JPMER

10.5005/jp-journals-10028-1160

ORIGINAL ARTICLE

Predominant Causes of Metabolic Syndrome in Adolescents *vs* Adults of Northwest India

[1]Abhimanyu Saini, [2]Daisy Sahni, [3]Anil Bhansali

ABSTRACT

Prevalence and distribution of metabolic syndrome was studied among 167 adolescents (aged 12–17 years) and 361 adults (aged 18–80 years) of Chandigarh zone of northwest India. Measurements of anthropometric variables, blood pressure, triglycerides (TGs), high-density lipoproteins and fasting blood glucose were taken. The metabolic syndrome was examined using criteria reported by national cholesterol education program adult treatment panel III. The overall prevalence of metabolic syndrome was 9% in adolescents and 40.7% in adults. No gender differences in its incidence were noted in adolescents or adults. In adolescents, the contribution of TGs was highest, high blood pressure and low high-density lipoprotein were of about equal significance as risk factors. The least common risk factors were fasting blood sugar and waist circumference. In adults, abdominal obesity was the most common inconsistent factor among the subjects having metabolic syndrome. Efforts should be made to screen out the metabolic syndrome positive subjects, as it is one of leading risk factors of cardiovascular disease and diabetes mellitus.

Keywords: Epidemiology, Indians, Metabolic syndrome, Prevalence.

How to cite this article: Saini A, Sahni D, Bhansali A. Predominant Causes of Metabolic Syndrome in Adolescents *vs* Adults of Northwest India. J Postgrad Med Edu Res 2015;49(3):121-125.

Source of support: Nil

Conflict of interest: None

INTRODUCTION

The locution metabolic syndrome (MetS) has been extensively employed by experts after WHO framed diagnostic standards to denote this entity (WHO 1999). Later, other clinical criterion were also formulated particularly by the national cholesterol education program's adult treatment panel III report (ATP III)[1] and then by the American Association of Clinical Endocrinologists (AACE). According to these definitions, MetS is identified as a multiplex of metabolic risk factors including abdominal obesity, elevated blood pressure, atherogenic dyslipidemia and insulin resistance.

There is a progressive increase in the obese population in developing countries like India.[2] This may be largely because of internal migration of people from rural to urban areas and associated with lifestyle switch off to more sedentary lifestyle. Thus, prevalence of MetS is increasing rather rapidly in these countries.

Seeing the overall scenario, it has become necessary for us to study the prevalence and to figure out the main emerging risk factors of MetS for its early diagnosis in the adolescents *vs* adults of Chandigarh, where the per capita income is the highest in the country.

MATERIALS AND METHODS

The study is based on randomly selected 528 apparently healthy subjects, out of which 167 were adolescents (111 boys, 56 girls) between the age group 12 to 17 years and 361 were adults (199 males, 162 females) between the age group 18 to 80 years. The adolescent's data was collected from various public and private schools while the adult subjects were well to do shopkeepers of Chandigarh, Northwest India.

A written informed consent was obtained from the parents and clearance was taken from the Institute's Ethical Committee. Subjects fasting for less than 8 hours and taking medications such as insulin, androgens or anabolic steroids that might alter blood glucose were excluded from the study. All subjects who had documented endocrinology disorders, such as hypothyroidism, Cushing syndrome, acromegaly and pheochromocytoma were also excluded from this study.

The metabolic syndrome was examined using criteria reported by national cholesterol education program adult treatment panel III.[4] Various parameters recorded were: age, sex, body height, body weight, waist circumference (WC), blood pressure (BP), blood triglycerides (TGs),

[1]Fellow, [2]Professor and Head, [3]Professor

[1]Department of Cardiovascular Disease, John H Stroger Jr Hospital of Cook County, Chicago, USA

[2]Department of Anatomy, Postgraduate Institute of Medical Education and Research, Chandigarh, India

[3]Department of Endocrinology, Postgraduate Institute of Medical Education and Research, Chandigarh, India

Corresponding Author: Daisy Sahni, Professor and Head, Department of Anatomy, Postgraduate Institute of Medical Education and Research, Chandigarh, India, e-mail: daisy_sahni@rediffmail.com

blood high density lipoproteins (HDL) and fasting blood glucose (FBG). Height was measured in the upright posture with a stadiometer and body weight was recorded in a standing position using a self-zeroing scale. Waist circumference was also measured in standing position with a non-stretchable tape at the highest point of the iliac crest during normal respiration and to the nearest 0.1 cm. The adolescents with waist circumference at or above the 90th percentile on age and gender-specific growth chart and the adults with WC >102 cm in men, and ≥88 cm in women were classified as having abdominal obesity.

Blood pressure was recorded on right arm in sitting position after the person had rested for at least 15 minutes and the average of the three readings was taken at intervals of 2 to 3 minutes. Diastolic blood pressure was taken with the disappearance of the korotkoff sounds (5th phase). Elevated BP in adolescents was defined as a value at or above the 90th percentile for age, gender and height[3] and in adults ≥130/85 mm Hg.

Triglycerides, HDL and FBG were measured with autoanalyser (Miles India Limited, model CH-100). TGs ≥1.7 mmol/l ≥(150 mg/dl) for adults and ≥6.1 mmol/l (>110 mg dl) for the adolescents and HDL ≤1.03 mmol/l (40 mg/dl) and FBG ≥6.1 mmol/l (≥110 mg/dl) were taken as standards in the present study (modified NCEP ATP III criteria for south Asian Indian adults).[4] Subjects who met at least three of the following criterion, i.e. abdominal obesity, elevated BP, high TGs, high FBG and low HDL and were classified as having MetS. The data were also reanalyzed using revised American Diabetes Association (ADA) criteria, i.e. blood glucose cut-off ≥5.5 mmol/dL.

STATISTICAL METHODS

Statistical analysis was performed using the window-based SPSS-10 statistical software. Stepwise logistic regression was used to predict the MetS in the dataset and the hypothesized risk factors (including WC, BP, TGs, HDL FBG) involved in predicting MetS and also to test the association of various risk factors with MetS. The statistical significance of the associations are based on Wald test.

RESULTS

Adolescents

As shown in Table 1, the positive incidence of MetS was 9% in the two sexes. It remained unchanged when the cut off levels of fasting blood sugars were reduced to 5.5 mmol/l (100 mg/dl). Gender differences in its incidence were statistically insignificant ($p > 0.05$), although the percentage incidence in males was higher (11.7%) than in the females (3.6%). Number and percentage of individual risk factor profile for MetS in the two sexes is given in Table 2. In males, hypertriglyceridemia was the greatest contributor in 100% subjects followed by low HDL and elevated BP (92.3% each), hyperglycemia (15.4%) and least was the abdominal obesity in 7.7% cases. Whereas in the females, hypertriglyceridemia and elevated BP were the findings in 100% instances, followed by low HDL and abdominal obesity (50% each). Hyperglycemia was not found in any girl subject.

Adults

The occurrence of MetS in the total sample as 40.7%, which increased to 45.4%, when cut off levels of FBG was lowered to 5.5 mmol/l (100 mg/dl) as shown in Table 1. Statistically there was no gender differences ($p > 0.05$) in the percentage incidence of MetS.

The distribution of individual components of MetS in adults in the two sexes is shown in Table 2. Abdominal obesity was found to be the greatest risk factor of MetS in both sexes (males: 91.5%, females: 96.9%). Next in row was elevated BP in the males (80.5%) and low HDL in the females (89.2%). Hyperglycemia was found to be less important contributor for MetS in the two genders (males: 34.1%, females: 23.1%).

Distribution of number of risk factors along with prevalence of each factor in adults is given in Table 3. None of the risk factors was found in 17 (4.7%) of the individuals. Out of 256 individuals WC above the cut off value was observed in 118 (46.1%) subjects who are not positive for MetS but were having risk factor 1 and 2. This highlights the fact that WC is not the sole criteria for defining MetS, whereas having WC within the cut off range is a good prognostic value as only 9 persons who were not having

Table 1: Demographic characteristics and prevalence of metabolic syndrome in 528 persons*

	*No. of subjects***			*Subjects with MetS*		
Subjects	*Males*	*Females*	*Total*	*Males*	*Females*	*Total*
Adolescents	111 (66.5%)	56 (33.5%)	167	13 (11.7%)	2 (3.6%)	15 (9%)
Adults	199 (55.1%)	162 (44.9%)	361	82 (41.2%)	65 (40.1%)	147 (40.7%)
Total sample size	310 (58.7%)	218 (41.3%)	528	95 (30.6%)	67 (30.7%)	162 (36.7%)

*Fasting plasma sugar ≥6.1 mmol/l (110 mg/dl)

**Statistically insignificant sexual difference *p > 0

Table 2: Individual risk factor profile for MetS in adolescents* and adults in the two sexes

	Adolescents					*Adults*				
	Males (n = 13)		*Females (n = 2)*		*Total (n = 15)*	*Males (n = 82)*		*Females (n = 65)*		*Total (n = 147)*
Risk factors	*No. (%)*	*CI*	*No. (%)*	*CI*	*No. (%)*	*No. (%)*	*CI*	*No. (%)*	*CI*	*No. (%)*
Abdominal Obesity/waist circumference	1 (7.7%)	6.7–22.1	1 (50%)	–19–119	2 (13.3%)	75 (91.5%)	85.4–97.5	63 (96.9%)	92.7–101.1	138 (93.8%)
Hyperglycemia	2 (15.4%)	4.2–34.9	Nil	Nil	2 (13.3%)	28 (34.1%)	23.8–44.4	15 (23.1%)	12.8–33.3	43 (29.2%)
Hypertriglyceridemia	13 (100%)	—	2 (100%)	—	15 (100%)	51 (62.2%)	51.6–72.6	32 (49.2%)	37–61.3	83 (56.4%)
Low HDL	12 (92.3%)	77.8–106.7	1 (50%)	–19–119	13 (86.6%)	59 (72%)	62.2–81.6	58 (89.2%)	81.6–96.7	117 (79.6%)
Elevated BP	12 (92.3%)	77.8–106.7	2 (100%)	—	14 (93.3%)	66 (80.5%)	71.9–81	49 (75.4%)	64.9–85.8	115 (78.2%)

*Fasting plasma sugar ≥ 6.1 mmol/l (110 mg/dl)
The percentages are the individual risk factors found positive in subjects having MetS

Table 3: Distribution of number of risk factors along with prevalence of each factor in adults (n = 361)

*No. of risk factors**	*Abdominal obesity/WC*		*Low HDL*		*TGs*		*BP*		
	Negative	*Positive*	*Negative*	*Positive*	*Negative*	*Positive*	*Negative*	*Positive*	*Total*
0	17	—	17	—	17	—	17	—	17 (4.7%)
1	49	19	34	34	63	5	60	8	68 (22.7%)
2	30	99	53	76	95	34	86	43	129 (43%)
3	9	94	26	77	54	49	31	72	103 (34.3%)
4	—	33	4	29	10	23	1	32	33 (11%)
5	—	11	—	11	—	11	—	11	11 (3.7%)
Total	105	256	134	227	239	122	195	166	361

*Criteria for MetS

abdominal obesity but fall under the category as suffering from MetS. Table 3 also depicts that a deranged lipid profile will not label a person having MetS because out of 134 people having favorable HDL, only 30 (22.4%) suffered from MetS. Similarly 64 persons out of 239 people and 32 out of 195 persons although having TGs and BP within range developed MetS. But a favorable lipid profile is a good prognostic criteria as well as a controlled BP profile is a protective function against a developing MetS.

DISCUSSION

In the year 1938, Hinsworth coined the term insulin resistance and later in 1988 Reaven[5] was the first to describe syndrome X in Banting Lecture at annual meeting of American Diabetes association. Since then, the research in this field has been unprecedented because of the importance it holds.

Metabolic syndrome or syndrome X is a constellation of metabolic disorders, which results from primary disorder of insulin resistance. All metabolic abnormalities associated with MetS can lead to cardiovascular disorders (CVD) and when present as a group, the risk for cardiovascular disease and premature death is very high.

Adult treatment panel III[4] identified 6 components of the MetS that relate to CVD:

- Abdominal obesity
- Atherogenic dyslipidemia
- Raised blood pressure
- Insulin resistance ± glucose intolerance
- Proinflammatory state
- Prothrombotic state

Adult treatment panel III considered the 'obesity epidemic' as the main key responsible for the rising prevalence of MetS. Obesity contributes to hypertension, high serum cholesterol, low HDL cholesterol and hyperglycemia which in turn associate with higher CVD risk. The other chief abnormality present in MetS is insulin resistance. Many investigators place a greater priority on insulin resistance than on obesity in pathogenesis.[6] They argue that insulin resistance, or its accomplice, hyperinsulinemia, directly causes other metabolic risk factors. That is, the body's tissues do not respond normally to insulin. As a result, insulin levels become elevated in the body's attempt to overcome the resistance to insulin. The elevated insulin levels lead directly or indirectly to the other metabolic abnormalities seen in these subjects. Very often, the insulin resistance is severe enough to develop into type[2] diabetes.

When diabetes occurs, the high risk of cardiovascular complications goes even higher. Persons at risk are those who adopt sedentary lifestyle and become obese. In fact MetS (like type 2 diabetes) can most often be prevented with exercise and weight loss. Anyone with a family history of type 2 diabetes who is also overweight and who gets little exercise should be evaluated for glucose, lipid and BP abnormalities associated with MetS.

Adult treatment panel III recommended that abdominal obesity as one of the most important risk factor for development of metabolic syndrome. Some males can develop multiple metabolic risk factors with only a marginal increase in WC, i.e. 94 to 102 cm. Abdominal obesity is closely associated with high TGs. First-line therapy should be the weight reduction reinforced with increased physical activity. Weight loss lowers serum cholesterol and TGs, raises HDL, lowers BP and glucose and reduces insulin resistance. Routine cholesterol testing should begin in young adulthood and should be encouraged to modify life habits to minimize the risk. Elevated BP should be lowered to at least 140/90 or 130/80 mm Hg if diabetes is present. Reduced intake of saturated fat, trans fat and cholesterol rich foods are also proposed.

Recent studies have shown that the prevalence of MetS and particularly diabetes mellitus (DM) is very high among migrant Asian Indians and is rapidly rising even within the Indian subcontinent. In a study conducted by Ramachandran[7] in a city of Chennai, Tamil Nadu, India, it was noted that MetS is more common in Asian Indian adults and low HDL (65.5%) is a more prevalent risk factor. The prevalence of MetS is age related and is more common in women. Contrary to the findings of Ramachandran[7] no gender differences were found in current study and abdominal obesity was the most common inconsistency among subjects having MetS and hyperglycemia was the uncommon deviation. The prevalence of MetS in adults as 13%, high TGs 30%, hypertension 39% and elevated FBG 5% in Jaipur urban population[8] of India. In another Indian study from Chennai[9] the MetS was prevalent in 11.2% adults (95% CI: 9.4–13.3) and higher socioeconomic status were considered as important risk factors. In the present study in Northwest Indians the prevalence is very less as compared to that given by other workers[8,9] and another study conducted on Indian population (Ramachandran[7]). It appears that even with the same ethnic population group there can be significant differences in prevalence of individual factor that constitute the MetS.

Indeed, a report shows that India already has the largest number of diabetic subjects in the world[10] and majority of people with diabetes are in the age range of 45 to 64 years. Our findings of 9% MetS in adolescents is in accordance with various studies from other parts of world, mainly from developed countries. In the data set study of NHANES (1988–1992)[11] recorded the prevalence of MetS in adolescents as 4.2% and highlighted that a high percentage of overweight adolescents may have a high risk for future MetS in adulthood with subsequent increased risk for premature CVD and type 2 diabetes. The overall prevalence of MetS among US adolescents increased significantly from 4.2 to 6.4% in NHANES 1999–2000 ($p < 0.001$); the syndrome was more prevalent ($p < 0.01$) in male than female adolescents and was found in 32% overweight adolescents.[12] Investigators reported a prevalence of 3.6% from the Bogalusa Heart Study in young adolescents of 8 to 17 years of age[13] and indicated that childhood obesity is a powerful predictor of development of syndrome. In another study,[14] the prevalence of the MetS in Mexican children and adolescents aged 10 to 18 years was 6.5% (95% CI 4.7–7.8). The incidence of prevalence of risk factors given by Moran et al[14] is very less as compared to our study.

The prevalence of MetS is highly age dependent which is clearly demonstrated in the present study, in which the prevalence of MetS in adolescents is 9% and increased to 40.7% in the adults. This agrees with the findings given in Iranian[15] and Japanese[16] population respectively. Differences in the prevalence of MetS between populations may be due to life style, genetic factors and the age and sex of population study. Dhingra et al[17] stated that high prevalence of low value of low HDL in urban adolescents and young adults is an important observation for future development of atherosclerosis related complications and risk factors track from early childhood to adulthood and old age.

It is also observed that the body weight among school going children especially in urban areas has increased progressively due to physical inactivity, which is a major risk factor for the development of obesity and dislipidemia.[18] The incidence of MetS reported in different hospital community based studies in USA is 23 to 43.6%.[19] In Indian adults, it is 36.4% in males and 46.5% in females.[7] A lower level of HDL is a more prevalent risk factor in Asian Indian than the white caucasians as the former are more insulin resistant and centrally obese than the later.[20] In the current study the contribution of TGs was highest. High BP and low HDL were also of equal significance as risk predictors. Low HDL had an incidence of 86.6% and high BP had an incidence of 93.3% among the adolescents positive for MetS. The least common risk factors were FBG and WC. The pattern of individual risk factors as seen in adults and adolescents showed a peculiar pattern. It was expected that abdominal obesity was a major predictor of MetS in adults and hence premature diabetes mellitus, CVD morbidity, etc. In case of adolescents the foremost forecaster of MetS and its related premature effects were high TGs, low HDL and high BP. Because of increasing rates of obesity MetS increases the future risk of type 2 diabetic mellitus and premature coronary artery disease in adults, hence lifestyle, modifications and aggressive remedial therapy should be directed toward adolescents and young adults to reduce the related comorbidities that accumulate over years.

A country like India presents a very unique demographic profile. It is listed as one of the fastest upcoming countries in terms of socioeconomic growth. But in terms of medical infrastructure it still has a long way to go. Indian population is still divided into affluent and the poor. But it still presents a prevalence data comparable with developed countries. These countries have a definitive advantage of screening out the people at risk, counsel them and treat them if necessary. But India still is lacking in these fields of screening and counselling and then treating them.

CONCLUSION

According to present study, TGs, high blood pressure and low HDL were found to be major contributing factors for MetS in adolescents whereas in adults abdominal obesity contributed the most. This information would be useful to screen out MetS positive subjects because it is one of the leading risk factors of CVD, DM and stroke posing an emerging health problem to old and the new stressed out younger generation.

REFERENCES

1. National cholesterol education program expert panel on detection, evaluation and treatment of high blood cholesterol in adults (adult Treatment Panel III). Bethesda Md: National Institutes of Health. 2001 (NIH publication no. 01-3670).
2. Settee PS. Nutrition transition in India. Public Health Nutrition. 2002;5(1A):175-182.
3. National high blood pressure education program working group on hypertension control in children and adolescents. A working group report from the national high blood pressure education program. Pediatrics 1996;98(4 pt 1):649-658.
4. Third report of the National Cholesterol Education Programme (NCEP) expert panel on detection, evaluation, and treatment of high blood cholesterol in adults (Adult Treatment Panel III). Final report. Circulation 2002;106(25):3143-3421.
5. Reaven GM. Banting lecture. Role of insulin resistance in human diseases. Diabetes 1988;37(12):1595-1607.
6. Alexander CM, Landsman PB, Teutsch SM, Haffner SM. National cholesterol education programme defined metabolic syndrome, diabetes and prevalence of coronary heart disease among NHANES III participants age 50 years and older. Diabetes 2003;52(5):1210-1214.
7. Ramachandran A, Snehalatha C, Satyavani K, Sivasankari S, Vijay V, et al. Syndrome in urban Asian Indian adults—a population study using modified ATP III criteria. Diabetes Res Clin Pract 2003;60(3):199-204.
8. Gupta A, Gupta R, Sarna M, Rastogi S, Gupta VP, Kotharia K. Prevalence of diabetes impaired fasting glucose and insulin resistance syndrome in an urban Indian population. Diabetes Res Clin Pract 2003;61(1):69-76.
9. Deepa R, Shanthirani CS, Premalatha G, Sastry NG, Mohan V. Prevalence of insulin resistance syndrome in a selected south Indian population—the Chennai urban population study 7 (CUPS-7). Indian J Med Res 2002;115:118-127.
10. King H, Aubert RE, Herman WH. Global burden of diabetes 1995-2025: Prevalence, numerical estimates and projections. Diabetes Care 1998;21(9):1414-1431.
11. Cook S, Weitzman M, Auinger P, Nguyen M, Dietz WH. Prevalence of a metabolic syndrome phenotype in adolescents. Findings from the third National Health and Nutrition Examination Survey, 1988-1994. Arch Pediatr Adolesc Med 2003;157(8):821-827.
12. Duncan GE, Sierra MLI, Zhou XH. Prevalence and trends of a metabolic syndrome phenotype among US adolescents. 1999-2000. Diabetes Care 2004;27(10):2438-2443.
13. Srinivasan SR, Myers L, Bereson GS. Predictability of childhood adiposity and insulin resistance syndrome (Syndrome X) in young adulthood: the Bogalusa Heart Study: Diabetes 2002;51(1):204-209.
14. Moran MR, Vazquez BS, Violante R, Romero FG. Metabolic syndrome among children and adolescents aged 10 to 18 years. Diabetes Care 2004;27(10):2516-2517.
15. Azizi F, Salehi P, Etemadi A, Zahedi Asl S. Prevalence of metabolic syndrome in an urban population: Tehran lipid and glucose study. Diab Res Clin Pract 2003;61(1):29-37.
16. Balkau B, Vernay M, Mhamdi L, Novak M, Arondel D, Vol S, et al. The incidence and persistence of the NCEP (National Cholestrol education Program) metabolic syndrome. The Grench DESIR study. Diabet Metab 2003;29(5):526-532.
17. Dhingra V, Chatterjee A, Guleria R, Sharma R, Pandey RM, Talwar KK, et al . Adverse physical activity pattern in urban adolescents. J Assoc Phys India 2002;50:1521.
18. Dhingra V, Chatterjee A, Sharma R, Pandey RM, Guleria R, Jain D, et al. Blood glucose and lipid profile in urban adolescents and young adults. J Assoc Phy India 2003;51:1267.
19. Cameron AJ, Shaw JE, Zimmet PZ. The metabolic syndrome: Prevalence in worldwide population. Endocrinol Metab Clin N Am 2004;33(2):351-375.
20. Chandalia M, Abate N, Garg A, Stray Gundersen J, Grundy SM. Relationship between generalized and upper body obesity to insulin resistance in Asian Indian men. J Clin Endocrinol Metab 1999;84(7):2329-2335.