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Prevalence and association of cardiometabolic risk factors with sociodemographic variables amongst teenagers of rural population of central India

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Original Article

Abstract

BACKGROUND: The prevalence of the cardio-metabolic risk factors is rapidly increasing amongst the children and adolescents and is a topic of concern due to their induced risk of development of cardiovascular diseases (CVDs) and diabetes mellitus (DM) in adulthood. The aim of this study is to determine the prevalence of the cardio-metabolic risk factors associated with sociodemographic variables amongst the teenagers of rural population in India.

METHODS: This cross-sectional study was carried out on 405 teenagers (13-19 years old) in a rural population of central India. The data on the socio-demographic variables and cardio metabolic risk factors were collected using a predesigned proforma. The blood pressure and body mass index (BMI) of the subjects were also recorded. Blood samples were collected for lipid profile and blood sugar. Data was analyzed with the Epi Info software version 6.04.

RESULTS: A total of 405 subjects were studied, of whom 182 were male and 223 were female. The prevalence of metabolic syndrome was found to be 9.9% [95% confidence interval (CI): 7.3-13.1]. The prevalence of cardiometabolic risk factors, including low level of high-density lipoprotein cholesterol (HDLC) and impaired fasting glucose (IFG), were found to be 58.3% (95% CI: 53.4-63.0) and 13.8% (95% CI: 10.7-17.5), respectively. 2.2% of the teenagers had a waist circumference (WC) more than the cut off (> 90th percentile), while high blood pressure was found in 24.40% (95% CI: 18.6-26.7), i.e. ≥ 90th percentile for age, sex, and height. Similarly, risk factors such as obesity and overweight were found significant (P < 0. 05) in teenagers with family history of obesity.

CONCLUSION: Cardiometabolic risk factors is slowly extending to rural areas. Therefore, early detection of these risk factors can be an attempt to prevent or delay the metabolic syndromes, DM, and CVDs.

KEYWORDS: Prevalence; Cardiometabolic Risk Factors; Teenagers; Rural Population

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Introduction

Metabolic syndrome is rapidly becoming a global health issue and a topic of concern for epidemiologists and clinicians due to the risk of development of cardiovascular diseases (CVDs) and diabetes mellitus (DM) in early adult life.[1] There has been an increase in the prevalence of cardio-metabolic risk factors amongst the children and adolescents worldwide in the last

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decades.[2] It has been estimated that by the year 2025, 80% of the global DM and CVD burden shall be in the low and middle income countries with the bulk being in South Asian countries like India and China.[3]

Epidemiological evidence suggests a high level of risk factors and a high mortality burden of cardiometabolic diseases in rural India, which is of concern, as 68% of India's population live in rural areas. The socio-economic patterning of cardiometabolic risk factors also has an important implication for individuals and households in the low and middle income countries like India, where the reach of preventative health programs and health care services remain substantially underdeveloped.[4]

The association between the metabolic syndrome and the risk of CVDs is notable. Metabolic syndrome increases the risk of the subsequent CVDs in children and is characterized by obesity with increased waist-hip ratio (WHR), dyslipidemia, insulin resistance, hypertension, and non-alcoholic fatty liver disease (NAFLD). The prevalence of MS in adolescents is increasing, in parallel with the increasing trends in obesity, as 90% of obese adolescents have at least one feature of the metabolic syndrome.[5] Obesity plays a central role for initiating the other risk factors, including hyperinsulinemia, hypertension, hyperlipidemia, type 2 DM, and an increased risk of atherosclerotic CVDs.[6] Excess adipose tissue in obese children releases inflammatory cytokines, leading to proinflammatory state, and at the same time, the production of the potentially protective adipokine and adiponectin is reduced. In India, the prevalence of obesity in adolescents is around 19.3%.[5] Reduced physical activity and unhealthy dietary habits had a major role in the causation of childhood obesity.[6] However, very little data is available in this regard, especially in rural areas of India. Therefore, the aim of this study is to explore the prevalence of cardiometabolic risk factors associated with the sociodemographic variables in teenagers of rural population.

Methods

This cross-sectional study was carried out in the rural area of primary health center (PHC) Anji, Wardha District, India, from June 2014 to June 2016. All the teenagers in the age group of 10-19 years of PHC were included in the study. The study protocol was approved by the Institutional Review Board (IRB), Mahatma Gandhi Institute of Medical Sciences, Wardha, Reference No. /IEC/MS/257/14 prior to the commencement.

Considering the prevalence of metabolic syndrome among teenagers as 4.2%,[7] a sample size of 405 was required at α-error level of 5%, the allowable error of 2%, and non-response rate 5%. The subjects were selected by using simple random sampling. The sampling frame available with the Department of Community Medicine was used for drawing the sample. The subjects were selected after obtaining written informed consent from the parents, and in case of children aged 18 years and above, consent was taken from them. The subjects who were not willing to participate in the study or not willing to remain fasting during the sample collection, were excluded from the study.

The sociodemographic data were collected in a predefined proforma by house to house visit. The data pertaining to age, sex, education, caste, physical activity, type of family, family income, family history of obesity, hypertension, and DM was recorded.

Physical activity was calculated using close-ended questions probing self-perceived, self-reported domestic activity, leisure time, and transport, and intensity of physical activity. The physical activity scores based on the intensity and time spent were allotted to each activity and the scores were added together to assess the overall physical activity.[7,8]

Height and weight of the subjects were measured (without shoes) with a standard tape measure and weighing machine to the nearest 0.1 cm and 0.1 kg, respectively. Waist circumference (WC) was measured in centimeters (cm) to the nearest 0.1 cm at a level midway between the lower rib margin and the iliac crest, when subjects were lightly clothed. Body mass index (BMI) was assessed by dividing weight (kg) by height (m^2). Blood pressure was recorded in the right arm in sitting position, three times in subjects after giving a rest of 10 minutes between each recording with a mercury sphygmomanometer (which was regularly calibrated against a standard blood pressure instruments). The systolic and diastolic high blood pressure is defined by the blood pressure value > 90th percentile for age, sex, and height.[9]

The obesity in the family was assessed by measuring BMI of parents, at least one parent being obese was considered as the family history of obesity.[10] Likewise, blood pressure of the parents was taken for family history of hypertension. At least one parent being hypertensive by the Seventh Joint National Committee (JNC-VII) criteria was considered as family history of hypertension. The parents were asked whether they had DM or were on medication for family history of DM.

Biochemical Analysis: After an overnight fast (8-10 hour), early morning blood samples were taken from the subjects. All the collected samples were stored and transported to the laboratory in a blood transport box (maintained at a temperature of 2 to 6 °C], and were processed within 4-6 hours after sample collection. Fasting plasma glucose (FPG) was measured by the glucose oxidase peroxidase method. Total cholesterol, triglyceride, and high-density lipoprotein cholesterol (HDLC) were respectively measured using the cholesterol oxidase peroxidase method, glycerol peroxidase oxidase method, and a phospotungstic acid method using XL-300 autoanalyser (Erba, Tranasia, Germany), and the low-density lipoprotein (LDL) cholesterol value was calculated. In our laboratory, the coefficient of variation (CV) of glucose, total cholesterol, triglyceride, and HDLC by the above stated methods lay within 4.0%, 3.5%, 6.5%, and 7.0%, respectively, indicating a good precision of the methods in use. The National Cholesterol Education Program (ATP III) definition modified for age was used to define abnormal levels of cardio-metabolic risk factors in adolescent.[11-14]

The criteria were as follows:

1) Abdominal obesity ($\geq$ 90th percentile WC).
2) Triglyceride level $\geq$ 110 mg/dl.
3) HDLC level $\leq$ 40 mg/dl.
4) Systolic or diastolic high blood pressure defined by blood pressure value $\geq$ 90th percentile for age, sex, and height
5) Fasting blood glucose levels $\geq$ 100 mg/dl.[15]

The presence of any three of five risk factors mentioned above were consider as the metabolic syndrome.

Statistical analysis was performed using the SPSS (version 12.0, SPSS Inc., Chicago, IL, USA) and Health Watch Pro version 3.1 software. P value < 0.05 considered as significant and the chi-square test was used to test the significance. The odd ratio was calculated to evaluate the risk factors along with their 95% confidence interval (CI).

Results

405 teenagers in the age group of 10-19 years were included in the study, of who 185 were male and 223 were female, with a male-to-female ratio of 0.8:1. The overall prevalence of the metabolic syndrome was about 9.9% (95% CI: 7.3-13.1) in the study population. The prevalence rate of the cardiometabolic risk factors including low level of HDLC, hypertriglyceridemia, and impaired fasting glucose (IFG) were found to be 58.3% (95% CI: 53.4-63.0), 27.9% (95% CI: 23.7-32.4), and 13.8% (95% CI: 10.7-17.5), respectively.

2.2% (95% CI: 1.1-4.0) of the teenagers had a WC more than the cut off (> 90th percentile), while high blood pressure was found in 24.4 % (95% CI: 18.6-26.7), i.e. ≥ 90th percentile for age, sex, and height (Figure 1).

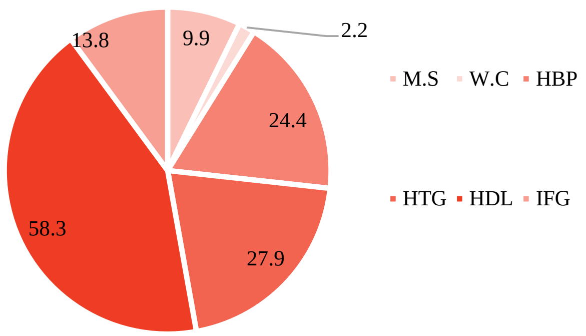

Figure 1. Prevalence of metabolic syndrome and cardiometabolic risk factors in the study population

M.S: metabolic syndrome; WC: Waist circumference; HBP: High blood pressure, HTG: High triglyceride; HDL: High density lipoprotein; IFG: Impaired fasting glucose

Association of Sociodemographic Variables with Metabolic Syndrome and Cardiometabolic Risk Factors

Age, Sex, and Physical Activity: The prevalence of metabolic syndrome did not differ significantly (P ≥ 0.05) by age, sex, and physical activity. Prevalence of individual cardiometabolic risk factors such as high blood pressure, obesity, overweight, lower level of HDLC, hypertriglyceridemia, and IFG did not differ significantly (P ≥ 0.05) with sociodemographic variables of age, sex, and physical activity (Table 1).

Family Income and Family History of Obesity: The prevalence of metabolic syndrome (P ≥ 0.05) and cardio-metabolic risk factors such as high blood pressure, obesity, overweight, lower level of HDLC, hypertriglyceridemia, and IFG did not differ significantly (P ≥ 0.05) with family income.

In contrast, the prevalence of metabolic syndrome was found to be higher (18.6%) in the subjects with family history of obesity compared to the subjects (8.8%) without a family history of obesity. The prevalence differed significantly with a family history of obesity (P < 0.05) (Table 2).

The prevalence of obesity (14.0%) and overweight (14.0%) was also found higher in the subjects with a family history of obesity than the subjects without a family history of obesity (0.8%) and overweight (0.8%), and the difference was statistically significant (P < 0.05).

Table 1. Association of age, sex, and physical activity with cardio-metabolic risk factors and metabolic syndrome

Variables	Total (n)	M.S	HBP	WC	BMI	HDLC	HTG	IFG
		n (%)						
Age group (year)								
< 15	159	17 (10.7)	37 (23.3)	3 (1.9)	9 (5.7)	86 (54.1)	47 (29.6)	20 (12.6)
≥ 15	246	23 (9.3)	62 (25.2)	6 (2.4)	13 (5.3)	150 (61.0)	66 (26.8)	36 (14.6)
Total	405	40 (9.9)	99 (24.4)	9 (2.2)	22 (5.4)	236 (58.3)	113 (27.9)	56(13.8)
P	-	≥ 0.05	≥ 0.05	≥ 0.05	≥ 0.05	≥ 0.05	≥ 0.05	≥ 0.05
Sex								
Male	182	14 (7.7)	43 (23.6)	3 (1.6)	14 (7.7)	103 (56.6)	47 (25.8)	27 (14.8)
Female	223	26 (11.5)	56 (25.1)	6 (2.7)	8 (3.6)	133 (59.6)	66 ((29.6)	29 (13.0)
Total	405	40 (9.9)	99 (24.4)	9 (2.2)	22 (5.4)	236 (58.3)	113 (27.9)	56 (13.8)
P	-	≥ 0.05	≥ 0.05	≥ 0.05	≥ 0.05	≥ 0.05	≥ 0.05	≥ 0.05
Physical activity								
Light	291	25 (8.6)	69 (23.7)	9 (3.1)	16 (5.5)	161 (55.3)	76 (26.1)	35 (12.0)
Moderate	114	15 (13.2)	30 (26.3)	0	6 (5.3)	75 (65.8)	37 (32.5)	21 (18.4)
Total	405	40 (9.9)	99 (24.4)	9 (2.2)	22 (5.4)	236 (58.3)	113 (27.9)	56 (13.8)
P	-	> 0.05	> 0.05	-	> 0.05	> 0.05	> 0.05	> 0.05

n: Number of subjects; M.S: Metabolic syndrome; HBP: High blood pressure; WC: Waist circumference for obesity; BMI: Body mass index for overweight; HDLC: High density lipoprotein cholesterol (< 40 mg/dl); HTG: high triglyceride; IFG: Impaired fasting glucose

Table 2. Association of cardio metabolic risk factors and metabolic syndrome with family income and family history of obesity

Risk factors	Total (n)	M.S	HBP	WC	BMI	HDLC	HTG	IFG
		n (%)						
Family Income in quartiles								
1st Quartile	117	9 (22.5)	23 (23.2)	1 (11.1)	5 (22.7)	67 (28.4)	32 (28.3)	13 (23.2)
2nd Quartile	115	10 (25.0)	22 (22.2)	1 (11.1)	6 (27.3)	75 (31.8)	29 (25.6)	14 (25.0)
3rd Quartile	89	11 (27.5)	28 (28.3)	2 (22.2)	4 (18.2)	49 (20.8)	26 (23.0)	15 (26.8)
4th Quartile	84	10 (25.0)	26 (26.3)	5 (55.6)	7 (31.8)	45 (19.1)	26 (23.0)	14 (25.0)
Total	405	40 (9.9)	99 (24.4)	9 (2.2)	22 (5.4)	236 (58.3)	113 (27.9)	56 (13.8)
P		≥ 0.05	≥ 0.05	≥ 0.05	≥ 0.05	≥ 0.05	≥ 0.05	≥ 0.05
Family history of obesity								
Yes	43	8 (18.6)	13 (30.2)	6 (14.0)	6 (14.0)	29 (67.4)	12 (27.9)	10 (23.3)
No	362	32 (8.8)	86 (23.8)	3 (0.8)	16 (4.4)	207 (57.2)	101 (27.9)	46 (12.7)
Total	405	40 (9.9)	99 (24.4)	9 (2.2)	22 (5.4)	236 (58.3)	113 (27.9)	56 (13.8)
P	-	< 0.05	> 0.05	< 0.05	< 0.05	> 0.05	> 0.05	> 0.05

n: Number of subjects; M.S: Metabolic syndrome; HBP: High blood pressure; WC: Waist circumference for obesity; BMI: Body mass index for overweight; HDLC: High density lipoprotein cholesterol (≤ 40 mg/dl); HTG: high triglyceride; IFG: Impaired fasting glucose

However, the prevalence of high blood pressure, low level of HDLC, hypertriglyceridemia, and IFG did not differ significantly (P ≥ 0.05) with a family history of obesity.

Family History of Hypertension and DM: The prevalence of metabolic syndrome was found to be higher (25.0%) in the subjects with a family history of hypertension and lower (8.9%) in the subjects with no family history of hypertension. Thus, the metabolic syndrome differed significantly (P < 0.05) in the subjects with a family history of hypertension**.** Additionally, the prevalence of overweight and IFG was significantly different (P < 0.05) in the subjects with a family history of hypertension.

Nevertheless, the prevalence rate of high blood pressure, low level of HDLC, and hypertriglyceridemia were not significantly different in the subjects with a family history of hypertension (P ≥ 0.05).

However, in the families with a history of DM, obesity, and overweight, they were found higher (15.4%) and (23.1%), respectively**.** Thus, the prevalence of obesity and overweight differed significantly (P < 0.05) with the family history of DM.

The prevalence of metabolic syndrome, high blood pressure, lower level of HDLC, hypertriglyceridemia, and IFG did not differ significantly (P ≥ 0.05) with the family history of DM (Table 3).

Table 3. Association of family history of hypertension and diabetes mellitus (DM) with cardio metabolic risk factors and metabolic syndrome

Family history	Total (n)	M.S	HBP	WC	BMI	HDLC	HTG	IFG
		n (%)						
Family history of hypertension								
Yes	24	6 (25.0)	7 (29.2)	4 (16.7)	5 (20.8)	16 (66.7)	8 (33.3)	8 (33.3)
No	381	34 (8.9)	92 (24.1)	5 (1.3)	17 (4.5)	220 (57.7)	105 (27.6)	48 (12.6)
Total	405	40 (9.9)	99 (24.4)	9 (2.2)	22 (5.4)	236 (58.3)	113 (27.9)	56 (13.8)
P	-	< 0.05	≥ 0.05	-	< 0.05	≥ 0.05	≥ 0.05	< 0.05
Family history of DM								
Yes	13	2 (15.4)	2 (15.4)	2 (15.4)	3 (23.1)	9 (69.2)	4 (30.8)	4 (30.8)
No	392	38 (9.7)	97 (24.7	7 (1.8)	19 (4.9)	227 (57.9)	109 (27.8)	52 (13.3)
Total	405	40 (9.9)	99 (24.4)	9 (2.2)	22 (5.4)	236 (58.3)	113 (27.9)	56 (13.8)
P	-	> 0.05	> 0.05	< 0.05	< 0.05	> 0.05	> 0.05	> 0.05

n: Number of subjects; M.S: Metabolic syndrome; HBP: High blood pressure; WC: Waist circumference for obesity; BMI: Body mass index for overweight; HDLC: High density lipoprotein cholesterol (≤ 40 mg/dl); HTG: high triglyceride; IFG: Impaired fasting glucose

Table 4. Association of caste with cardio metabolic risk factors and metabolic syndrome

Caste	Total (n = 810)	M.S	HBP	WC	BMI	HDLC	HTG	IFG
		n (%)						
General	47	4 (8.5)	9 (19.1)	1 (2.1)	2 (4.3)	27 (57.4)	12 (25.5)	10 (21.3)
OBC	187	24 (12.8)	54 (28.9)	7 (3.7)	13 (7.0)	113 (60.4)	57 (30.5)	30 (16.0)
ST/SC	171	12 (7.0)	36 (21.1)	1 (0.6)	7 (4.1)	96 (56.1)	44 (25.7)	16 (9.4)
Total	405	40 (9.9)	99 (24.4)	9 (2.2)	22 (5.4)	236 (58.3)	113 (27.9)	56 (13.8)
P		≥ 0.05	≥ 0.05	< 0.05	≥ 0.05	≥ 0.05	≥ 0.05	≥ 0.05

n: Number of subjects; M.S: Metabolic syndrome; HBP: High blood pressure; WC: Waist circumference for obesity; BMI: Body mass index for overweight; HDLC: High density lipoprotein cholesterol (≤ 40 mg/dl); HTG: high triglyceride; IFG: Impaired fasting glucose; OBC: Other Backward Classes; ST: Scheduled tribes; SC: Scheduled caste

In the present study, the prevalence of dyslipidemia was found to be higher among other backward classes (Table 4).

Discussion

The overall prevalence of metabolic syndrome in the present study was 9.9%, which was on the higher side compared to the studies by Panda,[5] Singh et al.,[16] and Gupta et al.[17] from India, which were 3.8, 2.6, and 3.3%, respectively. Within the capital city of Iran, Esmaillzadeh et al. reported a prevalence of 10.1% for the metabolic syndrome in adolescents aged 10-19 years (10.3 and 9.9% in boys and girls, respectively).[18] Cook et al. also reported a 4.2% prevalence for metabolic syndrome in 12-19 year old group of adolescents, which increased to 6.4% in the National Health and Nutrition Examination Survey (NHANES) during 1999-2000.[14] A comparatively higher prevalence of metabolic syndrome reported in the current study can be attributed to difference in study setting, population, and difference in the definition used for metabolic syndrome.

Metabolic syndrome, in the present study, was significantly associated with a family history of obesity (P < 0. 05). It was found in the current study that the prevalence of metabolic syndrome was significantly higher, being 25% among those with a family history of hypertension as against 8.9% in subjects without a family history of hypertension (P < 0.05). Similarly, the prevalence of metabolic syndrome was significantly higher, being 18.6% among those with a family history of obesity as against 8.8% among those without family history of obesity (P < 0.05). Recent models identified some genes causing human obesity, which include leptin (LEP), leptin receptor (LEPR), melanocortin-4 receptor (MC4R), and pro-opiomelanocortin (POMC) genes. Deletion in POMC gene affects body weight and food motivation, thereby showing the importance of the overall leptin/melanocortin pathway on the obese phenotype.[19]

The prevalence of metabolic syndrome was higher in females 182 (11.7%) than in males 223 (7.7%), though it was not statistically significant. There was a considerable number of reports suggesting no significant difference in the prevalence of metabolic syndrome with age and sex. The cross-sectional survey of adolescents in Ho Chi Minh City showed an overall prevalence of metabolic syndrome as 4.6%, and there was no difference by gender (P = 0.90), but the prevalence of metabolic syndrome was slightly higher in females (4.7%) than in males (4.6%).[20] In contrary to the current finding, the study by Cook et al. reported a higher prevalence in males (6.1%) than in females (2.1%).[14] In contrast, Panda PK[5] found a nearly equal prevalence of metabolic syndrome in males and females as 3.9 and 3.8%, respectively.

The reason for the gender differences in the prevalence of metabolic syndrome in the present study might be the different cutoff points set as criteria for metabolic syndrome like WC and HDLC. Moreover, the increase in the prevalence of the metabolic syndrome is higher in females than in males worldwide, including developing South Asian countries, which is due to the increased obesity in females.[21]

In the present study, the prevalence of obesity was found 2.2% (95% CI: 1.1-4.0) by WC percentile and that of overweight was 5.4% by BMI.

Similarly, Prasad et al. suggested that the prevalence of overweight and obesity was respectively 9.7 and 4.3% among teenagers aged 10 to 18 years.[22] A study conducted by George et al. in Kerala among rural adolescents reported a prevalence of overweight and obesity as 16.0 and 7.0%, respectively.[23] However, another study from Kerala among the rural school girls indicated that nearly 42.66% of subjects were overweight, whereas 8.7% were obese.[24,25]

In the present study, the prevalence of overweight was found to be significantly higher in subjects with a family history of obesity, hypertension, and DM ($P < 0.05$). Furthermore, the prevalence of obesity was found to be higher in children of families with higher (55.6%) monthly income (4th quartile) compared to those with lower monthly income (1st Quartile) and less educational achievements (< 7th class). Similarly, Goyal et al. suggested a positive association of obesity with a family history of obesity and higher economic level.[25] However, in the USA, the prevalence of obesity was more in children of parents with lower monthly income and less educational achievement.[5]

The overall prevalence of high blood pressure was found to be 24.4% (95% CI: 18.6-26.7), 25.1% in females as against 23.6% in males. Another study from the rural central India found the prevalence of hypertension as 6.8% and 7.0% in males and females, respectively.[26] Moreover, the prevalence of adolescents' hypertension vary between different populations within India. Goel et al. in their study on students aged 14-19 years in New Delhi found 6.4% of adolescents to be hypertensive.[27] Kumar et al. from Patna, India showed an overall prehypertension prevalence of 10.9% in adolescents.[28]

The prevalence of hypertension in teenagers is high in India compared to western countries like the USA where it was found to be 2.7-3.7% in different population-based surveys.[26] Variations in the prevalence of hypertension among these studies could partly be attributed to differences in the study design, selection of different cutoff points for defining hypertension, age difference, number of visits made for measurement of BP, and type of instruments used for recording of the blood pressure.

In contrast to several other studies, the present study did not find a significant association of family history of hypertension in adolescent with high blood pressure. Ezeudu et al. found that the prevalence of hypertension was higher among subjects with positive family history of hypertension.[29]

The prevalence of hypertriglyceridemia and increased lower level of high-density lipoprotein cholesterol were found to be 27.9% (95% CI: 23.7-32.4) and 58.3% (95% CI: 53.4-63.0), respectively. The prevalence of hypertriglyceridemia was found higher in females (29.6%) than in males (25.8%). Similarly, given the study by Krishna et al., hypertriglyceridemia was observed in 62.1% of girls and 47.8% of boys.[30]

In the present study, the prevalence of dyslipidemia was found to be higher, among other backward classes. The possible causes of dyslipidemia in upper caste could be due to their higher socioeconomic groups, overeating dietary habit, low physical activity, and sedentary lifestyle.

The prevalence of dyslipidemia was found to be higher in the subjects with family history of obesity, hypertension, and DM. Thus, the subjects from these families were at more risk of developing disease, including CVDs and DM in the future.

In the current study, 13.8% of subjects had IFG and 86.2% of them had normal glucose levels. The prevalence of IFG differed significantly ($P < 0.05$) with a family history of DM. Similarly, findings were also noted by Andrabi et al.[7] in their study on the prevalence of MS in 758 school children (8-18-year-old) of Kashmir, India.

The results of the present study revealed that clustering of the cardio-metabolic risk factors and metabolic syndrome is a major health problem in rural areas of developing countries. Therefore, awareness of cluster of risk factors and preventive measures should be emphasized in population-wide prevention strategies in rural areas, primarily focusing on children and teenagers. The study was limited by its relatively small sample size and cross-sectional design; we recommend a larger, prospective, cohort study, which will include all cardiometabolic risk factors and sociodemographic variables in the evolution of metabolic syndrome in teenagers.

Conclusion

The prevalence of metabolic syndrome is concerning even in rural India. Identification of cardiometabolic risk factors, i.e., family history of DM and hypertension at the early ages can be useful to prevent subsequent CVDs and DM in early adulthood. Families and health workers should be educated on integrated healthful lifestyles as measures to prevent early development and progression of cardiometabolic risk factors.

Conflict of Interests

Authors have no conflict of interests.

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None.

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