Indian J Physiol Pharmacol 2017; 61(4) : 368–377

Original Article

Metabolic Syndrome : Not Even the Urban Indian Youth is Spared

Anumeha Bhagat*, Anita S. Malhotra, Gurjit Kaur and Nandini Kapoor

Department of Physiology,
Government Medical College & Hospital
Chandigarh

Abstract

Introduction: Prevalence of metabolic syndrome(MS) is increasing in lower middle income group countries of south East Asian region. Studies regarding prevalence of MS in adults and children in Asia have been published, but we did not come across any data on prevalence of MS in college going students in the age group of 18-25 years. Aim: To estimate prevalence of metabolic syndrome in college going youth in the age group of 18-25 years. Material and method: Waist circumference, height, weight, blood pressure, fasting blood glucose, high density lipoprotein & triglycerides of 616 participants was measured. Prevalence of MS was determined using International Diabetic Federation (IDF) consensus definition for Indian subjects using ethnic specific cut offs for waist circumference. Result: The prevalence of MS in college going students of an urban territory of India using ethnic specific cut offs is 18.3%. Conclusion: A high prevalence of metabolic syndrome in the urban Indian youth clearly indicates that there is a dire need to spread awareness regarding the importance of early recognition of risk factor of MS so as to give them more years free of morbidity.

Introduction

Metabolic syndrome (MS) is a constellation of risk factors which include central obesity, glucose intolerance, hyperinsulinemia, low HDL cholesterol, high triglycerides and hypertension (1, 2). Other conditions such as physical inactivity (3, 4), aging (5) and hormonal imbalance (6) also contribute to the development of metabolic syndrome. Individuals with MS are twice as likely to die from and three times as likely to develop cardio vascular disease compared to people without MS (7). They also have a five-fold greater risk of developing type 2 diabetes if not already present. Thus MS is increasingly being recognized as a risk factor for cardiovascular disease (8) and cardiovascular mortality (9).

A recent report by WHO (10) and other studies have revealed that the prevalence of various risk factors for MS is on the rise in lower middle income group countries most of which are in the South East Asian region. Metabolic syndrome is highly prevalent in adult population worldwide with ethnic predisposition in Asians (11). High prevalence of the metabolic

***Corresponding author :**

Anumeha Bhagat, Department of Physiology, E Block, Level IV, Government Medical College and Hospital, Chandigarh, Mobile No.: 91-9646121590 Email: anumehabhagat@gmail.com

(Received on August 1, 2017)

syndrome has also been reported from sub- Saharan Africa, Middle East, South Africa as well as South America and Korea (12, 13, 14, 15). Data shows that one fourth to one third of urban population of India have metabolic syndrome (16). Furthermore, the prevalence is 1.5–2 times higher in women compared with men (16, 17). Certain communities in India (*e.g.* Punjabi Bhatia community in north India) have inordinately high tendency to have obesity, type 2 diabetes mellitus and metabolic syndrome (18). The higher prevalence of MS at younger ages in Asian Indians is of particular concern, as it means that they will have a more prolonged exposure to the atherosclerotic risk factors associated with MS. It was observed in a study that compared Indians, Malays and Chinese that prolonged exposure to atherosclerotic risk factors before the onset of diabetes could also contribute to the excess mortality in Asian Indians (19).

Studies in India have estimated the prevalence of metabolic syndrome in children and adolescent population of India. According to a recent study the overall prevalence of MS in adolescents was 4.2% (20).

Although several studies have been done on the prevalence of metabolic syndrome in children and adults in Asia yet there is no data on the prevalence of metabolic syndrome in the college going age group of 18-25 years. Estimating the prevalence in this group of students is important since this is the transition phase for the adolescent who is leaving behind his childhood, becoming independent and entering into college thus venturing into the outside world. With more freedom and increasing pressure of academic life, the dietary and physical activity pattern also undergoes a drastic change. Thus estimating the prevalence of metabolic syndrome in the proposed age group is an urgent need.

Materials and Method

The study was conducted by the Department of Physiology, Government Medical College, India. Approval of the institutional ethical and research committee was taken prior to starting the study. It was a cross-sectional observational study. Based on previous data of prevalence of metabolic syndrome in adults and children (20, 21), we assumed a prevalence rate of 10% in our study population. Thus in order to have detection rate of 60% at 95% confidence interval the estimated sample size was 616 students.

College going students of either gender in the age group of 18-25 years were included in the study. Students with prior history of diabetes mellitus, hypertension, disability limiting locomotion and on any medication were excluded from the study. Written informed consent was taken from all the participants before enrolling them for the study.

Based on information available on the official website of Chandigarh Administration a comprehensive list of all colleges in Chandigarh was prepared. Letters for participation in the study were sent to the heads of all the colleges explaining the purpose of study. A second request for participation was sent to the colleges for participation in the study after one month. After waiting for their responses for sufficient time, students of the colleges, which had indicated their willingness to participate, were finally enrolled for the study. Thus finally we had the approval of administration of ten colleges to participate in the study.

Subsequently a detailed list of students enrolled for each course in the college was prepared. For selecting the primary sampling unit each class was taken as a cluster. Using the 30 sampling technique, 30 clusters were selected out of the whole distribution (colleges willing to participate) which satisfied the probability proportional to size method. After the procedure of cluster selection, simple random sampling method with replacement was used to generate the random numbers with standard number of pre-calculated students (25 for each cluster) for within cluster sampling.

The parameters such as waist circumference, height, weight and blood pressure were recorded by the junior faculty members of the Department of Physiology who were unaware of the purpose of data collection. Blood samples for blood glucose, high density lipoproteins (HDL) and triglycerides were collected

and analyzed by our trained technical staff.

All participants were instructed to report to the laboratory for blood sample collection between 9-11 AM, after having had their last meal in the previous night no later than 9:00 PM. They were specifically instructed to dress in loose and light clothing. After reporting to the laboratory the subjects removed their shoes and rested for 10 minutes before the measurements.

Anthropometric profile

Waist circumference (WC) was measured using non-stretchable flexible tape in horizontal position, just above the iliac crest, at the end of normal expiration, with the subject standing erect and looking straightforward and observer sitting in front of the subject.

Weight was determined with an electronic balance. Height was measured using a wall mounted, non-extensible measuring tape with subjects in standing position with no shoes and feet kept together.

Body mass index (BMI) was calculated using the standard formula: Weight (kg)/ Height $(m)^2$

According to the Consensus statement of BMI for Indian adults (22) the various categories are: normal BMI: 18-22.9 kg/m^2, overweight: 23-24.9 Kg/m^2 and obese: > $25Kg/m^{2.}$ *Blood pressure (BP)*

With the subject in supine position right arm systolic and diastolic BP was measured by auscultatory method using mercury sphygmomanometer. Three readings were measured 5 min apart and mean of the three was noted.

Biochemical analysis

Blood sample was collected by venipuncture of antecubital vein after an overnight fast. Venous blood was collected in oxalate and fluoride vials for measurement of glucose, and plain vials for estimating High Density Lipoprotein (HDL) and triglycerides TG). The plasma (in case of glucose)/serum (in case of HDL and TG) was separated after centrifugation at 3000 rpm for 10 minutes. Glucose, HDL and TG estimation was done using kits from Recon Diagnostic Pvt. Ltd., Gujarat, India on a semi-automated clinical chemistry analyzer (Model: BSA10, Company: Recorders and Medical Systems, Ambala, India).

Subjects were also categorized as per the socio-economic status on the basis of family income in Rupees/year into Grade I : <12000, Grade II: 12000-60000, Grade III: 60000-120000 and Grade IV: >120000.

Prevalence of metabolic syndrome was assessed using the International Diabetic Foundation IDF consensus definition for Indian subjects using ethnic specific cut offs for waist circumference (22). This definition of MS is same as the joint interim statement of the IDF task force and several other important organizations that have proposed common criteria for clinical diagnosis of metabolic syndrome to be used worldwide (23). According to this definition MS is diagnosed if any three of the following risk factors occur together i) Waist circumference more than 80 cm in females and more than 90 cm in males ii) Systolic blood pressure more than or equal to 130 and/ or diastolic blood pressure more than or equal to 85 mm of mercury iii) Fasting blood glucose more than or equal to 100 mg/dl iv) Serum triglycerides more than or equal to 150 mg/dl v) Serum HDL less than 40 mg/dl in males and less than 50 mg/dl in females.

Statistical analysis

The data was analyzed using SPSS software (SPSS Inc. 2013, version 22.0 for Windows, Armonk, NY, USA). Prevalence values were compared using the chi square test for proportions of students with or without MS. Comparison of continuous variables was carried out with student's *t*-test with a significant *P*-value of < 0.05. Multivariate analysis was also performed by bivariate logistic regression analysis.

Result

Although written informed consent was taken from

620 college going students only 611 students were considered for statistical analysis since data of 9 students was incomplete. The physical, biochemical and general characteristics of the study population are given in Table I. Fig. 1 shows the number of students with 1, 2, 3, 4 or 5 risk factors for metabolic syndrome.

The overall prevalence of MS was 18.3% in our study population. There was female preponderance in the samples analyzed with 68.9% females and 31.1% males (Table II). There was no statistically significant difference in the prevalence on account of gender, socioeconomic status and family history of diabetes mellitus/myocardial infarction/hypertension in parents

TABLE I: Physical, Biochemical and general characteristics of the study population.

	Mean±SD
Age (years)	19.62±1.8
Height (Cm)	164.52±14.83
Weight (Kg)	57.44±12.74
BMI	21.22±4.25
Waist circumference (cm)	80.29±9.929
Systolic Blood Pressure (mm of Hg)	119.89±10.22
Diastolic Blood Pressure (mm of Hg)	76.85±8.49
Pulse pressure	43.17±8.41
Mean Blood Pressure (mm of Hg)	91.24±8.26
Fasting glucose (mg/dl)	84.41±14.55
High Density Lipoprotein (mg/dl)	43.15±9.08
Triglyceride (mg/dl)	118.47±36.12

TABLE II: Prevalence of metabolic syndrome in relation to various factors.

	Number of subjects	*Prevalence of metabolic syndrome (%)*	*p value*
Total	611	18.3	
Male	190(31.1%)	18.4	0.969
Female	421(68.9%)	18.3	
BMI			<0.001
<18	136(22.3%)	8.8	
Normal	292(47.8%)	15.4	
Overweight	82(13.4%)	26.8	
Obese	100(16.4%)	33.0	
Parental history of DM			0.2
Yes	81(13.3%)	23.5	
No	530(86.7%)	17.5	
Parental history of HT			
Yes	180(29.5%)	21.1	
No	431(70.5%)	17.2	0.253
Parental history of MI			
Yes	51(8.3%)	13.7	
No	560(91.7%)	18.8	0.375
Socio economic status			0.105
Grade I	6(1%)	50	
Grade II	58(9.5%)	20.7	
Grade III	129(21.1%)	21.7	
Grade IV	418(68.4%)	16.5	

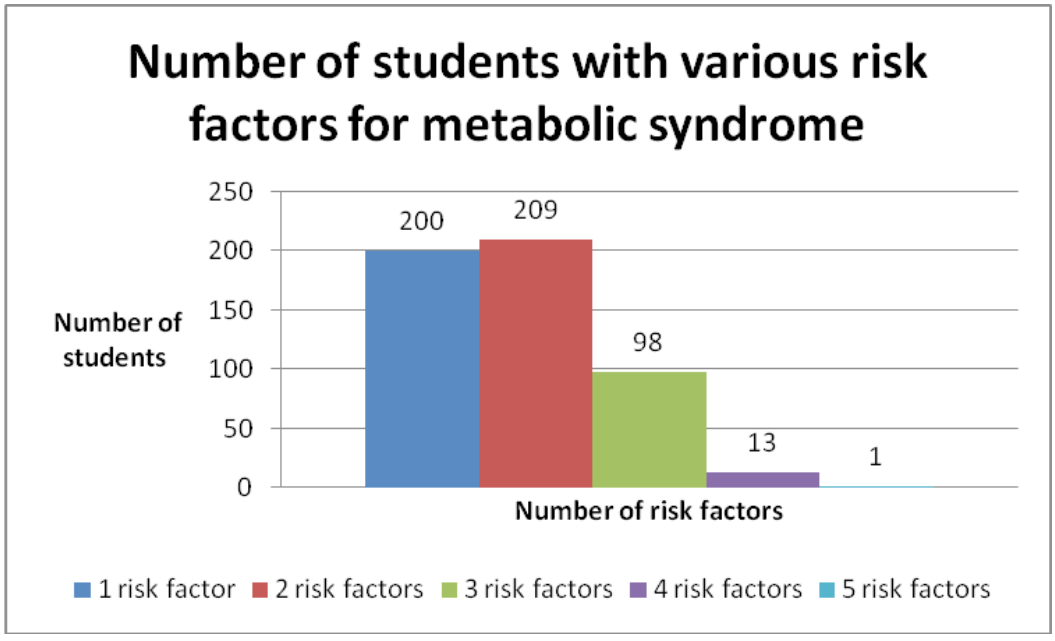

Fig. 1: Number of students with various risk factors for metabolic syndrome.

(Table II).The mean waist circumference of males was 82.48±9.08 cm and females was 79.32±10.14 cm which was not statistically significant (p=0.063).

There was a highly significant difference in the prevalence of metabolic syndrome in various BMI categories by Chi Square test (p<0.001). Post hoc analysis shows that there was a highly significant difference (p<0.001) between underweight versus overweight and normal vs obese categories. There was also a significant difference in the underweight versus obese (p=0.001) and normal vs overweight categories (p=0.017) (Table VI). A cut off for BMI as predicted by ROC curve is 21.88 with sensitivity 0.545 and specificity 0.34 (Fig. 2). The odds ratio for normal, overweight and obese BMI categories is 1.88, 3.79 and 5.09.

Cut off for age as a predictor of MS by the ROC curve was 19.5 years with sensitivity of 0.554 and specificity of 0.365 (Fig. 3).

Each risk factor was further analyzed. Pearson's Chi square test was applied to find the statistical significance of the number of individuals having MS with a risk factor beyond the cut off versus those having normal value of that particular risk factor. For all risk factors such as waist circumference, blood pressure, fasting blood glucose, HDL and triglycerides there was a highly significantly (p<0.001) difference (Table III).

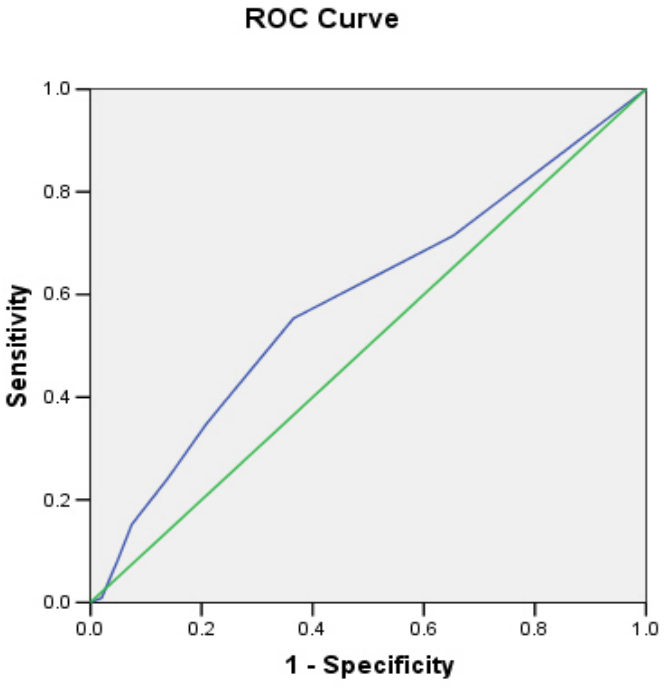

Fig. 2: ROC curve for BMI.

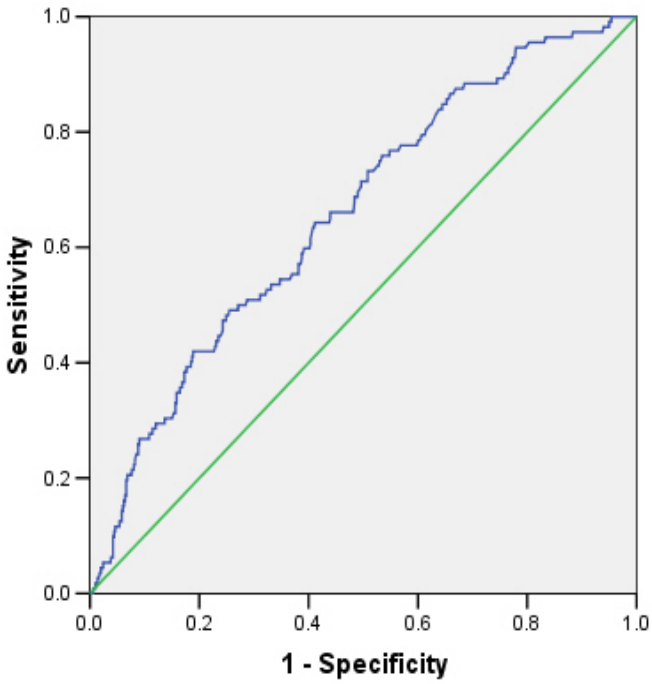

Fig. 3: ROC curve for age.

TABLE III: Association of risk factors with metabolic syndrome.

	Total numbers (%)	*Metabolic syndrome present*	*Pearson's Chi Square Test*
Waist circumference			p<0.001
Normal	374(61.2%)	38	
Raised	237(38.8%)	74	
Systolic BP			p<0.001
Normal	534(87.4%)	74	
Raised	77(12.6%)	38	
Diastolic BP			p<0.001
Normal	519(84.9%)	77	
Raised	92(15.1%)	35	
Fasting blood sugar			p<0.001
Normal	506(82.8%)	66	
Raised	103(16.9%)	46	
Triglyceride			p<0.001
Normal	496(81.2%)	43	
Raised	115(18.8%)	69	
HDL			p<0.001
Normal	227(37.2%)	5	
Raised	384(62.8%)	107	

p denotes statistical significance of the number of individuals having MS with a risk factor beyond the cut off versus those having normal value of that particular risk factor.

TABLE IV: Co-relation of individual risk factors with metabolic syndrome.

		BMI	*Waist circumference*	*Systolic BP*	*Diastolic BP*	*Fasting glucose*	*TG*	*HDL*
Metabolic syndrome	Pearson correlation	.262**	.276**	.275**	.229**	.046	.362**	-.322**
	Sig. (2-tailed)	.000	.000	.000	.000	.261	.000	.000

**Correlation is significant at the 0.01 level (2-tailed).

On applying Pearson's correlation coefficient analysis although a weak strength of association of BMI, Waist circumference, blood pressure, fasting blood sugar, TG and HDL was found with metabolic syndrome but this was statistically significant (Table IV).

Table V shows the odds ratio of various risk factors with metabolic syndrome. High triglyceride levels had the highest odds of being associated with metabolic syndrome. The strength of association of risk factors with metabolic syndrome was in the following decreasing order: raised triglycerides (most common), low HDL, raised systolic blood pressure, elevated fasting blood sugar, increased waist circumference, higher diastolic blood pressure (least common).

TABLE V: Odds ratio of various risk factors for metabolic syndrome.

	Odds ratio	*95% CI*		*P*
		Lower limit	*Upper limit*	
Waist circumference	3.07	2.60	6.19	0.00
Systolic blood pressure	3.56	2.61	4.85	0.00
Diastolic blood pressure	2.56	1.84	3.58	0.00
Fasting blood sugar	3.42	2.51	4.67	0.00
Triglyceride	12.65	5.24	30.55	0.00
High Density Lipoprotein	4.706	2.451	9.035	0.00

TABLE VI: Post hoc analysis of prevalence of metabolic syndrome in various BMI categories.

BMI	*p value*
<18 vs Normal	0.062
<18 vs Overweight	<0.001
<18 vs Obese	0.001
Normal vs Overweight	0.017
Normal vs Obese	<0.001
Overweight vs Obese	0.367

Discussion

In recent years several studies have reported prevalence of metabolic syndrome in various regions of the world and in various age groups. However in all these studies the minimum age range considered was either 20-29 or 18-29. Thus there is no data on prevalence of MS in college going students in the age group of 18-25 years.

In a Norwegian study the prevalence of metabolic syndrome was 11% in the age group of 20-29 years (24). In the same age group a prevalence of 6.7% was reported by the third national health and nutrition examination survey in United States (5), 6.2% in a European Mediterranean area (11) and 6.4% in Iran (25).

A low prevalence of 2.5% in men and 2.9% in women was reported in a North West Russian study in the age group of 18-29 years (26). A similarly low prevalence of 2.9% in the age group 15 to 25 years was reported from Bangladesh (27). Chennai Urban Rural Epidemiology Study (21) is one of the largest epidemiological studies on diabetes carried out in India, in which 26001 individual aged ≥20 years were screened. In the age group of 20–29 years, the prevalence of MS ranged from 5.1–8.9% depending on the criteria used to define MS. However the researchers did not use the IDF consensus definition with ethnicity specific cut offs.

Other studies have shown that the prevalence of MS, and particularly diabetes, is very high among migrant Asian Indians and is rapidly rising even within the Indian subcontinent (28).

Another Indian study published in 2010, estimated

the prevalence of metabolic syndrome in adults above 18 years of age in Chandigarh (29). The prevalence of MS in this study according to IDF definition in the age group of 18-25 years was 9.4%. The difference between this study and our study is that we have used the IDF consensus definition with ethnicity specific cut offs for Indian population. Moreover the student college going population was considered in our study, whereas in the previous study participants were slum dwellers.

Another study published from the same region in 2007 showed the prevalence of MS to be 4.2% in the age group of 12-17 years using the IDF definition (22). When stratified by body mass index, 5.5% adolescents were overweight. Of the overweight, 36.6% were identified as cases of MS and only 1.9% of the normal population had MS. Low high-density lipoprotein was the most common and abdominal obesity the least common constituent of MS in this population. There was a significant difference ($p<0.001$) between the prevalence of MS adolescents from low to high socio-economic strata. There was no gender difference in the distribution of MS which is similar to our study. This could probably be due to similar type of lifestyles in the college going youth of India in an urban setting like ours.

In a recent study, published in 2014, prevalence of MS in young urban Indian population in the same age group as our study and using the same definition of MS as used by us, was estimated to be 8.7% (30). One reason for the difference in the prevalence of MS from our study could be the difference in ethnic groups and there might be different dietary habits and physical activity patterns of both these groups.

One important reason for heterogeneity in the prevalence of MS is the use of different definitions of MS in various studies. The various definitions of MS that have been used are the World Health Organization (WHO) definition, IDF definition and the National Cholesterol Education Program Adult Treatment Panel III (ATP III) definition. In 2009 a joint interim statement of the IDF task force on epidemiology and prevention**,** National heart lung and blood institute, American Heart Association, World Heart Federation, International Atherosclerosis Society and International Association for the Study of Obesity was published. They proposed common criteria for the clinical diagnosis of the metabolic syndrome (13). Using these commonly agreed-upon criteria will facilitate adequate international comparisons between various studies. However, till the time more studies using these common ethnic specific criteria are published comparisons between various studies on MS will be affected by this confounding factor.

Thus our finding of prevalence of metabolic syndrome of 18.3% is much higher than other comparable studies, although in these studies the age range considered is relatively higher than the present study. In addition, there is a wide regional variation in the prevalence of MS from as low as 13% to as high as 47% (22). The prevalence of MS in Asian Indians varies according to the region, the extent of urbanization, lifestyle patterns, and socioeconomic/ cultural factors. Metabolic syndrome (MS) is a crucial factor in causation of diabetes and coronary artery disease (CAD) in Asian Indians. The prevalence of MS varies by the criteria used and the population studied, with greater prevalence in urban areas and in people with diabetes or obesity.

Asian Indians tend to develop central obesity rather than generalized obesity. Underlying the problem are complex factors—genetic, physiological, psychological, familial, social, economic, and political—coalescing to over determine these conditions (31). With improvement in economic situation in developing countries, increasing prevalence of obesity and the metabolic syndrome is seen in adults. The main causes are increasing urbanization, nutrition transition, and reduced physical activity.

Although there is abundant published literature regarding prevalence of MS in various age groups, we specifically concentrated on the prevalence of metabolic syndrome in the age group of 18-25 years because studies have shown that CVD risk factors such as abdominal obesity, hypertension and diabetes which are also risk factors for MS are higher among Indians, even at younger age than other ethnic groups (32). A recently published study in which the

New Delhi birth cohort was followed for seven years reported that the incidence and prevalence of CVD risk factors was high at a young age in an urban Indian population that is rapidly transitioning (33). Although there were gender differences in the incidence rates of obesity, hypertension and diabetes mellitus but central obesity, as measured by waist circumference, appeared to be increasing in both men and women. The high incident rates of obesity, hypertension, and diabetes in this young, urban Indian cohort definitively show that in future there will be a high burden of CVD in this population.

However since the reasons for the high burden of risk factors amongst Indians is still not clearly known we speculate that probably in our part of the world before the age of eighteen years students are mostly influenced by parental instructions and family norms controlling/monitoring their eating pattern and exercise practices. Beyond twenty-five years of age studies are complete and the individuals becomes mature enough to take their own decisions about their lifestyles. Thus in the vulnerably transitioning age group of 18-25years, exposure to a range of choices regarding food makes the youth more susceptible to unhealthy lifestyle patterns.

Several studies in India as well as other regions confirm that consumption of cooked food from outside is related to a higher proportion of overweight/obesity in adolescent age groups (31, 34, 35). It has also been observed that intake of sweetened soft drinks was related to overweight (31, 35). In a recent meta analysis it was found that People who spend higher amounts of time in sedentary behaviors have greater odds of having metabolic syndrome. Reducing sedentary behaviors is potentially important for the prevention of metabolic syndrome (36).

The economic cost of obesity and related diseases in developing countries, having meager health budgets is enormous. Latest reviews on this topic provide guidelines for treatment of each of the risk factors comprising metabolic syndrome (37). Creating a panel of biomarkers with a known and predictable association with metabolic syndrome can provide a means to detect those at risk and intervene as needed. This could significantly decrease the burden complications impose on patients and the healthcare system in high risk populations (38).

To prevent increasing morbidity and mortality due to obesity-related T2DM and cardiovascular disease in developing countries, there is an urgent need to initiate large-scale community intervention programs focusing on lifestyle modification by increased physical activity and emphasizing healthier food options, particularly for children. International health agencies and respective government should intensively focus on primordial and primary prevention programs for obesity and the metabolic syndrome in developing countries (14).

Conclusion

A prevalence of 18.3% of metabolic syndrome in college going students as reported in our study using ethnic specific cut offs is quite high. This high prevalence is alarming with India heading towards being declared as the diabetic capital of the world. There is a dire need to spread awareness amongst the youth of the nation about the importance of early recognition of risk factor of MS which will give them more years free of morbidity in a very cost effective manner. They should be encouraged to adopt a healthy lifestyle. Further, it is suggested that wide spread measures for awareness of metabolic syndrome should be taken on a bigger platform with more involvement of the policy makers. Message of how a healthy lifestyle can prevent the young generation from this syndrome should be adequately spread by use of media.

Future scope

Further studies need to look at the effectiveness of repeated awareness measure for MS. More studies are needed to be able to comment on rural urban differences in the same type of population. Also longitudinal intervention studies for the individuals diagnosed with MS should be planned so as to be able to comment on the most sustainable lifestyle modification in the individuals at risk of complications of MS.

Acknowledgements

This project is a part of the grant received by Department of Science and Technology- UT, Chandigarh, India vide letter number S&T/Sanc/11/2011/ 1158-1163 dated 21.11.2011. Acknowledgements are due to Ms. Dipti, Ms. Sumali and Mr. R P Singh for help in data collection. I am also thankful to Mrs. Neetu for technical help in analyzing the blood samples and Ms. Neelam for data entry.

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