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Hypertension And Its Associated Factors Among Type 2 Diabetes Mellitus Patients

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ABSTRACT

Background: *Hypertension is the most prevalent cardiovascular comorbidity among patients with Type 2 Diabetes Mellitus (T2DM), substantially increasing the risk of cardiovascular and renal complications. The coexistence of these conditions reflects shared pathophysiological mechanisms including insulin resistance, endothelial dysfunction, and activation of the renin–angiotensin–aldosterone system. Despite global evidence, district-level data from Pakistan remain limited.* ***Objective:*** *To determine the prevalence of hypertension and identify its associated factors among patients with T2DM attending a secondary-level healthcare facility.* ***Methods:*** *A hospital-based cross-sectional observational study was conducted among 90 adults with T2DM at DHQ Hospital Sheikhupura. Data were collected using structured interviews, anthropometric measurements, standardized blood pressure assessment, and medical record review. Hypertension was defined as systolic blood pressure ≥140 mmHg and/or diastolic blood pressure ≥90 mmHg or current antihypertensive use. Multivariable logistic regression was performed to identify independent predictors.* ***Results:*** *The prevalence of hypertension was 61.1%. Age >60 years (AOR 2.41; 95% CI 1.01–5.74), diabetes duration >10 years (AOR 2.21; 95% CI 1.00–4.92), obesity (AOR 2.96; 95% CI 1.25–7.01), and poor glycemic control (AOR 2.39; 95% CI 1.01–5.66) were independently associated with hypertension. Smoking and residence were not significant after adjustment.* ***Conclusion:*** *Hypertension is highly prevalent among T2DM patients, with modifiable metabolic factors significantly increasing risk. Integrated screening and risk-based management are essential to reduce cardiovascular burden.*

Keywords: *Type 2 Diabetes Mellitus; Hypertension; Prevalence; Obesity; Glycemic Control; Risk Factors.*

INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder characterized by insulin resistance and progressive β-cell dysfunction, and it is strongly associated with accelerated cardiovascular morbidity and premature mortality. Among the spectrum of cardiovascular risk factors affecting individuals with T2DM, hypertension (HTN) is the most prevalent and clinically consequential comorbidity. The coexistence of T2DM and hypertension substantially amplifies the risk of coronary artery disease, stroke, heart failure, and chronic kidney disease compared with either condition alone (1,2). Epidemiological evidence indicates that more than half of patients with T2DM have concomitant hypertension, with prevalence estimates ranging from 50% to 75% globally depending on population characteristics and diagnostic criteria (3–5). This clustering of metabolic and hemodynamic abnormalities reflects shared pathophysiological pathways, including insulin resistance, endothelial dysfunction, activation of the renin–angiotensin–aldosterone system (RAAS), oxidative stress, and chronic low-grade inflammation (6,7). Consequently, hypertension in T2DM is not merely a coexisting condition but a synergistic determinant of adverse vascular outcomes.

The pathophysiological interplay between hyperglycemia and elevated blood pressure accelerates both microvascular and macrovascular complications. Persistent hyperglycemia contributes to endothelial injury, vascular stiffness, and atherogenesis, while hypertension

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exacerbates shear stress on already compromised vascular endothelium, thereby promoting retinopathy, nephropathy, neuropathy, and atherosclerotic cardiovascular disease (8,9). Large cohort studies have demonstrated that even modest elevations in blood pressure among diabetic patients are associated with a graded increase in cardiovascular events and mortality (9,10). Moreover, poor glycemic control further potentiates vascular injury, reinforcing the bidirectional relationship between metabolic dysregulation and hypertension (8,11). Obesity, prolonged duration of diabetes, advancing age, and sedentary lifestyle have consistently emerged as significant determinants of hypertension among individuals with T2DM (12–14). These risk factors often cluster in low- and middle-income countries (LMICs), where rapid urbanization, dietary transitions, and limited preventive services contribute to an expanding dual burden of non-communicable diseases (3,5).

From a public health and clinical management perspective, the coexistence of T2DM and hypertension markedly increases healthcare utilization, treatment complexity, and economic burden (15,16). International guidelines emphasize strict blood pressure control in diabetic patients to mitigate cardiovascular risk (1,17). Despite clear recommendations, hypertension frequently remains underdiagnosed or suboptimally controlled in routine clinical practice, particularly in resource-constrained settings (4,18). In South Asia, where both diabetes and hypertension prevalence are rising rapidly, epidemiological transitions have intensified the need for integrated chronic disease management strategies (5,19). However, prevalence estimates and determinants of hypertension among T2DM patients vary considerably across regions due to heterogeneity in demographic profiles, healthcare access, lifestyle factors, and diagnostic approaches (4,12). Therefore, locally generated evidence is essential to guide targeted interventions.

In Pakistan, T2DM prevalence has increased substantially over recent decades, yet data examining the magnitude and independent predictors of hypertension among diabetic patients at district-level healthcare facilities remain limited. Most available studies are either region-specific, focus on tertiary centers, or lack comprehensive multivariable analysis to identify independent predictors after adjustment for confounders. Furthermore, variations in body mass index distribution, glycemic control patterns, and duration of diabetes across local populations necessitate context-specific investigation. In the absence of robust local data, clinical decision-making and policy formulation may rely excessively on extrapolated evidence from other countries, potentially limiting relevance and effectiveness.

Within the PICO framework, the population of interest comprises adult patients (≥20 years) diagnosed with T2DM attending a district-level hospital outpatient setting. The exposure variables include sociodemographic factors (age, sex, residence), clinical characteristics (duration of diabetes, type of treatment, body mass index, glycemic control), and behavioral factors (smoking). The comparison groups consist of patients with and without these exposures (e.g., obese versus non-obese; poor versus good glycemic control). The primary outcome is the presence of hypertension, defined according to standard blood pressure criteria or documented diagnosis. The central research problem is the high and potentially underrecognized burden of hypertension among individuals with T2DM and the uncertainty regarding which factors independently predict its occurrence in the local clinical context.

Given the established global association between T2DM and hypertension but the limited district-level data in Pakistan, there exists a clear knowledge gap regarding the magnitude of this comorbidity and its modifiable determinants within this specific population. Identifying independent predictors such as obesity, prolonged diabetes duration, and inadequate glycemic control is critical for risk stratification and for designing integrated screening and prevention programs at primary and secondary care levels. Accordingly, this study aims to determine the prevalence of hypertension and to identify its associated factors among patients with Type 2 Diabetes Mellitus attending a district-level hospital. The underlying hypothesis is that advancing age, longer duration of diabetes, obesity, and poor glycemic control are independently associated with increased odds of hypertension among patients with T2DM.

MATERIAL AND METHODS

This hospital-based cross-sectional observational study was conducted to determine the prevalence of hypertension and its associated factors among patients with Type 2 Diabetes Mellitus (T2DM). A cross-sectional design was selected because it allows estimation of the burden of hypertension and simultaneous assessment of associations between clinical, sociodemographic, and behavioral factors within a defined population at a specific time point, consistent with recommendations for observational epidemiological research (20). The study was carried out in the Diabetes Outpatient Department of DHQ Hospital Sheikhupura, Pakistan, over a four-month period following institutional approval. The hospital is a secondary-level public healthcare facility serving both urban and rural populations of the district.

The source population comprised adult patients diagnosed with T2DM attending routine follow-up visits during the study period. Eligible participants were individuals aged 20 years or older with a confirmed diagnosis of T2DM documented in their medical records and with available clinical data including fasting blood glucose, glycated hemoglobin (HbA1c), and blood pressure measurements. Patients diagnosed with Type 1 Diabetes Mellitus, pregnant women, individuals with known structural heart diseases such as congenital heart defects or established ischemic heart disease, and critically ill or cognitively impaired patients unable to provide informed consent were excluded to minimize clinical heterogeneity and potential confounding from advanced cardiovascular pathology. Participants were recruited consecutively from those attending the outpatient clinic during the study period and meeting eligibility criteria. After verification of eligibility, the study purpose and procedures were explained in the local language, and written informed consent was obtained prior to enrollment.

Data were collected using a structured, pretested questionnaire and standardized clinical assessment procedures. The questionnaire captured sociodemographic characteristics (age, sex, residence, education level, occupation), behavioral factors (smoking status), and relevant medical history including duration of diabetes and current anti-diabetic treatment modality. Clinical data including HbA1c values and previous diagnoses were retrieved from hospital medical records to ensure accuracy. Anthropometric measurements were performed by trained healthcare personnel following standardized protocols. Body weight was measured using a calibrated digital weighing scale with participants wearing light clothing and no shoes, and height was measured using a stadiometer with participants standing upright. Body mass index (BMI) was calculated as weight in kilograms divided by the square of height in meters (kg/m^2) and categorized according to World Health Organization criteria: normal (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2), and obese ($\geq$30.0 kg/m^2) (21).

Blood pressure was measured using a calibrated automated sphygmomanometer after the participant had rested for at least five minutes in a seated position, with the arm supported at heart level and an appropriately sized cuff applied. Two measurements were taken at an interval of at least one minute, and the average was recorded as the final value. Hypertension was operationally defined as systolic blood pressure $\geq$140 mmHg and/or diastolic blood pressure $\geq$90 mmHg, or current use of antihypertensive medication, consistent with established guideline criteria (22,23). Blood pressure staging was categorized according to standard classifications into normal, pre-hypertension, Stage I, and Stage II hypertension (22). Glycemic control was defined using HbA1c levels, with good control defined as HbA1c <7% and poor control as HbA1c ≥7%, in accordance with international diabetes management recommendations (1).

The primary outcome variable was the presence of hypertension (yes/no). Independent variables included age (categorized as ≤60 years and >60 years), sex, residence (urban/rural), duration of T2DM (≤10 years and >10 years), BMI category (non-obese vs obese), glycemic control (good vs poor), smoking status (current smoker vs non-smoker), and type of anti-diabetic treatment (oral hypoglycemic agents, insulin, or both). Operational definitions were established a priori to ensure clarity and reproducibility. To minimize information bias, standardized instruments were used for all measurements, data collectors received training prior to study initiation, and calibration of equipment was performed regularly. Selection bias was mitigated through consecutive sampling of all eligible patients during the study period. Potential confounding was addressed analytically using multivariable logistic regression modeling.

The sample size of 90 participants was determined based on feasibility within the study period and to provide sufficient precision to estimate hypertension prevalence with an anticipated proportion exceeding 50%, ensuring an acceptable margin of error at a 95% confidence level (24). Data were coded and entered into IBM SPSS Statistics version 27.0 for analysis. Data cleaning procedures included range checks, consistency verification, and cross-validation with source documents. Descriptive statistics were computed as means with standard deviations for continuous variables and frequencies with percentages for categorical variables. The prevalence of hypertension was calculated as the proportion of participants meeting the operational definition.

Bivariate analysis was conducted using chi-square tests for categorical variables and independent t-tests for continuous variables where appropriate to examine associations between independent variables and hypertension status. Crude odds ratios (COR) with 95% confidence intervals (CI) were calculated using binary logistic regression. Variables with a p-value ≤0.25 in bivariate analysis or deemed clinically relevant based on prior literature were entered into a multivariable logistic regression model to identify independent predictors while adjusting for potential confounders (25). Adjusted odds ratios (AOR) with 95% CI were reported, and statistical significance was defined as a two-sided p-value <0.05. Multicollinearity among independent variables was assessed using variance inflation factors, and model fitness was evaluated using the Hosmer–Lemeshow goodness-of-fit test. Missing data were assessed for pattern and magnitude; where minimal, complete-case analysis was performed to maintain analytical integrity.

Ethical approval was obtained from the Institutional Review Board of the affiliated academic authority prior to commencement of the study. Permission to access patient records and conduct data collection was granted by the hospital administration. All procedures were conducted in accordance with the ethical principles outlined in the Declaration of Helsinki (26). Participant confidentiality was strictly maintained by assigning unique identification codes and removing personal identifiers from the dataset. Data were stored in password-protected electronic files accessible only to the research team. To enhance reproducibility and data integrity, standardized data collection forms were used, double data entry verification was performed, and all analytical procedures were documented in a predefined statistical analysis plan prior to final modeling.

RESULTS

The socio-demographic characteristics of the study participants (n = 90) demonstrate that the majority of patients with Type 2 Diabetes Mellitus (T2DM) were middle-aged. Specifically, 51 participants (56.7%) were between 41 and 60 years, while 26 individuals (28.9%) were older than 60 years and 13 (14.4%) were aged 20–40 years. The mean age distribution indicates a concentration in the mid-to-late adulthood period, which is epidemiologically consistent with the natural history of T2DM. Males constituted 50 participants (55.6%), whereas females accounted for 40 (44.4%), reflecting a modest male predominance. A greater proportion of participants resided in urban areas (58; 64.4%) compared to rural areas (32; 35.6%), suggesting a higher clinic attendance or disease burden in urban populations. Regarding educational attainment, 28 individuals (31.1%) had no formal education, 24 (26.7%) completed primary education, 20 (22.2%) had secondary education, and 18 (20.0%) were graduates or above, indicating that more than half of the cohort (51.1%) had education up to primary level or none. Occupational distribution showed that 32 participants (35.6%) were employed, 29 (32.2%) were housewives, 16 (17.8%) were laborers, and 13 (14.4%) were retired or unemployed.

The clinical profile revealed that 42 participants (46.7%) had been living with diabetes for 5–10 years, while 25 (27.7%) had a disease duration exceeding 10 years and 23 (25.6%) had diabetes for less than 5 years. Thus, nearly three-quarters of the cohort (74.4%) had diabetes duration of five years or more, indicating prolonged metabolic exposure. In terms of treatment modality, 46 patients (51.1%) were managed with oral hypoglycemic agents (OHA) alone, 20 (22.2%) were on insulin therapy, and 24 (26.7%) were receiving a combination of OHA and insulin, reflecting that nearly half (48.9%) required insulin-based regimens either alone or in combination. Body mass index (BMI) distribution demonstrated that 42 participants (46.7%) were overweight and 24 (26.6%) were obese, while only 24 (26.7%) had normal BMI. Consequently, 66 individuals (73.3%) were either overweight or obese, highlighting a high burden of excess body weight in this population. Glycemic control assessment showed that 53 participants (58.9%) had poor control (HbA1c ≥7%), compared to 37 (41.1%) who achieved good control, indicating that more than half of the study population had suboptimal metabolic regulation.

Behavioral assessment indicated that 17 participants (18.9%) were current smokers, whereas 73 (81.1%) were non-smokers. Although smoking prevalence was lower compared to other risk factors, nearly one-fifth of patients were exposed to this modifiable cardiovascular risk factor.

The prevalence of hypertension among the study participants was 55 out of 90, yielding a proportion of 61.1%. Conversely, 35 participants (38.9%) were normotensive. This indicates that approximately three out of every five patients with T2DM in this cohort had coexisting hypertension. When categorized by blood pressure stage, 35 individuals (38.9%) were classified as normal, 20 (22.2%) had pre-hypertension, 24 (26.7%) had Stage I hypertension, and 11 (12.2%) had Stage II hypertension, while no cases of hypertensive crisis were recorded. Among those with confirmed hypertension (n = 55), the majority were in Stage I (24/55; 43.6%), followed by Stage II (11/55; 20.0%), while 20 individuals (36.4% of hypertensive range including pre-hypertension category depending on classification) were in the pre-hypertensive stage. Overall, moderate elevation of blood pressure predominated, with severe stages being comparatively less frequent.

Bivariate logistic regression analysis demonstrated significant associations between hypertension and several clinical variables. Participants aged >60 years had nearly three times higher odds of hypertension compared to those aged ≤60 years (COR = 2.89; p = 0.014). Duration of diabetes exceeding 10 years was associated with 2.46-fold increased odds of hypertension compared with shorter duration (p = 0.031).

Obesity showed a strong association, with obese individuals having 3.12 times higher crude odds of hypertension compared to non-obese participants (p = 0.007). Poor glycemic control was also significantly associated, with 2.34 times higher odds of hypertension among those with HbA1c ≥7% (p = 0.038). In contrast, gender (COR = 1.31; p = 0.48), urban residence (COR = 1.74; p = 0.17), and smoking status (COR = 1.88; p = 0.20) did not reach statistical significance in crude analysis.

In the multivariable logistic regression model adjusting for potential confounders, age >60 years remained an independent predictor of hypertension (AOR = 2.41; p = 0.047). Similarly, diabetes duration >10 years independently increased the odds by 2.21 times (p = 0.049). Obesity retained a strong independent association, with nearly threefold increased adjusted odds (AOR = 2.96; p = 0.013).

Poor glycemic control remained statistically significant, with an adjusted odds ratio of 2.39 (p = 0.046). Although urban residence showed an AOR of 2.18 and smoking showed an AOR of 1.52, neither variable achieved statistical significance after adjustment (p = 0.39 and p = 0.41, respectively), indicating that their apparent crude associations were likely confounded by other metabolic or demographic factors.

Overall, the numerical distribution across tables demonstrates a high burden of hypertension (61.1%) among T2DM patients, with statistically significant independent associations observed for advanced age, longer diabetes duration, obesity, and poor glycemic control, while behavioral and residential variables did not independently predict hypertension after multivariable adjustment.

Table 1. Socio-Demographic Characteristics of Study Participants (n = 90)

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	20–40	13	14.4
	41–60	51	56.7
	>60	26	28.9
Sex	Male	50	55.6
	Female	40	44.4
Residence	Urban	58	64.4
	Rural	32	35.6
Education	No formal education	28	31.1
	Primary	24	26.7
	Secondary	20	22.2
	Graduate/Above	18	20.0
Occupation	Employed	32	35.6
	Housewife	29	32.2
	Laborer	16	17.8
	Retired/Unemployed	13	14.4

Table 2. Clinical Characteristics of Study Participants (n = 90)

Variable	Category	Frequency (n)	Percentage (%)
Duration of T2DM	<5 years	23	25.6
	5–10 years	42	46.7
	>10 years	25	27.7
Treatment Type	OHA	46	51.1
	Insulin	20	22.2
	Both	24	26.7
BMI (kg/m²)	Normal	24	26.7
	Overweight	42	46.7
	Obese	24	26.6
Glycemic Control (HbA1c)	Good (<7%)	37	41.1
	Poor (≥7%)	53	58.9

Table 3. Behavioral Characteristics (n = 90)

Variable	Category	Frequency (n)	Percentage (%)
Smoking Status	Current smoker	17	18.9
	Non-smoker	73	81.1

Table 4. Prevalence and Staging of Hypertension among T2DM Patients (n = 90)

Variable	Category	Frequency (n)	Percentage (%)
Hypertension Status	Yes	55	61.1
	No	35	38.9
Hypertension Stage	Normal	35	38.9
	Pre-hypertension	20	22.2
	Stage I	24	26.7
	Stage II	11	12.2
	Crisis	0	0

Table 5. Association Between Independent Variables and Hypertension (Bivariate Logistic Regression)

Variable	Category	Hypertension n (%)	COR	95% CI	p-value
Age	>60 vs ≤60	20/26 (76.9%)	2.89	1.23–6.78	0.014*
Gender	Male vs Female	32/50 (64.0%)	1.31	0.54–3.15	0.48
Residence	Urban vs Rural	39/58 (67.2%)	1.74	0.79–3.86	0.17
Duration of DM	>10 yrs vs ≤10 yrs	20/25 (80.0%)	2.46	1.08–5.63	0.031*
BMI	Obese vs Non-obese	20/24 (83.3%)	3.12	1.37–7.10	0.007*
Glycemic Control	Poor vs Good	38/53 (71.7%)	2.34	1.04–5.29	0.038*
Smoking	Yes vs No	13/17 (76.5%)	1.88	0.67–5.27	0.20

Table 6. Independent Predictors of Hypertension (Multivariable Logistic Regression)

Variable	Category	AOR	95% CI	p-value
Age	>60 years	2.41	1.01–5.74	0.047*
Duration of DM	>10 years	2.21	1.00–4.92	0.049*
BMI	Obese	2.96	1.25–7.01	0.013*
Glycemic Control	Poor	2.39	1.01–5.66	0.046*
Residence	Urban	2.18	0.35–13.62	0.39
Smoking	Yes	1.52	0.56–4.11	0.41

The figure demonstrates the independent effect sizes of key predictors of hypertension among patients with T2DM using adjusted odds ratios (AORs) and 95% confidence intervals. Obesity (BMI ≥30 kg/m²) showed the strongest independent association, with nearly threefold higher odds of hypertension (AOR 2.96; 95% CI 1.25–7.01), indicating a clinically substantial elevation in risk and the widest confidence interval range, reflecting greater variability but clear statistical significance.

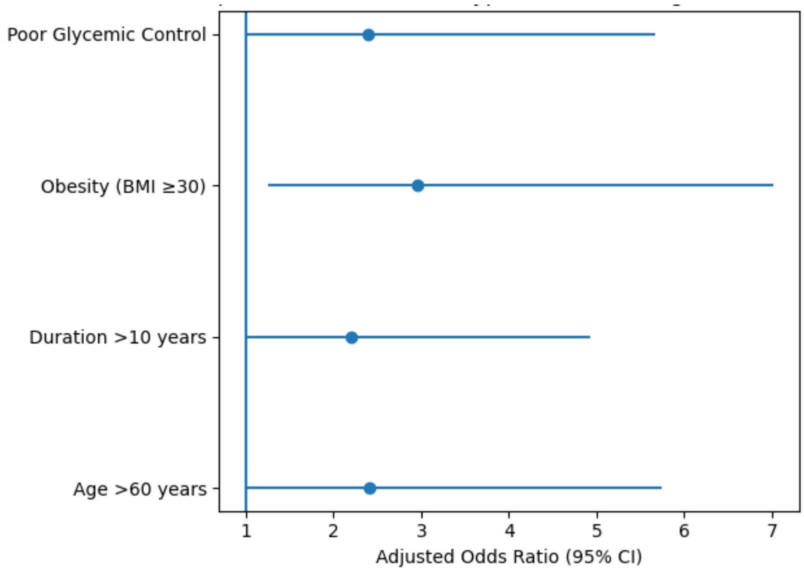

Figure 1 Independent Predictors of Hypertension Among T2DM Patients

Age >60 years was associated with 2.41 times higher odds (95% CI 1.01–5.74), while diabetes duration >10 years demonstrated a 2.21-fold increase (95% CI 1.00–4.92), both crossing just above the null threshold yet remaining statistically significant. Poor glycemic control (HbA1c ≥7%) independently increased hypertension odds by 2.39 times (95% CI 1.01–5.66). Notably, all significant predictors exhibit confidence intervals entirely above unity, reinforcing independent associations after confounder adjustment. Clinically, the gradient of effect sizes highlights obesity as the most influential modifiable determinant, followed by metabolic control and disease chronicity, underscoring the synergistic cardiometabolic burden in this cohort.

DISCUSSION

The present study demonstrated that hypertension is highly prevalent among patients with Type 2 Diabetes Mellitus (T2DM), affecting 61.1% of the study population. This magnitude is consistent with international evidence indicating that more than half of individuals with T2DM develop concomitant hypertension (3–5,12). The observed prevalence falls within the global range of 50–75% reported in diabetic cohorts and reinforces the concept that hypertension represents the most common and clinically significant comorbidity in T2DM (6,15). From a cardiometabolic standpoint, this coexistence reflects shared pathophysiological mechanisms, including insulin resistance, endothelial dysfunction, RAAS activation, and chronic inflammatory pathways that collectively accelerate vascular damage (6,7). The high burden identified in this district-level Pakistani population suggests that the dual epidemic of diabetes and hypertension is not confined to tertiary centers but is equally entrenched in secondary healthcare settings.

Age emerged as a significant independent predictor of hypertension, with patients older than 60 years demonstrating more than twice the adjusted odds compared to younger counterparts. This finding aligns with epidemiological data showing progressive arterial stiffness, reduced vascular compliance, and cumulative endothelial injury with advancing age (4,10). In diabetic individuals, age-related vascular changes are superimposed on chronic hyperglycemia-induced damage, thereby amplifying susceptibility to elevated blood pressure (8,9). The clinical implication is that elderly patients with T2DM require intensified blood pressure surveillance and early therapeutic intervention to mitigate cardiovascular risk.

Duration of diabetes greater than 10 years was independently associated with hypertension, increasing the odds by more than twofold. This association is biologically plausible, as prolonged exposure to hyperglycemia promotes structural and functional vascular alterations, nephropathy, and autonomic dysfunction, all of which contribute to elevated systemic vascular resistance (8,11). Long-standing diabetes also intensifies RAAS activation and sodium retention, mechanisms closely linked to hypertensive pathophysiology (6,7). Similar associations between longer diabetes duration and hypertension have been documented in previous observational studies across diverse populations (12,14). The cumulative metabolic burden over time therefore appears to be a critical determinant of blood pressure dysregulation in T2DM.

Obesity demonstrated the strongest independent association with hypertension in this study, with nearly threefold increased adjusted odds. This observation is consistent with established evidence linking adiposity to sympathetic nervous system overactivity, RAAS stimulation, insulin resistance, and endothelial dysfunction (13,16). Excess adipose tissue contributes to increased cardiac output, vascular stiffness, and inflammatory cytokine production, thereby promoting sustained elevations in blood pressure. Given that 73.3% of the cohort was either overweight or obese, the interplay between obesity and diabetes likely magnifies cardiovascular risk in this population. These findings underscore the importance of structured weight management interventions as an integral component of integrated diabetes care.

Poor glycemic control (HbA1c ≥7%) was also independently associated with hypertension. Persistent hyperglycemia induces advanced glycation end products, oxidative stress, and impaired nitric oxide bioavailability, resulting in endothelial dysfunction and increased arterial stiffness (8,11). Large clinical datasets have demonstrated that suboptimal glycemic control correlates with both microvascular and macrovascular complications, including hypertension (9,15). The independent association observed in the adjusted model suggests that metabolic dysregulation exerts an additive effect beyond demographic and anthropometric factors. Clinically, this reinforces the necessity of achieving and maintaining target HbA1c levels not only to prevent classical diabetic complications but also to reduce blood pressure–related cardiovascular risk.

Although urban residence and smoking demonstrated elevated crude odds ratios, these associations lost statistical significance after multivariable adjustment. This suggests that their apparent effects were likely mediated through metabolic variables such as obesity and glycemic control. While smoking is a recognized cardiovascular risk factor (18), its independent contribution to hypertension within diabetic populations may be less pronounced when metabolic and demographic variables are simultaneously considered. Similarly, urban residence may reflect lifestyle clustering rather than a direct causal pathway. These findings highlight the predominance of metabolic and disease-related factors over purely sociodemographic determinants in this cohort.

The staging distribution further indicated that Stage I hypertension constituted the largest proportion among hypertensive individuals, suggesting that most patients were in a moderate elevation category rather than severe hypertensive states. This pattern presents a critical window for early intervention before progression to advanced cardiovascular or renal complications. International hypertension management guidelines emphasize aggressive blood pressure control in patients with diabetes to reduce morbidity and mortality (17,23). The observed prevalence and associated factors in this study therefore provide actionable evidence for strengthening routine blood pressure screening and integrated chronic disease management at district-level facilities.

From a public health perspective, the coexistence of T2DM and hypertension significantly increases healthcare utilization, polypharmacy, and long-term economic burden (15,16). In resource-constrained settings, fragmented management of these conditions may contribute to suboptimal outcomes. The identification of obesity, poor glycemic control, prolonged diabetes duration, and older age as independent predictors offers a pragmatic framework for risk stratification. Patients exhibiting these characteristics should be prioritized for intensified lifestyle counseling, pharmacological optimization, and close monitoring.

This study has certain limitations inherent to its cross-sectional design, which precludes causal inference and temporal sequencing between exposure variables and hypertension. The single-center setting and modest sample size may limit generalizability to broader populations. Nonetheless, standardized measurement protocols and multivariable adjustment enhance internal validity and strengthen the reliability of observed associations.

In summary, the findings confirm a high prevalence of hypertension among patients with T2DM and identify advancing age, longer disease duration, obesity, and poor glycemic control as independent determinants. These results reinforce existing evidence on the synergistic cardiometabolic interaction between diabetes and hypertension while providing context-specific data relevant to secondary healthcare settings. Integrated, risk-based management strategies targeting modifiable metabolic factors are essential to reduce cardiovascular burden and improve long-term outcomes in patients with T2DM (1,17,23).

CONCLUSION

Hypertension is highly prevalent among patients with Type 2 Diabetes Mellitus in this district-level cohort, affecting more than three out of five individuals, thereby underscoring a substantial cardiometabolic burden. Advancing age, longer duration of diabetes, obesity, and poor glycemic control were independently associated with significantly increased odds of hypertension, highlighting the cumulative and synergistic effects of metabolic and vascular dysregulation. These findings emphasize the necessity of integrated screening and management strategies that prioritize early blood pressure monitoring, aggressive glycemic optimization, and structured weight management within routine diabetes care. Strengthening risk stratification and comprehensive cardiometabolic control at secondary healthcare facilities may substantially reduce future cardiovascular and renal complications in this high-risk population.

REFERENCES

1. American Diabetes Association. Standards of Medical Care in Diabetes—2022. Diabetes Care. 2022;45(Suppl 1):S1–S264.

2. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL Jr, et al. Seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. Hypertension. 2003;42(6):1206–52.

3. International Diabetes Federation. IDF Diabetes Atlas. 10th ed. Brussels: International Diabetes Federation; 2021.

4. Kearney PM, Whelton M, Reynolds K, Whelton PK, He J. Global burden of hypertension: analysis of worldwide data. Lancet. 2005;365(9455):217–23.

5. NCD Risk Factor Collaboration (NCD-RisC). Worldwide trends in diabetes since 1980. Lancet. 2016;387(10027):1513–30.

6. Sowers JR, Epstein M, Frohlich ED. Diabetes, hypertension, and cardiovascular disease: an update. Hypertension. 2001;37(4):1053–9.

7. Ferrannini E, Cushman WC. Diabetes and hypertension: the bad companions. Lancet. 2012;380(9841):601–10.

8. Stratton IM, Adler AI, Neil HA, Matthews DR, Holman RR. Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes. BMJ. 2000;321(7258):405–12.

9. Adler AI, Stratton IM, Neil HA, Yudkin JS, Matthews DR, Cull CA, et al. Association of systolic blood pressure with macrovascular and microvascular complications of type 2 diabetes. BMJ. 2000;321(7258):412–9.

10. Eeg-Olofsson K, Cederholm J, Nilsson PM, Zethelius B, Svensson AM, Gudbjörnsdottir S, et al. New aspects of HbA1c and blood pressure in relation to cardiovascular diseases in type 2 diabetes. Diabetologia. 2010;53(10):2126–34.

11. Erku DA, Ayele AA, Mekuria AB, Belachew SA. The impact of glycemic control on hypertension among type 2 diabetes patients. Diabetes Metab Syndr. 2019;13(1):215–22.

12. Rahman M, Williams G, Neupane D. Hypertension among diabetes patients: a systematic review and meta-analysis. Glob Health Res Policy. 2018;3:1–12.

13. Yuen N, Lau E. The relationship between obesity, hypertension, and diabetes. Diabetes Res Clin Pract. 2018;143:1–9.

14. Afroz A, Zhang W, Wei Loh AJ, Jie Lee DX, Billah B. Macro- and microvascular complications and their determinants among people with type 2 diabetes in low- and middle-income countries: a systematic review. Diabetol Metab Syndr. 2019;11:1–20.

15. Ali MK, Bullard KM, Saaddine JB, Cowie CC, Imperatore G, Gregg EW. Achievement of goals in U.S. diabetes care, 1999–2010. Diabetes Care. 2013;36(8):2271–9.

16. Shaheen S, Afzal B, Tahir M, Mahmood U, Yousaf F, Tariq F. Combined Effects of Brunnstorm Movement Therapy and Low-Level Laser Therapy on Upper Limb Function and Hand Dexterity in Chronic Stroke Patient. Journal of Health and Rehabilitation Research. 2024 Mar 21;4(1):1457-62.

17. Farooq U, Tahir M. Effectiveness of Robotic-Assisted Gait Training in Enhancing Functional Mobility in Post-Stroke Patients: A Randomized Controlled Trial. Link Medical Journal. 2024 Dec 30:e34-.

18. Shah F, Hassan SN, Shabbir M. BENEFICIAL ROLE OF PASSIVE JOINT MOBILIZATION TECHNIQUES IN THE MANAGEMENT OF ADHESIVE CAPSULITIS.

19. Shabbir M, Rashid S, Umar B, Ahmad A, Ehsan S. Frequency of neck and shoulder pain and use of adjustable computer workstation among bankers. Pakistan journal of medical sciences. 2016 Mar;32(2):423.

20. Tahir M, Saeed A, Sohail A, Hassan A, Azfar H, Nazir UF. The Role of High-Intensity Interval Training (HIIT) vs. Moderate-Intensity Continuous Training (MICT) in Improving Cardiovascular Fitness in Patients with Coronary Artery Disease: HIIT vs. MICT for Cardiovascular Fitness in CAD. Journal of Health and Rehabilitation Research. 2024 Sep 13;4(3):1-4.

21. Omer A, Moghadam BA, Shadmehr A, Hafeez T, Azfar H, Arif M, Tahir M. Effects of Kinesio Taping and Modified Constraint-Induced Movement Therapy on Upper Extremity Function, Quality of Life, and Spasticity in Individuals Recovering from Stroke. Journal of Health and Rehabilitation Research. 2024 Jan 17;4(1):167-72.

22. Safdar Z, Asghar M, Tahir M. Level of Quality of Life among Post Stroke Patients; A Cross Sectional Survey. Journal of Health and Rehabilitation Research. 2023 Dec 4;3(2):299-304.

23. Asghar M, Safdar Z, Tahir M. Quality of life and functional Outcomes among Burn Patients: A Cross Sectional Survey. Journal of Health and Rehabilitation Research. 2023 Dec 4;3(2):293-8.

24. Nguyen Q, Dominguez J, Nguyen L, Gullapalli N. Hypertension management in patients with diabetes. Curr Cardiol Rep. 2017;19(9):1–9.

25. Williams B, Mancia G, Spiering W, Agabiti Rosei E, Azizi M, Burnier M, et al. 2018 ESC/ESH Guidelines for the management of arterial hypertension. Eur Heart J. 2018;39(33):3021–104.

26. Harrabi I, et al. Smoking and hypertension among diabetic patients. Int J Public Health. 2019;64(1):123–30.

DECLARATIONS

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