Original Article

Prevalence of Metabolic Syndrome among Obese Diabetic Subjects

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Abstract

Background: Metabolic syndrome (MS) is a cluster of metabolic risk factors including obesity, glucose intolerance, insulin resistance, dyslipidemia and hypertension. MS in obese and type 2 diabetic (T2DM) subjects increases the risk of cardiovascular diseases (CVD). The objective of the present study is to estimate the prevalence of MS in obese T2DM subjects by using International Diabetes Federation (IDF) and National Cholesterol Education Program-Adult Treatment Panel III (NCEP-ATP III) definitions.

Methods: Obese T2DM (n=70) and normal healthy subjects (n=30) of both genders were selected from hospitals and diabetic centers of various localities of Karachi, Pakistan. The frequency of MS was estimated by utilizing criteria of the proposed definitions of IDF and NCEP-ATP III.

Results: The prevalence of MS using IDF definition in obeseT2DM subjects was 85.7%. It is significantly higher ($p \leq 0.05$) in females (45.70%) as compared to males (30.0%). While, using NCEP-ATP III definition the overall prevalence of MS in obese T2DM subjects was 75.7%, the prevalence is significantly higher ($p \leq 0.05$) in females (47.1%) than males (38.6%). The development of MS was highly observed between 31 – 40 years of age under criteria of both definitions.

Conclusion It is concluded that, the overall prevalence of MS is increasing significantly in obese T2DM subjects by using IDF and NCEP – ATP III definitions. However, IDF is more stringent for defining MS. Therefore, it is needed to initiate the preventive measures of a healthy lifestyle and emphasis should be given to reduce weight, increase physical activity, and increase intake of healthy low-glycemic-index foods.

Key Words

Metabolic Syndrome, Diabetes Mellitus, Insulin Resistance Obesity, Atherosclerotic Cardiovascular Disease, IDF, NCEP-ATP III

Introduction

Diabetes mellitus (DM) is a group of metabolic diseases characterized by hyperglycemia resulting from deficiency of insulin secretion (type 1 diabetes mellitus; T1DM), defects in insulin action (type 2 diabetes mellitus; T2DM), or both of them (*American Diabetes Association, 2014*).There are a number of identified risk factors to raise the prevalence of DM. Abdominal obesity, physical inactivity, unhealthy life style, hypertension, smoking, and excessive alcohol ingestion are modifiable risk factors to increase the incidence of DM whereas genetic or family history, age, gender, race, low-socioeconomic status, increased stress are considered as non-modifiable risk factors to develop DM in different populations (Chege MP, 2010)**.**

Besides DM, obesity is also a multi-factorial disease and plays a vital role for the progression of T2DM **(**Odum EP, 2014**).**The increase incidence of DM is depending upon the increased prevalence of obesity and in 21st century both of them become a major public health problem all over the world (Subhashini Y, 2011). Furthermore, MS is a constellation of multiple metabolic risk factors including obesity (especially central obesity), glucose intolerance or insulin resistance, dyslipidaemia, hypertriglyceridaemia, increased free fatty acids (FFA), decreased HDL-C, hypertension,proinflammatory and prothrombotic state. These risk factors increased five-fold and three-fold T2DM and cardiovascular diseases (Grundy SM, 2008).

Previously, different international organizations such as World Health Organization (WHO), The European Group for the Study of Insulin Resistance (EGIR), The National Cholesterol Education Programme-Adult Treatment Panel III (NCEP-ATP III), The American Association of Clinical Endocrinology (AACE), The International Diabetes Federation (IDF) and The American Heart Association (AHA) / National Heart, Lung, and Blood Institute (NHLBI) defined a sets of criterion for the diagnosis of MS, many of which have been continually updated. All these organizations proposed that abdominal obesity and insulin resistance are main contributing factors for the onset of MS. These organizations provide the opportunity to assess the prevalence of MS and determine the metabolic risk factors which are contributing factors of T2DM and cardiovascular diseases (Kengne AP, 2012).

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Obesity especially abdominal obesity is associated with insulin resistance on peripheral glucose and fatty acid utilization, leading to T2DM. Insulin resistance, hyperinsulinemia, hyperglycaemia, and adipocyte cytokines (adipokines) may leads to vascular endothelial dysfunction, an abnormal lipid profile, hypertension, and vascular inflammation, all of them endorse the progression of MS and atherosclerotic cardiovascular disease (ASCVD) (Vidigal FC, 2013).The most prevalent manifestation to cause abdominal obesity and insulin resistance are rapid economic growth, acceleration of urbanization, and lifestyle modifications which increases the prevalence of T2DM (Cheng Y, 2014).

Globally, the prevalence of MS ranges from 10% - 50% in the world (Cameron AJ, 2004) and in Pakistan ranges from 18% - 46% (Fawwad A, 2015). One of the reasons for MS is considered is the increasing prevalence of obesity and T2DM. World health organization (WHO) reported that the prevalence of obesity is increasing globally, more than one billion adults were categorized as overweight among them 300 million were clinically obese (BMI more than 24.9 kg/m^2), it is predicted that more than 700 million adults will be obese by 2025. It is also estimated that all over the world 150 million peoples are affected by diabetes and this number is likely to reach 300 million people by the year 2025 (World Health Organization, 1999 & World Health Organization 2008). The prevalence of MS in Pakistan is increasing significantly (Basit A, 2008). Previous studies showed that the prevalence of MS in Pakistan, in impaired glucose tolerance (IGT) subjects is 34.8% by using IDF definition and 49% by using NCEP-ATP III definition (Hydrie MZI, 2009)and 46% in T2DM subjects (Sohail SMA, 206) Therefore, the aim of the present study is to investigate the prevalence of MS in obese T2DM subjects by NCEP-ATP III and IDF definitions. The clinical criterion for the definitions is mentioned in the following **Table.1**.

Table.1: Definition and clinical criteria for the diagnosis of the Metabolic Syndrome by IDF and NCEP-ATP III definitions

Clinical Measures	IDF	NCEP – ATPIII
Central Obesity	Increased waist Circumference (Asian men ≥90 cm; Asian women ≥80cm)	WC ≥102 cm in men or ≥88 cm in women
Blood Pressure	≥ 130/85 mmHg or hypertension	≥ 130/85 mmHg
Triglycerides	≥150 mg/dL or treated for this abnormality	≥150 mg/dL
HDL-C	<40mg/dL in men; <50mg/dL in women or treated for this abnormality	<40mg/dL in men; <50mg/dL in women
Glucose	≥100 mg/dL or previously diagnosed T2DM	≥110 mg/dL or previously diagnosed T2DM

Material and methods

Total 100 subjects were selected for the present study. Among them 30 were normal healthy non obese subjects as control group and 70 were clinically diagnosed obese T2DM subjects. Pregnant women and insulin users were not included in this study. The subjects were selected from hospitals or health care centers of various localities of Karachi. Clinical criteria for the selection of obese subjects was, having central obesity i.e., waist circumference ≥ 90 cm for men and ≥ 80 cm for women , the control subjects selected having waist circumference less than 90 cm. Clinical history of selected subjects were conducted by using questionnaire. It was designed to get the information about age, sex, education, and about the occurrence of MS and related disorders in the families of obese T2DM patients. Anthropometric measurements such as height, weight, waist circumference, hip circumference, and blood pressure were measured by using standardized methods.

Clinical analysis of blood samples

Whole blood sample of obese T2DM patients and control subjects were collected after a 12 hour overnight fasting by standardized venipuncture technique. Samples were collected in Sodium fluoride potassium oxalate tube and gel coated tube for glucose estimation and for lipid profile respectively. Biochemical parameters including fasting plasma glucose (FG), total cholesterol (TC), triglycerides (TG), HDL -Cholesterol, and LDL-Cholesterol were estimated by kit (Randox reagents, UK) methods.

Statistical analysis

SPSS version 20.0 was used for statistical analysis Data is presented as frequency in percentage, level of

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association between variables which were determined by Chi-square test or mean ± SD. All reported *p* - values are based on p≤0.05, which was considered as statistically significant.

Results

Overall anthropometric measurements showed a significant elevation (p≤0.05) in BMI, waist circumference, and blood pressure and blood pressure in both genders of T2DM patients (**Table 2**).

Table 2: Anthropometric characteristics of control subjects and type 2 diabetes Mellitus (T2DM) patients.

S.no.	Parameters	Control Subjects			T2DM Patients		
		Male	Female	Total	Male	Female	Total
1.	Age (years)	42.8 ± 10.0	47.3 ± 11.8	45.1 ± 11.0	45.7 ± 7.0	49.8 ± 8.5	47.8 ± 7.5
2.	BMI (Kg / m²)	20.9 ± 1.1	21.4 ± 1.4	21.1 ± 1.2	33.3* ± 9.5	35.6* ± 6.5	34.4* ± 8.0
3.	WC (cm)	86.8 ± 5.9	75.2 ± 7.8	81.0 ± 6.8	101.4* ± 15.3	105.9* ± 13.4	103.6* ± 14.3
4.	SBP (mmHg)	118.3 ± 10.2	110.0 ± 12.5	114.1 ± 12.0	164.5* ± 24.1	162.2* ± 18.6	163.3* ± 21.3
5.	DBP (mmHg)	73.1 ± 4.3	71.6 ± 6.4	72.3 ± 5.4	102.3* ± 20.7	112.6* ± 21.5	107.4* ± 21.1

Data is presented as mean ± standard deviation with *p ≤ 0.05 was considered statistically significant in diabetic versus control groups. **BMI**: Body mass index; **WC**: Waist Circumference **SBP**: Systolic blood pressure; **DBP**: Diastolic blood pressure; **Control** (n)=30; **Diabetics** (n)=70

FBG, TC, TG was significantly increased (p≤0.05) in T2DM and HDL-C was significantly decreased (**Table 3**).

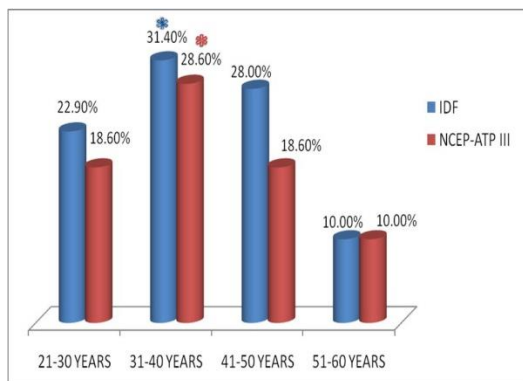Table 3: Evaluation of clinical and biochemical parameters (mg/ dL) in control and type 2 diabetic (T2DM) patients

S. no.	Parameters (mg/ dL)	Control			T2DM Patients		
		Male	Female	Total	Male	Female	Total
1.	FBG	96.0 ± 9.2	100.3 ± 11.9	98.2 ± 10.7	180.7*± 15.9	193.2*± 11.9	186.9*± 13.9
2.	TC	171.8 ± 32.1	167.2 ± 47.3	169.5 ± 39.8	178.9* ± 55.7	185.6*± 44.0	180.7*± 49.8
3.	TG	126.8 ± 57.8	126.9 ± 47.4	123.9 ± 52.0	187.4*± 24.2	175.2* ± 28.4	181.3*± 26.3
4.	HDL – C	45.9 ± 4.0	48.6 ± 2.8	47.2 ± 3.6	32.7* ± 6.1	35.7* ± 5.1	34.2* ± 5.6
5.	LDL – C	114.2 ± 21.8	109.6 ± 31.5	111.9 ± 26.7	125.2 ± 30.8	130.6 ± 35.5	127.9 ± 33.1

Data is presented as mean ± standard deviation of each parameter with *p ≤0.05 was considered statistically significant in diabetic group versus control groups. **FBG**: Fasting blood glucose; **TC**: Total cholesterol; **TG**: Triglycerides; **HDL-C**: High density lipoprotein-cholesterol; **LDL-C**: Low density lipoprotein-cholesterol.

The results of the present study indicate that the overall frequency of MS calculated by using IDF definition in obese T2DM subjects is 85.7% (60 /70), which is significantly higher (p ≤ 0.05) in females 45.70% (27/70) as compared to males 30.0% (21/70). Overall prevalence of MS is significantly high (p≤0.05) in 31–40 years of age group 31.4% (22/70) **(Figure. 1 & 3).**
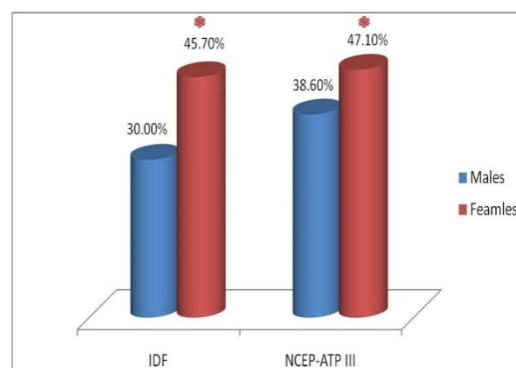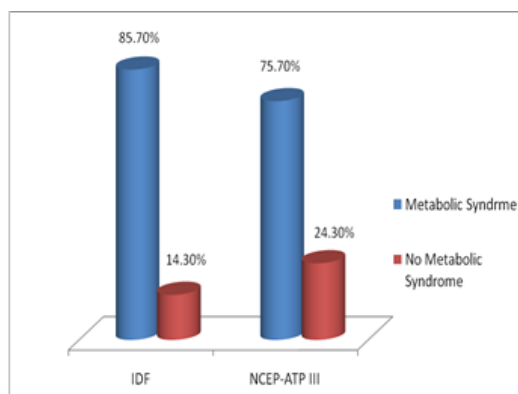

Figure 1: Prevalence of Metabolic Syndrome in obese type-2 diabetic subjects according to IDF and NCEP-ATP III definitions in urban population of Karachi. Values are expressed as frequency in percentage.

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Figure 2: Prevalence of Metabolic Syndrome in obese type-2 diabetic subjects according to IDF and NCEP-ATP III definitions with respect to gender. *$p \leq 0.05$ is considered significant.

Whereas, the overall prevalence of MS by using NCEP – ATP III definition in obese T2DM subjects is 75.7% (53 /70), which is significantly higher (p ≤ 0.05) in females 47.1% (33/70) as compared to males 38.60% (27/70). Overall prevalence of MS is significantly high (p ≤0.05) in 31–40 years of age group (28.6% (20/70) **(Figure 2 & 3).**

Figure 3: Prevalence of Metabolic Syndrome in obese type-2 diabetic subjects according to IDF and NCEP-ATP III definitions with respect to age groups. *$p \leq 0.05$is considered significant.

Discussion

MS is the biggest problem of the 21st century and it is also a most important risk factor of T2DM and obesity. It is estimated that approximately 10% - 50% of the World's adult population have MS (Khanam MA, 2011). The prevalence of MS in our obese T2DM subjects by using IDF definition is 85% and by using NCEP-ATP III definition is 75%, which is significantly increased in our obese T2DM subjects as compared to Asian countries like China, Taiwan,

Hong Kong, and Thailand, the cumulative prevalence of MS were ranging between in these countries are10 – 15% by NCEP – ATP III definition, prevalence of MS in Korea was 20% and in Indian population was 30% **(**Pan WH, 2008**).** Similarly, the prevalence of MS in our obese T2DM is increased as compared to developing countries such as South Africa was 33.5%, Morocco was 16.3%, in Oman 33.4%, in Turkey 33.7%, in Iran was 33.7%, Venezuela was 31.2%, and 25.4% in urban Brazil, Sri Lanka (males 35% and in females) (Yu S, 2014)

The prevalence of MS in our obese T2DM subjects is increased between 31 – 40 years of age group as compared to other age groups ranging between 21 – 60 years. The reason behind is that prevalence of MS increased with increase of age after third and fifth decade of life. It is mainly due to metabolic changes occurs in body size and fat distribution. Women having ≥50 years age had higher frequencies of large waist circumference than men or younger women because of menopause(Escobedo J, 2009).

The difference in the prevalence of MS by using two definitions is primarily due to the cut-offs points for waist circumference (In Asians population; IDF definition cut-offs point for waist circumference are lower ≥90cm in males and ≥80cm in females) and central obesity considered as an obligatory component. Whereas, the NCEP-ATP III definition cut-offs point for waist circumference in Asian population is higher ≥102cm in males and ≥88cm in females and it gives equal weightage to all five components of MS (Tan CE, 2004). Therefore, the prevalence of obese T2DM subjects is significantly increased by using IDF definition as compared to NCEP – ATPP III because T2DM subjects were obese.

Another study was conducted in Bulgaria to estimate the prevalence of MS in CVD and T2DM subjects. According to their findings the prevalence of MS in male was 85% and female was 93% of CVD subjects and prevalence of MS in type 2 diabetic subjects in female is 79% and in male 70% than control subjects (Temelkova, 2010). Their prevalence rate was high as compared to our male and female obese T2DM subjects. Furthermore, the prevalence of MS in T2DM subjects in Romanian population by using IDF definition is 28.4% in more than 60 years of age; 29.5% females have slightly higher prevalence than males 27.1%. Their prevalence was highly decreased as compared to our IDF definition results (85%). In Iran, the overall prevalence of MS in T2DM subjects is 51.5%, females 53.2% showed significantly higher

prevalence than males 48.7%. Their result is low as compared to prevalence of MS is increased in our population.

Prevalence of MS is increased not only in our country but it is constantly increased in developed and developing countries. Obesity in association with insulin resistance is associated with increased incidence of MS which is consequently related with increased occurrence of T2DM and CVDs. The causes of these metabolic risk factors are thought to consumption of high caloric diet and sedentary life style. Therefore, it is required to initiate the preventive measures by arranging public health awareness programs to highlight the significance of a healthy lifestyle and emphasis should be given to reduce weight, increase physical activity, and increase the intake of low-glycemic-index foods. These measures ultimately reduce the MS and consequently decrease the prevalence rate of T2DM.

Conclusion

Current Study showed that, MS is highly prevalent in adult obese T2DM population of Karachi. In this study, the IDF definition of MS is most significant definition as compared to NCEP-ATP III definition for screening and estimating MS in adult obese diabetic population because in IDF, obesity is the mandatory criteria for MS. This study also showed that, the frequency of MS was much higher in obese diabetic women as compared to obese diabetic men under both definitions. Therefore, women are at more risk than men undertaking both IDF and NCEP III definitions. Present study also showed that the development of MS was raised in any age of life especially between 31-40 years of age group as compared to 21-30, 41-50, and 51-60 years of age groups. Therefore, it is concluded that abdominal obesity and insulin resistance reflects the major contributing factors for the onset of MS.Hence, awareness is required to educate about the medical consequence of obesity as well as the measures should be taken to prevent MS by weight control, consumption of low –glycemic index healthy food, increase physical exercises and activities. It may reduce the MS and consequently decrease the prevalence rate of obesity and T2DM.

Competing Interests

We declare that we have no conflict of interest.

Authors' Contributions

First author is Ms. Mehwish Zeeshan. Ms Mehwish Zeeshan, Mr. Muhammad Imran and Ms. HumairaJabeen were involved in experimental work. Ms. Mehwish Zeeshan, Ms. Sumreen Begum and Ms. Nazia Ahmed were involved in statistical analysis and writing manuscript of this paper. RashidaQasim support and supervised the work. All authors have read and approved the final version of the manuscript.

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