ORIGINAL RESEARCH ARTICLE

Metabolic Syndrome and Its Associated Risk Factors and Morbidities Among Young Adults in Bhubaneswar: A Cross-Sectional Study

Manaswini Dash[1], Satavisha Sadangi[2], Braja Sundar Barik[3], Minaketan Barik[4], Nadeem Aziz Hussain[5], Tahziba Hussain[6*], Sanghamitra Pati[7]

[1,2,3,4,6]Department of NCDs, ICMR-Regional Medical Research Centre, Bhubaneswar, Odisha, India
[5]Department of IT, KIIT University, Bhubaneswar, Odisha, India
[7]Department of Public Health Research, ICMR-Regional Medical Research Centre, Bhubaneswar, Odisha, India

DOI: 10.55489/njcm.160320254776

ABSTRACT

Introduction: Metabolic syndrome is a combination of risk factors that increase the possibility of non-communicable diseases.

Methods: In this study, young adults, between the age of 18-35 years, were screened for signs and symptoms of MetS. The prevalence was estimated, various risk factors and morbidities were assessed.

Results: Out of 500 young adults, 69% were students and 30% were having jobs. 68% were sedentary, 6% were addicted to either/or alcohol and smoking. 55% preferred to eat fast food daily. 49% did less than 10 hours of physical activity per week. 47% slept for less than 6 hours and 38% of the young adults spent about 8-12 hours on internet. There is a significant difference in age group, literacy status, life style across the gender. Eating habits, fast food intake, physical activity, duration of sleep, BMI and waist circumference were significant risk factors. Hypertension, diabetes, cholesterol levels, low HDL-C and triglycerides contributed to development of MetS. Non-vegetarian eating habits, weekly fast-food intake, spending 8-12 hours online and sleeping less than 4-6 hours were high risk factors for developing Mets.

Conclusion: High prevalence, 25.4% (127) of MetS was observed among the young adults in this region.

Keywords: Metabolic Syndrome; risk factors; morbidities; young adults; Bhubaneswar

ARTICLE INFO

Financial Support: None declared
Conflict of Interest: The authors have declared that no conflict of interests exists.
Received: 16-10-2024, **Accepted**: 07-02-2025, **Published**: 01-03-2025
***Correspondence:** Dr. Tahziba Hussain (Email: tahziba_hussain@hotmail.com)

How to cite this article: Dash M, Sadangi S, Barik BS, Barik M, Hussain NA, Hussain T, Pati S. Metabolic Syndrome and Its Associated Risk Factors and Morbidities Among Young Adults in Bhubaneswar: A Cross-Sectional Study. Natl J Community Med 2025;16(3):261-270. DOI: 10.55489/njcm.160320254776

www.njcmindia.com | pISSN: 0976-3325 | eISSN: 2229-6816 | Published by Medsci Publications

INTRODUCTION

Metabolic syndrome (MetS) is a severe condition that affects about 23 percent of adults. Worldwide, Indians are more prone for MetS and Diabetes than any other population.[1-3] As standards of living have improved in India, more and more people are adopting western dietary patterns unsuitable for our climate and habitat, leading a sedentary manner of living and are susceptible to psycho-social stress. This has caused an unparalleled increase of MetS to epidemic dimensions over past decades in our country. MetS is a combination of adverse conditions that increase the possibility of emerging chronic diseases namely type 2 diabetes, dyslipidemia, cardiovascular disease, stroke, hepatic steatosis and other circulatory disorders.[4-7] MetS is a group of metabolic disorders that includes central obesity, hypertension, hyperglycemia and dyslipidemia and promotes the progress of cardiovascular diseases and type 2 diabetes mellitus (T2DM).

Many conventions were proposed for diagnosis of MetS by distinct organizations like WHO (World Health Organization), the NCEP-ATP III, the AHA/NHLBI and IDF during 1998-2009. The latest measure was introduced by IDF; AHA/NHLBI; WHF; IAS; and IASO in 2009 due to the deliberations and disputes on definition of MetS. These include >130/85 mm Hg or more of blood pressure, >150 mg/dl of triglyceride levels, >100 mg/dl of fasting blood glucose levels and <40 mg/dl (men) or <50 mg/dl (women) of high-density lipoprotein level (HDL) and >35 inches and >40 inches for women and men of waist circumference, respectively. Being overweight and/or obese, physically inactive, certain genetic factors and ageing are some of the basic risk factors of MetS.[8,9] Preceding by the middle adulthood stage, young adult stage is the most active and productive stage in life which is an ideal period for prevention of long term impact of MetS and its future morbidities including retinopathy, neuropathy, nephropathy and cardio vascular diseases.[10,11] With the incidence rate, severity and interplay of reduced insulin secretion in young adults, onset of MetS and diabetes are the emerging public health concerns in the present era.[12-15] MetS is escalating and prior glimpses of disease are evident in adolescents and young adults. Certain studies suggest that a substantial numeral of adolescents previously carry more than one risk factors for Met-S. Susceptibility to MetS risk factors in childhood and adolescence is correlated with disease progression in adulthood. Studies are, therefore, required to document the prevalence of MetS, Pre-diabetes and Diabetes among a population of young adults and then evaluate different prevention strategies. In this study, young adults, between the age of 18-35 years, either studying or working in various educational Institutes of Bhubaneswar were enrolled and screened for signs and symptoms of MetS, hypertension, obesity, prediabetes and Diabetes. They were pursuing advanced courses like post-graduation or Ph.D. or working as project staff. This involves desk job and they spend a lot of time sitting throughout the day. The prevalence was estimated and various socio-demographic, physical, behavioral, biochemical risk factors and morbidities were assessed and they were advised for adopting healthy life style.

METHODOLOGY

Ethics approval: Institutional Human Ethics Committee has reviewed and approved the detailed plan of study. Socio-demographic, behavioral, physical and biochemical data were documented after obtaining informed written consent using organized query. Blood samples were collected for screening from those eager to be registered in the study.

Study procedure: This comprehensive-rational trans-regional study was carried out during June,2021 to Dec.,2021 among young adults, either studying or working in various educational Institutes of Bhubaneswar. Sample size was calculated based on a population of 2000 employees using margin of error of 3.8%, as per study published earlier.[16] For a final sample size of 500 young adults, an extra 2% was included to adjust for non-responsive and missing data. In all, 540 young adults were enrolled in the study. Information on age, gender, marital and literacy status, occupation, life style, habits, physical activity, eating preferences, frequency of fast-food consumption, duration of sleep, time spent on internet, record of chronic diseases, family history and health check-up were collected. Complications at the time of interview were documented as well.

Data collection: Height and weight of the participants were measured upon removal of footwear and other accessories. Measuring tape was used for determining the waist circumference in a state of relaxation after expiration. Physical activity was assessed across three different spheres namely work, travel and during relaxation time as per the Global Physical Activity Questionnaire (GPAQ, WHO).[17]

Biochemical measurements: Every individual was subjected to biochemical tests and Blood pressure and Blood Glucose were used for measuring, respectively. For lipid profile, 5 ml of venous blood samples were collected from young adults after 10-12 hours fasting and serum was tested for various investigations.

Operational definitions

Metabolic syndrome: Metabolic syndrome was defined using updated NCEP/ATP-III (National Cholesterol Education Program/Adult Treatment Panel-III) guidelines with modified waist circumference for Indians and IDF (International Diabetes Federation) criteria.[3]

Hypertension: Individuals were categorized as hypertensive if diagnosed by a physician and/or taking

anti-hypertensive drugs with a mean blood pressure of ≥140 mmHg / ≥90 mmHg.

Pre-diabetes and diabetes: Individuals were categorized as having pre-diabetes if diagnosed by a physician and/or taking anti-diabetic drugs with FBG levels of >110mg/dl and <126mg/dl for pre- diabetes and FBG levels of >126mg/dl for diabetes.

Dyslipidemia: Individuals were categorized as having dyslipidemia if serum triglyceride and cholesterol levels were ≥200 mg/dl (≥1.7 mmol/l) and lipoprotein levels (HDL) <40 mg/dl (men) or <50 mg/dl (women).

Body mass index (BMI): Individuals with a BMI <25 were considered to have normal weight while those with BMI ≥ 25 were considered overweight and Obesity was defined as BMI ≥30.[3]

Statistical Analysis: IBM SPSS version, 25 was used for analysis of the results. Prevalence is reported with 95% confidence intervals with reference to the design effect. Pearson Chi-Square (χ^2) test, binary and multiple logistic regressions, crude odds ratios (cOR) and adjusted odds ratios (aOR) were used to determine the correlation between MetS and other dynamic features like demographic profile and risk factors. The IBM SPSS Statistics software guide's recommended methods produced the VIF results. For analytical significance, p< 0.05 was chosen as the cut-off value.

Approval of Institutional Ethical Committee: Institutional Human Ethics Committee of ICMR-Regional Medical Research Centre, Bhubaneswar, Odisha, India has reviewed and approved the detailed plan of study vide ICMR-RMRCB/IHEC-2020/037.

RESULTS

In this study, 500 young adults, either studying or working in various educational Institutes of Bhubaneswar were screened for Metabolic Syndrome and associated risk factors. The gender wise distribution of socio-demographic profile of the young adults is depicted in Table 1. Out of 500, 64% were females and 35% were males. The mean age of the participants was 23.4±10.5. 69% of the participants in this study were students and 30% were having jobs. Among them, 68% were sedentary and 32% were active. There is a significant difference in age group, literacy status and life style across the gender but occupation and family history were not significant. The gender wise distribution of anthropometric characteristics and risk factors for various NCDs is depicted in Table 2. While 6% of the study participants consumed alcohol, smoked and/or chewed tobacco, yet only 73% were not having any addictive habits. While 67% of young adults were non-vegetarians, about 55% of them preferred to eat fast food daily whereas 31% preferred fast food every week. Majority, i.e., 38% of the young adults spent about 8-12 hours online while 25% spent more than 12 hours online. While 49% of the young adults did less than 10 hours of physical activity per week, 27% of them worked for 10-12 hours per week. Maximum, i.e., 47% slept for less than 6 hours.

While 23% were overweight and 13% were obese. 66% of the females and 52% of the males had wider waist circumference. The mean±SD waist circumference is 89.2% and this is a significant factor for MetS as per IDF (International Diabetes Federation) guidelines. Thus, eating habits, fast food intake, less physical activity, lesser duration of sleep, BMI and waist circumference were significantly different across gender whereas habits and time spent online had no influence on the metabolic syndrome among young adults.

The gender wise distribution of clinical profiles of the young adults is depicted in Table 3.

Table 1: The gender-wise distribution of socio-demographic profile of young adults

Parameters	Total (n = 500) (%)	Males (n = 176) (%)	Females (n = 324) (%)	p-value
Age Group (Years)				
18 - 23	39 (7.8)	19 (10.79)	20 (6.17)	0.031*
24 - 29	328 (65.6)	103 (58.52)	225 (69.44)	
30 - 35	133 (26.6)	54 (30.68)	79 (24.38)	
Age Mean ± SD	23.46 ± 10.51	22.12 ± 12.05	23.37 ± 11.54	0.031#
Literacy Status				0.0001*
Secondary	31 (6.2)	21 (11.93)	10 (3.08)	
Graduation	212 (42.4)	77 (43.75)	135 (41.67)	
Above Graduation	257 (51.4)	78 (44.31)	179 (55.24)	
Lifestyle				0.002*
Active	159 (31.8)	71 (40.34)	88 (27.16)	
Sedentary	341 (68.2)	105 (59.65)	236 (72.83)	
Profession				0.559*
Student	349 (69.8)	124 (70.45)	225 (69.44)	
Job	151 (30.2)	52 (29.54)	99 (30.56)	
Familial History				0.370*
Yes	211 (42.2)	79 (44.88)	132 (40.74)	
No	289 (57.8)	97 (55.11)	192 9.26)	

*Chi-square test applied; #t test applied

Table 2: The gender-wise distribution of risk factors among young adults

Parameters	Total (n = 500) (%)	Males (n = 176) (%)	Females (n = 324) (%)	p-value
Habits				
Smoking	18 (3.6)	10 (5.68)	8 (2.46)	0.06
Alcohol	86 (17.2)	37 (21.02)	49 (15.12)	
All	31 (6.2)	12 (6.81)	19 (5.86)	
None	365 (73)	117 (66.47)	248 (76.54)	
Eating Habits				
Vegetarian	163 (32.6)	43 (24.43)	120 (37.03)	0.004
Non-vegetarian	337 (67.4)	133 (75.56)	204 (62.96)	
Fast Food Intake				
Daily	257 (55.8)	90 (51.13)	164 (50.61)	0.046
Weekly	159 (31.8)	56 (31.81)	103 (31.79)	
Monthly	36 (7.2)	13 (7.38)	26 (8.02)	
Occasionally	48 (9.6)	17 (9.65)	31 (9.56)	
Time Spent on Internet				
Up to 4 Hours	51 (10.2)	19 (10.79)	32 (9.87)	0.149
4-8 Hours	129 (25.8)	47 (26.70)	82 (25.30)	
8-12 Hours	193 (38.6)	79 (44.88)	114 (35.18)	
≥12 Hours	127 (25.4)	31 (17.61)	96 (29.60)	
Physical Activity				
≥10 Hours/week	249 (49.8)	79 (44.88)	170 (52.46)	0.022
10-12 Hours/week	137 (27.4)	51 (28.97)	86 (26.54)	
≥12 Hours/week	114 (22.8)	46 (26.13)	68 (20.98)	
Duration of Sleep				
≤6 Hours	235 (47)	103 (58.52)	132 (40.74)	0.001
6-8 Hours	119 (23.8)	41 (23.29)	78 (24.07)	
≥8 Hours	146 (29.2)	32 (18.18)	114 (35.18)	
BMI				
Underweight	29 (5.8)	11 (6.25)	18 (5.55)	0.006
Normal weight	285 (57)	103 (58.52)	182 (56.17)	
Overweight	117 (23.4)	44 (25)	73 (22.53)	
Obesity	69 (13.8)	18 (10.22)	51 (15.74)	
Waist Circumference Mean ± SD	89.20 ± 16.42	80.50 ± 13.89	93.56 ± 12.40	0.037
≤90 cm for males, ≤80 cm for females	310 (62)	93 (52.84)	217 (66.97)	0.001
>90 cm for males, >80 cm for females	190 (38)	83 (47.15)	107 (33.02)	

Table 3: The gender-wise distribution of clinical profile among young adults

Parameters	Total (n = 500) (%)	Males (n = 176) (%)	Females (n = 324) (%)	p-value
Hypertension				
Yes	126 (25.2)	33 (18.75)	93 (28.70)	0.014
No	374 (74.8)	143 (81.25)	231 (71.29)	
Diabetes				
Yes	11 (2.2)	8 (4.54)	3 (0.92)	0.001
No	489 (97.8)	168 (95.45)	321 (99.08)	
Total Cholesterol Level				
Yes	157 (31.4)	73 (41.47)	97 (29.93)	0.003
No	343 (68.6)	103 (58.52)	227 (70.07)	
Low HDL-C (mg/dl)				
Yes	108 (21.6)	41 (23.29)	67 (20.67)	0.039
No	392 (78.4)	135 (76.70)	257 (79.32)	
Triglycerides				
Yes	135 (27)	57 (32.38)	78 (24.07)	0.045
No	365 (73)	119 (67.61)	246 (75.93)	
HDL-C (mg/dl) Mean ± SD	33.10 ± 15.27	36.24 ± 13.55	33.44 ± 16.44	0.508
Diastolic Blood Pressure Mean ± SD	75.80 ± 18.38	75.74 ± 10.72	75.83 ± 10.72	0.203
Systolic Blood Pressure Mean ± SD	119.26 ± 13.88	119.23 ± 13.90	119.26 ± 13.92	0.02
Glycemia Mean ± SD	102.43 ± 12.83	102.44 ± 12.86	102.35 ± 12.80	0.001

Twenty-five percent of the young adults were having hypertension. 2% were having diabetes and 31% were having high cholesterol levels. The serum levels of triglycerides were high among 27% of young adults. The mean HDL-C was 33.10±15.2, Systolic BP was 119.2±13.8 and Diastolic BP was 75.8±18.3. The

mean Blood glucose levels were 102.4±12.8 among the participants. Thus, hypertension, diabetes, total cholesterol levels, low HDL-C and triglycerides were significant risk factors across gender. The mean±SD for Systolic Blood pressure was 0.020 and Glycemia was 0.001. The Diastolic blood pressure and HDL-C did not seem to influence the MetS.

Table 4 depicts the prevalence of MetS and its components by age groups. In all, 14% of the young adults in the age group, 30-35 years, 8% in the age group 24-29 years and 2% in the age group 18-23 years were having MetS. Thus, the prevalence of MetS is 25.4% and the difference across age groups is statistically significant. Increased waist circumference (WC) was observed in the age group, 24-29 years among 25% each of the males and females indicating abdominal obesity. Further, among 176 men and 324 women, raised WC, raised triglycerides (TG), HDL-C, blood glucose levels (BG) and blood pressure (BP) were observed in the age group, 30-35 years. Thus, increased WC, TG, HDL-C, BG and BP all of which together contribute to MetS were significant risk factors among the study participants. The prevalence of MetS in males is 27.2% (48) and statistically significant (p-value = 0.042). The prevalence of low HDL-C, raised BG and raised BP shows a significant difference in the 30-35 years age group among males. The prevalence of MetS in females is 24.3% but not statistically significant. There is a significant difference in the prevalence of raised WC, raised TG levels, low HDL-C, raised BG, raised BP in the 30-35 years group in females. Table 5 shows the crude odds ratio and odds ratios (Exp(B)), confidence intervals and p-values of risk factors of MetS. Participants addicted to alcohol, smoking and/or chewing tobacco, had higher risk of MetS. With regards to eating habits, non-vegetarians have an increased risk of MetS. Longer sleep duration (≥ 8 hours) is associated with reduced odds of MetS. Moderate to high physical activity seems protective against MetS but did not show a significant association. This analysis reveals multiple risk factors contributing to MetS with alcohol consumption, BMI, physical activity and dietary habits playing significant roles.

Participants with BMI ≥ 30 kg/m^2, waist circumference ≥90 cm for males and ≥80cm for females, those who practice moderate intensity physical activity, those with hypertension, diabetes, Low HDL-Cholesterol shows a potential higher risk of MetS. Those with non-vegetarian eating habits and weekly fast food intake habits possess high risk of developing Mets. Those who spent 8-12 hours online and those who slept less than 4-6 hours also have shown a greater risk of MetS.

In men, the risk of MetS was higher among those who consumed alcohol, smoked and/or chewed tobacco than female, with 8-12 hours' time spending online and among those having hypertension or diabetes.

In women, the risk of MetS was higher among BMI ≥ 30 kg/m^2, those with moderate physical activity, and those having hypertension, non-vegetarian eating habits, waist circumference or Low HDL-cholesterol, respectively and were statistically significant.

In the multi-variate analyses, all risk factors that were statistically significant and related to MetS as per univariate analyses were depicted in Table 6. The VIF (Variance Inflation Factor) is also reported for each variable, indicating multi-collinearity. The multi-variable model found four risk variables for MetS in the whole study: Hypertension, diabetes, BMI ≥ 30 kg/m2 and 10-12 hours of physical activity. Habits, alcohol consumption, hypertension, low HDL-C, more time spent online, waist circumference, diabetes, less duration of sleep, frequent fast-food intake and eating habits have a higher risk of MetS. The "Backward Wald" technique produced the close model across all three multi-variable evaluations.

Table 4: The prevalence of Metabolic Syndrome & its components by age groups

Characteristics of overall sample (n = 500)	Age Group (Years)			p-value
	18 - 23 yrs (n = 39) (7.8%)	24 - 29 yrs (n = 328) (65.6%)	30 - 35 yrs (n = 133) (26.6%)	
Overall MetS Individuals (127)	14 (2.8%)	41 (8.2%)	72 (14.4%)	0.001
Men (n = 176)				
MetS (48)	5 (2.8)	14 (7.9)	29 (16.4)	0.042
Raised WC	4 (2.27)	45 (25.56)	44 (25)	0.733
Raised TG	2 (1.13)	19 (10.79)	36 (20.45)	0.101
Low HDL-c	2 (1.13)	16 (9.09)	23 (13.06)	0.048
Raised Glucose	1 (0.56)	16 (9.09)	24 (13.63)	0.003
Raised SBP	15 (8.52)	32 (18.18)	44 (25)	0.002
Raised DBP	11 (6.25)	33 (18.75)	40 (22.72)	0.091
Women (n = 324)				
MetS (79)	9 (2.7)	27 (8.3)	43 (13.27)	0.127
Raised WC	38 (11.72)	87 (26.85)	92 (28.39)	0.023
Raised TG	4 (1.23)	33 (10.18)	41 (12.65)	0.045
Low HDL-c	3 (0.92)	21 (6.48)	43 (13.27)	0.037
Raised Glucose	4 (1.23)	14 (4.32)	32 (9.87)	0.005
Raised SBP	5 (1.54)	30 (9.25)	41 (12.65)	0.002
Raised DBP	3 (0.92)	34 (10.49)	45 (13.88)	0.075

Met-S – Metabolic syndrome

Table 5: The risk factors associated with MetS by Pearson Chi-Square and Binary Logistic Regression

Risk Factors	MetS in all Sample (n = 500)	cOR (95% CI)	MetS in Men (n = 176)	cOR (95% CI)	MetS in Women (n = 324)	cOR (95% CI)
Gender						
Men	48(9.6)	1.16 (0.77 - 1.77)	-	-	-	-
Women	79(15.8)	1	-	-	-	-
Habits						
No	55(11)	1	15	1	40	1
Yes	47(9.4)	3.01 (1.91 - 4.75)	29	6.57 (3.12 - 13.84)	18	1.61 (0.86 - 3.02)
Alcohol						
No	43(8.6)	1	20	1	23	1
Yes	32(6.4)	0.19 (0.11 - 0.33)	17	0.18 (0.08 - 0.41)	15	0.21 (0.10 - 0.44)
Smoking						
No	7(1.4)	1	2	1	5	1
Yes	6(1.2)	0.02 (0.008 - 0.10)	3	0.02 (0.004 - 0.19)	3	0.02 (0.005 - 0.14)
All						
No	5(1)	1	2	1	3	1
Yes	9(1.8)	0.02 (0.008 - 0.08)	5	0.02 (0.003 - 0.13)	4	0.03 (0.006 - 0.16)
BMI						
≤ 30	76(15.2)	1	35	1	41	1
≥ 30	32(6.4)	4.04 (2.37 - 6.89)	9	3.51 (1.30 - 9.53)	23	4.65 (2.44 - 8.85)
Waist Circumference						
≤ 90 cm for males, ≤80 cm for females	48(9.6)	1	21	1	27	1
≥ 90 cm for males, ≥80 cm for females	67(13.4)	2.97 (1.94 - 4.56)	24	1.39 (0.71 - 2.75)	43	4.73 (2.70 - 8.26)
Physical Activity (Hours/week)						
≤ 10	48(9.6)	1	17	1	31	1
10-12	39(7.8)	1.67 (1.03 - 2.72)	15	1.52 (0.68 - 3.40)	24	1.74 (0.94 - 3.12)
≥ 12	35(7)	1.86 (1.12 - 3.10)	14	1.60 (0.70 - 3.64)	21	2.00 (1.05 - 3.82)
Hypertension						
Absent	71(14.2)	1	30	1	41	1
Present	41(8.2)	2.06 (1.30 - 3.24)	12	2.15 (0.95 - 4.87)	29	2.10 (1.21 - 3.65)
Diabetes						
Absent	108(21.6)	1	36	1	72	1
Present	6(1.2)	3.53 (1.12 - 11.16)	4	3.67 (0.87 - 15.36)	2	1.73 (0.15 - 19.34)
Low HDL-C						
Absent	54(10.8)	1	22	1	32	1
Present	62(12.4)	8.44 (5.23 - 13.6)	23	6.56 (3.05 - 14.14)	39	9.79 (5.32 - 18.03)
Eating Habits						
Vegetarian	41(8.2)	1	12	1	29	1
Non-Vegetarian	186(37.2)	3.67 (2.42 - 5.54)	69	2.79 (1.32 - 5.89)	117	4.22 (2.50 - 6.97)
Fast Food Intake						
Daily	53(10.6)	1	22	1	31	1
Weekly	38(7.6)	1.16 (0.72 - 1.86)	16	1.12 (0.53 - 2.36)	22	1.18 (0.64 - 2.18)
Monthly	8(1.6)	1.34 (0.57 - 3.16)	3	1.94 (0.43 - 8.76)	5	1.19 (0.41 - 3.46)
Occasionally	8(1.6)	0.77 (0.34 - 1.74)	4	0.92 (0.28 - 3.09)	4	0.66 (0.21 - 2.03)
Time Spent on Internet (Hours)						
Up to 4 hours	34(6.8)	1	15	1	19	1
4-8	38(7.6)	1.05 (0.63 - 1.76)	11	0.55 (0.23 - 1.30)	27	1.55 (0.81 - 2.99)
8-12	39(7.8)	1.90 (1.12 - 3.23)	14	2.80 (1.12 - 6.97)	25	1.76 (0.90 - 3.44)
Duration of Sleep (Hours)						
≤ 6	62(12.4)	1	25	1	37	1
6-8	21(4.2)	0.60 (0.34 - 1.04)	9	0.88 (0.37 - 2.09)	12	0.47 (0.23 - 0.96)
≥ 8	13(2.6)	0.27 (0.14 - 0.52)	3	0.32 (0.09 - 1.15)	10	0.25 (0.12 - 0.52)

Met-S – Metabolic syndrome; cOR – Crude/unadjusted Odds Ratio; CI- Confidence interval

DISCUSSION

In our study, 500 young adults (18-35 years) including 64% females and 36% males studying and/or working in various educational institutes of Bhubaneswar were screened for MetS. Out of 500 young adults, 22% were having pre-diabetes, 2% were having Diabetes, 20% were having pre-hypertension, 10% were having hypertension, 13% were obese and 4% were having dyslipidemia. Prevalence of Metabolic Syndrome in all the participants was 25.4% [27.2% (48) in males and 24.3% (79) in females]. Majority, i.e., 65% of young adults were in the age range, 24-29 years. While 44% of the participants were students, only 30% were having jobs. Among the participants, 68% were sedentary.

Table 6: The risk factors associated with MetS in overall sample by multiple logistic regression

Risk Factors	B	SE	Wald	Exp(B)	95% CI	P-Value	VIF
Habits							
No (Ref)	Ref	Ref	Ref	Ref	Ref	Ref	3.84
Yes	-1.60	0.50	10.24	4.95	2.2 – 9.1	0.023	
Alcohol Drinker							
No (Ref)	Ref	Ref	Ref	Ref	Ref	Ref	1.96
Yes	-1.60	0.30	28.40	3.90	1.6 – 15.3	0.030	
Smoker							
No (Ref)	Ref	Ref	Ref	Ref	Ref	Ref	2.12
Yes	-1.70	0.60	8.00	5.47	0.7 – 3.5	0.060	
All							
No (Ref)	Ref	Ref	Ref	Ref	Ref	Ref	2.00
Yes	-1.40	0.60	5.29	4.05	1.1 – 4.3	0.120	
BMI							
No (Ref)	Ref	Ref	Ref	Ref	Ref	Ref	2.72
Yes	-1.30	0.50	6.76	3.66	1.7 – 5.5	0.006	
Physical Activity							
≤10 (Ref)	Ref	Ref	Ref	Ref	Ref	Ref	4.76
10-12	-0.60	0.50	1.44	1.82	0.9 – 4.1	0.017	
≥12	-0.50	0.50	1.00	1.64	0.4 – 3.4	0.123	
Hypertension							
No (Ref)	Ref	Ref	Ref	Ref	Ref	Ref	1.19
Yes	-0.72	0.50	2.07	2.05	0.8 – 3.9	0.023	
Low HDL-C							
No (Ref)	Ref	Ref	Ref	Ref	Ref	Ref	7.69
Yes	-2.13	0.50	18.14	8.41	3.3 – 11.1	0.030	
Time Spent on Internet							
Up to 4 hours (Ref)	Ref	Ref	Ref	Ref	Ref	Ref	1.06
4-8	-0.50	0.50	1.00	1.04	1.1 – 3.3	0.116	
8-12	-0.64	0.50	1.63	1.89	1.6 – 8.1	0.144	
Waist Circumference							
≤ 90 cm for males, ≤ 80 cm for females (Ref)	Ref	Ref	Ref	Ref	Ref	Ref	2.12
≥ 90 cm for males, ≥ 80 cm for females	-1.08	0.50	4.66	2.94	0.6 - 9.3	0.030	
Diabetes							
No (Ref)	Ref	Ref	Ref	Ref	Ref	Ref	1.19
Yes	-1.26	0.50	6.35	3.52	1.4 – 12.6	0.001	
Duration of Sleep							
≤ 6 (Ref)	Ref	Ref	Ref	Ref	Ref	Ref	1.06
6-8	-0.51	0.50	1.04	1.66	0.6 – 2.1	0.001	
≥ 8	-1.30	0.50	6.76	3.66	0.1 – 1.4	0.007	
Fast Food Intake							
Daily (Ref)	Ref	Ref	Ref	Ref	Ref	Ref	1.17
Weekly	-0.89	0.50	3.16	1.33	0.9 – 3.1	0.041	
Monthly	-0.66	0.50	1.74	1.29	0.6 – 2.7	0.010	
Occasionally	-0.51	0.50	1.04	1.21	0.5 – 2.1	0.001	
Eating Habits							
Vegetarian (Ref)	Ref	Ref	Ref	Ref	Ref	Ref	2.07
Non-Vegetarian	-1.30	0.50	6.76	1.30	2.2 – 7.4	0.001	

Exp(B) gives adjusted odd ratio (aOR). VIF (Variance Inflation Factor). Ref (reference category). Logistic Regression Analysis

A sedentary lifestyle involves little or no physical activity. Usually, students spend a lot of time in studies indirectly being sedentary. In all, hypertension was present among 25% of the young adults and 2% were having diabetes. Extended sitting hours, 8 to 12 hours or more a day, and inactivity due to desk job are proven risk factors that lead to more hospitalization, heart disease, cancer and early death, even if one exercises regularly. Several studies have reported that sedentary lifestyle has a significant effect on the development of various NCDs like obesity, type 2 diabetes, cardiovascular diseases, some types of cancer and early death in this age group.[18-20] Metabolism and the ability to control blood sugar levels, blood pressure and lipolysis are reduced due to prolonged periods of inactivity. 6% of the study participants consumed either alcohol or smoked and/or chewed tobacco. Betel leaf chewing is quite common among the young, adults and old people of this State as it is grown in abundance and easily available. Majority of young adults were non-vegetarians and about 55% each of the study participants preferred to eat fast food daily whereas 31% preferred fast food every week. Frequent consumption of alcohol and fast-food leads to the rise of many chronic diseases like obesity, cardiovascular diseases due to the excess fat, carbohydrates, processed sugar and high salt content found in junk food and alcoholic drinks.[21-24] There

seems to be a direct correlation between consumption of junk food and obesity rates. There is a tendency among young people to eat excessively in one sitting and having satiated with junk food generally avoid eating nutritious foods, fruits or vegetables. Further, 49% of the young adults did less than 10 hours of physical activity per week. Physical activity is important for all age groups for maintaining good health and lack of exercise contributes to all components of MetS, i.e., increased weight, high blood pressure, hyperglycemia, hyperlipidemia, etc.[25-28] Maximum, i.e., 47% slept for less than 6 hours and 23% of the participants slept for about 6-8 hours. Among the participants who slept less than 6-8 hours, 43% were having pre-hypertension, 50% hypertension, 43% had pre-diabetes, 44% had diabetes and 51% were overweight. Among those who slept for more than 8 hours, 47% had pre-diabetes and 40% were obese. Generally, about 7 to 9 hours of sleep per night has been recommended for adults. Irregular and less sleep hours escalate the risk of several conditions like obesity, diabetes, heart disease, obstructive sleep apnea and decrease the life expectancy.[29] When continued over a period of long time, blood pressure rises damaging vital organs like heart, arteries and kidneys. It may cause stroke, loss of vision, declined creativity, attentiveness, mood swings, twitchy eyes, reproductive problems, eating disorders, weight gain, anxiety, stress, increased risk of road traffic injuries, etc. Majority, i.e., 38% of the young adults spent about 8-12 hours in online activities whereas 25% spent 4-8 hours online. Spending time on the laptop, mobile or internet means being glued to the screen which indirectly means spending time on the desk without any activity for prolonged hours. There has been a rise in online activities to meet our daily requirements including studying, job, shopping, entertainment, games, consultation, travel, interviews, meetings, ordering food, paying bills, bank transactions, etc. These have eased various tasks requiring our time and effort. As such usage of mobile, desktop, laptop including smart phones and tablets have increased enormously consuming a larger part of our time. Another study has shown that prolonged time on the internet can raise the risk of hypertension. Longer internet usage has been linked with risks like anxiety, depression, addiction, obesity and social isolation.[30] Sleep disruption and insomnia result from digital eye strain caused by screens of computers, smart phones and televisions, which emit blue light. The analysis indicates significant differences in the incidence of MetS and its constituents across age groups, particularly in men. Raised waist circumference, low HDL-C, raised BG and BP are more prevalent in older age groups. These findings suggest an age-related increase in the risk of developing MetS and its components, particularly after the age of 30 years. Men show significant differences in MetS prevalence across age bracket, whereas in women, some components like raised WC, TG, and low HDL-C are more significantly different across age groups. These observations emphasize the significance of targeted interventions to prevent and manage MetS, especially in older age groups, with attention to both gender-specific and age-related risk factors.

Several studies in different regions of India have reported the prevalence of MetS ranging from 4% to 41%.[31-46] Together, these studies reported that the prominent risk factors were abdominal obesity, sedentary life style, hypercholesterolemia particularly raised TG levels and high socio-economic status and female gender for MetS but they have not advocated prevention strategies. These studies reported that young adults are at risk of several diseases due to their preference of eating fast foods, spending a longer time online, exercising less and irregular sleep hours. The risk of MetS and CVDs are high among the young adults, sharing similar lifestyle and habits, beginning in the early years.[47,48] These adverse conditions are more detrimental when they occur together with other and are preventable by change in lifestyle. The vital benefactors of cardiovascular affliction and fatality are certain adaptable risk quotient, such as high blood pressure, smoking, diabetes, obesity, dyslipidemia, anxiety, inadequate diet and less physical activity. Therefore, increasing awareness of the cluster of risk factors and measures to prevent them comprehensively need to be stressed in prevention strategies among young adults, in particular and in Odisha, in general.

STRENGTHS AND CONSTRAINTS

There were definite strengths and few constraints of this study. Since this is an observational study, no causal inferences can be drawn. Screening young adults, at regular intervals, will help in identifying those at risk of developing MetS. Fasting blood glucose was used to detect pre-diabetes and diabetes by a glucometer due to logistic constraints.

CONCLUSION

This study is the first one conducted in this State among young adults. Therefore, follow-up researches are required to identify the various risk factors and mediators on the causal pathway in this population for control and prevention. High prevalence of MetS amongst the young adults emphasizes the need for safeguarding and management of non-communicable diseases.

Authors' contributions: Manaswini Dash and Satavisha Sadangi were involved in the collection of socio-demographic and clinical profile of young adults enrolled in the study. Braja Sundar Barik was involved in compilation of the data. Minaketan Barik was involved in laboratory analysis. Nadeem Hussain was involved in the statistical analysis of the data. Dr. Tahziba Hussain conceptualized the idea, designed the study, wrote and edited the article throughout all

stages. Dr. Sanghamitra Pati, Director facilitated the study by providing all necessary support.

Acknowledgements: We thank all the young adults who enrolled themselves for this study.

REFERENCES

1. Sun H, Saeedi P, Karuranga S, Pinkepank M, Ogurtsova K, Duncan BB, Stein C, Basit A, Chan JC, Mbanya JC, Pavkov ME. IDF diabetes atlas: Global, regional and country-level diabetes prevalence estimates for 2021 and projections for 2045. Diabetes Res. Clin. Prac. 2022 Jan;183:109119. DOI: https://doi.org/10.1016/j.diabres.2021.109119
2. Ogurtsova K, Guariguata L, Barengo NC, Ruiz PL, Sacre JW, Karuranga S, Sun H, Boyko EJ, Magliano DJ. IDF diabetes Atlas: Global estimates of undiagnosed diabetes in adults for 2021. Diabetes Res Clin Pract. 2022 Jan;183:109118. DOI: https://doi.org/10.1016/j.diabres.2021.109118
3. Huh JH, Kang DR, Kim JY, Koh KK. Metabolic syndrome fact sheet 2021: executive report. Cardiometabol. Syndr. J. 2021;1(2):125-134. DOI: https://doi.org/10.51789/cmsj.2021.1.e15
4. Diabetes Canada Clinical Practice Guidelines Expert Committee; Punthakee Z, Goldenberg R, Katz P. Definition, Classification and Diagnosis of Diabetes, Prediabetes and Metabolic Syndrome. Can J Diabetes. 2018 Apr;42 Suppl 1:S10-S15. DOI: https://doi.org/10.1016/j.jcjd.2017.10.003 PMid:29650080
5. Bhalwar R. Metabolic syndrome: The Indian public health perspective. Med. Journal Armed Forces India. 2020;76(1):8-16. DOI: https://doi.org/10.1016/j.mjafi.2019.12.001
6. Bhagat A, Malhotra AS, Kaur G, Kapoor N. Metabolic syndrome: not even the urban Indian youth is spared. Ind. J. Physiol. Pharmacol. 2017;61(4):368-77.
7. Semenkovich C F, Goldberg A C, Goldberg I J. Chapter 37 - Disorders of Lipid Metabolism. National Cholesterol Education Program. Williams Textbook of Endocrinology (13th Edition), 2016; Pdf: 1660-1700. DOI: https://doi.org/10.1016/B978-0-323-29738-7.00037-X
8. Halpern A, Mancini MC, Magalhães ME, Fisberg M, Radominski R, Bertolami MC, Bertolami A, de Melo ME, Zanella MT, Queiroz MS, Nery M. Metabolic syndrome, dyslipidemia, hypertension and type 2 diabetes in youth: from diagnosis to treatment. Diabetol Metab Syndr. 2010 Aug 18;2:55. DOI: https://doi.org/10.1186/1758-5996-2-55 PMid:20718958
9. Yadav D, Mishra M, Tiwari A, Bisen PS, Goswamy HM, Prasad GB. Prevalence of dyslipidemia and hypertension in Indian type 2 diabetic patients with metabolic syndrome and its clinical significance. Osong Public Health Res. Perspec. 2014;5(3):169-75. DOI: https://doi.org/10.1016/j.phrp.2014.04.009 PMid:25180150 PMCid:PMC4147218
10. Krishnamoorthy Y, Rajaa S, Murali S, Rehman T, Sahoo J, Kar SS. Prevalence of metabolic syndrome among adult population in India: A systematic review and meta-analysis. PLoS One. 2020 Oct 19;15(10):e0240971. DOI: https://doi.org/10.1371/journal.pone.0240971 PMid:33075086 PMCid:PMC7571716
11. Nolan PB, Carrick-Ranson G, Stinear JW, Reading SA, Dalleck LC. Prevalence of metabolic syndrome and metabolic syndrome components in young adults: A pooled analysis. Preventive Med. Reports. 2017;7(2017):211-15. DOI: https://doi.org/10.1016/j.pmedr.2017.07.004 PMid:28794957
12. Meher T, Sahoo H. The epidemiological profile of metabolic syndrome in Indian population: A comparative study between men and women. Clin. Epidemiol. Glob. Health. 2020;8(4):1047-52. DOI: https://doi.org/10.1016/j.cegh.2020.03.018
13. Sawant A, Mankeshwar R, Shah S, Raghavan R, Dhongde G, Raje H, D'souza S, Subramanium A, Dhairyawan P, Todur S, Ashavaid TF. Prevalence of metabolic syndrome in urban India. Cholesterol. 2011;2011:920983. DOI: https://doi.org/10.1155/2011/920983 PMid:21687582 PMCid:PMC3114375
14. Nerkar D, Mukherjee A, Mehta BK, Banerjee S. Metabolic syndrome associated complications. Int. J. Pharmacol. Pharm. Sci. 2015;7(7):22-25.
15. Khan HM, Mende S, Rafiq A, Gabbidon K, Reddy PH. Methods needed to measure predictive accuracy: a study of diabetic patients. Biochim Biophys Acta Mol. Basis Dis. BBA-MOL BASIS DIS. 2017;1863(5):1046-53. DOI: https://doi.org/10.1016/j.bbadis.2017.01.007 PMid:28088628 PMCid:PMC5429869
16. World Health Organization. Global Physical Activity Questionnaire (GPAQ) Analysis Guide- 2021. Available from: https://www.who.int/docs/default-source/ncds/ncd-surveillance/gpaq-analysis-guide.pdf
17. Esser N, Legrand-Poels S, Piette J, Scheen AJ, Paquot N. Inflammation as a link between obesity, metabolic syndrome and type 2 diabetes. Diabetes Res. Clin. Prac. 2014;105(2):141-50. DOI: https://doi.org/10.1016/j.diabres.2014.04.006 PMid:24798950
18. Shin JA, Lee JH, Lim SY, Ha HS, Kwon HS, Park YM, Lee WC, Kang MI, Yim HW, Yoon KH, Son HY. Metabolic syndrome as a predictor of type 2 diabetes, and its clinical interpretations and usefulness. J. Diabetes Invest. 2013;4(4):334-43. DOI: https://doi.org/10.1111/jdi.12075 PMid:24843675
19. Slagter SN, Van WRP, Van BAP, Van MM, Wolffenbuttel BH, Van JV. Sex, BMI and age differences in metabolic syndrome: the Dutch Lifelines Cohort Study. Endocrine connections. 2017;6(4):278-88. DOI: https://doi.org/10.1530/EC-17-0011 PMid:28420718 PMCid:PMC5457493
20. Biondi B. Thyroid and obesity: An intriguing relationship. J. Clin. Endocrinol. Metab. 2010;95(8):3614-3617. DOI: https://doi.org/10.1210/jc.2010-1245 PMid:20685890
21. Moreira GC, Cipullo JP, Ciorlia LA, Cesarino CB, Vilela-Martin JF. Prevalence of metabolic syndrome: association with risk factors and cardiovascular complications in an urban population. PLoS One. 2014;9(9):e105056. DOI: https://doi.org/10.1371/journal.pone.0105056 PMid:25180496
22. Dietrich P, Hellerbrand C. Non-alcoholic fatty liver disease, obesity and the metabolic syndrome. Best Pract. Res. Clin. Gastroenterol. 2014;28(4):637-53. DOI: https://doi.org/10.1016/j.bpg.2014.07.008 PMid:25194181
23. Boyle M, Masson S, Anstee QM. The bi-directional impacts of alcohol consumption and the metabolic syndrome: cofactors for progressive fatty liver disease. J. Hepatol. 2018;68(2):251-67. DOI: https://doi.org/10.1016/j.jhep.2017.11.006
24. Asghari G, Yuzbashian E, Mirmiran P, Mahmoodi B, Azizi F. Fast food intake increases the incidence of metabolic syndrome in children and adolescents: Tehran lipid and glucose study. PloS One. 2015;10(10):e0139641. DOI: https://doi.org/10.1371/journal.pone.0139641 PMid:26447855
25. Kataria I, Chadha R, Pathak R. Metabolic syndrome in adults: relation with diet and other lifestyle factors. Rev. Health Care. 2015;6(3):99-124. DOI: https://doi.org/10.7175/rhc.v6i3.1188
26. Myers J, Kokkinos P, Nyelin E. Physical activity, cardiorespiratory fitness and the metabolic syndrome. Nutrients. 2019;11(7):1652-60. DOI: https://doi.org/10.3390/nu11071652 PMid:31331009 PMCid:PMC6683051
27. Salonen MK, Wasenius N, Kajantie E, Lano A, Lahti J, Heinonen K, Räikkönen K, Eriksson JG. Physical activity, body composition and metabolic syndrome in young adults. PloS One. 2015;10(5):e0126737. DOI: https://doi.org/10.1371/journal.pone.0126737 PMid:25992848 PMCid:PMC4439134
28. Koren D, Dumin M, Gozal D. Role of sleep quality in the metabolic syndrome. Diabetes, Metabol. Syndr. Obesity: targets and therapy. 2016;9:281- 310. DOI: https://doi.org/10.2147/DMSO.S95120 PMid:27601926 PMCid:PMC5003523

29. Chakraborty SN, Roy SK, Rahaman MA. Epidemiological predictors of metabolic syndrome in urban West Bengal, India. J. Fam. Med. Pri. Care. 2015;4(4):535-538. DOI: https://doi.org/10.4103/2249-4863.174279 PMid:26985412 PMCid:PMC4776605

30. Dasgupta A, Banerjee R, Pan T, Suman S, Basu U, Paul B. Metabolic syndrome and its correlates: A cross-sectional study among adults aged 18-49 years in an Urban Area of West Bengal. Ind. J. Pub. Health. 2020;64(1):50-54. DOI: https://doi.org/10.4103/ijph.IJPH_50_19 PMid:32189683

31. Prasad DS, Kabir Z, Dash AK, Das BC. Prevalence and risk factors for metabolic syndrome in Asian Indians: A community study from urban Eastern India. J. Cardiovas. Dis. Res. 2012;3(3):204-211. DOI: https://doi.org/10.4103/0975-3583.98895 PMid:22923938 PMCid:PMC3425027

32. Deedwania PC, Gupta R, Sharma KK, Achari V, Gupta B, Maheshwari A, Gupta A. High prevalence of metabolic syndrome among urban subjects in India: a multisite study. Diabetes Metabol. Syndr. Clin. Res. Rev. 2014; 8(3):156-161. DOI: https://doi.org/10.1016/j.dsx.2014.04.033 PMid:25220918

33. Kaushal SK, Gupta V, Prakash G, Misra S. Correlates of metabolic syndrome and prevalence among urban population of Agra, Uttar Pradesh, India. Int. J. Comm. Med. Pub. Health. 2016;3(12):3570-3575. DOI: https://doi.org/10.18203/2394-6040.ijcmph20164293

34. Mangat C, Goel NK, Walia DK, Agarwal N, Sharma MK, Kaur J, Singh R, Singh G. Metabolic syndrome: a challenging health issue in highly urbanized Union Territory of north India. Diabetol. Metabol. Syndr. 2010;2:19. DOI: https://doi.org/10.1186/1758-5996-2-19 PMid:20331871 PMCid:PMC2848628

35. Sharma MK, Pandey S, Nagtilak S. Metabolic Syndrome In Urban And Rural Population Of Greater Noida National Capital Region Of India. Asian J. Pharm. Clin. Res. 2018;11(9):110-114. DOI: https://doi.org/10.22159/ajpcr.2018.v11i9.26487

36. Sinha S, Misra P, Kant S, Krishnan A, Nongkynrih B, Vikram NK. Prevalence of metabolic syndrome and its selected determinants among urban adult women in South Delhi, India. Postgrad. Med. J. 2013;89(1048):68-72. DOI: https://doi.org/10.1136/postgradmedj-2012-130851 PMid:23112218

37. Thakur S, Raina S, Thakur S, Negi PC, Verma BS. Prevalence of metabolic syndrome among newly diagnosed hypertensive patients in the hills of Himachal Pradesh, India. Ind. J. Endocrinol. Metabolism. 2013;17(4):723-726. DOI: https://doi.org/10.4103/2230-8210.113768 PMid:23961493

38. Verma P, Srivastava RK, Jain D. Association of lifestyle risk factors with metabolic syndrome components: A cross-sectional study in Eastern India. Int. J. Prevent. Med. 2018;9:6. DOI: https://doi.org/10.4103/ijpvm.IJPVM_236_17

39. Harikrishnan S, Sarma S, Sanjay G, Jeemon P, Krishnan MN, Venugopal K, Mohanan PP, Jeyaseelan L, Thankappan KR, Zachariah G. Prevalence of metabolic syndrome and its risk factors in Kerala, South India: Analysis of a community based cross-sectional study. PLoS One. 2018;13(3):e0192372. DOI: https://doi.org/10.1371/journal.pone.0192372 PMid:29584725 PMCid:PMC5870937

40. Krupp K, Adsul P, Wilcox ML, Srinivas V, Frank E, Srinivas A, Madhivanan P. Prevalence and correlates of metabolic syndrome among rural women in Mysore, India. Ind. Heart J. 2020;72(6):582-588. DOI: https://doi.org/10.1016/j.ihj.2020.09.015 PMid:33357649 PMCid:PMC7772584

41. Pemminati S, Prabha Adhikari MR, Pathak R, Pai MR. Prevalence of metabolic syndrome (METS) using IDF 2005 guidelines in a semi urban south Indian (Boloor Diabetes Study) population of Mangalore. J Assoc Physicians India. 2010; 58:674-677. PMID: 21510460.

42. Teli A, Jabannavar V, Adorno I, Gayatri GS, Lampis F, Patil P. Estimation of prevalence of metabolic syndrome among 1st year medical students of a medical college in North Karnataka, India. Ind. J. Health Sci. Biomed. Res. (KLEU). 2019;12(2):174-178. DOI: https://doi.org/10.4103/kleuhsj.kleuhsj_13_19

43. Kamble P, Deshmukh PR, Garg N. Metabolic syndrome in adult population of rural Wardha, central India. Ind. J. Med. Res. 2010;132(6):701- 705.

44. Bosak KA, Yates B, Pozehl B. Effects of an Internet physical activity intervention in adults with metabolic syndrome. Western J. Nursing Res. 2010;32(1):5-22. DOI: https://doi.org/10.1177/0193945909333889 PMid:19357421

45. Khan Y, Lalchandani A, Gupta AC, Khadanga S, Kumar S. Prevalence of metabolic syndrome crossing 40% in Northern India: Time to act fast before it runs out of proportions. J. Fam. Med. Pri. Care. 2018;7(1):118 - 23. DOI: https://doi.org/10.4103/jfmpc.jfmpc_10_17 PMid:29915744 PMCid:PMC5958552

46. Chandrupatla SG, Khalid I, Muthuluri T, Dantala S, Tavares M. Diabetes and pre-diabetes prevalence among young and middle-aged adults in India, with an analysis of geographic differences: findings from the National Family Health Survey. Epidemiol. Health. 2020;42:e2020065. DOI: https://doi.org/10.4178/epih.e2020065 PMid:32972049 PMCid:PMC7871157

47. Sawant AM, Shetty D, Mankeshwar R, Ashavaid TF. Prevalence of dyslipidemia in young adult Indian population. J. Asso. Physic. I. 2008;56(2):99-102.

48. Praveen PA, Madhu SV, Viswanathan M, Das S, Kakati S, Shah N, Chadha M, Bhadada SK, Kaur T, Dhaliwal RS, Das AK. Demographic and clinical profile of youth onset diabetes patients in India-Results from the baseline data of a clinic based registry of people with diabetes in India with young age at onset-[YDR-02]. Pedia. Diabetes. 2021;22(1):15-21. DOI: https://doi.org/10.1111/pedi.12973 PMid:31885113