Original Article

Metabolic syndrome: An independent risk factor for erectile dysfunction

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ABSTRACT

Objective: The objective was to determine the role of various components of metabolic syndrome (MetS) as independent risk factor for erectile dysfunction (ED). **Materials and Methods:** A total of 113 subjects of MetS, as recommended by recent IDF and AHA/NHLBI joint interim statement were selected for study who presented for ED. After doing Anthropometric examination, fasting laboratory assay for fasting plasma glucose (FPG), fasting insulin, hemoglobin A1c, triglyceride (TG), high-density lipoprotein (HDL), low-density lipoprotein (LDL), and 2 h oral glucose tolerance test (OGTT) was done. Erectile function was assessed by completing questions one through five of the International Index of Erectile Function (IIEF-5). A multiple linear regression analysis was carried out on 66 subjects with IIEF-5 score as dependent variable and components of MetS FPG, 2 h OGTT, TG, HDL, and waist circumference as independent variables. **Results:** Using a multiple linear regression analysis, we observed that presence of the various components of MetS was associated with ED and a decrease IIEF-5 score and this effect was greater than the effect associated with any of the individual components. Of the individual components of the MetS, HDL ($B = 0.136$; $P = 0.004$) and FPG ($B = -0.069$; $P = 0.007$) conferred the strongest effect on IIEF-5 score. However, overall age had most significant effect on IIEF-5 score. **Conclusion:** It is crucial to formulate strategies and implement them to prevent or control the epidemic of the MetS and its consequences. The early identification and treatment of risk factors might be helpful to prevent ED and secondary cardiovascular disease, including diet and lifestyle interventions.

Key words: Erectile dysfunction, international index of erectile function 5 score, metabolic syndrome

Introduction

The worldwide epidemic of metabolic syndrome (MetS) has led to a striking increase in the number of people afflicted with the diabetes mellitus, and atherosclerotic cardiovascular disease. The MetS or syndrome X is a cluster of interrelated risk factors, which includes central obesity, glucose intolerance, dyslipidemia, and elevated blood pressure. These metabolic abnormalities constitute major risk factors for diabetes mellitus, atherosclerotic cardiovascular disease. At present, five separate definitions for MetS exist the World Health Organization working definition (1999),[1] the European Group for the Study of Insulin Resistance definition (1999),[2] the American Association Of Clinical Endocrinologists position statement (2003),[3] the Adult Treatment Panel III guideline (2005),[4] and the definition from the International Diabetes Federation (IDF) Consensus Group (2005).[5] Although there is considerable debate over the terminology and diagnostic criteria of MetS.[6] Recently, IDF and American Heart Association/National Heart, Lung, and Blood Institute (AHA/NHLBI) representatives held discussions to attempt to resolve the remaining differences between definitions of MetS.[7] Both sides agreed that abdominal obesity should not be a prerequisite for diagnosis but that it is 1 of 5 criteria, so that the presence of any 3 of 5 risk factors constitutes a diagnosis of MetS.[7]

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For years, the terms impotence and erectile dysfunction (ED) were used interchangeably to indicate the man's inability to achieve or maintain erection sufficient for satisfactory sexual intercourse.[8] The National Institutes of Health Consensus Development Conference advocated that ED be used in place of the term impotence.[9] ED or impotence was now defined as "the inability of the male to achieve an erect penis as part of the overall multifaceted process of male sexual function." Although ED is not a life-threatening but it is associated with emotional distress can significantly affect important psychosocial factors, including self-esteem and confidence, and damage personal relationships.[10,11] The association of MetS with cardiovascular disease is well-known, now emerging data have shown a clear relationship of MetS with male sexual dysfunction. The MetS may lead to ED through multiple mechanisms. Atherosclerotic disease, which may be caused by the MetS may lead to ED by affecting the vascular tissues of the penis. Atherosclerosis can also lead to structural damage within the penile tissues.[12] The MetS leads to endothelial dysfunction also, which leads to a decrease in vascular nitric oxide (NO) levels, with resulting impaired vasodilation. Hypogonadism that may be caused by the MetS can cause ED through altered testosterone (T): Estrogen levels that lead to hypogonadotropic hypogonadism and by decreasing T level, which impair the NO synthesis. Hyperglycemia, induces a series of cellular events that increase the production of reactive oxygen species like superoxide anion that inactivates NO to form peroxynitrite and also increases oxygen-derived free radicals through activation of protein kinase C and other cellular elements.[13,14] The increase in free radical concentration also leads to atherosclerotic damage to the vascular walls.[15] Hyperglycemia may also cause glycation of penile cavernosal tissue, that lead to impairment of collagen turnover and later on ED.[16] Hyperglycemia that associated with a proinflammatory states, which can also lead to endothelial dysfunction by upregulation of E-selectin and altered tumor necrosis factor-α and interleukin-10 ratio.[17]

The association of MetS and hypertension,[18] coronary artery disease (CAD),[19] chronic obstructive pulmonary disease,[20] polycystic ovarian disease,[21] thyroid disease,[22] and psychiatric disorder[23] is well-described in the literature. Because of the relative paucity of randomized trials on the impact of the MetS on sexual dysfunction, most of the data were collected from cross-sectional or longitudinal studies, where association was observed but not a causation. Gunduz *et al*. first described the association in between MetS and ED and later it was reinforced by Heidler *et al*.[24,25] In addition, association of MetS and ED was reported in several other studies.[26,27] Furthermore, investigators still have not completely clarified the effects of the components of the MetS on ED. Furthermore, studies that have focused on the association between MetS and ED in the Indian population are sparse. Therefore, the present study aimed to intensively evaluate the relationship of MetS and ED in Indian men.

Materials and Methods

A total of 113 subjects was recruited among those attending outpatient department of Endocrinology and Metabolic Clinic of Lala Lajpat Rai Medical (LLRM) College, Meerut, western Uttar Pradesh between August 2013 and March 2014. Men presented with ED who had three or more criteria to meet the diagnosis of MetS, as recommended by recent IDF and AHA/NHLBI joint interim statement were selected for study.[7] The study was approved by the institutional committee of ethical practice of our institution, and all of the study participants provided written informed consent. Data on the demographic characteristics (e.g. age, education, and occupation), lifestyle characteristics (e.g. smoking, alcohol consumption, and physical activity), health status, and medical history were collected using a standardized Performa. The anthropometric measurements were performed by trained personnel using a standardized protocol. Body weight was taken by electronic weighing machine and height was measured by stadiometer with the subject barefoot fully erect, with the head in the Frankfurt plane; the back of the head, thoracic spine, buttocks, and both heels together with touching the vertical axis of the stadiometer. The body mass index (BMI) was then calculated formula given by Adolphe Quetelet as weight (in kilograms)/height^2 (in meters). The waist circumference (WC) was measured midway between the lowest rib and the iliac crest to the nearest 0.1 cm. The blood pressure was measured by trained staff nurses using a mercury sphygmomanometer placed on the right arm of the participants, with the participants in a comfortable sitting position after 5 min of rest.

Any men with chronic renal disease, chronic liver disease, cardiovascular disease, peripheral or autonomic neuropathy, mental illness, history of pelvic trauma and surgery, prostatic disease, use of drugs or alcohol abuse, and smoking (both present and past smoking) were excluded from the study. To avoid the effect of drugs on ED, patients with established diabetes mellitus and hypertension were also excluded from the study. Endocrine causes of ED were also excluded. Finally, a total of 66 men with complete data was included in the study.

Venous blood sample was collected from each participant in between 8 am and 9 am after an

overnight fast for laboratory assay. Plasma glucose was measured by a glucose oxidase method. Plasma total cholesterol, high-density lipoprotein (HDL) cholesterol, low-density lipoprotein (LDL) cholesterol, and triglycerides (TGs) were assessed with standard enzymatic spectrophotometric techniques in hospital's biochemistry laboratory. Haemoglobin A1c (HbA1c) was measured by high-performance liquid chromatography. Total serum testosterone, prolactin, and fasting insulin were measured with chemiluminescence method by abbott architect i1000SR in endocrinology laboratory. An homeostatic model assessment insulin resistance score (HOMA-IR) was computed with the formula given by matthews *et al*.: Fasting plasma glucose (FPG) (mmol/l) times fasting serum insulin (mU/l) divided by 22.5.[28]

Assessment of erectile dysfunction

Erectile function was assessed by completing questions one through five of the International Index of Erectile Function (IIEF-5), which is a multidimensional questionnaire consists of 5 questions for assessing ED.[29] IIEF-5 questionnaire was translated in Hindi for the better understanding. The erectile function score represents the sum of questions one through five of the IIEF-5 questionnaire, with a maximum score of 25; a score <21 indicates ED. The five questions assess erectile confidence, erection firmness, maintenance ability, maintenance frequency, and satisfaction. The severity of ED is classified into five categories as severe (score 5–7), moderate (score 8–11), mild to moderate (score 12–16), mild (score 17–21), and no (score 22–25) ED. Accordingly, out of 66 men 4, 22, 16 and 24 had mild, mild to moderate, moderate and severe ED, respectively.

Statistical analysis

For numerical variables, descriptive statistics was performed, and the results were expressed as mean ± standard deviation. Pearson correlation was used for normally distributed variables. A multiple linear regression analysis was carried out with IIEF-5 score as dependent variable and components of MetS FPG, 2 h oral glucose tolerance test (OGTT), TG, HDL, and WC as independent variables. In a multiple linear regression analysis assessing effect on IIEF-5 score age, BMI and WHR were also included as independent variables. In the multiple linear regression analysis, components of MetS FPG, 2 h OGTT, TG, HDL, and WC were used as continuous variables. The Statistical analysis was performed using the Statistical Package for the Social Sciences Version 20 ([SPSS] IBM Corporation, Armonk, NY, USA). A $P < 0.05$ was considered statistically significant.

Result

As Table 1 shows baseline characteristic of total 66 participants, all the parameters Age, Wt, BMI, Waist, Hip, WHR, FPG, fasting insulin, HOMA-IR, 2 h OGTT, HbA1c, TG, LDL, and HDL were highly variable in all participants. Mean age and BMI of study population were 43.24 ± 6.2 and 27.95 ± 3.27, respectively. Mean WC, FPG, 2 h OGTT, TG, and HDL were 104.05 ± 7.89, 95.80 ± 15.80, 149.65 ± 24.52, 176.15 ± 50.98, and 45.33 ± 8.29, respectively. Mean IIEF-5 score was 10.17 ± 3.76.

Correlation between erectile dysfunction and metabolic syndrome components

By using Pearson correlation analysis, as shown in Table 2, IIEF-5 score is statistically significantly correlated with age and correlation is negative. IIEF-5 score is statistically significantly correlated with components of MetS also; BMI ($r = -0.261$, $P = 0.017$); waist ($r = -0.216$, $P = 0.082$);

Table 1: Baseline characteristics

	Range	Minimum	Maximum	Mean	SD
Age (years)	24	32	56	43.24	6.232
Weight (kg)	57	62	120	81.70	12.885
Height (m)	0.28	1.58	1.86	1.7070	0.06997
BMI (kg/m^2)	12.65	23.18	35.83	27.95	3.27
Waist (cm)	36.0	92.0	128.0	104.053	7.894
Hip (cm)	55.173	76.826	132.0	98.870	11.973
WHR	0.358	0.87	1.23	1.06	0.11
FPG (mg/dl)	56.4	68.6	125.0	95.806	15.80
Fasting insulin (pmol/L)	159.99	26.30	186.30	101.04	49.85
HOMA-IR	7.3	0.9	8.2	3.791	2.21
2 h OGTT (mg/dl)	101.8	96.8	198.6	149.656	24.52
HbA1c (%)	2.1	4.3	6.4	5.602	0.61
TG (mg/dl)	286	58	344	176.15	50.98
HDL (mg/dl)	33	32	65	45.33	8.297
LDL (mg/dl)	176.0	66.0	242.0	158.553	42.14
IIEF-5 score	14	5	19	10.17	3.76

SD: Standard deviation, BMI: Body mass index, FPG: Fasting plasma glucose, WHR: Waist to hip ratio, HOMA-IR: Homeostasis model assessment-estimated insulin resistance, OGTT: Oral glucose tolerance test, HbA1c: Glycated hemoglobin, TG: Triglycerides, HDL: High-density lipoprotein, LDL: Low-density lipoprotein, IIEF: International index of erectile function

Table 2: Correlation between IIEF-5 score and MetS components

	Pearson correlation	Significant (1-tailed)
Age	r=−0.525	P=0.000
BMI	r=−0.261	P=0.017
Waist	r=−0.216	P=0.082
HDL	r=0.434	P=0.000
FPG	r=−0.507	P=0.000
2 h OGTT	r=−0.542	P=0.000
TG	r=−0.426	P=0.000

BMI: Body mass index, FPG: Fasting plasma glucose, IIEF: International index of erectile function, MetS: Metabolic syndrome, HDL: High-density lipoprotein, OGTT: Oral glucose tolerance test, TG: Triglycerides

HDL ($r = 0.434$, $P = 0.000$); FPG ($r = -0.507$, $P = 0.000$); 2h OGTT ($r = -0.542$, $P = 0.000$); TG ($r = -0.426$, $P = 0.000$).

Multiple linear regression analysis of various components of metabolic syndrome for erectile dysfunction

Using a multiple linear regression analysis as shown in Table 3, we also analyzed the effect on IIEF-5 score in relation to the presence of the MetS and the different components of the syndrome separately. The presence of the various components of MetS was associated with ED and a decrease IIEF-5 score, and this effect was greater than the effect associated with any of the individual components. Of the individual components of the MetS, HDL conferred the strongest effect on IIEF-5 score. However, the overall age had most significant effect on IIEF-5 score.

Discussion

In the recent years, MetS has received considerable interest because of its association with increasingly common pathophysiologic states such as heart failure, type 2 diabetes mellitus, and ED.[30-32] Multiple studies have shown a direct correlation in between various components of the MetS and ED.[33-36] In our study, we also observed independent association with components of MetS and ED. By using data from the Massachusetts Male Aging Study, Kupelian *et al*. have also demonstrated that the presence of MetS is associated with increased ED risk (relative risk = 2.09) even in those with a BMI of <25.[37] The cross-sectional analysis of adult participants in the 2001–2004 National Health and Nutrition Examination Survey revealed that poor glycemic control, impaired insulin sensitivity, and the MetS were associated with increased risk of ED.[38]

Russo *et al*. have also found the insulin resistance as an independent predictor of ED.[39] Thompson *et al*. confirmed in his study that ED is a sentinel marker and risk factor for future cardiovascular clinical events.[40] Montorsi *et al*. in the COBRA study observed that in the majority of patients who developed CAD symptoms experienced ED before CAD by an average of 2–3 years.[41] As the prevalence of the MetS is increasing at an alarming rate throughout the world. So by identifying high-risk asymptomatic individuals with the MetS could lead to improvements in the prevention and treatment of ED and hence risk of CAD. Taskinen has reported MetS, the most important public health threat of the 21st century.[42] Although multiple studies on western ethnicities investigating the associations between MetS and ED have been published, data from Indian population are still limited, and some doubts have not been completely explained. More importantly, identifying the relationships of MetS and ED will be useful to devise effective, population-based, preventive strategies.

Demir *et al*. observed in his study that IIEF-5 scores significantly decreased as the number of metabolic risk factors increased ($P < 0.001$).[26] In our study, we also found that the mean IIEF-5 scores decreased with an increasing number of MetS components. This finding proved that the severity of ED was associated with an increasing number of metabolic risk factors.

Even though the MetS appears to be an important risk factor for ED but still it is uncertain that which component of the MetS is more frequently associated with ED. In our study, we have demonstrated the relationship in between ED and various components of the MetS separately. We found an association between ED and the metabolic risk factors of abnormal fasting blood glucose (FBG) (B - 0.68, 95% confidence interval [CI] - 0.118–0.018), abnormal HDL (B - 0.135, 95% CI - 0.044–0.126), abnormal WC (B - 0.034, 95% CI - 0.199–0.131), and abnormal TG (B - 0.002, 95% CI - 0.019–0.015). Demir *et al*. and Lee *et al*. also reported a significant association between ED and abnormal FBG.[26,43] Yang *et al*. has showed that Diabetes mellitus alone, which is a component of MetS, is associated with presence and severity of ED; therefore, the

Table 3: Multiple linear regression analysis of various components of MetS for IIEF-5 score

Model	Unstandardized coefficients		Standardized coefficients	*t*	Significant	95.0% CI for *B*	
	B	SE	Beta			Lower bound	Upper bound
Constant	25.295	4.944		5.111	0.000	15.388	35.202
Age	−0.252	0.052	−0.416	−4.843	0.000	−0.356	−0.148
BMI	0.027	0.125	0.024	0.218	0.828	−0.223	0.278
Waist	−0.020	0.051	−0.042	−0.394	0.695	−0.083	0.123
TG	−0.004	0.008	−0.051	−0.462	0.646	−0.020	0.013
HDL	0.134	0.045	0.295	2.976	0.004	0.044	0.224
FPG	−0.069	0.025	−0.291	−2.816	0.007	−0.119	−0.020
2 h OGTT	−0.039	0.014	−0.255	−2.761	0.008	−0.068	−0.011

MetS: Metabolic syndrome, HDL: High-density lipoprotein, OGTT: Oral glucose tolerance test, TG: Triglycerides, IIEF: International index of erectile function, CI: Confidence interval, SE: Standard error, BMI: Body mass index, FPG: Fasting plasma glucose

association in between abnormal FBG and ED is appear to be logical.[35] In addition, our results were not in line with those from some similar studies. Demir *et al*. reported that an abnormal WC was also a significant risk factor predicting the risk of ED. However, we did not find this relationship in our study, although that might be attributable to the higher mean WC in our study.

Our findings indicate that the MetS and ED are common health problems affecting the male quality-of-life in India.

Conclusion

Thus, it is critical to establish strategies to prevent or control the epidemic trend of the MetS and its consequences. The early identification and treatment of at-risk individuals could help target interventions to improve ED and secondary cardiovascular disease, including weight management, lifestyle interventions, and physical activity. Several studies have shown the efficacy of the intervention. Esposito *et al*. found a Mediterranean-style diet rich in whole grain, fruits, vegetables, legumes, and walnut and olive oil might be effective in reducing the prevalence of ED in men with the MetS.[44]

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