**Research Article**
Volume 14:1, 2025

Journal of Metabolic Syndrome

ISSN: 2167-0943 Open Access

# Prevalence of Metabolic Syndrome and Its Associated Risk Factors among Young Adults in Bhubaneswar

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## Abstract

Metabolic Syndrome (MetS) is a combination of risk factors that increase the possibility of emerging non-communicable diseases namely type 2 diabetes, dyslipidemia, cardiovascular disease, etc.

In this study, young adults, between the age of 18-35 years, were enrolled and screened for signs and symptoms of MetS. Metabolic syndrome was defined using updated national cholesterol education program/adult treatment panel-III guidelines with modified waist circumference for Indians and international diabetes federation criteria. The prevalence was estimated and socio-demographic, physical, behavioral and biochemical risk factors were assessed.

Out of 500 young adults, 22% were having pre-diabetes, 2% were having diabetes, 20% were having pre-hypertension, 25% were having hypertension, 13% were obese and 23% were having dyslipidemia. Among the study participants, 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. In the multivariate analyses, all risk factors that were statistically significant and related to MetS in the univariate analyses were included. The multivariable model found four risk variables for MetS in the whole sample: BMI ≥ 30 kg/m$^2$, 10-12 hours physical activity, having hypertension and diabetes. Screening young adults, at regular intervals, will help in identifying those at risk of developing MetS. High prevalence, 25% of MetS observed amongst the young adults in this region emphasizes the need for safeguarding and management of non-communicable diseases.

**Keywords:** Metabolic syndrome • Prevalence • Risk factors • Young adults • Diabetes

## 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 risk factors that increase the possibility of emerging Non-Communicable Diseases (NCDs) namely type 2 diabetes, dyslipidemia, cardiovascular disease, stroke, hepatic steatosis and other circulatory disorders [4-7]. MetS is a group of metabolic abnormalities that includes abdominal obesity, high blood pressure Systolic Blood Pressure (SBP) or Diastolic Blood Pressure (DBP), high Fasting Blood Glucose (FBG), and dyslipidaemia elevated Triglyceride Levels (TG) and low High-Density Lipoprotein Cholesterol Levels (HDL-c) and promotes the development of Cardiovascular Diseases (CVD) and Type 2 Diabetes Mellitus (T2DM).

Many conventions were proposed for diagnosis of MetS by distinct organizations like World Health Organization, the national cholesterol education program expert panel on detection, evaluation, and treatment of high blood cholesterol in adults (Adult Treatment Panel III) (NCEP-ATP III), The American Heart Association/National Heart, Lung, and Blood Institute (AHA/NHLBI) and International Diabetes Federation (IDF) during 1998-2009. The latest measure was introduced by IDF; AHA/NHLBI; World Heart Federation (WHF); International Atherosclerosis Society (IAS); and International

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**Received:** 17 August, 2023, Manuscript No. JMS-23-110522; **Editor assigned:** 21 August, 2023, PreQC No. JMS-23-110522 (PQ); **Reviewed:** 05 September, 2023, QC No. JMS-23-110522; **Revised:** 14 January, 2025, Manuscript No. JMS-23-110522 (R) **; Published:** 21 January, 2025, DOI: 10.37421/2167-0943.2024.13.389

Association for the Study of Obesity (IASO) in 2009 due to the deliberations and disputes on definition of MetS. These include an increased blood pressure of >130/85 mm Hg or more, triglyceride levels >150 mg/dl, fasting blood glucose levels >100 mg/dl and High Density Lipoprotein level (HDL)<40 mg/dl (men) or <50 mg/dl (women) and waist circumference of >35 inches and >40 inches for women and men, 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 progressive and early indications of disease are evident in adolescents and young adults. Some reports suggest that a large number of adolescents already carry one or more risk factors for Met-S. Exposure to MetS risk factors in childhood and adolescence is associated with disease development in adulthood. Studies are, therefore, needed 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, pre-diabetes and Diabetes. They were pursuing advanced courses like post-graduation or PhD 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 and biochemical risk factors were assessed and they were advised for adopting healthy life style.

**Study procedure:** This descriptive-analytical cross-sectional study was conducted from June, 2021 to December 2021 among young adults, either studying or working in various educational institutes of Bhubaneswar. Based on a sample-size calculation for a study of finite population, with approximately 2000 employees, a minimum sample size of 500 was calculated to represent a cross-section of the population and to allow the study to determine the prevalence of MetS with a margin of error of 3.8%, as recommended by previous literature with a similar study population [16]. An additional 2% was included in the calculated sample to compensate for missing data and non-response, for a final sample size of 500 young adults. A total of 540 young adults were randomly invited to participate in the study. As part of the survey, 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 using adult portable stadio-meter and digital weighing scale (Dr. Morepen), respectively after removing footwear and any other accessories. Waist circumference was measured using a measuring tape in a relaxed state 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. Blood pressure and Blood Glucose were measured with digital Sphygmomanometer (BP Seven, Dr. Morepen) and Glucometer (Gluco One, Dr. Morepen), 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 National Cholesterol Education Program/Adult Treatment Panel-III (NCEP/ATP-III) guidelines with modified waist circumference for Indians and International Diabetes Federation (IDF) criteria [3].

**Hypertension:** Individuals were categorized as hypertensive if diagnosed by a physician and/or taking anti-hypertensive drugs with a mean systolic blood pressure of ≥ 140 mmHg and diastolic blood pressure of ≥ 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 >110 mg/dl and <126 mg/dl for pre-diabetes and FBG levels of >126 mg/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 BMI <25 were considered to be of 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. For each of the study's variables, descriptive statistics were performed. In order to evaluate the correlations between MetS and categorical independent variables such demographics, lifestyle risk behaviors and individual medical history, Pearson *chi-square* ($\chi^2$) test and binary logistic regressions were utilized. There were reported Crude Odds Ratios (cOR). The predictors of MetS in this sample were determined using multiple logistic regression analysis and the

"Backward," "Forward," and "Enter" regression procedures. The adjusted Odds Ratios (aOR) were reported. Only the most parsimonious model that identified the MetS risk variables for the entire sample and for both genders was chosen. The Variance Inflation Factor (VIF) values under 10 were tested for multi-colinearity between independent variables. A relatively low VIF rating (<5) indicates that no interaction testing is necessary. The IBM SPSS Statistics software guide's recommended methods produced the VIF results. $p<0.05$ was chosen as the cut-off for statistical significance.

## Results

In this study, 500 young adults, either studying or working in various educational Institutes of Bhubaneswar were screened for various NCDs namely Metabolic Syndrome (MetS), hypertension, pre-diabetes and type 2 diabetes and the associated risk factors. The gender wise distribution of socio-demographic profile of the young adults is depicted in Table 1.

| Parameters | | Total participants (n=500, %) | Males (n=176, %) | Females (n=324, %) | Statistical analysis p value |
|---|---|---|---|---|---|
| Age (in years) | 18-23 | 39 (7.8) | 19 (10.79) | 20 (6.17) | 0.031 |
| | 24-29 | 328 (65.6) | 103 (58.52) | 225 (69.4) | |
| | 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 | Secondary | 31 (6.2) | 21 (11.93) | 10 (3.08) | 0.0001 |
| | Graduation | 212 (42.4) | 77 (43.75) | 135 (31.6) | |
| | Above graduation | 257 (51.4) | 78 (44.31) | 179 (55.24) | |
| Life style | Active | 159 (31.8) | 71 (40.34) | 88 (27.16) | 0.002 |
| | Sedentary | 341 (68.2) | 105 (59.65) | 236 (72.83) | |
| Profession | Student | 349 (69.8) | 124 (24.08) | 225 (45.00) | 0.559 |
| | Job | 151 (30.2) | 52 (29.54) | 99 (30.55) | |
| Familial history | Yes | 211 (42.2) | 79 (44.88) | 132 (30.74) | 0.37 |
| | No | 289 (57.8) | 97 (55.11) | 192 (59.25) | |

**Table 1.** Depicts the gender-wise distribution of socio-demographic profile of the young adults.

Out of 500, 64% (324) were females and 35% (176) were males. 65% (328) of young adults were in the age group, 24-29 years, 26% (133) were in the range of 30-35 years, 7% (39) were in the age group 18-23 years. The mean age of the participants was 23.4 ± 10.5. 51% (257) of them had studied up to post-graduate level, 42% (212) had studied up to graduation level. With regard to occupation, 44% (221) of the participants in this study were students and 30% (151) were having jobs. Among the study participants, 68% (341) were sedentary and 32% (159) were active. 42% (211) had a positive history of one of the family members having NCDs. The gender wise distribution of anthropometric characteristics and risk factors for various NCDs among the young adults is depicted in Table 2.

| Parameters | | Total (n=500) | Males (n=176) | Females (n=324) | Statistical analysis, 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 | Under weight | 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 |
| Waist circumference | ≤ 90 cm for males | 310 (62) | 93 (52.84) | 217 (66.97) | 0.001 |
| | ≤ 80 cm for females | | | | |
| | ≤ 90 cm for males, | 190 (38) | 83 (47.15) | 107 (30.02) | |
| | ≤ 80 cm for females | | | | |

**Table 2.** Depicts the gender-wise distribution of risk factors among young adults.

While 23% (117) were overweight and 13% (69) were obese. Yet 57% (285) were having normal weight. The waist circumference of 62% (310) of the young adults was more. 66% (217) of the females and 52% (93) of the males had wider waist circumference. This is a significant factor for MetS as per IDF (International Diabetes Federation) guidelines. While 6% (31) of the study participants consumed alcohol, smoked and/or chewed tobacco, yet only 73% (365) were not having any addictive habits. 67% (337) of young adults in this study were non-vegetarians and 32% (163) were vegetarians. About 55% (257) each of the study participants preferred to eat fast food daily whereas 31% (159) preferred fast food every week. While 49% (249) of the young adults included in this study did less than 10 hours of physical activity per week. 27% (137) of them worked for 10-12 hours per week. Maximum, *i.e.*, 47% (235) slept for less than 6 hours and 23% (119) of the participants slept for about 6-8 hours and 29% (146) slept for more than 8 hours. Majority, *i.e.*, 38% (193) of the young adults spent about 8-12 hours on internet. 25% (129) of the young adults spent about 4-8 hours on the internet whereas 10% (51) spent up to 4 hours on the internet. About 25% (127) spent more than 12 hours on internet. The gender wise distribution of clinical profile of the young adults is depicted in Table 3.

| **Parameters** | | **Total (n=500)** | **Male (n=176)** | **Females (n=324)** | **Statistical analysis, 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 |

**Table 3.** Depicts the gender-wise distribution of clinical profile among young adults.

25% (126) of adults were having pre-adults were having pre-hypertension. 18% (33) males and 28% (93) of females were having hypertension. 2% (11) were having diabetes and 31%(157) were having high cholesterol levels. The serum levels of triglycerideswere high among 27% (135) of the 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, and the mean Blood glucose levels were 102.4 ± 12.8 among the participants. Table 4 depicts the prevalence of metabolic syndrome and its components by age groups. In all, 14% (72) of the young adults in the age group, 30-35 years, 8% (41) in the age group 24-29 years and 2% (14) in the age group 18-23 years were having MetS. Increased waist circumference was observed in the age group, 24-29 years among 25% each of both males and females/gender indicating abdominal obesity. Further, among 176 men and 324 women, raised waist circumference, triglycerides, HDL-C, blood glucose levels, blood pressure were observed in the age group, 30-35 years all of which together contribute to MetS.

| **Overall sample (n=500)** | | | | |
|---|---|---|---|---|
| **Characteristics** | **Age group (Years)** | | | **P-value** |
| | **18-23 yr N=39 (7.8)** | **24-29 yr N=328 (65.6)** | **30-35 yr N=133 (26.6)** | |
| Overall MetS individuals | 14 (2.8) | 41 (8.2) | 72 (14.4) | 0.001 |
| Men (n=176) | | | | |
| Mets | 5 (2.8) | 14 (7.9) | 29 (16.44) | 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 | 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 |

**Table 4.** Depicts the prevalence of metabolic syndrome and its components by age groups.

Table 5 shows the risk factors associated with MetS by Pearson *chi-square* and binary logistic regression cOR (crude Odds Ratio). MetS for the overall sample was significantly higher among participant addicted to alcohol, smoking and/or chewing tobacco (cOR 3.01, 95% CI 1.91-4.75). Participant with BMI ≥ 30 kg/m$^2$ (cOR 4.04, 95% CI 2.37-6.89), with waist circumference ≥ 90 cm for male and ≥ 80 cm for female (cOR 2.97, 95% CI 1.94-4.56), those who practice moderate intensity physical activity (cOR 1.67, 95% CI

1.03-2.72), and among those with hypertension (cOR 2.06, 95% CI 1.3-3.24), diabetes (cOR 3.53, 95% CI 1.12-11.16), Low HDL-Cholesterol (cOR 8.44, 95% CI 5.23-13.6) shows a potential higher risk of MetS. Those with non-vegetarian eating habits (cOR 3.67, 95% CI 2.42–5.54) and weekly fast food intake habits (cOR 1.16, 95% CI 0.72-1.86) possesses high risk of developing Mets. Those who spent 8-12 hours on internet (cOR 1.9, 95% CI 1.12-3.23) and those who slept less than 4-6 hours (cOR 0.6, 95% CI 0.34-1.04) also have shown a greater risk of MetS. In men, MetS was significantly higher among those who consumed alcohol, smoked and/or chewed tobacco (cOR 6.57, 95% CI 3.12–13.84) than female (cOR 1.61, 95% CI 0.86-3.02), with 8-12 hours' time spending on internet (cOR 2.8, 95% CI 1.12-6.97) and among those having hypertension (cOR 2.15, 95% CI 0.95-4.87) or diabetes (cOR 3.67, 95% CI 0.87-15.36). In women, MetS was significantly higher among BMI ≥ 30 kg/m$^2$ (cOR 4.65, 95% CI 2.44-8.85), those with moderate physical activity (cOR 1.74, 95% CI 0.94-3.12), and those having hypertension (cOR 2.1, 95% CI 1.21-3.65), non-vegetarian eating habits (cOR 4.22, 95% CI 2.5-6.97), waist circumference (cOR 4.73, 95% CI 2.7-8.26) or low HDL-cholesterol (cOR 9.79, 95% CI 5.32-18.03), respectively. These associations were statistically significant.

| Risk factors | | Mets in overall sample (n=500) | | C-OR (95%CI) | Mets in men (n=176) | | C-OR (95%CI) | Mets in women (n=324) | | C-OR (95%CI) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Yes | No | | Yes | No | | Yes | No | |
| Gender | Men | 48 | 128 | 1.16 (0.77-1.77) | - | - | | - | - | - |
| | Women | 79 | 245 | 1 | - | - | - | - | - | - |
| Habits | No | 55 | 310 | 1 | 15 | 102 | 1 | 40 | 208 | 1 |
| | Yes | 47 | 88 | 3.01 (1.91-4.75) | 29 | 30 | 6.57 (3.12-13.84) | 18 | 58 | 1.61 (0.86-3.02) |
| Alcohol | No | 43 | 371 | 1 | 20 | 120 | 1 | 23 | 251 | 1 |
| | Yes | 32 | 54 | 0.19 (0.11-0.33) | 17 | 19 | 0.18 (0.08-0.41) | 15 | 35 | 0.21 (0.10-0.44) |
| Smoking | No | 7 | 475 | 1 | 2 | 164 | 1 | 5 | 311 | 1 |
| | Yes | 6 | 12 | 0.02 (0.008-0.10) | 3 | 7 | 0.02 (0.004-0.19) | 3 | 5 | 0.02 (0.005-0.141) |
| All | No | 5 | 464 | 1 | 2 | 160 | 1 | 3 | 304 | 1 |
| | Yes | 9 | 22 | 0.02 (0.008-0.08) | 5 | 9 | 0.022 (0.003-0.132) | 4 | 13 | 0.03 (0.006-0.158) |
| BMI | <30 | 76 | 355 | 1 | 35 | 123 | 1 | 41 | 232 | 1 |
| | ≥ 30 | 32 | 37 | 4.04 (2.37-6.89) | 9 | 9 | 3.51 (1.3-9.53) | 23 | 28 | 4.65 (2.44-8.85) |
| Physical activity (hours/week) | ≤ 10 | 48 | 201 | 1 | 17 | 62 | 1 | 31 | 139 | 1 |
| | 10-12 | 39 | 98 | 1.67 (1.03-2.72) | 15 | 36 | 1.52 (0.68-3.4) | 24 | 62 | 1.74 (0.94-3.12) |
| | ≥ 12 | 35 | 79 | 1.86 ( 1.12 3.1) | 14 | 32 | 1.6 ( 0.7- 3.64) | 21 | 47 | 2 (1.05 -3.82) |
| Hypertension | Absent | 71 | 303 | 1 | 30 | 113 | 1 | 41 | 190 | 1 |
| | Present | 41 | 85 | 2.06 (1.3-3.24) | 12 | 21 | 2.15 (0.95-4.87) | 29 | 64 | 2.1 (1.21-3.65) |
| Eating habits | Vegetarian | 41 | 122 | 1 | 12 | 31 | 1 | 29 | 91 | 1 |
| | Non-vegetarian | 186 | 151 | 3.67 (2.42-5.54) | 69 | 64 | 2.79 (1.32-5.89) | 117 | 87 | 4.22 (2.5-6.97) |
| Fast food intake | Daily | 53 | 204 | 1 | 22 | 71 | 1 | 31 | 133 | 1 |
| | Weekly | 38 | 126 | 1.16 (0.72-1.86) | 16 | 46 | 1.12 (0.53-2.36) | 22 | 80 | 1.18 (0.64-2.18) |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Monthly | 8 | 23 | 1.34 (0.57-3.16) | 3 | 5 | 1.94 (0.43-8.76) | 5 | 18 | 1.19 (0.41-3.46) |
| | Occasionally | 8 | 40 | 0.77 (0.34-1.74) | 4 | 14 | 0.92 (0.28-3.09) | 4 | 26 | 0.66 (0.21-2.03) |
| Time spent on internet (In hours) | Up to 4 hours | 34 | 146 | 1 | 15 | 51 | 1 | 19 | 95 | 1 |
| | 4-8 | 38 | 155 | 1.05 (0.63-1.76) | 11 | 68 | 0.55 (0.23-1.3) | 27 | 87 | 1.55 (0.81-2.99) |
| | 8-12 | 39 | 88 | 1.9 (1.12-3.23) | 14 | 17 | 2.8 (1.12-6.97) | 25 | 71 | 1.76 (0.9-3.44) |
| Duration of sleep (In hours) | ≤ 6 | 62 | 173 | 1 | 25 | 78 | 1 | 37 | 95 | 1 |
| | 6-8 | 21 | 98 | 0.6 (0.34-1.04) | 9 | 32 | 0.88 (0.37-2.09) | 12 | 66 | 0.47 (0.23-0.96) |
| | ≥ 8 | 13 | 133 | 0.27 (0.14-0.52) | 3 | 29 | 0.32 (0.09-1.15) | 10 | 104 | 0.25 (0.12-0.52) |
| Waist circumference | 90 cm for males, ≤ 80 cm for females | 48 | 262 | 1 | 21 | 72 | 1 | 27 | 190 | 1 |
| | ≥ 90 cm for males, ≥ 80 cm for females | 67 | 123 | 2.97 (1.94-4.56) | 24 | 59 | 1.39 (0.71-2.75) | 43 | 64 | 4.73 (2.7-8.26) |
| Low HDL-C | Absent | 54 | 338 | 1 | 22 | 113 | 1 | 32 | 225 | 1 |
| | Present | 62 | 46 | 8.44 (5.23-13.6) | 23 | 18 | 6.56 (3.05-14.14) | 39 | 28 | 9.79 (5.32-18.03) |
| Diabetes | Absent | 108 | 381 | 1 | 36 | 132 | 1 | 72 | 249 | 1 |
| | Present | 6 | 6 | 3.53 (1.12-11.16) | 4 | 4 | 3.67 (0.87-15.36) | 2 | 2 | 1.73 (0.15-19.34) |

**Table 5.** Shows the risk factors associated with MetS by pearson chi-square and binary logistic regression cOR (crude odds ratio).

In the multi-variate analyses, all risk factors that were statistically significant and related to MetS in the univariate analyses were included. The multivariable model found four risk variables for MetS in the whole sample: BMI ≥ 30 kg/m$^2$ (aOR 3.66, 95% CI 1.7-5.5; P<0.006), 10-12 hours PA (aOR 1.82, 95% CI 1.2-5.0; P=0.015), having hypertension (aOR 2.0, 95% CI 1.1-4.3; P=0.023) and diabetes (aOR 3.9, 95% CI 0.9-4.1; P=0.017). Statistically significant risk factor for MetS was retained in the multivariable model: habits (aOR 4.95, 95% CI 2.2-9.1; P=0.023), alcohol drinker (aOR 3.9, 95% CI 1.6-15.3; P=0.030), smoker (aOR 5.47, 95% CI 0.7-3.5; P=0.060), hypertension (aOR 2.05, 95% CI 0.8-3.9; P=0.023), low HDL-C (aOR 8.41, 95% CI 3.3-11.1; P=0.030), time spent on internet 8-12 hours (aOR 1.89, 95% CI 1.6-8.1; P=0.144), waist circumference (aOR 2.94, 95% CI 0.6-9.3; P=0.030), diabetes (aOR 3.52, 95% CI 1.4-12.6; P=0.001), duration of sleep >8 hours (aOR 3.66, 95% CI 0.1-1.4; P=0.007), fast food intake 4-5 times weekly (aOR 1.33, 95% CI 0.9–3.1; P=0.041) and eating habits (aOR 1.30, 95% CI 2.2–7.4; P=0.001). Since there was no multi-colinearity between the independent variables in any of the three models, interaction analysis was not necessary. The "Backward Wald" technique produced the most parsimonious models across all three multivariable evaluations (Table 6).

| Risk factors | B | SE | Wald | Exp (B) | 95% CI | P-Value | VIF |
|---|---|---|---|---|---|---|---|
| Habits | | | | | | | |
| No | Ref | Ref | Ref | Ref | Ref | Ref | 3.84 |
| Yes | -1.6 | 0.5 | 10.24 | 4.95 | 2.2–9.1 | 0.023 | |
| BMI | | | | | | | |
| No | Ref | Ref | Ref | Ref | Ref | Ref | 2.72 |
| Yes | -1.3 | 0.5 | 6.76 | 3.66 | 1.7–5.5 | 0.006 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Physical activity | | | | | | | |
| ≤ 10 | Ref | Ref | Ref | Ref | Ref | Ref | 4.76 |
| 10-12 | -0.6 | 0.5 | 1.44 | 1.82 | 0.9–4.1 | 0.017 | |
| ≥ 12 | -0.5 | 0.5 | 1 | 1.64 | 0.4–3.4 | 0.123 | |
| Hypertension | | | | | | | |
| No | Ref | Ref | Ref | Ref | Ref | Ref | 1.19 |
| Yes | -0.72 | 0.5 | 2.07 | 2.05 | 0.8–3.9 | 0.023 | |
| Low HDL-C | | | | | | | |
| No | Ref | Ref | Ref | Ref | Ref | Ref | 7.69 |
| Yes | -2.13 | 0.5 | 18.14 | 8.41 | 3.3–11.1 | 0.03 | |
| Time spent on internet | | | | | | | |
| Up to 4 hours | Ref | Ref | Ref | Ref | Ref | Ref | 1.06 |
| 4-8 | -0.5 | 0.5 | 1 | 1.04 | 1.1–3.3 | 0.116 | |
| 8-12 | -0.64 | 0.5 | 1.63 | 1.89 | 1.6–8.1 | 0.144 | |
| Waist circumference | | | | | | | |
| ≤ 90 cm for male | Ref | Ref | Ref | Ref | Ref | Ref | 2.12 |
| ≤ 80 cm for female | | | | | | | |
| ≥ 90 cm for male | -1.08 | 0.5 | 4.66 | 2.94 | 0.6-9.3 | 0.03 | |
| ≥ 80 cm for female | | | | | | | |
| Diabetes | | | | | | | |
| No | Ref | Ref | Ref | Ref | Ref | Ref | 1.19 |
| Yes | -1.26 | 0.5 | 6.35 | 3.52 | 1.4–12.6 | 0.001 | |
| Fast food intake | | | | | | | |
| Daily | Ref | Ref | Ref | Ref | Ref | Ref | 1.17 |
| Weekly | -0.89 | 0.5 | 3.16 | 1.33 | 0.9–3.1 | 0.041 | |
| Monthly | -0.66 | 0.5 | 1.74 | 1.29 | 0.6–2.7 | 0.01 | |
| Occasionally | -0.51 | 0.5 | 1.04 | 1.21 | 0.5–2.1 | 0.001 | |
| Eating Habits | | | | | | | |
| Vegetarian | Ref | Ref | Ref | Ref | Ref | Ref | 2.07 |
| Non-vegetarian | -1.3 | 0.5 | 6.76 | 1.3 | 2.2–7.4 | 0.001 | |

**Table 6.** Shows the risk factors associated with MetS in overall sample by multiple logistic regression. Exp(B) gives adjusted Odd Ratio (aOR). VIF (Variance Inflation Factor).

## Discussion

In our study, 500 young adults (18-35 years) including 64% females and 36% males studying or working in various educational institutes of Bhubaneswar were screened for various NCDs. 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 was 25%.

Majority, *i.e.*, 65% of young adults were in the age group, 24-29 years. While 44% of the participants were students and 30% were having jobs. Among the participants, 68% were sedentary and 31% were active. Usually, students spend a lot of time in studies indirectly being sedentary. In all, hypertension was present among 25% (126) of the young adults and 2% (11) 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. A sedentary

lifestyle involves little or no physical activity. 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 [18,19]. 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 a 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. 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. While 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. Maximum, *i.e.*, 47% slept for less than 6 hours and 23% of the participants slept for about 6-8 hours and 29% slept for more than 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. 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 on internet. 25% of the young adults spent about 4-8 hours on the internet whereas 10% spent up to 4 hours on the internet. 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, 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.

Sleep disruption and insomnia result from digital eye strain caused by screens of computers, smart phones and televisions, which emit blue light. Several studies in different regions of India have reported the prevalence of MetS ranging from 4% to 41% but Dasgupta A, et al. Together, these studies reported that the prominent risk factors were abdominal obesity, sedentary life style, hypercholesterolmia 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. These risk factors become more damaging when they occur in combination with other and are avoidable by lifestyle changes. Modifiable risk factors, including hypertension, smoking, diabetes, obesity, dyslipidemia, stress, unhealthy diet and physical inactivity are the major contributors to cardiovascular morbidity and mortality. 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.

## Conclusion

This study is the first one conducted in this State among young adults. Therefore, follow-up studies are needed 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.

## Limitations

There were few limitations and certain strengths 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.

## Ethical Approval

Institutional human ethics committee of ICMR-regional medical research centre, Bhubaneswar, Odisha, India has reviewed and approved the detailed plan of study. Socio-demographic, behavioral, physical and biochemical data were collected using structured questionnaires after obtaining informed written consent. Blood samples for screening were collected from those willing to be enrolled in the study.

## Funding Source

No funding was received for this study.

## Competing Interests

The authors declare that they have no competing interests.

## Authors' Contributions

Braja Sundar Barik working as a junior research fellow was involved in compilation and statistical analysis of the data. Manaswini Dash and Satavisha Sadangi were involved in the collection of socio-demographic, anthropometric and clinical profile of young adults enrolled in the study. Minaketan Barik was involved in laboratory analysis and compilation of 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.

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**How to cite this article:** Hussain, Tahziba, Braja Sundar Barik, Manaswini Dash and Satavisha Sadangi, et al. "Prevalence of Metabolic Syndrome and Its Associated Risk Factors among Young Adults in Bhubaneswar." *J Metabolic Synd* 14 (2025): 389.