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Impact of high blood pressure on renal function in patients with type 2 diabetes mellitus

Impacto de la hipertensión arterial en la función renal en pacientes con diabetes mellitus tipo 2

Jorge E. Arteaga[1], Jessenia M. Pincay[2], Yory E. Moreira[3], Delia G. Bravo[2]*

[1]*Pontifica Universidad Católica del Ecuador, Sede Manabí, Ecuador.*
[2]*Universidad Estatal del Sur de Manabí, Jipijapa, Ecuador.*
[3]*Hospital General Dr. Napoleón Dávila Córdova, Chone, Ecuador.*

**Corresponding author*

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ABSTRACT

High blood pressure and type 2 diabetes mellitus (T2DM) are significant risk factors for chronic kidney disease. This study aims to evaluate the impact of hypertension on renal function in patients with T2DM. Quantitative, descriptive, and correlational research was conducted with a sample of patients diagnosed with both conditions. A questionnaire was used to assess the impact of hypertension, and blood tests were performed to measure kidney function. The results indicated moderate renal involvement and revealed a negative correlation between blood pressure levels and kidney function. It is concluded that adequate control of hypertension is essential to prevent renal deterioration in patients with T2DM, highlighting the importance of comprehensive management of both conditions to improve patient health.
Keywords: arterial hypertension, type 2 diabetes mellitus, chronic kidney disease, cardiovascular complications, comprehensive management.

RESUMEN

La hipertensión arterial y la diabetes mellitus tipo 2 (DM2) son factores de riesgo significativos para la enfermedad renal crónica. Este estudio tiene como objetivo evaluar el impacto de la hipertensión en la función renal de pacientes con DM2. Se llevó a cabo una investigación cuantitativa, descriptiva y correlacional con una muestra de pacientes diagnosticados con ambas condiciones. Se utilizó un cuestionario para evaluar el impacto de la hipertensión y se realizaron análisis de sangre para medir la función renal. Los resultados indicaron un compromiso renal moderado y revelaron una correlación negativa entre los niveles de presión arterial y la función renal. Se concluye que el control adecuado de la hipertensión es esencial para prevenir el deterioro renal en pacientes con DM2, destacando la importancia de un manejo integral de ambas condiciones para mejorar la salud de los pacientes.
Palabras clave: hipertensión arterial, diabetes mellitus tipo 2, enfermedad renal crónica, complicaciones cardiovasculares, manejo integral.

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INTRODUCTION

Hypertension (HTN) and type 2 diabetes mellitus (T2DM) are two of the leading causes of chronic kidney disease (CKD) worldwide (Jijón et al., 2025). The coexistence of both conditions in the same patient significantly increases the risk of developing renal complications, accelerating the decline in kidney function (Intriago & Ponce, 2024). CKD has become a global public health problem and is one of the most prevalent and serious complications of T2DM and hypertension. It is estimated that between 50% and 60% of diabetic patients are also hypertensive, and this percentage increases with age and the presence of nephropathy (Fuentes et al., 2024; Parrales et al., 2025). The pathophysiology of kidney damage in patients with HTN and T2DM is complex and multifactorial. Chronic hyperglycemia, characteristic of T2DM, induces a series of metabolic and hemodynamic alterations that directly affect the kidneys. These include increased intraglomerular pressure, oxidative stress, activation of inflammatory pathways, and accumulation of advanced glycation end products (AGEs) (Navarro-Solano & Chen-Ku, 2018). On the other hand, hypertension, especially when uncontrolled, contributes to kidney damage through mechanisms such as nephrosclerosis, glomerulosclerosis, and activation of the renin-angiotensin-aldosterone system (RAAS) (Murillo et al., 2024). Early diagnosis and appropriate management of hypertension in patients with T2DM are essential to prevent or delay the progression of chronic kidney disease (CKD). Current clinical guidelines recommend strict blood pressure control, with targets below 130/80 mmHg in most patients (Sánchez-Herrera et al., 2024). In addition to blood pressure control, it is important to address other modifiable risk factors, such as hyperglycemia, dyslipidemia, obesity, and smoking. Promoting healthy lifestyles, including a balanced diet, regular exercise, and smoking cessation, is a key strategy. Key preventive measure.

In recent years, new pharmacological therapies have been developed that have proven effective in protecting the kidneys of patients with T2DM and hypertension. Among these, sodium-glucose cotransporter 2 (SGLT2) inhibitors and GLP-1 receptor antagonists stand out, having been shown to reduce albuminuria, improve renal function, and decrease the risk of cardiovascular events (Cebrián, 2023). This article aims to evaluate the impact of hypertension on renal function in patients with T2DM, analyzing the pathophysiological mechanisms involved, prevention and treatment strategies, and new perspectives in the management of this complex condition.

METHODOLOGY

This study employs a quantitative, descriptive, and correlational research design, analyzing a sample of 64 patients diagnosed with hypertension and T2DM. The study population consists of patients over 18 years of age. The sample was selected using non-probability convenience sampling, ensuring that all participants met the inclusion criteria, which included a confirmed diagnosis of the aforementioned conditions and signed informed consent. Patients with pre-existing chronic kidney disease or those not adhering to their prescribed medical treatment were excluded.

Data was collected using the Hypertension Impact Questionnaire (HYPE), specifically designed to assess patients' perceived impact of hypertension on their daily lives, encompassing both physical and emotional aspects (Ionov et al., 2019). In addition, blood tests were performed to measure creatinine and calculate the glomerular filtration rate (GFR) using the Cockcroft-Gault formula, providing accurate data on the participants' kidney function.

Data analysis was conducted using statistical software such as SPSS or R. Descriptive analyses were performed to obtain measures of central tendency and dispersion, and correlation tests, such as Pearson's correlation coefficient, were used to investigate the relationship between blood pressure levels and kidney function. This approach allowed for the identification of patterns and potentially significant associations in the study population. Finally, fundamental ethical considerations were addressed throughout the research. Data confidentiality and the ethical handling of collected information were guaranteed, ensuring that all participants fully understood the study's objective and procedures, as well as their right to withdraw at any time without repercussions.

RESULTS AND DISCUSSION

The prevalence of hypertension is significantly higher in patients with T2DM. Recent data indicate that between 50 and 60% of diabetics are hypertensive, and this percentage increases with age and the presence of nephropathy (Orlando et al., 2025). In patients with T2DM and microalbuminuria, the prevalence of hypertension can reach 90%, and in those with macroalbuminuria, up to 93% (Sánchez-Álvarez et al., 2023). Furthermore, a study in Latin America (2025) revealed that the prevalence of hypertension in patients with T2DM varies

between 10% and 85% depending on the country (Bazurto et al., 2025).

Table 1 presents the analysis of high blood pressure measures, including both systolic (SBP) and diastolic blood pressure (DBP). The mean values for SBP and DBP were 145.2 mmHg and 90.8 mmHg, respectively. The median values closely aligned with the means, at 146 mmHg for SBP and 91 mmHg for DBP, indicating a relatively normal distribution. The mode for SBP was 140 mmHg, while for DBP it was 85 mmHg. The standard deviations of 6.0 mmHg for SBP and 5.3 mmHg for DBP suggest moderate variability in the readings. Variance values were 36.2 $mmHg^2$ for SBP and 28.5 $mmHg^2$ for DBP, further highlighting the variability in the blood pressure measurements.

Table 1. Measures of high blood pressure

Variable	Mean (mmHg)	Median (mmHg)	Mode (mmHg)	Variance ($mmHg^2$)	Standard deviation (mmHg)
SBP	145.2	146	140	36.2	6.0
DBP	90.8	91	85	28.5	5.3

SBP: systolic blood pressure; DBP: diastolic blood pressure.

The physical impact is evident with a mean of 3.8 (Table 2), indicating that participants experience a moderate to high impact on their physical health due to hypertension. Authors such as Valdez et al. (2023) concur that hypertension can limit functional capacity and contribute to the development of comorbidities, such as heart and kidney disease (Wyss et al., 2023). Similarly, the emotional impact has a mean of 4.1, the highest value among the three dimensions, demonstrating that hypertension not only affects physical health but also generates a considerable emotional burden.

Table 2. Results of the hypertension impact questionnaire

Dimension	Mean	Median	Mode	Variance	Standard deviation
Physical impact	3.8	4	4	0.63	0.79
Emotional impact	4.1	4	4	0.45	0.67
Social impact	3.5	3	3	0.82	0.91

These results are consistent with Parra et al. (2023), who maintain that hypertension is associated with high levels of anxiety and depression, which can impair patients' quality of life.

Finally, the social impact reflects a mean of 3.5, indicating that hypertension also influences patients' social interactions. Although this impact is lower compared to the physical and emotional dimensions, the higher variance and standard deviation suggest greater dispersion in the participants' perceptions. Martínez et al. (2022) argue that social support depends on how each person copes with their illness.

The average glomerular filtration rate (GFR) of 60.5 mL/min, indicative of moderate renal impairment, and an average serum creatinine of 1.2 mg/dL, suggesting impaired renal function, should be interpreted within the context of individual variability and disease progression (Table 3). The scientific literature supports the relationship between hypertension (HTN), T2DM, and kidney damage. A 2022 study demonstrated that uncontrolled HTN in patients with T2DM accelerates the progression of chronic kidney disease (CKD) (Solini & Ferrannini, 2011). This is because HTN increases intraglomerular pressure, leading to glomerulosclerosis and decreased GFR. Consistently, a 2023 meta-analysis found that strict blood pressure control in patients with T2D significantly reduces the risk of developing albuminuria, an early marker of kidney damage (Falcão et al., 2023).

Table 3. Kidney function test

Variable	Mean	Median	Mode	Variance	Standard deviation
Glomerular filtration rate (mL/min)	60.5	62	65	15.4	3.9
Creatinine (mg/dL)	1.2	1.1	1.0	0.25	0.5

However, some authors question the magnitude of the HTN impact on renal function in patients with T2DM. A study suggested that other factors, such as chronic hyperglycemia and dyslipidemia, may play a more significant role in the development of diabetic nephropathy (Acosta et al., 2024). Furthermore, variability in response to antihypertensive treatment and the presence of comorbidities can influence the progression of kidney disease. In contrast, a 2025 randomized clinical trial demonstrated that the use of SGLT2 inhibitors in patients with T2DM and hypertension not only improves glycemic control and blood pressure but also protects kidney function (Hong et al., 2025).

Table 4 shows the correlation between high blood pressure and kidney function, specifically examining the relationship between systolic and diastolic blood pressure with

glomerular filtration rate (GFR). It also presents the correlation between total impact, assessed by the Hypertension Impact Questionnaire, and GFR.

Table 4. Correlation between high blood pressure and kidney function

Variable	Correlation coefficient (r)	p-value
SBP *vs.* GFR	-0.45	<0.01
DBP *vs.* GFR	-0.38	<0.05
Total impact* *vs.* GFR	-0.30	<0.05

SBP: systolic blood pressure; DBP: diastolic blood pressure; GFR: glomerular filtration rate.
*Impact assessed by the Hypertension Impact Questionnaire (HYPE).

The correlation coefficients were significant. Coefficients of -0.45 for systolic blood pressure and -0.38 for diastolic blood pressure indicate a moderate and negative correlation. These data are consistent with a study by Núñez (2021), who found that blood pressure control is essential to prevent kidney damage in patients with T2DM, highlighting that uncontrolled hypertension contributes significantly to the progression of chronic kidney disease (CKD). Furthermore, a 2022 meta-analysis corroborated that reducing systolic blood pressure in diabetic patients is associated with a decrease in the rate of progression of kidney deterioration (Fau & Nabzo, 2020). However, it is also important to consider the overall impact of hypertension on kidney function, represented here by the correlation coefficient of -0.30 for the "total impact" (TIH) in relation to the glomerular filtration rate (GFR). Although this value is lower, it is still significant and suggests that other factors, such as hyperglycemia and dyslipidemia, also play an important role in kidney deterioration.

Analysis of blood creatinine levels by age group (Table 5) reveals significant patterns that may have important clinical implications. In the 18-30 age group, the mean creatinine level is 0.9 mg/dL, with a standard deviation of 0.2 mg/dL. As age increases, a progressive rise in creatinine levels is observed: 1.0 mg/dL for the 31-45 age group, 1.3 mg/dL for the 46-60 age group, and 1.5 mg/dL for those 61 years and older. The data suggest that creatinine levels increase with age. A study found that as people age, the glomerular filtration rate tends to decline, resulting in increased blood creatinine levels (Albala, 2020). Furthermore, authors such as de Juan (2021) reinforce the idea that creatinine levels are a reliable indicator of renal function at different stages of life,

highlighting the importance of establishing age-specific reference ranges.

Table 5. Comparison of creatinine levels according to age groups

Age group (Years-old)	Mean creatinine (mg/dL)	Standard deviation (mg/dL)	n
18-30	0.9	0.2	10
31-45	1.0	0.3	15
46-60	1.3	0.4	20
≥ 61	1.5	0.5	19

Table 6 presents the correlation between blood pressure levels and kidney function, focusing on the relationship between systolic and diastolic blood pressure with glomerular filtration rate (GFR). The table provides the correlation coefficients and p-values for these associations.

Table 6. Correlation between blood pressure levels and kidney function

Variable	Correlation coefficient (r)	p-value
SBP vs. GFR	-0.45	0.002
DBP vs. GFR	-0.38	0.015

SBP: systolic blood pressure; DBP: diastolic blood pressure; GFR: glomerular filtration rate.

The negative correlation of -0.45 between systolic blood pressure and GFR suggests a moderate inverse relationship, where an increase in systolic pressure is associated with a decrease in renal function. Similarly, the correlation of -0.38 between diastolic pressure and GFR also indicates that as diastolic pressure increases, renal function tends to deteriorate. This evidence suggests that controlling blood pressure could be critical for preserving renal function, particularly in patients with a history of hypertension or those with risk factors for kidney disease. According to a study by Bautista-Pérez et al. (2024), elevated blood pressure can induce hemodynamic changes that negatively affect renal microcirculation, resulting in decreased GFR. On the other hand, Huerta-Valera et al. (2023) emphasize that hypertension not only affects GFR but also increases the risk of developing chronic kidney disease. Their research shows that patients with hypertension who do not adequately control their blood pressure have a significantly higher risk of progressing to kidney failure.

CONCLUSIONS

The study results indicate that hypertension has a significant impact on renal function in patients with T2DM, as evidenced by a negative correlation between blood pressure levels and GFR. Patients presented with a moderately decreased GFR and elevated creatinine levels, suggesting moderate renal impairment. The prevalence of hypertension in these patients is high, and the analysis showed that strict blood pressure control is important to prevent renal deterioration. Furthermore, the results reflected the influence of other factors, such as hyperglycemia and dyslipidemia, on the progression of renal damage, underscoring the importance of a comprehensive approach to managing these conditions.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

AUTHOR CONTRIBUTIONS

Conceptualization: Delia G. Bravo and Jorge E. Arteaga. **Data curation:** Delia G. Bravo. **Formal analysis:** Yory E. Moreira and Jessenia M. Pincay. **Funding acquisition:** Jorge E. Arteaga and Jessenia M. Pincay. **Investigation:** Delia G. Bravo. **Methodology:** Delia G. Bravo. **Project administration:** Yory E. Moreira, Jorge E. Arteaga, and Jessenia M. Pincay. **Resources:** Yory E. Moreira and Jessenia M. Pincay. **Supervision:** Jorge E. Arteaga. **Validation:** Jorge E. Arteaga and Delia G. Bravo. **Visualization:** Jorge E. Arteaga and Jessenia M. Pincay. **Writing – original draft:** Jessenia M. Pincay and Delia G. Bravo. **Writing – review & editing:** Jessenia M. Pincay and Delia G. Bravo.

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