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Determinant Analysis of Hypertension in Type 2 Diabetes Mellitus Patients: A Cross-Sectional Study in Medan, North Sumatera, Indonesia

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ABSTRACT

Background: Type 2 diabetes mellitus (T2DM) and hypertension are two chronic conditions that frequently co-occur and pose a significant health burden. At Padang Bulan Primary Healthcare Center in Medan, out of 260 Prolanis participants, 117 T2DM patients sought treatment, and 90 of them were diagnosed with hypertension. This study aimed to analyze the determinants of hypertension in T2DM patients receiving care at Padang Bulan Primary Healthcare Center in Medan.

Subjects and Method: An analytical cross-sectional study was conducted on 100 T2DM patients selected through consecutive sampling. Data were collected using structured questionnaire, anthropometric measurement, and blood pressure and blood glucose examinations. The variables studied included sociodemographic characteristics (gender, education, occupation, marital status) and clinical characteristics (body mass index, duration of T2DM, blood glucose levels, family history). Data analysis was performed using Chi-square test.

Results: The majority of respondents were women (62%), highly educated (79%), and obese (87%). The prevalence of hypertension in T2DM patients was notably high (>70%) across all groups. However, bivariate analysis showed no statistically significant relationship between any of the studied variables and the incidence of hypertension ($p>0.05$).

Conclusion: There was no significant relationship between sociodemographic and clinical factors with the incidence of hypertension in T2DM patients. Nevertheless, the high prevalence of hypertension indicates the importance of a comprehensive approach in managing both conditions.

Keywords: Determinants, type 2 diabetes mellitus, hypertension, sociodemographic factors, primary care

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BACKGROUND

Type 2 diabetes mellitus (DMT2) and hypertension are two chronic conditions that frequently co-occur and pose a significant health burden. Data from the Centers for Disease Control and Prevention (CDC) shows a sharp increase in the incidence of DMT2 in recent decades, with a high coexistence of hypertension in this population (Centers for Disease Control and Prevention, 2020). The combination of these two conditions is not just a coincidence, but rather reflects a complex metabolic disorder often referred to as cardiometabolic or cardiorenal syndrome (Naha et al., 2021; Oparil et al., 2003).

The global prevalence of diabetes mellitus in the age group of 20-79 years reaches 425 million people and is projected to increase by 48% to 629 million people by 2045 (IDF, 2021). In Indonesia, the number of people with DM reached 10.3 million people in 2017 and is expected to increase to 16.7 million people by 2045 (IDF, 2021). Riskesdas 2018 data shows an increase in the prevalence of DM from 6.9% in 2013 to 8.5% in 2018 (Depkes, 2018).

Hypertension in DMT2 sufferers significantly increases the risk of macrovascular and microvascular complications (Petrie et al., 2018). Previous studies have shown that 40-80% of DMT2 patients face twice the risk of developing hypertension than non-diabetic populations (Naseri et al., 2022; Anjajo et al., 2023). At the Padang Bulan Community Health Center, Medan, out of a total of 9,805 patient visits during January-June 2024, 1,778 patients (18.13%) were diagnosed with DMT2, and 1,515 patients (15.45%) had hypertension. Of the 260 participants of the Chronic Disease Management Program (Prolanis), 117 DMT2 patients visited for treatment, and 90 of them were hypertensive patients.

A variety of factors may affect the incidence of hypertension in T2DM patients, including sociodemographic, clinical, and lifestyle factors (Devanaganvi et al., 2020). Several previous studies have shown the contribution of factors such as age, gender, body mass index, duration of diabetes, glycemic control, and family history (Belew et al., 2022; Megantari et al., 2023). However, the results of the study still vary across different populations and different healthcare settings (Bhave et al., 2020).

Given the complexity of the relationship between DMT2 and hypertension and its impact on public health (Sowers, 2013), a better understanding of the determinants of hypertension in people with DMT2 is urgently needed, especially in the context of primary health care (Jia & Sowers, 2021). This study aims to analyze the determinants of hypertension incidence in DMT2 patients who are treated at the primary care of the Padang Bulan Community Health Center, Medan, focusing on sociodemographic and clinical factors. The results of the study are expected to provide useful information for more effective hypertension prevention and management strategies in the DMT2 population.

SUBJECTS METHOD

1. Study Design

A cross-sectional study was conducted at the Padang Bulan Community Health Center, Medan, North Sumatera, Indonesia, from August to September 2024.

2. Population and Sample

The target population is all DMT2 patients who were treated at the Padang Bulan Community Health Center. Samples were taken using consecutive sampling techniques with inclusion criteria: (1) DMT2 patients with or without hypertension who had been diagnosed by medical personnel for at least 6 months, (2) were ≥18 years

old, and (3) were willing to participate in the study. Exclusion criteria include: (1) patients with severe comorbidities other than hypertension, (2) who were pregnant or breastfeeding, and (3) who had severe mental disorders. The sample size was calculated using the Lemeshow formula with a confidence level of 95%, precision of 10%, and proportion of 50%, resulting in a minimum of 96 samples, rounded into 100 respondents.

3. Study Variables

The independent variables included:

- Sociodemographic characteristics (gender, education level, employment status, marital status)
- Clinical characteristics (BMI, duration of DMT2, blood glucose levels, family history)

The dependent variable was the incidence of hypertension in DMT2 patients.

4. Operational Definition of Variables

Hypertension on DMT2: Hypertension in individuals with Type 2 Diabetes Mellitus (DMT2) is defined as having a blood pressure equal to or greater than 140/90 mmHg.

Body Mass Index (BMI): BMI is defined as the ratio of an individual's weight in kilograms divided by the square of their height in meters (kg/m^2).

Duration of DMT2: Duration of DMT2 is defined as the length of time since a person was first diagnosed with Type 2 Diabetes Mellitus.

Blood Glucose Levels: Blood glucose level is defined as the concentration of glucose in the blood as measured during testing at the time of data collection.

5. Study Instruments

a. Structured questionnaire for sociodemographic data
b. Standardized digital sphygmomanometer for blood pressure measurement
c. Digital scales and stadiometer for anthropometric measurements
d. Glucometer (Easy Touch) for checking blood glucose levels
e. Medical records for verification of diagnosis and treatment history

6. Data Analysis

Data were analyzed using the latest version of SPSS with stages:

a. Univariate analysis: frequency and percentage distributions to describe sample characteristics.
b. Bivariate analysis: Chi-square test to assess the relationship between independent variables and the incidence of hypertension ($\alpha=0.05$)
c. Multivariate analysis: logistic regression to determine the most influential determinants of hypertension incidence in patients with DMT2.

This study has received ethical clearance from the Research Ethics Committee of the Faculty of Medicine, Universitas Prima Indonesia, and all respondents signed informed consent before participating.

RESULTS

This study involved 100 DMT2 patients who were treated at the Padang Bulan Community Health Center in Medan. The results of the study are presented in three main sections: respondent characteristics, clinical characteristics, and bivariate analysis of hypertension incidence.

1. Respondent Characteristics

The sociodemographic characteristics of the respondents showed that the majority were women (62%), with most of them having a university (46%) and high school (33%) education. Most of the respondents were married (88%) and had various types of jobs with the distribution: civil servants (24%), self-employed (21%), private employees (10%), farmers (6%), and

laborers (3%), as well as other categories (36%). The vast majority of DMT2 sufferers, i.e., 88 people or 88% of the total sample, were married (Table 1).

Table 1. Sociodemographic Characteristics of Respondents of Determinant Analysis of Hypertension Incidence in Patients with Type 2 Diabetes Mellitus

Characteristics	Frequency (n)	Percentage (%)
Gender		
Male	38	38
Female	62	62
Education Level		
Non-School	2	2
Elementary	4	4
Junior High School	15	15
Senior High School	33	33
University	46	46
Occupation		
Civil Servants	24	24
Private employee	10	10
Self employed	21	21
Laborer	3	3
Farmer	6	6
Others	36	36
Marital Status		
Unmarried	1	1
Married	88	88
Divorced	11	11

2. Clinical Characteristics

In terms of clinical characteristics, the majority of respondents had BMI in the categories of obesity I (48%) and obesity II (21%). Most (67%) have been suffering from DMT2 for less than 10 years. Glycemic control showed 98% of respondents had blood glucose levels of <200 mg/dL, and only 18% had a family history of hypertension. The vast majority of patients, 82 people or 82% of the total sample, had no family history of T2DM (Table 2).

Table 2. Clinical Characteristics of Respondents of Determinant Analysis of Hypertension Incidence in Patients with Type 2 Diabetes Mellitus

Characteristic	Frequency (n)	Percentage (%)
BMI		
Under	1	1
Normal	12	12
At risk of obesity	18	18
Obesity I	48	48
Obesity II	21	21
Duration of Illness		
< 10 years	67	67
≥ 10 years	33	33
Blood glucose level		
≥200	2	2
<200	98	98
Family history of DM		
Yes	18	18
No	82	82

3. Bivariate Analysis

The results of the bivariate analysis showed that there was no statistically significant relationship between the variables studied and the incidence of hypertension in DMT2 patients (p>0.05) (Table 3). In terms of gender, the proportion of hypertension in men (76.3%) was slightly higher than in women (72.6%) (p=0.815).

Regarding the level of education, all respondents who did not attend school and had an elementary education (100%) experienced hypertension. Meanwhile, the proportion of hypertension in junior high school and high school graduates was the same (66.7%), while in university graduates reached 78.3%. Although there was variation, there was no statistically significant relationship between education and hypertension incidence (p=0.566).

Judging from the Body Mass Index (BMI), the only respondent with an underweight BMI had hypertension (100%). The group at risk of obesity had the highest proportion of hypertension (83.3%), followed by the obesity group I (77.1%). The group with a normal BMI actually had the lowest proportion of hypertension (58.3%). However, this difference was not statistically significant (p=0.475).

Proportion of hypertension in people with DM ≥10 years (78.8%) was slightly higher than in people with DM <10 years (76.3%) (p=0.480).

In terms of blood glucose levels (BGL), in the group with a BGL of ≥200 mg/dL, 71.6% experienced hypertension, while in the BGL group <200 mg/dL, 74.5% experienced hypertension. This difference was not statistically significant (p=0.454).

Regarding family history, the proportion of hypertension was higher in respondents who had a family history of hypertension (88.9%) than in those without a history (70.7%). However, this difference was not statistically significant (p=0.144).

Based on occupation, all respondents who worked as laborers experienced hypertension (100%), followed by private employees (90%), farmers (83.3%), and self-employed (81%). The lowest proportion of hypertension was found in civil servants (58.3%). This difference was statistically insignificant (p=0.278).

For marital status, the only unmarried respondent experienced hypertension (100%), while the proportion of hypertension in divorced respondents (81.8%) was higher than in married respondents (72.7%). This difference was not statistically significant (p=0.679).

Overall, although there were variations in the proportion of hypertension in different groups, no statistically significant association was identified between all the variables studied and the incidence of hypertension in DMT2 patients.

Table 3. Relationship between gender, education, BMI, duration of dm, blood sugar level, family history, work, marriage, and hypertension in T2DM patients

Independent Variables	Hypertension n(%)	Non Hypertension n(%)	Total n(%)	p
Gender				
Male	29 (76.3)	9 (23.7)	38 (100)	0.815
Female	45 (72.6)	17 (27.4)	62 (100)	
Education				
Non- school	2 (100)	0	2 (100)	0.566
Elementary	4 (100)	0	4 (100)	
JHS	10 (66.7)	5 (33.3)	15 (100)	

Independent Variables	Hypertension n(%)	Non Hypertension n(%)	Total n(%)	p
SHS	22 (66.7)	11 (33.3)	33 (100)	
University	36 (78.3)	10 (21.7)	46 (100)	
BMI				
Under	1 (100)	0	1 (100)	0.475
Normal	7 (58.3)	5 (41.7)	12 (100)	
Risk of Obesity	15 (83.3)	3 (16.7)	18 (100)	
Obesity I	37 (77.1)	11 (22.9)	48 (100)	
Obesity II	14 (66.7)	7 (33.3)	21 (100)	
Duration of DM				
< 10 years	29 (76.3)	9 (23.7)	38 (100)	0.480
≥ 10 years	26 (78.8)	7 (21.2)	33 (100)	
Blood glucose level				
≥200	48 (71.6)	1 (50)	2 (100)	0.454
<200	73 (74.5)	25 (25.5)	98 (100)	
Family History				
Existent	16 (88.9)	2 (11.1)	18 (100)	0.144
Non-Existent	58 (70.7)	24 (29.3)	82 (100)	
Occupation				
Civil Servant	14 (58.3)	10 (41.7)	24 (100)	0.278
Private Employee	9 (90.0)	1 (10.0)	10 (100)	
Self employed	17 (81.0)	4 (19.0)	21(100)	
Laborer	3 (100)	0	3(100)	
Farmer	5 (83.3)	1 (16.7)	6 (100)	
Others	26 (72.2)	10 (27.8)	36 (100)	
Marriage				
Unmarried	1 (100)	0	1 (100)	0.679
Married	62 (72.7)	24 (27.3)	88 (100)	
Divorced	9 (81.8)	2 (18.2)	11 (100)	

DISCUSSION

This study analyzed the determinants of hypertension incidence in T2DM patients in the primary care of the Padang Bulan Community Health Center, Medan. The results of the study suggest some important findings that need to be discussed in the context of the existing literature and their implications for clinical practice.

This study was conducted to analyze various determinants that can affect the incidence of hypertension in DMT2 patients at the Padang Bulan Community Health Center, Medan. Eight key variables were studied to understand their relationship with the incidence of hypertension in the DMT2 population.

In terms of gender characteristics, the study discovered a dominance of women (62%) among T2DM sufferers. Although the prevalence of hypertension was slightly higher in men (76.3%) than in women (72.6%), statistical analysis showed no significant association between gender and the incidence of hypertension (p=0.815). This finding is interesting because it is different from several previous studies such as Almalki (2020) and Nawfal (2017) which discovered a significant relationship between gender and hypertension in T2DM patients. These differences may be due to variations in population characteristics and sample sizes.

Regarding the education level, most respondents (79%) had higher education (high school and university). However, no significant relationship was identified between education level and the incidence

of hypertension (p=0.566). This result is different from a study by Poljicanin (2010), which discovered a significant relationship (p=0.001). However, the high proportion of patients with higher education shows the importance of health education programs that are tailored to the patient's level of understanding.

The Body Mass Index (BMI) aspect showed alarming findings, where 87% of sufferers were overweight. Although no significant association with hypertension was discovered (p=0.475), this high prevalence of obesity deserves special attention given its role in insulin resistance and cardiovascular system dysfunction. The literature suggests that obesity can affect blood pressure through a variety of mechanisms, including activation of the renin-angiotensin-aldosterone system and increased sympathetic activity. (De Marco, et al., 2014)

In terms of duration of illness, most respondents (67%) had been suffering from T2DM for less than 10 years. Statistical analysis did not indicate a significant association between the duration of DMT2 and hypertension (p=0.480). This is different from Mubarak's (2008) study which discovered an increase in the risk of hypertension by 2.5 times in patients with a duration of T2DM ≥10 years. These differences may reflect variations in disease management and other factors that influence the development of hypertension (Mubarak et al., 2008)

Glycemic control in this study population was relatively good, with 98% of respondents having blood glucose levels of <200 mg/dL. However, no significant relationship was found between blood glucose levels and hypertension (p=0.454). Nonetheless, good glycemic control remains important given previous studies that have shown a causal relationship between DMT2 and hypertension. (Cannata, et al., 2020)

Variations in the type of work showed the dominance of civil servants (24%) and self-employed (21%), but no significant association was found with hypertension (p= 0.278). This is in line with a study of Ayutthaya and Adnan (2020), marital status also did not show a significant relationship with hypertension (p=0.679), even though the majority of respondents (88%) were married. (Ayutthaya & Adnan, 2020)

Regarding family history, only 18% of respondents had a family history of hypertension. Although no significant association with hypertension was found (p=0.144), previous studies have indicated the role of genetic factors in the development of hypertension through various molecular mechanisms (Sayed, et al., 2006)

The main interesting finding of this study is the absence of a significant relationship between all the variables studied and the incidence of hypertension in DMT2 patients. However, the high prevalence of hypertension (>70%) in all groups highlights the importance of a comprehensive approach in the management of these two conditions. This includes regular blood pressure screening and monitoring, prevention strategies that consider various risk factors, and educational programs tailored to the patient's characteristics.

The practical implications of this study are the importance of an individualized approach in the management of T2DM and hypertension, taking into account various risk factors and patient characteristics. Hypertension prevention and control programs in people with DMT2 need to be designed comprehensively, involving not only medical aspects but also social and behavioral factors.

This study shows that there is no statistically significant relationship between sociodemographic factors (gender, education, occupation, marital status) and clinical factors (BMI, length of DM, blood glucose levels, family history) with the incidence of hypertension in T2DM patients. However, the high prevalence of hypertension (>70%) in all groups indicates the importance of a comprehensive approach in the management of T2DM and hypertension, including regular screening, prevention strategies, and educational programs tailored to the patient's characteristics.

AUTHORS CONTRIBUTION

Mariaman Tjendera: Principal researcher, study design, data collection, data analysis, and manuscript writing. Gusbakti: Main supervisor, study concept, methodology, and manuscript review. Linda Chiuman: Co-supervisor, study supervision, and manuscript review. Ade Indra Mukti: Contribution to data analysis and interpretation of results. Dewi Sartika: Contribution to data collection and manuscript review

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CONFLICT OF INTEREST

The author states that there was no conflict of interest.

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