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The Prevalence of Pediatric Metabolic Syndrome Risk Factors in Iran

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Abstract

Background: The aim of this study was to evaluate the prevalence of Cardiovascular Disease (CVD) risk factors in 6-18-year-old students in Birjand, east of Iran.

Methods: This cross-sectional study was performed on 4182 students, including 2086 females and 2096 males, in two age groups of 6-11 and 12-18 years. In order to pinpoint overweight and obesity in them, the percentiles presented by the Centre for Diseases Control (CDC) were applied. Percentiles equal to or greater than 90 were considered as high blood pressure or abnormal. Fast blood sugar over 100 mg/dl, total cholesterol over 200 mg/dl, LDL over 130 mg/dl, HDL over 40 mg/dl and triglyceride more than 100 mg/dl and 130 mg/dl for ages of 6-9 and 10-18 years, were regarded as abnormal values. Data was analyzed by SPSS Software (V. 16), using T-test and X2 at the significance level of 0.05.

Results: The prevalence of selected CVD risk factors for the age groups of 6-11 and 12-18 years were 9.5% and 7.3% for overweight, 9.2% and 8.2% for obesity, 15.7% and 16.3% for abdominal obesity, 11.2% and 4.6% for diastolic hypertension, 21.8% and 10.1% for systolic hypertension, respectively. The prevalence rates were found to be ,respectively, 4.7% and 7.5% for high blood glucose, %13.4 and 6.1% for high cholesterol, 8.5% and 3.5% for high LDL, 15.3% and 14% for high triglycerides, and 11.3% and 24.7% for low HDL levels, in the two age groups of 6-11 and 12-18 years.

Conclusions: This study shows a high prevalence of CVD risk factors in children and adolescents of Birjand.

Key Words: Cardiovascular Risk Factors, Children and Adolescents, Diabetes, Dyslipidemia, Hypertension, Obesity, Overweight.

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1- INTRODUCTION

Rapid change in lifestyle during the recent decades has caused a shift in the pattern of Non-Communicable Diseases (NCDS); as a result, cardiovascular disease (CVD) is the most common cause of mortality worldwide, including Iran (1-4).

The World Health Organization has stated that Non-Communicable Diseases (NCDS) are responsible for three-quarters of the developing countries deaths in 2020 (1). It is widely believed that their risk factors are present since childhood and progress into adulthood (5).

Obesity is a major risk factor for NCDS. Childhood obesity, especially abdominal obesity, is associated with an increased risk of metabolic syndrome in childhood and adolescence. Moreover, childhood obesity is associated with the risk of obesity in adulthood and as a result, increased morbidity and mortality due to cardiovascular complications, diabetes and hypertension (1, 2, 6). Profound changes in lifestyle between the years 1980 - 2000, in many countries of the world, have led to a significant increase in the prevalence of overweight and obesity in children (2, 3, 7). Childhood obesity is growing in developing countries (1, 2, 8). In recent years, the prevalence of obesity in children and adolescents has increased in Iran, as in many countries (1, 9).

Hypertension in childhood is a predictor of the risk of high blood pressure in adulthood and it is a risk factor for atherosclerosis (10). Obesity and being overweight are the most important factors for high blood pressure. Lifestyle modification is considered an important factor in the prevention and control of blood pressure (11).

Dyslipidemia is a Triggering factor for the process of atherosclerosis and its progression. The process of atherosclerosis begins in childhood (12-14).

The risk from CVD has a 3-4-fold increase in a diabetic patient (15). Type 2 diabetes, a new clinical problem within pediatric practice (16) is increasing worldwide (16, 17) currently, more than 200 children and adolescents develop the disease every day worldwide (18).

The high prevalence of CVD is alarming in Iran; therefore, identification of CVD risk factors and intervention measures in childhood is needed. On the other hand, considering the effects of racial and geographic factors, the prevalence of risk factors should be surveyed in each region and appropriate interventions should be designed and performed. This study aimed to determine the prevalence of CVD risk factors such as overweight, obesity, abdominal obesity, hypertension, hyperglycemia, and dyslipidemia among 6-18-year-old students, in Birjand.

2- MATERIALS AND METHODS

2-1. Design and participants

This cross-sectional, descriptive-analytical study involved 4182 students in the age range of 6-18 years, in Birjand city, Iran, including 2086 females and 2096 males. The samples were selected through a multiple-proportional sampling method. In order to cover all areas of the city, 24 girls' schools and 24 boys' schools (10 primary schools, 7 secondary schools and 7 high schools for each sex) were selected based on the distribution of schools in different districts of the city. The sample size in each school was selected based on the number of students studying in that particular school.

4600 students were selected and informed consent was sought and documented from their parents or legal guardians. Considering the exclusion criteria, subjects were assessed; and 4182 students were finally enrolled in the study. Weight, height, waist circumference and blood pressure of students were measured subsequently.

2-2. Inclusion and Exclusion criteria

The main inclusion criteria were as follows:

a) Being a student aged six to eighteen years old

b) Living in Birjand city

The main exclusion criteria were as follows:

c) Having a genetic syndrome

d) Having an endocrine disorder

e) Having a physical complication preventing normal activity

f) Taking drugs affecting fasting blood sugar and plasma lipid profile

2-3. Materials and Methods

The weight of students was measured, while the subjects were bare-feet and had light clothes on (with probable error of 100 g). The height of the students was measured and recorded while they were bare-feet, both legs attached, buttocks, shoulders, and occipital area touching the height-meter index (probable error: 0.5 cm). Waist circumference of each student was measured by placing a measuring tape in a horizontal plane around the abdomen at the level of the iliac crest (probable error: 0.5 cm).

Body Mass Index (BMI) of every student was also calculated, and categorized according to the measures of Center for Diseases Control (CDC). Similarly, in order to pinpoint overweight and obesity in them the percentiles presented by CDC were applied. A BMI between the 85th percentile and 95^{th} percentile means overweight, while children above the 95th percentile are considered obese. Blood pressure was also measured using standard protocols and appropriate cuff size on two separate occasions, 10 minutes apart; and the mean of the two readings was documented. The fourth report of children's hypertension diagnosis, assessment, and treatment was used to interpret blood pressure values according to gender, age, and height (19). Percentiles equal to or greater than 90 were considered as high blood pressure or abnormal.

Following 12 hours of fasting, a blood sample was drawn to measure Fasting Blood Sugar (FBS) and lipid profile. The blood samples were taken to the laboratory; in standard conditions, they were poured into vacuum 5ml tubes containing gel separator and clot activator (made in Bacton Dickinson Co (U.K)). Less than a quarter of an hour later, clot samples were separated by means of the Sigma centrifugal machine with 3000 RPM in 10 minutes. In less than one hour, FBS, triglyceride, and HDL were measured through enzymatic methods using German Roche kits by means of Roche Integra biochemical auto analyzer (made in Germany).

Abnormal values were as follows: FBS>100 mg/dl, total cholesterol >200 mg/dl, LDL >130 mg/dl, HDL< 40, triglyceride more than 100 mg/dl and 130 mg/dl in those aged 6-9 and 10-18 years, respectively. Lipid profile values were interpreted based on NHLBI panel definition (2011) (20).

2-4. Data Analysis

Data was analyzed by SPSS Software (V. 16), using independent samples T-test to compare means of quantitative variables and X2 to determine relations for qualitative variables in each age group by sex at the significance level of 0.05.

3- RESULTS

4182 students aged 6 to 18 years old, including 2096 (50.1 % (boys and 2086 (49.9%) girls, have been assessed in the present study. Of all, 36.8% and 63.2% of students were in the age groups of 6-11 and 12-18 years, respectively. The age of 36.8% of the assessed students was between 6-11 years, and 63.2% of them

were between 12-18 years old**.** Systolic and diastolic blood pressure, blood sugar, lipid profile and body mass index of the students was classified according to age groups and sex presented in **Table 1**.

Table-1: Comparing the cardiac risk factors in two age groups by sex

Age groups		Total	Boys N=2096	Girls N=2086	P-Value
		Mean ± sd	Mean ± sd	Mean ± sd	
BMI	6-11	16.58±3.26	16.92±3.33	16.29±3.18	<0.001
	12-18	20.22±4.01	19.79±4.17	20.58±3.84	0.001
WC	6-11	58.34±8.63	59.15±9.34	57.69±7.97	0.001
	12-18	68.4± 9.7	69.17±9.85	67.82±8.43	0.01
FBS	6-11	87.67±8.73	87.99±7.6	86.13±9.65	0.001
	12-18	89.8±9.8	92.07±11.3	87.83±7.7	<0.001
TG	6-11	81.3±37.2)	78.3±35.9	83.8±38.1)	0.003
	12-18	92.16±44.93	93.58±50.16	90.89±39.67	0.12
TC	6-11	168.4±28.7)	169.1±29.6)	167.7±27.8)	0.33
	12-18	152.58±29.11	150.06±30.04	154.83±28.07	<0.001
LDL	6-11	95.3±23.3)	95.1±23	95.5±23.5	0.79
	12-18	83.49±23.08	81.99±23.75	84.83±22.39	0.002
HDL	6-11	52.1±10.8)	53.3±11.4)	51.1±10.2)	<0.001
	12-18	47.29±10.65	46.91±11.23	47.64±10.11	0.01
Non-HDL-C	6-11	116.28±28.12	116±28.9	116.53±27.4	0.70
	12-18	105.24±2813	103.15±29.04	107.12±27.16	<0.001
SBP	6-11	97.45±19.6	99.2±20.1	96.2±19.1	0.002
	12-18	107.04±16.74	111.42±17.73	101.77±14.4	<0.001
DBP	6-11	55.99±12.8	57.3±12.8	54.9±12	<0.001
	12-18	60.54±11.03	61.47±11.14	58.75±10.95	<0.001

According to the results of the present study, the metabolic risk factors of those aged between 6-12 years old in order of prevalence were as follows: systolic hypertension (22.7%), hypertriglyceridemia (15.9%), abdominal obesity (15.7%), hypercholesterolemia (14.1%), low HDL (11.8%), diastolic hypertension (11.7%), overweight (9.5%), obesity (9.2%), high LDL (9%) and high blood glucose (4.7%); the metabolic risk factors of 12-18 years old students in order of prevalence were as follows: low HDL (24.7%), abdominal obesity (16.3%), high TG (14%), systolic hypertension(8.2%), obesity (7.6%), high blood glucose(7.5%), overweight(6.8%), hypercholesterolemia(6.1%), diastolic hypertension(4.2%) and high LDL(3.5%) (**Table 2**).

The prevalence of risk factors was higher in those aged between 6-12 years, compared to those aged 12-18 years. Overweight, obesity, high triglycerides, high total cholesterol, high LDL and hypertension were more prevalent in the 6-12 age group, while abdominal obesity, high blood glucose and low HDL were more common among 12-18-year-old students (**Table 2**).

Compared to girls in the same age group, the frequency of most risk factors was higher in boys aged 12-18 years old, except for obesity, high LDL, total cholesterol and systolic hypertension.

Table-2: The prevalence of risk factors in two age groups by sex

Age groups		Total	Boys	Girls	P-Value
		N (%)	N (%)	N (%)	
Overweight	6-11	147(9.5)	76(8.9)	71(10.3)	<0.001
	12-18	180(6.8)	97(7.7)	83(5.9)	<0.001
Obesity	6-11	142(9.2)	75(8.8)	67(9.7)	<0.001
	12-18	202(7.6)	94(7.5)	108(7.7)	<0.001
WC	6-11	243(15.7)	140(16.4)	103(14.9)	<0.001
	12-18	433(16.3)	249(20)	184(13.2)	0.0001
FBS≥100	6-11	72(4.7)	38(4.4)	39(5.6)	0.12
	12-18	200(7.5)	133(10.6)	67(4.8)	<0.001
Abnormal TG	6-11	246(15.9)	103(12.1)	113(16.3)	0.01
	12-18	371(14)	201(16.1)	170(12.2)	0.004
Abnormal TC	6-11	217(14.1)	110(12.9)	107(15.5)	0.01
	12-18	160(6.1)	74(5.9)	86(6.2)	0.05
Abnormal LDL	6-11	139(9)	63(7.4)	76(11)	0.01
	12-18	93(3.5)	41(3.3)	52(3.7)	0.06
Abnormal HDL	6-11	183(11.8)	71(8.3)	112(16.2)	<0.001
	12-18	652(24.7)	345(27.7)	307(22)	0.002
Abnormal Non-HDL-C	6-11	226(14.6)	110(12.9)	116(16.8)	0.01
	12-18	209(7.9)	90(7.2)	119(8.5)	0.04
SBP >90th percentiles	6-11	350(22.7)	174(20.4)	176(25.5)	0.02
	12-18	219(8.2)	91(7.3)	128(9.1)	0.01
DBP >90th percentiles	6-11	181(11.7)	92(10.8)	89(12.8)	0.01
	12-18	112(4.2)	69(5.5)	65(4.6)	0.04

Compared to the boys in the same age group, most risk factors were more prevalent among girls aged 6-11 years old, except for overweight, obesity, waist circumference, abnormal total cholesterol, and abnormal diastolic blood pressure (**Table2**).

4- DISCUSSION

4-1. Overweight and obesity

According to the results of this study, overweight and obesity were more prevalent in male students, compared to females.

According to the results of the CASPIAN III Study in 23 provinces of Iran, among 5738 children aged 10–18 years, 17.7% were obese or overweight (21). A review study performed by Kumar, reported that one-third of children and youth in the United States are overweight or obese. The prevalence of both overweight and obesity increased with age so that 22.8% of preschool age (2-5 years), 34.2% of elementary school children (6-11 years) and 34.5% of adolescents (12–19 years of age) were either overweight or obese (6). Prevalence of obesity increased in elementary school children (6-11 years) from 6.5% to 18.5% and in adolescents (12-19 years) from 5% to 18.4%, respectively between 1976–1980 and 2009–2010 (6).

Based on a major review article, Prevalence of overweight and obesity together in adults and children was 27.5% and 47.1%, respectively; the increased prevalence of overweight and obesity in children compared to adults has been present across the world. In developed

countries, across the two generations, the prevalence has increased from 16.9% to 23.8% in males and from 16.2% to 22.6% in females; in developing countries, the prevalence has increased from 8.1% to 12.9% in males and from 8.4% to 13.4% in females. There was no difference between two genders in early childhood; but it was higher in boys aged 10 years and above in the developed countries (2).

In southern Brazil, the prevalence of overweight and obesity in those aged 6-18 years was 25.7% and 10.4% respectively; these values were 15.8% and 4.3% in the northeastern part of the country, and 16.8% and 5.3% in central and west Brazil (22).

The prevalence of obesity in North American children aged 2-19 years and Latin American children aged 5-9 years was 16.9% and 18.9% to 36.9%, respectively (23, 24).

The prevalence of overweight in Spanish children and adolescents aged 6 to 17 was 21.5% and 6.6%, respectively, and the prevalence of obesity among Spanish children and adolescents aged 6 to 17 was 17.4% and 5.2%, respectively (25).

The prevalence of overweight and obesity in children of Bahrain aged 10-13 years was different in boys and girls with percentages of 15.7% and 28.9% in boys and 21.1% 30.7% in girls, respectively (26). The prevalence of obesity among children and adolescents aged 5 to 19 years in some other developing countries are reported as follows: 41.8% in Mexico, 22.1% in Brazil, 22% in India, and 19.3% in Argentina (8).

Comparing the results of the present study with those of previous studies performed on the same population reveals that the prevalence of overweight and obesity has increased in Birjand city (9, 27). And according to the results of studies performed in other developing countries, obesity rates are increasing among children (2, 8).

Regarding the worldwide epidemic childhood obesity, developed countries have been able to stop or reduce the increasing childhood obesity trends by designing and implementing prevention programs and lifestyle modifications; for instance, a study reported a significant increase in daily physical activities and consumption of fruits and vegetables, and reduced consumption of energy-dense foods and television viewing, between 2001 and 2010 in students aged 6-10 years (3).

4-2. Abdominal obesity

In our study, the prevalence of central obesity among children 6- 11 and 12 -18 years of age were 15.7% and 16.3%, respectively which was more common in boys compared to girls. According to the CASPIAN study, the prevalence of abdominal obesity in Iranian adolescents was 16.3% (21).

Based on a review article, the prevalence of central obesity in adolescents aged 10-19 years in developing and developed countries varied from 3.8% to 51.7% and 8.7% to 33.2%, respectively (28). The prevalence of abdominal obesity among United Arab Emirates teenagers was 16% (22% boys and 4% girls) (29). The prevalence rate of central obesity in Chinese male students (7-18 years) was 19.9% and 11.9% in urban and rural areas, respectively, with no difference between urban and rural girls (5.8% in both groups). A significantly higher prevalence of abdominal obesity was observed among urban boys with high socioeconomic status, as compared with rural girls with low socioeconomic status (24.9% vs. 4.5%, respectively). Urbanization and Higher socioeconomic status was associated with a higher risk of abdominal obesity (30). The prevalence of abdominal obesity in Brazilian adolescents was 32.7

% (36.3 % in girls and 28.4% in boys) (31). This value was 9.4% (9.1% in boys and 9.7% in girls) and 9.6% (9.8% in boys and 9.5% in girls) among Spanish children and adolescents, respectively (25). The prevalence of abdominal obesity was 17.9% among American children aged 2-18 years in 2011-2012, and it did not essentially change between 2003 and 2012 (32). The prevalence of abdominal obesity in this study is similar to the results of the studies performed in UAE, and the CASPIAN study (21, 29, 31).

4-3. Hypertension

In our study, the prevalence of systolic and diastolic hypertension, in the 6-11 age group was 22.7% and 8.2%, respectively. Regarding the students aged 12-18 years old, the prevalence of systolic hypertension was 11.7%, and the prevalence of diastolic hypertension was 4.2%. The results indicate that hypertension is more prevalent among children compared to adolescents. Meanwhile, the prevalence of hypertension is higher among girls, except for the 12-18 age group in which boys are more affected with hypertension. In this study, blood pressure above the 90th percentile was considered to be elevated; this cut off point includes both pre-hypertension and hypertension.

According to the CASPIAN study which was performed among Iranian kids, the prevalences of systolic, diastolic, systolic or diastolic hypertension were 4.2%, 5.4% and 7.7%, respectively (21). According to a study performed on 6 to 12 year-old children of Ahwaz, a city in southern Iran, systolic and diastolic pre-hypertensions were present in 9.7% and 13.5% of the studied children, respectively, and systolic and diastolic hypertensions were reported in 23.6% and 17.1% of them, respectively (33). Based on a survey conducted on 7893 children and adolescents aged 6 to 18 years in China, the prevalence rates of pre-systolic and diastolic hypertension were 6.28%, 4.2%, and 3.86%, respectively (34).

4-4. High blood glucose

According to our study, 4.7% of children aged 6-11 years, and 7.5% of children aged 12-18 years had blood glucose levels over 100 mg/dl.

Based on the result of the CASPIAN study, 18.5% of girls aged 10-18 years and 12.2% of boys in the same age range had blood glucose levels over 100 mg/dl (21). The prevalence of impaired glucose and diabetes in west China was reported to be 0.7% and 0.1%, respectively (35). The prevalence of type 2 diabetes is on the rise worldwide among children of all racial and ethnic groups (16, 17). The prevalence of both type 1 and type 2 diabetes increased significantly between 2001 and 2009 in five diverse geographic regions of the United States; the prevalence of type 2 diabetes has increased by 30.5%, and regarding type 1 diabetes, this value is 21.1% (36).

4-5. Dyslipidemia

According to the results of the present study, the prevalence of high cholesterol, high LDL, high triglycerides, and low HDL levels in the 6-11 and the 12-18 age groups were found to be %14.1 and 6.1%, 9% and 3.5%, 15.9% and 14% , and 11.8% and 24.7%, , respectively.

The prevalence of dyslipidemia among children has been increasing during the past 20 years in many countries, which has been similar to the increasing pattern in adults (1, 8, 9).

According to the CASPIAN Study performed on Iranian children, the most common type of dyslipidemia was low HDL level; and it was present in 40.8% of boys and 44.7% of girls (21). Based on Jung's study performed on 10-18 years old Korean children and adolescents in 2012, 19.7% of the studied population had at least one type of dyslipidemia.

Low HDL, hypercholesterolemia, high LDL, and hypertriglyceridemia were reported in 14.5%, 6.5%, 4.7% and 10.1%, respectively (37). The prevalence rates of hypercholesterolemia and high LDL were higher among girls than boys. Low HDL was significantly higher in boys (37).

A study in Japan revealed that 18.8% of boys and 24.9% of girls in the 9-10 age group, have high LDL. The values in the 12-13 age group were 15.6% and 20.6%, respectively (38).

In the CASPIAN Study, the risk factors in Iranian adolescents, in order of prevalence, were low HDL, high TG, abdominal obesity, high blood glucose, and hypertension (21). The prevalence rates of abdominal obesity, low HDL, hypertension, hypertriglyceridemia, and high FBS among Brazilian adolescents were 55%, 35.5%, 21%, 18.5% and 2%, respectively (39). In Nepal (9-12 years), low HDL, hypertension, prehypertension, high TG, and high TC were reported in 70.6%, 6.4%, 13.3%, 8.7% and 0.9% of children, respectively (40).

In this study, hypertension was the most common risk factor among children aged 6–11 years old. The high prevalence of hypertension was also reported among children in Iran (Ahvaz city) and Nepal (33, 40). In our study, low HDL was the most common risk factor in adolescents; this finding is similar to the results of other studies (21, 40). There are several studies reporting a higher prevalence of low LDL among Iranian children and adolescents, as compared to Western countries (21, 40, 42). The pattern of the components of metabolic syndrome, especially low HDL, high TG, and abdominal obesity varies in Europe, Asia, and South America (1, 41). The most common component of metabolic syndrome in children and adolescents of Iran and Turkey was high TG and low HDL, While, high total cholesterol and high LDL are more common in western countries, which might be due to racial differences (1,41).

Our findings, further, demonstrate that the prevalence of CVD Risk factors, especially dyslipidemia, among children living in Birjand is high and it has had an increasing pattern in recent years (42). Like other developing countries, this condition could be due to urbanization, sedentary lifestyle, and increased consumption of energy-dense foods, fast-food and also increased prevalence of obesity in the region. There are successful experiences about controlling risk factors through lifestyle interventions (43). Kit et al. have reported a decrease in mean total cholesterol levels and the prevalence of high total cholesterol from 165 mg/dl to 160 mg/dl and from 11.3% to 8.1%, respectively, in the 6-19 age group, in the US, between 1988-1994 and 2007-2010 (41). According to their survey, the mean HDL has increased and the prevalence of high blood pressure has decreased, but the prevalence of low HDL has not changed (43). An interventional study based on Isfahan Healthy Heart Program (IHHP), in Iran, demonstrated that the lifestyle intervention program decreased the prevalence of abdominal obesity, hypertension, hypercholesterolemia, hypertriglyceridemia, and high LDL, between 2000-2007 (44).

4-6. Limitations of the study

Limitations of our study were as follows:

a) The study was cross-sectional

b) Because of the unavailability of information about nutrition and economic status of the subjects, determining the extent of effects of above factors on cardio metabolic risk factors was not possible.

5- CONCLUSION

The Prevalence of CVD risk factors among children living in Birjand city, in east Iran is high. We should use successful experiences of other communities in order

to prevent, diagnose and control risk factors in this age group. Interventions must also be designed according to the local pattern of the components of the metabolic syndrome and financial resources.

Educating children and adolescents and their families, through the educational programs in schools and media for lifestyle modification including nutrition and physical activity is essential. We recommend performing the screening programs among more children and adolescents and monitoring individuals with risk factors. In order to reduce the morbidity and mortality associated with cardio metabolic risk factors among adults, pediatricians and other health care workers involved in the care of children and adolescents must be aware about the extent of the prevalence of cardio metabolic risk factors among children.

6- ETHICAL CONSIDERATION

Parents' informed consent was obtained before participation in the study. The aim of the present study was also explained to the patient's parents, and participation in this study imposed no costs on patients.

7- ACKNOWLEDGMENTS

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8- COMPETING INTEREST

None.

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