ORIGINAL ARTICLE

# Metabolic syndrome in Mirpurkhas: frequency and key risk factors among adults

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## ABSTRACT

**Background and Objective:** Metabolic syndrome poses a significant public health challenge in developing nations and accounts for the highest mortality and morbidity rates globally. It is associated with an increased risk of developing cardiovascular diseases in individuals of all age groups. This study assessed the risk factors and frequency of metabolic syndrome among adults at MirpurKhas, Sindh.

**Methods:** The current cross-sectional study was conducted at the Department of Biochemistry, Bhitai Medical and Dental College, MirpurKhas, Sindh. A total of 1,000 subjects with clinically suspected metabolic syndrome were enrolled and their anthropometric measurements, including weight and height, serial blood pressure estimation, blood sugar, total cholesterol, high and low density lipoproteins, and triglycerides levels were carried out following standard procedures The logistic regression was used to establish the correlation between the metabolic syndrome and risk variables.

**Results:** There were 550 (55%) male and 450 (35%) female participants. The mean age was 43.0 ±11.2 years. Metabolic syndrome was present in 350 (35%) participants. In our study, we found that obese individuals had an odds ratio (OR) of 15.01, individuals aged ≥ 51 years or older had an OR of 5.91, and overweight participants had an OR of 5.91. These findings indicate that these groups are at a much higher risk of developing metabolic syndrome.

**Conclusion:** Our findings show that metabolic syndrome is common in our community, with a higher frequency in females. Key contributing factors include hyperglycemia, hypertension, abdominal obesity, elevated triglycerides, and low high-density lipoprotein levels.

**Keywords:** Metabolic syndrome, risk factors, anthropometric measurement, blood sugar, lipid profile, obesity.

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## Introduction

Metabolic syndrome (MS) is a growing global health concern, defined as a cluster of risk factors, including abdominal obesity, hypertension, hyperglycemia, and dyslipidemia, that markedly raise the risk of type 2 diabetes, cardiovascular disease, and early mortality. Its prevalence, estimated between 20% and 40% worldwide, is rising rapidly in low- and middle-income countries, including Pakistan. It is a significant public health concern due to its correlation with an increased risk of developing diabetes and cardiovascular issues in individuals of all age groups.[1-3] Further, abdominal obesity, elevated blood pressure, and increased fasting plasma glucose levels are considered as greater risks for developing cardiovascular disease due to the combination of these risk factors.[4,5] Metabolic syndrome has emerged as a prominent and complex condition in the early 21st century and is considered a global pandemic. Irrespective of the nature or actual existence of the syndrome, all of its component problems have been scientifically shown to independently and regularly increase the likelihood of developing heart disease and diabetes.[6,7] Over the years, Pakistani food and lifestyle patterns have changed in accordance with global political, social, and economic transformations. The extensive promotion and easy availability of fast food and carbonated drinks have a notably adverse effect on youngsters. The province of Sindh has also experienced a similar transformation, where physicians now face the challenge of maintaining a perfect equilibrium between the needs of individual patients and the broader aspects of public health in their approach to treatment.[8] This study aimed to evaluate the frequency of metabolic syndrome and its related risk factors amongst individuals in MirpurKhas Sindh, Pakistan.

## Methods

This cross-sectional study was conducted at the Department of Biochemistry, Bhitai Dental and Medical College, Mirpurkhas, Sindh for a period of one year (from April 2022 to April 2023). Prior to sampling, the hospital research and ethics committee granted approval for this project. All participants provided written informed consent. The total sample size was 1,000, determined using the World Health Organization sample size calculator. The study's inclusion criteria included individuals of both genders who were >18 years of age and agreed to take part in our study. Conversely, the exclusion criteria consisted of individuals with known chronic debilitating or immune diseases, documented eating disorders, the presence of acute or chronic infections like hepatitis B/C, and women who were pregnant. A predesigned proforma was used to collect the relevant anthropometric and socio-demographic data. The physical activity was self-classified based on four groups: low (walking for up to 1 hour/day), moderate (walking for more than 1 hour/day), high (engaging in intense exercise for up to half an hour per day), and very high (engaging in severe exercise for more than half an hour per day). Anthropometric measurements, including weight and height, and blood pressure, were recorded through standard procedures. Fasting venous blood samples were collected and analyzed in the hospital's biochemistry laboratory for determining blood glucose, total cholesterol, high-density lipoprotein (HDL), LDL, and triglyceride levels using standard enzymatic methods on an automated chemistry analyzer under the supervision of a senior laboratory technologist.

### *Statistical* analysis

The data was analyzed using the SPSS version 23 program. Standard deviation (SD) and mean were recorded for continuous data, whereas categorical variables were computed as percentages and proportions. The categorical variables were analyzed using a chi-square test. The study used logistic regression to establish the correlation between the metabolic syndrome and several risk variables (odds ratio:OR). A *p*-value of less than 0.05 was taken as statistically significant.

## Results

This research had a total of 1,000 participants, with 550 (55%) males and 450 individuals (35%) females. The mean age of the study population was 43.05 ± 11.2 years, ranging from 18 years to 72 years. The age-wise distribution reveals a maximum, 450 (45%), subjects within the age range of 18-30 years. Based on the participants' educational level, 180 individuals (18%) had no formal education, while 380 individuals (38%) had completed secondary education, and 19% had completed university-level education. A total of 2% subjects were reported as current smokers, while 93% reported as never smoking. The mean (SD) body mass index (BMI) was 27.99 (9.42) kg/m$^2$. In terms of obesity, 320 (32%) participants were classified as obese. Based on the level of physical activity, 720 (72%) individuals were classified as having a low level of activity, while 200 individuals (20%) reported a moderate level. The mean waist circumference, presence or absence of diabetes and hypertension is depicted in Table 1. Metabolic syndrome was found to be present in 350 (35%) of the subjects (Figure 1). There were 58.29% females and 41.71% male participants having metabolic syndrome, while the mean age of individuals with metabolic syndrome was 47.05 (SD = 8.11) years ($p$ = 0.002) (Table 1).

The mean(SD) glycemic levels, total cholesterol, HDL, LDL, and triglycerides were 112 (5.13), 161 (42.21), 32.23 (6.05), 82 (23.05), and 166 (23.85) mg/dl, respectively.

***Table 1.*** *Socio-demographic characteristics of the enrolled patients (n = 1,000).*

| Parameter | Category | Frequency (%) |
|---|---|---|
| Gender | Male | 550 (55%) |
| | Female | 350 (35%) |
| Age | 18-30 | 450(45%) |
| | 31-40 | 250 (25%) |
| | 41-50 | 180 (18%) |
| | ≥51 | 120 (12%) |
| Education | Uneducated | 180 (18%) |
| | Primary | 250 (25%) |
| | Secondary | 380 (38%) |
| | University level | 190 (19%) |
| Obesity | Underweight | 50 (5%) |
| | Normal weight | 350 (35%) |
| | Overweight | 280 (28%) |
| | Obese | 320 (32%) |
| Physical activity | Low | 720 (72%) |
| | Moderate | 200 (20%) |
| | High | 50 (5%) |
| | Very high | 30 (3%) |
| Smoking | Current smoker | 20 (2%), |
| | Former smoker | 50 (5%) |
| | Never smoke | 930 (93%) |
| Abdominal obesity | Yes | 450 (45%) |
| | NO | 550 (55%) |
| Diabetes | Yes | 50 (5%) |
| | NO | 180 (90%) |
| Hypertension | Yes | 450 (45%) |
| | NO | 550 (55%) |

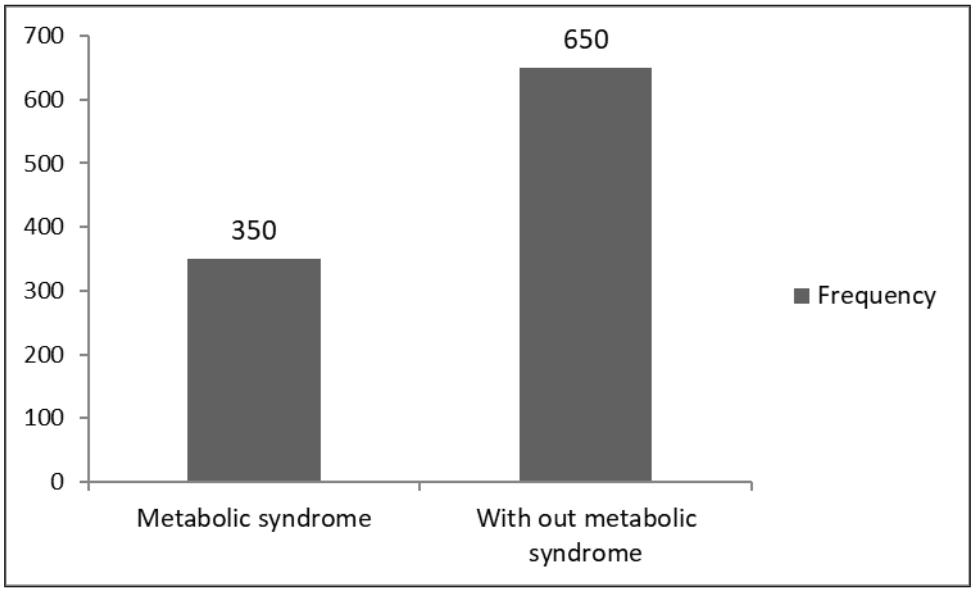


***Figure 1.*** *Overall frequency of metabolic syndrome among study population (n = 1,000).*

The frequency of metabolic syndrome varied according to the degree of education ($p$ = 0.001), smoking status ($p$ = 0.07), and mean (SD) BMI ($p$ = 0.002). No underweight participants were reported to have metabolic syndrome ($p$ = 0.001). The frequency of metabolic syndrome was 70.86% for those with little physical activity, 22.28% for those with moderate physical activity, 4.57% for those with high physical activity, and 2.29% for those with very high physical activity ($p$ = 0.002). The mean (SD) waist circumference was 93 (12.75) cm in individuals diagnosed with metabolic syndrome ($p$ = 0.001). A total of 326 patients (93.14%) with abdominal obesity were found to have metabolic syndrome ($p$ = 0.002). The frequency of metabolic syndrome was 40% among patients with diabetes and 52.57% among those with hypertension ($p$ = 0.003). The mean systolic blood pressure amongst individuals with metabolic syndrome was 133 (2.45) mmHg and diastolic blood pressure was 84 (5.05) mmHg, accordingly ($p$ < 0.001). Additionally, the mean levels of glycaemia, cholesterol, HDL, LDL, and triglycerides among participants with metabolic syndrome were 112 (6.45), 172 (54.11), 32.05 (2.99), 113 (39.41), and 182 (21.99) mg/dl, respectively ($p$ < 0.02) (Table 2).

In our research, we found that obese individuals had an odds ratio (OR) of 15.01, individuals aged 51 years or older had an OR of 5.91, and overweight participants had an OR of 5.91. These findings indicate that these groups are at a much higher risk of developing metabolic syndrome (Table 3). According to our research, the variables that had the highest impact on participants were hyperglycemia (odds ratio: 5.15), high blood pressure (odds ratio: 4.61), abdominal obesity (odds ratio: 351.12), high triglyceride levels (odds

***Table 2.*** *Association of metabolic syndrome with different clinico-demographic variables among study population.*

| Parameter | Category | Individuals with metabolic syndrome *N* (%) | *p* value* |
|---|---|---|---|
| Gender | Male | 146 (41.71%) | 0.002 |
| | Female | 204 (58.29%) | |
| Age | Mean (SD) | 47.05 (8.11) years | 0.002 |
| Education | Uneducated | 10 (2.86%), | 0.001 |
| | Primary | 140 (40%), | |
| | Secondary | 174 (49.71%) | |
| | University level | 26 (7.43%) | |
| Obesity | Underweight | 00 (00%) | 0.002 |
| | Normal weight | 26 (7.43%), | |
| | overweight | 140 (40%), | |
| | Obese | 184(52.57%) | |
| Physical activity | Low | 248 (70.86%), | 0.002 |
| | Moderate | 78 (22.28%), | |
| | High | 16(4.57%) | |
| | Very high | 8 (2.29%) | |
| Smoking | Current smoker | 6 (1.71%), | 0.07 |
| | Former smoker | 26 (7.43%) | |
| | Never smoke | 318 (90.86%) | |
| Abdominal obesity | Yes | 326 (93.14%) | 0.002 |
| | NO | 24 (6.86%) | |
| Diabetes | Yes | 140 (40%) | 0.002 |
| | NO | 210 (60%) | |
| Hypertension | Yes | 184 (52.57%) | 0.002 |
| | NO | 166 (47.43%) | |

*Chi-square test.

***Table 3.*** *Correlation between risk of metabolic syndrome and clinico-demographic variables.*

| Parameter | Sub-category | Frequency *N* (%) | OR | CI (95%) | *p*-value |
|---|---|---|---|---|---|
| Age | 18-30 | 450(45%) | 3.11 | 1.93-7.01 | **0.001*** |
| | 31-40 | 250 (25%) | 4.32 | 2.07-8.01 | 0.007 |
| | 41-50 | 180 (18%) | 4.33 | 3.41-8.26 | **0.002*** |
| | ≥51 | 120 (12%) | 5.91 | 3.81-12.51 | **0.005*** |
| Education | Uneducated | 10 (2.86%), | 0.39 | 0.12-1.99 | 0.09 |
| | Primary level | 140 (40%), | 0.59 | 0.14-2.11 | 0.08 |
| | Secondary level | 174 (49.71%) | 0.69 | 0.15-1.99 | 0.21 |
| | University level | 26 (7.43%) | 0.13 | 0.09-0.51 | **0.002*** |
| Obesity | Underweight | 00 (00%) | 0.00 | 00 to 00 | 0.73 |
| | Normal weight | 26 (7.43%), | 0.00 | 00 to 00 | 0.79 |
| | overweight | 140 (40%), | 5.91 | 5.01- 12.11 | **0.004*** |
| | Obese | 184(52.57%) | 15.01 | 7.99-23.11 | **0.003*** |
| Physical activity | Low activity | 248 (70.86%), | 0.59 | 0.29-1.12 | 0.03 |
| | Moderate activity | 78 (22.28%), | 0.71 | 0.28-1.11 | **0.004*** |
| | High activity | 16(4.57%) | 0.31 | 0.12-0.92 | 0.71 |
| | Very high activity | 8 (2.29%) | 0.39 | 0.08-0.81 | 0.09 |
| Smoking | Current smoker | 6 (1.71%), | 3.01 | 0.4-7.13 | 0.09 |
| | Former smoker | 26 (7.43%) | 2.07 | 0.59-6.31 | 0.07 |
| | Never smoke | 318 (90.86%) | 2.09 | 0.2-7.77 | 0.06 |
| Abdominal obesity | Yes | 184 (52.57%) | 351.12 | 129.22- 980.33 | **0.004*** |

*Statistically significant $p < 0.05$.

***Table 4.*** *Correlation of risk of metabolic syndrome with respect to laboratory profile and anthropometric measurements.*

| Variable | Odd ratio | CI (95%) | *p*-value |
|---|---|---|---|
| High Blood pressure | 4.61 | 3.21-9.61 | 0.002 |
| Hyper-glycemia | 5.15 | 3.01-9.89 | 0.001 |
| cholesterol (High) | 2.37 | 1.33-6.22 | 0.01 |
| HDL | 11.9 | 5.01-33.21 | 0.005 |
| triglycerides (High) | 4.61 | 3.01-14.21 | 0.002 |

Statistically significant $p < 0.05$.

ratio: 4.61), and low high-density lipoprotein levels (odds ratio: 11.9) (Table 4).

## Discussion

The purpose of this study was to examine metabolic syndrome and its risk variables in the Mirpurkhas region of Sindh. In contrast to the findings of our study (35%), previous research in different populations suggests variations in the incidence of metabolic syndrome that range from 18% to 46%.[9-14] The prevalence of metabolic syndrome in adults in Mirpurkhas, Sindh, may be explained by the high frequency of obesity, diabetes, and hypertension in this population, that play a significant role in developing risk for metabolic syndrome in this population ($p < 0.05$). Genetics, lifestyle factors, and gender distribution also play an important role in these phenomena. In our research, metabolic syndrome was found in 58.29% of the females as compared to males (41.71%). These results are in concordance with Hussain et al. [15], while in contrast with the findings of Mahmood et al. [16] who reported early development of metabolic disturbances in obese males being at higher risk for metabolic syndrome and related diseases as compared to females.

Individuals with metabolic syndrome had higher levels of total cholesterol, diastolic blood pressure, glycaemia, and were more prone to developing hypertension, diabetes, and abdominal obesity in comparison to those without the condition. Previous research has linked metabolic dysfunctions, like hypertension, obesity, and hyperglycemia, to an increased chance of developing the metabolic syndrome.[17,18]

A recent systematic review from Pakistan reported that among individuals who had central obesity, hypertension, increased glucose level, high triglyceride and low HDL levels, the prevalence for metabolic syndrome was found to be 37.1% (95% CI: 23.7-50.5), 29.5% (95% CI: 20.0-38.9), 20.6%

(95% CI: 15.3-25.9), 35.8% (95% CI: 24.3-47.3), and 48.2% (95% CI: 30.8-65.6), respectively.[19] These findings are similar to our research, where we found that obese individuals had an OR of 15.01, individuals aged 51 years or older had an OR of 5.91, and overweight participants had an OR of 5.91. Similarly, hyperglycemia (odds ratio: 5.15), high blood pressure (odds ratio: 4.61), abdominal obesity (odds ratio: 351.12), high triglyceride levels (odds ratio: 4.61), and low high-density lipoprotein levels (odds ratio: 11.9) were the primary risk factors for developing metabolic syndrome. Similar findings are reported by other studies [15,17,20] where Adil et al. [19] reports that metabolic syndrome is considerably prevalent among the Pakistani population who perceived themselves as healthy based on the absence or ignorance of the silent diseases such as obesity, dyslipidemia, and hypertension. In particular, prevalence was significantly higher among individuals who are living in Sindh and Punjab province. Moreover, individuals having high triglyceride, low HDL, and central obesity are at significant risk for the development of metabolic syndrome.[19] Therefore, early identification and treatment of cardiometabolic factors and conditions associated with metabolic syndrome will be related to a favorable impact on mortality and morbidity in the local population.

## Limitations of the study

This study has several limitations that must be acknowledged. First, its cross-sectional design prevents the establishment of temporal or causal relationships between risk factors and metabolic syndrome. Second, the study was conducted at a single center in Mirpurkhas, which may limit the generalizability of findings to other regions of Sindh or Pakistan with different demographic or lifestyle characteristics. Third, some variables, such as dietary habits, smoking status, alcohol intake, and family history of metabolic diseases, were not comprehensively assessed, which may have introduced residual confounding. Fourth, the classification of physical activity was based on self-reported information, making it prone to recall bias and potential misclassification. Finally, the exclusion of individuals with chronic illnesses such as cancer, HIV, hepatitis B/C, and pregnancy may have resulted in a selection bias, and the true prevalence in the general population could be slightly different.

## Conclusion

Metabolic syndrome was found to be highly prevalent among adults in Mirpurkhas, with a greater burden observed in females. Abdominal obesity, hyperglycemia, hypertension, hypertriglyceridemia, and low HDL emerged as the most significant contributing factors, with abdominal obesity serving as the strongest predictor. These findings highlight the urgent need for targeted community-based interventions focusing on lifestyle modification, early detection, and evidence-based management strategies to reduce the growing burden of metabolic syndrome in this region.

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## List of Abbreviations

| | |
|---|---|
| BMI | Body mass index |
| CHD | Coronary Heart Disease |
| CI | Confidence interval |
| CVD | Cardiovascular disease |
| HDL | High-Density Lipoprotein |
| ISI | Institute for Scientific Information (Impact Factor reference) |
| LDL | Low-Density Lipoprotein |
| NCDs | Non-Communicable Diseases |
| OR | Odds ratio |
| S.D | Standard deviation |
| SPSS | Statistical Package for the Social Sciences |
| TC | Total cholesterol |

## Conflicts of interest

None to declare.

## Grant support and financial disclosure

None to disclose.

## Ethics approval

The ethical approval of the study was obtained from the Ethics Review Committee of Bhitai Dental and Medical College Mirpurkhas vide Letter No: BDMC/R&D/ERC/2022-07 dated: 24-02-2022.

## Authors' contributions

**SN:** Conceptualization, study design, data collection, manuscript drafting, and critical intellectual input.

**AB, NA, AM:** Critical intellectual input, acquisition of data, and drafting of manuscript.

**BG:** Analysis of data, interpretation of results, critical intellectual input, and drafting of manuscript.

**ALL AUTHORS:** Approval and full responsibility of the final version of the manuscript to be published.

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