THE RELATIONSHIP BETWEEN METABOLIC SYNDROME AND ITS COMPONENTS WITH SOCIO-ECONOMIC STATUS AMONG ADOLESCENTS IN SHIRAZ, SOUTHERN IRAN

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Abstract. The objective of this study was to investigate the relationship between metabolic syndrome and its individual components with socio-economic factors among 14-18 year-old adolescents in Shiraz, Iran. Using a multistage random sampling, a total of 538 (289 males and 249 females) adolescents consented to the study. Socio-economic status was obtained using a self-administered questionnaire while presence of metabolic syndrome and its individual components was ascertained using NCEP-ATP III criteria. The relationships between the participants' socio-economic status and metabolic syndrome and its components were determined using bivariate and multivariate statistical analyses. Approximately 6% of the adolescents had metabolic syndrome, with significantly more males than females (9.3% *vs* 2.4%, $p<0.001$). The most commonly found abnormality was low high-density lipoprotein cholesterol (42.4%), followed by hypertensive (16.3%). The prevalence rates of elevated triglycerides, abdominal obesity and high fasting plasma glucose were 15.6%, 8.6% and 3.1%, respectively. Metabolic syndrome was significantly more prevalent in obese participants (44.4%) than those with normal body weight (2.0%) or overweight (9.3%). There were positive associations between the components of metabolic syndrome and parental education, school location and household monthly income. Having a family history of obesity was associated with metabolic syndrome after controlling for other variables (OR=2.1; 95% CI: 0.9-5.2, $p=0.042$). Overweight and obese subjects were approximately 8 times and 15 times more likely to develop metabolic syndrome, respectively (overweight: OR = 8.2; 95% CI: 3.6-17.2; obese: OR = 15.4; 95% CI: 4.8-43.7). In conclusion, a positive association exists between socio-economic status and metabolic syndrome and its individual components among the studied participants. An intervention program to prevent metabolic syndrome needs to be developed for this young generation, especially among those who are overweight or obese and those with a family history of obesity.

Keywords: adolescents, metabolic syndrome, components of metabolic syndrome, socio-economic status, Iran

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INTRODUCTION

Previous studies from Iran showed that the prevalence of metabolic syndrome (MetS) is high (Azizi *et al*, 2003; Delavar *et al*, 2009), but these studies were conducted among middle-age adults, with limited data about MetS among adolescents in Iran. The high prevalence of MetS among adults suggests that it is important to determine the prevalence and risk factors for MetS among the adolescents.

Metabolic syndrome (MetS) is a clustering of risk factors for cardiovascular disease and type 2 diabetes mellitus (Alberti *et al*, 2009), with its major components including abdominal obesity, elevated blood pressure, plasma triglycerides, fasting blood glucose and low fasting high-density lipoprotein cholesterol (HDL-C). Previous study suggested each component of the MetS must be identified as early as possible to prevent definitive lesions (Mancini, 2009). In view of cardiovascular risk factors tend to track from childhood into adulthood (Deshmukh-Taskar *et al*, 2006; Chen and Wang, 2008; Casazza *et al*, 2009; Nguyen *et al*, 2010), early identification of MetS and its individual metabolic abnormalities is valuable in targeting efforts for chronic disease prevention (Cruz and Goran, 2004). Several studies found an association between genetics (Song *et al*, 2006) and fetal growth (Hoffmann *et al*, 2002) with the development of MetS later in life, however, environmental factors can also influence this genetic predisposition (Kelishadi *et al*, 2008). Higher prevalence of MetS has been found to be associated with lower socioeconomic status (SES) in developed country (Tamashiro, 2011). This association however is not consistently found in low and middle income countries (Mirhosseini *et al*, 2009; Ferguson *et al*, 2010).

In Iran, data about the association between MetS and SES is limited. Due to changes in epidemiological, demographic and nutrition conditions in Iran, adolescents are at increased risk for developing MetS (Kelishadi *et al*, 2009; Alwan, 2011). Determining the prevalence and factors associated with MetS and its individual components among adolescents in Iran can help in developing prevention programs. Therefore, in the present study we examined the prevalence of MetS and its components and the socioeconomic factors associated with MetS and its components among the adolescents in Iran.

MATERIALS AND METHODS

We conducted a cross sectional study in Shiraz, southern Iran among high school adolescents aged 14-18 years. Using a multistage random sampling procedure, a total of 12 high schools were selected from four educational districts. The calculated sample size needed for the study was 560 subjects, of whom 538 completed the evaluation. Subjects taking medication for hyperglycemia, hypertension or dyslipidemia were excluded from the study. This study was approved by the Ethics Committee for Research Involving Human Subject Universiti Putra Malaysia. Written informed consent was obtained from parents of subjects and verbal consent was obtained from the subjects themselves prior to being included in the study.

A set of structured questionnaire was administered to ascertain information on gender, age, parental educational level, parental occupation, monthly household income, SES of school location and presence of family history of obesity in their first degree relatives. Body weight, height and waist circumference (WC) were measured using a portable scale, stadiometer, and upstretched measuring tape using standard protocol (Cameron, 1984). Body weight was recorded to the nearest 0.1 kg and height to the nearest 0.1 cm. Body mass index (BMI) was used as the proxy measure for body weight status and was computed as weight (in kg) by height square (in meter^2). Using cut-off proposed by WHO 2007 Growth Reference, thinness, overweight and obese were defined as BMI < -2SD, BMI > +1SD and BMI > +2SD, respectively while normal body weight status was defined as BMI > -2SD but < +1SD.

Blood pressures were taken by a physician using mercury sphygmometer. Subjects were asked to refrain from drinking tea or coffee, physical activity, and to empty their bladder 30 minutes before the blood pressure measurement and requested to rest in a sitting position at least for 15 minutes prior to the blood pressure measurement. Blood pressures were measured twice at least 60 seconds apart. The mean of the two readings was recorded as the subject's blood pressure.

Venous blood samples were drawn between 7:00 and 9:00 AM after a 12 hours fast. The blood samples were centrifuged for 5 minutes at 2,000 rpm at room temperature and the serum was examined for triglycerides (TG) level and high-density lipoprotein cholesterol (HDL-C) level using an enzymatic method (Élan 2000 auto-analyzer, Eppendorf, Germany). The fasting plasma glucose (FPG) level was measured with the same auto-analyzer using the enzymatic colorimetric method with glucose oxidase.

Presence of MetS was confirmed using the National Cholesterol Education Program - Adult Treatment Panel III (NCEP-ATP III) criteria, modified for adolescents (Cook *et al*, 2003). According to this definition, MetS is present when the respondent met three or more of the following abnormalities: abdominal obesity (waist circumference ≥ 90th percentile for age and sex), hypertriglyceridemia (triglycerides ≥ 110 mg/dl), low HDL cholesterol (HDL cholesterol ≤ 40 mg/dl), hypertension (≥ 90th percentile for height, age and sex), and finally, high fasting plasma glucose level (FPG ≥ 110 mg/dl).

Data were analyzed using SPSS version 20 (SPSS, Chicago, IL). Differences in prevalence rates were confirmed with chi-square test. Multivariate logistic regression was applied to estimate the simultaneous effect of selected determinants on MetS as a dichotomous (yes/no) outcome. Fitness of data was checked and assumptions were met before performing analysis. Statistical significance was set at $p < 0.05$ and all tests were 2-sided.

RESULTS

As shown in Table 1, a total of 538 adolescents comprised of 53.8% males and 46.2% females were recruited. Paternal and maternal education were significantly higher among male subjects than their female counterparts (p<0.05). On the other hand, female subjects had a higher proportion of father who are self-employed as compared to male subjects. Traditional families dominate this studied sample where 88.3% of the household with husband as the sole-breadwinner stereotypical family while only 8.0% were dual-income families. Mean household monthly income was approximately USD 550, with a significantly higher household monthly income among the male subjects (p<0.001). A majority of the subjects' schools were located at low class neighborhood. There was significant proportion of male subjects who attending schools located at

Table 1
Descriptive characteristics of subjects.

	Male (n=289)	Female (n=249)	Total (n=538)	Test value
Age (years)	16.4 ± 0.9	16.3 ± 1.0	16.3 ± 1.0	t =1.2
Paternal education (years)	11.0 ± 4.4	9.9 ± 3.6	10.5 ± 4.0	t = 3.2[e]
Maternal education (years)	9.8 ± 4.2	9.0 ± 3.4	9.4 ± 3.8	t = 2.5[d]
Paternal occupation				
Employee[a]	77 (26.6)	50 (20.1)	127 (23.6)	χ^2 = 5.5
Self-employed[b]	110 (38.1)	118 (47.4)	228 (42.4)	
Others	102 (35.3)	81 (32.5)	183 (34.0)	
Maternal occupation				
Employee	32 (11.1)	11 (4.4)	43 (8.0)	χ^2 = 17.2[f]
Housewife	240 (83.0)	235 (94.4)	475 (88.3)	
Others	17 (5.9)	3 (1.2)	20 (3.7)	
Household monthly income (USD)	583.1 ± 208.4	519.1 ± 176.4	553.5 ± 196.7	t =3.9[f]
Location of school				
High class neighborhood	110 (38.1)	45 (18.1)	155 (28.8)	χ^2 = 31.04[f]
Middle class neighborhood	42 (14.5)	68 (27.7)	111 (20.6)	
Low class neighborhood	137 (47.4)	135 (54.4)	272 (50.6)	
Self-reported family history of obesity in close relatives[c]				
Yes	126 (43.6)	118 (47.4)	244 (45.4)	χ2 = 1.2
None	163 (56.4)	131 (52.6)	294 (54.6)	
Anthropometric measurement				
Body weight (kg)	63.2 ± 13.5	55.3 ± 9.9	59.6 ± 12.6	t = 7.62[f]
Body height (cm)	171.4 ± 7.5	159.4 ± 6.4	165.8 ± 9.2	t = 18.85[f]
Waist circumference (cm)	70.8 ± 9.5	64.8 ± 7.5	68.1 ± 9.2	t = 7.77[f]
BMI (kg/m^2)	21.5 ± 4.0	21.8 ± 3.7	21.6 ± 3.9	t = -0.96
Classification of body weight status				
Thinness	10 (3.5)	12 (4.8)	22 (4.1)	χ^2 = 1.5
Normal	206 (71.3)	177 (71.1)	383 (71.2)	
Overweight	48 (16.6)	49 (19.8)	97 (18.0)	
Obese	25 (8.6)	11 (4.4)	36 (6.7)	

Data were presented as *n* (%) or mean ± SD
[a]Employed with insurance coverage. [b]Working independently *eg*, salesman or taxi driver. [c]Close relatives include father, mother, sister, and brother. [d]Significant at $p < 0.05$; [e]Significant at $p < 0.01$; [f]Significant at $p < 0.001$.

high class neighborhood (p<0.001). Presence of family history of obesity is evident with slightly less than half of the subjects having family history of obesity. As expected, male subjects had significantly higher means of body weight, height and waist circumference (WC) than their female counterparts (p<0.001). Body Mass Index (BMI) and body weight status however were comparable between male and female subjects (p>0.05).

The prevalence of MetS and the in-

Table 2
Prevalence of metabolic syndrome and its components according to sex and body weight status.

	Male (N=289) No. (%)	Female (N=249) No. (%)	Total (N=538) No. (%)	χ^2
Low concentration of HDL	140 (48.4)	88 (35.5)	228 (42.4)	8.9[b]
Hypertension	76 (26.3)	12 (4.8)	88 (16.3)	21.6[c]
Hypertriglyceridemia	47 (16.2)	37 (14.9)	84 (15.6)	0.1
Abdominal obesity	33 (11.4)	13 (5.2)	46 (8.6)	5.7[a]
High fasting plasma glucose	12 (4.1)	7 (2.8)	19 (3.1)	0.4
Aggregation of ≥ 3 metabolic abnormalities	27 (9.3)	6 (2.4)	33 (6.1)	10.0[b]
Presence of MetS according to body weight status				
Normal	7 (3.4)	1 (0.5)	8 (2.0)	19.7[c]
Overweight	6 (12.5)	3 (6.1)	9 (9.3)	
Obese	14 (56.0)	2 (18.2)	16 (44.4)	

[a]Significant at $p < 0.05$; [b]Significant at $p < 0.01$; [c]Significant at $p < 0.001$.

dividual components among male and female adolescents are shown in Table 2. The overall prevalence of MetS was 6.1%. Low HDL-C level was the most common metabolic abnormality in both sexes, followed by hypertension, hypertriglyceridemia, abdominal obesity and high fasting plasma glucose. The prevalence of low HDL (48.4% compared with 35.5%; p<0.01), high blood pressure (26.3% compared with 4.8%; p<0.001), abdominal obesity (11.4% compared with 5.2%; p<0.05) and overall MetS (9.3% compared with 2.4%; p<0.01) were significantly higher in boys than in girls. No significant differences in the prevalence of hypertriglyceride or plasma glucose concentrations were observed between sexes. When categorized according to body weight status, the prevalence of MetS was significantly higher among obese subjects (44.4%), compared to 2% in normal weight or 9.3% in overweight subjects.

Table 3 depicts the associations between components of MetS and socioeconomic variables. Male subjects had significantly higher means of WC, systolic blood pressure (SBP) and FPG as compared to female subjects. On the other hand, mean HDL-C was significantly lower among male subjects (p<0.05). Means SBP and FPG were found to be significantly higher in older adolescents (p<0.05). Mean SBP of subjects was significantly higher among subjects with higher years of parental education while mean DBP was significantly higher among subjects with higher years of maternal education (p<0.05). While lower mean of HDL-C was reported among subjects whose fathers were salary earners (p<0.05), there was no significant mean difference in WC, SBP, DBP, TG, HDL-C or FPG with regards to maternal occupation. This may be attributed by approximately 90% of the mothers were housewives, hence limit the ability to make comparison. Subjects attending schools located at high class neighborhood had significantly higher SBP (p<0.001) and DBP (p<0.01). Subjects with family history of obesity were presented with higher means of WC and TG

Table 3
Associations between components of metabolic syndrome and selected variables.

Variables	n	WC	SBP	DBP	TG	HDL-C	FPG
Sex							
Male	289	71.1±9.4	110.0±15.5	68.3±11.2	93.0±36.9	42.1±8.3	86.5±7.5
Female	249	64.9±7.3[c]	100.0±11.3[c]	66.7±0.9	91.1±34.5	43.9±10.7[a]	71.1±9.4[a]
Age (years)							
14-15	104	67.6±10.4	103.0±14.0	66.1±10.2	91.7±34.1	44.7±9.7	84.7±6.6
16-17	385	68.1±8.6	105.1±13.8	67.6±10.3	92.0±36.5	42.6±9.5	85.2±7.4
18	49	70.4±9.2	111.9±19.5[a]	70.3±10.8	92.2±34.2	42.1±8.3	87.3±7.1[a]
Paternal education							
≤8 years	182	67.4±8.6	103.3±14.5	67.0±10.7	89.7±36.5	43.8±9.9	85.5±6.9
9-12 years	244	68.6±9.02	104.9±13.4	67.2±10.3	93.3±35.7	42.6±9.0	85.3±7.1
≥13 years	112	68.8±9.7	109.7±16.3[b]	69.2±10.0	92.9±35.0	42.5±9.8	86.1±8.5
Maternal education							
≤8 years	238	67.6±8.6	104.0±14.9	66.4±10.7	91.1±37.4	43.2±9.5	85.0±7.2
9-12 years	226	68.2±9.3	105.7±13.7	68.0±9.7	91.4±31.8	42.9±9.3	86.2±7.5
≥13 years	74	70.4±9.2	108.7±16.0[a]	69.8±10.9[a]	96.6±41.8	42.1±9.8	85.5±7.2
Paternal occupation							
Employee	127	68.5±9.4	107.5±15.9	68.3±10.2	97.0±38.6	41.0±8.0	85.2±7.7
Self-employed	228	68.1±9.0	104.4±14.2	68.0±10.7	89.8±33.7	43.2±9.2	85.6±7.5
Others	183	68.3±8.8	105.1±14.0	66.4±10.0	91.3±36.2	44.0±10.5[a]	85.7±6.8
Maternal occupation							
Employee	43	68.8±9.0	107.9±14.3	68.4±10.8	104.1±37.5	41.5±6.8	85.8±8.5
Housewife	475	68.0±8.8	107.9±14.5	67.4±10.3	91.0±35.6	43.1±9.7	85.4±7.1
Others	20	71.7±13.0	110.1±17.5	68.6±11.0	32.6±7.3	42.6±10.0	88.2±8.8
Monthly family income (USD)							
<553.5	302	66.8±8.4	102.4 ±12.8	66.7±9.5	91.2±33.8	43.5±10.5	85.2±7.0
>553.5	236	70.6±9.5[c]	108.9±15.3[a]	69.7±10.5[a]	95.4±38.7[a]	42.4±9.2	87.0±7.2[a]
SES of school neighborhood							
High	155	68.3±8.1	110.0±15.3	69.2±11.3	92.7±38.1	42.5±10.1	84.9±8.5
Middle	111	68.0±9.7	102.2±11.9	69.0±11.4	89.7±33.9	44.4±7.9	85.7±7.0
Low	272	68.3±9.2	104.0±14.6[c]	66.0±9.6[b]	92.5±35.3	42.6±9.6	85.9±6.7
Family history of obesity							
Yes	244	69.06±9.92	10.54±1.45	6.82±1.04	96.75±39.61	42.77±9.97	85.63±7.28
No	294	67.53±8.15[a]	10.57±1.45	6.69±1.03	88.04±31.80[a]	43.08±9.03	85.47±7.35

WC, waist circumference; SBP systolic blood pressure; DBP, diastfic blood pressure, TG, triglyceride; HDL-C, hihg density lipoprotein cholesterol; FPG, fasting plasma glucose; SES, socioeconomic status.
[a]Significant at $p < 0.05$, [b]Significant at $p < 0.01$, [c]Significant at $p < 0.001$.

Table 4
Logistic regression predicting likelihood of metabolic syndrome among the subjects.

	p-value	Odds ratio	95% CI
Sex	0.015[a]	0.3	0.1-0.8
Female (1)			
Age	0.863	1.1	0.6-1.5
Paternal education (1)	0.109	1.8	0.9-4.1
Maternal education (1)	0.715	0.9	0.4-1.8
Paternal occupation			
Employee (reference)	0.721		
Self-employed (1)	0.463	0.7	0.2-2.0
Others (2)	0.472	0.7	0.2-2.0
Maternal occupation			
Employee (reference)	0.073		
Housewife (1)	0.636	1.5	0.3-7.5
Others (2)	0.051	7.2	1.0-52.3
Monthly family income	0.031[a]	1.2	0.7-1.5
SES of school neighborhood			
High (reference)	0.095		
Middle (1)	0.025[a]	0.6	0.04-0.7
Low (2)	0.036[a]	0.4	0.2-2.1
Family history of obesity			
Positive (1)	0.042[a]	2.1	0.9-5.2
Body weight status			
Normal (reference)	0.067		
Overweight (1)	0.018[a]	8.2	3.6-17.2
Obese (2)	0.000[b]	15.4	4.8-43.7

[a]Significant at $p < 0.05$; [b]Significant at $p < 0.001$.

($p<0.05$) while other metabolic parameters were comparable.

Results of multivariate logistic regression performed to predict likelihood of MetS among subjects was depicted in Table 4. Females were less likely (OR = 0.3, 95% CI: 0.1-0.8, $p < 0.05$) and subjects with higher monthly family income were more likely (OR = 1.2, 95% CI: 0.7-1.5, $p < 0.05$) to have MetS. On the other hand, subjects with a positive family history of obesity had 2.1 times (OR = 2.1, 95% CI: 0.9-5.2, $p < 0.05$) higher odds of MetS as compared to those who did not have a family history of obesity. In addition, SES of school neighborhood showed significant contribution to this model indicating lower risk of MetS for students who studied at lower class SES neighborhood. The strongest predictors for MetS were overweight and obesity where overweight and obese subjects were approximately 8 times and 15 times more likely to develop MetS, respectively (overweight: OR = 8.2; 95% CI: 3.6-17.2; obese: OR = 15.4; 95% CI: 4.8-43.7).

DISCUSSION

Although the lacking of a standard definition for MetS among adolescents makes comparison with other studies difficult, the prevalence of metabolic syndrome in our study (6.1%) was higher than the world median of 3.3% (Friend *et al,* 2013) and that of adolescents from Hong Kong (2.4%) (Ozaki *et al,* 2007) and United States of America (4.2%) (Cook *et al,* 2003). However, the prevalence of MetS found in this study was lower than previous studies from Iran (Esmaillzadeh *et al,* 2006; Chiti *et al,* 2010; Barzin *et al,* 2012) and other countries (Budak *et al,* 2010; You and Son, 2012; Bhalavi *et al*, 2015). The discrepancies on the criteria adopted may explain a certain degree of instability in MetS diagnosis. Our finding of the prevalence of MetS being more common among males than females is similar to that of other studies (Esmaillzadeh *et al,* 2006; Chiti *et al,* 2010; Barzin *et al,* 2012), which may be attributed to significant higher WC, systolic and diastolic blood pressures and lower HDL-C levels among males. The reason for the lower mean HDL-C level among males than females in our study is unclear. Similar findings were seen in a study investigating trends of clustering of cardiometabolic risk factors among American adolescents (Okusun *et al,* 2012), where hormonal changes that occur among males during puberty has been proposed as the contributing factor (Kwiterovich, 1991).

A low mean HDL-C level was the most common metabolic abnormalities in our study. Our findings are in agreement with previous studies either among Iranian (Esmailzadeh *et al,* 2006; Kelishadi *et al,* 2008; Mirhosseini *et al,* 2009; Afkhami-Ardekani *et al,* 2010), Jordanian (Khader *et al,* 2010), American (Cruz *et al,* 2004), Canadian (Setayeshgaar *et al*, 2012) or Chinese (Li *et al*, 2014). This may be due to ethnic, genetic or environmental factors (Kelishadi *et al,* 2008).

High blood pressure was the second most common component of metabolic syndrome after low HDL-C level, affecting more than 16% of our subjects, which was lower compared to studies from Hong Kong (Ozaki *et al,* 2007) or Canada (Setayeshgar *et al*, 2012) but was higher than American (Cook *et al*, 2003) and Jordanian adolescents (Khader *et al,* 2010). Although the prevalence of abdominal obesity was only 8.6% in our study, it correlates well with other cardiovascular disease risk factors [total cholesterol, TG, HDL-C, low density lipoprotein cholesterol (LDL-C), and blood pressure (Savva *et al,* 2000; Janssen *et al,* 2005)]. When screening for metabolic syndrome in children and adolescents using blood testing is not feasible, measuring a waist circumference may be useful for predicting risk of metabolic syndrome.

Despite the current findings support earlier study that the overall prevalence rates of metabolic syndrome in adolescents is lower than adult (Ford *et al,* 2002), a different perspective was observed in overweight adolescents (Cook *et al,* 2003, Cruz *et al,* 2004). In our study, compared with normal weight subjects, overweight and obese subjects were more likely to develop MetS, which supports previous studies in Iran (Esmaillzadeh *et al,* 2006; Chiti *et al,* 2010; Mirhosseini *et al,* 2009) and other countries including China (Xu and Ji, 2008; Chen *et al*, 2012), Malaysia (Quah *et al*, 2010), Argentina (Hirschler *et al,* 2010) and Jordan (Khader *et al,* 2010). Systematic review by Tailor *et al* (2010) found that up to 60% of overweight and obese children and adolescents have MetS. The available evidence support the view that obesity is a powerful determinant of MetS among adolescents. Obese adolescents are at increased risk of having a poor psychosocial status, a poor physical functioning and a poor health-related quality of life (Schwimmer *et al*, 2003; Nadeau *et al*, 2011). A review study suggested that lifestyle modifications encompass increasing in physical activity and promoting dietary changes are the mainstay of treatment of MetS. It is believed comprehensive behavioral modification in overweight children may reduce body weight, improve body composition, and positively modifies the individual components of MetS (Pacifico *et al*, 2011). Therefore, it is important to develop appropriate strategies to combat obesity among the adolescents.

Our data coincides with those reported previously, in that the parental obesity is associated with a higher prevalence of MetS (Ekelund *et al*, 2009; Monzani *et al*, 2014). In our study, the association between family history of obesity and MetS persisted even after controlling for other factors on the multivariate logistic analysis. Family history of obesity was a significant and independent determinant of MetS among subjects in this study. The high clustering of components in family and twin studies has implied the importance of a genetic contribution to MetS (Carmelli *et al*, 1994; Lin *et al*, 2005). On the other hand, family history of obesity was significantly associated with subject's waist circumference, but not with any other metabolic parameters except TG, suggesting that the influence of family history of obesity on adolescents' status of MetS could be mediated by obesity in the subjects (Ekelund *et al*, 2009), this was recently supported by a suggestion that the effects of some gene variants on metabolic traits are modified by or present only in the setting of obesity (Aguilera *et al*, 2013).

In our study, subjects with higher monthly family income and from higher SES of school neighborhood were more likely to have MetS. Metabolic syndrome is not an inevitable result of genetic predisposition as health-related behaviors such as dietary habits and physical activity as well as environmental factors such the economic development level of a neighborhood, may play a role in MetS. The association between MetS and its components with SES of respondents are similar to a previous study among adolescent girls from Mashhad, northern Iran (Mirhosseini *et al*, 2009). Our findings are also consistent with findings from Venezuela (Velásquez *et al*, 2006), Brazil (Figueiredo *et al*, 2007), Benin (Ntandou *et al*, 2009) and Nigeria (Adedoyin *et al*, 2013) where the higher the SES of families, the more likely the subjects was to develop dyslipidemia, hypertension and a large WC among youth. However, our findings contradict those from Europe (Leal *et al*, 2011; van den Berg *et al*, 2012), America (Matthews *et al*, 2008; Manuck *et al*, 2010) and Beijing, China (Zhan *et al*, 2012). The discrepancy on the association between SES and MetS across several communities is not unexpected and has been well established (Gharipour *et al*, 2011). Most studies from developed countries report an inverse association between SES and cardiovascular risk factors, while studies from developing countries usually report a positive association (Ferguson *et al*, 2010). In Iran, adolescents have their main meals at home. Children from families with a higher SES receive pocket money (Gupta *et al*, 2012) that might be spent for snacks or fast food. These children are targeted by food industries. Children from families with a higher SES may also be more likely to have a sedentary lifestyle. More affluent children are more likely to use bus or car for transportation while less affluent children are more likely to walk or ride a bicycle. Less affluent children in developed countries are more likely to have a poor quality diet and be physically inactive (Gupta *et al*, 2012).

Our findings among adolescents about the association between SES and MetS contradict of a study among adults in Iran (Gharipour *et al*, 2011). This suggests adolescents and adult may have different manner of associations. A higher SES among adults might result in a better awareness of the risks of some factors associated with MetS. We also found gender differences in the individual components of MetS. Females from schools located in higher SES neighborhoods had a lower prevalence of an elevated WC while males from schools in lower SES neighborhoods had higher prevalence of unfavorable HDL-C levels. Such findings were comparable to a study from China (Zhan *et al*, 2012) which found gender differences by SES for components of MetS.

The prevalence of elevated SBP increased with age. A possible explanation could be an age-dependent increase in blood pressure during puberty (Shankar *et al*, 2005). In this study, we did not assess the stage of puberty of the subjects. An inverse association was also seen between age and mean FPG in our study. This may be explained by the effect of pubertal stage. Transient insulin resistance is common during puberty (Mohan *et al*, 1999). Insulin resistance is more common at the onset of puberty (Tanner stage 2), but decreases to near prepubertal levels by the end of puberty (Tanner stage 5). Since the mean age of our subjects was 16 years old, we speculate the majority of the subjects were in Tanner stage 5.

Several studies had found overweight children and adolescents have lower HDL cholesterol levels, higher triglycerides and insulin levels, but normal glucose levels (Mo-Suwan and Lebel, 1996; Weiss *et al*, 2004), suggesting glucose intolerance may develop later than other components of MetS (Saffari *et al*, 2012). It may be important to assess insulin levels along with fasting plasma glucose levels in children and adolescents, because many children presented with components of MetS may have normal glucose levels (Jessup and-Harrell, 2005).

In conclusion, in this study the prevalence of metabolic syndrome and its components were high. Dyslipidemia and elevated blood pressure were common especially among male subjects. Although no studies to date have explored the impact of MetS on disease outcomes among children and adolescents, the high prevalence of MetS among overweight adolescents coupled with the epidemic childhood obesity may lead to a disproportionate increase in cardiovascular disease in adulthood. MetS can persist into adulthood, increasing the risk for insulin resistance, cardiovascular disease and liver impairment. Given the long term consequences of MetS, proper intervention strategies in the prevention and treatment of adolescents' metabolic syndrome are urgently needed.

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