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*Original Article*

# Cardiovascular Risk Factors: A Study on the Prevalence of MS among 11-18 Years Old School Children in East of Iran, 2012

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## ABSTRACT

**Background and Objectives:** Metabolic syndrome (MS) is associated with increased risk of cardiovascular disorders. MS is increasing among adolescents. This study was conducted to determine the prevalence of MS in 11-18 years old Birjandi school children in 2012.

**Materials and Methods:** This cross–sectional study was conducted on 2394 eleven-eighteen years old school children in Birjand (1304 girls and 1090 boys) through Multiple-Cluster Sampling. Height, weight, waist circumference and blood pressure were measured by standard methods. Blood glucose, triglycerides, cholesterol, HDL-C and LDL-C were measured after a 12-hour fasting. MS was defined according to the modified Adult Treatment Panel III criteria. Data were analyzed by the SPSS software (ver. 16) using statistical T test, logistic regression and Chi square at $P<0.05$.

**Results:** According to this study, 6.9% of adolescents (4.5% of females and 9.9% of males) had MS. Occurrence rate of MS in male students was 2.32 times of female ones.

Components of MS included low HDL (27.7%), hypertriglyceridemia (23.7%), central obesity (16.2%), systolic hypertension (9.4%), diastolic hypertension (0.9%), and high FBS (0.6%). This study showed a significant relationship between MS, and overweight, obesity and central obesity. 48.5% of the adolescents had at least one component of MS.

**Conclusions:** MS has a high prevalence in Birjandi adolescents, particularly in the obese ones. Thus, preventive measures such as correcting life style, having appropriate nutrition, and encouraging adolescents to have more physical activity are recommended.

**Keywords:** Metabolic syndrome, Adolescents, Obesity, Cardiovascular risk factor, Iran

## Introduction

Metabolic syndrome (MS) is defined as a pattern of metabolic disturbances including central obesity, insulin resistance, hyperglycemia, dyslipidemia, and hypertension. It was first presented by Dr. Reaven in 1988. Individuals with MS are at high risk of cardiovascular diseases (CVDs) (1). MS and its individual components are detectable during the childhood, and both commonly persist throughout adolescence and adulthood. Prevalence of MS is parallel to increasing of obesity in children and adolescents. By being transferred to adulthood, the syndrome predisposes an individual to premature CVD and type II diabetes. Obesity is the most prevalent cause of the syndrome in children and adolescents (2).

As in the other developing countries, obesity in children and adolescents is increasing in Iran due to changes in the life style (3, 5). Identifying MS during

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childhood is vital to curbing the development and progression of cardiovascular and metabolic diseases during the adulthood.

Therefore, determining the frequency of the syndrome in children and adolescents in order to estimate the prevalence of the problem in the youth is necessary.

Due to increase in the mortality rate of CVD in Iran (6), it is necessary to conduct extensive studies about the geographical distribution of the syndrome. Having insufficient information about MS in Birjandi adolescents, the present study aimed at determining the prevalence rate of MS in 11-18 years old school children in Birjand (Iran).

## Materials and Methods

This cross-sectional, descriptive-analytical study was done on 2394 eleven-eighteen years old Birjandi school children, including 1304 females and 1090 males in 2012. The sample size was determined based on the formula with $\alpha$=0.05, MS prevalence = 9.5% (10), and effect size = 0.012,2300.

The samples were selected through multiple-proportional sampling. At first, 14 girls' schools and 14 boys' schools (7 secondary schools and 7 high schools from each sex) were selected regarding the distribution of schools in different districts of the city. Then, from each school, some students were selected from each class, in proportion to the total number of students in that specific school and to the total of the whole population of students in that class. The subjects were healthy, and aged between 11 and 18 years (average 14.52 ± 3.51 years). Subjects with diabetes who were under treatment with medication that influences blood pressure (BP), blood glucose, or lipid metabolism were excluded from the study. Also children with secondary obesity due to drugs or endocrine or genetic disorders were excluded from the study.

In the first stage, 2600 students were selected and trained by medical students. Demographic checklist together with a content form was dispatched to the parents of all children. They were required to fill out the checklist and the content form, and return them to the office of their kid's school if they agreed with the student's participation in the plan. In this stage, 2394 checklists were completed and returned. In the second stage, trained coworkers of the plan, after getting permission of the education office and coordinating with different schools, referred to the schools, and after measuring weight, height, waist circumference, and blood pressure of each student in a standard way, recorded them in the respective form. In the third stage, blood tests were performed. The necessary blood sample was derived from cubital vein to test FBS, triglyceride, and HDL after a 12-hour fasting. The blood sample was poured into a 5ml vacuum tube containing gel separator and clot activator (Becton Dickinson Co., USA). Half an hour later, the clot samples were separated by means of Sigma centrifugal machine with 3000 RPM in 10 minutes. In less than an hour, FBS, triglyceride, and HDL were measured through enzymatic method using German Roche kit by means of Roche Integra biochemical auto-analyzer (Germany).

Weighing was done by means of German Seca scales (with probable error 100 g), while the subjects were bare-footed and had light clothes on. The height of the students was measured and recorded while they were bare-footed, both legs attached, and their buttocks, shoulders, and occipital area were touching the height-meter index (probable error: 0.5 cm). Waist circumference of each student was measured by calculating the distance between the last rib and ileum while he/she was exhaling and in a standing position by means of a strip meter (probable error: 0.5 cm).

BMI was measured, and in order to pinpoint overweight and obesity, the percentiles presented by Iran's Centre for Diseases Control were applied. Thus percentiles 85-95 were taken as overweight, and percentiles >95 as obesity regarding age and sex. In order to determine central obesity, waist circumference values equal to or more than 90$^{th}$ percentile referred to in the tables of International Diabetes Federation with respect to age and sex, were used. Blood pressure was taken two times (with a lapse of ten minutes between the two) under standard conditions using an Hg blood pressure tester with an appropriate cuff. Then the mean obtained was recorded as the individual's BP. In order to diagnose hypertensive cases, the tables presented in The Fourth Report of Children's Hypertension Diagnosis, Assessment, and Treatment were taken into account.

MS was defined according to modified Adult Treatment Panel III criteria. We used the age-

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modified standards of the ATP III MS criteria (7.8). Subjects with three or more characteristics of the following components were categorized as having metabolic syndrome: 1) abdominal obesity (waist circumference, WC) > the age- and sex-specific 90$^{th}$ percentile for this population); 2) elevated blood pressure (systolic and/or diastolic blood pressure > the age-, sex- and height-specific 90$^{th}$ percentile, for systolic and diastolic blood pressure, respectively); 3) Low HDL-C level (<40 mg/dL); 4) elevated serum TGs (>110 mg/dL ); and 5) elevated FPG >110 mg/dL. Exclusion criteria were: suffering from genetic syndromes, endocrine disorders, physical complication preventing normal activity, and taking drugs affecting on MS symptoms.

Data were analyzed by the SPSS software (ver. 16) using statistical T test ,logistic regression and $X^2$ at P<0.05.

## Results

In the present study, 2394 Birjandi school children, including 1090 (45.5%) boys and 1304 (54.5%) girls (mean 14.47±2.06 yrs), were surveyed. Their mean BMI and mean WC were 20.21±4.01and 68.42±9.74 cm, respectively. The overall prevalence of MS in the students was 6.9%; but in males and females, it was 9.9% and 4.5%, respectively. The difference between the two sexes was statistically significant (P<0.001). Occurrence probability of MS in male students was 2.32 times greater than in females OR=2.32 (1.67-3.22).

Mean BMI, WC, DBP, and mean FBS in the females were more; whereas the mean SBP of males was significantly more (Table 1).

Low HDL in the study population was 27.7% (25.2% in females, 30.7% in males). Prevalence of hypertriglyceridemia, central obesity, systolic hypertension, diastolic hypertension, and hyperglycemia was 23.7% (22.5%, 25.1%), 16.2% (13%, 19.9%), 9.4% (4.1%, 15.1%), 0.9% (0.4%, 1.6%) and 0.6% (0.4%, 0.9%), respectively (Table 2).

According to Table 2, by Chi square test, central obesity (p<0.001), hypertension (both systolic (p<0.001) and diastolic (p=0.003)), and low HDL (p=0.003) were significantly higher in males compared to females. Prevalence of hyperglycemia and hypertriglyceridemia was higher in males, but the difference between the two genders was not significant (p>0.05).

**Table 1.** Comparison of the baseline characteristics of the study subjects by sex

| Variables | Boys (n=1090) | Girls (n=1304) | P value |
|---|---|---|---|
| | Mean±SD | Mean±SD | |
| Age (years) | 14.43±1.93 | 14.59±2.13 | 0.049 |
| Weight (kg) | 49.59±11.33 | 50.33±15.31 | 0.14 |
| Height (cm) | 154.48±12.42 | 157.92±12.59 | <0.001 |
| BMI (kg/m$^2$) | 19.79±.17 | 20.58±3.84 | <0.001 |
| Waist circumference (cm) | 67.81±8.75 | 69.10±11.63 | 0.001 |
| Systolic blood pressure (mm Hg) | 111.42±17.73 | 101.7±14. | <0.001 |
| Diastolic blood pressure (mmHg) | 59.00±21.51 | 61.51±17.99 | 0.001 |
| FBS (mg/dl) | 87.02±11.24 | 91.56±12.64 | <0.001 |
| TG (mg/dl) | 90.46±41.41 | 93.74±54.36 | 0.06 |
| HDL (mg/dl) | 47.33±11.02 | 46.65±11.16 | 0.1 |

**Table 2.** Comparison of the prevalence of MS symptoms by sex

| variable | Boys n (%) | Girls n (%) | P value |
|---|---|---|---|
| Increased waist circumference | 217(19.9) | 170(13) | <0.001 |
| High systolic blood pressure | 165(15.1) | 59(4.5) | <0.001 |
| High diastolic blood pressure | 17(1.6) | 5(0.4) | 0.003 |
| Hyperglycemia | 10(0.9) | 5(0.4) | 0.09 |
| High TG | 274(25.1) | 294(22.5) | 0.13 |
| Low HDL | 335(30.7) | 329(25.2) | 0.003 |

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Out of the subjects, 27.4% had only one symptom, 14.2% had two and 6.9% had three or more of the symptoms of metabolic syndrome. Generally speaking, 48.5% of the students had at least one MS symptom.

Prevalence of MS had a positive correlation with overweight, BMI, and central obesity (The prevalence of MS was 29.1% and 46.6% in individuals whose BMI was >85% and >95%, respectively). Probability of the occurrence of the syndrome in those with BMI>85% was 27.57 times greater than in the individuals with BMI<85% (Table 3).

Prevalence of MS in the subjects with central obesity was 38.2%, and its probability was 64.79 times greater in these subjects than those lacking central obesity, OR=64.79; 39.45-106.41 (Table 4).

**Table 3.** Independent association of variables with MS (logistic regression analysis)

| Variable | B | SE | P value | Exp (B)* | CI (exp B) |
|---|---|---|---|---|---|
| Sex | 0.63 | 0.20 | 0.002 | 1.88 | 1.26-2.80 |
| Ws90 | 3.13 | 0.32 | <0.001 | 22.95 | 12.14-43.38 |
| BMI (85%) | 1.16 | 0.30 | <0.001 | 3.20 | 1.77-5.76 |
| BMI (95%) | 0.44 | 0.22 | 0.054 | 1.52 | 0.99-2.46 |
| Age | 0.017 | 0.056 | 0.76 | 1.01 | 0.91-1.13 |
| Constant | -10.73 | 1.00 | <0.001 | 0.001 | |

Adjusted OR*

**Table 4.** Comparison of MS symptoms in adolescents regarding BMI and central obesity

| Variables | Category | Metabolic syndrome | | |
|---|---|---|---|---|
| | | Yes/No, n | OR (CI 95%) | OR (CI 95%) adjusted |
| BMI of 85% Percentile[1] | Abnormal | 139/341 | 27.57(18.07-42.05) | 30.59 (19.83-47.18)* |
| | Normal | 28/1886 | | |
| BMI of 95% Percentile[2] | Abnormal | 76/88 | 20.5(14.12-29.75) | 19.21(13.15-28.08)* |
| | Normal | 91/2139 | | |
| WS of 90% Percentile[3] | Abnormal | 148/239 | 64.79(39.45-106.41) | 59.68 (36.28-98.16)* |
| | Normal | 19/1988 | | |
| Sex | Males | 108/982 | 2.32(1.67-3.22) | 1.86 (1.27-2.74)** |
| | Females | 59/1245 | | |

*adjusted by sex

** adjusted by ws 90%

1. BMI equal to or more than 85% Percentile by sex and age=abnormal
2. BMI equal to or more than 95% Percentile by sex and age=abnormal
3. WS equal to or more than 90% Percentile by sex and age=abnormal

## Discussion

In this study, 2394 eleven-eighteen years old students (1304 females, 1090 males) were surveyed. It was found that 6.9% of the students (4.5% of females, 9.9% of males) had metabolic syndrome.

Prevalence rate of the syndrome highly depends on various definitions offered. Here, some of the similar Iranian and other countries studies are given.

According to a study on Iranian adolescents in 23 provinces, the prevalence of MS was 2.5% (9).

Based on the ATP III definition, prevalence of MS in 10-19 years old adolescents in Tehran was 9.5%. It was more prevalent in males (10). The results of another study in the same place and on the same age group revealed that prevalence of the syndrome was 7.4%, which was decreased to 6.7% after a lapse of 3.6 years (11).

In Mashhadi adolescents, prevalence of MS was 6.5% (12), in 15-18 years old in Gorgani children, it was 3.3%; more in males (13), and in Rafsanjani 11-18 years old girls, it was found 3.9% (14).

A study about 12-18 year olds in the United Arab Emirates (UAE) showed the prevalence of MS as13% (4% in females, 21% in males) (15).

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According to ATP III criteria, prevalence of the syndrome in the adolescents of Kuwait, Turkey, China, USA, India, South Korea, Iran, Mexico, and Brazil was 9.8%, 2.2%, 4.2%, 5.1%, 5.8%, 9%, 10.3%, 20.2%, and 30.9%, respectively (16).

Another study on 10-18 year olds in India indicated the prevalence of MS as 2.6%; 1.6% in females and 3.8% in males (17). A different survey in South Korea reported that prevalence of the syndrome in adolescents and adults was 6.4% and 22.3%, respectively (18).

Prevalence of MS in 13-16 years old Vietnamese, according to various definitions of the syndrome, ranged between 3.9% and 12.55% (19). A study on Chinese students reported the MS prevalence as 6.6% (20). Taking Cook's definition, prevalence of the syndrome in 7-17 year olds in China was 23.9% (21). According to a study on 321 ten-sixteen year olds in Brazil (2009-2011), 18% of the subjects had MS, which was more prevalent in females (22).

In Canadian adolescents, the prevalence MS is 3.5% (23), and it is said that obesity and MS in USA adolescents are two times of Canadians' (24, 25).

The present study revealed that prevalence of MS in boys is higher than in girls; a finding which accords with the results of many domestic and foreign studies such as Tehran, Gorgan, UAE, and India (10, 13, 15, 17).

Compared to the findings of other Iranian studies, prevalence of MS in the present study is close to those of Mashhad and Tehran (11.12), but it is higher than in 23 provinces, Gorgan, and Rafsanjan. However, this result approximates the findings regarding the adolescents of South Korea and China (18, 20). Based on the present study, prevalence of MS in Birjandi boys is similar to that of Kuwaiti boys (16).

Similar to others (15,13,29), we found a significant difference in MS prevalence between boys (9.9%) and girls (4.5%); this may be related to hormonal differences, such as testosterone and sex hormone binding globulin (SHBG) between the two genders (15). More pragmatically, the higher energy and fat intake among males may well have contributed to this difference.

In the present study, MS symptoms in descending order were low HDL (22.6%), hypertriglyceridemia (21.2%), central obesity (16.3%), hypertension (14.7%), and hyperglycemia (0.8%). In the adolescents of 23 Iranian provinces, the symptoms were low HDL, hypertriglyceridemia, central obesity, hyperglycemia, and hypertension in importance order (7). In Gorgan, symptoms of MS were hypertriglyceridemia, hyperglycemia, low HDL, hypertension, and central obesity in prevalence order (13). From the view of prevalence order of MS symptoms, the findings of present study are similar to those of the study on the adolescents of 23 provinces in Iran, except for hyperglycemia and hypertension. In the present study and in the above study, 110mg/dl and 100mg/dl were, respectively, pinpointed as borderlines of hyperglycemia.

The most prevalent symptom of MS in Canadian and American adolescents was low HDL. In Kuwait, the symptoms were low HDL (46.3%), hypertriglyceridemia (22.9%), hypertension (13.9%), central obesity (11.1%), and hyperglycemia (3.3%). In Vietnamese 13-16 adolescents, the symptoms were hypertriglyceridemia, low HDL, hypertension, and (the least prevalent) hyperglycemia in prevalence order (19). In Indian adolescents, the most prevalent complication was low HDL, and the least was hypertension (17). Symptoms of MS in Brazilian adolescents were central obesity (55%), low HDL (35.5%), hypertension (21%), hypertriglyceridemia (18.5%), and hyperglycemia (2%) (22). In Chinese children and adolescents, the symptoms included central obesity, hyperglycemia, and hypertension (21).

The present study revealed that the most prevalent MS symptom was low HDL, which is similar to that of the adolescents of 23 provinces of Iran, Canada, USA, India, and Kuwait. Various studies have reported that low HDL in Iranian children and that Iranian adolescent have a higher prevalence compared to the condition of these age groups in the West, which can be due to racial differences (26, 27).

Hypertriglyceridemia has a high prevalence in Birjandi adolescents, which can be because of nutritional factors and fatty foods they take. The least prevalence was that of hyperglycemia, which is similar to the findings of many similar studies in such countries as China, Vietnam, and Brazil (19, 20, 22). It is noteworthy that in the present study, FBS >110 was accounted as abnormal; though many studies take

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FBS>100 as abnormal level. The present study found that prevalence of MS was proportionate to overweight and obesity such that in the overweight it was 29.1%, in the obese 46.6%, and in those with central obesity 38.2%.This finding is similar to what is reported in many similar studies. Total prevalence of MS in the adolescents of 23 provinces of Iran was 2.5%; however, in the overweight or obese ones, it was reported as 15.4% (9). In Tehrani adolescents, the syndrome was diagnosed in 21.5% of individuals at overweight risk, 42.2% in the moderately overweight, and 62.9% in highly overweight individuals (10).

The prevalence of MS in Mashhadi obese children was 45.1% (10). Another study on 5-15 years old overweight and obese Mashhadi children reported the prevalence of the syndrome to be 20.1% (28).

Cook's study found that prevalence of MS in the general population of American children was 4.2%. It was 6.8% in the overweight and 28.7 in the obese ones (29). Aprecido et al. estimated the prevalence of the syndrome as 15.3% in obese Brazilian children (32). It was also reported that the general prevalence of the syndrome in Chinese children was 6.6%. It was diagnosed in the overweight and obese children to be 20.5% and 33.1%, respectively (20). In 7-17 years old Chinese with normal body weight, overweight, and obesity, prevalence of the syndrome was 0.7%, 0.8%, and 23.9%, respectively (21). It was also found that 8.4% of Malaysian 12-18 year olds were obese and one-third of the obese had MS (31). Another study on Mexican obese children reported the prevalence of MS as 23.3% (32). According to a study on Lebanese children, prevalence of the syndrome was 4% in the overweight but 26.4% in the obese (33). In addition, it is reported that obesity in Kuwait has increased the possibility of MS three-fold (16).

Various studies have mentioned the relationship between MS and obesity. This confirms the fact that obesity can predispose individuals to CVD complications and diabetes, which requires an emphasis on the correction of life-style and nutrition. Therefore, although it is not possible to suggest screening in all children and adolescents, it must be taken into account with respect to overweight and obese ones.

Iran is among the countries experiencing a nutritional transfer. This is why a growing prevalence of obesity is reported in Iranian children and adolescents. It is reported that prevalence of obesity and central obesity has critically increased compared to ten years ago (34). In 2012, the prevalence of overweight, obesity, and central obesity in Birjandi primary school children was 9.6%, 9.2%, and 15.7%, respectively (3).

Another study on Birjandi primary school children in 2002 reported the prevalence of overweight and obesity as 2.2% and 1.2%, respectively (34).

The warning findings of the present study are high prevalence of MS (manifested in hyperdyslipidemia), and high prevalence in central obesity. Besides, almost half of the subjects had at least one symptom of MS.

The strengths of the study were the large sample size and the efforts to include a representative sample; however, this study had some limitations. For example, the number of BP measurements is a crucial factor impacting the prevalence of hypretension, which may be decreased upon repeated visits. A further limitation of this study may be due to error in recall of the lifestyle exposure and possible outcome, because the study had no control over the exposure of interest such as diet or physical activity. Overall, taking preventive measures including correcting life-style, having more physical mobility, avoiding the consumption of high-calorie foods and fast foods are important. Caring about weighing of children and adolescents during their routine references, and screening lipids, together with sensitizing health-workers and families to this point have important roles in identifying at-risk adolescents (8). It is recommended that proper interventions should be made in order to control weight, dyslipidemia, and hypertension. It is also recommended to promote the knowledge of adolescents and their parents through mass media and appropriate educational programs in schools. Accurate screening of at-risk adolescents can decrease long-term consequences during adulthood. Besides, it is advisable to carry out periodic surveys to identify the development of MS complications.

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## Ethical issues

The Ethical Committee of Birjand University of Medical Sciences (BUMS) approved the present study.

## Financial disclosure

The authors declare that they have no competing interests.

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The present study was adopted from the proposal number 610 approved by the Research Office of BUMS.

## Authors' contributions

Taheri and Kazemi designed the research; Namakin drafted;Bijari analyzed data; Zardast done laboratory test; and Chahkandi was co-worker.

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