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Early clinical markers of metabolic syndrome among secondary school adolescents in Dar es Salaam, Tanzania

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Abstract

Background: Metabolic syndrome is defined by the presence of three of four disorders; hypertension, obesity, dyslipidemia and diabetes mellitus type 2. The presence of any one or two of these constitutes early markers of the syndrome. It occurs in children and adolescents but its magnitude has not been determined consistently in many countries including Tanzania. Detection of early clinical markers is effective preventive strategy. The aim of this study was to determine the prevalence of early clinical markers of metabolic syndrome among secondary school adolescents in Dar es Salaam.

Methods: A descriptive cross-sectional study was conducted among secondary schools in Dar es Salaam. Structured questionnaires were used to record demographic data. Blood pressure and anthropometric measurements were taken using standard methods. Fasting blood samples were collected for blood glucose, total cholesterol, low density lipoprotein, high density lipoprotein and triglyceride. The International Diabetes Federation (IDF) criteria were utilized.

Results: A total of 217 adolescents were enrolled; of these males and females were 32% (69) and 68% (148) respectively. Of these; 75% (162) were young adolescents (14-17years). Participants from public and private schools were 48% (104) and 52% (113) respectively. Early clinical markers of metabolic syndrome were detected in 43% (94) with at least one clinical marker and 9% (19) with two markers. The prevalence of full-blown metabolic syndrome was 1.4% (3). Overall, the clinical markers included; dyslipidemia 30% (64), central obesity 22% (48), hyperglycemia 13% (29) and hypertension 2% (4). Prevalence of central obesity was 26% (42) among young adolescents and 11% (6) among elderly adolescents and the difference was significant (p value= 0.02).

Conclusion: Early clinical markers of metabolic syndrome exist among Dar es Salaam secondary school adolescents with dyslipidemia being the commonest marker while central obesity was much common among young adolescents. School programs for screening students for detection of early markers of metabolic syndrome are needed.

Keywords: Metabolic syndrome; clinical markers; adolescents

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Introduction

Metabolic syndrome was first described as syndrome X by Gerald Reaven in 1988 being a cluster of risk factors for cardiovascular disease that include; diabetes mellitus type 2, obesity, dyslipidemia and hypertension (NCEP 2001). Currently, metabolic syndrome is defined clinically by presence of three of four conditions; hypertension, obesity, dyslipidemia and type 2 diabetes mellitus (NCEP 2001; Haiquan et al 2012). These are known as clinical markers of metabolic syndrome. Bio markers of the syndrome include leptin, adiponectin, uric acid and tumor necrosis factor (TNFα) (Haiquan et al 2012). The syndrome has become a global public health concern due to the rapid increase in childhood obesity. Obesity is significantly associated with hypertension, dyslipidemia and diabetes mellitus type 2 and poses a

higher chance of premature death. Control of hypertension, by adopting lifestyle modifications at early stages, is associated with a reduction of cardiovascular complications (AAP 2014; Morrison et al 2008). Diabetes mellitus type 2 is primarily associated with insulin resistance and subsequent dyslipidemia (Cosmas et al 2016). Insulin resistance is central to the pathophysiology of the metabolic syndrome.

The prevalence of adolescent hypertension has been rising over time with great variability globally. For example, some studies have indicated a rise from 13% in 2015 to 31% in 2017 (Miller et al 2014; Jiao et al 2015; Mehryar et al 2012). During the same period (2017), the prevalence of obesity and dyslipidemia was 25% and 18% respectively (Haiquan et al 2012; Krushnapriya et al 2015). The prevalence of metabolic syndrome also increased from 1% to 20% between 2001 and 2016 (Miller et al 2014; Mehryar et al 2012; Sokokotla et al 2017; Ngo-Song et al 2014).

Central obesity and dyslipidemia have been found to be the most prevalent markers among males (Miller et al 2014; Dalia et al 2018). Early detection and timely prevention is less costly and effective. However, studies on early markers of metabolic syndrome among adolescents have not been extensively and consistently conducted in many African countries including Tanzania. This study aimed at describing the prevalence of the early clinical markers of metabolic syndrome among adolescents in secondary schools, Dar es Salaam, Tanzania.

Methods

Study design:

Descriptive cross-sectional study was conducted among secondary school adolescents in Dar es Salaam

Sampling and recruitment technique

Multistage sampling was employed. Secondary school students with fully informed consent were recruited into the study. Disabled students with difficult anthropometric measurements were excluded.

Data collection

Demographic data were collected using structured questionnaire. Weight was measured using the Seca weighing scale (Seca Company, Germany), without shoes, to the nearest 0.5 kilograms. Height was measured without shoes to the nearest 0.5cm. Waist circumference was taken at mid-way between lowest rib and iliac crest to the nearest 0.5cm at the end of tidal expiration. The average of two blood pressure readings taken at a 5-minute-interval, after a 5-minute rest in a sitting position using a mercury sphygmomanometer was recorded. The IDF criteria for adolescents were used to diagnose hypertension: systolic blood pressure$\geq$130mmHg and diastolic blood pressure $\geq$85mmHg defined hypertension.

After overnight fast, blood samples for serum lipids; High Density Lipoprotein, Low Density Lipoprotein, Triglyceride, Total cholesterol and blood glucose were collected and transported to the laboratory for analysis within a day using an automated analyzer (HUMASTAR 300, Germany).

The IDF criteria for adolescents were used to define clinical markers of metabolic syndrome: waist circumference ≥94 cm, ≥80 cm indicated central obesity for boys and girls respectively. Serum triglycerides ≥1.7 mmol/L and serum HDL< 1.03 mmol/L, fasting serum

glucose ≥5.6 mmol/L, systolic blood pressure ≥130mmHg or diastolic blood pressure ≥85 mmHg defined dyslipidemia, hyperglycemia and hypertension respectively.

Data entry and analysis

The data was entered into a computer and analyzed utilizing SPSS Version 20. Chi-squared and student's t tests were used for categorical and continuous variables respectively. A p-value <0.05 was statistically significant.

Results

A total of 233 (78 males and 155 females) adolescent secondary school students, were recruited. Complete data were available in 217 (69 males; 148 females) while 16 were excluded: 11 no consent and 5could not fast. Table 1 shows the demographic characteristics of secondary school adolescents. The overall mean age was16.9±1.08 years (range 14-19 years); a slight majority (52%) came from private schools.

Table 1: Demographic data of secondary school adolescents in Dar es Salaam: n=217

Variable	Frequency (%)
Gender	
Males	69 (32)
Females	148 (68)
Age	
14-17 years (Young adolescents)	162 (75)
18-19 years (Elder adolescents)	55 (25)
Overall mean	16.9±.1.08
School	
Public school	104 (48)
Private school	113(52)

Table 2 shows clinical parameters: body mass indices, waist circumferences and blood pressure. Overall, 22% (48/217), all females, had central obesity. Of these, private students; 35/113 (31%) were more affected than public counterparts {(13/104; 13%) p=<0.001}. Peripheral obesity was observed in 5% students (10/217) of whom, 8 were females from private schools. Five students; 3 and 2 had systolic and diastolic hypertension respectively.

Table 2: Body mass indices, Waist circumferences and Blood Pressure among secondary school adolescents in Dar es Salaam: n=217

	ALL (217)	Males (69)	Females (148)	p-value	Public (104)	Private (113)	p-value
Body mass index (BMI) in kg/m^2							
Mean	21.38 ±3.92	20.04 ±2.63	22.00± 4.27	0.422	20.90 ±3.20	21.82± 3.92	0.197
Peripheral Obesity	10(4.6%)	0	10(6.8%)	0.003	2(1.9%)	8(7.1%)	0.02

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Waist circumference (WC) in cm							
Mean	75.63 ±7.16	73.67± 7.16	76.55 ±9.41	0.076	71.85± 7.42	79.12± 8.64	<0.001
Central obesity	48(22.1%)	0	48(32.4%)	0.004	13(12.5%)	35(31%)	<0.001
Systolic Blood Pressure (SBP) in mmHg							
Mean	111.53±8.70	113.36±8.6	110.68±8.61	0.06	111.70±8.8	111.4±8.56	0.148
SHT	3(1.4%)	0	3(2.0%)	0.238	1(1%)	2(1.8%)	0.608
Diastolic Blood pressure (DBP) in mmHg							
Mean	65.21± 5.90	65.33±5.32	65.16 ±6.16	0.723	65.54 ±5.77	64.9±6.013	0.513
DHT	2(0.9%)	0	2(1.4%)	0.407	1(1.9%)	1(0.9%)	0.719

Table 3 shows laboratory parameters: fasting glucose, total cholesterol, low density lipoprotein, high density lipoprotein and triglyceride blood/serum levels among secondary school adolescents. Overall, 13% (29/217) had hyperglycemia (diabetes mellitus). Of the 113 private school adolescents, 25% had hyperglycemia compared to only 1 student from public schools. Furthermore, 30% (64/217) had dyslipidemia of whom 18 % {(39/217), 10% (21/217), 3% (6/217) and 2% (4/217)} had low HDL, total hypercholesterolemia, hypertriglyceridemia and high LDL respectively.

Table 3: Fasting blood glucose, total cholesterol, low density lipoprotein cholesterol, high density lipoprotein cholesterol and triglyceride of secondary school adolescents in Dar es Salaam

	ALL (217)	Males (69)	Females (148)	p-value	Public (104)	Private (113)	p-value
Fasting Blood glucose in mmol/L							
Mean	4.82± 0.76	4.73±0.90	4.86± 0.69	0.45	4.45± 0.57	5.16± 0.75	0.326
Hyperglycemia	29(13.4%)	9(13%)	20(13.5%)	0.920	1(1%)	28(24.8%)	<0.001
High density lipoprotein in mmol/L							
Mean	1.36 ±0.27	1.26± 0.24	1.41 ±0.27	0.068	1.33 ±0.26	1.39± 0.27	0.469
Low	39(18%)	23(33.3%)	6(10.8%)	<0.001	23(22.1%)	16(14.2%)	0.157
Total cholesterol in mmol/l							
Mean	4.01 ±0.95	3.51±0.88	4.24 ±0.89	0.201	3.88± 0.85	4.13 ±1.02	0.421
Hypercholesterolemia	21(9.7%)	1(1.4%)	20(13.5%)	0.03	6(5.8%)	15(13.3%)	0.068

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Triglyceride in mmol/L							
Mean	0.87 ±0.42	0.77± 0.28	0.92 ±0.43	0.607	0.76 ±0.42	0.98 ±0.33	0.128
Hypertriglyceridemia	6(2.8%)	1(1.4%)	5(3.4%)	0.667	1(1%)	5(4.4%)	0.215
Low density lipoprotein cholesterol in mmol/l							
Mean	0.871±0.39	0.77 ±0.28	0.92 ±0.43	0.259	1.74± 0.99	2.12 ±0.66	0.426
High	4(1.8%)	0	4(2.7%)	0.309	2(1.9%)	2(1.8%)	0.933

Table 4 shows the distribution of clinical markers of metabolic syndrome by age-group (young and elder adolescents). Central obesity was more prevalent; 26% (42/162), among young than elderly adolescents; 11 %;(6/55), the difference was significant (p-value = 0.02). Hyperglycemia was more prevalent among elderly adolescents; 20% (11/55) than the young; 11% (18/162); p-value = 0.04.

Metabolic syndrome was found in three students (1%) while 33% (72/217) and 9% (19/217) had one and two clinical markers respectively. Overall, 43% (94/217) had at least one clinical marker of metabolic syndrome higher in private school (p-value = 0.02)

Table 4: Distribution of clinical markers of metabolic syndrome among young and elder secondary school adolescents in Dar es Salaam: n=217.

Clinical marker	ALL (217)	Young adolescents (12-17years) n=162	Elder adolescents (18-19 years) n=55	p-value
Central obesity	48(22.1%)	42(26%)	6(11%)	0.02
Low HDL cholesterol	39(18%)	29(18%)	10(18.2%)	1.000
Hyperglycemia	29(13.4%)	18(11.1%)	11(20%)	0.04

Discussion

Early clinical markers of metabolic syndrome among secondary school adolescents in Dar es Salaam were investigated. A total of 217 adolescents from public and private schools were enrolled. Overall, clinical markers were detected in about 43% of them which is similar to other reports (Miller et al 2014; Jiao et al 2015).

Central obesity was the most prevalent (22%) clinical marker as observed by other researchers, 21%; (2018) (Dalia et al 2018) and 25%; (2017) (Krushnapriya et al 2015). Other studies have reported higher rates (Miller et al 2014; Nebal et al 2010). The high prevalence of obesity among females has been reported by others as well (Miller et al 2014; Mehryar et al 2012; Sokokotla et al 2017), but that, is more prevalent among private schools' and young adolescents, has not been reported by these studies. The high prevalence of obesity among private school students could be due to high socio-economic state of their parents which could expose them to 'risky diets'. The high obesity prevalence among the young is probably elusive.

The second prevalent clinical marker; low HDL (18%); higher among males, has been reported by other studies in Africa being more frequent in females (Sokokotla et al 2017; Ngo-Song et al 2014; Sabir et al 2016). Hyperglycemia (13%); was the third prevalent clinical marker and higher among private schools, which is contrary to findings from South Africa (Sokokotla et al 2017) and Sudan (Sabir et al 2014). Furthermore, the study revealed that hyperglycemia was more prevalent among elderly adolescents than young ones; a finding which is also elusive and not reported in other studies.

Hypertriglycedemia and hypertension were the least prevalent clinical markers observed in this study contrary to other reports (Cosmas et al 2016; Mehryar et al 2012; Sokokotla et al 2017; Sabir et al 2016; Nebal et al 2010), this could be due to differences in types of food and feeding pattern (Noublap et al 2018).

This study revealed a low prevalence of metabolic syndrome among adolescents (1%) which is similar to Indian and Iranian studies (2.6%; 3.3% respectively) (Mehryar et al 2012; Dalia et al 2018) but studies from USA, China and Cameron (Miller et al 2014; Jiao et al 2015; Ngo-Song et al 2014) have reported higher rates (10.1%, 17.6%, and 20.3% respectively), which could partly be explained by differing economic states, types of food and the cultural feeding patterns.

Conclusion: Early clinical markers of metabolic syndrome exist among Dar es Salaam secondary school adolescents with dyslipidemia being the overall commonest marker while central obesity is much common among young adolescents.

Declarations

Ethical issues: The ethical clearance and permission to conduct this study were issued by Hubert Kairuki Memorial University (HKMU) and Kinondoni municipal education officer respectively. Assent/consent were obtained from study participants

Consent for publication: Not applicable.

Availability of data and materials: The data sets analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests: The authors declare that they have no competing interests.

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Authors' contributions: All authors contributed equally in conception, research development and study design. WCL contributed in data collection and entry. YM was instrumental in statistical analysis. All authors read and gave final approval for the manuscript's submission and publication.

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