PREVALENCE AND RISK FACTORS OF METABOLIC SYNDROME AMONG STUDENTS AT THE UNIVERSITY OF DAR-ES-SALAAM

By

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CERTIFICATION

The undersigned certifies that she has read and hereby recommended for submission a dissertation entitled ***"Prevalence and risk factors of the metabolic syndrome among students at the University of Dar-Es-Salaam"*** in fulfillment of the requirements of the degree of Masters of Medicine in internal medicine of Muhimbili University of Health and Allied Sciences.

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DEDICATION

To *Charlie, Romeo, Cara and Esperanza*

ABSTRACT

Background

Metabolic syndrome describes a clustering of factors including dyslipidemia, glucose intolerance and hypertension with central obesity. The metabolic syndrome has a marked impact on the prevalence of cardiovascular disease and type 2 diabetes worldwide.

The exact mechanism of the complex pathways of the metabolic syndrome is not yet fully known. Most patients are found to be elderly, obese, and sedentary and also have a degree of insulin resistance. The most important observable factors are overweight, genetics, and increase in age and low physical activities.

The estimated global prevalence of metabolic syndrome for adults above 20 years is 16%. In Sub Saharan African countries, the prevalence of metabolic syndrome by using ATP III criteria was found to be zero in rural area for both men and women and to very low prevalence in urban areas at 0.2% and 0.5% in women and men respectively. However, by using WHO & IDF criteria the prevalence was higher in urban areas at up to 5.9% women and 7.3% men respectively.

Though there is no single treatment plan for the syndrome, the first line therapy has been to reduce the major risk factors for cardiovascular disease. The key to prevent the syndrome however remain diet and physical activities.

Broad objective: To determine the prevalence and risk factors of the metabolic syndrome among students aged 18years and above at the University of Dar-es-Salaam, Mlimani campus.

Methods: The study was a descriptive cross-sectional design that was conducted at the University of Dar es Salaam Mlimani campus. A sample of 420 adults (277 male & 143 female) were recruited. Participants were interviewed on their personal medical history. Blood pressure and anthropometric measurement were taken by using standardized methods. Blood

samples were collected in a fasting state to measure triglyceride, FBG and HDL-C. For this study, the WHO criteria was used to describe the metabolic syndrome.

Results:

The prevalence of metabolic syndrome in the population of University students was 0.2% using WHO criteria. However it was slightly higher using IDF criteria 1.1% and 0.9% by ATP criteria.

Conclusions:

The study reveals low prevalence of metabolic syndrome and its associated risk factors in the young generation population. This provides opportunity for preventive strategies, reinforcing the good practices and learning the advantages of maintaining them in order to lower the clustering of potential risks for cardiovascular diseases.

Recommendation:

Positively reinforce and educate benefits of reducing the risk factors of metabolic syndrome in this population.

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ABBREVIATIONS

VLDL	-Very low density lipoprotein
HDL	- high density lipoprotein
WHO	- World Health Organisation
BMI	- Body Mass Index
ATP III	-Adult Treatment Panel III
IGT	-Impaired Glucose Tolerance
IFG	- Impaired Fasting Glucose
T2D	-Type 2 diabetes
USA	-United States of America
UDSM-	University of Dar es Salaam
MS	- Metabolic Syndrome
CVD	- Cardiovascular disease
DM	- Diabetes Mellitus
SSA	-Sub Saharan Africa
hs-CRP	-High sensitivity C reactive protein
FPG	-Fasting plasma glucose
HOMA- IR	-Homeostatic Model Assessment Insulin resistance
CPL	- Central Pathology laboratory
TG	-Triglyceride
BP	-Blood Pressure
AHA	- American Heart Association
NCEP	- National Cholesterol Education Program
EGIR	- European Group for the study of Insulin Resistance

IDF -International Diabetic Federation

CoNAS -College of Natural and Applied Science

CASS -College of Arts and Social Sciences

UDBS -University of Dar es Salaam Business School

DASF -Department of Aquatic Sciences and Fisheries

1.0 CHAPTER ONE

1.1 INTRODUCTION AND LITERATURE REVIEW

Non communicable diseases which include Diabetes mellitus and cardiovascular disease are world's biggest killer diseases, estimated to cause 3.5millions death each year. Eighty percent of them are found in the low and middle income countries. [1]

The WHO has developed an action plan for implementation of global strategies in prevention and control of non-communicable diseases. [1]

One of the objectives of this plan is to develop simple strategies to identify those at risks together with appropriate and cost effective interventions. The metabolic syndrome has been advocated as a simple clinical tool for predicting diabetes mellitus and cardiovascular diseases. It also forms a conceptual base for understanding some of the pathophysiological links between metabolic risks, DM and CVD.

The clustering of metabolic syndrome risks with cardiovascular disease and DM has been recognized for more than 80 years, but the modern concept of metabolic syndrome began when Reaven proposed a conceptual frame work which links between biological events in a single pathophysiological construct. [2]

Reaven construct suggested that insulin resistance provide common mechanisms underlying the associated abnormalities such as blood pressure, lipid abnormalities and glucose intolerance.

In 1947 Vague, a physician from Marseilles, observed that upper body obesity was significantly associated with diabetes mellitus, atherosclerosis, gout and calculi, in which all these conditions were improved by eating low carbohydrate diet. [3, 4]

Haller in 1977 described metabolic syndrome to be associated also with obesity, diabetic mellitus, hyperlipoproteinemia, hyperuricemia and hepatic stenosis. In the same year, Singer added that hypertension and gout could also be associated with the syndrome. [5, 6]

Later on Reaven in 1988 proposed that insulin resistance was the underlying factor for metabolic syndrome and also termed the disease as a syndrome X. He did not include obesity as one of the factors in the syndrome as the previous authors did. However obesity in particular central obesity came later to be recognized as one of the important underlying factor of metabolic syndrome [7]

The terms metabolic syndrome, insulin resistance syndrome or syndrome X were used to define the clustering of factors that increase the risk for cardiovascular disease and type 2 diabetic mellitus.

There has been a lot of debate about whether metabolic syndrome should be considered a syndrome at all. As it was well known that, a syndrome defines a group of signs and symptoms with a common underlying pathology, but the real pathology of metabolic syndrome is still not yet fully known. [8]

Some authors argue that although the symptoms of the metabolic syndrome often appear together, they may reflect diverse disease processes. Kahn, for instance, argues that the risks of metabolic syndrome were real even if the terminology is questionable. He proposed that using metabolic risk or cardiometabolic risk could be the better way to describe the syndrome. He also ends up by saying that it is useful as a concept rather than using the word “syndrome” [8]

In 2005 American Diabetes Association (ADA) and European Association on the Study of Diabetes (EASD) pointed out specific controversies in the diagnosis of the metabolic syndrome [9] For instance the value of including diabetes in the definition was questionable. Also the use of insulin resistance as the unifying etiology was considered to be uncertain. The ADA/EASD committee also pointed out that there was no clear basis for including or

excluding cardiovascular disease (CVD) risk factors in the diagnosis of the metabolic syndrome. There are still a lot of arguments and the debate regarding the definition and diagnosis of the metabolic syndrome continues.

There are several existing criteria in use for defining the metabolic syndrome like the definition used by the American Heart Association (AHA), European Group for the Study of Insulin Resistance EGIR, National Cholesterol Education Program-Adult Treatment Panel III (NCEP/ATP III), World Health Organization (WHO) and International Diabetes Federation (IDF). The most commonly used definition of MS was described by the (WHO) and ATP III criteria. [9]

Regardless of the existing controversies in diagnosis and definition, the metabolic syndrome is still considered to be a useful diagnostic tool in primary care prevention. It gives opportunity for early patient identification and education on proper and early health behavioral changes implicated in the development of the deadly cardiovascular diseases like hypertension and diabetes. Patients could be educated early about the connection between their lifestyle, health risks, and medical outcomes. For instance the (NCEP/ATP III) identifies metabolic syndrome as an indication for vigorous lifestyle intervention. Effective interventions include diet, exercise, and judicious use of pharmacologic agents to address specific risk factors. Weight loss will significantly improve all aspects of metabolic syndrome. Increase in physical activity and decrease in caloric intake by reducing portion sizes have been found to improve metabolic syndrome abnormalities, even in the absence of weight loss. Specific dietary changes that are appropriate for addressing different aspects of the syndrome include reducing saturated fat intake to lower insulin resistance, reducing sodium intake to lower blood pressure, and reducing high-glycemic-index carbohydrate intake to lower triglyceride levels.

Primary health care workers could be more effective in helping patients to change their lifestyle behaviours by assessing each patient for the presence of specific risk factors, clearly communicating these risk factors to patients, identifying appropriate interventions to address specific risks, and assisting patients in identifying barriers to behavior change

1.2 PREVALENCE OF THE METABOLIC SYNDROME

The syndrome is increasing in prevalence worldwide as a consequence of increasing obesity prevalence. Most studies have used the ATP III definition of the syndrome and some with modifications to the criteria. Some studies have used the WHO criteria and some have used other criteria.

The recently used data-sets (family history of DM, body weight >20%, history of DM during pregnancy or having baby over 9 pounds (4kg), sedentary life and additional question related to the MS i.e. HTN, Dyslipidemia & race/ethnicity) were employed to derive the current global diabetes prevalence [9] and to estimate global metabolic syndrome prevalence for adults >20 years. The estimated current global prevalence of the metabolic syndrome is approximately 16% (95% CI 10-23). [10]

The metabolic syndrome affects 44% of the U.S. population older than age 20. A greater percentage of women older than age 50 have the syndrome than that of men. [11]

Studies from Europe, North America, and Australia report the prevalence of the metabolic syndrome to be between 12% and 25% [12-15-18] while studies in Asia have mostly found a lower prevalence of 5%. [19- 21]

Using the 2005 version of NCEP-ATP III the prevalence of metabolic syndrome in China, Taiwan Hong Kong and Thailand [22] was ranging from 10-15% but it was much lower (around 5%) in southern rural China [23] On other hand, rates in the Koreans were higher than the Chinese and Thai's even though their body mass index was similar to other East Asia countries. India had strikingly high prevalence rate compare to the rest of Asia.

In Sub-Saharan Africa (SSA), a study done in South Africa using International Diabetes Federation (IDF) criteria to diagnose metabolic syndrome, found the absence of the metabolic syndrome in rural men, and low prevalence in rural (0.3%) and urban (1.5%) women while in

urban men it was 1.2%. Equally, using ATP III definition of metabolic syndrome, there was absence of the metabolic syndrome in rural men and women, and very low prevalence in urban men (0.5%) and in urban women (0.2%). Higher rates were found when the WHO criteria were used, being 1.8% (rural) and (5.9%) urban women and 1.9% (rural) 7.3 % (urban) men. Using any of both criteria's i.e. WHO and IDF, urban rates were higher, both in women and men compared to rural rates. However the general prevalence of the metabolic syndrome was low. The explanation for the lower rate was the high level of physical activity in SSA countries. [24]

Analysing the prevalence of individual risk factors for the metabolic syndrome in Sub-Saharan Africa showed that, the elevated serum triglyceride was the least frequent for both women (0.3%) and men (1.4 %). In men, the most frequent abnormality was the elevated blood pressure 37.7%. Central obesity was the most frequent component both in rural and urban 58.6% vs 49.5% respectively. The prevalence of all the components was higher in urban samples. [24]

In Cameroon, a study done in a community population aged 24-74 years, it was found that the highest prevalence of metabolic syndrome as defined using WHO definition, and lowest with NCED-ATP III definition. Central obesity was more prevalent component of metabolic syndrome than HOMA-IR. [25] The study also found that the prevalence of MS varies greatly by urban/rural with the definition used.

In a study done among Zimbabwean type 2 diabetic patients to determine the prevalence of metabolic syndrome showed that 43% of the participants had metabolic syndrome. [26]

Metabolic syndrome was also seen in 25.2% of type 2 diabetic patients in Nigeria. However the systemic hypertension was found to be the most common component of metabolic syndrome by 38.5%. This study concluded that metabolic syndrome is associated with higher risk of stroke, peripheral vascular disease and microalbuminuria. [27]

In Temeke Municipality Dar es Salaam Tanzania, risk factors of metabolic syndrome like central obesity, low HDL-Cholesterol and high FBG were found to be more in women. This made the women to have 3 fold greater odds of having metabolic syndrome compared to men. [28]

1.3THE RISK FACTORS IN METABOLIC SYNDROME

The exact mechanisms of the complex pathways of metabolic syndrome are not yet fully known. The pathophysiology is extremely complex and has been only partially elucidated. Most patients are older, obese, sedentary, and have a degree of insulin resistance. The most important factors in order are: overweight, genetics,[29][30][31] aging, sedentary lifestyle, i.e. low physical activity and excess caloric intake.[32]

A debate exists regarding whether obesity or insulin resistance cause the metabolic syndrome or if they are consequences of a metabolic derangement. A number of markers of systemic inflammation, including C-reactive protein, fibrinogen, interleukin 6 (IL–6), tumor necrosis factor-alpha (TNFα) and others have been found to be associated with MS. Some studies have even pointed out the variety of causes including increased uric acid levels by dietary fructose.[33] [34] [35]

1.3.1 Overweight and Obesity

Central adiposity is a key feature of the metabolic syndrome, as reflected by the strong relationship between the prevalence of the syndrome and waist circumference and increasing adiposity. The study done in South Africa in 2009 reported that central obesity measured by waist circumference was the most prevalent component of the metabolic syndrome, (58.6% vs 49.5%) for rural and urban women respectively. [24] Another hospital based study in Botswana also showed that obesity (28.7%) and overweight (27.3%) were the major high risk factors for the metabolic syndrome among hospital workers. [36]

Furthermore in the USA, overweight men were about 6 times and obese men about 32 times as likely as normal weight men to have metabolic syndrome. The study also showed similar findings among overweight and obese females who were 5 and 17 times (respectively) more than the normal weight females to meet the criteria. [37]

However, studies done among the obese and overweight Asian population, central obesity was not found to be an essential component of the syndrome. [38] Moreover being obese or overweight is not the only component of the metabolic syndrome as even patients who are normal weight have also been found have the syndrome. [39]

Though some criteria uses waist circumference (WC) and other use Body mass index (BMI) to estimate the excessive deposition of fat in the body, it has been found that WC and BMI are highly correlated and there's no superiority between the two.

1.3.2 Physical inactivity

Physical inactivity is one of major risk factor for the metabolic syndrome. Physical inactivity is a risk for a number of factors associated with the metabolic syndrome such as obesity, hypertension, and hyperlipidaemia. Physical activity was found to be the major intervention component, in terms of treatment and prevention of metabolic syndrome. Studies comparing individual engaged in less active activities like watched television or videos or using computer for less than one hour daily to those that carried out these behaviors for greater than four hours daily have a twofold increased risk of the metabolic syndrome [40]

Level of physical activity assessment

Physical activities can be quantified in a variety of ways. It is categorized by its type, intensity, frequency and duration as well as by environmental and social conditions under which it takes place. The level of physical activity can also be characterized according to type of occupation, leisure, and whether it is continuous, intermittent or associated with weight bearing. A physical activity is therefore expressed in terms of energy expenditure (EE) or as

the time period of activity (hours or minutes) or in units of movement (counts). Additionally, physical activity assessment can be derived from responses to a questionnaire. [41]

Some of the methods used to assess level of physical activity include the indirect calorimetric, heart rate response to physical activity, movement sensors using accelerometer and self-reported quantification of physical activity. The selection of appropriate method is based on several factors such as experimental goals, sample size, budget cultural & social/environmental factors, statistical factors like validity and reliability.

Measuring total energy expenditure using instruments were more precise like the doubly labeled water and indirect calorimeter but cumbersome for population studies, methods such as self report technique are applicable for epidemiological studies though they lack accuracy in measuring energy expenditure.

Physical activity assessment by indirect calorimeter

This is found to be the most accurate measurement of energy generated and calories burned by the body during rest and low muscular effort. Since early 1980's, use of indirect calorimeter in determining oxygen consumption (V02) and carbon dioxide production (VC02) through metabolic measurements continue to increase. The indirect calorimetry measures energy expenditure using two principles. First, the closed collection system in which the expired air is collected from either an airtight rigid structure (i.e. a Tissot Gasometer) or a portable flexible bag (i.e. a Douglas bag).

Second, the open-circuit calorimeter systems which records energy expenditure over several hours or days. In an open-circuit system, the person breathes either normal room air or a gas mixture, following which expired gases were then analyzed.

Based on individual's respiratory exchange i.e. oxygen consumed and carbon dioxide produced, energy expenditure is calculated by Weir's equation [42]

REE = [VO2 (3.94) + VCO2 (1.11)] 1440 min/day

Whereby REE = resting energy expenditure, VO2=oxygen consumption & VCO2 =carbon dioxide production.

The standard Weir equation therefore defined the relationship between VO2 and CO2 production and energy expenditure.

The procedure was impractical, invasive which requires a fully enclosed laboratory setting, and computerized system for collection, analysis and output of respiratory data.

Physical activity assessment by doubly labeled water (DLW)

The DLW method used stable isotopes of hydrogen and oxygen to measure energy expenditure in free-living humans. The subject received a single oral bolus dose of heavy water (2H2180) then followed with 10ml of tap water. Adults are given a dose consisting of 0.15gH2180/kg body weight and 0.06g2H20/kg body weight. Following an overnight fast (about 8hours), a urine specimen was collected before administration of isotope. This served as the baseline isotope measurement. The first urine collection is done four hours following the dose. The sample used to determine the isotope dilution space and total body water. The next urine collection is 24 hours from the isotope dose. Thereafter a minimum of two samples, at the beginning and end study period, are necessary to determine energy expenditure during the study period of 21 days.

The rate of carbon dioxide production is used in conjunction with Weir equation to estimate energy expenditure Q over the period in which body water samples was collected.

The Weir equation uses measured values for respiratory quotient (RQ) and the urinary nitrogen production rate (UN):

$$Q=3.941(rCO2/RQ) + 1.06rCO2-2.17\ UN$$

The daily food intake is noted during the observation period and the diet remains the same throughout the study for the most accurate results and the respiratory quotient (RQ) calculated based on daily intake. Blood, saliva or urine can be used as a sample to assess the isotope dilution space. However, a urine sample was used as the first choice because of the ease of collection and availability of the fluid.

The doubly labeled water method has an advantage of being noninvasive, and the subjects could maintain their daily activities. However it is expensive because of using isotopes. The technical problems are mainly related on how to administer the dose of isotope, and collect several samples of body water to check for differential isotope elimination.

Physical activity assessment by accelerometer

Accelerometer measures the proper acceleration experience relative to freefall. The device is placed at the wrist, hip or low back of the user. The tri-axial accelerometer is an objective method that distinguishes differences in activity levels between individuals and assesses the effect of intervention on physical activity within the individual. [43]

There are different cut off points used for different levels of physical activity. For sedentary activities, the cut off points used is less than 800 count per minutes, for light activities it ranges between 801-3200 count per minute, for moderate activity range from 3200-8199 count per minute and for vigorous activity more than 8200.[44] Metabolic equivalent value (MET) can be calculated by using the number of counts in the following equation. [45]

$$MET=0.0015(count\ per\ min) – 0.08957(age\ in\ yrs) -0.000038(count\ per\ min) +2.757$$

Accelerometers provide a detailed description of activity patterns. It has excellent data storage capacity and has been very extensively validated for children and adults. However the devices

cannot measure energy expenditure when the individual is bicycling, walking uphill and on carrying weights.

Physical activity assessment by Heart rate

This measures the direct physiological response of heart rate to physical activity. It measures the linear relationship that exists between heart rate and energy expenditure in steady state exercises involving the large muscle groups. A heart rate (HR) monitor placed as a chest strap with a wireless connection to a data logger hidden in a watch.

The primary outcome of the heart rate is identified as the time spent at different intensity levels by using absolute heart rate/or heart rate indices. A secondary outcome measure is the physical activity energy expenditure which is estimated by using regression equation derived from individual/group calibration. Heart rate monitoring has limitations as it is not useful when elevation of HR is due to stress and environmental factors.

Physical activity assessment by self-reports methods

Self-report instruments continue to be the most widely used type of physical activity measures. They are defined as self-administered or interviewer-administered recall questionnaires, activity logs or diaries, and proxy reports.

They are so many physical activity questionnaire which are used in general population to assess the energy expenditure per intensity activities, examples are seven days activity recall e.g. International physical activity questionnaire (IPAQ), modifiable activity questionnaire, Minnesota activity questionnaire, compendium method etc.

The international physical activity (IPAQ) questionnaire of August 2002 comprises of 2 versions. The long version which provide a comprehensive assessment of physical activity practices and the short version which assess the activities done during last 7 days. IPAQ is

useful in young and middle aged adults (15-69 years). It comprises of four generic items i.e. type of physical activities, days in a week, time in hour and minutes in a week and intensity. The short version was designed for large population surveillance in which time and space are limited. [46]

Assessment of physical activities by Compendium method

Compendium of physical activities is a coding scheme that classifies specific physical activities by rate of energy expenditure. The coding scheme links the physical activities and their intensity metabolic equivalent value (MET).

MET is defined as the ratio of work metabolic rate to a standard resting metabolic rate (KJ or Kcal). One MET is considered to represent resting energy expenditure, or approximately of 3.5ml-1mm-1 in terms of oxygen consumption.

The compendium as mainly used as a reference to identify examples of moderate intensity activities. All activities in compendium are assigned on intensity levels based on the rate of energy expenditure as MET's. Based on the model proposed[47] for classifying the MET intensity of physical activities, light intensity activities are the ones which have less than 3 MET's, moderate intensity activities are those activities which have MET's within 3-6, and for vigorous intensity activities are those with more than 6 MET's.

The individual is considered to have adequate light physical activities if he/she spends 60minutes per day of light physical activities in more than 5 days in a week, for moderate activities if he/she spends at least 30 minutes a day of moderate physical activities in five days a week and three to five days a week of vigorous physical activities for at least 20 minutes per session.

The self-report questionnaire method is easy to assess the physical activities. It is more reliable and it provides the prevalence estimates of physical activities. By using self-report it is

possible to categories respondents into activity categories. Self-reports however are affected by recall bias i.e. the participant is required to recall only the time spent on movement. It also provides a poor measure of absolute time spent at different intensity levels and the associated energy expenditure. [48].

Current estimates from World Health Organization report that 60% to 80% of adults around the world are physically inactive. [49]

1.3.3 Aging and sex

Many studies reported that age and sex were one of the most determinant factors in developing MS. As the individual grows older the risk increases and being a female the chance to have the syndrome was higher. The study done in Mongolian China reported that the standardized prevalence rate of MS was lower in men (11.4%) than in women (21.6%) ($p<001$). [50] In Botswana female gender was also found to strongly associate with MS and the age group of 34-54 years was most affected. [51]

Despite of many studies showing the increase of MS by age and female sex, Taiwan and Karachi studies reported males to be in higher risk of developing MS with the prevalence of 21.8% and 7.0% in females.[30,52]

1.3.4 Glucose intolerance

It was estimated that the large majority (~75%) of patients with type 2 diabetes or impaired glucose tolerance (IGT) have the metabolic syndrome.[53]Approximately 80% of participants with DM also had MS and the prevalence was approximately lower by 32% upon exclusion of DM this was found in Seychelles, African region[54].The presence of the metabolic syndrome in these populations was associated with a higher prevalence of CVD than found in patients with type 2 diabetes or IGT without the syndrome.[53] Hypoadiponectinemia has been shown to increase insulin resistance[55] and was considered to be a risk factor for developing metabolic syndrome.

1.3.5 Coronary Heart Disease

The approximate prevalence of the metabolic syndrome in patients with coronary heart disease (CHD) was 50%, with a prevalence of 37% in patients with premature coronary artery disease (age 45), particularly in women. With appropriate cardiac rehabilitation and changes in lifestyle (e.g., nutrition, physical activity, weight reduction and in some cases, drugs), the prevalence of the syndrome could be reduced.[53]

1.3.6 Dyslipidemia

Dyslipidemia consists of elevated level triglyceride, low concentration of HDL-C and greater concentration of small and dense LDL. This derangement of lipids has been shown to have a significant relation with insulin resistance, which predisposes a person to CVD. Low HDL-C and high level of triglycerides are the only ones which have been considered in the various definition of metabolic syndrome.

1.3.7 Microalbuminuria

Microalbuminuria is an important clinical marker in patients with DM because of its well established association with progressive renal diseases. It is also recognized as an independent risk factor for CVD in patients with hypertension and DM and also in the general population. Microalbuminuria is recommended under the WHO criteria as one of the indicator to diagnose the metabolic syndrome.

1.3.8 Procoagulant and proinflammatory

Plasminogen activator inhibitor-1 and C-reactive protein like any other cardiovascular risks have been associated with the development of CVD.

Plasminogen activator inhibitor -1(PAI-1) is the major inhibitor of fibrinolysis. [1].The PAI-1 inhibits the tissue plasminogen activator and urokinase, which are the enzymes that activate plasmin, hence it degrades the blood clots (fibrin). High level of plasminogen activator

inhibitor -1 is linked to the increased occurrence of thrombosis formation, hence increases CVD risk.

C- reactive protein (CRP) is the proinflammatory factor that has been associated with increased CVD risk. CRP is a blood test marker for inflammation in the body. The elevation of CRP has been recently linked to atherosclerosis and cardiovascular disease, since the pathophysiology of these diseases has been related with inflammatory processes. However the elevated CRP alone has not been shown to be a cause of CVD. Nevertheless CRP can be used as predictor of CVD based on its correlation with other known cardiac risk factors like insulin resistance.

High levels of white cell count has also been associated with increased insulin resistance; hence CVD. [56]

1.3.9 Smoking

Smoking is a major risk factor for coronary heart disease (CHD), with a dose-response correlation between CHD morbidity and mortality and the number of cigarettes smoked. [57] Several studies have shown that smoking induces insulin resistance or hyperinsulinemia and leads to type two diabetes. [58–61]. Increased insulin resistance may underlie the clustering of the metabolic and hemodynamic abnormalities that have potent atherosclerotic properties, which end up with metabolic syndrome [62, 63].

The mechanism of how cigarette smoking increases the risk of the metabolic aberrations is not clear. But it was found that cigarette smoking increases the circulating levels of insulin-antagonistic hormones (i.e., catecholamine, cortisol, and growth hormone. [64–66] In addition to that, cigarette smoking increases the circulating levels of free fatty acids, which indicate the increase of lipolysis. [67] Thus, cigarette smoking provoked the metabolic perturbations and may increase the risk of the metabolic syndrome.

Smoking cessation was found to be associated with weight gain, the mechanisms of weight gain may include increased energy intake, decreased resting metabolic rate, decreased physical activity, and increased lipoprotein lipase activity [68–71]

Fat oxidation was a critical lipostatic factor that regulates energy balance. [72] It had been reported that fat oxidation per kilogram lean mass was positively correlated with 24 hour excretion of nicotine, and this indicated that smokers with high nicotine uptake use more lipids to sustain fasting resting energy expenditure than non-smokers [73]. Therefore, if subjects stop smoking and do not modulate their lipid intake over time, the imbalance in lipid intake and fat oxidation induced an increase in body fat.

It was important for the prevention of the metabolic syndrome not only to quit smoking but also to prevent weight gain after smoking cessation

1.4 Diagnosis

There are no well-accepted criteria for diagnosing the metabolic syndrome. The criteria proposed by the National Cholesterol Education Program Adult Treatment Panel III (NCEP-ATP III), with minor modifications, were currently recommended and widely used. Other criteria were those of the World Health Organization (WHO), the International Diabetes Federation (IDF), and the American Heart Association (AHA)

Table 1 Different clinical criteria's for Clinical Diagnosis of Metabolic Syndrome

CLINICAL MEASURES	**WHO.** Individual has to be either DM, or have IFG,IGT or insulin resistance + at least 2 of the following:	**ATP III** Individual must have 3 or more of the following below:	**IDF** Central obesity define as :waist circumference and any of the following below:
Waist circumference	NO	≥102cm in men ≥88cm in women	≥102cm in men ≥88cm in women
BMI	BMI>30kg/m^2	NO	NO
Triglycerides	≥150mg/dl	≥150mg/dl	≥150mg/dl
HDL-C	<35mg/dl in men <39mg/dl in women	<40mg/dl in men <50mg/dl in women	<40mg/dl in men <50mg/dl in women
Blood pressure	≥140/90mmHg	≥130/85	≥130/85
Glucose	IGT,IFG, or T2D	Fasting>110mg/dl (IFG)	Fasting>100mg/dl (IFG)
Insulin Resistance	YES	NO	NO
Microalbuminuria	YES	NO	NO

WHO- World health organization, ATP III- Adult Treatment Panel III; IDF-International Diabetes Federation

1.4.1 The National Cholesterol Education Program (NCEP) Adult Treatment Panel III (ATPIII)

According to the third report of the National Cholesterol Education Program (NCEP) Adult Treatment Panel III (ATPIII), adults to be diagnosed with metabolic syndrome must have three or more of the following:

1. Waist circumference >102 cm (40.2 in) in men and >88 cm (35.6 in) in women
2. Serum triglycerides ≥150 mg/dl
3. Blood pressure ≥130/85 mmHg
4. HDL cholesterol <40 mg/dl in men and <50 mg/dl in women
5. Fasting plasma glucose >6.1mmol/l (≥100 mg/dl)

1.4.2 The World Health Organization (WHO)

On the other hand, definition of metabolic syndrome by the World Health Organization (WHO), the individual has to either be diabetic, or have , impaired fasting glucose (IFG) >5.6mmol/l, impaired glucose tolerance (IGT), or insulin resistance and then have **at least two** of the following:

1. Waist-to-hip ratio >0.90 in men or >0.80 in women or BMI> 30kg/m^2
2. Serum triglycerides ≥150 mg/dl or HDL cholesterol <35 mg/dl in men and <39 mg/dl in women
3. Blood pressure ≥140/90 mmHg
4. Urinary albumin excretion rate >20 mg/min or albumin-to-creatinine ratio≥30 mg/g. (Microalbuminuria)

1.4.3 International Diabetes Federation (IDF) [75]

Central obesity (defined as waist circumference with ethnicity specific values, if BMI is >30kg/m², central obesity can be assumed and waist circumference does not need to be measured)

AND any two of the following:

- Raised triglycerides : >150 mg/dL (1.7 mmol/L), or specific treatment for this lipid abnormality.
- Reduced HDL cholesterol: < 40 mg/dL (1.03 mmol/L) in males, < 50 mg/dL (1.29 mmol/L) in females, or specific treatment for lipid abnormality
- Raised blood pressure: systolic BP >130 or diastolic BP >85 mm Hg, or treatment of previously diagnosed hypertension.
- Raised fasting plasma glucose :(FPG)>100 mg/dL (5.6 mmol/L), or previously diagnosed type 2 diabetes. If FPG >5.6 mmol/L or 100 mg/dL, OGTT Glucose tolerance test is strongly recommended but is not necessary to define presence of the Syndrome.

1.5 Treatment of Metabolic Syndrome

The major aim in the treatment of the metabolic syndrome was to reduce the risk for cardiovascular disease and type 2 diabetes. Stop smoking and reduce LDL cholesterol, blood pressure and glucose levels to the recommended levels. For managing both long- and short-term risk, lifestyle therapies were the first-line interventions to reduce the metabolic risk factors. These lifestyle interventions include:

- Weight loss to achieve a desirable weight (BMI less than 25 kg/m^2)
- Increased physical activity, with a goal of at least 30 minutes of moderate-intensity activity on most days of the week

- Healthy eating habits that include reduced intake of saturated fat, Tran's fat, cholesterol as well as calories diet.

There is no a clear cut point on treating metabolic syndrome; each individual is treated according to the risk factors that he/she is found to have.

1.5.1 Treating the Insulin Resistance

While there is no drug treatment that directly treats the underlying insulin resistance in metabolic syndrome, diet modification and exercise have been advocated as ways to use in improving insulin sensitivity.

1.5.2 Treating Lipid Abnormalities

Lipid abnormalities seen with metabolic syndrome (low HDL, high LDL, and high triglycerides) respond well to weight loss and exercise, and drug therapy is often required. The treatment usually first aims primarily at reducing LDL levels according to specific recommendations. Once reduced LDL targets are reached, efforts at reducing triglyceride levels and raising HDL levels should be made. Successful drug treatment usually required treatment with a statin, a fibrate drug, or a combination of a statin with either niacin or a fibrate.

1.5.3 Treating the Clotting Disorder

Patients with metabolic syndrome have several disorders of coagulation that make it easier for blood clots to form within blood vessels. These blood clots often precipitate the development of heart attacks. Patients with metabolic syndrome should generally be placed on daily aspirin therapy to help prevent such clotting events.

1.5.3 Treating the Hypertension

High blood pressure presented in more than half the people with metabolic syndrome and, in the setting of insulin resistance, high blood pressure shown to be an important risk factor. Adequate blood pressure treatment in these individuals substantially improved the outcome.

1.6 Prevention

The key to prevent metabolic syndrome, however, remains diet and exercise. Any person with a strong family history of metabolic syndrome or type 2 diabetes should be especially careful to maintain a healthy lifestyle

Various strategies have been proposed to prevent the development of metabolic syndrome. These include increased physical activity (such as walking 30 minutes every day), [75] and a healthy, reduced calorie diet.[76] However, one study stated that these measures are effective in only a minority of people, primarily due to a lack of compliance with lifestyle and diet changes.[32]

2.0 CHAPTER TWO

2.1 PROBLEM STATEMENT

Over the past few decades the prevalence of Metabolic Syndrome has increased in a population.

There was considerable biological and epidemiological evidence that MS increased the risk of CVD, DM and premature death. People who become overweight/obese and sedentary were more susceptible to get metabolic syndrome.

Although the absolute CVD and DM risk associated the MS in youth is low, it has been shown that clusters of risk factors track into adulthood even more than a single risk factors suggesting that early identification may be beneficial in the amelioration of the diseases associated this syndrome.

The main treatment of metabolic syndrome is prevention, where by it is good to recognize risk factors of metabolic syndrome in young populations so as to prevent their occurrence before the onset of old age when such diseases occur.

Despite all these advances in the understanding of metabolic syndrome, their risk factors and the possible treatment, the epidemiology of it in Tanzania was largely unknown.

The current study aimed at describing the prevalence and risk factors of metabolic syndrome among students of University of Dar es Salaam at Mlimani campus in Dar es Salaam city.

3.0 CHAPTER THREE

3.1 RATIONALE

The syndrome was shown to be of a great challenge due to its association with subsequent development of cardiovascular disease and Type 2 diabetes. It was the fastest growing public health problem in both developed and developing countries.

The main determinant factor of metabolic syndrome in Sub-Saharan Africa was found to be central obesity, [28] which can be treated mainly by the increase of physical activity and restricted caloric intake as well as fat containing diet.

Increased urbanisation & sedentary lifestyle in Tanzania, especially in young generation lead to high risk of metabolic syndrome.

Early identification of metabolic syndrome risk factors is considered to be a useful diagnosis tool in primary care prevention. It gave the opportunity for the early patient identification and education on proper and early health behavioral changes implicated in the development of MS in which eventually will lead to the deadly cardiovascular diseases like hypertension and diabetes.

Patients could be educated early about the connection between their lifestyle, health risks, and medical outcomes.

Physical activity was found to be the key in prevention of metabolic syndrome and was cheap and affordable rather than pharmacological treatment which most of the population could not afford.

There are limited published data on the prevalence of metabolic syndrome among young adults in Sub-Saharan Africa but none in our country.

It was therefore justifiable to have this study which described the prevalence and risk factors of metabolic syndrome among adults at University of Dar-es-Salaam that recommended the

program to screen the risk factors by means of routine medical examinations and improving lifestyles.

The study findings could also be the basis for future research among the population.

4.0 CHAPTER FOUR

4.1 OBJECTIVES

4.1.1 Broad Objective

To determine the prevalence and risk factors of the metabolic syndrome among students aged 18years and above at the University of Dar-es-Salaam, Mlimani campus.

4.1.2 Specific objectives

1. To determine the social demographic characteristics (age, sex and marital status), physical exercise and smoking of the study population
2. To determine the prevalence of the individual component of the metabolic syndrome according to WHO criteria among the Students University of Dar-es-Salaam.
3. To determine the prevalence of metabolic syndrome using WHO criteria among the University of Dar-es-Salaam students
4. To compare the prevalence of metabolic syndrome by using the different criteria (ATP-III and IDF)

5.0 CHAPTER FIVE

5.1 METHODOLOGY

5.1.1 Study design

Descriptive cross-sectional study

5.1.2 Study site

The University of Dar es salaam is the oldest and biggest public university in Tanzania. It is situated on the western side of the city of Dar es salaam, occupying 1,625 acres on the observation hill, and 13 kilometers from the city centre. In 1961 it was founded as University College affiliated to the University of London. I t became an autonomous university by an act of parliament to award own degrees in 1970.

The University of Dare S Salaam (UDSM) is a public institution funded primarily by the government of Tanzania. It has a number of different academic units, 2 constituent colleges, 3 campus colleges, 4 schools, 4 institutes and several centers and bureaus.

The University of Dar es salaam offers various academic programmes leading to the award of certificates, diplomas, and degrees. A total of 4 certificates, 5 diplomas and 63 undergraduate degree programmes are offered at various academic units of the University of Dar es salaam

The number of students admitted at the University of Dar es salaam has been increasing steadily, from 14 in 1961 to 18,266 (11, 472 male and 6,794 female) undergraduate degree and non-degree in the 2007/08 academic year. Female students constitute 37.2% of all undergraduate students at the University of Dar es salaam.

5.1.3 Study population

422 students from University of Dar-es-Salaam, Mlimani campus aged 18 and above who gave the consent to take part in the study were studied. Two (2) students were excluded in analysis because of incomplete blood tests.

5.1.4 Sampling Technique & Sample size

A multistage sampling technique was employed to select study subjects.

Stages 1.Conveniently, from University of Dar-es-Salaam (UDSM) students were selected, mainly because of easy access within the allocated time

Stage 2.Selection faculties:

The list of all names of faculties was obtained from UDSM administration office. Four faculties were randomly selected from a list of 14 provided. The selected faculties were college of natural and applied science (CoNAS), college of arts and social sciences (CASS); University of Dar es Salaam business school (UDBS) and Department of aquatic sciences and fisheries (DASF).

Stage 3.Selection of degree program

Each faculty has at least 6 degree programs which run for a 3year period. The study required to select 2 degree program from each selected faculty. The 2 degree programs were selected by random sampling.

Stage 4.Selection of students by names

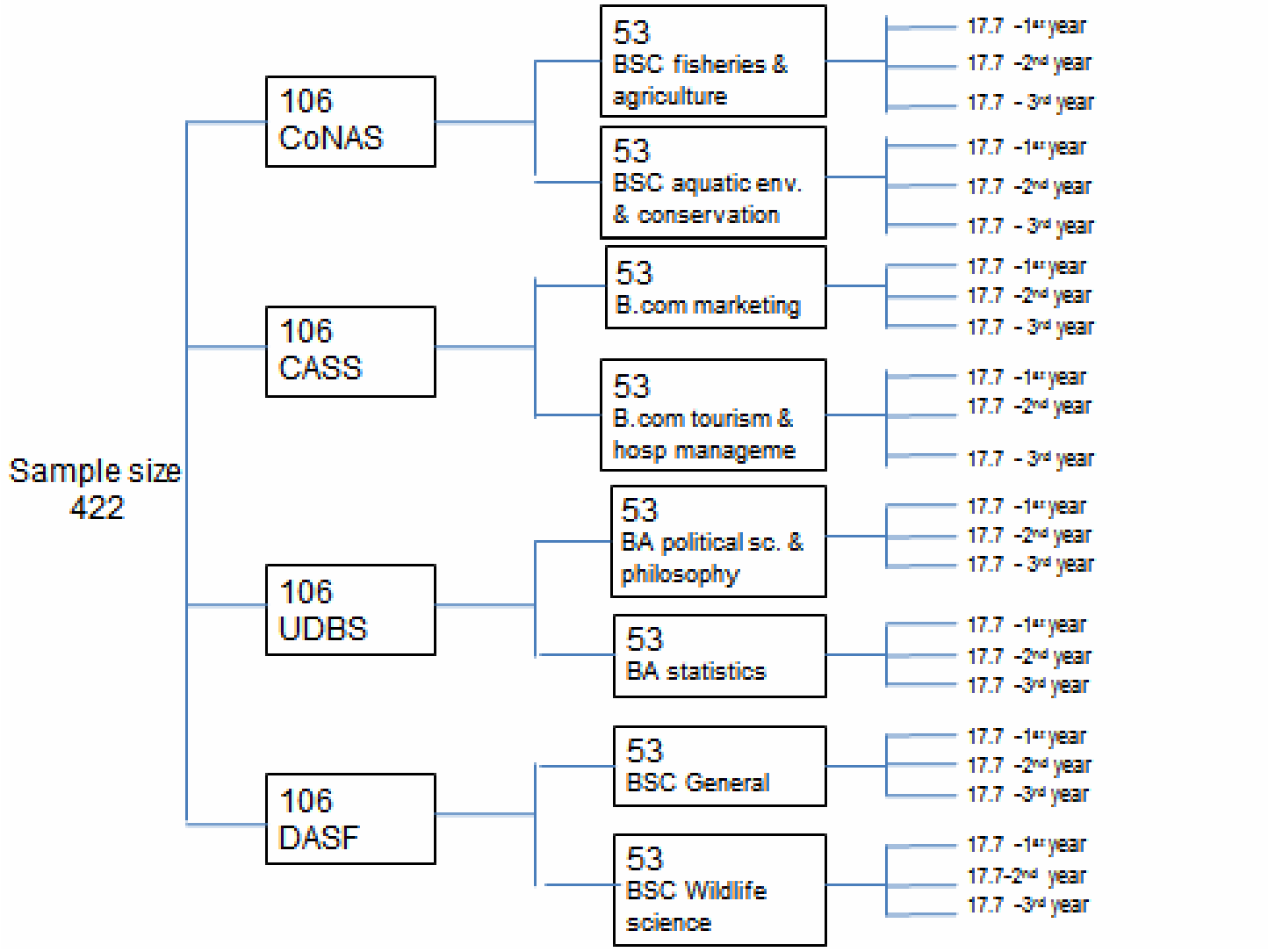
In order to get a sample of 422 students, 106 students were further select randomly from each faculty. Since each selected faculty had different programs, the two selected program from each faculty had students in year one, two and three, a further random selection of 18 students

from each year was done making a total of 53 students selected from each program and 106 students from the two program of each selected faculty. The list of student's names was obtained from head of departments.

Systematic sampling technique was used to select the students by name from a list given to participate in a study.

The sample fraction was calculated by total number of students per class divided with sample size needed per class in order to get the starting point, therefore and by rotary method the first name from a list was picked. The next name was picked by adding up the sample fraction from a serial number of a previous student.

Figure 1 Schematic diagram showing the multistage sampling procedure



5.1.5 Study procedures

The first visit was to ask for a research permit to conduct the study at UDSM. After the permission was obtained, the selected participants by names were followed to their respective classes. The participants in the study were interviewed and examined in a selected room for maintenance of privacy and confidentiality. A structured questionnaire was used to obtain the information.

The anthropometric measurement was performed after filling up the questionnaire. Students were asked to come in the subsequent days while fasting at the laboratory for blood sample collection of serum triglyceride, serum HDL-C and blood glucose assessment. The height of the participant was also obtained at the laboratory where the measuring rod was.

5.1.6 Sample size Determination

Sample size was calculated from the following formula.

$$N = \frac{Z^2 p\, q}{E^2}$$

Whereas:

N =sample size

Z=% point corresponding to significant level of 5%=1.96

p=prevalence of central obesity in metabolic syndrome (urban Sub Saharan Africa) = 44.5%

q= 100-p = 55.5

q=100-44.5=55.5

E= maximum likely error=5%

$\frac{1.96^2 \text{ x } 49.5 \text{ x } 55.5}{5 \text{ x } 5} = 422$

n = 422

5.1.7 Data collection

Demographic data, that is, name, sex, age, and marital status and risk factors i.e. (Diabetes, hypertension, physical activity, smoking, and clinical measurement of height, weight and waist circumference) was collected by using structured questionnaires.

The interview was done by the principle investigator and one an assistant who was trained before going to the field.

The assistant was trained on how to fill the questionnaire, and on how to take the anthropometric measurement.

5.2 Clinical measurements

5.2.1 Weight and height measurements

Weight of the participants was measured using the Secca weighing scale. Calibration was done every morning before starting the work using a standard weight. Weight was taken without shoes and in light clothing. Reading was measured to the nearest 0.5 kilograms

Height assessment was done using a height measuring rod without shoes and recorded to the nearest 0.5 centimeters.

BMI for each respondent was calculated by dividing weight (kilograms) with height squared (meter). BMI of 30kg/m^2 and over was taken as obesity.

5.2.2 Waist circumference measurements

Waist circumference was also taken using a non-stretchable tape measure at level of the uppermost edge of the hip bone on a light clothed abdomen with the tape parallel to the ground and recorded to the nearest 0.5 centimeters. The measurement above 102cm and 88cm in men and women respectively was considered as central obesity. This was according to the IDF & NCEP ATP III criteria.

5.2.3 Blood pressure measurements

Blood pressure was taken from the arm (brachial artery) from all respondents in the first encounter by using digital sphygmomanometer.

Blood pressure measurement was done in a sitting position with the arm supported and repeated after 5 minutes; the average of the two measurements was taken as a blood pressure.

The systolic pressure of above or equal to140mmHg and diastolic pressure above or equal to 90mmHg was regarded as a high blood pressure. Those who found to have high BP were referred to a physician for further evaluation and possible treatment.

5.2.4 Physical activities assessment

In this study, independent self-report (compendium coding) of activities that the individual did over the past one month were identified and recorded. The respondent was asked to remember and put a tick on the list given of any of the physical activities (PA) which he/she had done during the last one month, how many days in a week and time spent on each activity per week. Then the different physical activities were categorized into light, moderate and vigorous levels of physical activities respectively. The categories of physical activities were assigned intensity levels based on the rate of energy expenditure as MET's. Light physical activities were those activities with score of <3 MET's, moderate physical activities those with the score of 3-6 MET's and vigorous physical activities those with score of >6 MET's. These categories together with their different physical activities were listed in a table found in the questionnaire. After the respondent put a tick in the type of physical activities done, the investigator analyzed the mentioned activities in a correspondent category. The respondent was considered to have light physical activities if he/she had 60minute**s** of light activities in >5 days in a week, for moderate activities if he/she had at least 30 minutes of moderate physical activities in at least 5 days a week or three to five days a week of vigorous activity for at least 20 minutes per session.

5.3 Laboratory procedure

5.3.1 Biochemical tests

After an overnight fasting, blood samples for high density lipoproteins (good cholesterol), serum triglycerides and blood glucose was collected. Five milliliters of venous blood was taken from the antecubital fossa and placed in empty sterile tubes. The samples were transported to the Central Pathological Laboratory (CPL) at the Muhimbili National Hospital (MNH) for analysis within a day, using an automated ARCHITECT c8000 machine.

5.4 Diagnosis criteria for the metabolic syndrome

In this study, metabolic syndrome was diagnosed using the Modified WHO definitions, as summarized below.

The individual has to either be diabetic, or have impaired fasting glucose (IFG) >5.6mmol/l, and then have **at least two** of the following:

1. BMI>30Kg/m^2

2. Serum triglycerides ≥150 mg/dl or HDL cholesterol <35 mg/dl in men and <39 mg/dl in women

3. Blood pressure ≥140/90 mmHg

Physical visits were done to deliver the results to the participants. Health education on importance of physical activity and diet modification was also provided to all participants.

A subject who was found to have high serum triglycerides, high blood pressure, and/or high blood sugar was asked to repeat the test and those who had persisted in high levels were referred to a physician for further management. Overweight and obese participants were also referred to a physician.

5.5 Data entry and analysis

The collected data was checked for quality and coding was done prior to entering into the computer statistical program. Analysis was done using SPSS Version 15.0.The descriptive statistics was computed, comparisons of variables were done using chi-square test (parametric and non-parametric). Two sided p-value of less than 0.05 were considered to indicate statistical significance.

5.6 Ethical clearance

Ethical clearance was sought from the Chairperson, Research and Publications Committee of Muhimbili University of Health and Allied Sciences (MUHAS).The permission was sought from authorities of University of Dar-es-Salaam. The information about the study was given to students prior to interview and sample collection. A written consent was obtained from each participant. Confidentiality was ensured/guaranteed to all individuals who participated in the study.

Permission to conduct a study at UDSM was sought from the director of research at university of Dar es Salaam.

6.0 CHAPTER SIX

6.1 RESULTS

Of the total study population of 420, there were 277(66.0%) males and 143(34.0%) females.

The overall mean age of the study subject was 22.8±2.4 years with range of (18-40) years. Majority of the females were aged (18-22) while male aged (23-27) years. Males were older than females (p=0.000).

The other parameters including height, BMI, waist circumference and blood pressure were not statistically different when compared between genders. Also there was no significant difference of levels of glucose intolerance, HDL-C and triglyceride among females and males.

The more common risk factors found in this study were low HDL-C (17.6%), hypertension (11.7%) and glucose intolerance (11.4%)

Most of the students were single 405 (96.4%) and only 15(3.6%) were married. Among the married students female constituted 53.3%.

6.1.1 Levels of physical activities

Level of physical activities was obtained by interviews on self-reported activities by the participants, undertaken over the past one month. The different physical activity levels were then categorized into light, moderate and vigorous physical activity using the compendium of physical activities coding [48].

The study showed that all 420 participants were performing physical activities. Higher proportional of males were involved in physical activities. Almost 92 percent of the male students reported performing vigorous physical activities compared to the female (8.3%). The majority of the female students reported performing light and moderate physical activities 42.8% and 46.9% respectively. (P=0.000).

The main type of light physical activities performed was regular walks between classes like walking about 2Km from one lecture hall to the next for at least one hour between periods. Vigorous activities performed were mainly gym workup like push up and sit up which were mainly performed by male students.

The physical activities performed mainly were walking for more than 2km from one lecture hall to the next and was done every day in a week and for vigorous physical activities push-up and sit-up were mainly done by males.

6.1.2 Smoking

Most of the students 398(94.7%) were nonsmokers. Of the 22(5.2 %) who smoked there were mainly male students 19(86.4%) compare to females 3(13.6%), p- value 0.02 (TABLE 2)

Table 2: BASELINE CHARACTERISTICS OF THE STUDY POPULATION n=420

	MALE (%) N=277(66.0%)	FEMALE (%) N=143(34.6%)	p- value*
AGE(YEARS)			
18-22	117(55.2)	95(44.8)	
23-27	148(77.1)	44(22.9)	0.000
28-40	12(75.0)	4(25.0)	
MARITAL STATUS			
single	270(66.7)	135(33.3)	0.09
married	7(46.7)	8 (53.3)	
PHYSICAL ACTIVITIES			
Light (<3METs)	107(57.2)	80(42.8)	
Moderate (3-6 METs)	60(53.1)	53(46.9)	0.000
Vigorous 9(<6 METs)	110(91.7)	10(8.3)	
Cigarette Smoking			
Yes	19(86.4)	3(13.6)	0.02
No	254(64.8)	140(35.2)	

*chi-squire test

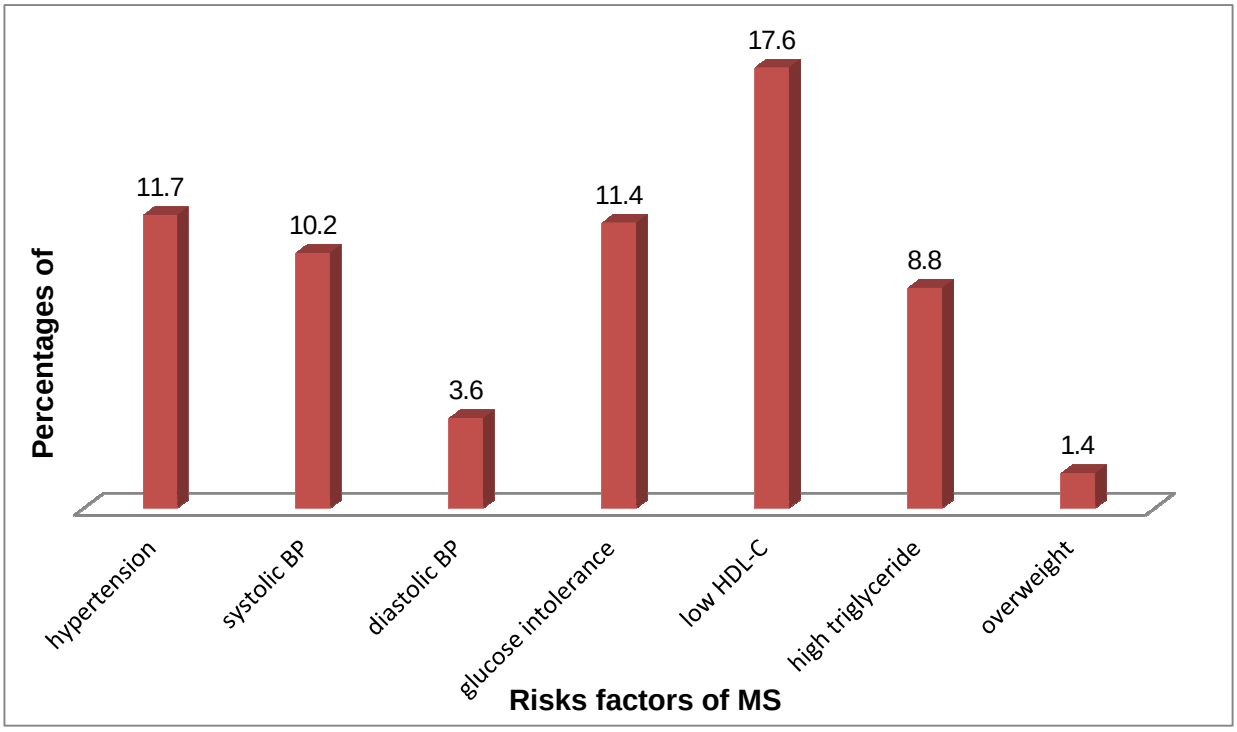
6.1.3 Prevalence of individual risk factor for metabolic syndrome.

The most prevalent metabolic risk observed was the low levels of HDL-C, present in 74(17.6%) participants. Glucose intolerance was present in 48(11.4%); high blood pressure values recorded high in 49(11.7%) subjects and 37(8.8%) had raised triglyceride levels

Obesity (BMI> 30kg/m2) was noted in only 6(1.4%) participants. (Figure 2)

The distribution of the metabolic risks was equal in both male and female students except the prevalence of hypertension which was significantly high in male students15.5% vs 4.2% compared to the prevalence among female students. (p=0.0000)

Figure 3: Prevalence of individual risk factors for MS



6.1.4 Clustering of risk factors for metabolic syndrome

In this study 145(34.5%) of the students were found to have at least one of the risk factors of metabolic syndrome. Twenty three (5.5%) had been identified with two or more of the metabolic risk factors. (TABLE 3)

Table 3: CLUSTERING OF RISK FACTORS FOR METABOLIC SYNDROME IN STUDY POPULATION. n=420

Participants with risk factors for MS		
Number of risks factors	**Frequency**	**%**
0	275	65.5
1	122	29.1
2	19	4.5
3	2	0.5
4	1	0.2
5	1	0.2
TOTAL	**420**	**100.0**

6.1.5 Metabolic syndrome by NCEP ATP-III criteria

By using National Cholesterol Education Program (NCEP) Adult Treatment Panel III, the subject must have three or more of the risk factors. Table 3 shows 4(0.9%) subjects that had three or more of the risk factors and therefore met the criteria to be diagnosed with metabolic syndrome.

6.1.6 Metabolic syndrome by WHO criteria

According to the WHO criteria, it requires one to have glucose intolerance i.e. to be diabetic, or have IFG 5.6mmol/l or IGT and have at least 2 of the metabolic risk factors. In this study only 1 (0.2%) participant met the criteria for diagnosis of metabolic syndrome using WHO criteria. (TABLE 4) The participant was a known diabetic on oral hypoglycemic drugs; the other risk factors which this participant had were hypertension, high level of triglyceride and low levels of HDL-cholesterol.

Table 4: METABOLIC SYNDROME BY WHO CRITERIA n=420

	Risk factors for metabolic syndrome						
Glucose intolerance	**No risk**	**1 risk**	**2 risk**	**3 risk**	**4 risk**	**5 risk**	**TOTAL**
Absent	242(65.1%)	108(29.0%)	19(5.1%)	1(0.3%)	1(0.3%)	1(0.3%)	372(88.6%)
Present	33(68.8%)	14(29.2%)	**0(0.0%)**	**1(0.2%)**	**0(0.0%)**	**0(0.0%)**	48(11.4%)
TOTAL	275(65.5%)	122(29.0%)	19(4.5%)	2(0.5%)	1(0.2%)	1(0.2%)	420(100%)

6.1.6 Metabolic syndrome by IDF criteria

The IDF criteria require one to have central obesity and at least 2 of the metabolic risk factors. Table 4 shows that there were 10 subjects with central obesity and 23 subjects who had at least 2 or more risk factor of metabolic syndrome (highlighted cells in table 5). Out of those 5(1.1%) were identified to have metabolic syndrome by IDF criteria.

Table 5: METABOLIC SYNDROME BY IDF CRITERIA n=420

Risk factors for metabolic syndrome							
CENTRAL OBESITY	**No risk**	**1 risk**	**2 risk**	**3 risk**	**4 risk**	**5 risk**	**TOTAL**
Absent	272(66.3%)	120(29.3%)	17(4.1%)	0(0.0%)	1(0.2%)	0(0.0%)	410(100.0%)
Present	3(30.0%)	2(20.0%)	**2(0.4%)**	**2(0.5%)**	**0(0.0%)**	**1(0.2%)**	10(100.0%)
TOTAL	275(65.5%)	122(29.0%)	19(4.5%)	2(0.5%)	1(0.2%)	1(0.2%)	420(100%)

7.0 CHAPTER SEVEN

7.1 DISCUSSION

The aim of this study was to determine the prevalence of metabolic syndrome and its associated risk factors among students of the University of Dar es Salaam. Four hundred and twenty students participated in this study, the majority of the participants being male students constituting 66% of the study population. The University of Dar es Salaam has fewer female students enrollment, constituting only 37.2% of all university students. The average age of the study participants was 22.8 ± 2.4 years old, the youngest being 18 and the oldest 40 years of age. Male students were much older compared to females, but in general all the students were young in age.

The overall prevalence of metabolic syndrome in this study was found to be 0.2%, the syndrome was (0%) in males and very low (0.2%) in females. This prevalence was lower than the study done in South Africa in a general population with the age 20-79 year old; where by the prevalence of metabolic syndrome was 5.9% among women and 7.3% among men. [24]

The prevalence of 0.2% is also much lower than in the other studies done in USA population among adults aged 20 years [11] and Europe [12-15], 44% and 12% -25% respectively.

Of surprise, in this study the prevalence of the metabolic syndrome was found to be highest in IDF criteria, 1.1% followed by ATP III criteria 0.9% and lastly 0.2% by WHO criteria. This was in contrast to the other study done in South Africa where by the prevalence was highest by using WHO, followed by IDF and ATP-III criteria [24].It was also found in the study done in Cameroon where the prevalence was highest by WHO criteria and lowest with ATP-III definition. [25]This difference could be explained by the fact that; the prevalence of metabolic syndrome clearly varied widely depending on the definition applied, and the ethnicity and age of the study [24, 76].population. [79] However in this study the general prevalence of metabolic syndrome is low.

Many hypotheses could explain this low prevalence of metabolic syndrome. The first reason is the relatively young age of the study population as it is well known the prevalence of MS increase with age. [77, 78].With the ageing of this study population, the prevalence of MS will probably increase to levels similar to those described elsewhere notably in African population. Second; this could be explained by the higher level of physical activities performed by the studied participants. As it was observed in this study, 44.5% had performed light physical activities, 28.5% vigorous physical activities and 26.9% moderate physical activity. The mainly light physical activity performed was walking less than 2km from one lecture hall to the next at least in every 1hour between periods and this could be done in more than 3hrs a day in a week. Vigorous activities performed more were push-up and sit-up and they were mainly done by males. It has been shown that high physical activity such as walking for at least 30 minutes every day greatly improves all the metabolic profile. This was also supported by results of the Sub Saharan Africa study [24] that high level of physical activity, even without reduced body fat mass, had led to low prevalence of metabolic syndrome in Africa.

In this study the prevalent subject of metabolic syndrome was also known to be diabetic on oral hypoglycemic drugs. It was estimated that the large majority (≈75%) of patient with type 2 diabetics have the metabolic syndrome [54].In Seychelles, it was found that approximately 80% of participants with DM also had metabolic syndrome and the prevalence was approximately lower upon exclusion of DM. [54]The study had 0% prevalence on exclusion of diabetes.

The prevalence of risk factors for metabolic syndrome in this study showed that obesity was the least frequent (1.4%). This finding could be explained by the fact that all study participants were much involved on physical activities.

Low level of HDL-C and impaired fasting glucose were the most frequent (17.6% and 11.4% respectively) components of metabolic syndrome. This could make the population to have greater odds of having cardiovascular disease and type 2 diabetes and eventually metabolic syndrome in the future.

This finding of low level of HDL-C was also contradictory to literatures which say that high levels of physical activity, which was also found in this study raises the levels of HDL-C (good cholesterol). Surprisingly in this study it was not the case. This could be explained by the fact that the cut- off level used to assess HDL-C was mainly studied in European or American populations in which might differ much in African population.

Systemic hypertension was also found to be one of the most components of MS by 11.7%. The findings were similar in studies done in Nigeria [27] and Cameroon. [25] In this study men were significant found to have high blood pressure than female, similarly like what was found in Sub Saharan Africa. [24]

Elevated level of serum triglyceride was frequent in 8.8% subjects. This was contrary to what had been shown in a study done in Sub Saharan Africa where elevated triglyceride was the least frequent. [24]

The study showed 22(5.2%) of the students smoked, male students smoked more (86.4%) than female student (13.6%). Cigarette smoking has been shown to increase the risk of metabolic syndrome. Cigarette smoking increases the circulating levels of insulin antagonists and free fat acids thus provoking the metabolic changes hence increasing the risk of the MS

Notwithstanding low prevalence in this study, 34.5% of the students have been identified to have at least one risk factor of metabolic syndrome. Thus, if efforts are not taken to reduce the level of the risk factors then this population have the high chance of being susceptible to developing the syndrome in their future life.

8.0 CHAPTER EIGHT

8.1 CONCLUSION

This study revealed a low prevalence of metabolic syndrome using either WHO, ATP-III or IDF definition in young generation among students of University of Dar es Salaam, and thirty four percent of students found to have at least one risk factors of metabolic syndrome. Hypertension, low level of HDL-C and glucose intolerance was common among them.

The prevalence of individual risk factors and the population trends in this prevalence are indicators of the MS and its subsequent consequences in the future life of this young generation in Tanzania.

The three MS definitions have generated a range of prevalence, not only as a consequence of the burden of the MS in this population, but also because of the components in each definition and cut-off levels used.

8.2 RECOMMENDATION

This study reveals low prevalence of metabolic syndrome because of the young age of the studied population and high level of physical activities. It also identified 34.5% students with at least one risk factors of metabolic syndrome.

Metabolic syndrome as being found to be associated with killer diseases, i.e. type 2 diabetes mellitus and cardiovascular diseases.

Therefore there is need of positive reinforcement and education on benefits of reducing and prevention of the risk factors of MS by increasing physical activities and diet modification, i.e. (reduce intake of saturated fat and calories diet) in this population.

8.3 STUDY LIMITATION

A potential limitation which may affect the generalizability of the findings is that the study was conducted in a single center.

The study could not be used to assess participants' dietary habits. Dietary lipids, fibers or carbohydrates may influence fasting glucose level and diet with a high glycemic load and low cereal fiber contents may be associated with the risk of the metabolic syndrome.

The self-report questionnaire method was used to assess the physical activities in this study, and therefore it might be affected by recall bias.

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APPENDIX I

QUESTIONNAIRE **Serial no……..**

A. SOCIODEMOGRAPHIC CHARACTERISTICS

1. Name of the respondent…….
2. Year of the study…….
3. Age……
4. Sex 1= Male 2= Female
5. Marital Status 1. Single
   2. Married/cohabiting
   3. Divorced/Separated
   4. Widow/widower

B. RISK FACTORS

6. Have you ever smoked cigarettes?

   1=Yes 2=No

7. If yes for how long ……..
8. How many cigarettes per day……..
9. If no, were you a former smoker?

   1= Yes 2=No

10. When did you stop smoking……
11. Have you ever been diagnosed with diabetes?

    1=Yes 2=No

12. When is the diagnosis made…….
13. If yes what medications are you on?

a) Glibenclamide

b) Chloropropamide

c) Metfomin

d) Insulin

e) others…….

14. What type of Diabetic?

1= Type 1 2=Type 2

15. Family history of Diabetes

1= Yes 2=No 3= don't know

16. Are you known hypertensive?

1=Yes 2= No

17. If yes what medications are you on

a) Beta blocker

b) ACE –inhibitors

c) Diuretics

d) Calcium channel blockers

e) Others…….

18. Family history of hypertension?

1=Yes 2=No 3=don't know

C. PHYSICAL ACTIVITIES ASSESSMENT

19. What kind of physical activities did you do in the past one month?

Physical activity	**Time spent per week**	**Number of days**	**Remark**

LIGHT PHYSICAL ACTIVITIES Water plants			
Sawing			
Ironing			
Shopping			
Feeding animals			
Washing dishes			
Walking < 2m.p.h (to neighbor to bus, tax stop)			
Cooking or food preparation			
Ridding in car			
Yoga			
Lying quietly doing nothing			
Taking medication sitting or standing			
MODERATE PHYSICAL ACTIVITIES Dancing			
Bicycling< 10m.p.h for leisure, to work			
Home activities(mopping, vacuuming, cleaning)			
Moving households (boxes, furniture)			
Tennis double			
Running with animals			
Jogging			
Loading & unloading, moving furniture			
Sweeping sidewalk, outside, garage			
VIGOROUS PHYSICAL ACTIVITIES Farming			
Aerobic (any type)			
Walking 5m.p.h			
Water jogging			
Volleyball, football competitive way			
Push up			
Sit-up			
Pull-ups			
Bicycling			

Source: Ainsworth B E, Haskell WL, Whitt MC, et al. Compendium of physical activities: an update of activity codes and MET intensities. Med. Sci. Sports Exerc., Vol. 32, No. 9, Suppl., pp. S498–S516, 2000.

20. Decide on the category of physical activities

i) Light physical activities

ii) Moderate physical activities

iii) Vigorous physical activities

D. PHYSICAL EXAMINATION

ARTHROPOMETRY

21. Height……CM

22. Weight……KG

23. Waist circumference……..CM

24. BMI…….Kg/m^2

25. BP 1st reading…….mmHg

26. BP 2nd reading (after 5min)…….mmHg

27. Average BP……..mmHg

E. BIOCHEMISTRY

28. Fasting blood glucose…….mmol/L

29. Serum triglyceride…….mg/dL

30. HDL……..mg/dL

APPENDIX II

CONSENT FORM

Title: Prevalence and risk factors of the metabolic syndrome among students at the University of Dar-Es-Salaam

Greetings madam/sir, I am Dr Mastidia K. Rutaihwa a resident in the department of Internal Medicine. I would like to conduct the study above as a necessary requirement for fulfillment of my postgraduate studies

This study requires you to participate so that important information can be obtained from you regarding your health.

This study aims to determine the prevalence and risk factors of the metabolic syndrome among students at university of Dar es Salaam, Mlimani campus that will recommend the implementation of program to screen the risk factors by means of routine medical exams and improving lifestyles.

Students who meet the inclusion criteria will be recruited into the study. They will be interviewed using a questionnaire, which will include their social demographic characteristics, medical history and physical examination

Blood tests for glucose level and lipid profile will be taken, weight, height and waist circumference will be measured.

There will be a slight pain and thrombophlebitis risk on venepuncture.

Study findings will not be released to anybody except the researches and the subject him/herself

The participant will not be asked any fee during the study.

Person to contact in case of questions or problems

Prof J. Lutale, Head of department, Internal Medicine, MUHAS

Dr Mastidia K. Rutaihwa, Post-graduate student, Department of Internal Medicine

Director of Research and publication, MUHAS

I, _____have read/been told of the contents of this form and understood its meaning; hence, I do agree to participate in this study.

Signature_____ (Participant), Date_____

Signature_____ (Researcher), Date_____