frequency of main staple and relish among school children.

This could be due to low education level and income of mothers in public schools. Similar studies by Larson *et al.* (2006) and Naserirad and Akbari (2018) among school children and adolescents in Minneapolis and north-eastern Iran, respectively, reported low milk intake. Larson and colleagues 2006, stated that low milk intake could be due to milk taste preference, especially in girls, poor socioeconomic status, and high body weights of adolescents. Children in public schools had higher preference and consumption of fried foods than private school children, which could be linked to the presence of food vendors who prepare these snacks in the school premises, unlike in private schools where no food vendors are allowed. Although daily consumption was moderate, children in private schools had a higher preference for sugary foods/snacks. This can be linked to availability and accessibility to these foods with regard to the SES of their mothers. Rice and stiff porridge were the most preferred and consumed staple foods in public and private schools because they are the typical staple foods available in Tanzania and the most frequently served foods during lunch breaks in private schools.

In the current study, boys who preferred milk had higher BMI-for-age than those who did not prefer. This could be due to a small number of children who consumed milk to make a reasonable comparison. The study of Larson *et al.* (2006) reported that being overweight was associated with low milk intake among middle and high school students from Minneapolis. In the current study, BMI-for-age was related to the intake of more cereal foods and sugary snacks in boys and fewer fruits in girls. Thus, early precautions need to be considered as the evidence suggests linkages between energy-dense snacks and increased overweight and obesity (Alangea *et al.,* 2018), particularly when there is an increase in portion size (Govender *et al.,* 2018). Boys who consumed fried foods/snacks at school had lower median BMI-for-age than those who did not consume. This outcome can be explained by the fact that these children being from public schools and their tendency to use fried foods as both main meals and snacks while at school, which is likely that the portion sizes were not adequate. This is so because many children from these schools do not go home for lunch. Furthermore, regression analysis found that consumption of fried foods/snacks at school was inversely associated with overweight/obesity, which can be related to inadequate portion size. Therefore, the clear association could have been explained by nutrient intake data which was not the scope of this study.

This study had some limitations. Dietary habits data were based on recall which is subject to memory bias. However, observation of foods available in the school environment and information on the number of times a child is allowed to eat during school hours aided in the recall. Additional probing on the questions was applied to minimize this bias.

Conclusion

This study found a high prevalence of overweight and obesity among school children. Prevalence of overweight and obesity, body fat, and MUAC increased in private schools than public schools. Undernutrition, assessed as thinness and stunting, was also observed in this study. Thinness and stunting were higher in the Mkuranga district (peri-urban) than in the Ilala district (urban). The frequency of consumption of fruits, vegetables, and milk was low. BMI-for-age and gender were associated significantly with the intake of specific energy-giving foods such as cookies, biscuits, cakes, soda, ice cream, and fewer fruits intake but not with the type of school. These results are critical to inform appropriate policy options for schools. Further research is needed to explore additional correlates of overweight and obesity among school children.

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Declaration

The authors declare that they have no competing interest.

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