Prevalence of Pediatric Metabolic Syndrome and Associated Risk Factors among School-Age Children of 10–16 Years Living in District Shimla, Himachal Pradesh, India

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Abstract

Introduction: Recently, an increasing trend in the prevalence of pediatric metabolic syndrome (PMS) among school-age children has been documented in different parts of India. There is lack of data on the prevalence of PMS and its associated risk factors among school-age children living in district Shimla, Himachal Pradesh. Hence, to fill in the gap in the existing knowledge, the present study was conducted. **Methodology:** A cross-sectional study was conducted during 2015–2016. Thirty clusters (schools) were identified from a list of all schools using population proportionate to size sampling methodology. From each school, 70 children in the age group of 10–16 years were selected. Data was collected on the sociodemographic characteristics, anthropometry, waist circumference, blood pressure, and physical activity. Fasting venous blood samples were collected for estimation of blood glucose, triglycerides, and high-density lipoprotein levels. **Results:** The prevalence of PMS using International Diabetes Federation classification was 3.3% and using modified-adult treatment panel classification criteria was 3.5%. Risk factors identified to be associated with PMS among school-age children were (i) male gender, (ii) high family monthly income, (iii) sedentary lifestyle, (iv) consumption of evening snack, (v) television/computer viewing, and (vi) motorized transportation for commuting to school. **Conclusion:** The PMS prevalence was 3.3% in school-age children residing in District Shimla. There is a need to formulate interventions to prevent and correct metabolic syndrome among them for reducing early onset of cardiovascular disease during adulthood.

Keywords: Diabetes, dyslipidemia, Himachal Pradesh, hypertension, obesity, pediatric metabolic syndrome

Introduction

Pediatric metabolic syndrome (PMS) in childhood can lead to early onset of diabetes mellitus and cardiovascular diseases in adulthood. PMS among school-age children is considered to be present when at least 3 or more of the following clinical and metabolic abnormalities are present together: (i) abdominal obesity, (ii) low level of high-density lipoprotein (HDL), (iii) high triglyceride, (iv) high fasting blood glucose (FBG), and (v) elevated blood pressure (BP).

Earlier studies have documented the prevalence of PMS in different parts of the country in the range of 1.5%–9.9%.[1-6] An increasing trend in the prevalence of PMS is being observed possibly due to the increase in the prevalence of obesity in school-age children. This may lead to an increase in cholesterol, triglyceride level, impaired fasting glucose, and high BP among them.[7-15]

Earlier studies on the prevalence of PMS have been conducted in the plain regions of the country.[1-3] There was lack of data on the prevalence of PMS and associated risk factors among school-age children residing in District Shimla,

Access this article online	
Quick Response Code:	**Website:** www.ijem.in
	DOI: 10.4103/ijem.IJEM_251_17

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How to cite this article: Gupta A, Sachdeva A, Mahajan N, Gupta A, Sareen N, Pandey RM, *et al*. Prevalence of pediatric metabolic syndrome and associated risk factors among school-age children of 10–16 Years living in District Shimla, Himachal Pradesh, India. Indian J Endocr Metab 2018;22:373-8.

Himachal Pradesh. Hence, to fill the gap in the existing knowledge, the present study was conducted.

Methodology

A school-based cross-sectional study was conducted during 2015–2016. A list of all schools catering to high-income populations in District Shimla was prepared. Thirty clusters (schools) were identified using population proportionate to size sampling methodology. Since the school enrollment was >90% (as per the secondary data available with the Department of Education, Himachal Pradesh), the children studying in the school were considered as a proxy for school-age children residing in the area.

In each school, a complete list of all school-age children in the age group of 10–16 years was developed. With the help of random number table, 70 children were selected from each custer. If the requisite sample of school-age children was not available in the identified cluster, the nearest school was included to complete the sample size. A total of 2100 school-age children in the age group of 10–16 years were enrolled. A written informed consent was obtained from the parents of each participant. Written assent from each child was also obtained. The research protocol was approved by Institution Ethical Committee.

The following exclusion criterion was adopted: (i) Participants having deformity of the vertical column, (ii) Participants suffering from a disease which could change their dietary intake, (iii) Participants who were either fasting or feasting, and (iv) Participants who had migrated from plain areas within last 5 years of the study.

Data collection parameters

A team of three field investigators and one research assistant were trained in methods of data collection by the first author. This training was conducted for 2 weeks.

Sociodemographic profile

A questionnaire was administered to each child to obtain information on sociodemographic profile such as name, sex, age, family monthly income, occupation, and educational qualification.

Assessment of dietary pattern

Information regarding dietary pattern (vegetarian or nonvegetarian), consumption of fast foods, junk foods, and evening snacks was collected.

Assessment of physical activity

The physical activity undertaken by a child during last 24 h was collected by administering a detailed questionnaire. Domain-wise metabolic equivalents (MET) scores were calculated for light, moderate, and vigorous activity.[16] The 24-h energy expenditure was computed by adding all the MET values for the various activities in a day. Physical activity level (PAL) was calculated as the ratio of the 24 h energy expenditure to the basal metabolic rate. The PAL values were categorized into three categories, namely, physically active lifestyle (PAL 1.75 and above), limited physically active lifestyle (PAL 1.55–1.74), and sedentary lifestyle (PAL <1.54).

Information regarding mode of commuting to school and number of hours spent on viewing television (TV)/computer was also collected.

Assessment of abdominal obesity

Waist circumference (WC) was measured using a SECA 203 nonstretchable fibreglass tape, to the nearest of 0.1 cm. WC was measured midway between the superior border of the iliac crest and the lowermost margin of ribs at the end of normal expiration. School-age children with a WC of ≥90th percentile[17] or adult cutoffs[18] were considered as having abdominal obesity.

Assessment of blood pressure

BP was measured using mercury sphygmomanometer. Appropriate cuff size was used which covered 80%–100% of the circumference of the arm.[19,20] The stethoscope was placed over the brachial artery pulse, proximal and medial to the cubital fossa, and below the bottom edge of the cuff (i.e., about 2 cm above the cubital fossa). The systolic BP was defined as the appearance of the first sound (Korotkoff phase 1), and diastolic BP was defined as the disappearance of the sound (Korotkoff phase 5) during deflation of the cuff at a 2–3 mm/s decrement rate of the mercury column. The mean of two measurements was considered to be the participant's BP. Hypertension was defined as systolic (SBP) and diastolic BP (DBP) greater than 90th percentile for age and sex[19,20] as per the seventh report of the Joint National Committee on Evaluation, Diagnosis, Treatment, and Prevention of BP (JNC7) classification criteria.[21,22]

Biochemical parameters

Fasting venous blood samples were taken from all the participants. The samples were centrifuged at the field and stored at–80° Celsius till the time of analysis. Samples were transported from the field to the central laboratory for analysis in a thermocol box with ice within 3 h of blood collection.

Assessment of fasting blood glucose

FBG was estimated by the glucose oxidase peroxide (God-Pod) method using Randox kit.

Assessment of triglycerides and high-density lipoprotein

Serum samples were estimated for triglycerides (TG) and HDL using automated analyzer (Hitachi-902 fully automated biochemistry analyzer, Roche, Mannheim, Germany) using Roche kits.

Criteria for assessing pediatric metabolic syndrome

The school-age children were identified to be suffering from PMS based on 2 classifications:

(A) International Diabetes Federation classification: A child was identified to be suffering with PMS when he/she along with abdominal obesity had any of the 2 following parameters were present: (i) TG ≥150 mg/dL, (ii) HDL <40 mg/dL, (iii) FBG ≥100 mg/dL, and (iv) BP ≥SBP 130/DBP 85 mmHg)[23]

(B) Modified adult treatment panel-III (modified-ATP) classification: A child was identified as suffering with PMS when any of the following three parameters were present concomitantly (i) WC ≥90th percentile, (ii) TG ≥150 mg/dL, (iii) HDL <40 mg/dL, (iv) FBG ≥100 mg/dL, and (v) hypertension (>95th percentile for SBP or DBP).[24]

Statistical analysis

The collected data were entered into Microsoft Excel worksheets. Statistical Package for the Social Sciences (SPSS) version 20.0 was utilized for conducting the statistical analysis of the data (IBM SPSS statistics for windows. version 20. Armonk, NY: IBM corporation). Data were presented as mean ± standard deviation or percentages. Chi-square test was applied with 95% confidence interval (CI) to assess the association of various parameters with PMS. Univariate and multivariate analysis was conducted to identify the risk factors associated with PMS. The $P < 0.05$ was considered for statistical significance.

Sample Size Calculation: Assuming a 10% prevalence of obesity,[6] the desired sample size using the formula $N = \frac{z^2_{crit} P(1-P)}{D^2}$ is 1276 with $z = 1.96$ at 0.05 level of significance and 5% CI. Considering design effect of 1.5 and 10% noncompliance, the total sample size of 2105 school-age children was calculated. However, we included 2100 school-age children from the district.

Results

A total of 2100 school-age children (1149 males, 951 females) in the age group of 10–16 years were included. The mean age of the males and females was 13.4 ± 1.8 years and 13.5 ± 1.8 years, respectively. The mean WC, WHR, SBP, DBP, FBG, HDL, and PAL were significantly ($P < 0.001$) higher in males as compared to females [Table 1].

The prevalence of abdominal obesity, hypertension, dyslipidemia, and impaired fasting glucose among school-age children has been depicted in Table 2. The prevalence of PMS using International Diabetes Federation (IDF) classification and modified-ATP classification criteria among school-age children was found to be 3.3% ($n = 69$) and 3.5% ($n = 74$), respectively.

The risk factors of PMS in school-age children were found to be similar both by IDF classification and modified ATP classification [Table 3].

Risk factors associated with pediatric metabolic syndrome

Males (73.9%) had a significantly higher prevalence of PMS as compared to females (26.1%) ($P = 0.001$). High prevalence of PMS was observed among school-age children whose parents were graduates or above (79.7%) ($P = 0.018$). The high family monthly income of >Rs. 36,017 ($P = 0.015$) was also found to be significantly associated with PMS. We found that school-age children with PMS had a significantly lower PAL (1.2 ± 0.2) than children without PMS (1.5 ± 0.3) ($P < 0.001$). In addition, children with TV/computer viewing hours of >2 h ($P = 0.033$) and who commuted to school through motorized transport ($P = 0.049$) had a significantly high prevalence of PMS [Table 3].

Independent risk factors of pediatric metabolic syndrome

After controlling for confounding factors, we found that the odds of having PMS were significantly higher among

Table 1: Basic characteristics of participants according to gender

Parameters	Mean±SD		*P*
	Males (*n*=1149)	Females (*n*=951)	
Age (years)	13.4±1.8	13.5±1.8	0.704
Physical activity level	2.6±0.7	2.4±0.8	<0.001
BMI (kg/m²)	18.7±3.8	18.7±3.6	0.618
WC (cm)	68.3±10.7	66.4±9.2	<0.001
Waist hip ratio	0.9±0.1	0.8±0.1	<0.001
SBP (mmHg)	116.3±11.5	112.9±12.3	<0.001
DBP (mmHg)	76.6±7.1	74.8±7.5	<0.001
Fasting blood glucose (mg/dL)	85.6±14.0	83.4±12.4	<0.001
Triglyceride level (mg/dL)	93.9±45.5	93.0±37.6	0.662
High-density lipoprotein level (mg/dL)	49.1±12.5	54.0±11.8	<0.001

BMI: Body mass index, SD: Standard deviation, WC: Waist circumference, SBP: Systolic blood pressure, DBP: Diastolic blood pressure

Table 2: Distribution of participants according to the presence of metabolic indicators of pediatric metabolic syndrome

Parameters	Total, *n* (%)
Fasting blood glucose level ≥100 (mg/dL)	283 (13.5)
Low HDL level (<40 mg/dL)	354 (16.9)
High triglyceride level (≥150 mg/dL)	193 (9.2)
IDF classification	
Abdominal obesity (WC ≥90th percentile)	168 (8.0)
Systolic hypertension (SBP ≥130 mmHg)	273 (13)
Diastolic hypertension (DBP ≥85 mmHg)	205 (9.8)
Hypertensive (SBP ≥130 and DBP ≥85 mmHg)	159 (7.6)
Modified ATP classification	
Abdominal obesity (WC ≥90th percentile or adult cutoff whichever lower)	81 (3.8)
Hypertensive (SBP/DBP >95th percentile)	431 (20.5)
Presence of metabolic indicators of PMS	
Any 1 metabolic indicator	716 (34.1)
Any 2 metabolic indicators	194 (9.2)
Any 3 metabolic indicators	59 (2.8)
Any 4 metabolic indicators	14 (0.7)
All 5 metabolic indicators	1

HDL: High-density lipoprotein, IDF: International Diabetes Federation, WC: Waist circumference, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, PMS: Pediatric metabolic syndrome, ATP: Adult treatment panel

Table 3: Distribution of study participants according to the presence of pediatric metabolic syndrome (International Diabetes Federation, classification) (*n*=2100)

Variables	PMS (IDF classification)		*P*	Unadjusted OR 95% CI	*P*	Adjusted OR 95% CI	*P*
	No (*n*=2031) (%)	Yes (*n*=69) (%)					
Age (years)							
10-13 (*n*=1064)	1034 (50.9)	30 (43.5)	0.225	1.0	-		
14-16 (*n*=1036)	997 (49.1)	39 (56.5)		1.3 (0.8-2.2)	0.226		
Sex							
Female (*n*=951)	933 (45.9)	18 (26.1)	0.001	1.0	-	1.0	-
Male (*n*=1149)	1098 (55.1)	51 (73.9)		2.4 (1.4-4.1)	0.002	2.3 (1.3-4.0)	0.003
Type of family							
Nuclear family	1392 (68.5)	43 (62.3)	0.275	1.0	-		
Joint family	639 (31.5)	26 (37.7)		1.3 (0.81-2.2)	0.276		
Parent's education							
Class 12 or below	689 (33.9)	14 (20.3)	0.018	1.0	-		
Graduate or above	1342 (66.1)	55 (79.7)		2.0 (1.1-3.6)	0.021		
Parent's occupation							
Semi-skilled/unskilled worker	1370 (67.4)	44 (63.8)	0.521	1.0	-		
Skilled worker	661 (32.5)	25 (36.2)		1.2 (0.7-1.9)	0.521		
Family income per month (Rs)							
<36,017	665 (32.7)	13 (18.8)	0.015	1.0	-	1.0	-
≥36,017	1366 (67.3)	56 (81.2)		2.1 (1.1-3.9)	0.017	2.0 (1.1-3.6)	0.032
Socioeconomic status (as per Kuppuswamy scale)							
High and middle	1826 (89.9)	58 (84.1)	0.116	1.0	-		
Lower	205 (10.1)	11 (15.9)		1.7 (0.9-3.3)	0.120		
Religion							
Others	193 (9.5)	5 (9.4)	0.528	1.0	-		
Hindu	1838 (90.5)	64 (92.7)		1.3 (0.5-3.4)	0.530		
Physical activity level							
Physically active lifestyle (PAL 1.75 and above)	317 (15.6)	1 (1.4)	<0.001	1.0	-	1.0	
Limited physically active lifestyle (PAL 1.55-1.74)	432 (27.3)	6 (8.7)		4.4 (0.5-6.7)	0.171	-	-
Sedentary lifestyle (PAL<1.54)	1282 (63.1)	62 (89.9)		15.3 (2.1-110.9)	0.007	5.0 (2.3-11.0)	<0.001
Mode of commuting to							
School cycle/on foot	1127 (55.5)	30 (43.5)	0.049	1.0	-		
Vehicle	904 (44.5)	39 (56.5)		1.6 (1.0-2.6)	0.051		
Number of hours spent on television/computer viewing							
1-2 h a day	152 (7.5)	1 (1.5)	0.033	1.0	-		
>2 h a day	1879 (92.5)	68 (98.5)		5.5 (0.7-39.9)	0.092		
Dietary pattern							
Vegetarian	1188 (58.5)	41 (59.4)	0.878	1.0	-		
Nonvegetarian	843 (41.5)	28 (40.6)		1.0 (0.6-1.6)	0.878		
Packed lunch taken to school							
Yes	1933 (95.2)	64 (92.7)	0.360	1.0	-		
No	98 (4.8)	5 (7.2)		1.5 (0.6-3.9)	0.363		
Consumption of evening snacks							
Yes	353 (17.4)	6 (8.7)	0.059	1.0	-	1.0	-
No	1678 (82.6)	63 (91.3)		2.2 (0.9-5.1)	0.066	2.5 (1.0-5.8)	0.038
Consumption of fast food							
Irregular (<4 days a week)	1434 (70.6)	49 (71.0)	0.942	1.0	-		
Regular (≥4 days a week)	597 (29.4)	20 (29.0)		1.0 (0.6-1.7)	0.942		
Consumption of junk food							
Irregular (<4 days a week)	503 (24.8)	21 (30.4)	0.285	1.0	-		
Regular (≥4 days a week)	1528 (75.2)	48 (69.6)		0.7 (0.4-1.3)	0.286		

IDF: International Diabetes Federation, PMS: Pediatric metabolic syndrome, PAL: Physically active lifestyle, OR: Odds ratio, CI: Confidence interval school-age children who were (i) males (adjusted odds ratio (AOR) = 2.3; 95% CI: 1.3–4.0, P = 0.003), (ii) high family monthly income (AOR for Rs. 36017 and above = 2.0; 95% CI: 1.1–3.6, P = 0.032), (iii) sedentary lifestyle (AOR for PAL <1.5 = 5.0; 95% CI: 2.3–11.0, P < 0.001), and (iv) consumption of evening snack (AOR = 2.5; 95% CI: 1.0–5.8, P = 0.038) [Table 3].

Discussion

In the present study, we found that the 3.3% school-age children had PMS using IDF classification and 3.5% using modified-ATP classification. Earlier studies conducted in Jammu and Kashmir and Delhi reported similar prevalence of 1.5%[4] and 3.0%,[2] respectively, using IDF classification. Studies conducted in Chandigarh, Delhi, Maharashtra, Jammu and Kashmir have also reported similar prevalence of PMS of 4.2%,[1] 4.3%,[2] 9.9%,[3] 3.5%,[4] and 3.8%,[5] respectively, using modified-ATP classification.

We found that males had 2.3 times higher risk of developing PMS than females. A recent systematic review of studies conducted in different countries also found that males (5.1%) had a higher prevalence of PMS compared to females (3.0%) (P < 0.001).[25] Higher tendency of boys to accumulate fat around the waist as compared to females, possibly makes them more prone to PMS.[18,1,4,5]

In the present study, we found that the prevalence of PMS was significantly higher in school-age children with sedentary lifestyle (89.9%) and who commuted to school by motorized transport (56.5%) as compared to children without PMS. Physically active lifestyle has been associated with lower systolic and diastolic BP, HDL, triglyceride, glucose and WC among school-age children.[26-28] Physical exercise improves insulin sensitivity,[29,30] lowers BP,[31] raises HDL-C, lowers TG concentrations[32,33] and is inversely associated with PMS.[34-36]

TV viewing has been suggested as a measure of sedentary behavior in school-age children.[37,38] Eating snacks while viewing TV has been documented to increase the energy intake among them.[39] We observed that the prevalence of PMS was significantly higher (P = 0.033) in school-age children who watched TV/played on the computer for >2h in a day. Similar observations have also documented in earlier studies.[37-43]

Limitation of the study

Information on dietary pattern, consumption of snacks, fast foods and junk foods provided by school-age children in the age group of 10–11-year-old may not be reliable.

In the present study, the prevalence of 3.3% of PMS found among school-age children residing district Shimla, Himachal Pradesh, was similar to plain areas in the country. Symptoms of the metabolic indicators of PMS are not explicit in school-age children, and hence, there is a need for undertaking regular health check-ups in the schools with the aim to diagnose risk factors of PMS so that early intervention can be undertaken for their prevention and control.

Acknowledgments

We are extremely grateful to Indian Council of Medical Research, Government of India (vide letter no: GIA/30/2014-DHR) for providing us the financial grant for conducting this study.

Author contributions

All the authors have accepted responsibility for the entire content of this submitted manuscript and approved submission.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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