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ASSOCIATION OF DIET AND PHYSICAL ACTIVITY WITH METABOLIC SYNDROME IN INDIAN ADULTS

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ABSTRACT

Asians have an unusual high tendency to develop metabolic syndrome and coronary heart disease; important determinants of both these non communicable diseases are insulin resistance and clustering of other proatherogenic factors. These diseases are escalating due to marked shift in life style in Asian countries caused by economic growth, affluence, urbanization and dietary westernization. The present study was done to assess the association of metabolic syndrome, diet and physical activity in 1500 urban adults. Anthropometric measurements were taken and blood pressure was measured. Blood lipid profile and blood glucose levels were assessed. Both quantitative as well as qualitative data related to diet and lifestyle was collected from the subjects. Dietary intake was determined by 24 hour recall method and food frequency questionnaire. Physical activity assessment was done by a suitable structured questionnaire. The results reviled that by NCEP (ATP III) criteria, 750 subjects (44.9% males and 55.1% females) with metabolic syndrome (MS) and 750 non-metabolic syndrome (NMS) subjects were identified. The major components of MS were low HDL levels in 85% and elevated waist circumference in 80% of the MS subjects. Intake of energy and fats was higher among the MS subjects. Majority of MS subjects had low activity levels as per Physical Activity Levels (PAL) and Global guidelines for physical activity. The study concluded that unhealthy choices of foods and low physical activity are associated with a higher incidence of chronic diseases, characteristic of metabolic syndrome.

KEY WORDS

Metabolic Syndrome, Physical activity and Obesity.

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INTRODUCTION

Health is a key determinant of development and a precursor of economic growth. Non-communicable diseases impose a significant economic burden on already strained health systems, and inflict great costs on society[1].

The burden of mortality, morbidity and disability attributable to non-communicable diseases is currently greatest and continuing to grow in the developing countries, where those affected are, on an average, younger than in developed countries, and where 66% of these deaths occur. Unhealthy diets and physical inactivity are among the leading causes of the major non-communicable diseases, including cardiovascular disease, type 2 diabetes and certain types of cancers. The coexistence of obesity, glucose intolerance, dyslipidemia and hypertension is termed as insulin resistance syndrome (IRS) or Metabolic syndrome. The clinical picture of IRS, however, may be dominated by one of its components[2].

Metabolic syndrome and their risk factors are initially mostly limited to economically successful groups in low and middle income countries. However, recent evidence shows that, over time, patterns of unhealthy behavior and the metabolic syndrome associated with them cluster among poor communities and contribute to social and economic inequalities. In the poorest countries, even though infectious diseases and under nutrition dominate their current disease burden, the major risk factors for chronic diseases are spreading. The prevalence of overweight and obesity is increasing in developing countries, and even in low income groups in richer countries. An integrated approach to combat the causes of unhealthy diet and decreasing levels of physical activity would contribute to reducing the future burden of metabolic syndrome. Factors that increase the risks of metabolic syndrome include elevated consumption of energy dense, nutrient poor foods that are high in fat, sugar and salt; reduced levels of physical activity at home, at school, at work and for recreation and transport. Diet and physical activity influence health, both together and separately.

There are a number of studies which state the relationship between metabolic syndrome, diet and physical activity in the Western countries but the researches are not as vast in the Indian context. The present study was, therefore, planned to determine the association between diet, physical activity and metabolic syndrome.

MATERIALS AND METHODS

A hospital based study was conducted with 1500 subjects. The subjects comprised of middle aged men and women visiting the OPDs of 7Delhi 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 (ATPIII) 2005)[3], metabolic syndrome is defined as having three or more of the following abnormalities: Elevated waist circumference $\geq$40 inches for men, $\geq$35 inches for women; Elevated triglycerides $\geq$150mg/dl; Reduced HDL Cholesterol <40 mg/dl in men, <50mg/dl in women; Elevated fasting glucose $\geq$100 mg/dl; Elevated blood pressure $\geq$130/85 mmHg. NCEP (ATP III) criteria[3] was used to select freshly diagnosed cases of metabolic syndrome. Anthropometric measurements were taken using standardized techniques and the subjects were examined for blood pressure. Data regarding biochemical parameters viz blood glucose and lipid profile was obtained from the hospital authorities.

A statistical calculation of probabilistic sample size of individuals with MS, aged 35 to 55 years (n = 750) at the 95% confidence interval with a 5% margin of error was done. An equal number of non metabolic syndrome (NMS) subjects matched for age and gender were selected.

Quantitative as well as qualitative data related to diet and lifestyle was collected from the subjects. Physical activity assessment was done by a suitable structured questionnaire developed by Bharathi, Sandhya and Vas (2000)[1] for the assessment of physical activity pattern in urban middle aged Indians. The dietary assessment was done by using 24 hour recall method and food frequency questionnaire. The data was statistically analyzed. The project was approved by the ethics committee of Delhi University, India and all participants signed an informed consent form.

RESULTS

Prevalence of MS Diagnostic Components

By NCEP (ATPIII) criteria, 750 subjects (44.9% males and 55.1% females) were identified with metabolic syndrome (MS). An equal number of age

and gender matched non metabolic syndrome subjects (NMS) were taken. Table No.1 illustrates the percentage prevalence of individual metabolic syndrome diagnostic components in the MS subjects. A large majority of MS females (89.3%) and males (85.7%) had low HDL levels - thus a major characteristic contributing to metabolic syndrome in both the genders. Abdominal Obesity (larger than desirable waist circumference) was found in a large majority of MS females (82.5%) as compared to males (51.3%). Elevated blood glucose, triglycerides and blood pressure levels were prevalent in a fairly large number of MS males as compared to females.

Physical activity

The Global Recommendations on Physical Activity for Health aim to provide guidance on the dose-response relationship between physical activity and health benefits (i.e. the frequency, duration, intensity, type and total amount of physical activity needed for health enhancement and prevention of NCDs). In order to improve cardio respiratory and muscular fitness, bone health and to reduce the risk of NCDs and depression, the global recommendations on physical activity have been given by WHO (2010)[1].

In accordance with these guidelines, the physical activity of the subjects was calculated based on type of physical activity, duration and pace of physical activity reported by them.

The findings (Table No.2) revealed that a fairly large number of MS subjects (20.8% males and 30.1% females) were doing less than 150 minutes moderate/75 minutes vigorous intensity physical activity per week. The relative number of NMS subjects in this category was lesser. On the other hand, more of NMS subjects (both males 84.7% and females 82.1%) were doing physical activity more than 150 minutes of moderate/75 minutes vigorous intensity activity per week. The differences were statistically significant as per chi-square ($p=0.01$).

Tabe No.3 indicates PAL values, according to PAL values, a fairly large number of MS males were sedentary as compared to NMS males (65.57% vs 32.35%). Similarly, more of MS female subjects were sedentary as compared to NMS females (70.9% vs 45.27%). Odds ratio further showed a 3 times greater risk of MS with decrease in physical activity in terms of PAL values. A negative significant association of PAL levels with metabolic syndrome was found.

Dietary data

Table No.4 shows that more of MS subjects reported preference for deep fried (86.7%) and shallow fried foods (89.9%) as compared to NMS subjects (75.6% and 82% respectively). The differences was statistically significant ($p<0.01$). A high frequency of consumption (5-6 times a week or more) of high sodium, high sugar and high fat foods was reported by a large number of subjects in both the groups. The consumption of vegetable oils rich in PUFA was reported by more of MS subjects (91.2%) as compared to NMS subjects (81.07%), whereas more of NMS subjects reported consumption of vegetable oil rich in MUFA as compared to MS subjects. The differences was statistically significant ($p<0.01$). Desi ghee was also reportedly consumed by a larger percentage of MS subjects (92.4%) as compared to NMS subjects (88.26%), but the difference was not statistically significant ($p=0.127$). Only 13% of MS subjects reported frequent change of oil used as compared to NMS subjects (30%) and the difference was significant ($p<0.01$) according to chi square.

Regarding type of milk, majority of both metabolic syndrome and non metabolic syndrome subjects reported consuming full cream milk and the differences were not significant ($p=0.726$). A large majority of subjects in both the groups also reported consumption of sweetened beverages. However, more of MS subjects (91.2%) reported addition of sugar in the milk as compared to NMS subjects (76.54%) and this difference was statistically significant ($p<0.01$).

The findings thus denote that metabolic syndrome subjects were consuming more of fried foods, processed foods rich in sodium and fats and sugar based beverages which could be a contributory reason for abdominal obesity, high blood glucose levels and high blood pressure levels.

Energy and Nutrient Intake of Male Subjects

Figure No.1 gives the energy and nutrient intake of male subjects as percent of RDAs. In relation to

RDAs, the energy intake was 84.2% for MS and 77% for NMS males, protein intake for MS males was 121.4% and 99.8% for NMS males. Thus, the intake of energy and protein in terms of percent of RDA was higher for MS males as compared to NMS males and the difference was statistically significant ($p<0.01$). The amount of fat consumed was analyzed in terms of energy intake. Although the percent energy intake from fat was less than 30% in both cases, it was higher in MS males than NMS males (25.7% and 24.8% respectively). The percent intake of iron, calcium, thiamine, niacin, riboflavin and vitamin C in respect of RDAs was higher in MS males than that of NMS males. Differences were statistically significant for thiamine, niacin and calcium ($p<0.01$) but not for riboflavin ($p=0.115$), iron ($p=0.942$) and vitamin C consumption ($p=0.889$). The percent adequacy of vitamin A intake was low for both the groups and the difference was not statistically significant ($p=0.992$).

Energy and Nutrient Intake of Female Subjects

The intake of energy and protein with regard to RDAs (Figure No.2) was higher for MS females (92.8% and 107.8% respectively) than NMS females (68.59% and 89.5% respectively) and the difference was statistically significant ($p<0.01$). The percent of energy intake from fat was higher in MS females then NMS females (26.8% and 21.8% respectively).

The percentage intake of calcium, thiamine, riboflavin and niacin in relation to RDAs was higher in MS females as compared to NMS females. Differences were statistically significant for thiamine, niacin ($p<0.01$) but not for riboflavin ($p=0.886$) and calcium intake ($p=0.964$). Both MS and NMS females had a fairly high percentage adequacy of iron intake. The percent adequacy of vitamin A intake was low for both the groups and the difference was not statistically significant ($p=0.064$).

The study reveals that both MS males and females were having higher intake of energy, proteins and fats which could be a contributory reason for prevalence of obesity/overweight, high blood pressure, high cholesterol and high blood glucose. Brunner et al (2001)[4]in a cross-sectional analysis of 4497 men and 1865 women aged 39-62 years showed that higher intakes of both polyunsaturated fats and carbohydrates were linked to lower waist-hip ratio, triglycerides and LDL-cholesterol.

Nutritional Factors and Metabolic Syndrome – Results of Logistic Regression Analysis

The results of logistic regression analysis are shown in Table No.5. The data reveals that energy, fats, carbohydrates and thiamine showed a strong positive, significant association with metabolic syndrome. On the other hand, protein, fiber, iron, niacin and folic acid were found to be negatively and significantly associated. No significant association was found in case of calcium, riboflavin, vitamin A and vitamin C.

According to Cacciapuoti (2008)[5], several experimental studies and some clinical experience have shown that metabolic syndrome and caloric restriction exert opposite effects on thrombosis, because these two nourishing conditions are at extreme ends of the same spectrum. Esposito et al (2007)[6] documented nutritional factors that may affect the prevalence of the metabolic syndrome which state that beyond weight control and reduction of total calories, the diet should be low in saturated fats, trans fats, cholesterol, sodium, and simple sugars[7-9].

Table No.1: Percentage prevalence of metabolic syndrome diagnostic components in MS subjects

S.No	Components of Metabolic Syndrome	MS Males (%)	MS Females (%)
1	Elevated BG	66.46	58.59
2	Elevated TG	53.70	44.55
3	Low HDL	85.7	89.3
4	Elevated BP	61.43	54.4
5	Elevated WC	51.3	82.5

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

Table No.2: Distribution of subjects as per Global guidelines for physical activity

S.No	WHO recommendations (2010)	MS Subjects		NMS Subjects	
		Males (n=103)	Females (n=93)	Males (n=150)	Females (n=145)
1	< 150 minutes moderate / 75 minutes vigorous PA per week	21 (20.8)	28 (30.1)	23 (15.3)	26 (17.9)
2	≥ 150 minutes moderate / 75 minutes vigorous PA per week	82 (79.2)	65 (69.9)	127 (84.7)	119 (82.1)

Table No.3: Distribution of subjects by PAL values

S.No	Physical activity level (PAL)	Males		Females	
		Metabolic syndrome	Non metabolic syndrome	Metabolic syndrome	Non metabolic syndrome
		n = 337	n = 337	n = 413	n = 413
1	Sedentary (1.40-1.69)	221 (65.57)	109 (32.35)	293 (70.94)	187 (45.27)
2	Moderate (1.70-1.99)	116 (34.43)	228 (67.65)	120 (29.06)	226 (54.73)
3	Heavy (2.00-2.40)	-	-	-	-

Chi-square ($p < 0.01$), Odds ratio – 3.34

Table No.4: Distribution of subjects for food preferences

Foods Liked	MS SUBJECTS	NM S SUBJECTS
	n = 750	n = 750
Boiled	17 (2.3)	63 (8.4)
Roasted	412 (54.9)	403 (53.7)
Shallow Fried**	674 **(89.9)**	615 **(82)**
Deep Fried**	650 **(86.7)**	567 **(75.6)**
Processed FOODS	**n= 750**	**n=750**
High Sodium	415 (55.3)	426 **(56.8)**
High Sugar	300 (40.0)	230 (30.6)
High Fat	357 (47.6)	338 (45.06)

**Denotes significant difference ($p<0.01$)

Type of Fats Consumed	MS Subjects	NMS Subjects
	n = 750	n = 750
Vanaspati	5 (0.66)	25 (3.33)
Desi Ghee	693 (92.4)	662 (88.26)
Vegetable oil rich in PUFA**	684 (91.2)	608 (81.06)
Vegetable oil rich in MUFA**		
Mustard oil	3 (0.4)	29 (3.86)
Canola oil	5 (0.6)	22 (2.93)
Olive oil	2 (0.3)	9 (1.2)
Total	10 (1.3)	60 (7.99)
Change of Oil		
YES**	100 (13.33)	251 (33.46)
NO	650 (86.67)	499 (66.54)
How Frequently	(n = 100)	(n = 251)
Every month	20 (20.0)	61(24.31)
Every 2 months	52 (52.0)	116 (46.21)
Every 6 months	27(27.0)	74(29.48)
After one year	1(1.0)	0 (0.0)

**Denotes significant difference (p<0.01)

Type of Milk Consumed	**MS Subjects**	**NMS Subjects**
	n = 750	n = 750
Full cream milk	518 (69.06)	501 (66.8)
Toned milk	199 (26.55)	211 (28.14)
Doubled Toned milk	28 (3.73)	30 (4.0)
Skimmed milk	5(0.66)	8 (1.06)
Consumption of Sweetened Beverages		
Yes	704(93.87)	690 (92.0)
No	46 (6.13)	60 (8.0)
Consumption of Sugar With Milk		
Added sugar**	684 (91.2)	574 (76.54)
No sugar	29 (3.87)	123 (16.4)
Artificial sweeteners	37 (4.93)	53 (7.06)

**Denotes significant difference (p<0.01)

Table No.5: Nutritional factors that contribute to metabolic syndrome – results of logistic regression analysis

S.No	Independent Variables	Metabolic Syndrome	
		Regression coefficient	p- value
1	Energy**	0.172	<0.01
2	Protein**	-0.720	<0.01
3	Fat*	1.53	<0.05
4	CHO*	0.63	<0.05
5	Fiber**	-0.124	<0.01
6	Calcium	0.000	0.602
7	Iron**	-0.139	<0.01
8	Thiamin**	1.75	<0.01
9	Riboflavin	-0.205	0.709
10	Niacin**	-0.193	<0.01
11	Vitamin A	0.003	0.05
12	Vitamin C	0.003	0.054
13	Folic acid**	-0.033	<0.01

**Denotes significant difference (p<0.01) *Denotes significant difference (p<0.05)

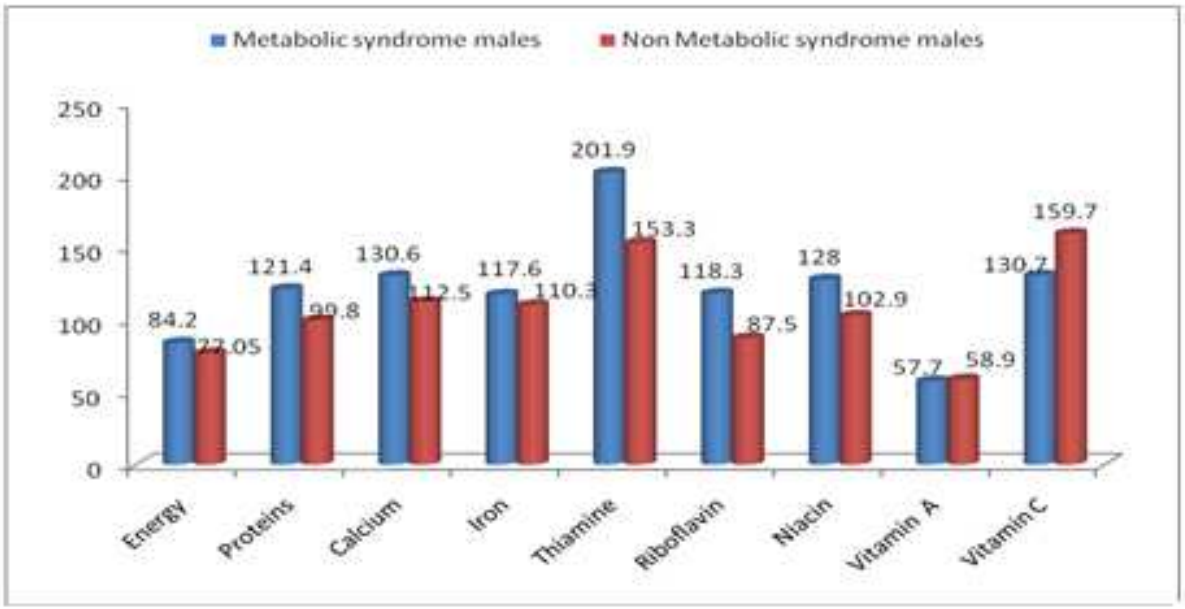

Figure No.1: Energy and nutrient intake as percent of RDAs of male subjects

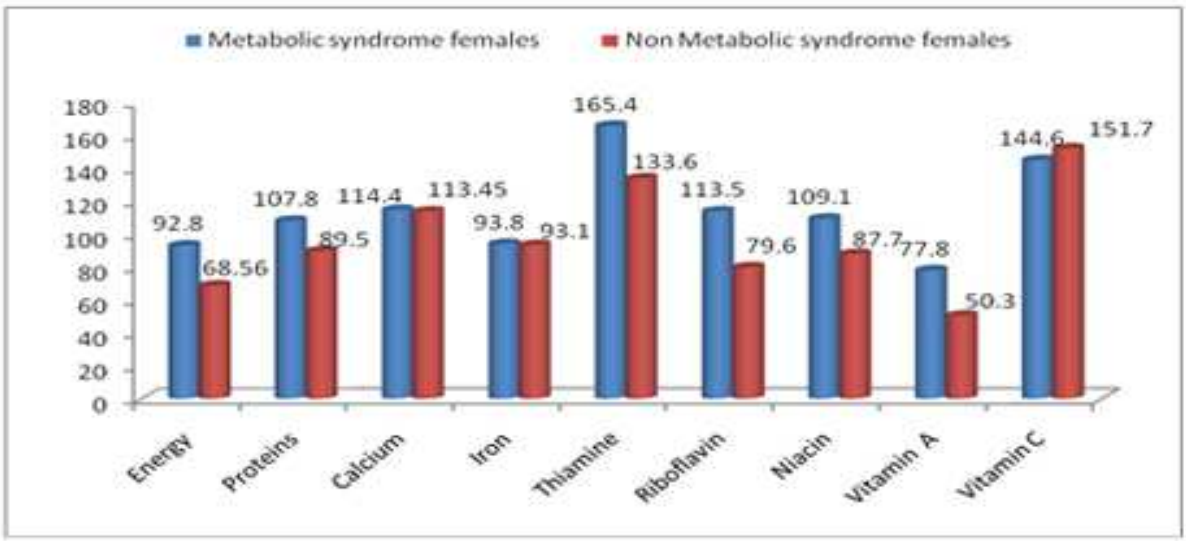

Figure No.2: Energy and nutrient intake as percent of RDAs of female subjects

CONCLUSION

The findings of the study revealed a strong association between MS, diet and physical activity. These findings concur with those of various epidemiological studies that have examined the relationship between diet, physical activity and the MS. The findings of the present study depict that according to PAL and Global Recommendations of physical activity given by WHO (2010)[1], more of MS subjects, both males and females, were doing less physical activity as compared to NMS subjects. These findings are similar to that of a survey conducted by the Indian component of the World Health Survey (WHS)[10], the only national level survey thus far which found that 29% of the adult population had inadequate physical activity levels. A quarter of men (24%) and one third of women (34%) had inadequate physical activity levels.

The present study shows that a high intake of energy, fats, and proteins combined with decreased physical activity is associated with occurrence of chronic diseases.

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