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METABOLIC SYNDROME AND PHYSICAL ACTIVITY IN URBAN INDIANS

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ABSTRACT

Asian Indians have a high predisposition to metabolic syndrome (MS) due to a marked shift in life style and physical inactivity caused by economic growth, urbanization and dietary westernization. The present study was done to assess the association of physical activity and metabolic syndrome in an urban middle aged population. A hospital based study was conducted with 1000 subjects. Anthropometrics and lipid profile were assessed. Physical activity level (PAL) was estimated by a standardized Physical Activity Questionnaire. By NCEP (ATP III) criteria, 500 subjects (40.8% males and 59.2% females) were categorised as having MS and 500 were non-metabolic syndrome (NMS) subjects. Almost all MS females (94.9%) and males (85.2%) had low HDL levels; abdominal obesity was the major characteristic in a large majority of MS females (86.4%). Majority of MS males (56.7%) and females (62.5%) had low PAL values indicative of a sedentary lifestyle as compared to NMS subjects (42.4% and 44.4% respectively). Odds ratio indicated that lack of physical activity increases the risk of metabolic syndrome by 1.37 times. The study showed that reduced HDL, high blood pressure and elevated waist circumference were the major cause of MS. Physical inactivity was associated with the occurrence of metabolic syndrome.

Key words: Metabolic syndrome, physical activity, phenotypic markers, abdominal obesity.

INTRODUCTION

The metabolic syndrome (MS) is a constellation of interrelated metabolic risk factors, including abdominal obesity, insulin resistance, hyperglycemia, dyslipidemia, and elevated blood pressure, often accompanied by a prothrombotic and proinflammatory state (Alberti et al, 2005). Asians have an unusual high tendency to develop type 2 diabetes mellitus and coronary heart disease. These diseases are escalating due to marked shift in life style in Asian countries caused by economic growth, affluence, urbanization and dietary westernization (Mishra et al, 2004; Mishra et al, 2007). Recent recommendations for the prevention and treatment of the metabolic syndrome and its components promote increased physical activity (including aerobic and resistance exercise), a healthy diet, and weight loss (Hamilton et al, 2007).

Physical inactivity is an independent risk factor for chronic diseases and overall is estimated to cause 1.9 million deaths globally (WHO, 2011). Regular physical activity reduces the risk of obesity, blood lipid abnormalities, hypertension and non insulin dependent diabetes mellitus and has been shown to reduce substantially the risk of coronary heart disease (Doro et al, 2006; Frank et al, 2004). Conversely, a measure of sedentary lifestyle or physical inactivity has been associated with a 1.5 – 2.5 fold elevation in cardiovascular disease risk. As a result of economic changes and increase mechanization, the prevalence of physical inactivity is increasing in India, particularly in urban areas, to levels compared with west (Ranjith et al, 2008; Rastogi et al, 2004). There are some data that suggest that Indians have genetically determined increased risk of coronary artery disease (Murray et al, 1997). Physical inactivity would tend to enhance that risk. In order to understand the epidemiology of these chronic diseases, and plan effective interventions, it is necessary to assess physical activity pattern effectively. The present study was, therefore, planned to determine the association between physical activity and metabolic syndrome as research to this effect is not vast in the Indian context.

MATERIAL AND METHODS

A hospital based study was conducted with 1000 subjects. The subjects comprised of middle aged men and women visiting the OPDs of 7 Delhi hospitals for medical problems related to the components of metabolic syndrome and/or for preventive health checkups. According to third report of National Cholesterol Education Program (NCEP) expert report (ATPIII) (2006), metabolic syndrome is defined as having three or more of the following abnormalities.

Waist circumference $\geq$40 inches for men, $\geq$35 inches for women, Blood Triglyceride $\geq$150mg/dl
HDL Cholesterol <40 mg/dl in men, <50mg/dl in women

Fasting blood glucose ≥100 mg/dl
Blood pressure ≥130/85 mmHg (Grundy et al, 2007).

An NCEP (ATP III) criterion was used to select freshly diagnosed cases of metabolic syndrome. The project was approved by the ethics committee of Delhi University, India and all participants signed an informed consent form. The study consisted of collection of ground data and relevant literature for a statistical selection of probabilistic sample size of individuals with MS, aged 35 to 55 years (n = 500) calculated at the 95% confidence interval with a 5% margin of error. An equal number of non metabolic syndrome (NMS) subjects matched for age and gender were selected (Mohan et al, 2005; Ramachandram et al, 2009).

Suitable questionnaires were formulated to collect demographic & baseline information, smoking and alcohol consumption, family history of the components of metabolic syndrome; information on routine daily physical activity and exercise pattern, occupational and leisure time physical activity, physical activity during the last 3-4 years including occupation, recreation and exercise patterns. Anthropometric measurements like height, weight and waist circumference were taken using standardized techniques and the subjects were examined for blood pressure (Bamji et al, 2004). Data regarding biochemical parameters viz blood glucose and lipid profile was obtained from the hospital authorities. Phenotypic markers were assessed as early detectors of metabolic syndrome (Misra et al, 2008).

Physical activity assessment was done by a suitable structured questionnaire developed by Bharathi, Sandhya and Vas (2000) for the assessment of physical activity pattern in urban middle aged Indians. The physical activity questionnaire estimates 24 hour energy expenditure as well as components of occupational and discriminatory leisure time activity. In this questionnaire, information is collected for daily, weekly and monthly physical activity (Bharathi et al, 2000; Rastogi et al, 2004).

To validate the questionnaire for assessment of physical activity, accelerometey was used as a gold standard. Accelerometry is a physical activity monitoring technique with the basic objective of measuring the free living physical activity pattern (Singh et al, 2010). This was done using a calibrated water proof activity monitoring device (Actical). It was put on the wrists of 10 subjects of same age group as per the study design for three days after uploading the required information on age, height, weight. The data was then analyzed using Actical software. Information on the daily physical activity of the subjects for the same three days was also gathered by the questionnaire used for the study. The total energy expenditure as calculated by the two methods was then compared. The data indicated that PAL values as calculated for physical activity data collected by physical activity questionnaire and Actical method had similar results (within 10% of error). This validated the questionnaire and its applicability.

The data was statistically analyzed. Mean and standard deviation (SD) were calculated for parametric data. Odds ratio was calculated. Chi-square and *t* tests were used for comparison between the MS and NMS groups. The significance level used was $\alpha = 0.01$ for a two-tailed test. All statistical analyses were carried out using the SPSS 19 version statistical program.

RESULTS

According to the NCEP ATP III criteria, 500 MS subjects (59.2% females and 40.8% males) were identified. An equal number of age and gender matched Non Metabolic Syndrome (NMS) subjects were taken.

DISTRIBUTION OF SUBJECTS FOR PREVALENCE OF MS CHARACTERISICS

Figure 1 gives the percentage prevalence of metabolic syndrome characteristics in MS subjects. Although all the characteristics were seen in a fairly large number of MS subjects, the highest prevalence was that of low HDL levels (94.9% females and 85.2% males). Abdominal obesity as reflected by a large waist circumference was another major characteristic, especially in MS females (86.4%). The subjects taken as controls (NMS), (figure 2) were those who had less than three components of MS as per NCEP (ATPIII) criteria. The results revealed that low HDL levels and abdominal obesity were present even in a large number of NMS subjects.

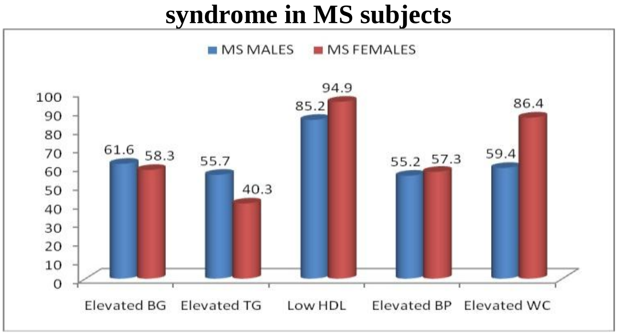
DISTRIBUTION OF SUBJECTS BY MEAN VALUES OF THE COMPONENTS OF METABOLIC SYNDROME

Table 1 gives the mean values for the various components of metabolic syndrome for MS and NMS subjects. The results showed that there was a highly significant difference (p<0.00) between the MS and NMS subjects regarding all the characteristics of metabolic syndrome viz blood glucose, triglycerides, BP, HDL and waist circumference.

DISTRIBUTION OF SUBJECTS BY PHYENOTYPIC MARKERS OF MS

Simple yet reliable phenotypic markers like buffalo hump, double chin, skin tag and xanthalsma are needed for early detection of MS (Misra et al, 2008). Assessment of phenotypic markers showed that more than 50% of MS subjects had buffalo hump and double chin (Figure 3).

Figure 1: Percentage prevalence of metabolic syndrome in MS subjects



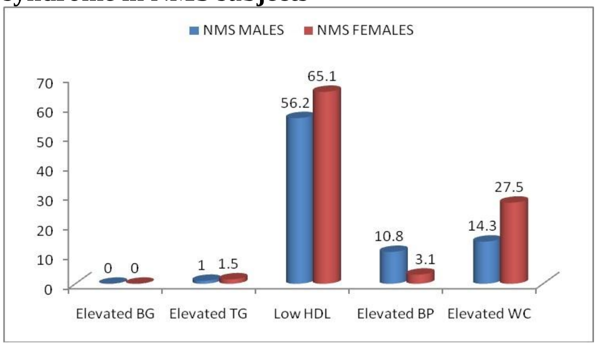
LEGEND: BG: Blood Glucose; TG: Triglycerides; HDL: High Density Lipoprotein; BP: Blood Pressure; WC: Waist Circumference.

Table 1: Mean values of the components of metabolic syndrome in MS and NMS subjects

Parameters	Metabolic syndrome		Non metabolic syndrome		
	Mean+SD		Mean+SD		T-value
WC	Males	Females	Males	Females	0.00
(inches)	46.72 +15.9	40.67+11.02	35.82+4.5	30.86+4.01	0.00
HDL(mg/dl)	33.47+8.2	31.23+9.7	40.42+11.00	38.5+13.53	0.00
BG (mg/dl)	118.40+41.08		85.63+14.19		0.00
TG (mg/dl)	147.51+41.0		110.36+15.19		0.00
SBP (mmHg)	134.16+16.2		120.49+8.08		0.00
DBP (mmHg)	87.44+9.65		79.68+5.3		0.00

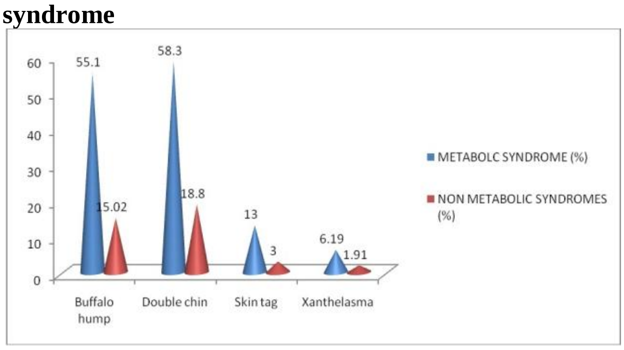
LEGEND: WC: Waist Circumference; HDL: High Density Lipoprotein; BG: Blood Glucose; TG: Triglycerides; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure.

Figure 2: Percentage prevalence of metabolic syndrome in NMS subjects



LEGEND: BG: Blood Glucose; TG: Triglycerides; HDL: High Density Lipoprotein; BP: Blood Pressure; WC: Waist Circumference.

Figure 3: Phenotypic markers and metabolic syndrome

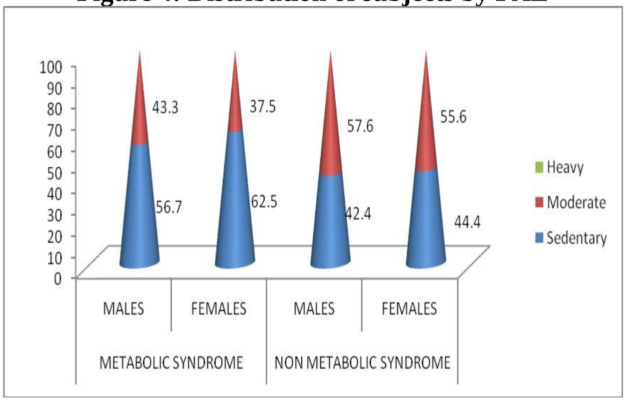


DISTRIBUTION OF SUBJECTS BY PHYSICAL ACTIVITY LEVEL

Physical Activity Level (PAL) of the subjects was determined on the basis of Basal Metabolic rate and 24 hour energy expenditure, calculated as 24 hour energy expenditure divided by basal metabolic rate. The subjects were accordingly classified as sedentary, moderate and heavy by WHO classification for PAL (WHO, 2004).

Distribution of subjects by PAL values (Figure 4) shows that a relatively much higher number of MS subjects (56.7% males, 62.5% females) were sedentary as compared to NMS (42.4% males, 44.4% females). The differences were statistically significant ($p<0.01$). The results thus reflect that physical activity may provide protection against MS. Odds ratio indicated that lack of physical activity increases the risk of metabolic syndrome by 1.37 times.

Figure 4: Distribution of subjects by PAL



DISTRIBUTION OF SUBJECTS BY MET/wk

US department of health and human services introduced the physical activity guidelines for Americans (2008) derived from an evidence based report on the health benefits of physical activity. A key finding of the Advisory Committee Report is that the health benefits of physical activity are assessed on the basis of weekly energy expenditure (MET/wk) due to aerobic physical activity.

Table 2 depicts the physical activity level of the subjects as determined by MET/wk for those who reported doing any kind of aerobic activity. A higher percentage of MS subjects, both males and females, were found to be 'insufficiently active' (<600MET/wk) as compared to NMS subjects, more of whom were 'very active' (>1500 MET/wk). The differences were statistically significant ($p<0.01$).

DISCUSSION

The findings of the study indicate an inverse association between physical activity and metabolic syndrome and are similar to those of other studies.

A research, using NHANES data, examined the relationship between objectively measured sedentary time and metabolic syndrome in a representative sample of older adults living in the U.S.

Table 2- Physical activity level by MET/wk

Physical activity level (MET/Wk)	Males		Females	
	Metabolic syndrome	Non metabolic syndrome	Metabolic syndrome	Non metabolic syndrome
	n = 69, N (%)	n = 85, N (%)	n = 71, N (%)	n = 102, N (%)
Insufficiently active (<600)	19 (27.5)	17 (20.0)	16 (22.5)	15 (14.7)
Sufficiently active (601-1500)	41 (59.4)	33 (38.8)	35 (49.2)	48 (47.1)
Very active (>1500)	9 (13.1)	31 (36.4)	20 (28.1)	39 (38.2)

Compared with people without metabolic syndrome, people with metabolic syndrome spent more hours and a greater percentage of their wear time as sedentary (Bankoski et al, 2011). The present study also revealed that more of MS subjects were sedentary as compared to non MS subjects.

Physical activity has a protective effect on metabolic syndrome through improvement in plasma lipid concentration, particularly through increase in HDL and decrease in triglyceride concentrations (Byberg et al, 2001; Leon et al, 2001; Wilmore et al, 2001). Some studies state that physical activity results in low blood pressure and improves glucose intolerance (Delavar et al, 2008). The findings of our study showed a high prevalence of low HDL, elevated triglyceride levels, high blood pressure and high blood glucose levels in MS subjects. This may be attributed to lack of adequate physical activity as reflected by PAL values.

A study on Balinese subjects showed that abdominal obesity and hypertriglyceridaemia appear to be the key determinants of metabolic syndrome in both urban and rural Balinese (Safarina et al, 2011). Our findings also reflect elevated waist circumference as one of the contributory factors for metabolic syndrome.

Buffalo hump and double chin as novel phenotypic markers for detection of MS were reported for the first time by a cross sectional study done on both MS and non MS subjects (Misra et al, 2008). Our study also reflects similar results as buffalo hump and double chin being present in a large number of MS subjects.

The strength of our study was a standardized and validated questionnaire; freshly diagnosed cases of MS; a fairly large sample size and assessment of physical phenotypic markers.

Current findings suggest creating awareness among people to include at least 30 minutes of physical activity everyday as recommended by WHO. These minimal changes may result in increases in daily energy expenditure or could provide direct effects on metabolic regulation (Hamilton et al, 2007; Levine, 2004).

CONCLUSION

Low HDL levels and high blood pressure are the main components of metabolic syndrome in most people. Abdominal obesity is another major component, especially making females prone to metabolic syndrome. A strong family history for some of the related disorders also contributes to the problem. Physical inactivity as indicated by a sedentary lifestyle is associated with the occurrence of metabolic syndrome.

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