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The Relationship of Diabetes Mellitus with Hypertension in Patients at Jungkat Health Center, Mempawah District

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Abstract

Diabetes mellitus is a chronic metabolic disorder characterized by insufficient insulin production or ineffective utilization of insulin by the body. One of its most common complications is hypertension, a cardiovascular condition marked by persistently elevated blood pressure. Both diabetes mellitus and hypertension are major public health concerns and are among the most frequently reported conditions at the Jungkat Health Center, Mempawah Regency. Understanding the relationship between these two conditions is critical for improving disease management and patient outcomes. This study utilized an analytical cross-sectional design involving 40 patients from the Jungkat Health Center. Participants were selected using incidental sampling based on their willingness to participate and confirmed registration at the health center. Data collected included systolic and diastolic blood pressure measurements, as well as random blood glucose levels. The relationship between diabetes mellitus and hypertension was analyzed using the Chi-Square statistical test. The mean systolic blood pressure among participants was 158.03 mmHg, while the mean diastolic pressure was 87.92 mmHg. The average random blood glucose level recorded was 289.83 mg/dL. Statistical analysis revealed a significant association between diabetes mellitus and hypertension, with a p-value of 0.001 ($p < 0.05$). There is a statistically significant relationship between diabetes mellitus and hypertension among patients at the Jungkat Health Center. These findings underscore the importance of integrated management strategies to address both conditions concurrently, suggesting the need for early detection and simultaneous management strategies to reduce complications and improve overall patient outcomes.

Keywords: Diabetes and Hypertension

Introduction

Diabetes mellitus (DM) is a chronic metabolic disorder marked by impaired metabolism of carbohydrates, lipids, and proteins. It is caused by inadequate insulin secretion, impaired insulin action, or both, leading to persistent hyperglycemia. Insulin, produced by pancreatic β-cells, is crucial for maintaining glucose balance. When insulin function is disrupted, blood glucose levels rise, causing progressive damage to various organs, especially the vascular and nervous systems.[1,2]

Globally, the burden of DM continues to rise. According to the International Diabetes Federation (IDF, 2022), an estimated 536.6 million adults aged 20–79 years were living with diabetes in 2021, representing a global prevalence of 10.5%. This figure is projected to increase to 783.2 million (12.2%) by 2045. Both males and females are equally affected, with the highest prevalence observed among individuals aged 75–79 years.[2] In Indonesia, diabetes ranks as the third leading cause of mortality, accounting for 6.7% of all deaths. National prevalence rates have shown an upward trend, rising from 1.5% to 2.0% according to the 2018 Basic Health Research[3] indicating a 0.5% increase. Among individuals aged 15 years and older, the prevalence based on blood glucose testing increased from 6.9% to 8.5%, suggesting that approximately one-quarter of cases were previously undiagnosed.[4]

In 2018, West Kalimantan reported about 28.3 million diabetes cases, ranking 20th nationally, with physician-diagnosed diabetes prevalence of 1.15% provincially and 1.12% in Mempawah Regency. Diabetes mellitus is mainly classified into two types: Type 1, an autoimmune disease causing destruction of insulin-producing β-cells requiring lifelong insulin therapy; and Type 2, the more common form, resulting from insulin resistance and insufficient insulin secretion, influenced by genetics and modifiable lifestyle factors like obesity, inactivity, poor diet, stress, and aging.[3,5]

Diagnosis of DM follows specific clinical and biochemical criteria, including the presence of classic symptoms with random plasma glucose ≥200 mg/dL, fasting plasma glucose ≥126 mg/dL, or a 2-hour post-load plasma glucose ≥200 mg/dL during an oral glucose tolerance test (OGTT)[6]. One of the most frequently encountered complications of diabetes is hypertension. In individuals with type 2 DM, insulin resistance not only contributes to hyperglycemia but also promotes sodium retention and sympathetic nervous system activation, both of which elevate blood pressure. Chronic hyperglycemia is therefore implicated in the pathogenesis of hypertension among diabetic individuals. [7]

Hypertension is a cardiovascular condition defined by persistently elevated systolic (≥140 mmHg) and/or diastolic (≥90 mmHg) blood pressure[8]. It remains a pressing public health challenge in Indonesia, especially at the primary healthcare level [9], and is a

major global contributor to premature morbidity and mortality. The World Health Organization has targeted a 33% reduction in global hypertension prevalence between 2010 and 2030.[10]

In West Kalimantan, 18.1 million individuals were reported to have hypertension in 2018. That same year, physician-diagnosed diabetes prevalence reached 8.16% in the province and 8.87% in Mempawah Regency.[3] Hyperglycemia is known to significantly influence blood pressure and is a core component of metabolic syndrome, which also includes dyslipidemia, obesity, endothelial dysfunction, and increased thrombotic risk. These interrelated conditions collectively elevate the risk of cardiovascular complications.[11]

DM-related complications are commonly categorized into macrovascular, microvascular, and neuropathic types. Macrovascular complications affect the heart, brain, and large blood vessels, while microvascular complications primarily involve the kidneys and eyes. Neuropathic complications, including motor, sensory, and autonomic dysfunction, are prevalent in both newly diagnosed and long-standing cases of type 2 DM.[6]

Despite extensive global and national data highlighting the rising prevalence and interrelation of diabetes mellitus and hypertension, there remains a lack of localized, empirical studies that explore the clinical association between these conditions in primary care settings, particularly in underrepresented regions like Mempawah Regency. While reports from Jungkat Health Center indicate a substantial burden of both diseases, existing data are primarily descriptive and do not elucidate the extent to which these conditions are interlinked at the patient level. This knowledge gap limits the development of targeted interventions and integrated care strategies within local healthcare systems. Therefore, a contextual analysis examining the relationship between diabetes mellitus and hypertension among patients at the Jungkat Health Center is not only timely but essential for informing evidence-based clinical practices and optimizing resource allocation in the region.

Data from Jungkat Health Center in 2022 documented 21,830 outpatient visits and 887 inpatient admissions. Hypertension emerged as the third most commonly diagnosed condition, accounting for 1,405 cases (14.25%), while DM ranked fifth, with 744 cases (7.54%) (Jungkat Health Center Annual Report, 2022). Given the increasing incidence of both diabetes mellitus and hypertension, and the pathophysiological relationship between them, this study aims to examine the association between DM and hypertension among patients at Jungkat Health Center, Mempawah Regency.

Materials and methods

This study employed a **cross-sectional design**, which is used to simultaneously assess exposure and disease outcomes in each research subject. The primary aim of this design is to evaluate the relationship between the presence of an exposure—in this case, diabetes mellitus—and the occurrence of a related health outcome—namely, hypertension—at a single point in time.

The study population comprised all patients diagnosed with diabetes mellitus at the Jungkat Health Center**,** located in Mempawah Regency, West Kalimantan, Indonesia. The sample consisted of 40 individuals who met the inclusion criteria and were accessible during the study period. A non-probability incidental sampling technique was used. Incidental sampling, also known as convenience sampling, involves selecting subjects who are encountered by chance and who meet the criteria for participation. This approach is appropriate when the researcher includes individuals deemed suitable as data sources upon incidental contact [12]

The sample selection criteria included individuals who were willing to participate, registered as diabetes mellitus patients at Jungkat Health Center, and aged 30 years or older, while excluding pregnant women and those who were absent or unavailable during the sample collection period.

Subjects and Blood Pressure Measurement

This study involved patients from Jungkat Health Center, where both capillary blood glucose levels and blood pressure measurements were taken. Blood pressure was measured using standard sphygmomanometer techniques, ensuring patients were seated and at rest prior to measurement.

Methods of Examination

Blood glucose measurement

The measurement of blood glucose levels was performed using the Point of Care Testing (POCT) method. This method is based on *amperometric detection*, which utilizes an electrochemical reaction to measure the electrical current generated. When a blood sample is applied to a test strip, the chemical reaction generates an electric current proportional to the glucose concentration in the sample.[13]

Capillary blood sampling was performed by cleaning the 2nd, 3rd, or 4th fingertip with a 70% alcohol swab and allowing it to dry before gently pressing the selected finger to reduce pain, after which a glucose test strip and lancet were prepared and inserted into a POCT device that activated automatically; the puncture site—typically the fourth finger of the left hand—was cleaned and dried again, the finger massaged from base to tip to increase blood flow, and a sufficiently deep puncture made to obtain an adequate sample, with the first drop discarded to avoid contamination, followed by careful application of the strip tip to the blood until absorbed, triggering the device to beep and begin a countdown, after which the blood glucose result was displayed, with normal random blood glucose defined as <200 mg/dL for serum or plasma[14]

The blood glucose measurement using Point of Care Testing (POCT) ensures high analytical validity through amperometric detection, which provides rapid and reliable results directly at the point of care. While convenient and widely used in clinical settings, its accuracy may vary slightly depending on operator technique, device calibration, and sample quality.

Blood Pressure Measurement

Blood pressure was measured digitally using an automated sphygmomanometer, which records pressure in millimeters of mercury (mmHg). The device operates based on a pressure sensor (MPX2050GP) that detects pulse signals and an ATMega 32 microcontroller that processes the data. During measurement, the cuff is placed around the patient's upper arm and inflated to a predetermined pressure before the device automatically performs the reading. This system functions similarly to conventional sphygmomanometers but is fully automated and displays the results digitally. In addition to providing numerical systolic and diastolic values, the system also categorizes the patient's blood pressure status—hypotension, normotension, or hypertension—based on the recorded values (Yazid & Harjoko, 2011). Diastolic blood pressure is classified as normal if the value is <80 mmHg, prehypertension if it ranges from 80–89 mmHg, stage 1 hypertension if it ranges from 90–99 mmHg, and stage 2 hypertension if it is ≥100 mmHg.

The blood pressure measurement employed a digital sphygmomanometer, which offers instrumental validity through standardized, automated readings with minimal user variability. The classification system used aligns with clinical guidelines, supporting the construct validity of the measurements.

Data analysis

The data obtained from the study were analysed using the Chi-square statistical test with the assistance of the SPSS (Statistical Product and Service Solutions) version 17 for Windows.

Results

Univariate analysis was conducted to provide an overview of each individual variable. This analysis involved statistical testing, with the results presented in both tabular and narrative formats. The outcomes of these tests are summarized in the tables below.

Table. 1 Frequency Distribution of Respondents by Age at Jungkat Health Center, Mempawah Regency

Age Category	Frequency	Percentage (%)
30-40 Years	1	2.5
41-50 Years	7	17.5
51-60 Years	12	30.0
61-70 Years	19	47.5
71-81 Years	1	2.5
Total	40	100.0

Table 1 shows the age distribution of respondents, revealing that the most dominant age group was 61–70 years, comprising 47.5% of the total participants. This indicates that nearly half of the individuals with a history of diabetes and hypertension were within this age bracket, suggesting a higher prevalence of these conditions among older adults in the study population.

Table. 2 Frequency Distribution of Respondents by Gender at Jungkat Health Center, Mempawah Regency

Gender	Frequency	Percentage (%)
Male	13	32.5
Female	27	67.5
Total	40	100.0

Table 2 shows the gender distribution, with females accounting for 67.5% of the respondents. This finding indicates that the majority of diabetes and hypertension cases in this study were female, which may be influenced by hormonal factors, lifestyle patterns, or other contributing variables affecting disease prevalence.

Table. 3 Systolic Blood Pressure Distribution Among Diabetes Mellitus Patients at Jungkat Health Center, Mempawah Regency

Systolic Category	Frequency	Percentage (%)
Prehypertension (120-139)	1	2.5
Stage 1 Hypertension (140-159)	25	62.5
Stage 2 Hypertension (≥160)	14	35.0
Total	40	100.0

Table 3 outlines the distribution of systolic blood pressure, where the most common category was Stage 1 Hypertension (140–159 mmHg), observed in 62.5% of respondents. This suggests that most patients were experiencing early-stage hypertension, a level that, while elevated, remains manageable with appropriate intervention.

Table 4. Diastolic Blood Pressure Distribution Among Diabetes Mellitus Patients at Jungkat Health Center, Mempawah Regency

Diastolic Category	Frequency	Percentage (%)
Normal (<80)	8	20.0
Prehypertension (80-89)	18	45.0
Stage 1 Hypertension (90-99)	8	20.0
Stage 2 Hypertension (≥100)	6	15.0
Total	40	100.0

Table 4 shows the diastolic blood pressure distribution, with prehypertension (80–89 mmHg) being the most prevalent category at 45%. This implies that nearly half of the respondents were in a prehypertensive state, indicating mildly elevated diastolic pressure and a risk of progression to hypertension if left untreated.

Table 5. Random Blood Glucose Distribution Among Diabetes Mellitus Patients at Jungkat Health Center, Mempawah Regency

Category	Frequency	Percentage (%)
Normal	1	2.5
Hyperglycemia	39	97.5
Total	40	100.0

Table 5 shows the distribution of random blood glucose levels, with hyperglycemia (≥200 mg/dL) being highly predominant at 97.5%. This suggests that nearly all participants exhibited significantly elevated glucose

levels, indicating poor glycemic control among the study population.

Table 6. Blood Pressure Distribution by Random Glucose Level Among Diabetes Mellitus Patients at Jungkat Health Center

Category	Frequency	Percentage (%)
Normal BP and Normal Glucose	0	0.0
Prehypertension and Normal Glucose	1	2.5
Stage 1 HT and Hyperglycemia	24	60.0
Stage 2 HT and Hyperglycemia	15	37.5
Total	40	100.0

Table 6 shows the relationship between blood pressure levels and blood glucose concentrations. The data show that a substantial proportion of patients with elevated glucose also had hypertension. Specifically, 60% of those with Stage 1 Hypertension and 37.5% of those with Stage 2 Hypertension exhibited hyperglycemia. This underscores a notable correlation between high blood glucose and hypertension.

Table 7. Mean and Standard deviation score

	Mean	SD
Age	58.8	8.78
Systolic blood preasure	156.18	10.61
Diastolic blood preassure	87.68	9.54
Random blood glucose	285.5	28.10

Table 7 shows the mean and standard deviation of the main variables. The mean age of respondents was 58.8 years. The average systolic and diastolic blood pressures were 156.18 mmHg and 87.68 mmHg, respectively. The mean random blood glucose level was 285.5 mg/dL, indicating a clinically pathological state of hyperglycaemia that requires urgent and comprehensive management.

Bivariate analysis was performed to examine the relationship between two variables. In this study, the analysis was conducted using computer-assisted methods. The distribution of variables and the relationships between them were assessed using the Chi-square test.

Table 8. Relationship Between Diabetes Mellitus and Hypertension at Jungkat Health Center

Blood Glucose	Prehypertension	Stage 1 HT	Stage 2 HT	Total
Normal	1	0	0	1
Hyperglycemia	0	24	15	39
Total	1	24	15	40

Table 8 shows the direct association between blood glucose levels and the presence of hypertension. Almost all patients with normal glucose levels (only one individual) did not exhibit hypertension, whereas the majority of those with hyperglycemia were hypertensive. Most hyperglycemic patients were categorized as having Stage 1 or Stage 2 Hypertension, suggesting a strong correlation between elevated glucose levels and the incidence of hypertension.

Table 9. Chi-Square Test Results for the Relationship Between Diabetes Mellitus and Hypertension at Jungkat Health Center

Test	Value	df	Significance (2-sided)
Pearson Chi-Square	40.000a	2	0.001
Likelihood Ratio	9.353	2	0.009
Linear-by-Linear Association	10.640	1	0.001
Number of Valid Cases	40		

Table 9 shows the results of the Chi-Square statistical test, yielding a p-value of 0.001. Since this value is below the conventional significance level of 0.05, it indicates a statistically significant association between diabetes mellitus and hypertension in this study. In other words, the presence of diabetes substantially increases the risk of developing hypertension, and this relationship is not due to random chance.

Discussion

The results of this study align with findings reported by Renatasari (2009)[15], which demonstrated a statistically significant relationship between diabetes mellitus and hypertension. The Chi-Square test revealed a p-value of 0.001, which is lower than the threshold of $\alpha = 0.05$, indicating a significant association between the two conditions. This is consistent with the physiological theory that elevated blood pressure impairs glucose distribution to cells, leading to the accumulation of glucose and cholesterol in the bloodstream. When blood pressure is well-regulated, glucose levels also tend to be stable. Conversely, insulin plays a regulatory role in the renin-angiotensin system, and sufficient insulin levels contribute to blood pressure control. Persistent systolic blood pressure readings above 120/90 mmHg are associated with a twofold increase in diabetes risk, according to a 10-year longitudinal study by researchers at Brigham and Women's Hospital and Harvard Medical School.

Hypertension, defined as elevated blood pressure above the normal range, particularly during periods of rest or emotional stress, increases the risk of developing diabetes. The buildup of glucose and cholesterol due to diabetes leads to arterial stiffness, which disrupts normal blood flow and raises blood pressure. In addition to precipitating hypertension, diabetes is also a risk factor for heart failure and renal impairment. The relationship between hypertension and diabetes mellitus is particularly strong, as hypertensive patients often exhibit related risk factors, including elevated blood pressure, obesity, dyslipidemia, and hyperglycemia. The prevalence of hypertension among individuals with diabetes is reported to be 1.5 to 3 times higher than in non-diabetic populations.

Furthermore, the study by Kusumawaty et al. (2018)[16] found that women were more likely to develop diabetes mellitus, potentially due to higher average blood glucose levels compared to men and differences in daily activities and lifestyle. Women tend to have a higher body fat percentage—20–25% of total body weight compared to 15–20% in men—contributing to a 3–7 times greater risk of developing diabetes.

This study also observed that most hypertensive cases occurred in female respondents, which aligns with Cortas (2008)[17], who found that while hypertension prevalence is generally similar between sexes, premenopausal women are protected against cardiovascular diseases by estrogen. Estrogen raises high-density lipoprotein (HDL) cholesterol, which is protective against atherosclerosis. However, as women approach menopause—typically between ages 45 and 55—estrogen levels naturally decline, reducing this protective effect. After the age of 65, the prevalence of hypertension in women surpasses that in men due to hormonal changes[18]. A preliminary study at Lakbok Public Health Center found that among eight elderly respondents, five women aged 65–70 had hypertension, while three men aged 50–55 also had hypertension.

The present study confirmed a significant association between diabetes mellitus and hypertension at Jungkat Health Center, with a p-value of 0.001 ($p < 0.05$), supporting the conclusion that diabetes is significantly related to the incidence of hypertension in this population. Among 40 diabetic respondents, only one had a normal random blood glucose level (115 mg/dL), while the highest recorded glucose level was 554 mg/dL. The single normoglycemic diabetic patient was undergoing treatment for type 2 diabetes, explaining the lower value.

Regarding blood pressure measurements, 39 of the 40 respondents were hypertensive, and only one was classified as prehypertensive. Systolic blood pressure ranged from 135 mmHg to 201 mmHg with an average of 158.03 mmHg. Diastolic pressure ranged from 64 mmHg to 123 mmHg, averaging 87.92 mmHg. Random blood glucose levels ranged from 115 mg/dL to 554 mg/dL, with a mean value of 289.83 mg/dL.

Conclusion

This study confirms a significant association between diabetes mellitus and hypertension among patients at Jungkat Health Center, Mempawah Regency. The findings highlight that individuals with diabetes mellitus tend to exhibit higher blood pressure levels, supporting the clinical relevance of their co-occurrence. These results underscore the necessity for integrated clinical strategies that simultaneously address both conditions. Early identification and coordinated management approaches are crucial to mitigate the progression of complications and to enhance patient outcomes in primary care settings.

Conflict of interest

Authors state no conflict of interest.

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