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Original Research Article

PREVALENCE OF METABOLIC SYNDROME AND ITS ASSOCIATION WITH CARDIOVASCULAR RISK FACTORS AMONG PATIENTS WITH ESSENTIAL HYPERTENSION: AN OBSERVATIONAL STUDY

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ABSTRACT

Background: Metabolic syndrome frequently coexists with essential hypertension and contributes to increased cardiovascular risk through abdominal obesity, dyslipidemia, impaired glucose metabolism, and associated metabolic disturbances. Early identification of these abnormalities is essential for comprehensive cardiovascular risk assessment and management. The aim is to determine the prevalence of metabolic syndrome and evaluate its association with cardiovascular risk factors among patients with essential hypertension.

Materials and Methods: This hospital-based observational cross-sectional study included 95 patients with essential hypertension at a tertiary care hospital. Demographic characteristics, clinical history, lifestyle factors, anthropometric measurements, blood pressure, lipid profile, glycaemic parameters, and renal function were assessed. Metabolic syndrome was diagnosed using harmonized diagnostic criteria with Asian-specific waist circumference thresholds. Statistical analysis was performed using SPSS version 28.0, with $p<0.05$ considered statistically significant.

Results: Metabolic syndrome was identified in 58 (61.05%) patients. Patients with metabolic syndrome had significantly higher mean age (60.02 ± 9.77 vs. 52.00 ± 8.52 years; $p<0.001$) and BMI (28.17 ± 3.02 vs. 25.16 ± 3.06 kg/m²; $p<0.001$). Abdominal obesity (86.21% vs. 27.03%), elevated triglycerides (81.03% vs. 18.92%), and reduced HDL cholesterol (72.41% vs. 16.22%) were significantly more frequent ($p<0.001$). Uncontrolled hypertension (87.93% vs. 62.16%; $p=0.003$) and physical inactivity (70.69% vs. 27.03%; $p<0.001$) were also significantly associated with metabolic syndrome. Multivariable analysis identified hypertension duration ≥5 years (aOR=6.41; $p=0.005$) and physical inactivity (aOR=3.99; $p=0.008$) as significant independent associated factors.

Conclusion: Metabolic syndrome was highly prevalent among patients with essential hypertension and was associated with multiple cardiovascular risk factors. Routine metabolic screening, lifestyle modification, and comprehensive cardiovascular risk assessment are important for identifying high-risk patients and guiding preventive management.

Keywords: Essential Hypertension; Metabolic Syndrome; Cardiovascular Risk Factors; Abdominal Obesity; Dyslipidemia.

INTRODUCTION

Essential hypertension remains a major contributor to cardiovascular morbidity and premature mortality worldwide. Its clinical importance extends beyond sustained elevation of arterial pressure because affected individuals frequently exhibit abnormalities of glucose metabolism, lipid regulation, body-fat distribution, and renal function. These overlapping disturbances influence vascular health and complicate the assessment of cardiovascular risk. Increasing urbanization, dietary changes, population

ageing, and sedentary lifestyles have contributed to the growing burden of hypertension, where detection and risk-factor control remain challenging. Recognition of associated metabolic abnormalities is therefore essential for comprehensive assessment of patients receiving treatment for essential hypertension.[1]

Metabolic syndrome is a constellation of interrelated cardiometabolic abnormalities characterized by central obesity, elevated blood pressure, impaired glucose regulation, increased triglycerides, and reduced high-density lipoprotein cholesterol. The syndrome reflects more than isolated clinical abnormalities, involving common biological pathways including insulin resistance, excess visceral adiposity, chronic low-grade inflammation, and altered lipid metabolism. Diagnosis is generally based on the presence of multiple defined components, with waist-circumference thresholds adapted to population characteristics. Among patients with established essential hypertension, the blood-pressure component is already present, making screening for additional metabolic abnormalities particularly important for identifying individuals with a greater clustering of cardiovascular risk factors.[2]

The relationship between obesity and hypertension is mediated through several interconnected mechanisms. Visceral adipose tissue acts as a metabolically active organ that can promote inflammatory signalling, insulin resistance, sympathetic nervous system activation, and dysregulation of the renin–angiotensin–aldosterone system. These processes may increase sodium retention, vascular resistance, and endothelial dysfunction, thereby contributing to sustained blood-pressure elevation. Body mass index provides a general assessment of adiposity, whereas waist circumference and waist-to-hip ratio offer additional information about abdominal fat distribution. Evaluating both overall and central obesity is relevant to assessing the metabolic profile of patients with essential hypertension and cardiovascular vulnerability.[3]

Metabolic abnormalities can also influence arterial function through pathways that are not fully captured by routine brachial blood-pressure readings. Hyperglycaemia, atherogenic dyslipidaemia, and abdominal obesity may accompany oxidative stress, vascular inflammation, increased arterial stiffness, and impaired nitric-oxide availability. The simultaneous presence of these abnormalities may intensify vascular dysfunction and contribute to subclinical target-organ damage. Their distribution is not necessarily uniform among individuals with the same hypertension diagnosis, making it important to investigate how different risk factors occur together. A structured assessment of metabolic-syndrome components can therefore complement conventional blood-pressure evaluation and help characterize the heterogeneous cardiovascular risk profiles encountered clinically.[4]

Cardiovascular risk among individuals with metabolic syndrome is influenced by both the number and the pattern of metabolic disturbances. Elevated triglycerides and reduced high-density lipoprotein cholesterol coexist with central obesity, while impaired fasting glucose may signal progressive insulin resistance and increased susceptibility to type 2 diabetes. These abnormalities can also contribute to atherosclerotic processes linked to coronary artery disease and cerebrovascular events. Age, sex, smoking, familial predisposition, and physical inactivity may modify this risk profile. Consequently, evaluating metabolic syndrome as a single diagnostic category, alongside its individual components, offers an informative approach than considering blood pressure or body weight in isolation.[5]

Renal health constitutes another dimension of cardiometabolic risk in hypertensive populations. Metabolic dysfunction, vascular injury, and impaired kidney function are closely interconnected, and deterioration in one system may aggravate disease in the others. Serum creatinine and estimated glomerular filtration rate provide useful measures of renal function, while serum uric acid may offer supplementary information about associated metabolic disturbances. An integrated cardiovascular–kidney–metabolic perspective encourages clinicians to identify coexisting conditions before advanced organ damage becomes apparent. This is particularly relevant in tertiary-care settings, where patients may present with longstanding hypertension, multiple prescribed medications, and combinations of recognized or undiagnosed risk factors.[6]

MATERIALS AND METHODS

The present study was designed as a hospital-based observational cross-sectional study to determine the prevalence of metabolic syndrome and evaluate its association with cardiovascular risk factors among patients diagnosed with essential hypertension. The study aimed to assess the relationship between metabolic syndrome and various demographic, anthropometric, biochemical, clinical, and lifestyle-related parameters contributing to cardiovascular risk among hypertensive individuals. The study was conducted at a tertiary care hospital in the Department of General Medicine. Patients attending the outpatient department and those admitted to the medical wards with an established diagnosis of essential hypertension were evaluated. The study protocol was approved by the Institutional Ethics Committee, and written informed consent was obtained from all participants before enrolment. A total of 95 patients diagnosed with essential hypertension were included in the study. Participants were recruited using a consecutive sampling technique based on predefined eligibility criteria. All eligible patients underwent detailed clinical evaluation, anthropometric assessment, and

biochemical investigations. Patients were subsequently categorized into two groups based on the presence or absence of metabolic syndrome for comparative analysis.

Inclusion Criteria

Patients aged 18 years and above, of either gender, with an established diagnosis of essential hypertension were eligible for inclusion. Essential hypertension was defined by documented blood pressure measurements of ≥140/90 mmHg at diagnosis or current use of prescribed antihypertensive medication. Patients willing to provide informed consent and undergo the required clinical and laboratory investigations were included.

Exclusion Criteria

Patients with secondary hypertension due to renal, endocrine, or vascular disorders were excluded. Pregnant women, patients with acute infections, severe systemic illnesses, active malignancy, or conditions affecting metabolic parameters were also excluded. Patients receiving long-term systemic corticosteroid therapy and those with incomplete clinical or biochemical records were not considered for analysis.

Clinical and Demographic Assessment: A structured case record form was used to document demographic and clinical characteristics, including age, gender, educational status, occupation, socioeconomic status, duration of hypertension, family history of hypertension, diabetes mellitus, and premature cardiovascular disease. Information regarding smoking, tobacco consumption, alcohol intake, dietary habits, physical activity, and sedentary lifestyle was recorded. Associated comorbidities, including type 2 diabetes mellitus, dyslipidemia, coronary artery disease, and cerebrovascular disease, were documented. Details of antihypertensive medications, lipid-lowering agents, and antidiabetic treatment were also collected.

Anthropometric Assessment: Anthropometric measurements included height, weight, body mass index (BMI), waist circumference, hip circumference, and waist-to-hip ratio. BMI was calculated as weight in kilograms divided by height in metres squared (kg/m²). Waist circumference was measured midway between the lower rib margin and iliac crest using a non-stretchable measuring tape. Central obesity was defined using Asian-specific waist circumference cut-offs of ≥90 cm for males and ≥80 cm for females. BMI was categorized according to Asian population recommendations, with overweight defined as 23.0–24.9 kg/m² and obesity as ≥25.0 kg/m².

Blood Pressure Assessment: Blood pressure was measured using a calibrated sphygmomanometer with an appropriately sized cuff after at least five minutes of seated rest. Two readings were obtained at an interval of two minutes, and the mean value was recorded. Systolic blood pressure, diastolic blood pressure, and pulse pressure were documented. Blood pressure control status was assessed, with office blood pressure ≥140/90 mmHg considered uncontrolled for the study analysis.

Biochemical Investigations: Venous blood samples were collected after an overnight fast of 8–12 hours under aseptic precautions. Laboratory investigations included fasting plasma glucose, glycated haemoglobin (HbA1c), total cholesterol, serum triglycerides, high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), serum creatinine, and serum uric acid. Renal function was evaluated using the estimated glomerular filtration rate (eGFR). These investigations were performed using standardized laboratory procedures and internal quality-control protocols.

Diagnostic Criteria for Metabolic Syndrome: Metabolic syndrome was diagnosed according to the 2009 harmonized criteria, using Asian-specific waist circumference thresholds. Diagnosis required the presence of at least three of five components: abdominal obesity (waist circumference ≥90 cm in males or ≥80 cm in females), triglycerides ≥150 mg/dL or specific treatment, HDL-C <40 mg/dL in males or <50 mg/dL in females or specific treatment, blood pressure ≥130/85 mmHg or antihypertensive treatment, and fasting plasma glucose ≥100 mg/dL or previously diagnosed diabetes mellitus. Since all participants had essential hypertension, the blood pressure component was considered fulfilled.

Assessment of Cardiovascular Risk Factors: Cardiovascular risk assessment included advancing age, male gender, smoking, physical inactivity, obesity, abdominal adiposity, diabetes mellitus, dyslipidemia, uncontrolled hypertension, family history of premature cardiovascular disease, and impaired renal function. The frequency of individual metabolic syndrome components and the clustering of cardiovascular risk factors were compared between patients with and without metabolic syndrome. The association of metabolic syndrome with hypertension duration, BMI, lipid abnormalities, glycaemic status, and blood pressure levels was evaluated.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics version 28.0. Categorical variables were expressed as frequencies and percentages, while continuous variables were presented as mean ± standard deviation or median with interquartile range, as appropriate. Normality was assessed using the Shapiro–Wilk test. Independent samples t-test or Mann–Whitney U test was applied for continuous variables, whereas the Chi-square test or Fisher's exact test was used for categorical variables. Binary logistic regression was performed to identify independent factors associated with metabolic syndrome, with adjusted odds ratios and 95% confidence intervals reported. A p-value of <0.05 was considered statistically significant.

RESULTS

[Table 1] Comparison of Baseline Demographic and Clinical Characteristics Between Hypertensive Patients With and Without Metabolic Syndrome (N=95)

[Table 1] presents the baseline demographic and clinical characteristics of 95 patients with essential hypertension, comprising 58 patients with metabolic syndrome and 37 without metabolic syndrome. The mean age was significantly higher among patients with metabolic syndrome (60.02 ± 9.77 years) compared to those without metabolic syndrome (52.00 ± 8.52 years; p<0.001), with 72.41% and 43.24% of patients aged ≥55 years, respectively (p=0.004). Male predominance was observed in both groups (58.62% vs. 54.05%), although the difference was statistically insignificant (p=0.661). The mean duration of hypertension was significantly longer in patients with metabolic syndrome (8.87 ± 3.01 vs. 5.43 ± 2.62 years; p<0.001), and hypertension duration ≥5 years was more frequent (93.10% vs. 54.05%; p<0.001). Physical inactivity (70.69% vs. 27.03%; p<0.001) and known type 2 diabetes mellitus (20.69% vs. 2.70%; p=0.013) were significantly more prevalent among patients with metabolic syndrome. However, family history of hypertension, premature cardiovascular disease, smoking, and previous cardiovascular disease did not demonstrate statistically significant differences between the groups (p>0.05).

[Table 2] Prevalence of Metabolic Syndrome and Distribution of Its Diagnostic Components Among Patients With Essential Hypertension (N=95)

[Table 2] demonstrates that metabolic syndrome was present in 58 (61.05%) of the 95 hypertensive patients, whereas 37 (38.95%) did not fulfil the diagnostic criteria. Elevated blood pressure or antihypertensive treatment was observed in all participants (100.00%), consistent with the inclusion of patients diagnosed with essential hypertension. Abdominal obesity was the most frequently observed metabolic abnormality, affecting 60 (63.16%) patients, followed by elevated triglycerides in 54 (56.84%), reduced HDL cholesterol in 48 (50.53%), and elevated fasting plasma glucose in 44 (46.32%). Patients with metabolic syndrome exhibited significantly higher frequencies of abdominal obesity (86.21% vs. 27.03%), elevated triglycerides (81.03% vs. 18.92%), reduced HDL cholesterol (72.41% vs. 16.22%), and elevated fasting plasma glucose (62.07% vs. 21.62%), with p<0.001 for all comparisons. Among patients with metabolic syndrome, 12 (20.69%) fulfilled three diagnostic components, 33 (56.90%) fulfilled four components, and 13 (22.41%) fulfilled all five components. In contrast, 6 (16.22%) patients without metabolic syndrome had only one component, while 31 (83.78%) had two components, indicating greater clustering of metabolic abnormalities in the metabolic syndrome group.

[Table 3] Comparison of Anthropometric Measurements and Blood Pressure Parameters Between Patients With and Without Metabolic Syndrome (N=95)

[Table 3] compares anthropometric measurements and blood pressure parameters between hypertensive patients with and without metabolic syndrome. The mean BMI was significantly higher in patients with metabolic syndrome (28.17 ± 3.02 kg/m²) compared to those without metabolic syndrome (25.16 ± 3.06 kg/m²; p<0.001). Similarly, waist circumference (95.16 ± 9.33 vs. 83.23 ± 10.69 cm) and waist-to-hip ratio (0.95 ± 0.12 vs. 0.83 ± 0.11) were significantly elevated in the metabolic syndrome group (p<0.001 for both). Mean systolic blood pressure (147.98 ± 15.81 vs. 139.73 ± 13.12 mmHg; p=0.007) and diastolic blood pressure (93.66 ± 9.25 vs. 85.86 ± 8.11 mmHg; p<0.001) were also significantly higher among patients with metabolic syndrome. Furthermore, BMI ≥25 kg/m² was observed in 89.66% of patients with metabolic syndrome compared to 43.24% without metabolic syndrome (p<0.001), while uncontrolled hypertension was significantly more prevalent (87.93% vs. 62.16%; p=0.003). However, mean pulse pressure was comparable between the groups (54.33 ± 18.17 vs. 53.86 ± 15.22 mmHg; p=0.894), indicating no statistically significant difference.

[Table 4] Comparison of Biochemical and Metabolic Parameters Between Patients With and Without Metabolic Syndrome (N=95)

[Table 4] illustrates significant differences in several biochemical and metabolic parameters between hypertensive patients with and without metabolic syndrome. Mean fasting plasma glucose (115.44 ± 28.47 vs. 96.43 ± 15.74 mg/dL) and HbA1c (5.88 ± 0.84% vs. 5.36 ± 0.61%) were significantly higher in patients with metabolic syndrome (p<0.001 for both). Triglyceride levels were markedly elevated in the metabolic syndrome group (184.62 ± 38.48 vs. 129.96 ± 37.24 mg/dL; p<0.001), whereas HDL cholesterol was significantly reduced (41.62 ± 10.41 vs. 52.59 ± 9.56 mg/dL; p<0.001). Serum creatinine (1.06 ± 0.21 vs. 0.96 ± 0.23 mg/dL; p=0.039) and serum uric acid (6.47 ± 1.12 vs. 5.98 ± 1.05 mg/dL; p=0.032) were also significantly higher among patients with metabolic syndrome. Mean eGFR was significantly lower in the metabolic syndrome group (73.22 ± 15.02 vs. 91.23 ± 14.58 mL/min/1.73 m²; p<0.001), with eGFR <60 mL/min/1.73 m² observed in 24.14% compared to 0.00% of patients without metabolic syndrome (p=0.001). However, differences in total cholesterol (p=0.118), mean LDL cholesterol (p=0.088), and the proportion with LDL cholesterol ≥130 mg/dL (p=0.081) were statistically insignificant.

[Table 5] Multivariable Binary Logistic Regression Analysis of Factors Associated With Metabolic Syndrome Among Patients With Essential Hypertension (N=95)

[Table 5] presents the multivariable binary logistic regression analysis evaluating factors associated with

metabolic syndrome among patients with essential hypertension. Hypertension duration ≥5 years emerged as a significant independent factor associated with metabolic syndrome, with an adjusted odds ratio (aOR) of 6.41 (95% CI: 1.76–23.29; p=0.005), indicating approximately 6.4-fold higher adjusted odds of metabolic syndrome. Physical inactivity was also significantly associated with metabolic syndrome, demonstrating approximately fourfold higher adjusted odds (aOR=3.99; 95% CI: 1.44–11.04; p=0.008). Patients aged ≥55 years exhibited higher adjusted odds of metabolic syndrome (aOR=2.67; 95% CI: 0.94–7.59), although this association did not reach statistical significance (p=0.066). Family history of premature cardiovascular disease was not significantly associated with metabolic syndrome (aOR=0.89; 95% CI: 0.27–2.86; p=0.839). Similarly, current smoking demonstrated no statistically significant independent association (aOR=1.34; 95% CI: 0.46–3.94; p=0.594).

Table 1: Comparison of Baseline Demographic and Clinical Characteristics Between Hypertensive Patients With and Without Metabolic Syndrome (N=95)

Parameters	With Metabolic Syndrome (n=58)	Without Metabolic Syndrome (n=37)	p-value
Age (years), mean ± SD	60.02 ± 9.77	52.00 ± 8.52	<0.001
Age ≥55 years	42 (72.41%)	16 (43.24%)	0.004
Male	34 (58.62%)	20 (54.05%)	0.661
Female	24 (41.38%)	17 (45.95%)	—
Duration of hypertension (years), mean ± SD	8.87 ± 3.01	5.43 ± 2.62	<0.001
Hypertension duration ≥5 years	54 (93.10%)	20 (54.05%)	<0.001
Family history of hypertension	30 (51.72%)	15 (40.54%)	0.287
Family history of premature cardiovascular disease	19 (32.76%)	10 (27.03%)	0.554
Current smoking	22 (37.93%)	11 (29.73%)	0.413
Physical inactivity	41 (70.69%)	10 (27.03%)	<0.001
Previous cardiovascular disease	12 (20.69%)	4 (10.81%)	0.210
Known type 2 diabetes mellitus	12 (20.69%)	1 (2.70%)	0.013

Table 2: Prevalence of Metabolic Syndrome and Distribution of Its Diagnostic Components Among Patients With Essential Hypertension (N=95)

Parameters	Total (N=95)	With Metabolic Syndrome (n=58)	Without Metabolic Syndrome (n=37)	p-value
Prevalence of metabolic syndrome	58 (61.05%)	—	—	—
Metabolic syndrome absent	37 (38.95%)	—	—	—
Individual metabolic syndrome components				
Elevated blood pressure/antihypertensive treatment	95 (100.00%)	58 (100.00%)	37 (100.00%)	—
Abdominal obesity	60 (63.16%)	50 (86.21%)	10 (27.03%)	<0.001
Elevated triglycerides	54 (56.84%)	47 (81.03%)	7 (18.92%)	<0.001
Reduced HDL cholesterol	48 (50.53%)	42 (72.41%)	6 (16.22%)	<0.001
Elevated fasting plasma glucose	44 (46.32%)	36 (62.07%)	8 (21.62%)	<0.001
Number of metabolic syndrome components present				
One component	6 (6.32%)	0 (0.00%)	6 (16.22%)	—
Two components	31 (32.63%)	0 (0.00%)	31 (83.78%)	—
Three components	12 (12.63%)	12 (20.69%)	0 (0.00%)	—
Four components	33 (34.74%)	33 (56.90%)	0 (0.00%)	—
Five components	13 (13.68%)	13 (22.41%)	0 (0.00%)	—

Table 3: Comparison of Anthropometric Measurements and Blood Pressure Parameters Between Patients With and Without Metabolic Syndrome (N=95)

Parameters	With Metabolic Syndrome (n=58)	Without Metabolic Syndrome (n=37)	p-value
BMI (kg/m²), mean ± SD	28.17 ± 3.02	25.16 ± 3.06	<0.001
Waist circumference (cm), mean ± SD	95.16 ± 9.33	83.23 ± 10.69	<0.001
Waist-to-hip ratio, mean ± SD	0.95 ± 0.12	0.83 ± 0.11	<0.001
Systolic blood pressure (mmHg), mean ± SD	147.98 ± 15.81	139.73 ± 13.12	0.007
Diastolic blood pressure (mmHg), mean ± SD	93.66 ± 9.25	85.86 ± 8.11	<0.001
Pulse pressure (mmHg), mean ± SD	54.33 ± 18.17	53.86 ± 15.22	0.894
BMI ≥25 kg/m²	52 (89.66%)	16 (43.24%)	<0.001
Uncontrolled hypertension (≥140/90 mmHg)	51 (87.93%)	23 (62.16%)	0.003

Table 4: Comparison of Biochemical and Metabolic Parameters Between Patients With and Without Metabolic Syndrome (N=95)

Biochemical Parameters	With Metabolic Syndrome (n=58)	Without Metabolic Syndrome (n=37)	p-value
Fasting plasma glucose (mg/dL)	115.44 ± 28.47	96.43 ± 15.74	<0.001
HbA1c (%)	5.88 ± 0.84	5.36 ± 0.61	<0.001
Total cholesterol (mg/dL)	211.86 ± 27.05	201.89 ± 31.61	0.118
Triglycerides (mg/dL)	184.62 ± 38.48	129.96 ± 37.24	<0.001
HDL cholesterol (mg/dL)	41.62 ± 10.41	52.59 ± 9.56	<0.001
LDL cholesterol (mg/dL)	129.13 ± 21.16	121.51 ± 20.77	0.088
Serum creatinine (mg/dL)	1.06 ± 0.21	0.96 ± 0.23	0.039
Serum uric acid (mg/dL)	6.47 ± 1.12	5.98 ± 1.05	0.032
eGFR (mL/min/1.73 m²)	73.22 ± 15.02	91.23 ± 14.58	<0.001
LDL cholesterol ≥130 mg/dL	26 (44.83%)	10 (27.03%)	0.081
eGFR <60 mL/min/1.73 m²	14 (24.14%)	0 (0.00%)	0.001

Table 5: Multivariable Binary Logistic Regression Analysis of Factors Associated With Metabolic Syndrome Among Patients With Essential Hypertension (N=95)

Variables	Adjusted Odds Ratio (aOR)	95% Confidence Interval	p-value
Age ≥55 years	2.67	0.94–7.59	0.066
Hypertension duration ≥5 years	6.41	1.76–23.29	0.005
Physical inactivity	3.99	1.44–11.04	0.008
Family history of premature cardiovascular disease	0.89	0.27–2.86	0.839
Current smoking	1.34	0.46–3.94	0.594

DISCUSSION

The present study evaluated 95 patients with essential hypertension and demonstrated a high prevalence of metabolic syndrome, affecting 58 patients (61.05%), while 37 patients (38.95%) did not fulfil the diagnostic criteria. These findings were comparable with those reported by Thakur et al. (2013), who conducted a hospital-based cross-sectional study involving 118 newly diagnosed hypertensive patients in Himachal Pradesh, India. They documented a metabolic syndrome prevalence of 68.60% according to modified NCEP-ATP III criteria and 63.60% according to International Diabetes Federation criteria. Their study further reported abdominal obesity in 90.10%, reduced HDL cholesterol in 70.40%, and elevated triglycerides in 67.90% of patients with metabolic syndrome under the modified NCEP-ATP III classification. Similarly, the present study demonstrated abdominal obesity in 86.21%, elevated triglycerides in 81.03%, and reduced HDL cholesterol in 72.41% of patients with metabolic syndrome. The close agreement in overall prevalence highlights the substantial clustering of metabolic abnormalities among hypertensive individuals, although differences in diagnostic criteria and population characteristics may explain variations in individual components.[7] In the present study, metabolic syndrome was associated with significantly higher frequencies of abdominal obesity (86.21% vs. 27.03%), elevated triglycerides (81.03% vs. 18.92%), reduced HDL cholesterol (72.41% vs. 16.22%), and elevated fasting plasma glucose (62.07% vs. 21.62%), with p<0.001 for all comparisons. Comparable findings were reported by Kant et al. (2019), who investigated 400 newly diagnosed essential hypertensive patients in India and observed a metabolic syndrome prevalence of 50.50% according to International Diabetes Federation criteria. However, the prevalence increased to 60.50% when modified IDF criteria for Asian Indians were applied and reached 64.50% according to NCEP-ATP III criteria. Their study identified abdominal obesity and reduced HDL cholesterol as prominent metabolic abnormalities, with 49.00%, 33.00%, and 3.00% of the reported patients having three, four, and five risk factors, respectively. In comparison, the present study showed that 20.69%, 56.90%, and 22.41% of patients with metabolic syndrome fulfilled three, four, and five diagnostic components, respectively. These findings emphasize the importance of diagnostic criteria and demonstrate that multiple metabolic disturbances frequently coexist in hypertensive patients.[8] The present study demonstrated a significant association of metabolic syndrome with advancing age, longer hypertension duration, physical inactivity, and coexisting diabetes mellitus. Mean age was significantly higher among patients with metabolic syndrome than those without metabolic syndrome (60.02 ± 9.77 vs. 52.00 ± 8.52 years; p<0.001), while physical inactivity was observed in 70.69% and 27.03% of patients, respectively. Similar observations were reported by Salagre et al. (2016), who evaluated 151 essential hypertensive patients and documented metabolic syndrome in 49.01%. Among affected patients, 62.16% were in their sixth decade of life, 85.00% reported a sedentary lifestyle, and 66.21% had diabetes mellitus. In comparison, the frequency of known diabetes among patients with metabolic syndrome in the present study was 20.69%. Interestingly, Salagre et al. observed no significant association between metabolic syndrome and hypertension duration (p=0.850), whereas the present study demonstrated significantly longer hypertension duration among affected patients (8.87 ± 3.01 vs. 5.43 ± 2.62 years; p<0.001). This difference may

reflect variations in clinical characteristics, disease severity, and study populations.[9] The present study revealed considerable clustering of cardiovascular risk factors among hypertensive patients with metabolic syndrome. Among the 58 affected patients, 12 (20.69%) fulfilled three diagnostic components, 33 (56.90%) fulfilled four components, and 13 (22.41%) fulfilled all five components, suggesting a substantial burden of concurrent metabolic abnormalities. These findings can be compared with those of Barrios et al. (2007), who analyzed 12,954 hypertensive patients in the Spanish PRESCOT study and reported metabolic syndrome in 52.00% of participants. Among patients with metabolic syndrome, 54.60% had three risk factors, 32.40% had four, and 13.00% had five risk factors. Their study further demonstrated that only 4.70% of patients with metabolic syndrome achieved simultaneous blood pressure and LDL cholesterol control, compared with 13.50% of those without metabolic syndrome ($p<0.0001$). Similarly, uncontrolled hypertension was more prevalent in the metabolic syndrome group in the present study (87.93% vs. 62.16%; $p=0.003$). These observations suggest that metabolic syndrome frequently accompanies suboptimal cardiovascular risk-factor control and supports comprehensive clinical assessment beyond blood pressure measurement alone.[10]

Anthropometric abnormalities were significantly more pronounced among hypertensive patients with metabolic syndrome in the present study. Mean BMI was significantly higher in the metabolic syndrome group (28.17 ± 3.02 vs. 25.16 ± 3.06 kg/m²; $p<0.001$), accompanied by increased waist circumference (95.16 ± 9.33 vs. 83.23 ± 10.69 cm; $p<0.001$) and waist-to-hip ratio (0.95 ± 0.12 vs. 0.83 ± 0.11; $p<0.001$). Similar findings were reported by Acherjya et al. (2024), who investigated metabolic syndrome among hypertensive patients in Jashore, Bangladesh, and documented a mean BMI of 27.7 ± 4.2 kg/m² among patients with metabolic syndrome. They also reported elevated waist circumference in 60.40%, hypertriglyceridaemia in 46.00%, and reduced HDL cholesterol in 51.30% of affected subjects. Multivariable analysis identified obesity as a significant independent predictor of metabolic syndrome (aOR=4.24; 95% CI: 2.55–7.98; $p<0.001$). In comparison, 89.66% of patients with metabolic syndrome in the present study had BMI ≥25 kg/m², compared with 43.24% without metabolic syndrome ($p<0.001$). These findings reinforce the close relationship between excess adiposity and metabolic abnormalities in hypertensive populations.[11] The present study demonstrated significantly higher systolic and diastolic blood pressure among patients with metabolic syndrome compared with those without metabolic syndrome (147.98 ± 15.81 vs. 139.73 ± 13.12 mmHg; $p=0.007$ and 93.66 ± 9.25 vs. 85.86 ± 8.11 mmHg; $p<0.001$, respectively). Furthermore, fasting plasma glucose and triglyceride concentrations were significantly elevated, whereas HDL cholesterol levels were reduced among patients with metabolic syndrome. These results were consistent with the observations of Tadewos et al. (2017), who investigated 238 hypertensive patients in Southern Ethiopia and reported an overall metabolic syndrome prevalence of 48.70%. Their study demonstrated significantly higher mean systolic blood pressure, diastolic blood pressure, fasting blood glucose, triglycerides, and BMI among patients with metabolic syndrome ($p<0.0001$ for all comparisons). Mean HDL cholesterol was also significantly lower in affected patients (39.4 vs. 47.6 mg/dL; $p<0.0001$). Additionally, age above 60 years (aOR=8.2; 95% CI: 1.1–62.4) and obesity (aOR=10.7; 95% CI: 3.8–29.8) were independently associated with metabolic syndrome. These findings support the observation that hypertension accompanied by metabolic syndrome is characterized by a greater burden of anthropometric and biochemical risk factors.[12] The biochemical evaluation in the present study revealed significantly higher fasting plasma glucose (115.44 ± 28.47 vs. 96.43 ± 15.74 mg/dL), triglycerides (184.62 ± 38.48 vs. 129.96 ± 37.24 mg/dL), and lower HDL cholesterol (41.62 ± 10.41 vs. 52.59 ± 9.56 mg/dL) among patients with metabolic syndrome, with $p<0.001$ for all comparisons. Similar metabolic abnormalities were documented by Yu et al. (2015), who conducted a population-based study involving 5,866 hypertensive adults in rural Northeast China and reported a metabolic syndrome prevalence of 43.10%. Among all hypertensive participants, abdominal obesity was observed in 51.70%, hypertriglyceridaemia in 39.60%, reduced HDL cholesterol in 29.30%, and elevated fasting glucose in 55.90%. In comparison, the corresponding frequencies in the total hypertensive population of the present study were 63.16%, 56.84%, 50.53%, and 46.32%, respectively. Yu et al. also reported a significantly higher prevalence of metabolic syndrome among women than men (56.40% vs. 29.20%; $p<0.001$), whereas the present study showed no significant gender association ($p=0.661$). These findings indicate that the distribution of metabolic abnormalities may vary across geographical regions, lifestyle patterns, and population characteristics.[13]

The present study also demonstrated an association between metabolic syndrome and altered renal function among hypertensive patients. Mean serum creatinine (1.06 ± 0.21 vs. 0.96 ± 0.23 mg/dL; $p=0.039$) and serum uric acid (6.47 ± 1.12 vs. 5.98 ± 1.05 mg/dL; $p=0.032$) were significantly higher in patients with metabolic syndrome. Conversely, mean eGFR was significantly lower in the metabolic syndrome group (73.22 ± 15.02 vs. 91.23 ± 14.58 mL/min/1.73 m²; $p<0.001$), with eGFR below 60 mL/min/1.73 m² observed in 24.14% compared with 0.00% of patients without metabolic syndrome ($p=0.001$). These findings were consistent with Dai et al. (2016), who evaluated 19,848 hypertensive subjects and demonstrated a significant association between metabolic syndrome, serum uric acid, and chronic kidney disease. Their multivariable analysis

showed that metabolic syndrome was associated with increased odds of chronic kidney disease (OR=1.49; 95% CI: 1.30–1.71), while hyperuricaemia demonstrated an OR of 2.30 (95% CI: 2.02–2.63). Furthermore, individuals with hyperuricaemia and four metabolic syndrome components had 5.77-fold higher adjusted odds of chronic kidney disease relative to the reference group. These findings suggest that renal function assessment is an important component of cardiovascular risk evaluation in hypertensive patients with metabolic syndrome.[14] Multivariable logistic regression analysis in the present study identified hypertension duration ≥5 years (aOR=6.41; 95% CI: 1.76–23.29; p=0.005) and physical inactivity (aOR=3.99; 95% CI: 1.44–11.04; p=0.008) as significant independent factors associated with metabolic syndrome. Although age ≥55 years demonstrated increased adjusted odds (aOR=2.67; 95% CI: 0.94–7.59), the association did not reach statistical significance (p=0.066). Comparable findings were reported by Matar et al. (2024), who studied 336 hypertensive patients in Jordan and documented metabolic syndrome in 33.60%. Their regression analysis identified advanced age (OR=2.006; 95% CI: 1.280–2.913), increased waist circumference (OR=2.864; 95% CI: 1.534–4.322), overweight (OR=5.522; 95% CI: 1.371–7.422), and obesity (OR=7.521; 95% CI: 4.520–9.016) as significant associated factors. Importantly, high physical activity was associated with lower odds of metabolic syndrome (OR=0.321; 95% CI: 0.107–0.961), supporting the association observed between inactivity and metabolic syndrome in the present study. These findings highlight the importance of regular physical activity, weight management, and metabolic screening in hypertensive patients, although the cross-sectional design does not establish causality.[15]

CONCLUSION

The present study demonstrated a high prevalence of metabolic syndrome (61.05%) among patients with essential hypertension, highlighting the considerable burden of associated cardiovascular risk factors. Metabolic syndrome was associated with advancing age, obesity, abdominal adiposity, dyslipidemia, impaired glucose metabolism, uncontrolled hypertension, and reduced renal function. Longer duration of hypertension and physical inactivity emerged as significant independent associated factors. Routine screening for metabolic abnormalities, early identification of high-risk patients, lifestyle modification, and comprehensive cardiovascular risk management are essential for improving clinical outcomes and reducing long-term cardiovascular complications.

REFERENCES

1. NCD Risk Factor Collaboration (NCD-RisC). Worldwide trends in hypertension prevalence and progress in treatment and control from 1990 to 2019: a pooled analysis of 1201 population-representative studies with 104 million participants. Lancet. 2021;398(10304):957-980. doi: 10.1016/S0140-6736(21)01330-1.
2. Fahed G, Aoun L, Bou Zerdan M, Allam S, Bou Zerdan M, Bouferraa Y, et al. Metabolic syndrome: updates on pathophysiology and management in 2021. Int J Mol Sci. 2022;23(2):786. doi: 10.3390/ijms23020786.
3. Powell-Wiley TM, Poirier P, Burke LE, Després JP, Gordon-Larsen P, Lavie CJ, et al. Obesity and cardiovascular disease: a scientific statement from the American Heart Association. Circulation. 2021;143(21):e984-e1010. doi: 10.1161/CIR.0000000000000973.
4. Laucyte-Cibulskiene A, Chen CH, Cockroft J, Cunha PG, Kavousi M, Laucevicius A, et al. Clusters of risk factors in metabolic syndrome and their influence on central blood pressure in a global study. Sci Rep. 2022;12(1):14409. doi: 10.1038/s41598-022-18094-y.
5. Ao L, Willems van Dijk K, van Heemst D, Noordam R. Differential and sex- and age-specific risks of cardiometabolic diseases with unrelated metabolic syndrome dimensions. Obesity (Silver Spring). 2023;31(7):1933-1941. doi: 10.1002/oby.23778.
6. Ndumele CE, Neeland IJ, Tuttle KR, Chow SL, Mathew RO, Khan SS, et al. A synopsis of the evidence for the science and clinical management of cardiovascular-kidney-metabolic (CKM) syndrome: a scientific statement from the American Heart Association. Circulation. 2023;148(20):1636-1664. doi: 10.1161/CIR.0000000000001186.
7. 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. Indian J Endocrinol Metab. 2013;17(4):723-726. doi: 10.4103/2230-8210.113768.
8. Kant R, Khapre M. Profile of metabolic syndrome in newly detected hypertensive patients in India: an hospital-based study. Int J Appl Basic Med Res. 2019;9(1):32-36. doi: 10.4103/ijabmr.IJABMR_108_18.
9. Salagre SB, Itolikar SM, Churiwala JJ. Prevalence and clinical profile of metabolic syndrome in hypertensive subjects. J Assoc Physicians India. 2016;64(4):22-24. PMID: 27734637. PubMed.
10. Barrios V, Escobar C, Calderón A, Llisterri JL, Alegría E, Muñiz J, et al. Prevalence of the metabolic syndrome in patients with hypertension treated in general practice in Spain: an assessment of blood pressure and low-density lipoprotein cholesterol control and accuracy of diagnosis. J Cardiometab Syndr. 2007;2(1):9-15. doi: 10.1111/j.1559-4564.2007.06313.x.
11. Acherjya GK, Ali M, Tarafder K, Deb SR, Dan KK, Sarker HN, et al. Frequency and risk factors association with metabolic syndrome among the hypertensive patients in Jashore, Bangladesh. Mymensingh Med J. 2024;33(3):822-831. PMID: 38944728. PubMed.
12. Tadewos A, Egeno T, Amsalu A. Risk factors of metabolic syndrome among hypertensive patients at Hawassa University Comprehensive Specialized Hospital, Southern Ethiopia. BMC Cardiovasc Disord. 2017;17(1):218. doi: 10.1186/s12872-017-0648-5.
13. Yu S, Guo X, Yang H, Zheng L, Sun Y. Metabolic syndrome in hypertensive adults from rural Northeast China: an update. BMC Public Health. 2015;15:247. doi: 10.1186/s12889-015-1587-7.
14. Dai H, Lu S, Tang X, Lu M, Chen R, Chen Z, et al. Combined association of serum uric acid and metabolic syndrome with chronic kidney disease in hypertensive patients. Kidney Blood Press Res. 2016;41(4):413-423. doi: 10.1159/000443443.
15. Matar RAA, Aldamen AFF, Eial Awwad EMA, Otoum SMH, Alkhawaldeh DSH. Prevalence and risk factors of metabolic syndrome among patients with hypertension. Int J Sci Res Manag. 2024;12(1):977-985. doi: 10.18535/ijsrm/v12i01.mp01.