

ORIGINAL ARTICLE

Predicting factors for readmission type 2 diabetes mellitus patients in Indonesia: A cross-sectional study

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Abstract. *Background and aim:* Readmissions negatively impact patient's quality of life and increase health and care costs. Readmission among type 2 diabetes mellitus (T2DM) patients can be related to several factors, including age, gender, complications of diabetes, instability of blood sugar levels, diabetes education strategies, diet management, physical exercise, and therapy adherence. This study aims to identify the determinants of readmission of T2DM patients at the regional hospital of Aceh, Indonesia. *Methods:* The study employed a correlational design with a cross sectional approach. The sample was 184 T2DM readmission patients selected using an accidental sampling technique. Data was collected using several instruments: the Diabetes Early Readmission Risk Indicators (DERRI™) questionnaire, laboratory results of blood sugar levels, diabetes education strategies, United Kingdom Diabetes and Diet Questionnaire, International Physical Activity Questionnaire (IPAQ), Insulin Treatment Appraisal Scale (ITAS), and the readmission questionnaire. Data were analyzed using the Chi-square test and multiple logistic regression. *Results:* Data analysis revealed significant relationships between age ($p<0.013$), diabetes complications ($p<0.000$), unstable blood sugar levels ($p<0.000$), diabetes education strategies ($p=0.000$), diet management ($p<0.000$), and therapy adherence ($p<0.000$) with T2DM readmissions. No significant relationship was found for gender ($p<0.073$) or physical activity ($p<0.430$). Among all factors, diabetes complications were the strongest predictor of readmission ($OR=5.330$). *Conclusions:* The findings emphasize the importance of increasing patient independence in self-care to manage diabetes effectively. Stakeholders are encouraged to re-evaluate diabetes care strategies by optimizing discharge planning to address complications and reduce readmissions among T2DM patients.

Key words: readmission, type 2 diabetes mellitus, diabetes complications, hospital

Introduction

Readmission refers to being readmitted after five days of hospitalization. It is defined as an unplanned admission to the hospital within 30 days following discharge from previous hospitalization. Unplanned hospital readmission in the first 30 days is considered a measure of quality of healthcare of diabetic patients and could be prevented appropriately that occur in this period through increased self-management (1,2).

Hospital readmission may occur at the same or different hospital within a specified period. The most commonly studied readmission periods are 30 days, 90 days, and 1 year. Approximately 30% of diabetes mellitus (DM) patients who are hospitalized experience two or more readmissions within the subsequent year, making DM one of the top 10 causes of hospital readmissions globally (3). Also, the rate of 30 days unplanned readmission of diabetic patients has been estimated 14.4% –21% (4), and a study reported that

30-day readmissions for patients with diabetic foot ulcer has been reached 22% (5). Gender, race, age, affordability of medical insurance, comorbidities, and length of stay are several factors significantly associated to 30-day unplanned hospital readmission diabetic patients (6). Readmissions have negative impacts from various perspectives. Hospital readmissions are an indicator of service quality and often highlight the inadequacy of the health service system (7). Readmissions frequently result from a lack of continuity of care between in-hospital and post-hospital care. In addition, readmission strains family dynamics, requiring adjustments to accommodate the care needs of the readmitted patient (2), and associated with a substantial cost and family burden. Prevention efforts related to patients' readmissions are essential to reducing the overall costs of care. Patients readmission has negatively impact on hospitals' reputation (5,8). Hospitals have implemented various strategies to reduce patient readmissions. Key measures include enhancing coordination and communication between healthcare providers, including nurses and educators. Nurses are critical in preparing patients for discharge by providing necessary interventions and education (2). The efforts to strengthen the health care services system in hospitals, a set health care providers according to their competences and reinforce patient discharge planning activities are main priorities for the entire health care system (9). One disease associated with frequent readmissions is diabetes mellitus (DM). DM is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both (10). Type 2 diabetes mellitus (T2DM) accounts for 90%-95% of all DM cases (11). In nursing care, every diabetic patient treated in the hospital should receive comprehensive discharge planning. Nursing intervention for patients includes educating patients on self-care, medication adherence and independent insulin administration at home. Despite these efforts, high rates of hospital readmissions persist. Educational nursing interventions are significantly correlated with patient readmissions (12). Uncontrolled DM can lead to severe complications for multiple organs (7), including blindness, kidney failure, heart failure, stroke, neurological disease, amputation and impotence, urinary incontinence, weight loss,

weakness, hypoglycemia, peripheral neuropathy, peripheral vascular disease, diabetic retinopathy, hypertension, arthritis and Parkinson's disease (13,14). Risk factors contributing to readmission among T2DM patients include age, gender, diabetes complications, unstable blood sugar levels, educational strategies, diet management, physical activity, and treatment adherence (15). Several strategies to reducing readmission patients related to dedicated care team to monitor ongoing outpatient follow-up. Multifaceted in-hospital intervention for diabetic patients may contribute to improvements in hospital length of stay and HbA1c concentration (16). This regional hospital reported that many DM patients transferred to a provincial hospital due to complications and readmissions related to diabetic problems.

Methods and Materials

The correlational study with a cross-sectional design was conducted through a convenience sampling technique. By using Slovin formula with a margin of error of 5% totaling 184 respondents were collected in five in-patients' wards from December 13, 2023 to January 24, 2024. The sample inclusion criteria were: aged ≥ 30 years, diagnosed with DMT2, fully conscious, able to communicate verbally, literate, and using insulin therapy. Exclusion criteria include patients with stroke related problems or mental disorders. Data collection was conducted by administering several questionnaires. Data collection tools included the Diabetes Early Readmission Risk Indicators (DERRI™) (17), laboratory results of blood sugar levels, DM education strategies, United Kingdom Diabetes and Diet Questionnaire, International Physical Activity Questionnaire (IPAQ), Insulin Treatment Appraisal Scale (ITAS), and the readmission questionnaire. The readmission questionnaire comprised four answer choices: ≤ 30 days, $>30-60$ days, >60 days-90 days, and >90 days (18). The reliability test results for the DERRI™ questionnaire yielded a Cronbach alpha of 0.80 and a validity coefficient of 0.36. The study was conducted at a general hospital of North District of Aceh, Indonesia. The hospital is a referral hospital to care many kinds of cases including in-patients and out-patients services.

The Research Ethics Committee of the Faculty of Nursing, Universitas Syiah Kuala, granted this study's ethical approval (approval number: 112009161023). All respondents were provided with detailed information about the study and gave written informed consent to participate. Data analysis was conducted using the Chi-square test and multiple logistic regression by using computerized software.

Results

The research results for sociodemographic data are shown in Table 1, while related to the readmission of diabetes patients are presented in Tables 2-5. As shown in Table 1, the respondents had a mean age of 57.30 ± 10.2 years, and most respondents were male (60.3%). Regarding education, most respondents had primary school education (64.7%), and the predominant occupations were farmers, laborers, or fishermen (55.4%). Humalog was the most commonly used type of insulin, utilized by 67 respondents (36.4%). Additionally, most respondents were on their third admission for treatment (37.5%).

Table 2 shows 105 respondents (57.1%) experienced complications from other diseases, and 71 respondents (38.6%) experienced readmission <30 days.

Table 3 shows that most readmitted respondents were aged >61 years, with 47.8% experiencing readmissions within ≤ 30 days. Most readmitted respondents were male (34.2%), with a readmission interval of ≤ 30 days. Respondents with complications accounted for 56.2%, with a readmission interval of ≤ 30 days. Among those readmitted, 58.9% had abnormal blood sugar levels within ≤ 30 days. Additionally, 51.7% of the respondents experienced readmissions within ≤ 30 days due to poor educational strategies. Poor diet management was observed in around half of the respondents (50.9%), with a readmission interval of ≤ 30 days. Light physical exercise was reported by 42.5% of respondents who were readmitted within ≤ 30 days. Lastly, nearly half of the respondents who were non-compliant with their treatment program experienced readmissions within ≤ 30 days (45.7%).

The results of the multivariate analysis showed that gender ($p < 0.486$) and physical exercise ($p < 0.275$)

Table 1. Socio-Demographic of Readmission T2DM Patients (n=184)

No	Category	f	%
1	Age (year): (Mean $\pm$ SD)	57.30 $\pm$ 10.2	
	35-50	45	24.4
	51-60	70	38.0
	>60	69	37.5
2	Gender		
	Male	111	60.3
	Female	73	39.7
3	Latest education		
	No education	57	31.0
	Primary school education	119	64.7
	High School education	7	3.8
	Higher education	1	0.5
4	Employment		
	Unemployed	69	37.5
	Farmers/laborers/fishermen	102	55.4
	Civil Servant	1	0.5
	Entrepreneur	12	6.5
5	Type Insulin		
	Apidra	4	2.2
	Humalog	68	36.9
	Humalog mix	10	5.4
	Humulin R	57	31.0
	Lantus	9	4.9
	Levemir	22	12.0
	Novorapid	14	7.6
	Readmission (time)		
	2	38	20.7
	3	69	37.5
	4	58	31.5
	≥ 4	19	10.3

were excluded from the modeling test due to p-values >0.05. Meanwhile, age ($p < 0.002$), DM complications ($p < 0.000$), unstable blood sugar levels ($p < 0.001$), DM education strategies ($p < 0.010$), diet management ($p < 0.025$), and therapy adherence ($p < 0.041$) were included in the multiple logistic regression test, as shown in Table 4.

The multivariate analysis identified diabetic complications as the most significant readmission predictor

Table 2. Distribution of Readmission Factors in T2DM Patients (n=184)

No	Variable	f	%
1	Complication diabetic		
	Yes	105	57.1
	No	79	42.9
2	Instability of blood sugar levels (M±SD)		
	Normal (117.9±0.48)	72	39.1
	Abnormal (460.2±0.48)	112	60.9
3	Diabetes education strategies		
	Good	66	35.9
	Fair	118	64.1
4	Diet management		
	Good	72	39.1
	Fair	112	60.9
5	Physical exercise		
	Light	127	69.0
	Moderate	57	31.0
6	Compliance therapy		
	Yes	46	25.0
	No	138	75.0
7	Readmission (day)		
	≤30	71	38.6
	31-60	24	13.0
	61-90	25	13.6
	>90	64	34.8

in T2DM patients, with an odds ratio (OR) of 5.330. This indicates that diabetic complications increase the likelihood of readmission by 5.3 times compared to other factors, such as unstable blood sugar levels (OR=4.468), as shown in Table 5.

Discussion

Readmission refers to the unplanned readmittance of a patient to the hospital within 30 days of discharge from a previous hospitalization. This issue impacts the quality of healthcare services and highlights inadequacies in the health service system, particularly the lack of continuity between in-hospital and

post-hospital care. Readmissions also affect family roles and responsibilities in patient care and contribute to increased healthcare costs. The data analysis revealed that the highest readmission rates occurred among respondents with complications, with 56.2% of these readmissions within ≤30 days. More than 50% of the respondents with complications experienced the highest number of readmissions. The Chi-square test analysis indicated statistically significant relationships between readmissions and several factors: age ($p=0.013$), DM complications ($p=0.000$), unstable blood sugar levels ($p=0.000$), DM education strategies ($p=0.000$), diet management ($p=0.000$), and adherence to the treatment program ($p=0.000$). However, no significant relationships were found with gender ($p=0.073$) or physical exercise ($p=0.430$). The mean age of respondents was 57.30 ± 10.2 , corresponding to late adulthood. This age group experiences a decline in systemic bodily functions and a weakening immune system, leading to various complications that worsen the health conditions of patients with T2DM. Additionally, advancing age often results in deteriorating physical health and reduced self-care capacity, necessitating long-term healthcare plans tailored to the elderly (19). Aging also affects health status and alters perceptions of health and illness, underscoring the importance of age-appropriate healthcare interventions (20). In contrast, gender was not significantly associated with readmissions among diabetes patients. Gender does not appear to significantly influence diabetes management, nor does it impact patient readmissions. This finding aligns with previous studies that reported no differences in fat levels, lipid profiles, or insulin sensitivity between male and female DM patients. While beta-cell function in women may be better than in men, this difference does not significantly affect readmission rates (21,22). Additionally, gender does not influence the frequency of readmissions within a year among DM patients (23). DM patients can engage in different physical activities and exercises depending on the severity of their condition. This study found no significant relationship between physical exercise and readmissions in patients with T2DM. Most readmitted respondents engaged in light physical exercises, with 54 individuals (42.5%) experiencing readmission within ≤30 days. These findings contrast with prior

Table 3. Factors Related to T2DM Readmitted Patients (n=184)

Readmission of Diabetic Patients												
Related Factors		≤30 days		31-60 days		61-90 days		>90 days		Total		p
		N	%	n	%	n	%	n	%	n	%	
Age (year):												
	35-50	14	31.1	3	6.7	5	11.1	23	51.1	45	100	0.013
	51-60	24	34.3	7	10.0	13	18.6	26	37.1	70	100	
	>61	33	47.8	14	20.3	7	10.1	15	21.7	69	100	
	Sub-total	71	38.6	24	13.0	25	13.6	64	34.8	184	100	
Gender:												
	Male	38	34.2	17	15.3	20	18.0	36	32.4	111	100	0.073
	Female	33	445.2	7	9.5	5	6.8	28	38.4	73	100	
	Sub-total	71	38.6	24	13.0	25	13.6	64	34.8	184	100	
Complication's diabetic:												
	Yes	59	56.2	19	18.1	21	20.0	6	5.7	105	100	0.000
	No	12	15.2	5	6.3	4	5.1	58	73.4	79	100	
	Sub-total	71	38,6	24	13,0	25	13,6	64	34,8	184	100	
Instability of blood sugar levels:												
	Normal	5	6.9	0	0	19	26.4	48	56.7	72	100	0.000
	Abnormal	66	58.9	24	21.4	6	5.4	16	14.3	112	100	
	Sub-total	71	38.6	24	21.4	25	13.6	64	34.8	184	100	
Diabetes educational strategy:												
	Good	10	15.2	2	3.0	5	7.6	49	74.2	66	100	0.000
	Fair	61	51.7	22	18.6	20	16.9	15	12.7	118	100	
	Sub-total	71	38.6	24	13.0	25	13.6	64	34.8	184	100	
Diet management:												
	Good	14	19.4	4	5.6	12	16.7	42	58.3	81	100	0.000
	Fair	57	50.9	20	17.9	13	11.6	22	9.6	103	100	
	Sub-total	71	38.6	28	15.2	25	13.6	64	34.8	184	100	
Physical exercise:												
	Light	54	42.5	15	11.8	16	12.6	42	33.1	127	100	0.430
	Moderate	17	29.8	9	15.8	9	15.8	22	38.6	57	100	
	Sub-total	68	37.0	24	13.0	25	13.6	64	34.8	184	100	
Compliance Therapy:												
	Yes	8	17.4	2	4.3	13	9.4	40	29.0	82	100	0.000
	No	63	45.7	22	15.9	12	26.1	24	52.2	102	100	
	Sub-total	68	37.0	24	13.0	25	13.6	63	34.8	184	100	

Table 4. Multiple Logistic Regression Modeling Test

Predictor Factors	OR	P	95% CI for EXP(B)	
			Lower	Upper
Age	0.864	0.566	0.525	1.423
Complication diabetic	5.356	0.000	2.357	12.168
Instability of blood sugar levels	4.330	0.001	1.886	9.941
Diabetes education strategy	3.614	0.010	1.352	9.663
Diet management	2.759	0.025	1.137	6.690
Therapy adherence	2.761	0.041	1.042	7.318
Constant	0.097	0.002		

Table 5. Prediction Factors for Readmission of Type 2 DM Patients (n=184)

Predictor Factors	OR	p	95% CI for EXP(B)	
			Lower	Upper
Complication diabetic	5.330	0.000	2.351	12.086
Instability of blood sugar levels	4.468	0.000	1.959	10.192
Diabetes education strategy	3.860	0.006	1.478	10.080
Diet management	2.762	0.024	1.141	6.683
Therapy adherence	2.797	0.038	1.058	7.392
Constant	0.068	0.000		

research, suggesting that physical exercise can stabilize blood sugar levels and reduce the risk of complications. In this study, the mean age of respondents was 57.30 ± 10.2 , which, combined with a 57.1% prevalence of diabetes complications, limited their ability to perform even light or moderate physical activities. The types of exercise suitable for diabetes patients include aerobic exercises such as walking, cycling, jogging and swimming, which involve continuous and repetitive movements of large muscle groups. Resistance exercises are also beneficial for improving the range of motion in diabetes patients (24). Regular aerobic exercise and endurance training are essential for optimizing health

and maintaining stable blood sugar levels. Physical exercise plays a crucial role in fostering healthy lifestyle behaviors, improving overall health, and preventing the progression of diabetes and its complications, which can have severe and sometimes fatal consequences (25). The analysis also revealed that nearly half of the respondents with readmissions within ≤ 30 days (45.7%) were non-compliant with therapy. Non-adherence to diabetes therapy, whether oral medication or insulin injections, contributes to unstable blood sugar levels and increased readmission rates. This finding aligns with previous research reporting that treatment adherence refers to patients taking medication as prescribed. Patients with type 2 diabetes often exhibit poor adherence, particularly to anti-hyperglycemia medication, due to the prolonged and complex treatment regimens (26). Non-compliance with insulin therapy is a strong predictor of readmission. Patients who fail to use insulin as recommended often experience poor blood sugar control. Meanwhile, patients using a combination of oral anti-diabetic drugs and metformin and glibenclamide had shorter treatment durations compared to those on metformin alone (27). Insulin therapy adherence is a critical predictor of 30-day readmissions, with patients exhibiting poor adherence being more likely to experience complications leading to readmission (3). The study also found that more than half of the respondents with readmissions within ≤ 30 days (58.9%) had unstable blood sugar levels. The blood sugar levels of DM patients are closely related to the complaints and complications of acute (hypo/hyperglycemia) and chronic complications. These results align with previous research identifying that average blood sugar levels and HbA1c as independent predictors of readmission in DM patients. Poor blood sugar control significantly increases the risk of readmission (28). Blood sugar concentration is also associated with mortality, as patient with patients with low blood sugar levels are more likely to be readmitted within 30 days of discharge. Severe hypoglycemia can result in serious macrovascular and microvascular problems and death (29).Hyperglycemia has been identified as an independent predictor of 30-day readmissions, particularly in elderly diabetes patients undergoing surgery. (30). The study results showed that most readmission respondents with

readmissions within ≤ 30 days (51.7%) had received inadequate educational strategies. DM education is critical in DM management, enabling patients to practice effective self-management and prevent DM complications. Evidence supports the notion that patients receiving high-quality education during their treatment have shorter treatment periods and lower readmission rates than those not. Health education is vital to DM patient care, aiming to enhance patients' knowledge and understanding of managing their condition post-discharge (31). Education is crucial in raising awareness, protecting health, and improving quality of life (32). To reduce the risk of readmission in diabetes, diabetes education should be complemented by effective individual post-discharge planning, coordination with referral services, adjustments in therapy, and regular outpatient follow-ups with specialists (33). The study also indicated that respondents with good diet management were predominantly those with readmissions > 90 days (58.3%), while respondents with poor diet management accounted for the majority of readmissions within ≤ 30 days (50.9%). Diet management is a pillar of effective diabetes self-management. Previous studies have demonstrated that poor dietary compliance significantly increases the incidence of readmissions. Patients with poor dietary adherence are more likely to experience multiple hospital readmissions within a month, often accompanied by complications (34). A strong relationship exists between adherence to dietary guidelines and improved quality of life among individuals with T2DM. Patient compliance in adhering to a DM diet is important in stabilizing blood sugar levels (35). Furthermore, HbA1c levels can prevent diabetes complications. Increasing knowledge, attitudes and practices to diet management practices can improve disease control (36). This study revealed that more than half of the respondents (55.98%) exhibited poor dietary management. Coupled with the observation that most respondents also received inadequate educational strategies, a correlation between ineffective education and poor diet management becomes apparent. Inadequate dietary education post-discharge can lead to poor diet practices, such as excessive carbohydrate intake triggering hyperglycemia or overly restrictive food practices resulting in hypoglycemia. The study further found that 56.2% of respondents with

readmissions within ≤ 30 days had DM complications. Complications were identified as a fivefold predictor of readmissions in T2DM patients ($OR=5.330$), compared to other factors such as unstable blood sugar levels ($OR=4.468$) and inadequate educational strategies ($OR=3.860$). The findings align with prior research highlighting acute diabetes complications as significant predictors of readmission and mortality in DM patients. Chronic hyperglycemia, resulting from poor blood sugar control, damages various organs and systems, exacerbating complications and reducing patients' quality of life (37). Complications are risk factors for hospital readmissions in T2DM. Approximately 40% of readmission patients have at least one diabetes microvascular complication, and approximately 50% have one macrovascular complication (38). Previous research corroborates those comorbidities and complications are one of the predictors of unplanned readmissions in adult DM patients within 30 days post-discharge. Insulin resistance in diabetes patients causes hyperglycemia, which can trigger atherosclerosis lesions, a major cause of cardiovascular disease (3). T2DM patients have inadequate insulin production to meet the needs of glucose transport into cells, leading to acute and chronic complications. Although this study did not specifically examine the types of DM complications, previous research explained that acute complications in T2DM patients include diabetic ketoacidosis, diabetic coma, hypoglycemia and hyperglycemia. Hypoglycemia, a major complication in diabetes treatment, may result from incorrect insulin dosage, excessive physical exercise, or lack of food or carbohydrate intake. Hyperglycemia, a serious and life-threatening complication of diabetes, may stem from skipped medication, insufficient dosing, excessive consumption of sugary foods or infection. Chronic complications include macroangiopathy, retinopathy, nephropathy, neuropathy, diabetic foot, and increased susceptibility to infection (39). The complications due to T2DM increase the rate of hospitalization, death and disability. Poorly managed T2DM can lead to severe complications, such as blood coagulation disorders, retinopathy, hypertension, chronic kidney disease, and leg ulcers. These complications substantially reduce productivity and life expectancy (40). The findings of this study are needed for nurses and diabetic

patients, including communities to provide health education and training regarding to diabetic management and doing follow-up to evaluate and monitor the patient's capability to care themselves. It is a linked with the previous study suggested that continuous training on early recognition of diabetes should be extended to schools and community elements that could be delivered through health campaigns and information on any social medias. Trainings and follow-up for lay people particularly for diabetic patients to improve their health care are a critical issue for the future (41).

Conclusion

Several factors may contribute to the readmission of T2DM patients, including imbalances in blood sugar levels, diet management, physical activity, therapy adherence, and complications. This study found that diabetes-related complications are significantly associated with the readmission of T2DM patients, with complications increasing the likelihood of readmission by 5.3 times compared to other factors. The study findings revealed that more than half of the respondents (57.1%) experienced complications, such as hypoglycemia, hypertension, heart failure, kidney failure, diabetic wounds and ketoacidosis.

Ethic Approval: The research was approved by the Ethics Committee of Nursing research Faculty of Nursing, Universitas Syiah Kuala, Banda Aceh (No:112009161023).

Limitations: Small sample size due to time frame and cost available are limitations in this study were reported. Several factors could be related to readmission patients diabetic such as complication diabetic, blood sugar, education strategy, diet management, physical exercise, and compliance therapy, thereby it is necessary about follow-up, education and training related to management diabetic for the patients and their communities.

Conflict of Interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article.

Authors' Contribution: CH Conceptualization, methodology, writing – review and editing writing and final approval,

AM (Data collection and processing, data analysis, writing original draft), FF Writing, review and editing, critical review, and writing and final approval: all authors.

Declaration on the Use of AI: None.

Funding: None.

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Received: 29 January 2025

Accepted: 19 March 2025

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