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# Prevalence and Determination of Hypertension among Diabetes Mellitus Patients Attending Primary Health Care Centres

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## ABSTRACT

**Background:** The primary objective of this investigation was to identify the root causes of hypertension in individuals with diabetes, as it represents a significant modifiable risk factor for various cardiovascular diseases and poses a major global public health challenge. **Aim:** To identify the prevalence and determination of hypertension among diabetes mellitus patients in Mosul City. **Methods:** This study is a data analysis that was obtained from primary health care centers based on a cross-sectional study. The study period was from the 1st of January to the 1st of July 2022. The study examined the prevalence of hypertension among diabetes mellitus patients attending primary health care centers: 303 patients with diabetes mellitus and 300 patients's hypertensions with diabetes mellitus. Patients' ages ranged from 40 to over 70 years, divided as follows: 40-49, 50-59, 60-69, and over 70 years old. As well as their genders, males, and females, who visited the primary health care centers in the right and left sectors and the Al-Wafaa Centre for Diabetes and Endocrinology in the city of Mosul, Iraq. **Results:** The study shows 15 determinants of hypertension among diabetes mellitus patients who are age (the highest rate is among patients 50-59years with 37.1%), gender (the highest rate among females with 64.3%), marital status (the highest rate among married with 45.2%), employment (the highest rate is among unemployed with 77%), duration of diabetes (the highest rate is among patients with diabetes and hypertension less than 5 years with 46.8%),smoking (the highest rate is among never smoking), BMI (the highest rate is among obese patient with 54.3%), family history with hypertension (96.7% of patients have family history), sedentary activity (52.2% of patients set less than 4 hours ), sleep duration (66.6% of patients sleep more than 7 hours), stress (63.2% of patients have moderate to high stress), salt consumption after diabetes (33.4% of patients stopped salt consumption at all), physical activity (62.7% of patients do moderate physical activity ), level of education (52.7% of patients educated with primary school ),and residency (52.6% of patients live in the left side of Mosul city). **Conclusion:** This study concluded that the factors most affected by high blood pressure that affected patients were age, especially 50-59, BMI (obesity), occupation (for non-workers), family history, high stress, and little physical activity.

*Keywords: Prevalence; Determinant; Hypertension; Diabetes Mellitus*

## INTRODUCTION

Hypertension and diabetes mellitus are two significant chronic conditions that pose a considerable health burden worldwide. Both diseases independently contribute to morbidity and mortality rates, and their coexistence further exacerbates the associated health risks (Mareai & Gawli, 2023; Hamdi & Jasim, 2022). Hypertension, commonly known as high blood pressure, is characterized by elevated systemic arterial pressure, while diabetes mellitus is a metabolic disorder characterized by chronic hyperglycemia resulting from insulin resistance or insufficient insulin production. (Haile *et al.*, 2023; Malikovna & Erkinovna, 2023; Yan *et al.*, 2023).

The prevalence of hypertension among individuals with diabetes mellitus has been widely documented, and it represents a major clinical concern. Studies have shown that diabetes mellitus patients are at a significantly higher risk of developing hypertension compared to thegeneral population (Peerdwod & Abdulla, 2021). The

coexistence of these two conditions leads to a synergistic effect, substantially increasing the risk of cardiovascular diseases, renal complications, and other adverse outcomes. (Khedkar *et al.*, 2023; Lamelas *et al.*, 2019; Li *et al.*, 2020; Ramakrishnan *et al.*, 2019).

Mosul, located in northern Iraq, is a diverse urban centre with a significant population burdened by chronic diseases. The prevalence of hypertension and diabetes mellitus in Mosul has been on the rise in recent years, mirroring global trends. Understanding the prevalence and determinants of hypertension among individuals with diabetes mellitus in Mosul is crucial for healthcare planning, resource allocation, and developing effective preventive and management strategies.

This study aims to assess the prevalence of hypertension among diabetes mellitus patients in Mosul city and identify the factors associated with its occurrence. By elucidating the relationship between these two conditions, we can shed light on the underlying mechanisms, potential risk factors, and complications arising from their coexistence. This research will provide valuable insights into the local burden of hypertension among diabetes mellitus patients and guide healthcare professionals in optimizing patient care and improving health outcomes.

**The objectives of this study include:**

1.  Determining the prevalence of hypertension among individuals with diabetes mellitus in Mosul city.

2.  Identifying demographic and clinical factors associated with hypertension in this population.

3.  Assessing the impact of hypertension on the progression and management of diabetes mellitus.

By addressing these objectives, the study is expected to contribute to the existing body of knowledge on the prevalence and determinants of hypertension among diabetes mellitus patients in Mosul city. Ultimately, the findings of this study can guide healthcare providers, policymakers, and public health officials in devising targeted interventions and improving the quality of care for individuals living with these concurrent conditions.

## METHODOLOGY

### Study Design

This study is a secondary data analysis based on a cross-sectional study conducted in primary health care centers (PHCs) in the right and left sectors, as well as the Al Wafaa Center for Diabetes and Endocrinology in the Nineveh Province of Iraq. The primary study aimed to investigate the prevalence and risk factors of hypertension among diabetic patients attending these healthcare facilities.

### Settings

The study was conducted in the city of Mosul, Iraq. Mosul is located at latitude 36.34' N and longitude 43.13' E, with a total area of 180 km2. The city is divided into 132 districts, with 55 districts on the right side and 77 districts on the left side. The estimated population of Mosul is 1,800,000.

### Study Population and Sample Calculation

The researchers performed a medical chart survey in 2021 to identify diabetic and non-diabetic hypertensive patients who were receiving treatment at the PHCs. A total of 603 participants were interviewed during the study period, with half of them having developed hypertension after being diagnosed with diabetes. The sample selection was purposeful and based on the following inclusion and exclusion criteria:

### Inclusion Criteria

Diabetic and diabetic/hypertensive patients in regular follow-up at the PHCs for at least one year, starting in 2021.

Patients considered to be in regular follow-up had their last appointment less than a year before data collection or had a quarterly schedule for returning to the PHCs.

## Exclusion Criteria

- Patients diagnosed with chronic kidney disease at the time the cohort was created to exclude patients with diabetes.

- Patients under 40 years old.

- Pregnant women.

## Study Tools and Methods

Data collection involved the use of a structured questionnaire to gather information on socio-demographic variables (sex, age, education), clinical and anthropometric variables (blood pressure, weight, height, drug prescription), and various laboratory tests. The assessment of outcomes and risk factors included evaluating cardiovascular events through participant interviews and verifying information from medical records. Peripheral casual blood pressure measurements were used to assess blood pressure control. Dyslipidemia, hyperglycemia, smoking, alcoholism, and a sedentary lifestyle were considered risk factors.

## Pilot Study

A pretest of the questionnaire session was conducted with 10 purposively sampled individuals attending the outpatient unit. The primary researcher carried out the pretest, paying attention to question sensitivity, acceptability, clarity, adequacy, and logical flow. The pretest was conducted from January 10th to 25th, 2022.

## Validity

A panel of twelve experts from various fields related to the study field established the validity of the questionnaire. They reviewed the questionnaire for clarity and adequacy to ensure the tools' appropriateness.

## Reliability

A reliability test was conducted to assess the consistency or repeatability of the questionnaire. Both language versions of the questionnaire were administered to 10 patients on two separate occasions, two weeks apart. The answers were found to be identical, and the questionnaire items had a correlation coefficient (r) of 0.79.

## Statistical Analysis

In this study, the data was analyzed (Khedkar *et al.*, 2023) using SPSS version 26. To explore the relationships between different factors and the outcome variable, a bivariable logistic regression analysis was conducted. The variables with a *p*-value $\leq 0.2$ in the bivariable analysis were selected for the multivariate logistic regression analysis. The adequacy of the statistical model was assessed using the Hosmer-Lemeshow test, and multicollinearity was examined using the variance inflation factor. The assumptions of binary logistic regression were verified for their validity.

To quantify the strength of the relationship between the dependent and independent variables, odds ratios with 95% confidence intervals were calculated. A p-value of less than 0.05 was considered the threshold for statistical significance in determining associations between variables.

## Ethical Consideration

The study received approval from the scientific committee of postgraduate studies from the College of Nursing, Ninevah University, Iraq and the Collegiate Committee for Medical Research Ethics with Approval No. CCMRE-NUR-21-32 on 29th of December 2021. Additionally, the study obtained approval from the Ethical Research Committee in the Nineveh Health Directorate with reference number Session #.225, 22nd of December 2021.

## RESULTS

The results indicate that age, gender, and employment status are significantly associated with hypertension among the study population. Patients above the age of 50 have a lower likelihood of having hypertension compared to those below 50. There is a marginally significant association between gender and hypertension,

with males having a lower likelihood of hypertension compared to females. Additionally, employment status shows a statistically significant association, with unemployed individuals being more likely to have hypertension compared to employed individuals. However, marital status does not show a significant association with hypertension, although there is a borderline significant result (Table 1).

*Table 1: Comparison between Patients with Hypertension and Patients without Hypertension According to their Age*

| Variable | Categories | Hypertension | |
|---|---|---|---|
| | | Yes, $n$ (%) | No, $n$ (%) |
| Age^ | >50 | 85 (28.3) | 110 (36.7) |
| | <50 | 215 (71.7) | 190 (63.3) |
| OR= 0.6829 95 % CI: 0.4842 to 0.9631 z statistic 2.175 *P* < 0.0297 | | | |
| | | Yes, $n$ (%) | No, $n$ (%) |
| Gender | Male | 130 (43.3) | 154 (51.3) |
| | Female | 170 (56.7) | 146(48.7) |
| OR= 0.7250 95 % CI: 0.5256 to 1.0000 z statistic 1.960 *P* < 0.05 | | | |
| | | Yes, $n$ (%) | No, $n$ (%) |
| Marital status | Single | 20 (6.7) | 10 (3.1) |
| | Married | 280 (93.3) | 290 (96.7) |
| OR= 2.0714, 95 % CI: 0.9527 to 4.5037, z statistic 1.838, *P* < 0.06 | | | |
| | | Yes, $n$ (%) | No, $n$ (%) |
| Employment | Unemployed | 222(74) | 200(66.7) |
| | Employed | 78(26) | 100(33.3) |
| OR= 1.4231, 95 % CI: 1.0004 to 2.0243, z statistic 1.962, *P* < 0.0497 | | | |

The results indicate that the duration of DM and family history of hypertension are significantly associated with hypertension among the study population. Patients with a duration of DM of more than 5-10 years have a higher likelihood of having hypertension compared to those with a duration of DM of less than 5 years. On the other hand, having a family history of hypertension is associated with a lower likelihood of developing hypertension. However, there is no statistically significant association between BMI and hypertension, although there is a trend suggesting a potential relationship (Table 2).

*Table 2: Comparison of between Patients with Hypertension and Patients without Hypertension in Relation to their Duration of DM*

| Variable | Categories | Hypertension | |
|---|---|---|---|
| | | Yes (%) | No (%) |
| Duration of DM | Less than 5 years | 79(26.3) | 45 (15) |
| | More 5-10 years | 221(73.7) | 255 (85) |
| OR= 2.0256, 95 % CI: 1.3470 to 3.0461, z statistic 3.391, *P* < 0.0001 | | | |
| | | Yes (%) | No (%) |
| Family history of hypertension | No | 210(70) | 250 (83.3) |
| | Yes | 90(30) | 50(16.7) |
| OR= 0.4667, 95 % CI: 0.3155 to 0.6902, 3.817, *P* < 0.0001 | | | |
| | | Yes (%) | No (%) |
| BMI | <25 | 180 (60) | 201(67) |
| | ≥25 | 120 (40) | 99(33) |
| OR= 0.7388, 95 % CI: 0.5292 to 1.0313, 1.779, *P* < *P* = 0.0753 | | | |

Among patients with type 2 diabetes, the variables significantly associated with hypertension are high physical activity, a family history of hypertension, smoking (both ex-smokers and current smokers), overweight and obesity (higher BMI categories), sedentary activity of more than 4 hours, high stress levels, and higher creatinine levels. These findings highlight the importance of lifestyle factors, genetic predispositions, and certain clinical markers in the development and management of hypertension in patients with type 2 diabetes (Table 3).

*Table 3: Variables Significantly Associated with Hypertension among Type 2 Diabetes Patients*

|  |  | Hypertension | *P*-value |
|---|---|---|---|
| **Physical Activity** | Low | 10.6 |  |
|  | Moderate | 62.7 | 0.158 |
|  | High | 26.7 | 0.017 |
| **Family History of Hypertension** | No | 3.3 |  |
|  | Yes | 96.7 | 0.001 |
| **Smoking Status** | Never | 55.5 |  |
|  | Ex-Smoker | 23.8 | 0.001 |
|  | Current Smoker | 20.7 | 0.001 |
| **BMI** | Normal | 4.9 |  |
|  | Underweight | 14.8 | 0.711 |
|  | Overweight | 26.0 | 0.021 |
|  | Obese | 54.3 | 0.001 |
| **Sedentary Activity** | ≤4 Hours | 52.2 |  |
|  | >4 Hours | 47.8 | 0.024 |
| **Stress** | No or Low Stress | 36.8 |  |
|  | Moderate or High Stress | 63.2 | 0.001 |
| **Creatinine** |  | 1.0 (0.8-1.2) | 0.003 |

Among the laboratory parameters compared, there are significant differences in serum creatinine and total cholesterol levels between patients with and without hypertension. Patients with hypertension tend to have higher serum creatinine and total cholesterol levels. The other parameters, including hemoglobin A1c, LDL, HDL, and FBS, do not show significant differences between the two groups. These findings imply that hypertension may have an impact on renal function (higher serum creatinine levels) and lipid profile (higher total cholesterol levels) in people with type 2 diabetes. However, it's important to note that clinical interpretation should consider these results in conjunction with other relevant clinical factors and guidelines (Table 4).

*Table 4: Comparison of Laboratory Parameters among Patients with and without Hypertension*

| Variables | Hypertension | | *P*-value |
|---|---|---|---|
|  | **Yes** | **No** |  |
| **Haemoglobin A1c (%)** | 8.4 (7-10) | 8.6 (7.2-9.8) | 0.624 |
| **Serum creatinine (mg/dl)** | 1.0 (0.8-1.2) | 0.82 (0.7-1.1) | 0.007* |
| **Total cholesterol (mg/dl)** | 175 (139-214) | 165 (131-226) | 0.028* |
| **Low-density lipoprotein (mg/dl)** | 110 (82-139) | 106 (83-130.5) | 0.293 |
| **High-density lipoprotein (mg/dl)** | 41 (33-51) | 41 (34-49) | 0.426 |
| **Variables** | **Hypertension** | |  |
| **FBS** | Yes (%) | No (%) |  |
| **<130** | 110 (36.7) | 165 (55) |  |
| **≥130** | 190 (63.3) | 135 (45) |  |
| **OR= 0.4737, 95 % CI: 0.3416 to 0.6569, 4.480, *P* < *P* = 0.001** | | | |

## DISCUSSION

The primary objective of this study was to examine the correlation between hypertension and diverse demographic, clinical, and laboratory factors among individuals with type 2 diabetes. The findings brought to light numerous noteworthy associations and patterns, offering insights into potential risk factors and indicators of hypertension within this specific group. The study findings revealed significant associations between hypertension and various demographic factors. Patients below the age of 50 were observed to have a higher likelihood of hypertension compared to those above 50, consistent with previous research studies (Kane & Howlett, 2018; Xu *et al.*, 2017) that also reported an increased prevalence of hypertension with advancing age. The underlying reasons for this association may involve age-related changes in blood vessel structure and function, as well as hormonal regulation alterations. Gender also exhibited a marginal association with hypertension, with females being more prone to hypertension than males. This finding aligns with previous research (Azizi *et al*., 2023; Tamargo, Caballero, & Mosquera, 2023) consistently identifying female gender as a risk factor for hypertension. Hormonal influences and differences in behavioral and lifestyle factors between genders may contribute to this discrepancy.

Furthermore, employment status emerged as a significant factor, with unemployed individuals having a higher likelihood of hypertension compared to employed individuals. This finding supports earlier studies (Zagożdżon *et al.*, 2014) that have demonstrated the impact of socioeconomic factors, including employment status, on hypertension prevalence. Unemployment might be associated with psychosocial stress, reduced access to healthcare, and unhealthy lifestyle behaviors, all of which can contribute to the development of hypertension. Although not statistically significant, marital status showed a borderline association with hypertension in this study, which contradicts some prior research studies (Bergmann, Gyntelberg, & Faber, 2014; Sun *et al.*, 2014) that have identified marital status as a predictor of hypertension. The lack of statistical significance in our study may be attributed to the specific characteristics of the sample or the potential influence of other unaccounted confounding factors. Regarding diabetes-related factors, the duration of diabetes and family history of hypertension were both found to be significantly associated with hypertension in the study population. Patients with a longer duration of diabetes (over 5-10 years) were more likely to have hypertension compared to those with a shorter duration (less than 5 years). This finding is consistent with existing literature (Johnson *et al.*, 2021; Ceriello *et al.*, 2023; Jyotsna *et al.*, 2023; Mahmmoed, Ibrahim, & Andulgani, 2020; Zakir *et al.*, 2023) that highlights the relationship between diabetes duration and hypertension risk. Long-standing diabetes can lead to vascular damage and impaired blood pressure regulation, thereby increasing the risk of hypertension. Interestingly, having a family history of hypertension was associated with a lower likelihood of developing hypertension in the present study. This finding contrasts with previous research (Mulchandani *et al.*, 2023; Touil, Mounts, & De Jager, 2023) that consistently reported a positive association between family history of hypertension and an increased risk of hypertension. These different results may be due to the complicated interaction between genetic predisposition, shared environmental factors, and lifestyle choices. More research is needed to fully understand how these things work.

Table 3 highlights several lifestyle factors and clinical markers that demonstrated significant associations with hypertension among patients with type 2 diabetes. Surprisingly, high physical activity was linked to a higher likelihood of hypertension, which appears to contradict the well-known beneficial effects of regular exercise on blood pressure control. However, it's essential to consider that this finding may be influenced by various factors, including the intensity and duration of physical activity as well as the potential confounding effects of other lifestyle factors. Consistent with previous studies (Alreshidi *et al*., 2023; Kumar, Goutam, & Pore, 2023; Shahbazi *et al*., 2023), a family history of hypertension and smoking (both ex-smokers and current smokers) were identified as significant risk factors for hypertension among patients with type 2 diabetes. These findings underscore the importance of considering both genetic susceptibility and modifiable lifestyle behaviors when managing hypertension. Furthermore, higher BMI categories, specifically overweight and obesity, were associated with an increased likelihood of hypertension in this study. This observation aligns with extensive evidence (Ekpor, Akyirem, & Adade Duodu, 2023; Mamdouh *et al.*, 2023; Rouhani *et al*.,

2023) linking obesity to the development of hypertension. Excess adiposity contributes to insulin resistance, dyslipidemia, and the activation of the renin-angiotensin-aldosterone system, all of which can lead to elevated blood pressure. Among patients with type 2 diabetes, sedentary activity exceeding 4 hours and high stress levels were also significantly associated with hypertension. Sedentary behavior has been recognized as an independent risk factor for hypertension (Teixeira *et al.*, 2023; Gonzalez & Bolaños, 2023; Paterson *et al.*, 2023; You *et al.*, 2023), while chronic stress has been implicated in blood pressure dysregulation through various physiological pathways (Gayathri, Sujata & Thakur, 2023; Sekgala *et al.*, 2023).

The presence of higher creatinine levels among patients with hypertension indicates a potential impact of hypertension on renal function. High levels of creatinine in the blood indicate that the kidneys aren't working as well as they should. This could be because of the damage that long-term high blood pressure does to the kidneys' blood vessels and filtering systems. These findings are consistent with previous research (Eckardt *et al.*, 2023; Kaneyama *et al.*, 2023; Qawaqzeh *et al.*, 2023; Sawhney *et al.*, 2023) that has demonstrated the association between hypertension and renal dysfunction in individuals with type 2 diabetes. Regarding laboratory parameters, patients with hypertension had significantly higher total cholesterol levels compared to those without hypertension. This finding aligns with previous studies (Chen *et al.*, 2023; Janssen *et al.*, 2023) that have established the relationship between dyslipidemia, particularly elevated total cholesterol, and the development of hypertension. Elevated cholesterol levels can promote atherosclerosis and endothelial dysfunction, contributing to the pathogenesis of hypertension. The strengths of this study include its focus on patients with type 2 diabetes, a well-defined study population, and the consideration of various demographic, clinical, and laboratory variables.

However, there are some limitations that should be acknowledged. Firstly, the cross-sectional nature of the study design restricts the establishment of causal relationships between variables. Longitudinal studies are warranted to investigate the temporal associations and predictive value of the identified risk factors. Secondly, the study relied on self-reported information for some variables, which may introduce recall bias and affect the accuracy of the findings. Objective measurements and validated assessment tools could enhance the reliability of the data. Finally, the study was conducted on a specific population, and the generalizability of the results to other populations may be limited.

## CONCLUSION

In summary, this research offers valuable knowledge regarding the risk factors and clinical indicators linked to hypertension in individuals with type 2 diabetes. Significant factors such as age, gender, employment status, duration of diabetes, family history of hypertension, lifestyle choices, and laboratory parameters were identified as influential factors in hypertension development. These findings emphasize the importance of adopting a comprehensive approach to manage hypertension in patients with type 2 diabetes, addressing both lifestyle modifications and clinical considerations. It is crucial to recognize and target modifiable lifestyle factors alongside relevant clinical markers. However, further studies are warranted to validate and expand upon these findings. Additionally, exploring potential interventions to effectively prevent and manage hypertension in this high-risk population is essential to improve the overall health outcomes of individuals with type 2 diabetes.

### Conflict of Interest

The authors declare that they have no competing interests.

### ACKNOWLEDGEMENT

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