

Research Article

Prevalence of Depression among Patients with Hypertension and Its Association with Cardiovascular Risk Factors: A Multicenter Cross-Sectional Study

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ABSTRACT

Objective: To determine the prevalence of depressive symptoms among patients with hypertension and examine their association with cardiovascular risk factors in tertiary-care hospitals across Punjab, Pakistan.

Methods: This multicenter cross-sectional study included 410 adults with hypertension who attended three tertiary-care hospitals between January 2024 and June 2025 in Punjab, Pakistan. Participants were enrolled consecutively. Depressive symptoms were assessed using the nine-item Patient Health Questionnaire, with a score of ≥ 10 indicating clinically relevant symptoms. Sociodemographic characteristics, hypertension duration, medication adherence, smoking, physical activity, body mass index, blood pressure, diabetes mellitus and dyslipidaemia were recorded. Independent factors associated with depression were identified using multivariable logistic regression.

Results: The mean age was 56.2 ± 10.8 years, and 224 (54.6%) participants were women. Clinically relevant depressive symptoms were present in 159 patients, giving a prevalence of 38.8% (95% CI: 34.1-43.7%). Depression was more frequent among women and among patients with uncontrolled blood pressure, diabetes, obesity, physical inactivity and poor medication adherence. Female sex (AOR=1.78), uncontrolled hypertension (AOR=2.06), diabetes (AOR=1.69), obesity (AOR=1.74), physical inactivity (AOR=1.81) and poor medication adherence (AOR=2.28) remained independently associated with depression.

Conclusion: More than one-third of patients receiving treatment for hypertension experienced clinically relevant depressive symptoms. Integrating brief depression screening and appropriate referral into routine hypertension care may help identify vulnerable patients and improve both psychological and cardiovascular care.

Keywords: Depression, Hypertension, PHQ-9, Medication Adherence.

INTRODUCTION

Hypertension remained one of the most important preventable causes of cardiovascular disease, stroke, chronic kidney disease and premature death worldwide.[1] The number of adults aged 30–79 years living with hypertension increased considerably over

the previous three decades, while progress in its detection, treatment and control remained uneven, particularly in low- and middle-income countries.[2]

Recent hypertension guidelines placed greater emphasis on a patient's overall cardiovascular risk rather than relying on blood-pressure

values alone. [3] This approach was particularly relevant to Pakistan, where hypertension frequently occurred alongside diabetes, obesity, dyslipidaemia, smoking and physical inactivity, while long-term preventive care remained difficult for many patients to access. [4]

Depression also contributed substantially to disability and often remained unrecognized among people receiving treatment for chronic physical illnesses.[5] The relationship between depression and hypertension appeared to work in both directions, as each condition could contribute to the development or worsening of the other.[6] A recent systematic review and meta-analysis found that people with depression had a significantly greater risk of developing hypertension than those without depression.[7] Among patients already living with hypertension, the burden of daily medication, fear of complications, financial pressure, physical limitations and repeated hospital visits could add considerably to emotional distress.[8]

Biological mechanisms such as increased sympathetic activity, disturbed hypothalamic–pituitary–adrenal function, inflammation, endothelial dysfunction and poor sleep may also have linked the two conditions.[9] Depression could make hypertension more difficult to manage by reducing motivation, interfering with medication use and limiting a patient's ability to maintain a healthy diet, remain physically active or attend regular follow-up visits.[10]

International evidence showed wide variation in the reported prevalence of depression among hypertensive patients because studies differed in age distribution, cultural setting, disease severity and the screening instruments used.[11] Recent studies from Morocco, Afghanistan and India nevertheless showed that depressive symptoms were common among people receiving treatment for hypertension, especially when blood pressure remained uncontrolled or other chronic conditions were present.[12] The Patient Health Questionnaire-9 provided a brief, affordable and practical means of identifying depressive symptoms in busy outpatient departments, although a positive screening result still required clinical assessment before a diagnosis could be made.[13] Greater attention to psychological health was therefore considered an important part of patient-centered cardiovascular risk assessment and long-term hypertension care.[14]

Local multicenter evidence remained limited, particularly regarding the relationship of depression with modifiable cardiovascular risk factors in Pakistani patients. This study therefore determined the prevalence and severity of depressive symptoms among adults with hypertension attending tertiary-care hospitals across Punjab and examined their association with blood-pressure control, diabetes, dyslipidaemia, obesity, smoking, physical inactivity and medication adherence.

MATERIALS AND METHODS

This multicenter cross-sectional study was conducted in the cardiology and general-medicine outpatient departments of three tertiary-care hospitals located in different regions of Punjab, Pakistan. Data were collected over 18 months, from January 2024 to June 2025. Recruitment was distributed across the participating centers so that no single hospital contributed a disproportionately large share of the sample.

The sample size was calculated using the single-population proportion formula, $n = Z^2 p(1-p) / d^2$. An expected prevalence of depression of 40%, a 95% confidence level and 5% absolute precision produced a minimum sample of 369 participants. After allowing approximately 10% for refusals and incomplete questionnaires, the final target was increased to 410 patients.

Adults aged 18 years or older who had physician-diagnosed hypertension for at least six months and were receiving antihypertensive treatment were eligible. Patients who were acutely unwell, pregnant, unable to communicate or unable to complete the interview because of cognitive impairment were excluded. Patients with bipolar disorder, psychotic illness or severe neurocognitive disorder were also excluded. A previous history of depression or current antidepressant use did not lead to exclusion because removing these patients could have underestimated the true burden of depressive symptoms.

Ethical approval was obtained from the institutional review boards of the coordinating center and participating hospitals before data collection began. Written informed consent was obtained from every participant. Confidentiality was maintained by assigning a unique study code to each questionnaire. Any participant who reported thoughts of self-harm on the ninth PHQ-9 item was assessed immediately by the attending clinician and

referred to the psychiatry service according to the hospital's safety protocol.

Eligible patients were enrolled consecutively after their routine clinical consultation. Trained medical officers conducted face-to-face interviews in Urdu or the participant's preferred regional language. Information was recorded on a standardized form that covered age, sex, residence, education, employment, marital status, smoking, physical activity, duration of hypertension, antihypertensive treatment, diabetes, cardiovascular disease and family history.

Depressive symptoms experienced during the previous two weeks were assessed using the Patient Health Questionnaire-9. Each item was scored from 0 to 3, giving a total score between 0 and 27. Scores of 0–4, 5–9, 10–14, 15–19 and 20–27 represented minimal, mild, moderate, moderately severe and severe symptoms, respectively. A score of ≥ 10 was used to identify clinically relevant depressive symptoms. The questionnaire was used as a screening instrument and not as a substitute for a diagnostic psychiatric interview.

Blood pressure was measured with a validated automated monitor using an appropriately sized cuff. Participants rested for at least five minutes before measurement. Two readings were obtained one minute apart, and their mean was used in the analysis. Blood pressure $\geq 140/90$ mmHg was categorized as uncontrolled.

Height was measured without shoes, and weight was recorded in light clothing. Body mass index was calculated as weight in kilograms divided by height in meters squared. Obesity was defined as a body mass index ≥ 30 kg/m².

Diabetes mellitus was identified through medical records, current glucose-lowering treatment, HbA1c $\geq 6.5\%$, or fasting plasma glucose ≥ 126 mg/dL. Dyslipidaemia was defined by a documented diagnosis, current lipid-lowering therapy, LDL cholesterol ≥ 130 mg/dL, triglycerides ≥ 150 mg/dL, or reduced HDL cholesterol.

Current smoking was defined as the use of cigarettes or another smoked tobacco product during the preceding 30 days. Participants who did not complete at least 150 minutes of moderate-intensity physical activity per week were categorized as physically inactive.

Medication adherence was assessed through four short questions covering forgetfulness, intentional omission, stopping treatment when feeling well and stopping treatment because of adverse effects. Patients who answered "yes" to any question were categorized as having poor adherence. This brief approach was selected because it could be applied easily in a busy outpatient department without licensing fees or electronic monitoring. The operational definitions used for the main outcome and cardiovascular risk factors are summarized in Table 1.

Table 1. Study Variables and Operational Definitions

Variable	Operational definition
Clinically relevant depressive symptoms	PHQ-9 score ≥ 10
Depression severity	Minimal: 0–4; mild: 5–9; moderate: 10–14; moderately severe: 15–19; severe: 20–27
Uncontrolled hypertension	Mean office blood pressure $\geq 140/90$ mmHg
Diabetes mellitus	Documented diagnosis, glucose-lowering treatment, HbA1c $\geq 6.5\%$, or fasting glucose ≥ 126 mg/dL
Dyslipidaemia	Documented diagnosis, lipid-lowering treatment, or abnormal LDL, triglyceride or HDL value
Obesity	Body mass index ≥ 30 kg/m ²
Current smoking	Use of smoked tobacco during the preceding 30 days
Physical inactivity	Less than 150 minutes of moderate activity per week
Poor medication adherence	At least one affirmative response on the four-item adherence interview
Multimorbidity	Hypertension accompanied by at least two additional chronic conditions

Data were analyzed using SPSS version 26.0. Appropriate parametric, non-parametric and categorical tests were applied. Factors with $p < 0.20$ in univariable analysis were entered into multivariable logistic regression. Adjusted

odds ratios with 95% confidence intervals were reported, with $p < 0.05$ considered significant.

RESULTS

A total of 438 patients were assessed for eligibility. Twenty-eight were excluded because they did not meet the eligibility criteria, declined participation or submitted incomplete questionnaires. The final analysis included 410 participants, giving a completion rate of 93.6%.

The mean age was 56.2±10.8 years, and participants ranged from 27 to 82 years of age. Women accounted for 54.6% of the sample, while 65.4% of participants lived in

urban areas. More than one-third had received no formal education.

The median duration of hypertension was seven years. Blood pressure remained uncontrolled in 219 (53.4%) patients. Diabetes was present in 160 (39.0%), dyslipidaemia in 182 (44.4%) and obesity in 144 (35.1%) participants. Approximately half of the participants were physically inactive, and nearly one-third reported poor adherence to antihypertensive treatment (Table 2).

Table 2. Baseline Characteristics of the Participants (N=410)

Characteristic	Value
Age, years, mean±SD	56.2±10.8
Age ≥60 years	164 (40.0)
Female sex	224 (54.6)
Urban residence	268 (65.4)
No formal education	143 (34.9)
Unemployed or homemaker	205 (50.0)
Hypertension duration, years, median (IQR)	7 (4–12)
Hypertension duration ≥10 years	145 (35.4)
Uncontrolled blood pressure	219 (53.4)
Diabetes mellitus	160 (39.0)
Dyslipidaemia	182 (44.4)
Obesity	144 (35.1)
Current smoking	70 (17.1)
Physical inactivity	209 (51.0)
Established cardiovascular disease	78 (19.0)
Poor medication adherence	126 (30.7)

Values are presented as n (%) unless stated otherwise.

The mean PHQ-9 score was 8.6±5.7. Clinically relevant depressive symptoms were found in 159 patients, giving a prevalence of 38.8% (95% CI: 34.1–43.7%). Moderate symptoms were present in 22.2%, moderately severe symptoms in 11.7% and severe symptoms in

4.9% of the participants. Twenty-six patients reported thoughts of self-harm on at least several days during the previous two weeks and were assessed immediately by the clinical team (Table 3).

Table 3. Severity of Depressive Symptoms According To PHQ-9 Score (N=410)

PHQ-9 category	Score	n (%)
Minimal	0–4	146 (35.6)
Mild	5–9	105 (25.6)
Moderate	10–14	91 (22.2)
Moderately severe	15–19	48 (11.7)
Severe	20–27	20 (4.9)
Clinically relevant symptoms	≥10	159 (38.8)

Women represented 64.2% of participants with depression compared with 48.6% of those without depression. Uncontrolled blood pressure, diabetes, obesity, physical inactivity, established cardiovascular disease and poor

medication adherence were also more frequent among patients with depression. Their mean systolic blood pressure and body mass index were higher than those recorded among patients without depression (Table 4).

Table 4. Characteristics According To Depression Status

Characteristic	Depression, n=159	No depression, n=251	p-value
Age, years, mean±SD	57.4±10.5	55.4±10.9	0.066

Female sex	102 (64.2)	122 (48.6)	0.002
No formal education	68 (42.8)	75 (29.9)	0.008
Hypertension ≥ 10 years	69 (43.4)	76 (30.3)	0.007
Uncontrolled blood pressure	107 (67.3)	112 (44.6)	<0.001
Diabetes mellitus	78 (49.1)	82 (32.7)	0.001
Dyslipidaemia	79 (49.7)	103 (41.0)	0.086
Obesity	72 (45.3)	72 (28.7)	0.001
Current smoking	35 (22.0)	35 (13.9)	0.034
Physical inactivity	102 (64.2)	107 (42.6)	<0.001
Established cardiovascular disease	40 (25.2)	38 (15.1)	0.011
Poor medication adherence	73 (45.9)	53 (21.1)	<0.001
Systolic blood pressure, mmHg	151.6 $\pm$ 18.4	143.7 $\pm$ 16.9	<0.001
Body mass index, kg/m ²	29.4 $\pm$ 5.1	27.6 $\pm$ 4.7	<0.001

In the unadjusted analysis, female sex, lack of formal education, longer duration of hypertension, uncontrolled blood pressure, diabetes, obesity, smoking, physical inactivity, cardiovascular disease and poor medication adherence were associated with greater odds of depression.

After adjustment, women had 1.78 times greater odds of depressive symptoms than men. Uncontrolled blood pressure, diabetes, obesity, physical inactivity and poor

medication adherence also remained independently associated with depression. The strongest association was observed for poor medication adherence, followed by uncontrolled hypertension. Education, smoking, dyslipidaemia, duration of hypertension and established cardiovascular disease did not remain statistically significant after the effects of other factors had been considered (Table 5).

Table 5. Factors Associated with Clinically Relevant Depressive Symptoms

Variable	Crude OR (95% CI)	Adjusted OR (95% CI)	p-value
Female sex	1.90 (1.27–2.86)	1.78 (1.12–2.83)	0.015
No formal education	1.75 (1.15–2.65)	1.39 (0.87–2.23)	0.169
Hypertension ≥ 10 years	1.77 (1.17–2.68)	1.41 (0.89–2.24)	0.143
Uncontrolled blood pressure	2.56 (1.69–3.87)	2.06 (1.29–3.29)	0.002
Diabetes mellitus	1.99 (1.32–3.00)	1.69 (1.06–2.69)	0.027
Dyslipidaemia	1.42 (0.95–2.12)	1.18 (0.75–1.86)	0.477
Obesity	2.06 (1.36–3.13)	1.74 (1.08–2.80)	0.023
Current smoking	1.74 (1.03–2.95)	1.48 (0.82–2.68)	0.193
Physical inactivity	2.41 (1.60–3.64)	1.81 (1.14–2.88)	0.012
Established cardiovascular disease	1.89 (1.15–3.10)	1.43 (0.82–2.50)	0.208
Poor medication adherence	3.17 (2.06–4.88)	2.28 (1.40–3.71)	0.001

The final regression model showed acceptable calibration on the Hosmer–Lemeshow test ($p=0.61$). Its area under the receiver-operating-characteristic curve was 0.78 (95% CI: 0.73–0.82), indicating acceptable discrimination. All variance-inflation factors were below 2.0, and no important multicollinearity was identified.

DISCUSSION

The present study found that 38.8% of adults receiving treatment for hypertension had clinically relevant depressive symptoms, indicating that depression was an important but potentially overlooked concern among hypertensive patients attending tertiary-care hospitals in Punjab. This finding was consistent with a recent study from Lahore,

which also reported a considerable frequency of depression among patients with essential hypertension and identified socioeconomic and clinical factors that influenced their psychological health.[15]

A multicenter study from Afghanistan reported depressive symptoms in 51.8% of hypertensive patients, which was higher than the prevalence observed in the present study.[16] However, the Afghan study used a PHQ-9 score of ≥ 5 , whereas the present study used a score of ≥ 10 ; therefore, the Afghan estimate also included patients with mild symptoms. The same study identified low educational status, physical inactivity, medical comorbidity and poor blood-pressure control as important predictors of depressive

symptoms, which supported several of the associations observed in our patients.[16]

A hospital-based study from India found depression in approximately half of its hypertensive participants and similarly reported that uncontrolled blood pressure was associated with poorer psychological health.[17] Although its prevalence was higher than ours, differences in the screening instrument, patient characteristics and clinical setting may have contributed to the variation.[17] A recent systematic review from India reported a pooled depression prevalence of approximately 40% among patients with hypertension, which was very close to the prevalence found in the present study.[18] Together, these findings suggested that depression affected a substantial proportion of hypertensive patients across South Asian healthcare settings.[18]

Uncontrolled blood pressure remained independently associated with depression after other demographic, metabolic and behavioral factors had been considered. The relationship may have worked in both directions because persistent hypertension and fear of cardiovascular complications could increase emotional distress, while depressive symptoms could reduce a patient's motivation to take medication, modify dietary habits and attend follow-up visits. Prospective evidence has also shown that depressive symptoms may precede the development of hypertension, although the cross-sectional design of the present study did not allow the temporal direction of this association to be established.[19]

Poor medication adherence showed the strongest adjusted association with depressive symptoms. Patients experiencing sadness, fatigue, sleep disturbance, poor concentration or hopelessness may have found it difficult to follow a daily medication schedule, particularly when they were taking several medicines for hypertension and other chronic conditions. This finding suggested that clinicians should have explored emotional, financial and treatment-related difficulties when patients repeatedly missed medication rather than viewing non-adherence simply as careless behavior.[20]

Diabetes and obesity were also independently associated with depression, indicating that patients living with several cardio-metabolic conditions experienced a heavier physical and emotional burden. Obesity and depression may reinforce each other through reduced mobility, body-image concerns, inflammation,

unhealthy eating patterns and withdrawal from social activities.[21] The additional demands of diabetes treatment, dietary restrictions, monitoring costs and fear of complications may have further increased emotional distress among these patients.

Physical inactivity remained independently associated with depression. This relationship was clinically important because inactivity could have resulted from low mood and fatigue while also contributing to worsening mental health, obesity and cardiovascular risk. Regular physical activity has been associated with a lower risk of depression, supporting the use of realistic, culturally appropriate and gradually progressive activity advice for hypertensive patients.[22]

Smoking was related to depression in the unadjusted analysis, but the association did not remain significant after adjustment. This attenuation suggested that smoking may have clustered with other behavioral and socioeconomic factors rather than acting as an independent predictor in the present population. Nevertheless, the close relationship between smoking and poor psychological health supported the inclusion of smoking cessation within comprehensive behavioral care.[23]

The findings supported the integration of brief depression screening into routine hypertension clinics, particularly for women and patients with uncontrolled blood pressure, diabetes, obesity, physical inactivity or poor medication adherence. Screening should have been followed by clinical confirmation, assessment of self-harm risk, counseling and referral when required because a PHQ-9 score alone did not establish a psychiatric diagnosis. [24] Collaboration among cardiology, psychiatry and behavioral-science teams could have provided a more practical and patient-centered approach to managing the closely connected psychological and cardiovascular needs of these patients.

The multicenter design, standardized assessment and inclusion of several modifiable cardiovascular risk factors strengthened the study. The findings highlighted a clinically important overlap between depression and hypertension and supported a more integrated approach to cardiovascular care in resource-constrained settings.

CONCLUSION

Depressive symptoms were common among adults receiving treatment for hypertension in

tertiary-care hospitals across Punjab. Women and patients with uncontrolled blood pressure, diabetes, obesity, physical inactivity or poor medication adherence were particularly likely to experience depression. A brief depression screen, followed by clinical assessment and an appropriate referral pathway, could be incorporated into routine hypertension care without placing a major financial burden on hospitals. Bringing cardiology, psychiatry and behavioral support together may help patients manage both their emotional health and long-term cardiovascular risk.

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