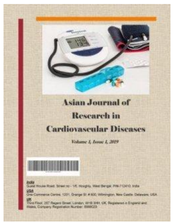

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Metabolic Syndrome among Sedentary Workers: A Cross-sectional Study in Tamale, Ghana

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Authors' contributions

This work was carried out in collaboration among all authors. Authors NA and PPMD designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors NA, SD and PPMD managed the analyses of the study. Authors NA and SD managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aim: The aim of the study was to assess the prevalence of metabolic syndrome among sedentary workers in Tamale metropolis.
Study Design: This was a cross-sectional study.
Place and Duration of Study: The study was conducted in Tamale, Ghana, from January to June 2018.
Methodology: One hundred and fifteen (115) sedentary workers were randomly selected for this study.
Sociodemographic data were collected using a self-designed questionnaire, anthropometric measurements were taken and blood samples collected for biochemical assays. Metabolic syndrome was defined by using the definitions from the International Diabetes Federation (IDF), National Cholesterol Education Program (NCEP) Adult Treatment Panel III (ATP III) and the World Health Organization.
Results: The prevalence of MetS was 1.7%, 14.8% and 17.7% according to the WHO, IDF and NCEP-ATP III criteria respectively. Using NCEP-ATP III and IDF criteria, the prevalence of abdominal obesity in female workers (75% and 84.7% respectively) was significantly higher

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compared to that of males (16.3% and 55.8% respectively). The prevalence of MetS generally increased with increasing age.

Conclusion: The study highlights a worrying trend of Metabolic syndrome in sedentary workers irrespective of the criterion applied. Hence, precautionary measures such as regular exercise, and active lifestyles must be encouraged to reduce the threatening impact of the MetS in this population.

Keywords: Metabolic syndrome; obesity; hypertension; diabetes.

1. INTRODUCTION

One of the most important health concerns internationally is a collection of interconnected physiological, biochemical, clinical and metabolic factors that directly increase the risk of cardiovascular disease, type 2 diabetes mellitus and their associated mortalities [1]. Metabolic syndrome is considered as a group of cardiovascular risk factors characterized by abdominal obesity/or central obesity, insulin resistance, atherogenic dyslipidemia and hypertension [2]. The global rise in the rate of Metabolic Syndrome (MetS) does not exclude developing countries like Ghana.

In Ghana, the prevalence vary from 2% among active sport persons, 14% among people with sedentary lifestyle in Kumasi, Ghana [3], 18% among the automobile industry workers [4], 21% in a healthy population [5], and 55.9% among diabetics [6]. The increasing rate of metabolic syndrome may be due to the changes in socio-economic conditions in the world, particularly in developing countries [7]. The 1998 world health report showed that 85% of cardiovascular diseases come from parts of the world that are of low- and middle- income countries [8]. Another study carried out by Hossain, Kawar [9] with regard to obesity and diabetes in the developing world illustrated the cause of death of 18 million people around the world was cardiovascular disease with diabetes and hypertension being the major risk factors. Metabolic syndrome is often a symptom- free condition and common in adults [10].

Sedentary lifestyle attributes to over 2 million deaths and 19 million disability changed lives, yearly worldwide [11]. Ghana, a developing country, has its population adapting to the western way of life and eating habits thereby increasing the prevalence of obesity and metabolic syndrome [3]. Sedentary lifestyle and physical activity are key modifiable lifestyle factors that influence metabolic health [12]. Lack of physical activity coupled with a poor diet, stress and modern sedentary lifestyle is complicit in an increase in the prevalence of MetS among sedentary workers [13].

The prevalence of MetS varies depending on the criteria of definition used, ethnicity, demographic location and obesity, age, physical inactivity, and low income of the study population [4,14]. Prolonged periods of inactivity including sitting or reclining is part of the key modifiable lifestyle factors that influence metabolic health [15,16]. Lack of physical activity in combination with a poor diet, stress and sedentary lifestyle is evident to an increase in the prevalence of MetS among the inactive workforce such as sedentary workers [13]. Consequently, the link between sedentary lifestyle and health status may offer new approach to non-communicable disease prevention and control. The aim of this study therefore was to assess the prevalence of MetS and its individual components among sedentary workers in Tamale, Ghana.

2. MATERIALS AND METHODS

2.1 Study Area and Design

This cross-sectional study was carried out in Tamale, Northern Ghana from January to June 2018.

2.2 Study Population

One hundred and fifteen (115) adult sedentary workers between the ages of 18-80 years were recruited for this study. Sedentary workers were people whose work or business involved being inactive or seated for a minimum of 6hrs while at work.

2.2.1 Sample size determination

The minimum sample size for the study was calculated to be 105 adults, based on the assumption that 7.4% of the Ghanaian adult population have metabolic syndrome [3], and a type I error (α) of 0.05.

$$n = \frac{z^2(1-p)p}{d^2}$$

Where n = minimum sample size; Z = standard normal variance=1.96 to obtain a power of 95% confidence interval (β=5%) and a type 1 error probability of 5%; d=Absolute standard error=0.05; p=prevalence=7.4%.

In the present study, which was limited to only adult sedentary workers who answered at least 85% of the questions in the questionnaire, the sample size was recalculated to evaluate any possible loss of precision. Given a response rate of 90%, the sample size was recalculated as: 105/0.90. Using the above formula, the calculated sample size was approximately 115. One hundred and fifteen subjects were therefore included in the study.

2.3 Data Collection

A detailed self-designed semi-structured questionnaire was administered to each consented participant for socio-demographic characteristics such as age, gender, educational level, marital status, smoking, alcohol consumption and exercise. Exercise was defined as any activity causing light perspiration or a slight to moderate increase in breathing or heart rate for at least 30 minutes. Alcohol intake was defined as the intake of at least one bottle of an alcoholic beverage per week. Participants were classified as smokers based on whether the respondent is in the habit of smoking at least one cigarette a day. Blood samples were also collected for biochemical analysis.

2.3.1 Anthropometric data

Anthropometric measurements included height, weight, waist and hip circumference. Height was measured to the nearest 0.5 centimeter without shoes using a wall mounted ruler while weight was measured to the nearest 0.1 kg in light clothing with a bathroom scale (Zhongshan Camry Electronic Co. Ltd, Guangdong, China) respectively. BMI was calculated as weight divided by height squared (kg/m^2).

Waist circumference (to the nearest centimeter) was measured at the mid-point between the last rib and the iliac crest with the participants standing balanced on both feet with feet touching each other and both arms hanging freely with a Gulick II spring-loaded measuring tape (Gay Mills, WI). The hip circumference was measured at the widest level over the trochanters [17].

Blood pressure was taken using a mercury sphygmomanometer and a stethoscope. Measurements were taken twice, adopting the American Heart Association recommendations, by taking the measurements from the left upper arm after the participant had been sitting for more than five minutes [18] and the mean of the two measurements taken. These measurements were taken between the hours of 7:00 am and 10:00 am. Systolic and diastolic blood pressure measurements were recorded.

2.3.2 Blood sample collection and preparation

Venous blood samples were collected from the antecubital vein after overnight fast (12-16 hours) between 7 am and 10 am. About 5 ml of venous blood was collected; 4 ml dispensed into serum separator tubes for the estimation of lipid profile and 1 ml into fluoride oxalate tubes for the estimation of fasting blood glucose. Serum was stored at -80°C until assayed after centrifugation at 500 g for 15 minutes whiles the plasma was assayed for glucose the same day. Parameters determined were: total cholesterol (TC), triglycerides (TG), high density lipoprotein cholesterol (HDL-C), and fasting blood glucose (FBG) using the Elitech Selectra pro S chemistry analyzer. Serum low density lipoprotein cholesterol (LDL-C) and very low-density lipoprotein-cholesterol (VLDL-C) were calculated using the Frederickson-Friedwald's equation.

2.4 Metabolic Syndrome Definitions

2.4.1 National Cholesterol Education Program, Adult Treatment Panel III (NCEP ATP III)

Metabolic syndrome was defined according to the criteria of the National Cholesterol Education Programme, Adult Treatment Panel III (NCEP ATP III) to include individuals with any three or more of the following five components: (1) abdominal obesity-ATP III (waist circumference > 102 cm for men, or > 88 cm for women); (2) high TG ≥ 1.7 mmol/L (150 mg/dl); (3) low HDL-C : men < 0.9 mmol/ L (< 40 mg/dl) or women < 1.0 mmol/L (< 50 mg/dl); and (4) High BP (systolic BP ≥ 130 mm Hg or diastolic BP ≥ 85 mm Hg or treatment of hypertension); and (5) high fasting glucose ≥ 6.1 mmol/l [19].

2.4.2 International Diabetes Federation (IDF)

According to the new definition by the International Diabetes Federation (IDF) (Alberti et al., 2006), metabolic syndrome can be diagnosed if central obesity (waist measurement

>90 cm for men or >80 cm for women) is accompanied by any 2 of the following 4 factors: (1) TG levels of 1.7 mmol/L or greater, (2) an HDL cholesterol lower than 1.03 mmol/L for men or lower than 1.29 mmol/L for women, (3) a blood pressure (BP) of 130/85 mm Hg or greater or treatment of previously diagnosed hypertension, and (4) a fasting blood glucose (FBG) of 5.6 mmol/L or greater or previously diagnosed type 2 diabetes.

2.4.3 World Health Organization (WHO)

World Health Organization criteria (Alberti et al., 2005) required presence of diabetes mellitus, impaired glucose tolerance or insulin resistance and any two of the following: (1) Body mass index (BMI) ≥30 kg/m2 and/or waist-to-hip ratio >0.90 (male), >0.85 (female), (2) blood pressure ≥140/≥90 mmHg or on medication, (3) diabetes ≥6.1 mmol/L or on medication for diabetes, impaired glucose tolerance or insulin resistance, (4) triglyceride ≥1.7 mmol/L and/or HDL-C <0.91 mmol/L (male), <1.01 mmol/L (female).

2.5 Statistical Analysis

Data was analyzed using Microsoft Excel 2013 (Microsoft Corporation, USA) and Graph Pad Prism version 6.00 for windows (San Diego California USA). Means, standard deviations and proportions were obtained for relevant variables. For comparison of categorical variables, the Chi-square test was used while for continuous variables, the unpaired t-test was employed. A p-value <0.05 was considered significant in all cases.

3. RESULTS

3.1 General Characteristics of Studied Population

From this study, the mean age of the study population was 44.2±11.6 with the male participants being significantly older (48.4±11.4; *P* = 0.002) than that of the female subjects (41.7± 10.9). Most (90%) of the study population were married, with about half the population having no education, the proportion of the female (63.9%) study subjects who had no education was higher (*P* = <0.0001) than that in males (23.3%). Likewise, a greater proportion of males had had secondary education compared to the females (*P*= 0.039). Very few of the study subjects either smoked, exercised or took alcohol, with no significant differences between the proportions of males and females who smoked, took alcohol or exercised (Table 1).

3.2 Anthropometrics and Biochemical Parameters Stratified by Gender

As shown in Table 2, females had broader hips (*P*= 0.001) than the males whereas the males were taller (*P*= 0.009) than the females. Regarding WHR, weight, BMI, systolic and diastolic blood pressure, total cholesterol, triglyceride, LDL-C, and fasting blood glucose,

Table 1. General characteristics of participants stratified by gender

Variable	Total (n=115)	Male (n=43)	Female (n=72)	P value
Age (Years)	44.2± 11.6	48.4± 11.4	41.7± 10.9	0.002
Marital Status				
Single	8 (7%)	2(4.7%)	6(8.3%)	0.45
Married	102(88.7%)	39(90.7%)	63(87.5%)	0.60
Divorced	3(2.6%)	2(4.7%)	1(1.4%)	0.29
Widowed	2(1.7%)	0(0%)	2(2.8%)	0.27
Highest Education				
No Education	56(48.7%)	10(23.3%)	46(63.9%)	<0.0001
Primary	22(19.1%)	10(23.3%)	12(16.7%)	0.39
Secondary	21(18.3%)	12(27.9%)	9(12.5%)	0.04
Tertiary	16(13.9%)	11(25.6%)	14(19.4%)	0.44
Smoking				
Yes	7(6.1%)	5(11.6%)	2(2.8%)	0.06
Alcohol				
Yes	3(2.6%)	1(2.3%)	2(2.8%)	0.88
Exercise				
Yes	10(8.7%)	6(14%)	4(5.6%)	0.12

the disparity between the males and females was insignificant. However, the females (1.63±0.38) had higher (*P*= 0.004) HDL-C values than the males (1.42±0.38) as shown in Table 2.

3.3 Prevalence of MetS and Its Score

According to the WHO, NCEP ATP III and IDF criteria, the prevalence of metabolic syndrome was 1.7%, 17.4% and 14.8% respectively. There were no significant differences in the prevalence of metabolic syndrome between male and female using the three criteria (Table 3).

3.4 Prevalence of the Various Metabolic Syndrome Risk Factors

The prevalence of obesity ranged from 53% to 73% using based on the three criteria. The prevalence of obesity was generally higher in females than males. The proportion of the study population who had a raised fasting glucose level based on the three criteria ranged from 7.8% to 16.5% with the distributions being similar in males and females. Similarly, the proportion of male with an increased blood pressure was not statistically different from that of females, with a distribution raised blood pressure among the general population ranging from 22.6% to 65.2% based on the three criteria (Table 4).

3.5 MetS and Its Components Stratified by Age

The prevalence of MetS and its components across different age categories were compared using the Chi-square for trend. From this study, the prevalence of MetS and abdominal obesity increased with age using the WHO and IDF criteria. Also, there is a significant rise in blood pressure as the age increases according to the NCEP ATP III, WHO and IDF criteria (Table 5).

4. DISCUSSION

Metabolic syndrome is a major health problem and it has been on the rise due to the change in socio-economic conditions in the world, particularly in developing countries [7]. Inadequate physical activity, sedentary lifestyle coupled with bad eating habits and stress have been known to cause an increase in the prevalence of MetS among sedentary workers [13]. The link between sedentary lifestyle and health status may thus offer a new approach to non-communicable disease prevention and control. The aim of this study therefore was to assess the prevalence of MetS and its individual components among sedentary workers in Tamale, Ghana.

The prevalence of MetS from this study using the WHO, IDF and NCEP-ATP III criteria in this study were 1.7%, 14.8% and 17.7% respectively. These figures are comparable to a those of a similar study by Owiredu, Amidu [3] in Kumasi, where prevalence among sedentary workers was observed to be 3.5%, 14% and 26% using the WHO, IDF and NCEP-ATP III criteria respectively. However, the prevalence of MetS as determined in this study is lower than the

Table 2. Anthropometric and biochemical parameters stratified based on gender

Variable	Total (n=115)	Male (n=43)	Female (n=72)	P value
WC (cm)	93.54± 12.12	91.58±12.37	94.71±11.91	0.18
HC (cm)	106.70±10.64	102.50±9.79	109.10±10.42	0.001
WHR	0.88±0.07	0.89±0.06	0.87±0.07	0.05
Height (m)	1.60±0.12	1.64±0.11	1.6±0.12	0.009
Weight (kg)	71.63±18.06	74.07±17.70	70.2±18.2	0.27
BMI (kg/m^2)	28.3±8.5	28.0±8.5	28.4±8.5	0.78
SBP (mmHg)	135.0±21.9	135.1±22.9	135.0 ±21.5	0.99
DBP (mm Hg)	85.0±13.7	85.6±11.9	84.7±14.8	0.74
TC (mmol/L)	6.10±1.71	5.88±1.47	6.22±1.84	0.30
TG (mmol/L)	1.39±0.92	1.60±1.02	1.27±0.84	0.06
HDL-C (mmol/L)	1.55±0.39	1.42±0.38	1.63±0.38	0.004
LDL-C (mmol/L)	3.91±1.56	3.73±1.30	4.01±1.71	0.35
FBG (mmol/L)	4.688±1.212	4.964±1.474	4.528±1.007	0.06

WC-Waist Circumference, HC-Hip Circumference, WHR-Waist to Hip ratio, BMI-Body Mass Index, SBP- Systolic Blood Pressure, DBP- Diastolic Blood Pressure, TC- Total Cholesterol, TG- Triglyceride, HDL-C – High Density Lipoprotein cholesterol, LDL-C - Low Density Lipoprotein cholesterol, FBG- Fasting Blood Glucose

Table 3. Prevalence of metabolic syndrome and its scores stratified by gender

Parameters	Total (n=115)	Male (n=43)	Female (n=72)	P value
Prevalence of Metabolic Syndrome				
WHO	2(1.7%)	2(4.7%)	0(0%)	0.07
NCEP ATP III	20(17.4%)	5(11.6%)	15(20.8%)	0.21
IDF	17(14.8%)	8(18.6%)	9(12.5%)	0.37
Prevalence of clustering one or two or more components of metabolic syndrome				
WHO (Score)				
0	38(33%)	14(32.6%)	24(33.3%)	0.93
1	35(30.4%)	11(25.6%)	24(33.3%)	0.38
2	35(30.4%)	15(34.9%)	20(27.8%)	0.42
>2	7(6.1%)	3(7%)	4(5.6%)	0.76
NCEP ATP III (Score)				
0	18(15.7%)	9(20.9%)	9(12.5%)	0.23
1	41(35.7%)	18(41.9%)	23(31.9%)	0.28
2	36(31.3%)	11(25.6%)	25(34.7%)	0.31
>2	20(17.4%)	5(11.6%)	15(20.8%)	0.21
IDF (Score)				
0	15(13%)	8(18.6%)	7(9.7%)	0.17
1	36(31%)	11(25.6%)	25(34.7%)	0.31
2	39(33.9%)	14(32.6%)	25(34.7%)	0.81
>2	25(21.7%)	10(23.3%)	15(20.8%)	0.76

Table 4. Prevalence of the various metabolic syndrome risk factors stratified based on gender

Parameters	Total (n=115)	Male (n=43)	Female (n=72)	P value
NCEP ATP III				
Abdominal Obesity	61(53%)	7(16.3%)	54(75%)	< 0.0001
Raised fasting Glucose	9(7.8%)	2(4.7%)	7(9.7%)	0.33
Raised triglyceride	29(25.2%)	13(30.2%)	16(22.2%)	0.34
Raised blood pressure	75(65.2%)	28(65.1%)	45(62.5%)	0.78
Reduced HDL-C	15(13%)	5(11.6%)	10(13.9%)	0.73
WHO				
Central obesity	67(58.3%)	21(48.8%)	46(63.9%)	0.11
Raised fasting Glucose	10(8.7%)	6(14%)	4(5.6%)	0.12
Dyslipidemia	31(27%)	14(32.6%)	17(23.6%)	0.30
Raised blood pressure	26(22.6%)	10(23.3%)	16(22.2%)	0.90
IDF				
Abdominal obesity	85(73.9%)	24(55.8%)	61(84.7%)	0.0006
Raised fasting glucose	19(16.5%)	9(20.9%)	10(13.9%)	0.33
Raised triglyceride	29(25.2%)	13(30.2%)	16(22.2%)	0.34
Raised blood pressure	47(40.9%)	21(48.8%)	26(36.1%)	0.18
Reduced HDL-C	15(13%)	5(11.6%)	10(13.9%)	0.73

35.9% reported among office workers in Iran [20]. This difference may be as a result of the differences in the study populations and criteria used. In this study also, the prevalence of MetS generally increased with age using the WHO and IDF criteria. This age-dependent prevalence of MetS is coherent with the outcomes of Fezeu, Balkau [21]. This association between age and Mets may be due to muscle mass reduction and reduced muscle oxidative capacity [22].

Obesity is considered an important public health problem on the rise and it has been considered a major predisposing factor to chronic conditions such as hypertension, MetS and type II diabetes [23]. The prevalence of obesity among the population in this study ranged from 53% to 73.9% when the three criteria were used. This study also showed a higher prevalence of obesity in females (75%, 63.9% and 84.7% using the NCEP-ATP III, WHO and IDF criteria

Table 5. MetS and its components stratified by age

Parameters	≤ 24 years (n=3)	25-44 years (n=62)	45-64 years (n=44)	≥ 65 years (n=6)	P value
WHO	0(0%)	0(0%)	1(2.3%)	1(16.7%)	0.02
NCEP ATP III	0(0%)	7(11.3%)	12(27.3%)	1(16.7%)	0.07
IDF	0(0%)	5(8.1%)	9(20.5%)	3(50%)	0.003
NCEP ATP III					
Abdominal Obesity	1(33.3%)	29(48.6%)	28(63.6%)	3(50%)	0.15
Raised Fasting Glucose	1(33.3%)	8(12.9%)	8(18.2%)	2(33.3%)	0.38
Raised Triglyceride	1(33.3%)	15(24.2%)	11(25%)	2(33.3%)	0.83
Raised Blood Pressure	1(33.3%)	34(54.8%)	32(72.7%)	5(83.3%)	0.02
Reduced HDL-C	1(33.3%)	7(11.3%)	5(11.4%)	2(33.3%)	0.63
WHO					
Central Obesity	1(33.3%)	24(38.7%)	25(56.8%)	6(100%)	0.003
Raised Fasting Glucose	1(33.3%)	5(8.1%)	3(6.8%)	1(16.7%)	0.75
Dyslipidaemia	1(33.3%)	17(27.4%)	11(25%)	2(33.3%)	0.93
Raised Blood Pressure	0(0%)	7(11.3%)	15(34.1%)	4(66.7%)	0.0001
IDF					
Abdominal Obesity	1(33.3%)	42(67.7%)	36(81.8%)	6(100%)	0.009
Raised Fasting Glucose	1(33.3%)	8(12.9%)	8(18.2%)	2(33.3%)	0.38
Raised Triglyceride	1(33.3%)	15(24.2%)	11(25%)	2(33.3%)	0.83
Raised Blood Pressure	0(0%)	18(29.0%)	25(56.8%)	4(66.7%)	0.0007
Reduced HDL-C	1(33.3%)	7(11.3%)	5(11.4%)	2(33.3%)	0.64

respectively) than in males. A number of studies have also revealed the same trend of females having higher prevalence rates of obesity compared to their male counterparts [14,24]. Biological changes due to hormones and childbirth in females contributes significantly to the higher prevalence of obesity in females [25].

Irace, Cortese [26] indicated in their study that hypertension can cause enhanced atherosclerosis in the carotid arteries and the WHO has also placed hypertension to be the leading cause of cardiovascular associated mortality causing over 7 million deaths yearly around the world. From this study, 22.6%, 40% and 65.2% of the study population had a raised blood pressure using the WHO, IDF and NCEP ATP III respectively. From this study, the proportion of the population with a raised blood sugar using the NCEP-ATP III, IDF and WHO criteria were 7.8%, 16.5% and 22.6% respectively. These categories of people are at risk of developing hypertension and diabetes respectively. Also, the prevalence of hypertension generally increased with age when all the three criteria i.e. WHO, IDF and NCEP-ATP III were applied. Similar pattern of results was observed by various studies. Increase in blood pressure with age is commonly related to alterations in arterial and arteriolar stiffness [27].

5. CONCLUSION

This study shows a prevalence of 1.7% to 17.7% of metabolic syndrome in sedentary workers based on the three criteria used. The major contributors to MetS in the study population are raised blood pressure for ATP III; central obesity for WHO and IDF definition, which are all stated to be on the increase in prevalence in the general population of Ghana.

CONSENT

All authors declare that informed consent was obtained from the patients before being included in the study. Participation was voluntary and non-consenting participants were assured that their non participation in the study will not affect the care given them at the facility.

ETHICAL APPROVAL

The study was approved by the Ethical Committee of the University for Development Studies, Ghana.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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