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Original Research

Factors Influencing Cognitive Status in Type-2 Diabetes Mellitus Patients at Royal Prima General Hospital Medan

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Abstract

Introduction: Type 2 Diabetes Mellitus (DM) is a significant global health concern. In Type 2 DM, hyperglycemia results from inadequate insulin production and the body's reduced ability to respond to insulin, a condition known as insulin resistance. Diabetes Mellitus is often associated with cognitive decline, as observed in many patients with Type 2 DM. This study aims to analyze factors influencing cognitive status in Type 2 Diabetes Mellitus patients at Royal Prima General Hospital Medan.
Methods: This descriptive quantitative study used a cross-sectional design. The study population consisted of 754 patients with Type 2 DM, with a sample of 150 selected. A mini-mental state exam was used to check the cognitive status. Data were analyzed using univariate, bivariate, and multivariate methods.
Results: The findings indicate that gender, education level, blood glucose status, and duration of DM significantly influenced cognitive status in Type 2 DM patients at Royal Prima General Hospital Medan, with a p-value < 0.05 for each variable. In contrast, occupational status did not show a significant influence (p-value > 0.05). Collectively, gender, education level, occupational status, blood glucose status, and DM duration impacted cognitive status in these patients (p-value < 0.05).
Conclusion: Among the variables studied, the duration of Type 2 DM was the most influential factor affecting cognitive status in patients at Royal Prima General Hospital Medan.

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INTRODUCTION

Diabetes is a chronic, non-communicable disease [1]. Diabetes Mellitus (DM) poses a significant public health challenge, being one of the leading causes of kidney disease, blindness in individuals under 65, and amputations due to cardiovascular complications [2]. Diabetes Mellitus is a chronic condition that occurs when blood glucose levels rise because the body cannot produce insulin or use it effectively. Insulin, a vital hormone produced by the pancreas, transports glucose from the bloodstream into the body's cells, where it is converted to energy. A lack of insulin or cells' inability to respond to insulin leads to high blood glucose levels, or hyperglycemia, a defining characteristic of DM [3]. High blood sugar levels in diabetic patients can lead to increased LDL and decreased HDL as the body derives energy from the breakdown of fats and protein metabolism [4].

Diabetes Mellitus is categorized into four types: Type 1, Type 2, gestational diabetes, and specific types. Type 2 DM is the most common, accounting for about 90% of all DM cases. Also known as non-insulin-dependent diabetes, Type 2 DM is characterized by reduced insulin effectiveness. In Type 2 DM, hyperglycemia results from inadequate insulin production and the body's inability to fully respond to insulin, known as insulin resistance [3]. Diet in Type 2 DM is significantly influenced by attitudes, subjective norms, behavioral control, and patients' intentions [5]. Type 2 DM is a global health concern. According to the International Diabetes Federation, there were 537 million people aged 20–79 with Type 2 DM worldwide in 2021, a number expected to rise to 643 million by 2030 and 783 million by 2045. Over 4 out of 5 (81%) adults with DM live in low- and middle-income countries. In 2021, DM was responsible for 6.7 million deaths, equating to one death every five seconds [6]. In the U.S., approximately 6% of the population has diabetes [7].

In Asia, data shows that 1 in 11 adults, totaling 90 million people, have diabetes, with projections reaching 113 million by 2030 and 151 million by 2045. Over half of these adults are undiagnosed. In 2021, diabetes caused 747,000 deaths in Asia [6]. The 2018 Riskesdas data in Indonesia revealed a 2% DM prevalence among individuals over 15, up from 1.5% in 2013, with the prevalence based on results increasing from 6.9% to 8.5% in 2018, indicating that only 25% of DM patients are aware of their condition. The provinces with the highest prevalence from 2013-2018 were Yogyakarta, DKI Jakarta, North Sulawesi, and East Kalimantan, with Aceh ranking seventh. Provinces like Riau, DKI Jakarta, Banten, Gorontalo, and West Papua saw the largest increases in prevalence, rising by 0.9% [8]. The Basic Health Research (Riskesdas) showed that the average DM prevalence in urban areas was 5.7% for those over 15 [9]. In 2019, the Medan City Health Office recorded 27,075 DM patients, 85% of whom were over 55, with 70% being women. These patients were distributed across 39 health centers in Medan. This data indicates that DM prevalence is relatively high in North Sumatra [10].

As a rapidly developing city, Medan is experiencing urbanization that has led to lifestyle changes, such as increased fast food

consumption and decreased physical activity. Low awareness of the importance of regular health check-ups has also contributed to delayed DM diagnoses, increasing the risk of complications, including cognitive decline.

Cognitive function encompasses attention, thinking, understanding, learning, memory, problem-solving, and decision-making [11]. It involves various aspects, such as memory, knowledge, decision-making, planning, reasoning, judgment, perceptual understanding, language, and visuospatial function [12]. he global prevalence of cognitive impairment associated with Type 2 DM is not well established; however, studies in several countries suggest a range of 2.2% to 20%. Mechanisms linking DM and cognitive function include vascular, metabolic, and oxidative/inflammatory processes that can cause disturbances in cerebral blood vessels, ischemia, subcortical lesions, silent infarcts, and cerebral atrophy [13]. Complications such as neuropathy or unmanaged nerve damage in diabetic patients can lead to cognitive decline and even dementia, with severity often linked to chronic hyperglycemia, increasing cognitive dysfunction risks [14]. Further research is needed to understand factors influencing cognitive status in Type 2 DM patients. This research will provide valuable insights for healthcare professionals and patients' families to recognize early signs of cognitive impairment and implement preventive measures.

DM is often associated with cognitive decline, as observed in many Type 2 DM patients. Studies highlight a strong link between DM, cognitive decline, and dementia, although the exact mechanisms are not fully understood. Chronic DM may contribute to vascular dementia and other dementia-related diseases. Neurocognitive decline in Type 2 DM patients is associated with reduced white and gray matter volume, affecting language and memory skills. Cognitive function may be impaired due to central nervous system disorders, including disrupted brain oxygen supply, degeneration, Alzheimer's disease, and malnutrition, leading to impairments such as disorientation and difficulty in accepting new ideas [10]. Cognitive decline is assessed using neuropsychological tests like the MoCA-Ina, which is sensitive in detecting Mild Cognitive Impairment (MCI) and is used to assess dementia progression. Risk factors for cognitive impairment include age, gender, race, genetics, blood pressure, heart disease, arrhythmias, diabetes, lipid levels, thyroid function, obesity, nutrition, alcohol, smoking, and trauma. Research by E. Van Exel found that cognitive function is generally better in women than in men due to cardiovascular risk factors being more common in men. Hypertension also increases the risk of mild cognitive impairment and dementia [10]. Based on this background and previous studies, this research aims to identify factors influencing cognitive status in Type 2 DM patients at Royal Prima General Hospital Medan.

METHODS

Research Design

This study was a descriptive, quantitative research design using a cross-sectional approach. Conducted at Royal Prima General Hospital Medan, The independent variables

included gender (X1), education level (X2), employment status (X3), blood glucose levels (X4), and duration of Type 2 DM (X5), while the dependent variable is the cognitive status of Type 2 DM patients (Y).

Sampling

The study population comprised 754 Type 2 DM patients from January 2023 to January 2024, with a sample of 150 patients selected using accidental sampling.

Procedures

Data collection involved two primary sources: structured interviews and hospital records. Demographic and health variables—age, gender, education level, employment status, blood sugar levels, and duration of diabetes—were gathered. Blood sugar levels were classified as high or normal, and the duration of diabetes was determined by self-reports, noting whether participants had managed diabetes for over five years, a known factor in cognitive decline.

To assess cognitive function, trained staff administered a standardized cognitive tool, such as the MMSE, to evaluate memory, attention, language, and visuospatial abilities. These tests helped identify the prevalence and severity of cognitive impairment among patients.

Instrument

Mini-Mental State Examination (MMSE) was a 30-point questionnaire that was widely used to measure cognitive impairment in clinical and research settings. The MMSE is also used to estimate the severity and progression of cognitive impairment over time, making it an effective tool for documenting an individual's response to treatment.

Data Analysis

Data analysis methods used in this study include univariate, bivariate (chi-square test), and multivariate (logistic regression test) analyses. Univariate tests include gender, education level, employment status, blood glucose levels, duration of Type 2 DM, and cognitive status. A chi-square test was done to check the connections between demographics and cognitive function. Multiple regression was done to check factors influencing cognitive status in type-2 diabetes mellitus patients.

Ethical Consideration

This research has passed the ethical review by the Prima Indonesia University Health Research Ethics Commission (KEPK) with No. 070/KEPK/UNPRI/VI/2024.

RESULTS

Table 1
Frequency Distribution of Respondent Characteristics

Gender	**n**	**%**
Male	46	30.7
Female	104	69.3
Education Level		
Elementary School	6	4.0
Junior High School	7	4.7
High School	101	67.3
Higher Education	36	24.0
Employment Status		
Unemployed	16	10.7
Civil Servant	28	18.7
Entrepreneur	33	22.0
Private Employee	73	48.7
Blood Glucose Level		
Normal (< 7%)	10	6.7
Moderate (7-8%)	21	14.0
High (> 8%)	119	79.3
Duration of Type-2 Diabetes		
≤5 Years	33	22.0
>5 Years	117	78.0
Total	**150**	**100**

Source: Processed primary data (2024)

Table 2
Cognitive Status of Type-2 Diabetes Patients

Cognitive Status	**n**	**%**
Cognitive Impairment	119	79.3
No Cognitive Impairment	31	20.7
Total	150	100

Source: Processed primary data (2024)

Table 3
Influence of Gender, Education Level, Employment Status, Blood Sugar Status, and Duration of Type 2 DM on Cognitive Status in Type-2 DM Patients

Variables	Cognitive Status				Total		Description
	Experiencing Cognitive Function		Not Experiencing Cognitive Function				
	n	%	n	%	n	%	
Gender							
Male	25	16,7	21	14	46	30,7	0,000
Female	94	62,7	10	6,7	104	69,3	
Total	**119**	**79,3**	**31**	**20,7**	**150**	**100**	
Education Level							
Elementary	5	3,3	1	0,7	6	4	0,000
Juniors High School	7	4,7	0	0	7	4,7	
Senior High School	93	62	8	5,3	101	67,3	
College	14	9,3	22	14,7	36	24	
Total	**119**	**79,3**	**31**	**20,7**	**150**	**100**	
Employment Status							
Non-employed	12	8	4	2,7	16	10,7	0,176
Civil Servants	23	15,3	5	3,3	28	18,7	
Self-employed	22	14,7	11	7,3	33	22	
Private Employee	62	41,3	11	7,3	73	48,7	
Total	**119**	**79,3**	**31**	**20,7**	**150**	**100**	
Blood Sugar State							
Normal < 7%	4	2,7	6	4	10	6,7	0,001
Medium 7-8%	14	9,3	7	4,7	21	14	
High > 8%	101	67,3	18	12	119	79,3	
Total	**119**	**79,3**	**31**	**20,7**	**150**	**100**	
Duration of diabetes mellitus type 2							
≤5 Year	20	13,3	13	8,7	33	22	0,003
>5 Year	99	66	18	12	117	78	
Total	**119**	**79,3**	**31**	**20,7**	**150**	**100**	

Source: Processed primary data (2024)

Table 4
Selection of Variables for Multivariate Analysis

Variable	P-Value	Candidate
Gender (X1)	0,000	Yes
Education Level (X2)	0,000	Yes
Employment Status (X3)	0,176	No
Blood Glucose Status (X4)	0,001	Yes
Duration of Type-2 Diabetes (X5)	0,004	Yes

Table 5
Multivariate Analysis Results

Variable	t	Sig
Gender (X1)	-4.548	
Education Level (X2)	0.825	0.000
Blood Sugar Status (X4)	-1.879	
Duration of Type 2 Diabetes Mellitus (X5)	4.340	

Source: Primary Data Processed 2024

The majority of respondents in this study were female, accounting for 69.3%. Most respondents had a high school education, making up 67.3% of the total. In terms of employment status, the majority worked as private employees, with 48.7%. Regarding blood sugar levels, 79.3% of respondents had high blood sugar levels exceeding 8%. Additionally, 78% of respondents had been living with type-2 diabetes mellitus for more than 5 years.

Univariate Analysis Results

Table 2 shows that 79.3% of Type-2 Diabetes patients experienced cognitive impairment, while 20.7% did not.

Bivariate Analysis Results

Table 3 illustrates significant relationships between several variables and cognitive status in patients with Type-2 Diabetes Mellitus. The majority of patients experiencing cognitive impairment were female (62.7%), notably higher than the percentage of males with cognitive impairment (16.7%). Education level also showed a marked association, with most patients experiencing cognitive impairment having only a high school education (62%), while those without impairment predominantly had a college education (14.7%). Blood sugar levels displayed a significant impact on cognitive status, with 67.3% of patients with cognitive impairment having levels above 8%. Furthermore, a diabetes duration exceeding 5 years was closely associated with cognitive impairment, with 66% of patients affected for over 5 years. Overall, these findings suggest that gender, education level, blood sugar levels, and diabetes duration are significantly associated with cognitive impairment in patients. Female patients with lower education levels, high blood sugar levels, and longer durations of diabetes appear to be more susceptible to cognitive decline.

Multivariate Analysis Results

Table 4 shows that variables with a p-value < 0.05—gender, education level, employment status, blood sugar status, and duration of Type-2 diabetes mellitus—were included in the multivariate model.

Table 5 confirms that these variables significantly influence cognitive status collectively, with a significance value of 0.000, below the threshold of 0.05. Among these, the duration of Type-2 diabetes mellitus (X5) had the strongest association with cognitive impairment, reflected in a t-value of 4.340.

Thus, the duration of diabetes is identified as the most influential factor affecting cognitive status in this study.

DISCUSSIONS

Gender and Cognitive Status

Gender differences appear to influence cognitive function, particularly in memory. Research suggests that men generally have larger amygdala and thalamus regions, while women tend to have larger hippocampal regions and a greater number of estrogen receptors in the hippocampus and androgen receptors in the amygdala. These differences contribute to variations in cognitive function, with women often showing strengths in verbal memory and men in spatial memory. Furthermore, research shows that a decline in estrogen levels during menopause heightens the risk of cognitive impairment in women. For example, Hasanah (2019) found that cognitive impairment prevalence in rural China was significantly higher in women (45.1%) than men (40.0%), particularly among those over 75, which may relate to socioeconomic and healthcare access differences [12].

Education Level and Cognitive Status

Higher education levels correlate with better cognitive function, as educational attainment fosters skills such as reasoning, reading, and cultural competence, which build synaptic density linked to intelligence. Education also indirectly influences cognitive function by improving socioeconomic standing and social behavior throughout life.

Employment Status and Cognitive Status

Analysis of employment status on cognitive function in patients with Type-2 Diabetes Mellitus at Royal Prima General Hospital Medan revealed that cognitive impairment was distributed across employment categories, with private employees having the highest proportion of cognitive impairment at 41.3%. However, the chi-square analysis yielded a significance value of 0.176, suggesting that employment status does not significantly influence cognitive status in these patients.

Blood Sugar Status and Cognitive Status

Complications of Type-2 diabetes mellitus can lead to changes and disruptions in various systems, including the central nervous system, which is associated with cognitive dysfunction. Increased levels of malondialdehyde (MDA), a marker for oxidative stress and lipid peroxidation, are closely linked to diabetes-related complications [15]. Cognitive function includes abilities such as attention, registration, memory, calculation, recall, language, judgment, writing, reading, and visuospatial skills. Cognitive dysfunction is characterized by the deterioration or impairment of brain function, evidenced by changes in affect, language skills, cognition, behavior, or personality. These changes may be due to factors such as anoxia, chemical or endocrine imbalances, structural alterations, thermal effects, toxicity, trauma, or vascular issues impacting brain function [16]. Patients with diabetes often show deficits in memory

and attention compared to controls in cognitive function tests. Diabetic patients have a 1.5 times higher likelihood of cognitive impairment than those without diabetes [16]. This increased risk may arise from diabetes-related vascular damage, including harm to blood vessels within the brain. Uncontrolled blood sugar levels can lead to toxic effects due to oxidative stress and the accumulation of advanced glycation end products (AGEs), potentially causing damage to brain tissue in the hippocampus [16].

Blood sugar levels are the most critical factor in the progression of diabetes[17]. High blood glucose levels in diabetic patients activate pro-inflammatory cytokines through various intracellular biochemical pathways, resulting in endothelial dysfunction in blood vessels. This heightened risk of vascular dysfunction is believed to underlie the increased risk of dementia and cognitive impairment in diabetic patients. Hyperglycemia leads to atherosclerosis in cerebral arteries, which disrupts blood circulation to the brain, thereby elevating the risk of dementia and cognitive impairment [16].

Duration of Diabetes and Cognitive Status

The duration of diabetes is strongly associated with the risk of cognitive impairment. Studies indicate that Type-2 diabetes duration over five years predicts a higher likelihood of cognitive decline, including mild cognitive impairment (MCI) and dementia in older patients. However, patients who manage diabetes effectively through lifestyle adjustments may mitigate cognitive decline risks and maintain a better quality of life [16].

CONCLUSION

This study, "Factors Related to Cognitive Status in Patients with Type-2 Diabetes Mellitus at Royal Prima General Hospital Medan," identified significant associations between gender, education level, blood sugar status, and diabetes duration with cognitive impairment. Employment status did not have a significant impact on cognitive function in these patients. Overall, the duration of diabetes emerged as the most impactful variable on cognitive status. These findings provide valuable insight for healthcare providers and patients, emphasizing the need for self-care and lifestyle management to preserve cognitive health in Type-2 diabetes patients.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest, financial or personal, that could influence the study results or interpretations.

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