School Children's Lifestyle and Behaviors Relating to Obesity: Collaborative Study in Urban Uganda

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ABSTRACT

Context: Child obesity, one of the major contributors to noncommunicable diseases in developing countries, is rising following drastic economic growth and lifestyle changes. In Uganda, noncommunicable diseases as a cause of death have increased from 15% in 1990 to 35% in 2019.

Aim: The study aimed to investigate schoolchildren's obesity status, lifestyle behaviors, and the factors of obesity in urban Uganda.

Methods: The study was conducted with a cross-sectional, descriptive quantitative design. The survey using the researcher-developed questionnaire and physical measurement tools for 330 children aged 9 to 11 years old in 6 elementary schools in urban Uganda in November 2018. The Japanese Red Cross College of Nursing Institutional Review Board approved this study (Approval Number: 2018-066).

Results: Obesity status among schoolchildren in urban Uganda was 67.6% normal, 25.2% underweight, 5.4% overweight, and 1.8% obese.

***Conclusion*:** Obesity and overweight have not been predominant in this population. However, children's growth must be carefully monitored to prevent future overweight and obesity due to the limited availability of school health services and rapid lifestyle changes. Demographic factors associated with obesity status (waist-hip ratio, body fat, and body mass index) were gender, financial access to food, screen time, sleep time, and sleep hours. Based on this study in Uganda, the researchers expect to develop further collaborative child obesity prevention projects.

Keywords: Uganda, obesity, schoolchildren, lifestyle and behaviors

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1. Introduction

About 1.9 billion adults were obese or overweight worldwide in 2016 *(World Health Organization [WHO], 2021).* The number of obese or overweight children aged two to 19 was 311 million worldwide in 2013 (Institute for Health Metrics and Evaluation *[IHME], 2022).* Of these children, 83%, or 257 million, live in low- or middle-income countries *(IHME, 2022).* Obese or overweight children face immediate and potentially long-term health impacts, including a higher risk of noncommunicable diseases (NCDs) such as diabetes or heart diseases later in life *(FAO, IFAD, UNICEF, WFP, and WHO, 2022a).* These NCDs were 74% of the causes of death worldwide in 2019 *(IHME, 2022).*

High Body Mass Index (BMI) contributed to 7.1% of deaths from any cause in 2015 *(The GBD 2015 Obesity Collaborators, 2017).* Therefore, preventing child obesity is an urgent issue. Nevertheless, many child obesity studies are from high-income countries, and studies from low- or middle-income countries are limited *(Brown et al., 2019).*

As a low-income country, Uganda has experienced considerable socioeconomic changes since the 2000s. Uganda's total economic activity expressed as its gross domestic product per capita has increased about 3-fold during the last 30 years *(World Bank, 2016).* Following lifestyle changes, NCDs as causes of death in Uganda have increased from 15% in 1990 to 35% in 2019 *(IHME, 2022). Baalwa et al. (2010)* mentioned that 15 percent of Ugandans aged 18 to 30 are obese or overweight. Despite these alarming issues, there are no health education classes in schools. The body measurements are taken only once in the first year of elementary school for six years in elementary schools.

One of the researchers *(Ogata, 2017)* revealed that Indonesia, a middle-income country demonstrated 40 percent of obese or overweight, 35 percent of underweight, and 25 percent of healthy-weight schoolchildren in urban elementary schools. Factors of obesity were the number of snacks, lack of sleep hours in boys, lack of peer exercise in girls, and limited school health system.

In order to contribute to preventing increasing child obesity in developing countries, our study aimed to investigate child obesity status and lifestyle behaviors (LSBs)

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to discuss a collaborative healthy weight development program for schoolchildren in urban Uganda.

2. Significance of the study

Obesity is recognized as one of the biggest global burdens of diseases, as 25% of the global population is obese or overweight *(WHO, 2021).* Child obesity is the contributor to adult obesity, and adult obesity is the contributor to NCDs. For investigating child obesity and lifestyle behaviors, this study will contribute to developing child obesity prevention programs to reduce childhood obesity in the future.

Child obesity and NCDs have been rapidly increasing worldwide and in Uganda. Uganda has more than doubled NCD deaths in these 20 years *(IHME, 2022),* and NCD prevention is an urgent issue in Uganda. However, most child obesity studies were conducted in high-income countries, and those from low- or middle-income countries, including Uganda, are limited *(Brown et al., 2019).* Healthcare coverage in developing countries is generally weak. Healthcare systems in developing countries are generally weak and vulnerable to poverty. Therefore, this study will accumulate evidence of child obesity studies in developing countries and has the potential to prevent future NCDs in developing countries.

The world is suffering from the double burden of malnutrition (DBM), over-nutrition, and under-nutrition at the same time *(WHO, 2022a).* Uganda also suffers from increasing NCDs and existing communicable diseases, a double burden of diseases (DBD). To respond to DBM and DBD, our team will contribute to a healthy weight development project to reduce adult obesity and NCDs in the future.

3. Aim of the study

The study aimed to investigate schoolchildren's obesity status, lifestyle behaviors, and the factors of obesity in urban Uganda.

3.1. Research hypotheses

The research hypotheses have been developed to achieve the aim of the study. Hypotheses were as follows:

- Hypothesis1: Demographic data are associated with obesity status (Body Mass Index, Waist Hip Ratio, and Body Fat)
- Hypothesis 2: Obesity status and Lifestyle Behaviors (LSBs) are associated.

4. Subjects & Methods

4.1. Research Design

The design was a quantitative study with a cross-sectional approach to explore the relationship between lifestyle behaviors and obesity status for future obesity prevention program development.

4.2. Study setting

The study venue was six elementary schools in urban Uganda, within a radius of 20 km of Kampala (capital city), Republic of Uganda. The place where the survey was held was in the classrooms in elementary schools where participants were comfortable, accessible, and secure.

4.3. Subjects

The researcher asked for research collaboration with Makerere University using the research proposal and letter of request for research collaboration as co-researchers. Some elementary schools to recruit 330 participants (statistical significance at α=.05, and the power .80 (β=.20), to deny no correlation, 80% of response rate expected) were recommended by the co-researchers based on the combination of random cluster sampling for the sample frame and stratified random sampling for the participants. Subjects' inclusion criteria were Ugandan children aged 9 to 11, with no medication and no chronic diseases.

4.4. Tools of data collection

The Child Obesity Prevention Lifestyle and Behaviors Questionnaire was used for data collection to measure the following.

4.4.1. Child Obesity Prevention, Lifestyle, and Behaviors Questionnaire

The Child Obesity Prevention, Lifestyle, and Behaviours Questionnaire consisted of the demographic data record, physical measurements record, and lifestyle and behaviors related questions in English. It is a self-developed questionnaire containing 60 items which consisted of 11 demographic data, seven physical measurements, and 42 LSB-related questions. The followings are the details of the contents of the questionnaire.

4.4.1.1. Demographic Data Record

The demographic data were collected on the first page of the questionnaire. Date of birth, religion, gender, and type of school was asked. Demographic data were 11 items such as the type of school, date of birth, religion, gender, exercise time in minutes, access to the health facilities in minutes, locational access to food in minutes, financial access to food in local currency, screen time (minutes spent looking at screens such as watching television, using computers, looking at smartphones, and playing games), dinner time, and sleep time.

4.4.1.2. Physical Measurements Record

Participants' physical measurements included the following seven items: Weight, height, body mass index (BMI), waist, hip, waist-hip ratio (WHR), and Body Fat (BF). Data directly measured participant children's obesity status. The BMI, WHR, and BF were proxy measurement tools for child obesity status.

Physical measurement tools were weighing scales (Innerscan 50 BC-309-PR, TANITA), height scales (Seca 206, Seca), and waist–hip ratio meters (Seca 203, Seca).

Physical measurement record was collected within the survey period. Definitions of measurement scales are as follows.

4.4.1.2.1. Body Mass Index (BMI)

It was calculated from children's weight and height. The researchers followed the WHO standards for BMI for the age of African children *(WHO, 2022b).* Obesity is defined as more than 2 SD (standard deviation), equivalent to a BMI of 30 kg/m^2 at 19 years). Being overweight is having more than 1 SD, equivalent to a BMI of 25 kg/m^2 at 19 years. Underweight is defined as less than 2 SD.

4.4.1.2.2. Waist Hip Ratio (WHR)

The waist-hip ratio was calculated from waist size and hip size. The researchers followed the *WHO* expert consultation *(2011)* and abnormal is defined as WHR >1.0 in boys and >0.85 in girls. Other than the abnormal is defined as normal WHR.

4.4.1.2.3. Body Fat (BF)

The researchers followed the body fat curves for children *(McCarthy et al., 2006)* in which cutoffs to define regions of 'under fat,' 'normal,' 'overfat,' and 'obese' are set at the 2nd, 85th, and 95th centiles as Table 1 shows. They are different curves in gender and age. For nine-year-old girls, body fat equal to or less than 16% is defined as under fat, 17-27% as normal, 28-31% as overfat, and equal to or more than 32% is defined as obese. For ten-year-old girls, body fat equal to or less than 16% is defined as under fat, 17-28 % as normal, 29-32 % as overfat, and equal to or more than 33% is defined as obese. For 11 years old girls, body fat equal to or less than 16% is defined as under fat, 17-28% as normal, 29-33% as overfat, and equal to or more than 34% is defined as obese.

For nine-year-old boys, body fat equal to or less than 13% is defined as under fat, 14-22% as normal, 23-27% as overfat, and equal to or more than 28% is defined as obese. For ten-year-old boys, body fat equal to or less than 13% is defined as under fat, 14-23% as normal, 24-28% as overfat, and equal to or more than 29% is defined as obese. For 11 years, old boys, body fat equal to or less than 13% is defined as under fat, 14-23% as normal, 24-28% as overfat, and equal to or more than 29% is defined as obese.

Table (1): Body fat ranges for children by gender.

Gender/Age	9 years old	10 years old	11 years old
Girls			
Under fat	16≦	16≦	16≦
Normal	17-27	17-28	17-28
Overfat	28-31	29-32	29-33
Obese	32≧	33≧	34≧
Boys			
Under fat	≦13	≦13	≦13
Normal	14-22	14-23	14-23
Overfat	23-27	24-28	24-28
Obese	≧28	≧29	≧29

4.4.1.3. Lifestyle and Behaviors Related Questionnaire

The researcher developed 42 questions to examine the relationships between obesity status and lifestyle and behaviors related to obesity. The questionnaire's validity and reliability were tested in a pilot study. The reliability of lifestyle behaviors was examined to assess the item consistency of instruments. All components of lifestyle behaviors relating to obesity were examined, and the total Cronbach α was 0.70. They are named as follows.

4.4.1.3.1. knowledge of obesity

Six items were included in this component. This component was named knowledge of obesity because items included knowledge of obesity prevention.

4.4.1.3.2. Efficacy control lifestyle behaviors

Four items were included in this component. This component was named efficacy control LSBs because items included the efficacy of controlling the dietary amount, exercise time, and screen time.

4.4.1.3.3. Family, school, and health center support

Seven items were included in this component. This component was named family, school, and health center support because items included support or education from the family, school, and health center.

4.4.1.3.4. Physical activity safety environment

Three items were included in this component. This component was named physical activity safety environment because items included exercise safety, such as no fear of road accidents, air pollution, or being kidnapped.

4.4.1.3.5. Family education and support

Three items were included in this component. This component was named family education and support because items included the family's education and support of dietary and rest patterns toward children.

4.4.1.3.6. Physical activity preference

Three items were included in this component. This component was named 'PA preference' because items included preferred or not lazy exercising.

4.4.1.3.7. Physical activity willingness

Three items were included in this component. This component was named 'physical activity willingness' because items included independent exercise behavior, exercise frequency, and length of exercise.

4.4.1.3.8. Healthy sleep and rest experience

Four items were included in this component. This component was named 'healthy sleep and rest experience' because items included rest pattern after the meal, daytime sleepiness, and staying up late.

4.4.1.3.9. Healthy diet choices

Seven items were included in this component. This component was named 'healthy diet' because items included dietary contents, frequency, and eating style.

4.4.1.3.10. Fruits-vegetables preference

Two items were included in this component. This component was named 'fruits-vegetables preference' because items included a preference for fruits and vegetables.

4.5. Procedures

Procedures of tool development, validity, and reliability of the study tools: A validity test (content and face validity) was conducted. Regarding content validity, six experts consisting of 5 faculty members of the Makerere University School of Public Health (3 public health experts and two nutrition experts) and one physical exercise teacher in elementary school were recruited to confirm content validity using the Content Validity Index (CVI) after obtaining the consent of research participation. While reviewing the questionnaire, the recruited scholars or professionals rated a checklist using an index of a 4-point scale (1 = not relevant to 4 = highly relevant). Then, the researcher calculated the average content validity of individual items (I-CVIs), recommended to be 0.78. The content validity of the overall scale (S-CVIs) should be 0.90 or higher. Average I-CVIs showed 0.92, and S-CVIs showed 0.92, too. Items with less than 0.78 in I-CVIs (Questions 24, 43, 52, 60, 65, 68, and 75) and 0.90 (None in the questions) in S-CVIs were discussed and revised with Ugandan researchers.

For testing face validity, one elementary school was selected. This school was excluded from the main study. In the target school, fourth and fifth graders were nominated as participants for the face validity test. The researcher checked the length of time to answer, comprehensibility, understandability, and respondent burden. This process was conducted with research assistants, and comments were noted. Less valid items were revised with Ugandan researchers. The time to answer was approximately 30 minutes on average, including the rest. Few children complained about the length of the questionnaire. However, in most cases, children were glad to answer the questions because the research assistants kept entertaining them to be attracted to answer the questionnaire. The research assistants checked comprehensibility, and the wording of the questionnaire was modified so that children could comprehend and understand the meaning of the questions.

A reliability test was also conducted. First, details of the components of predictors are as follows. The components of predictors were categorized using principal component analysis. Components with a Cronbach alpha of less than 0.50 were excluded from the analysis. Reliability was examined to assess the item consistency of instruments. Components with a Cronbach alpha of less than 0.50 were excluded from the analysis. All the components were examined, and the total Cronbach α of the predictors was 0.88.

Ethical Considerations: The Red Cross College of Nursing Ethics Committee, Tokyo, Japan, approved the study. After the approval, the study was started (Approval Number: 2018-066). The subjects were informed about the ethical considerations (informed consent, participation on free will, confidentiality, and anonymity) in participating in the research, and they participated after signing the consent form. The questionnaire with demographic data and physical measurement records was taken on the first page of the questionnaire, which was carried out anonymously and, therefore, unidentified.

The survey was conducted from the 3rd to the 8th of August 2018. Request for the research collaboration to consented elementary schools was made using a letter of request for the research collaboration. A total of six schools in Kampala were visited, and in all, 330 schoolchildren were enrolled in the survey with consent to participate in the study. Data were collected from children aged 9 to 11 years or in the fourth and fifth grades of elementary schools who were not on medication or had any chronic diseases. Among the schools visited, some had both day and boarding provisions while others were only daytime schools where pupils commuted from home to school.

The spoken language during the survey was English. Elementary school teachers and children in Uganda use English for their daily classes. Over 90% of the population in the target area speak English fluently. Ugandan research assistants from Makerere University were informed about the research's purpose, methods, and ethical considerations and conducted the face-to-face survey using directions (survey guides). The research assistants read the questionnaire and fill in the participants' answers on the questionnaire using a pen.

4.6. Data Analysis

Data cleaning was done and analyzed the data by descriptive statistics, Chi-square tests of significance, and a principal component analysis using the SPSS ver. 23. A p-value less than 0.05 was considered statistically significant. There were no missing data in the collected data. Based on the analysis, all the study members discussed the results and suggested future challenges and programs by e-mail or meeting.

5. Results

The characteristics of the schools were shown in Table 2 by type of school; 103 students from 3 national schools and 227 students from 3 private schools were involved in the study. By gender, 187 girls and 143 boys participated in the study.

Table 3 shows the degree of obesity by type of school. By school, 1.9%, 1.8%, and 5.8%, 5% of the national and private school students were obese or overweight. About normal weight, 85.4% and 59% of students in national and private schools, respectively. For underweight, 6.9% and 33% of students in national and private schools, respectively.

By school type, national schools (85%) were more in normal weight than private schools (59%). Underweight was observed more in private schools (33%) than in national schools (6.9%). The total reveals that normal weight was 67.6%, underweight was 25.2%, and obese 1.8% or overweight participants 5.4%, respectively. Most (67.6%) of the participants were of normal weight, and the other 32.4% were of abnormal weight.

Table 4 shows the degree of obesity by gender. By gender, 4.8% and 10.8% of girls and boys were obese or overweight. Boys were more obese or overweight in this population. About normal weight, 70.1% and 63.6% of girls

and boys, respectively. For underweight, 24.6% and 25.9% of girls and boys, respectively.

Table 5 shows the degree of obesity by religion. 4.8% of Muslims and 7.8% of Christians were obese or overweight. 58.7% of Muslims and 69.6% of Christians are of normal weight, respectively. 36.5% of Muslims and 22.5% of Christians were underweight.

Table 6 shows the obesity status and access time to the health center. Most children, 85.8% of the schoolchildren, had access to the health center within 30 minutes.

The demographic factors associated with obesity were analyzed in Table 7 by the Chi-square test. The factors that were found to be significantly associated with obesity status (WHR, BF, and BMI) included gender for WHR and BF, financial access to food for BMI, screen time for BF and BMI, sleep time for BF, and sleep hours for BF at a 95% confidence interval.

Table 8 shows comparisons of obesity measures of BMI and body fat. 33.3% of them were normal in BMI and body fat. Another 33% were normal in BMI but under fat in body fat.

Table 9 represents the percentage distribution of obesity measures of BMI and waist-hip ratio (WHR). Of the schoolchildren classified as obese or overweight by BMI (24 children), 21% (5 children) had an abnormal WHR. Of the schoolchildren classified as normal on BMI (223 children), 25% (55 children) were classified as having abnormal WHR. Of the schoolchildren underweight by BMI, 14% were classified as abnormal by WHR.

Table 10 shows the component analysis results to examine the relationship between obesity status and lifestyle behaviors. All the factors were statistically significantly associated with BMI obesity status. Especially the more schoolchildren study about obesity, the more pocket money they have for food, and the more exercise time in school tend to be underweight schoolchildren. The more schoolchildren eat with the television on, the more screen time they watch prone to be overweight. The more schoolchildren sleep well during nighttime, the more screen game time they play, and they tend to be obese.

Table (2): Frequency distribution of school children by school type.

School	School Type	Gender		Total
		Female	Male	
A	Private	43	30	73
B	Private	27	42	69
C	National	24	12	36
D	National	19	13	32
E	Private	52	33	85
F	National	22	13	35
Total		187	143	330

Table (3): Frequency and percentage distribution of schoolchildren obesity status (BMI) by school type.

School type	No. / %*	Obese	Overweight	Normal	Underweight	Total
National	No.	2	6	88	7	103
	%	1.9	5.8	85.4	6.9	31.2
Private	No.	4	12	135	76	227
	%	1.8	5	59	33	68.8
Total	No.	6	18	223	83	330
	%	1.8	5.4	67.6	25.2	100

**The percentage of obese, overweight, normal, and underweight in national and private schools indicates the percentage of the group to the total number of participants of each school type (national/ private school).*

Table (4): Frequency and percentage distribution of obesity status (BMI) by gender.

Gender	No. / %*	Obese	Overweight	Normal	Underweight	Total
Female	No.	2	7	132	46	187
	%	1.1	3.7	70.1	24.6	56.6
Male	No.	4	11	91	37	143
	%	2.8	7.7	63.6	25.9	43.3
Total	No.	6	18	223	83	330
	%	1.8	5.4	67.6	25.2	100

**The percentage of obese, overweight, normal, and underweight males and females indicates the percentage of the group to the total number of people of each gender.*

Table (5): Frequency and percentage distribution of obesity status (BMI) by religion.

Religion	No. / %*	Obese	Overweight	Normal	Underweight	Total
Islam	No.	1	2	37	23	63
	%	1.6	3.2	58.7	36.5	19.1
Christianity	No.	5	16	186	60	267
	%	1.9	5.9	69.6	22.5	80.9
Buddhism	No.	0	0	0	0	0
	%	0	0	0	0	0
Hindu	No.	0	0	0	0	0
	%	0	0	0	0	0
Total	No.	6	18	223	83	330
	%	1.8	5.4	67.6	25.2	100

**The percentage of obese, overweight, normal, and underweight in all religions indicates the percentage of the group to the total number of people of each religion.*

Table (6): Frequency and percentage distribution of obesity status (BMI) by access time to the health center.

Access Time (minutes)	No. / %*	Obese	Overweight	Normal	Underweight	Total
0-30	No.	6	15	189	73	283
	%	2.1	5.3	66.8	25.8	85.8
31-60	No.	0	2	33	9	44
	%	0	4.5	75	20.5	13.3
61 or more	No.	0	1	1	1	3
	%	0	33.3	33.3	33.3	0.9
Total	No.	6	18	223	83	330
	%	1.8	5.4	67.6	25.2	100

The percentage of obese, overweight, normal, and underweight in all access times indicates the percentage of the group to the total number of people in each access time group.

Table 7: Demographic factors associated with obesity status.

Factor*	WHR	BF	BMI
Religion	0.051	0.32	0.12
Gender	<0.001	0.001	0.22
Exercise Time	0.41	0.78	0.24
Access to Exercise Facility	0.758	0.65	0.25
Access to Health Facility	0.53	0.24	0.34
Locational access to food	0.26	0.15	0.5
Financial Access to Food	0.31	0.39	0.01
Screen Time	0.43	0.003	<0.001
Dinner Time	0.33	0.19	0.27
Sleep time	0.93	0.01	0.18
Sleep Hours	0.27	0.03	0.88

**Association is done using the Chi-square test.*

Table (8): Frequency and percentage distribution of Body Mass Index (BMI) and Body Fat (BF).

Body Fat/ BMI	No. / %*	Obese	Overfat	Normal	Under fat	Total
Obese	No.	4	0	0	2	6
	%	1.2	0	0	0.6	1.8
Overweight	No.	4	10	3	1	18
	%	1.2	3	0.9	0.3	5.4
Normal	No.	0	4	110	109	223
	%	0	1.2	33.3	33	67.6
Underweight	No.	0	0	2	81	83
	%	0	0	0.6	24.5	25.2
Total	No.	8	14	115	193	330
	%	2.4	4.2	34.9	58.5	100

The percentage of obese, overweight/ overfat, normal, and underweight/under fat in BMI and body fat indicates the percentage of the group to the total number of participants.

Table (9): Frequency and percentage distribution of Body Mass Index (BMI) and Waist Hip Ratio (WHR).

WHR/ BMI	No. / %*	Normal	Abnormal	Total
Obese	No.	5	1	6
	%	1.5	0.3	1.8
Overweight	No.	14	4	18
	%	4.2	1.2	5.4
Normal	No.	168	55	223
	%	41.8	16.6	67.6
Underweight	No.	71	12	83
	%	21.5	3.6	25.2
Total	No.	258	72	330
	%	78.2	21.8	100

The percentage of obese, overweight, normal, and underweight in BMI and normal and abnormal in WHR indicates the percentage of the group to the total number of participants.

Table (10): Principal component analysis: Obesity status (BMI), knowledge, and lifestyle behaviors.

Knowledge, Eating Behavior and Obesity Status (BMI)				
Factors	**P-Value**	**95% Confidence interval**		**Associated with**
Knowledge				
Studied obesity in school	0.03	0.043	0.945	Underweight BMI less than 2 SD.
Obesity is a sign of happiness	0.01	0.056	0.51	
Eating Behavior				
Eat with the television on	0.013	-1.014	-0.12	Overweight BMI more than 1 SD, equivalent to a BMI of 25 kg/m^2 at 19 years.
Pocket money for foods	<0.001	0.001	0.003	Underweight BMI less than 2 SD.
Pocket money spent at school	0.024	0.001	0.003	
Eat meals alone	<0.001	-0.002	-0.0002	
Eat with the television on	0.02	-0.55	-0.04	
Exercise behaviors				
Exercise Class time at school	0.001	-1.08	-0.26	Underweight BMI less than 2 SD.
I sleep well during night time	0.01	-1.65	0.16	Obesity BMI more than 2 SD, equivalent to a BMI of 30 kg/m^2 at 19 years.
Screen Time behaviors				
Screen game time	0.008	0.007	0.052	Obesity BMI more than 2 SD, equivalent to a BMI of 30 kg/m^2 at 19 years.
Screen game time	0.01	0.004	0.039	Overweight BMI more than 1 SD, equivalent to a BMI of 25 kg/m^2 at 19 years.
Screen computer time	0.011	0.006	0.051	
Eat with the television on	0.002	-1.084	-0.231	

6. Discussion

This study investigated schoolchildren's obesity status, lifestyle behaviors, and the factors of obesity in urban Uganda. The study's findings reveal the relationship between lifestyle behaviors and the obesity status of schoolchildren in Uganda.

Regarding the obesity status of schoolchildren in Urban Uganda, the data show the obesity status in six elementary schools in urban Uganda. The prevalence of obesity status showed that most were of normal weight, then more than one-fourth were underweight, respectively. Contrary to the researchers' prediction, only seven percent were obese or overweight. However, it is also predictable that obesity will increase in the future due to changes in eating and exercise behaviors. Limited school health services are also a concern. In addition, with the spread of the COVID-19 infection in 2020, there is a concern about children who cannot acquire appropriate eating and exercise behaviors in homes or schools. Future projects regarding these lifestyle behaviors are necessary.

The current study revealed a higher prevalence of being underweight in private schools. The study also reveals the degree of obesity by type of school. They were a similar prevalence of obese or overweight schoolchildren in national and private schools (less than one-tenth). The researchers observed that private school children were in a higher prevalence of being underweight (around one-third) than nationals (less than one-tenth). Private school students might be more concerned about their body shape and more careful

about diet and exercise to lose weight. However, these are not data-based inferences. Therefore, in the future, it will be necessary to collect and analyze information such as the nutritious value of meals and school lunches and the contents of exercise for each school type.

According to the meta-analysis of the prevalence of overweight and obese among primary school learners in Africa, there were particularly those attending urban and private schools *(Adom et al., 2019).* Ogata also reported that there were many more obese or overweight children in private schools, and they had more money for snacks than in national schools in Indonesia *(Ogata, 2017)*, contradicting the current study findings. Further qualitative studies are needed, such as asking contents of snacks and health education.

The current study's survey shows the degree of obesity by gender; boys were in higher prevalence of obesity or overweight than girls. It could be explained by the biological differences between boys and girls, but gender-based food inequality could not be investigated in this study. A study in West Africa by *Raru et al. (2022)* showed that adolescent girls' being underweight was associated with their households' socioeconomic status. In Uganda, a study showed that boys were more likely to be obese or overweight (aOR = 1.81; 95% CI 1.24 to 2.64) than girls *(Sserwanja, 2021). Shah et al. (2020)* pointed out that gender-related influences, such as societal ideals about body weight and parental feeding practices, may drive the differences in obesity prevalence. Gender-related influences, such as body composition and hormones. Further studies about gender differences regarding obesity status are needed to attain healthier weight among schoolchildren.

The percentage of religion in the population (80.9 percent Christian, 19.1 percent Muslim, as a result, showed) was almost the same as the national ratio (eighty-four percent Christian, fourteen percent Muslim). Therefore, it can be inferred that the sampled population is representative of the population. Regarding the prevalence of obesity by religion, Christian schoolchildren had a lower proportion of underweight and a higher proportion of normal weight than Muslim schoolchildren. However, the relationship between religion and obesity is unclear because the number of elementary schools sampled was only six, and Muslims attended only one school.

Around eighty-six percent of the schoolchildren had access to the health center within 30 minutes. Most schoolchildren have good access to health centers and health information resources. Currently, health education, including obesity prevention, is not conducted in health centers. Good access to the health center indicates the possibility that this place can implement a collaboration with schools as a place for obesity prevention education in the future.

Financial access to food was associated with the obesity status (BMI) of schoolchildren. In Uganda, street vendors are all around near schools. If schoolchildren had enough money for snacks, children could eat anytime they wanted. Street vendors sell chapatti, fried snacks, and sugary drinks. Therefore, this environment with easy access to snacks may be a risk factor for obesity for schoolchildren in these target schools.

Regarding financial access, *Li et al. (2017)* reported that children's pocket money was a risk factor for unhealthy eating and obesity in urban China. Li suggested that schools also had to restrict unhealthy foods. Involving guardians to reduce children's pocket money would help decrease the number of snacks. At the same time, healthy food choices and environment are inevitable for healthier eating behaviors of children.

In the current study, screen time was associated with schoolchildren's body fat and BMI. Both bedtime and sleep duration were also associated with body fat in urban Uganda. Schoolchildren watch television, play computer games, and use smartphones during their free time. The more screen time they consume, the more they stay up late. As a result, it is easy for us to assume they would eat something late at night without sleeping. These findings support the first research hypothesis.

Ruan et al. (2015) investigated a modest inverse association between sleep duration and the risk of childhood overweight/obesity from a meta-analysis of 25 studies. *Taheri et al. (2004)* revealed that short sleep had reduced leptin (appetite-suppressing hormone) and elevated ghrelin (appetite-stimulating hormone). Thus, short sleep, along with the increment in screen time, might associate with obesity status. Researchers must intervene against their screen time and sleeping behaviors to reduce unnecessary food consumption and poor sleep.

Obesity status and lifestyle behaviors were associated among the participant schoolchildren. Lifestyle behaviors such as studying obesity, having pocket money for food, and much exercise time were associated with being underweight. Contradicting another study *by Mahmudiono (2020),* pocket money was not associated with the obesity of school children. The contents of snacks should be asked for further research. In this case, they use a lot of pocket money for snacks but also exercise a lot, so that they might be underweight.

Lifestyle behaviors such as eating with the television on, many screentime or game time, and sleeping well during nighttime are associated with obesity or being overweight. Screentime was associated with obesity or overweight, as prior studies examined that screen media exposure cause obesity in children through increased eating while watching TV or screen, exposure to high-calorie foods, and reduced sleep duration *(Robinson, 2017).* In this study, obese children sleep well during nighttime, but it may have been the answer that "I sleep well after being tired from watching too much TV and games ." It will be necessary to confirm "good sleep" from various aspects in the future.

According to the meta-analysis reporting the association between screen time and overweight/obesity among adolescents, the most important obesogenic screen was TV (OR = 1.813; 95% CI: 1.420–2.315, $P < 0.001$). Other screens, such as video games or PC, were not the motivators of obesity but the motivator of food intake and snacking behaviors *(Haghjoo et al., 2022)*

The researchers used three measures (BMI, BF, and WHR) to measure schoolchildren's obesity status in urban

Uganda. BMI and body fat did not always match for school children belonging normal. In obesity classification by BMI, the normal BMI group did not necessarily match the normal body fat group. However, overweight and underweight on BMI correspond to each body fat status. Since schoolchildren are still developing, one measurement tool could not estimate the real obesity status. Our results show that combining the three measurement tools, WHR (waist type obesity), BF (visceral fat type obesity), and BMI (weight gain type obesity), can be estimated the obesity status of schoolchildren.

7. Conclusion

Obesity status among target schoolchildren in urban Uganda was relatively normal, and overweight or obesity has not been predominant. However, this study was conducted by cluster-random sampling and could not be generalized for all schoolchildren in urban Uganda. In this target population, lifestyle behaviors showed the factors of obesity for schoolchildren, such as gender, financial access to food, screen time, sleep time, and duration, thus replying to the first research hypothesis. The children's growth must be carefully monitored to prevent future overweight and obesity due to the limited availability of school health services and rapid lifestyle changes. Lifestyle behaviors were associated with schoolchildren's obesity status. Future projects to prevent obesity must include those factors (concentrating on eating without watching TV, reducing screen time, and education for good quality sleep) to prevent child obesity. Thus supporting the second research hypothesis.

8. Recommendations

Demographic factors associated with obesity status (WHR, BF, and BMI) were gender, financial access to food, screen time, sleep time, and sleep hours. These areas investigated in the study need to be included in a future project. Sleeping and screen time behaviors were associated with BMI. Actions toward these components are needed to change children's life to healthier weight development.

Regarding the knowledge on obesity, since almost all participants were accessible to the health centers within 30 minutes, health education on healthy weight from the health centers will be effective. For other lifestyle behaviors, the researchers can develop lifestyle behaviors education projects in schools collaborating with health centers, guardians, and the community.

Based on this study's findings, lifestyle behaviors such as eating, screen time, and sleeping are acquired in child times. Children establish these lifestyle behaviors in childhood, leading to adulthood lifestyle habits and parenting the children. So, preventing obesity in this childhood period is inevitable.

Screen time is an important factor in obesity. Screentime behaviors might affect children's sleep hours and eating behaviors. The researchers believe this screen time intervention can be a breakthrough to consider and change behaviors such as sleep, eating, and exercise together.

This study was collaborative with a university in Uganda, Japanese researchers, and elementary schools. Researchers expect this study to sensitize and motivate them to continue their child obesity prevention activities in these organizations and influence all stakeholders.

This study will benefit not only the participant schoolchildren but their future children. The findings of this study could pave the way for future efforts to combat child obesity and raise awareness of future mothers and fathers.

Based on this study's results, a program for school-health promotion human resources could be developed. As the sustainable development goals (SDGs) focus on good health (SDGs 3), researchers will discuss the programs and contribute to this area.

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