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Physical Activity And Dietary Factors As Determinants Of Metabolic Syndrome Among Adults In Jimma Town, South West Ethiopia.

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Abstract:
Background: Metabolic syndrome (Met S) is one of the major public health challenges worldwide and if not detected and controlled properly it can lead to Cardio Vascular disease (CVDs) and death. The presence of Metabolic syndrome in an individual can be estimated according to criteria such as those proposed by International Diabetes Federation (IDF), National Cholesterol Education Programme-Adult Treatment Panel-III(NCEP-ATP-III) and by World Health Organization(WHO). The purpose of all these definitions is to find out the edge group in the population who are at increased risk of developing cardio-metabolic diseases (CVDs / CHDs). Metabolic syndrome is mainly of lifestyle origin and the extent of physical activity and dietary habit can have some sort of influence on the development of the same.
Objective: The objective of this study was to assess the prevalence of metabolic syndrome, among adults aged 20 or more who have variations in their dietary habit and physical activity.
Materials and Methods: A community based cross-sectional study was conducted to asses Metabolic syndrome (Met S) by using IDF (Met S -IDF) and NCEP ATP-III criteria (Met S ATP-III) among 1316 individuals in accordance with the Stepwise approach of the World Health Organization. Anthropometric measurements were done, biochemical analysis were carried out using fasting blood and the prevalence of metabolic syndrome was determined .The association between Met S and various dietary factors, physical activity and genetic factors were verified using chi-square test and also by regression analysis using SPSS version-19.
Results and discussion: The study population comprises different economic, educational and occupational categories with variations in their life style and dietary habits. All kinds of physical activities from heavy exercise to sports /recreation were inversely correlated with the risk of Met S (Met S IDF: Yes=15.6%, No=21% and Met S ATP III: Yes =7.7%, No = 13.3%) as per the prevalence rate. Generally, type of staple food and non vegetarian food habit had no direct association with Met S, but high frequency of non-vegetarian food intake (> 4 days /week) was associated with a greater chance of development of Met S(Met S IDF =56.2% and Met S ATP III=43.7%). Family history had no significant influence on the Metabolic syndrome development (Met S IDF /Met S ATP-III)as per chi-square analysis. Logistic regression analysis revealed that sedentary life (not doing any kind of physical exercise), and consuming non vegetarian food in excessive quantities (>4days/week) (AOR=1.569; 95%CI=1.290-1.901) were associated with Met S- IDF. Non-vegetarian food in excessive quantities/>4 days/week (AOR=1.749) was associated with Met S ATP-III.
Conclusions: Heavy to mild physical activities reduced the risk of being affected with Met S compared to those who follow sedentary mode of life. High frequency non-vegetarian food intake had led to Met S development. Family history of HT/ DM / CVDs had no significant role in developing Met S, but was found to be more of life style origin as far as the study population was concerned.

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Key words: Metabolic syndrome, physical exercise, dietary habit, family history, waist circumference, BMI

INTRODUCTION

Metabolic syndrome is a cluster of metabolically related cardiovascular disease (CVD) risk factors that increases the risk of CVD by 2-fold and the risk of developing type 2 diabetes mellitus by 3-fold. The cluster includes various combinations of obesity (total body obesity measured by body mass index, or central obesity measured by waist-to hip ratio or waist circumference), atherogenic dyslipidemia (increased triglycerides, decreased high-density lipoprotein cholesterol), elevated blood pressure (systolic and diastolic), abnormal glucose tolerance, an insulin resistance measured by the homeostasis model assessment (HOMAIR) or fasting insulin [1,2]. The syndrome has been given different names such as the insulin resistance syndrome, or syndrome X [2,3,4] and the deadly quartet[5], the most popular being metabolic syndrome[6].

The definition of metabolic syndrome (MetS) appears to be in an ever-changing flux. Various organizations have proposed definitions of MetS. In 2001, the NCEP—ATPIII defined MetS as a constellation of metabolic abnormalities, including hypertension, dyslipidemia, and hyperglycemia associated with insulin resistance. Insulin resistance was excluded from their definition, as its measurement was difficult and not standardized [7]. Another definition was proposed by international Diabetes Federation (IDF) [8]. The 2010 report of the WHO Expert Consultation Committee defined metabolic syndrome as a pre-morbid condition rather than a clinical diagnosis, and they suggested that it should exclude individuals with established diabetes or known cardiovascular disease [9]. ATP III identified 6 components of the metabolic syndrome that relate to CVD: Abdominal obesity. Atherogenic, dyslipidemia, raised blood pressure, insulin resistance ± glucose intolerance, pro-inflammatory state and pro-thrombotic state [10, 11].

The metabolic syndrome has become one of the major public-health challenges worldwide [12]. The global statistics shows that approximately a quarter of adult populations suffer from this clinical entity [13]. Worldwide, prevalence estimates for the metabolic syndrome in men range from eight percent in India to 24 percent in the United States and for women from seven percent in France to 46 percent in India [14]. According to various studies the prevalence of MetS in general population in the United States, Saudi Arabia, and Turkey are 24%, 39.3%, and 33.4%, respectively [15-17]. The literature also reveals that the prevalence of MetS in Tehran is 30.1% while prevalence of MetS in three major cities in centre of Iran is 23.3%. A more interesting part of the MetS story in Iran is that 45% of adult the population in Khorasan (Northeast Iran) has MetS [18-20]. Similarly, the prevalence of the metabolic syndrome according to the WHO definition in seven European countries was estimated to be 23% [21]. In Canada, more than a quarter of the population between the ages of 35 to 75 years was affected by the metabolic syndrome based on the ATP III criteria [22]. At least 12% of the population aged 25 years and above was found to have three or more risk factors in Australia [23].Metabolic syndrome is evolving into a pandemic, contributing to approximately 6-7% for all-cause mortality, 12– 17% for cardiovascular disease, and 30–52% for diabetes in the population [24]. In populations free of cardiovascular disease at baseline, cardiovascular morbidity and mortality increases 1.5- to 3-fold in the presence of the metabolic syndrome [25, 26]. According to International Diabetes Federation (IDF) a quarter of the world's adults have metabolic syndrome. People with metabolic syndrome are twice as likely to die from, and three times as likely to have a heart attack or stroke compared with people without the syndrome. People with metabolic syndrome have a five-fold greater risk of developing type 2 diabetes mellitus. Up to 80% of the 200 million people with diabetes globally will die of cardiovascular disease. This puts metabolic syndrome and diabetes way ahead of HIV/AIDS in morbidity and mortality terms yet the problem is not as well recognized [27]. The main reason behind this is that the combination of Met S risk factors interacts synergistically to start or accelerate the progression of atherosclerosis. Individuals with metabolic syndrome are at increased risk for Coronary Heart Disease (CHD) [28].

Only very little information exists about the prevalence and epidemiological characteristics of Met S in sub-Saharan Africa. In Africa, the first reported Met S study conducted in the mid-90s in Cameroon found a 1.5% and 1.3% prevalence of Met S among urban dwelling women and men using IDF criteria [29]. Another conducted in 2004 in Seychelles, found a high prevalence of Met S where 25%–30% of their study population had the syndrome [30]. A recent study involving adults in semi-urban and rural communities in Nigeria found a prevalence of MetS to be 18% [31]. A community based study conducted in Tanzania in 2009 reported a 38% prevalence of Met S [32]. The prevalence of the metabolic syndrome in children and adolescents is relatively low (4%) when compared to the adult population (24%), except amongst overweight and obese adolescents where the prevalence of the metabolic syndrome has been reported as high as 29% [33,34,35].

The associated risk factors with metabolic syndrome can be divided into modifiable and non-modifiable types. The major modifiable types include high blood pressure, disturbances in sex hormones (e.g., polycystic ovary syndrome (POS), mental ill health, hyper-androgenism in pre- and postmenopausal women, energy excess (higher carbohydrate, high fat, low food fiber, high meat intake,

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family history (diabetes, hypertension, obesity, overweight, life styles (tobacco use, alcohol consumption, physical inactivity, snoring and obstructive sleep apnea syndrome, psychosocial and personality factors (lower social class , difficulty in coping with stress low socioeconomic status, alcohol etc. The non-modifiable risk factors include age, sex, ethnicity, family history and previous stroke and heart attack [16, 17, 36]. Metabolic syndrome overall more strongly predicts CHD, CVD, and total mortality than its individual components [37]. An important thing is that early diagnosis and efficient management of the disease will result in the reduced risk of future development of CAD [38-40].

A cross-sectional study conducted from 2000 to 2004 in Spain on 5814 participants included in "CDC de Canarias" cohort (CDC indicates cardiovascular, diabetes and cancer) revealed direct associations between a sedentary lifestyle and metabolic syndrome, body mass index, abdominal circumferences, systolic blood pressure, and triglycerides, and inverse associations with high-density lipoprotein cholesterol which demonstrated the greatest percentage difference between sedentary and active individuals. In accordance with ATP-III definition, in sedentary women there found a Met S prevalence of 26%, whereas sedentary men presented 27%. Similarly, with the IDF definition, prevalence was 33% in sedentary women and 41% in sedentary men. In contrast, the use of the two definitions of Met S did modify the capacity of sedentary lifestyle to detect presence of Met S [41].

In Ethiopia a cross-sectional study among working adults conducted in Addis Ababa, revealed that the overall prevalence of Met S was 12.5% and 17.9% according to ATP III and IDF definitions respectively. Using ATP III criteria, the prevalence of Met S was 10.0% in men and 16.2% in women. Application of the IDF criteria resulted in a Met S prevalence of 14.0% in men and 24.0% in women [42]. However, they have not studied the association between physical activity, dietary habit and genetic background of Cardiovascular diseases/Diabetes mellitus/and Hypertension on the Met S prevalence. No study has been conducted on prevalence and risk factors of metabolic syndrome in the present study area and therefore,the objective present study was to determine the influence of physical activities and dietary habit and the genetic background of Cardiovascular diseases/Diabetes mellitus/and Hypertension on the development of metabolic syndrome in Jimma town, South West Ethiopia.

MATERIALS AND METHODS

Study Area, Study Design and study Period

This study was conducted from January to March, 2013 in Jimma town, south west Ethiopia. A community based cross-sectional study design was employed to determine prevalence and to assess risk factors for Met S in Jimma town, South West Ethiopia.

Source Population and Study Population and Sampling procedures: Individuals aged 20 or more living in Jimma town at least for the last six months. Individuals having as cites due to any cause, pregnant women, known hypertensive individuals, known CVD, Diabetes Mellitus (DM) patients and HIV positive patients on Anti Retroviral Therapy (AR were all exempted. The sample size was determined using single population proportion formula with assuming a confidence level of 95%, a design effect of 2, and 5% allowance for non- response rate. The total sample size was estimated to be 1,316 individuals. Multi-stage sampling technique was employed for this study.

Data Collection

Data Collection Technique: The data collection was conducted in accordance with the STEP wise approach of the World Health Organization (WHO) for NCD surveillance in developing countries [43]. Physical activity was assessed by using Global Physical activity questionnaire of WHO (GPAQ) analysis Guide [43,59]. The approach had three levels: **(1)** interviewer administered questionnaires to gather socio-demographic characteristics and information about life style factors dietary characteristic, Physical activities and family history of hypertension(HT), CVDs and diabetes mellitus(DM) **(2)** Anthropometric measurements (weight, height, BMI, waist circumference) and blood pressure were determined **(3)** biochemical analysis to determine participants' Serum triglycerides (TGs), serum total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), low density lipoprotein cholesterol (LDL-C), fasting blood glucose (FBG).

Anthropometric measurements: Body weight was measured in kilograms (kg) using the WHO weighing scale (digital weighing machine) at a precision of 0.1kg with the study subjects minimally dressed. Body height was measured in centimetre (cm) in erect position at a precision of 0.1cm with shoes removed using a height scale. Waist circumference (WC) was measured in cm at the midpoint of the line between the lowest border of the thoracic cage and anterior superior iliac spine using a measuring tape. **Blood Pressure Measurement:** Blood pressure was measured using automatic digital sphygmomanometer. The measurement protocol used was as follows. After a supine rest of 5 minutes, one measurement in the standing position, and two in the sitting position at 5-minute intervals on the left and right hand were done. The mean of all three measurements was used as the systolic and diastolic blood pressures. **Biochemical Analysis:** About 6 ml of venous blood samples from the ante-cubital vein was taken after an overnight fasting of 10-12 hours. Fasting blood (plasma) glucose, serum total cholesterol, HDL-C and triglycerides

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were determined by Auto analyzer (Human Star Model 80) method by using specific reagents (Human). LDL-C will be calculate using the Freidwald's formula**;** VLDL = Triglycerides ÷5; LDL = Total cholesterol – (HDL + VLDL) [44].

Estimation of Met S: The presence of Met S in a individual was calculated by using IDF and ATP- III definitions.**IDF Definition**: In accordance with the IDF criteria, subjects were classified as having Met S if participants had abdominal obesity (defined as waist circumference of ≥94 cm for men and ≥80 cm women) plus two of any of the following risk factors: (1) Raised TG level (≥150 mg/dL) (2) Reduced HDL-C (<40 mg/dL in males and <50mg/dL in females) (3) Raised blood pressure (systolic BP ≥130 or diastolic BP ≥85 mmHg) and (4) Raised FG (≥100 mg/dL). **ATP III Definition**: In accordance with the ATP III criteria, subjects were classified as having Met S if participants had three or more of the following risk factors: (1) Abdominal obesity (waist circumference >102 cm in males and >88 cm in females) (2) Hyper-triglyceridemia (TG ≥150 mg/dL) (3) Reduced HDL-C (<40 mg/dL in males and <50 mg/dL in females) (4) High BP (≥130/85 mmHg (5) FBG (≥110 mg/dL).

Data Quality Assurance and Data Analysis

Data collectors were given intensive training and all the data collection instruments were standardized to maintain maximum accuracy. Biochemical analysis was carried out in the laboratory following standard laboratory procedures. The collected data was checked for completeness and consistency and analyzed using SPSS for Windows Version 19.0. The association between dependent and independent variables were analyzed and presented using chi square test at the adopted confidence level of 95%, P value of 0.05 (i.e. 5%) or less were considered to be significant. The strength of statistical association was measured by adjusted odds ratios at 95% confidence intervals. Binary Logistic regression was used to determine association between dependent and the independent variables.

Ethical clearance: Ethical clearance for the study was obtained from Jimma University, College of public health and Medical Science, Ethical Review Committee through Department of Biomedical Science.

RESULTS

The results of the community based cross-sectional study employed to assess the influence of physical activities, dietary habit and family history (of HT/CVDs/DM) to the development of Metabolic Syndrome (Met S) in Jimma town is discussed below under different headings.

Physical activities of the population

Physical activity was assessed by using Global Physical activity questionnaire of WHO(GPAQ) analysis Guide. Data regarding the physical activities of the study population are presented in Table: 1. Out of 1316 individuals of the study population, 1040(79%) are doing heavy or mild physical exercise. The habit of physical exercise is more common among males (83%) compared to female (75%) (P=0.001**). About half of the study population, 652 people (49.5%) were having the habit of doing even heavy exercise (P=0.021**). Exercising by means of simple walking / pedalling/cycling was habituated by 780(59.3%) individuals and found a significant variation between males (65%) and females (54.2%) (P=0.001**) of the study population. 324(24.6%) individuals are involved in sports/recreation activities and males were observed to be more active (31.6%) when compared to females (18.4%), (P=0.000**).

Table: 1. Physical activities of the study population.

Characteristics		Total N (%) N=1316	Men N (%) N=620	Women N (%) N=696	P value
Physical exercise	Yes	1040(79)	517(83.4)	523(75.1)	0.001
	No	276(21)	103(16.6)	173(24.9)	
Heavy physical exercise	Yes	652(49.5)	360(58.1)	292(42)	0.021
	No	664(50.5)	260(41.9)	404(58)	
Walking /pedalling	Yes	780(59.3)	403(65)	327(54.2)	0.001
	No	536(40.7)	217(35)	319(45.8)	
Sports /recreation	Yes	324(24.6)	196(31.6)	128(18.4)	0.000
	No	992(75.4)	424(68.4)	568(81.6)	

***P<0.05 is significant

Dietary characteristic of the population

The dietary characteristics of the population are given in Table: 2. In the study population 1112(85.3%) had a habit of consuming teff as their usual staple food , 15 individuals (1.1%) wheat as their common food whereas, 179 people (13.6%) were accustomed with mixed diet including teff , wheat and rice. A little less than half of the study population, ie. 623 individuals (47.3%) are vegetarians and the remaining 693 individuals (52.1%) are non-vegetarians (P=0.000***).

Table:2..Dietary characteristics of the study population.

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Characteristics		Total N (%) N=1316	Men N (%) N=620	Women N (%) N=696	P value
Staple food	Teff	1112(85.3)	533(86)	589(84.6)	0.106
	Wheat	15(1.1)	3(0.5)	12(1.7)	
	Mixed	179(13.6)	84(13.5)	95(13.6)	
Vegetarian/non-vegetarian	Vegetarian	623(47.3)	256(41.3)	367(52.7)	0.000
	Non vegetarian	693(52.7)	364(58.7)	329(47.3)	
	No	176(13.4)	87(14)	89(12.8)	

***P<0.05 is significant

Family history of the study population with regard to HT/ DM/CVD

The family history of the study population with respect to the lifestyle disorders such as Hypertension (HT), CVDs and Diabetes mellitus (DM) are given in Table:3.

In the study population 220(16.7%) were having the family background of HT, DM or CVDs and 1096(83.3%) didn't have the background of the same (P=0.000***).

Table:3. Family history of the individuals with respect to HT, DM or CVDs

Characteristics		Total N (%) N=1316	Men N (%) N=620	Women N (%) N=696	P value
DM/ CVD/ HT	Yes	220(16.7)	72(11.6)	148(21.3)	0.000***
	No	1096(83.3)	548(88.4)	548(78.7)	

***P<0.05 is significant

Physical exercise, dietary habit and family history vs. Met S-IDF

Life style factors such as physical exercise, walking, running pedalling /cycling ,sports/recreation etc. ,dietary factors such as food habit (type of food, frequency and quantity of food), and family history of disorders such as hypertension (HT)/ Diabetes mellitus (DM)/ Cardiovascular disorders(CVDs)etc. all possibly can have influence on the development of Met S IDF in an individual. The prevalence of Met S – IDF in different categories of the study population are incorporated in Table: 4.

Table: 4. Association of Metabolic syndrome (IDF) with the physical activity, dietary factors and family history of HT/DM/ CVD.

Characteristics		No Met S-IDF N =1316 N (%)	Met S-IDF N =1316 N (%)	P value
Exercise	Yes N=1040(79)	878(84.4)	162(15.6)	0.021
	No N=276(21)	218(79)	58(21)	
Heavy exercise	Yes N=652(49.5)	574(88)	78(12)	0.000
	No N=664(50.5)	522(78.6)	142(21.4)	
Walking/ pedalling	Yes N=780(59.3)	667(85.5)	113(14.5)	0.008
	No N=536(40.7)	429(80)	107(20)	
Sports /recreation	Yes N=324(24.6)	298(92)	26(8)	0.021
	No N=992(75.4)	798(80.4)	194(19.6)	
Staple food	Teff N=1112(85.3)	925(82.4)	97(17.6)	0.064
	Wheat N=15(1.1)	15(100)	0(0)	
	Mixed N=179(13.6)	156(87.2)	23(12.8)	
Food habit	Vegetarian N=623(47.3)	513(82.3)	110(17.7)	0.214
	Non vegetarian N=693(52.7)	583(84.1)	110(15.9)	
Family history of HT/DM/CVD	Yes N=220(16.7)	184(83.6)	36(16.4)	0.484
	No N=1096(83.3)	912(83.2)	184(16.8)	

***P<0.05 is significant

Physical exercise and Met S IDF: The variations in the prevalence rate of Met S IDF in exercising and non exercising categories of the study population are given in Table.4. Routine Physical exercise is an important factor that can utilize the unwanted calorie that helps to keep away from most of the lifestyle disorders and also from developing Met S. In the study population 79% individuals had the habit of doing exercise. The prevalence of Met S-IDF in exercising people (15.6%) was found to be significantly less than that of non exercising people (21%)(P=0.021**). Only 49% of the study population had the habit of doing very heavy exercise as a part of their daily work. Met S –IDF prevalence was found to be much less in heavy exercising people (12%) as compared to others who do not do heavy exercise (21.4%)(P=0.000**).

Other activities like simple walking /pedalling / cycling /swimming etc can cause the loss of excess calories to get rid of Met S. In study population 59.3 % of the individuals were having the habit of either walking /pedalling as a part of their daily activities. People who were accustomed with walking /pedalling had shown only less chance to develop Met S – IDF(14.5%) as compared to others who did not had the habit of performing these activities(20%)(P=0.008**).Sports and recreation activities can bring good

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health in addition to the timely mental enjoyments. In the study population comparatively less percentage of the people (24.6%) had the habit of sports / recreation as a routine thing. The present study established that people who do sporting /recreation activities had less chance to develop Met S – IDF (8%) as compared to the people who were not involving in these activities (19.6%)(P=0.021**).To generalize, the present study showed that physical exercises of all kinds starting from heavy physical exercise to sports/recreation had a negative influence on the development of Met S IDF as indicated by its prevalence rate. Women in general, because of their decreased attitude towards physical exercise had shown more tendencies to develop Met S IDF as compared to men.

Dietary habit and Met S IDF: Staple food and Met S IDF: The different dietary groups of the study population based on their usual staple food are teff eating-85.3%, wheat eating-1.1% and mixed usage -13.6% (Table.4.) Teff category had shown more prevalence of Met S – IDF as compared with wheat category (0%) and mixed category (12.8%) but was not very significant(P=0.064). **Non vegetarian diet Met S IDF**: 47.3% of the population was vegetarians with a Met S- IDF prevalence of 17.7%. The remaining 52.7 % were non vegetarians with a Met S IDF prevalence rate of 15.9 % (Table. 4.) No significant difference in the Met S prevalence was observed between vegetarians and non-vegetarians (P=0.214). **Family history of HT/DM/CVDs and Met S IDF:** In the study population 16.7 % had the background of familial hypertension (HT)/Diabetes mellitus (DM) / Cardiovascular disorders (CVDs) and among them the prevalence of Met S-IDF was found to be 16.8% (Table 4.) Most of the study population (83.3%) who had no family history of HT, DM and CVDs had shown a Met S – IDF prevalence rate of 16.7%.These prevalence rates established that there exist no significant relation between the development of Met S IDF with the family history of HT/DM/ CVDs in the studied population(P=0.484**).

Physical exercise, dietary factors and family history vs. Met S ATP-III

The prevalence of Met S – ATP-III in different categories (categorised according to the differences in the pattern of physical activities, dietary habit and family history)is incorporated in Table:5.

Physical exercise and Met S ATP III: In the study population 79% individuals had the habit of doing exercise (Table. 5). Generally, there observed a little variation in the prevalence of Met S – ATP-III between exercising people (10.2%) and non exercising people (11.6%), but was not statistically significant(P=0.282). It is also noticeable that only less than half (49%) of the study population had the habit of doing very heavy exercise as a part of their daily work. Met S – ATP-III prevalence was found to be significantly less(P=0.001**) in heavy exercising people (7.7%) as compared to others who do not do heavy exercise (13.3%). Abdominal obesity measured in the form of Waist circumference is one of the determinant of Met SATP III. The limits are >102 cm in males and >88 cm in females. This means that a person doing heavy exercise as a daily routine only will have WC less than the above prescribed limits.

Table: 5. Association of Metabolic syndrome (ATP-III) with the life style, exercise, dietary factors and family history of HT/DM/ CVD.

Characteristics		No Met S (ATP-III) N =1316 N (%)	Met S (ATP-III) N =1316 N (%)	P value
Exercise	Yes N=1040(79)	934(89.8)	106(10.2)	0.282
	No N=276(21)	244(88.4)	32(11.6)	
Heavy exercise	Yes N=652(49.5)	602(92.3)	50 (7.7)	0.001
	No N=664(50.5)	576(86.7)	88(13.3)	
Walking/pedalling	Yes N=780(59.3)	710(91)	70(9)	0.020
	No N=536(40.7)	468(87.3)	68(12.7)	
Sports /recreation	Yes N=324(24.6)	304(93.8)	20(6.2)	0.001
	No N=992(75.4)	874(88.1)	118(11.9)	
Staple food	Teff N=1112(85.3)	1004(89.5)	118(10.5)	0.397
	Wheat	15(100)	0(0)	

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	N=15(1.1)			
	Mixed N=179(13.6)	159(88.8)	20(11.2)	
Food habit	Vegetarian N=623(47.3)	562(90.2)	61(9.8)	0.245
	Non vegetarian N=693(52.7)	616(89.9)	77(11.1)	
Family history of HT/DM/CVD	Yes N=220(16.7)	196(89.1)	24(10.9)	0.450
	No N=1096(83.3)	982(89.6)	114(10.4)	

***P<0.05 is significant

In study population 59.3 % of the individuals were having the habit of either walking /pedalling as a part of their daily activities. People who were accustomed with walking /pedalling had shown only less chance to develop Met S – ATP-III (9%) as compared to others who did not had the habit of performing these activities(12.7%)(P=0.020**). Among the study participant comparatively less percentage of the people (24.6%) had the habit of sports / recreation as a routine thing. The present study established that people who do sporting /recreation activities had less chance to develop Met S – ATP-III (6.2%) as compared to the people who were not involving in these activities (11.9%)(P=0.001**).

The above results indicated that physical exercises of all kinds starting from heavy physical exercise to sports/recreation had an influence on decreasing the development of Met S-ATP-III as reflected in its prevalence rate. Women in general, had shown more tendencies to develop Met S ATP-III similar to Met S- IDF, might be because of their decreased attitude towards physical exercise.

Staple food and Met S ATP III: The different dietary groups of the study population based on their usual staple food are teff eating-85%, wheat eating-1.1% and mixed usage -13.6% (Table.5). There found no significant variation in prevalence of Met S – ATP-III between different categories (P=0.397).

Non Vegetarian food and Met S ATPIII: In the study population 47.3% were vegetarians with a Met S – ATP-III prevalence of 9.8%. The remaining 52.7 % were non vegetarians with a Met S – ATP-III prevalence rate of 11.1 % (Table.5). No significant difference in the Met S prevalence was observed between vegetarians and non-vegetarians (P= 0.245).This observation was similar to that in the case of Met S IDF and the possible reasons is that even though some people are literarily non vegetarians they are unable to afford the price and therefore the frequency as well as quantity of non -vegetarian food intake is less.

Family history of HT/DM/CVDs and Met S ATP-III: In the study population 16.7 % had the background of familial hypertension (HT)/Diabetes mellitus (DM) / Cardiovascular disorders (CVDs) and among them the prevalence of Met S – ATP-III was found to be 10.9% (Table.5). Most of the study population (83.3%) who had no family history of HT/ DM / CVDs had shown a Met S – ATP-III prevalence rate of 10.4%. This clearly indicates that there exists no significant relation between the development of Met S – ATP-III with the family history of HT/DM/ CVDs of the individuals in the studied population (P=0.450). This in turn reflects the fact that Met S – ATP-III is not only of hereditary origin, but also can be acquired type (because of many lifestyle factors) or can be a combination of both in the studied population. The pattern of manifestation of Met S IDF and Met S ATP –III are found to be similar in the population.

Frequency of Non Veg. Food Vs. Met S-IDF

The results of the influence of physical activities, dietary factors and family history on the development of Met S (Met S- IDF and Met S ATP-III) are already indicated before. As a part of the present investigation, it is also important to understand the effect of varying frequency/quantity of non veg. food on the development of Met S (Table 6).

Table:6. Association between the frequency /quantity of non veg. food intake and Met S-IDF.

Frequencies / usage		**No MS-IDF N=1316 N (%)**	**MS-IDF N=1316 N (%)**	**P value**
	Occasionally N=67(23.2)	67(100)	0(0)	
	Total=288(100)	256(88.9)	32(11.1)	
Non vegetarian food	Occasionally N=7(1)	7(100)	0(0)	0.001***
	1 -2day/week N=483(70.1)	425(88)	58(12)	
	3-4days/week N=183(26.6)	142(77.6)	41(22.4)	
	>4days/week N=16(2.3)	7(43.8)	9(56.2)	
	Total =689(100)	581(84.3)	108(15.7)	

***P<0.05 is significant

It is obvious that over consumption of animal products (non vegetarian food) can cause obesity due to its high caloric

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value and the presence of high proportion of fat. It may also contain cholesterol that can cause atherosclerosis when in excess leading to hypertension(HT) and CVDs. Obesity, HT, CVDs these entire together manifests in the form of Met S. Non vegetarians constitute 52.7% of the population having a Met S-IDF prevalence of 15.7 %. This is not significantly different from the prevalence rate of the entire study population (16.7%) or from the prevalence rate among the vegetarian category (15.9%).This is because of the fact that even though the people are potentially non vegetarians the frequency of consumption is very less because of the economic backwardness and we cannot expect much difference in the calorie intake between a vegetarian and non vegetarian.

But, on comparing the frequency of consumption with Met S IDF prevalence it was observed that the occasional non veg. consumers showed a significantly (P=0.001**) less percentage of Met S –IDF when compared to people who consumes 1-2 days /week (12%), people who consume 3-4 days/ week (22.4%) and above 4 days /week (56.2%).These clearly indicate that non.veg diet frequency had an influence on the development of Met S IDF in the study population provided.

Frequency of Non Veg. Food Vs. Met S-ATP-III

The results of the influence of the frequency /quantity of non- veg. food intake with the development of Met S ATP-III is indicated in Table. 7.

Table: 7. Association between the frequency /quantity of non veg. food intake and Met S- ATP-III.

Frequencies usage		No MS-ATP-III N=1316 N (%)	MS-ATP-III N=1316 N (%)	P value
Non vegetarian food	Occasionally N=7(1)	7(100)	0(0)	0.001
	1 -2day/week N=483(70.1)	447(92.5)	36(7.5)	
	3-4days/week N=183(26.6)	150(82)	33(18)	
	>4days/week N=16(2.3)	9(56.3)	7(43.7)	
	Total =689(100)	613(89)	76(11)	

***P<0.05 is significant

Non vegetarians constitute 52.7% of the population having a Met S-ATP-III prevalence of 11 %. This is not significantly different from the prevalence rate of the entire study population (10.5%) or from the prevalence rate among the vegetarian category (11.1%).This is because of the fact that even though the people are potentially non vegetarians the frequency of non – veg. food consumption is very less because of the economic backwardness and therefore the calorie intake between a vegetarian and non vegetarian may not be much different. But, on comparing the frequency of consumption with Met S ATP-III prevalence it was observed that the occasional non veg. consumers showed a less percentage of Met S –ATP-III (0%) when compared to people who consumes 1-2 days /week (7.5%), people who consume 3-4 days/ week (18%) and above 4 days /week (43.7%)These clearly indicate that non.veg diet frequency had an influence on the development of Met S ATP-III in the study population (P=0.001**).This very similar to the relationship between non-vegetarian diet and Met S-IDF given before.

Logistic regression analyses

The results of Binary Logistic regression analysis (Table:8) revealed that not doing physical exercise(AOR=0.775;95% CI=1.032-2.015) is associated with the development of Met S -IDF.

Table: 8. Logistic regression analysis-Metabolic syndrome (IDF) in Jimma Town, south west Ethiopia.

Characteristics		No MS ATP N (%)	MS ATP N (%)	AOR	C I 95 %
Physical exercise	Yes	878(84.4)	162(15.6)	1.00	
	No	218(79)	58(21)	0.775	1.032-2.015**
Staple food	Teff	925(82.4)	97(17.6)	1.00	
	Wheat	15(100)	0(0)	0.368	0.171-1.793
	Mixed	156(87.2)	23(12.8)	0.000	0.891-1.235
Food habit	Vegetarian	513(82.3)	110(17.7)	1.00	
	Non-vegetarian	583(84.1)	110(15.9)	0.749	0.446-1.258
Family history of HT/DM/ CVDs	Yes	184(83.6)	36(16.4)	1.00	
	No	912(83.2)	184(16.8)	0.442	0.232-0.843
	Hypertension-Stage-II	34(81)	42(3.2)	12.293	3.456-43.7

Even though non vegetarian food habit, is not associated with the development of Met S IDF, consuming non vegetarian food in excessive quantities (above 4 days /week) was found to be very closely associated (AOR=1.569;95%CI=1.290-1.901). The results of Logistic regression analysis (Table:9) revealed that not doing physical exercise is associated with the development of Met S ATP-IIII.(AOR=0.901;95% CI=1.515-2.576).

Table:9. Logistic regression analysis-Metabolic syndrome ATP –III in Jimma Town south west Ethiopia.

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Characteristics		No MS ATP N (%)	MS ATP N (%)	AOR	C I 95 %
Physical exercise	Yes	934(89.8)	106(10.2)	1.00	
	No	244(88.4)	32(11.6)	0.901	1.515-2.576
Staple food	Teff	1004(89.5)	118(10.5)	1.00	
	Wheat	15(100)	0(0)	0.394	0.182-1.053
	Mixed	159(88.8)	20(11.2)	0.023	0.345-1.236
Food habit	Vegetarian	562(90.2)	61(9.8)	1.00	
	Non-vegetarian	616(89.9)	77(11.1)	0.813	0.497-1.300
Coffee habit	Yes	1027(90.1)	113(9.9)	1.00	
	No	151(85.8)	25(14.2)	0.682	0.353-1.316
Family history of HT/DM/ CVDs	Yes	196(89.1)	24(10.9)	1.00	
	No	982(89.6)	114(10.4)	0.407	0.211-0.787
	Pre-hypertensive	362(81.5)	82(18.5)	0.208	0.053-0.812
	Hypertension Stage-I	82(60.7)	53(39.3)	3.382	1.875-11.7
	Hypertension-Stage-II	40(95.20)	2(4.8)	14.45	3.98-52.45

Even though non vegetarian food habit, is not associated with the development of Met S ATP- III, consuming non vegetarian food in excessive quantities (above 4 days /week) was found to be very closely associated(AOR=1.749;95%CI=1.409-2.171)as per regression analysis.

DISCUSSION

Association between physical exercise and Metabolic syndrome: **Routine Physical exercise is an important factor that can utilise the unwanted calorie that help to keep away from most of the lifestyle disorders and also from developing Met S. 79% of the study population is doing either heavy or mild physical exercise. The habit of physical exercise was observed to be more common among males (P=0.001**) compared to women. This could be one reason behind the higher prevalence of Met S ATP-III and Met S IDF in women of the study population when compared to men.** Physical activity and Met S IDF**: The prevalence of Met S- IDF in exercising people (15.6%) was found to be significantly less than that of non exercising people (21%)(P=0.021**). Met S – IDF prevalence was found to be much less in heavy exercising people (12%) as compared to others who do not do heavy exercise (21.4%)(P=0.000**). People who were accustomed with walking /pedalling had shown only less chance to develop Met S – IDF (14.5%) as compared to others who did not had the habit of performing these activities (20%)(P=0.008**).The present study established that people who do sporting /recreation activities had less chance to develop Met S – IDF (8%) as compared to the people who were not involving in these activities (19.6%)(P=0.021**). Sports and recreation activities can bring good health in addition to the timely mental enjoyments. In the study population comparatively less percentage of the people (24.6%) had the habit of sports / recreation as a routine thing.** Physical exercise and Met S ATP-III: **Generally, there observed a little variation in the prevalence of Met S – ATP-III between exercising people (10.2%) and non exercising people (11.6%), but was not statistically significant(P=0.282). But on close analysis it is evident that Met S – ATP-III prevalence was found to be significantly less(P=0.001**) in heavy exercising people (7.7%) as compared to others who do not do heavy exercise (13.3%).**

Abdominal obesity measured in the form of Waist circumference is one of the determinant of Met SATP III. The limits are >102 cm in males and >88 cm in females. This means that a person doing heavy exercise as a daily routine only will have WC less than the above prescribed limits**.** In study population 59.3 % of the individuals were having the habit of either walking /pedalling as a part of their daily activities. People who were accustomed with walking /pedalling had shown only less chance to develop Met S – ATP-III (9%) as compared to others who did not had the habit of performing these activities(12.7%)(P=0.020**) Other activities like simple walking /pedalling / cycling /swimming etc can cause the loss of excess calories to get rid of Met S. The present study established that people who do sporting /recreation activities had less chance to develop Met S – ATP-III (6.2%) as compared to the people who were not involving in these activities (11.9%)(P=0.001**).

To generalize, regarding the development of Met S IDF as well as Met S ATP-III, the present results indicated that physical exercises of all kinds starting from heavy physical exercise to sports/recreation had an influence on decreasing the chance of developing Met S as reflected in its prevalence rates. Women in general, because of their decreased attitude towards physical exercise (discussed before) had shown more tendencies to develop and Met S IDF and Met S ATP-III compared to men. The inverse relationship between physical activities and obesity/HT/CHDs/ CVDs/Hyper lipidemia (particularly, hypertriglyceridemia and hyperlipoproteinemia) are well established facts. Since all these are either direct or indirect components (determinants) of Met S it is also evident that there exist an inverse relation between the extent of physical activity and the chance of developing Met S. The present study population also reflected the same pattern of interrelationship. It is also important to note that women population had lesser tendency to do exercise and therefore

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they are more prone to the development of Met S(both Met S IDF and Met S ATP III) compared to men as indicated by the prevalence rate. There are so many studies supporting the above findings.

A cross-sectional study conducted from 2000 to 2004 in Spain on 5814 participants included in "CDC de Canarias" cohort (CDC indicates cardiovascular, diabetes and cancer) revealed direct associations between a sedentary lifestyle and metabolic syndrome, body mass index, abdominal circumferences, systolic blood pressure, and triglycerides, and inverse associations with high-density lipoprotein cholesterol(HDL-C) which demonstrated the greatest percentage difference between sedentary and active individuals. Women present significant differences in all variables whereas in men differences are not statistically significant for systolic blood pressure (SBP) (P= 0.14) and DBP (P=.09), and HDL-C (P=.13). With the ATP-III definition, in sedentary women we found 26% of MetS whereas sedentary men presented 27%. Similarly, with the IDF definition, prevalence was 33% in sedentary women and 41% in sedentary men. In contrast, the use of the two definitions of MetS did modify the capacity of sedentary lifestyle to detect presence of MetS specifically, on moving from the ATP-III definition to the IDF definition, prevalence of MS in sedentary women rises from 26% to 33% (P<.001) whereas in sedentary men prevalence of MS rises from 27% to 41% (P<.001). In multivariate analysis, only DBP, glycaemia, total cholesterol and LDL-C were not associated with sedentary lifestyle [41].In a recent study conducted in Ethiopian Adults higher levels of physical activity was inversely correlated with the development of Met S IDF [45]. A similar study suggested, physical exercise improved fitness, the reduction in total and abdominal fat and an increase in leanness were more strongly associated with favourable changes in the risk factors for cardiovascular disease and Diabetes mellitus including those that constitute MetS [46]. In similar studies, it was found that leisure time physical activity was an effective intervention or modulation to improve cardiovascular functional capacity and to prevent or delay the development of the MetS [47,48]. In another recent study, it was assessed that physical activity played an important role in reducing MetS risk [49]. C-reactive protein (CRP) is an inflammatory marker whose level increased during inflammatory states like obesity and a study it was established that there is an inverse correlation between CRP level and physical activity [50].

Physical activity reduces the level of peripheral inflammatory markers associated with endothelial dysfunction [51] and therefore physical activity is having direct relation with blood pressure and the development of Met S. It was also established that Physical activity improves endothelial function by preserving Nitric Oxide (NO) availability. NO is essential for maintaining vascular tone, inhibiting platelet aggregation and monocyte adhesion to the endothelium and also inhibit vascular smooth muscle growth [52] and is having direct relation with Blood Pressure and Met S. One study established that moderate to vigorous physical activity>26.5 METs hours/ week was sufficient to decrease the prevalence of MetS in middle aged Japanese men and women [53].

Association between Dietary habit and Metabolic syndrome

In the study population 85.3% were using teff as their usual staple food, 1.1% used wheat and 13.6% were accustomed with mixed diet. More than half of the study population were non-vegetarians (P=0.000***). **Type of Staple food and Met S IDF**: Teff category had shown more prevalence of Met S – IDF as compared with wheat category (0%) and mixed category (12.8%) but was not very significant (P=0.064). **Type of Staple food and Met S ATPIII:** There found no significant variation in prevalence of Met S – ATP-III between different categories (P=0.397) such as teff, wheat and mixed diet. In a previous study, there found no association between rice intake and metabolic syndrome estimated by using IDF criteria [54].

Non vegetarian diet Met S IDF: No significant difference in the Met S prevalence was observed between vegetarians and non-vegetarians (P=0.214). But, on comparing the frequency of consumption with Met S IDF prevalence it was observed that the occasional non veg. consumers showed a significantly (P=0.001**) less percentage of Met S –IDF when compared to people who consumes 1-2 days /week (12%), people who consume 3-4 days/ week (22.4%) and above 4 days /week (56.2%).These clearly indicate that non.veg diet frequency had an influence on the development of Met S IDF in the study population when it is consumed in high quantities. **Non Vegetarian food and Met S ATPIII:** As in the case of Met S IDF, no significant difference in the Met SATP III prevalence was observed between vegetarians and non-vegetarians (P= 0.245).But on closely analyzing frequency of consumption with Met S ATP-III prevalence it was observed that the occasional non veg. consumers showed a less percentage of Met S –ATP-III(0%) when compared to people who consumes 1-2 days /week (7.5%), people who consume 3-4 days/ week (18%) and above 4 days /week (43.7%).These clearly indicate that non.veg diet frequency had an influence on the development of Met S ATP-III in the study population , if the consumption rate is high(P=0.001**).This very similar to the relationship between non-vegetarian diet and Met S-IDF discussed before.

It is an established fact that non-vegetarian eating habit can lead to Met S because of the high calorie compared to vegetarianism. It is obvious that over consumption of animal

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products (non vegetarian food) can cause obesity due to its high caloric value and the presence of high proportion of fat. It may also contain cholesterol that can cause atherosclerosis when in excess leading to HT and CVDs. Obesity, HT, CVDs these entire together manifests in the form of Met S. Non vegetarians constitute 52.7% of the population having a Met S-IDF prevalence of 15.7 %. This is not significantly different from the prevalence rate of the entire study population (16.7%) or from the prevalence rate among the vegetarian category (15.9%).This is because of the fact that even though the people are potentially non vegetarians the frequency of consumption is very less because of the economic backwardness and we cannot expect much difference in the calorie intake between a vegetarian and non vegetarian. In the present study, the insignificant difference between the two categories could be because of the reasons that even though some people are literarily non vegetarians they are unable to afford the price and therefore the frequency as well as quantity of non -vegetarian food intake is less.

It was established that vegetarian diet intake does not reduce the risk of developing Metabolic syndrome, estimated by ATP III Criteria, but the concentration of HDL-C (reduced HDL-C is one of the metabolic syndrome determinant)) was significantly decreased among non vegetarians compared to vegetarian in a study conducted in Taiwan [55].This results of this study supported the view that non vegetarian diet consumption is having an association with the risk of development of Met S. Another study, reported that a vegetarian dietary pattern is associated with a more favourable profile of MRF s and lower risk of MetS assessed by NCEP ATP III criteria [56,57].

Family history of the study population with respect to HT DM/CVD

In the study population 16.7% were having the family background of HT, DM or CVDs and (P=0.000***). **Family history and Met S IDF:** In the study population 16.7 % had the background of familial hypertension (HT)/Diabetes mellitus (DM) / Cardiovascular disorders (CVDs) and among them the prevalence of Met S-IDF was found to be 16.8% Most of the study population (83.3%) who had no family history of HT, DM and CVDs had shown a Met S – IDF prevalence rate of 16.7%.These prevalence rates established that there exist no significant relation between the development of Met S IDF with the family history of HT/DM/ CVDs in the studied population(P=0.484**). **Family history and Met S ATP-III:** In the study population 16.7 % had the background of familial hypertension (HT)/Diabetes mellitus (DM) / Cardiovascular disorders (CVDs) and among them the prevalence of Met S – ATP-III was found to be 10.9% (Table.15). Most of the study population (83.3%) who had no family history of HT/ DM / CVDs had shown a Met S – ATP-III prevalence rate of 10.4%. This clearly indicates that as in the case of Met S IDF here also no significant relation between the development of Met S – ATP-III with the family history of HT/DM/ CVDs of the individuals in the studied population (P=0.450).

The results of the present study reflect the fact that Met S – ATP-III is not only of hereditary origin, but also can be acquired type (because of many lifestyle factors) or can be a combination of both in the studied population. The pattern of manifestation of Met S IDF and Met S ATP –III are found to be similar in the population. There are certain studies on the genetic background of Met S. According to one study, genetics likely play a crucial role in the development of Metabolic syndrome, elucidating the exact genes involved has been hindered by the lack of a consistent Met S definition and life style played an important role in the Met S development [58]. In our study population it was established that the development of Met S (by either definition) is of lifestyle origin rather than hereditary.

CONCLUSIONS

All kinds of physical activities from heavy exercise to simple walking reduced the risk of being affected with both Met S as assessed by both IDF and ATP III definitions. Type staple food used had no association with the development of Met S. Generally, non-vegetarian nature was not associated with development of Met S in the study population. At the same time more quantity /frequency non vegetarian diet ie. > 4 days in week was found to aggravate the chance of development of Met S. Family history of metabolic disorders such as HT/ DM / CVD/CHD was not associated with the risk of development of either Met S in an individual.

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