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Prevalence of Metabolic Syndrome among Senior High School Students in Akuapem North Municipality, Ghana

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Abstract:

Background: Metabolic Syndrome (MetS) is a cluster of interrelated metabolic abnormalities, including central obesity, dyslipidemia, hypertension, and hyperglycemia, which increase the risk of cardiovascular disease, type 2 diabetes, and overall mortality. This study aimed to assess the prevalence of MetS among adolescents aged 13–19 years in the Akwapem North Municipality, Ghana.

Methods: A descriptive cross-sectional study was conducted with 184 students from Presbyterian Senior High School, Mampong Akwapem. Participants were selected using stratified random sampling. Data were collected through questionnaires, anthropometric measurements (height, weight, waist circumference), blood pressure measurements, and biochemical assessments of fasting blood glucose, triglycerides, HDL cholesterol, and LDL cholesterol. The data were analyzed using STATA version 18.

Results: The prevalence of MetS among participants was 6.52% (95% CI: 3.73% – 11.17%). The most common metabolic abnormalities were low HDL cholesterol (46.74%) and elevated triglycerides (7.61%). The prevalence of elevated blood pressure (1.63%) and high fasting glucose (5.98%) were comparatively lower. A statistically significant association was found between BMI category and MetS ($p<0.001$), with overweight and obese participants showing a higher prevalence. Waist circumference also demonstrated a significant association with MetS ($p<0.001$).

Conclusion: The prevalence of MetS among adolescents in the Akwapem North Municipality is concerning, highlighting the need for early detection and intervention. The findings suggest that excess body weight and abdominal obesity are significant determinants of MetS in this population. Public health strategies, including routine screening, health education, and lifestyle interventions, are essential for addressing the rising prevalence of MetS and preventing long-term health complications.

Keywords: *Metabolic Syndrome, Dyslipidemia, Fasting Glucose, Adolescents*.

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Introduction

Metabolic Syndrome (MetS) refers to a constellation of interconnected physiological, biochemical, clinical, and metabolic factors that directly increase the risk of cardiovascular disease, type 2 diabetes mellitus, and all-cause mortality (Alberti *et al.,* 2009). Adolescents worldwide are increasingly affected, influenced by the rise in childhood obesity, sedentary lifestyle, and unhealthy dietary practices (Friend *et al.,* 2013). MetS is characterized by central obesity, dyslipidemia (high triglycerides and low high-density lipoprotein cholesterol), hypertension, and hyperglycemia (Zimmet *et al.,* 2007). Over the past years, several diagnostics methods and approaches have been developed to diagnose Metabolic Syndrome (MetS). This has also helped to develop means to improve the standard of life by therapeutic measures (Shafeeq *et al.,* 2021).

Metabolic Syndrome (MetS) has become an increasingly recognized global public health concern owing to its strong association with chronic diseases, such as cardiovascular disease (CVD), type 2 diabetes mellitus, and stroke (Shafeeq *et al.,* 2021).Although MetS has historically been considered an adult condition, emerging evidence suggests that it is becoming prevalent among children and adolescents, raising concerns about early onset metabolic dysfunction and the long-term consequences of the disorder (Weiss *et al.,* 2013).Early detection is crucial, as adolescence represents a critical period for establishing lifelong health habits, and timely intervention can mitigate future complications while reducing the burden on the healthcare system (Kaur, 2014).

MetS is characterized by a cluster of interrelated metabolic abnormalities that collectively increase an individual's risk of developing CVD and diabetes.Key components of MetS include insulin resistance, abdominal obesity, dyslipidemia, hypertension, and hyperglycemia (Okafor, 2012).The condition is typically

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diagnosed when an individual presents with three or more of the following criteria: elevated fasting blood glucose (≥100 mg/dL), elevated triglyceride levels (≥150 mg/dL), and low high-density lipoprotein cholesterol (HDL-C <40mg/dL in men and <50mg/dL in women) (Moore *et al.,* 2017).

In recent decades, the prevalence of MetS among adolescents has increased worldwide, driven primarily by lifestyle transitions such as increased sedentary behavior, reduced physical activity, and the consumption of energy-dense and nutrient-poor diets (Bankoski *et al*., 2011).In the United States, between 2007 and 2012, MetS affected up to 75% of adults, with a notably higher prevalence among white Latin Americans than black Latin Americans (Moore *et al.,* 2017). Similarly, research in South Asia estimated that 20–25% of the population exhibits characteristics of MetS (Padmavathi *et al.,* 2013).

In sub-Saharan Africa, including Ghana, the epidemiological transition from communicable diseases to non-communicable diseases has intensified concerns regarding metabolic disorders among adolescents (Ofori-Asenso *et al.,* 2017).Ghana is undergoing rapid urbanization, and lifestyle changes, such as increased consumption of processed foods, reduced physical activity, and socioeconomic shifts, are amplifying the prevalence of metabolic disorders (Onyegbutulem *et al*., 2009).Additionally, the widespread use of antiretroviral therapy (ART) for HIV has been linked to metabolic side effects, including dyslipidemia and insulin resistance, further exacerbating the metabolic health risks in the region (Onyegbutulem *et al.,* 2009).

Despite these growing concerns, there is limited research investigating the prevalence of MetS among school-aged children in Ghana, particularly in peri-urban communities, such as Akwapem Mampong. This town serves as a representative setting for urban transition, where traditional lifestyles are rapidly being replaced by sedentary behaviors and Westernized dietary patterns. Understanding the prevalence of MetS among adolescents in Akwapem Mampong is essential for identifying at-risk populations and for implementing early prevention strategies.

This study aimed to assess the prevalence of MetS among students aged 13–19 years in Akwapem Mampong, addressing a significant research gap in adolescent metabolic health in Ghana. By providing localized data, the findings will contribute to targeted health interventions such as school-based screenings, nutritional education programs, and policy recommendations to reduce metabolic risks among adolescents. Strengthening early detection and intervention frameworks will support public health strategies aimed at mitigating long-term health complications and promoting healthier lifestyle practices among Ghanaian youths.

Methodology

Study Design

A descriptive cross-sectional design was adopted for this study. This approach was appropriate for assessing the prevalence of metabolic syndrome (MetS) as it involves collecting data from the target population at a specific point in time without manipulating variables (Creswell, 2014). The design allowed the researcher to gather data on key indicators such as anthropometric measurements, dietary habits, and biochemical markers among adolescents, thereby estimating the prevalence of MetS in the population.

Cross-sectional studies are particularly effective for public health research, where understanding the distribution of a condition like MetS within a defined population is essential for health planning and intervention (Levin, 2006).

Study Setting

The research was conducted in Presbyterian Senior High School Akwapem Mampong, located in the Eastern Region of Ghana. The school has a population of two thousand eight hundred and twenty-nine (2,829), of which one thousand, one hundred and three (1103) are boys and one thousand seven hundred and twenty-six (1726) are girls making it ideal for the study population. Akwapem Mampong is characterized by moderate access to healthcare, variations in socioeconomic status, and differing dietary and physical activity patterns among adolescents. These conditions provide a realistic context to evaluate the factors contributing to metabolic syndrome.

Study Population

The target population included students aged 13–19 years enrolled in Presbyterian Senior High School in Akwapem Mampong. Adolescents in this age group are at a critical stage of physical and hormonal development, and lifestyle factors such as diet, physical inactivity, and stress may influence the onset of MetS (de Ferranti *et al.,* 2004). Both male and female students across various socioeconomic backgrounds were considered.

Inclusion Criteria

Participants in this study were required to be aged between 13 and 19 years at the time of the study. They had to be currently enrolled at Presbyterian Senior High School, Akwapem Mampong, and must have provided informed consent. For participants under 18 years of age, parental consent was also necessary. Participants needed to be physically present at school during the data collection period and must not have been diagnosed with any chronic illnesses or metabolic disorders at the time of recruitment.

Exclusion Criteria

- Individuals who fall outside the age range of 13 to 19 years will be excluded.
- Participants with a diagnosed history of metabolic disorders, including diabetes, hypertension, or other related conditions, will be excluded.
- Students who are currently taking medications that could potentially influence metabolic parameters (e.g., antihypertensives, antidiabetic drugs) will be excluded.
- Participants with physical or cognitive disabilities that would prevent them from participating in the study's required procedures (e.g., anthropometric measurements, blood sampling) will be excluded

Sample Size Determination

The sample size for this study was calculated based on an expected prevalence of 12.3%, derived from previous studies (Friend et al., 2013). Using a 95% confidence level and a margin of error (e) of 8%, the minimum sample size (n) was calculated using the formula:

$$n = \frac{Z^2 p(1-p)}{e^2}$$

Where:

- n = Minimum sample size
- Z = Z-score for 95% confidence level (1.96)
- p = Expected prevalence (12.3%)
- e = Margin of error (0.08)

Substituting the values:

$$n = \frac{(1.96)^2 \times (0.123) \times (1-0.123)}{(0.08)^2} = 165.8$$

To account for a possible 10% non-response rate, the adjusted sample size ($N_{adjusted}$) was calculated as:

$$N_{adjusted} = \frac{165.8}{0.9} = 184$$

Thus, the minimum sample size for this study was determined to be 184 students.

Sampling Technique

A multistage sampling method was used to select participants for this study. First, the student population at Presbyterian Senior High School, Akwapem Mampong, was stratified by class level (Form 1 to Form 3). Simple random sampling was then applied to select one class from each stratum. Within each selected class, participants were chosen through systematic random sampling from the class registers, ensuring a representative distribution of students across various age groups. systematic random sampling was used to choose participants from class registers. This method ensured a representative distribution of students across classes and age groups (Kumar, 2019).

Data Collection Instruments and Procedure

A variety of data collection instruments were utilized to ensure a comprehensive assessment of the components of metabolic syndrome which included, A self-administered, pre-tested questionnaire, adapted from the WHO STEPS Instrument and the IPAQ short form (Craig et al., 2003), was used to gather data on participants' demographics, dietary habits, physical activity, and family health history. These were measured using a stadiometer and a digital scale, respectively. Waist circumference was measured at the midpoint between the last rib and the iliac crest. BMI was calculated using the formula weight (kg)/height^2 (m^2) and categorized according to WHO standards. Blood pressure was measured using an automated digital sphygmomanometer. Two readings were taken five minutes apart, and the average was recorded (Pickering et al., 2005). Fasting blood samples were collected by trained health professionals to assess glucose, triglycerides, HDL, and LDL cholesterol levels. These samples were analyzed using enzymatic methods, following the NCEP ATP III guidelines (2001).

Data Analysis

The collected data were entered into STATA Version 18 for statistical analysis. The analysis plan involved several steps. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were calculated for both demographic and clinical variables. The prevalence of metabolic syndrome was estimated using the NCEP criteria (2002). Bivariate analysis was conducted using chi-square tests to assess associations between categorical variables, while t-tests were used to examine relationships between continuous variables. A significance level of $p<0.05$ was considered statistically significant.

Ethical Considerations

This study adhered to ethical principles for research involving human participants. Written informed consent was obtained from all participants, with assent from parents or guardians for those under 18 years of age. Ethical clearance was granted by the Baldwin University College Ethical Review Board. The study followed the guidelines set forth in the Declaration of Helsinki (World Medical Association, 2013). All data collected were kept confidential, and participants were assured that their identities would remain anonymous throughout the study. Data were assigned unique identification numbers, and access was restricted to the research team. Participants had the right to withdraw from the study at any time without any consequences,

and their decision would not affect their relationship with the researcher or the institution.

Results

Socio-demographic characteristics of Study Participants

A total of 184 adolescents, aged 13 to 19 years, participated in the study. The median age of the participants was 17 years, with a minimum age of 13 and a maximum age of 19 years. The largest proportion of participants were aged 16-17 years (44.02%). Females comprised the majority of the sample, accounting for 63.59% of the participants, while males represented 36.41%.

In terms of Body Mass Index (BMI), the majority of participants (65.76%) had a normal BMI, while 2.17% were classified as obese. Regarding waist circumference, 97.28% of the participants had normal values, with 2.72% exhibiting abdominal obesity.

These socio-demographic characteristics highlight the variability in age, sex, and physical characteristics among the study participants, which is important for understanding the distribution of metabolic syndrome risk factors in this population.

Table 1. Socio-demographic characteristics of Study Participants p -value <0.51

Variables	Frequency (n)	Percent (%)
Age Category (years)		
13–15	48	26.09
16–17	81	44.02
18–19	55	29.89
Sex		
Female	117	63.59
Male	67	36.41

Table 2: Anthropometric and laboratory measurements by sex of respondents

Variables	Males	Females	Total
Waist circumference (cm)	70.00 (56.00-103.00)	71.00 (58.00 -105.00)	71.00 (56-105.00)
BMI (m/kg2)	20.18 (11.92-27.57)	20.90(15.01-33.73)	20.59 (11.92-33.73)
Systolic BP (mm/Hg)	100.00 (86.00-119.00)	100.00(87.00-113.00)	100.00(86.00-119.00)
Diastolic BP(mm/Hg)	66.00(56.00-85.00)	67.00(54.00-98.00)	66.00(54.00-98.00)
Fasting Blood Glucose(mg/dl)	84.60(64.80-105.80)	82.80(68.40-113.40)	84.60(64.80-113.40)
Total Cholesterol (mg/dl)	157.77(112.14-199.92)	158.55(114.85-213.85)	158.55(112.14-213.85)
Triglyceride (mg/dl)	77.06(44.29-166.51)	81.48(35.43-172.71)	79.71(35.43-172.71)
HDL (mg/dl)	44.77(15.44-73.34)	47.86(20.84-73.34)	46.32(15.44-73.34)
LDL (mg/dl)	96.13(50.66-144.24)	94.74(50.66-137.67)	95.13(50.66-144.24)

Data is presented as medians (range)

Table .2 displays the anthropometric and laboratory measurements of study participants, categorized by sex. The median values for waist circumference, BMI, systolic and diastolic blood pressure, fasting blood glucose, total cholesterol, triglycerides, HDL, and LDL cholesterol are presented for both male and female participants.

For waist circumference, the median value for males was 70.00 cm (range: 56.00-103.00), and for females, it was 71.00 cm (range: 58.00-105.00), reflecting relatively similar measurements across both sexes. The median BMI for males was 20.18 (range: 11.92-27.57), while for females, it was slightly higher at 20.90 (range: 15.01-33.73). These values indicate a generally healthy weight distribution, with some variation across individuals.

Regarding blood pressure, both systolic and diastolic measurements were quite similar between sexes. The median systolic blood pressure for males and females was 100.00 mmHg, and the median diastolic blood pressure was 66.00 mmHg for males and 67.00 mmHg for females, with only minor differences between the two groups.

In the lipid profile, the median total cholesterol levels for males (157.77 mg/dL, range: 112.14-199.92) and females (158.55 mg/dL, range: 114.85-213.85) were similar, indicating comparable cholesterol levels between sexes. Triglycerides were also comparable, with median values of 77.06 mg/dL (range: 44.29-166.51) for males and 81.48 mg/dL (range: 35.43-172.71) for females. Similarly, the median LDL cholesterol levels for males (96.13 mg/dL, range: 50.66-144.24) and females (94.74 mg/dL, range: 50.66-137.67) were not significantly different.

HDL cholesterol levels were slightly higher in females, with a median of 47.86 mg/dL (range: 20.84-73.34) compared to 44.77 mg/dL (range: 15.44-73.34) in males, indicating a potential sex-based variation in HDL levels.

Table.3 below shows the prevalence of metabolic syndrome (MetS) among schoolchildren aged 13 to 19 years in Akwapem North Municipality. The overall prevalence of MetS was 6.52% (95% CI: 3.73% – 11.17%), indicating that a small proportion of adolescents in the study population exhibited the key risk factors associated with metabolic syndrome.

A significant majority of the participants (93.48%) did not meet the diagnostic criteria for MetS, further emphasizing that metabolic syndrome remains relatively uncommon in this group. The relatively low prevalence observed in this study may reflect the demographic and lifestyle factors of the participants, but it aligns with rates observed in similar populations in other parts of Ghana and low- and middle-income countries.

The reported prevalence, with a p-value of less than 0.001, suggests a statistically significant association between the examined factors and the presence of MetS. These findings underscore the importance of early detection and intervention strategies to reduce the long-term risks of cardiovascular disease, diabetes, and other associated conditions.

Table.3: Prevalence of Metabolic Syndrome among school children aged 13-19 years in Akwapem North Municipality. p-value<0.001

Metabolic syndrome	Frequency (n)	Prevalence (%)	Lower limit	Upper limit
No	172	93.48	88.83	96.27
Yes	12	6.52	3.73	11.17
Total	184	100		

Table 4. outlines the individual components of metabolic syndrome (MetS) among the schoolchildren aged 13 to 19 years in Akwapem North Municipality. The prevalence of each component was assessed, revealing varying rates across the different metabolic risk factors.

Regarding waist circumference, 4.35% of participants exhibited abdominal obesity, while the majority (95.65%) had normal waist circumference values, indicating that central obesity was relatively less common in the sample. The prevalence of elevated triglycerides was 7.61%, with participants showing triglyceride levels above the threshold of ≥150 mg/dL, which is a key indicator of MetS.

A significant portion of the participants (46.74%) had low levels of high-density lipoprotein (HDL) cholesterol, which is defined as less than 40 mg/dL for males and less than 50 mg/dL for females. This indicates a high prevalence of dyslipidemia, a critical component of MetS, suggesting that lipid imbalance is a prevalent concern in the study population.

The prevalence of elevated blood pressure (≥130/85 mmHg) was relatively low, with only 1.63% of participants meeting the criteria for hypertension. Similarly, 5.98% of the respondents had high fasting glucose levels (≥100 mg/dL), highlighting a moderate prevalence of hyperglycemia among the adolescents.

These findings reveal that while some components of MetS, such as low HDL and high triglycerides, were notably prevalent, others, including elevated blood pressure and glucose, were less common. The distribution of these components emphasizes the need for targeted interventions to address dyslipidemia and abdominal obesity, which are more widespread in this adolescent population.

Table 4. Individual components of metabolic syndrome most prevalent among school children

Variables	Frequency (n)	Percentage (%)
Waist circumference (cm)		
Normal (< 102 cm for men; <88 cm for women	176	95.65
Abdominal obesity (>= 102 cm for men; >=88 cm for women	8	4.35
Triglyceride (mg/dl)		
Normal level (< 150)	170	92.39
High level (>= 150)	14	7.61
HDL (mg/dl)		
Normal (>=40mg/dl for men; >=50mg/dl for women)	98	53.26
Low HDL (< 40 mg/dl for men; < 50mg/dl for women	86	46.74
Blood Pressure (mm/Hg)		
Normal Bp (<129/84)	181	98.37
High Bp (>=130/85)	3	1.63
Glucose (mg/dl)		
Normal glucose (<100)	173	94.02
High Glucose (>= 100)	11	5.98

Table .5 presents the association between various socio-demographic factors and the prevalence of metabolic syndrome (MetS) among the study participants. The analysis indicates that certain factors, such as Body Mass Index (BMI) and waist circumference, have a statistically significant relationship with MetS.

The association between BMI category and MetS was highly significant (p<0.001, Cramér's V=0.6185). The prevalence of MetS was notably higher among overweight (46.15%) and obese (75.00%) participants, compared to those with normal weight and underweight. This reinforces the strong link between excess body weight and the development of MetS, highlighting obesity as a key determinant of metabolic health risks in this population.

Waist circumference also demonstrated a significant association with MetS (p<0.001, Cramér's V=0.4974). Among participants with abdominal obesity, 80.00% had MetS, compared to just 4.47% of those with normal waist circumference. This finding underscores the importance of central obesity as a critical risk factor for MetS, further emphasizing the need for early identification of abdominal obesity to mitigate the risk of associated metabolic disorders.

In contrast, there were no statistically significant associations between age or sex and the presence of MetS. The prevalence of MetS did not vary notably across age groups (p=0.513) or between males and females (p=0.540), suggesting that MetS risk factors are relatively evenly distributed across these socio-demographic variables during adolescence.

Association between socio-demographic factors and metabolic syndrome

Bivariate analysis showed that BMI category showed a statistically significant association with metabolic syndrome (p<0.001, Cramer's V=0.6185). The prevalence was notably higher among overweight (46.15%) and obese participants (75.00%) compared to those with normal weight and underweight. Waist circumference was also significantly associated with metabolic syndrome (p<0.001, Cramer's V = 0.4974). Among those with abdominal obesity, 80.00% had metabolic syndrome compared to only 4.47% among respondents with normal waist circumference as shown in Table.5.

Table. 5: Association between socio-demographic factors and Metabolic Syndrome by study participants

Variables	Metabolic syndrome		p-value	Cremar's V
	No (%)	Yes (%)		
Age Category			0.513	
13–15	45 (93.75)	3 (6.25)		
16–17	74 (91.36)	7 (8.64)		
18–19	53 (96.36)	2 (3.64)		
Sex			0.540	
Female	108 (92.31)	9 (7.69)		
Male	64 (95.52)	3 (4.48)		
BMI Category			<0.001	0.6185
Underweight	45 (97.83)	1 (2.17)		
Normal	119 (98.35)	2 (1.65)		
Overweight	7 (53.85)	6 (46.15)		
Obese	1 (25.00)	3 (75.00)		
Waist Circumference			<0.001	0.4974
Normal	171 (95.53)	8 (4.47)		
Abdominal Obesity	1 (20.00)	4 (80.00)		

p-value of < 0.05 is considered statistically significant,

Discussion

This study assessed the prevalence and factors associated with metabolic syndrome (MetS) among Senior High School students in the Akwapem North Municipality. The findings revealed a prevalence of 6.52% (95% CI: 3.73 – 11.17%), indicating that a significant proportion of adolescents in the study population exhibit the clustering of risk factors that define MetS. This prevalence is consistent with a recent meta-analysis conducted by Bitew et al. (2020), which reported a pooled prevalence of 6.71% using ATP III criteria in low- and middle-income countries. However, this prevalence is lower compared to studies conducted in other regions of Ghana, such as those by Owiredu et al. (2011) and Yeboah et al. (2017). The lower prevalence observed in this study may be attributed to the predominance of normal BMI and waist circumference values among participants, which aligns with other studies indicating lower metabolic risk in adolescent populations with healthier weight profiles (Alberti et al., 2009; Owiredu et al., 2011).

When examining the individual components of MetS, low HDL cholesterol was the most prevalent abnormality, followed by elevated triglycerides (7.61%), elevated fasting glucose (5.98%), and abdominal obesity (4.35%). Interestingly, elevated blood pressure (≥130/85 mmHg) was the least common abnormality (1.63%). The high prevalence of low HDL cholesterol is consistent with findings from Bitew et al. (2020), which suggested that unhealthy dietary patterns and reduced physical activity are key contributors to lipid imbalances in adolescents. Conversely, the lower prevalence of elevated blood pressure may be explained by the younger age of the participants in this study, as hypertension is more commonly observed in older individuals (Kaur, 2014; Shafeeq et al., 2021).

Regarding socio-demographic factors, there were no statistically significant associations between age or sex and the presence of MetS. This suggests that risk factors for MetS are generally distributed evenly across these variables during adolescence, a finding also supported by other studies examining

MetS in adolescents across different regions (Ng et al., 2014; Weiss et al., 2013). However, a strong and statistically significant association was found between BMI category and MetS (Cramér's V=0.6185, p<0.001), with overweight and obese participants exhibiting a higher prevalence of MetS. This finding underscores the critical role of excess body weight as a determinant of metabolic risk in this adolescent population, which is supported by the growing body of literature that links obesity with MetS (Zimmet et al., 2007; Wang, 2020). Similarly, waist circumference was significantly associated with MetS (Cramér's V=0.4974, p<0.001), reinforcing its importance as a measure of central obesity and related metabolic risk. These results are consistent with the well-established understanding that obesity is a key pathophysiological mechanism underlying insulin resistance and dyslipidemia, which are central components of MetS (Reaven, 1988; Bokhari et al., 2018).

The presence of MetS in adolescents suggests that cardiovascular and metabolic diseases, which typically manifest in adulthood, may have their origins much earlier in life. Without timely intervention, adolescents with MetS are at greater risk of developing type 2 diabetes, hypertension, and cardiovascular disease at younger ages, placing a significant burden on healthcare systems (Fahed et al., 2022; Magge et al., 2017). These findings highlight the importance of early identification and intervention to mitigate the long-term health consequences of MetS, as early detection can reduce the risk of associated chronic diseases (Kaur, 2014).

Conclusion

This study assessed the prevalence and associated factors of metabolic syndrome (MetS) among adolescents in the Akwapem North Municipality. The findings revealed a prevalence of 6.52%, indicating that a significant proportion of the adolescent population is already exhibiting key metabolic risk factors. Among the individual components of MetS, low HDL cholesterol was the most prevalent, followed by elevated triglycerides, high fasting glucose, and abdominal obesity. Elevated blood pressure was the least common abnormality.

The study identified a statistically significant association between BMI category and MetS, with overweight and obese adolescents showing a higher prevalence of the syndrome. Similarly, waist circumference was strongly linked to MetS, highlighting central obesity as a crucial metabolic risk factor in this population.

The presence of MetS in adolescents suggests that metabolic and cardiovascular diseases, typically observed in adulthood, may have their origins much earlier in life. These findings underscore the importance of early detection and intervention, which are essential for preventing the long-term health consequences of MetS, including type 2 diabetes, cardiovascular disease, and other chronic conditions.

Given the rising prevalence of MetS in adolescents, particularly in urbanizing regions such as Akwapem Mampong, there is an urgent need for targeted public health interventions. Schools, healthcare providers, and policymakers should collaborate to implement early screening, promote healthier lifestyle choices, and develop preventive programs to reduce the risk of MetS and its associated complications among adolescents.

Limitations

This study, while providing valuable insights into the prevalence of metabolic syndrome (MetS) among adolescents in the Akwapem North Municipality, has several limitations that should be considered when interpreting the results. First, the study was limited to a single school in the municipality, which may not be fully representative of the broader adolescent population in the region. Consequently, the findings may not be generalizable to other schools or communities with different socio-economic characteristics or lifestyle factors.

Secondly, the cross-sectional design of the study only provides a snapshot of the prevalence of MetS at a specific point in time, limiting the ability to draw conclusions about the causal relationships between socio-demographic factors and MetS. Longitudinal studies would be necessary to better understand the progression of MetS and the long-term health outcomes associated with early metabolic abnormalities.

Additionally, the study relied on self-reported data for dietary habits and physical activity, which may be subject to recall bias and inaccuracies. Future studies should consider using more objective measures, such as food diaries or accelerometers, to provide more accurate assessments of lifestyle factors.

Finally, while the study included a sufficient sample size to detect key associations, the relatively small number of cases of MetS (12 participants) limits the statistical power for detecting subtler relationships between MetS and certain variables. A larger sample size would help to enhance the reliability and robustness of the findings.

Recommendations

Based on the findings of this study, the following recommendations are made to address the rising prevalence of metabolic syndrome (MetS) among adolescents in Akwapem North Municipality:

1. Future studies should include a larger, more diverse sample from various schools across different regions to provide a more comprehensive understanding of the prevalence and risk factors of MetS among adolescents. Longitudinal studies would also be valuable in examining the progression of MetS over time and its long-term health consequences.
2. It is crucial to implement regular screening programs for metabolic syndrome in schools, particularly in regions experiencing rapid urbanization. Early identification of adolescents at risk of MetS will facilitate timely interventions and prevent the progression of associated conditions, such as type 2 diabetes and cardiovascular diseases.
3. Schools and community health organizations should collaborate to create and implement comprehensive health education programs focusing on promoting healthy eating habits, regular physical activity, and the importance of maintaining a healthy weight. These programs should target both students and their families to ensure sustainable lifestyle changes.
4. Policymakers should prioritize the integration of MetS prevention strategies into national and local health

policies. This includes enhancing the availability of resources for health education in schools, promoting physical activity, and improving access to healthcare services for early detection and management of metabolic risk factors.

5. Given the role of socioeconomic factors in the development of MetS, it is essential to address barriers such as limited access to healthy foods and healthcare. Community-based interventions should focus on improving access to nutritious foods and physical activity opportunities, especially for adolescents from lower-income backgrounds.

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