

DIABETIC FOOT ULCERS AND FALL RISK IN PEOPLE WITH TYPE 2 DIABETES MELLITUS

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ABSTRACT

Patients with diabetic foot ulcers (DFU) have a higher risk of falling than others. The risk of falling for patients with diabetes mellitus (DM) not only has a direct injurious effect but also psychological impacts such as anxiety about falling. This study is important as it could provide information for patients and nurses for the prevention of DFU and fall risk in diabetic patients. This study aims to determine the risk factors for DFU and the fall risk of patients with type 2 DM with or without peripheral neuropathy. This is a quantitative study that applied a cross-sectional approach and was conducted at BLUD RSUD dr. Ben Mboi from April to June 2020 (n = 51). The convenience sampling method was used with a set of questionnaires that included demographic characteristics, diabetic foot screening, a risk stratification form, and Morse scale. The logistic regression test results showed that there were significant relationships between claudication (AOR: 8.409, 95% CI 1.664-42.500, p value 0.010) and history of previous DFU (AOR: 5,680, 95% CI 1,151-28,035, p value 0.033) with DFU. The results also showed that there were significant relationships between hypertension (AOR: 0.152, 95% CI 0.028-0.834, p value 0.030) and DFU, (AOR: 11.392, 95% CI 1.277-101.651, p value 0.029) with fall risk for patients with type 2 DM. Therefore, it is necessary to assess the risk factors for DFU and fall risk in patients with DM with or without peripheral neuropathy

Keywords: Diabetic foot ulcer; DM type 2; fall risk



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INTRODUCTION

Diabetes mellitus (DM) is a world health problem that can lead to increased morbidity and mortality due to complications. In 2017, 425 million adults worldwide lived with DM, 75% of which came from low and middle-income countries. Indonesia is in sixth place in the world ranking of adult DM sufferers, at 6.3% of the population. Moreover, DM causes 4 million deaths due to complications (IDF, 2017).

Diabetic foot ulcers (DFU) are one of the complications of DM that often occur in about 15% of DM patients and 15-20% of them have resulted in amputations (Fawzy et al., 2019; Mariam et al., 2017). Based on a systematic review in 2017, the prevalence of ulcers in diabetic patients ranges from 3% to 13% globally (Abdissa et al., 2020). The prevalence of DM in Manggarai Regency in 2019 was 535 people and the average person treated with or without DFU at BLUD dr. Ben

Mboi Hospital was as many as 17 patients every month (Dinas Kesehatan Kabupaten Manggarai, 2019).

Diabetic foot ulcers are a serious complication of DM as it causes an increase in morbidity and mortality rates and affects quality of life. The International Diabetes Federation estimates that every 30 seconds, at least one limb of a DM patient is amputated due to DFU. The prevalence of DFU in Indonesia is at about 15%, and the rate of amputation is 30%. 80% of the hospitalization cases of DM are because of DFU (Oktorina et al., 2019). Another study in Indonesia conducted by Yusuf et al. (2016) showed that 54.4% of the patients sampled with type 2 DM had a risk for DFU and the prevalence of DFU was 12% from a total of 249 respondents. Patients with DFU had a more than twofold increase in mortality compared with diabetic patients without ulcers. Long-term DFU requires lengthy medical care and disability

due to amputation. In addition, treatment costs for DFU are expensive (Abdissa et al., 2020; Mariam et al., 2017).

Several factors are attributed to the appearance of DFU in DM patients. Some of these factors include neuropathy, trauma to the legs, and peripheral vascular disease. Diabetic peripheral neuropathy puts DM patients at risk of developing DFU due to the reduced sensory role of the foot (Reeves et al., 2019). Diabetic foot ulcers also arise due to non-modifiable and modifiable risk factors. Risk factors that cannot be modified include age and duration of DM (≥ 10 years). Whereas modifiable risk factors include neuropathy (sensory, motor, peripheral), obesity, hypertension, uncontrolled levels of glycated hemoglobin (HbA1c) and blood glucose, smoking habits, non-adherence to DM diet, lack of physical activity, poor foot care, and use of inappropriate footwear (Prabowo et al., 2017).

Decreased sensory function due to neuropathy or retinopathy can lead to an increased risk of falls in people with diabetes. The risk of falling increases by 52-81% for DM patients (Yang et al., 2016). Patients with DFU have a higher risk of falling than patients with DM without DFU. This study differs from previous research because other factors than DFU that could increase the fall risk in patients with DM such as age, gender, and hypertension are examined.

A previous study only examined the prevalence and risk factors of DFU but did not examine the further impact of DFU on the risk of falls in DM patients (Yusuf et al., 2016). Another retrospective study of 40,000 diabetic patients who had diabetic ulcers (Mean \pm SD age: 63.5 ± 10.6 years) found that these patients have a twofold risk of falling (Odds ratio: 2.26%, 95% CI: 1.96-2.6) and three times the risk of fracture (Odds ratio: 3.65%, 95% CI: 2.59-5.15) compared with diabetic patients without diabetic ulcers (Mean \pm SD age: 64.4 ± 11.5 years) (Reeves et al., 2019). The sensory deficit in diabetic ulcers put patients with and without diabetic neuropathy at risk of falling with an adjusted odds ratio of experiencing injury in the neuropathy group being 15.0 compared to the control group (Reeves et al., 2019). The consequences of a fall in DM patients include fractures and poor prognosis of the rehabilitation process, which can affect the patients' quality of life (Yang et al., 2016).

Patients living with DFU have a poor quality of life, which can lead to reduced activity, social isolation, sleep disturbances, reduced productivity, pain, and depression, which also contributes to an increased risk of falling. Therefore, nurses need to assess the risk factors associated with DFU and identify the fall risks of patients with DM with or without DFU on a routine basis to detect and treat DFU early to minimize complications, reduce the risk of falls, and increase quality of life (ACE, 2019).

Thus, based on the concepts and problems stated above, it is necessary to conduct research on the risk factors for DFU and the fall risks of type 2 DM patients with or without DFU. The risk factors for DFU will be examined because DFU can decrease physical activity in patients with DM, results in poor glycemic control, and increases the risk of falls. Previous studies in Indonesia have only examined the quality of life of patients with DFU, but there were no studies that assessed the risk of falls in patients with or without DFU (Kusnanto, Dismalyansa, Pardanie, Retnayu, Arifin, 2019). Furthermore, this study aims to provide information on the preventive measures that can be taken to prevent diabetic ulcers and prevent falls. The results of this study are expected to contribute to the development of standard operating

procedure policies in the field of nursing, such as conducting mandatory assessments of DM patients with or without peripheral neuropathy and their risk for DFU and the risk of falling.

METHOD

Study Design

This is a quantitative study with a cross-sectional study design. This study was conducted at BLUD RSUD dr. Ben Mboi.

Sample

The population in this study were patients with type 2 DM who were treated at the BLUD RSUD dr. Ben Mboi Ruteng from April to June 2020. The total sample used was 51 respondents. The convenience sampling technique was implemented based on certain inclusion and exclusion criteria. The inclusion criteria included: type 2 DM patients who were admitted to the BLUD RSUD dr. Ben Mboi Ruteng with or without diabetic ulcers, 24-65 years of age, *composmentis* awareness, and willing to be involved in the study. The exclusion criteria are as follows: diabetic retinopathy and diabetic patients with amputations in both extremities (except finger amputations).

Instrument

The instruments used were questionnaires which consisted of a diabetes foot screening questionnaire, a risk stratification form that was adapted by the New Zealand Society for Study of Diabetes (NZSSD), and a Morse scale questionnaire which was translated into Indonesian and tested for validity and reliability (Garrett et al., 2010; Strini et al., 2021). The diabetes foot screening questionnaire and risk stratification form were used to identify the factors associated with the risk of DFU. This questionnaire gathered information on the identity of the respondents: name, gender, age, weight, height, body mass index (BMI); clinical factors include: history of hypertension, medication (insulin, oral anti-diabetics), random blood glucose, history of smoking, and duration of diabetes; diabetes foot screening includes: neurological factors, vascular tests, risk factors (history of previous DFU, amputation, significant changes in foot structure, foot care), and active foot diseases including active ulceration and suspected Charcot foot.

In this study, the factors associated with DFU include duration of diabetes, smoking, random blood glucose, neuropathy, history of previous DFU, claudication, and suspected Charcot foot. Duration of diabetes was defined as the length of time the respondent has had type 2 DM since being diagnosed by a doctor. The duration of diabetes was also classified into two categories, namely, < 5 years and ≥ 5 years. Smoking habits were also categorized into two, namely "yes" if the respondent has a smoking habit and "no" if the respondent has never smoked. Random blood glucose was defined as the result of measuring blood glucose levels conducted at any time without fasting and regardless of when the respondent last ate. The results of the blood sugar test were also categorized into two, namely, $< \text{mean (402)}$ and $\geq \text{mean (402)}$.

Neuropathy is defined as the loss of protective sensation function in the lower extremities. Neuropathy measurements were obtained by using a 10 mg monofilament at 12 locations on both feet. The results of neuropathic measurements were categorized into two, namely "yes" if there was loss of protective sensation (LOPS) in < 11 locations detected in both legs and "no" if 11-12 locations had no loss of protective sensation (Garrett et al., 2010).

History of ulcers was categorized into two categories, namely "yes" if the respondent had experienced DFU and "no" if the respondent has never had DFU. Claudication reflects one of the signs and symptoms of peripheral artery disease (PAD) and is characterized by pain in the calf, thigh, and buttock areas. Claudication is categorized into two, namely "yes" if there is pain in the calf, thigh, and buttocks during rest or activity and "no" if there is no pain in the calf, thigh, and buttock area during rest or during activities (Thulasikumar & Vijayasathy, 2017). Whereas suspected Charcot foot is defined as acute inflammation of the foot and is characterized by swelling, redness, hot feet with or without pain affecting the bones, joints, soft tissues of the feet, and ankles (Garrett et al., 2010; Rogers et al., 2011). Diabetic foot ulcers are defined as the presence of active ulceration with hot, swollen, and red feet with or without pain, infection, or ischemia in the lower extremities (Garrett et al., 2010).

The Morse scale questionnaire was used to identify the risk of falls in patients with type 2 DM. The risk of falling was categorized into two, namely "yes" if the respondent has a low-high risk of falling with a Morse scale score of ≥ 25 and "no" if the respondent has no risk of falling with a Morse scale score of < 25 (Strini et al., 2021).

Data Collection

Before the research was conducted, the researcher explained the purpose of the study and obtained informed consent from the participants. Data were collected by researchers from April to June 2020.

Data Analysis

The Chi-square test was conducted to determine the relationship between length of suffering from diabetes, smoking habits, random blood glucose level, neuropathy, history of previous DFU, claudication and suspected Charcot foot with DFU, and to determine the relationship between age, gender, hypertension and DFU with a risk of falling for patients with type 2 DM at BLUD RSUD dr. Ben Mboi. Binary logistic regression was used to predict the dependent variable by looking at the relationship between the independent variable and the dependent variable.

Ethical Consideration

This research has received an ethical agreement from the ethics commission of the Catholic University of Indonesia St. Paul Ruteng (Registration number: 07/SK-IIIa / WAREK I-02/k / 02/2020).

RESULTS

Table 1. Characteristics of respondents with type 2 DM patients at BLUD dr. Ben Mboi Hospital (n=51)

Variables	n	%
Age		
24-45	15	29.4
>45	36	70.6
Gender		
Female	27	52.9
Male	24	47.1
Body Mass Index/BMI (kg/m ²)		
< 18.5	6	11.8

Variables	n	%
18.5-25.0	35	68.6
>25.0	10	19.6

Based on Table 1, 36 respondents (70.6%) were > 45 years old and 27 respondents (52.9%) were female. The respondents that fall into the normal weight category based on BMI 18.5-25.0 were 35 respondents (68.6%) and those that fell into the obese category based on BMI > 25.0 were 10 respondents (19.6%).

Table 2. Clinical factors in patients with type 2 DM in BLUD RSUD dr. Ben Mboi (n=51)

Variables	n	%
Duration of diabetes (years)		
< 5	38	74.5
≥ 5	13	25.5
Medication		
Oral antidiabetic	13	25.5
Insulin	29	56.9
Oral antidiabetic and insulin	3	5.9
Not taking drugs	6	11.8
Smoker		
Yes	21	41.2
No	30	58.8
Hypertension		
Yes	31	60.8
No	20	39.2
Random blood glucose level		
< mean (402)	32	62.7
\geq mean (402)	19	37.3
Neuropathy		
Yes	28	54.9
No	23	45.1
History of previous DFU		
Yes	27	52.9
No	24	47.1
Claudication		
Yes	26	51
No	25	49
Suspected Charcot foot		
Yes	13	25.5
No	38	74.5
Diabetic foot ulcers (DFU)		
Yes	17	33.3
No	34	66.7
Fall risk		
No risk	14	27.5
Risk of falling (low-high)	37	72.5

As shown in Table 2, a total of 38 respondents (74.5%) have had DM type 2 for < 5 years and the diabetes drug that is used the most is insulin, with 29 respondents (56.9%). Moreover, it was found that 21 respondents (41.2%) had a smoking habit, hypertension was also seen in 31 respondents (60.8%), 19 respondents (37.3%) had the mean random blood glucose level of > 402 , and 28 respondents (54.9%) had neuropathy. As much as 26 (51%) respondents experienced claudication, 17 respondents (33.3%) had DFU, and a total of 37 respondents (72.5%) had the risk of falling.

Table 3. Bivariate analysis of factors associated with DFU in type 2 DM patients at BLUD RSUD dr. Ben Mboi (n=51)

Variables		Diabetic Foot Ulcer				OR	95 % CI	p value
		DFU		No Ulcer				
		n	%	n	%			
Duration of diabetes (years)	≥ 5	5	38.5	8	61.5	1.354	0.365-5.019	0.650
	< 5	12	31.6	26	68.4			

Variables		Diabetic Foot Ulcer				OR	95 % CI	p value
		DFU		No Ulcer				
		n	%	n	%			
Smoking	Yes	9	42.9	12	57.1	2.063	0.631-6.739	0.227
	No	8	26.7	22	73.3			
Random blood glucose	≥ mean (402)	10	52.6	9	47.4	3.968	1.160-13.579	0.024
	< mean 402)	7	21.9	25	78.1			
Neuropathy	Yes	9	32.1	19	67.9	0.888	0.276-2.857	0.842
	No	8	34.8	15	62.2			
History of previous DFU	Yes	14	51.9	13	48.1	7.538	1.811-31.373	0.003
	No	3	12.5	21	87.5			
Claudication	Yes	14	53.8	12	46.2	8.556	2.044-35.810	0.002
	No	3	12	22	88.0			
Suspected Charcot foot	Yes	8	61.5	5	38.5	5.156	1.344-19.779	0.012
	No	9	23.7	29	76.3			

Note: OR = Odds Ratio; CI: Confidence Interval; DFU: Diabetic Foot Ulcers

According to Table 3, the bivariate analysis showed that there was a significant relationship between random blood glucose (OR: 3,968, 95% CI 1.160-13.579, p value 0.024), history of previous DFU (OR: 7,538, 95% CI 1,811-31,373, p value 0.003), claudication (OR: 8.556, 95% CI 2.044-35,810, p value 0.002), and suspected Charcot foot (OR: 5,156, 95%

CI 1,344-19,779, p value 0.012) with DFU. As exhibited in Table 4, the results of the bivariate analysis showed that there was a significant relationship between hypertension (OR: 0.176, 95% CI 0.034-0.898, p value 0.025) and DFU (OR: 9.905, 95% CI 1.717-83.799, p value 0.015) with the risk of falling for patients with type 2 DM.

Table 4. Bivariate analysis of factors associated with the risk of falling in type 2 DM patients at BLUD RSUD dr. Ben Mboi (n=51)

Variable		Risk of falling				OR	95 % CI	p value
		Yes		No				
		n	%	n	%			
Age (years)	24-45	11	73.3	4	26.7	1.058	0.272-4.109	0.935
	>45	26	72.2	10	27.8			
Gender	Female	17	63.0	10	37.0	0.340	0.090-1.282	0.104
	Male	20	83.3	4	16.7			
Hypertension	Yes	19	61.3	20	38.7	0.176	0.034-0.898	0.025
	No	18	90.0	2	10			
Diabetic foot ulcers	DFU	16	94.1	1	5.9	9.905	1.171-83.799	0.015
	No	21	61.8	13	38.2			

Note: OR = Odds Ratio; CI: Confidence Interval; DFU: Diabetic Foot Ulcers

As exhibited in Table 4, the results of the bivariate analysis showed that there was a significant relationship between hypertension (OR: 0.176, 95% CI 0.034-0.898, p value 0.025)

and DFU (OR: 9.905, 95% CI 1.717-83.799, p value 0.015) with the risk of falling for patients with type 2 DM.

Table 5. Multivariate analysis of factors associated with DFU in type 2 DM patients at BLUD RSUD dr. Ben Mboi (n=51)

Variable		B	S.E	Wald	df	p value	Exp (B)/AOR	95,0% C.I. for Exp (B)	
								Lower	Upper
Step 1a	Claudication	2.129	0.827	6.635	1	0.010	8.409	1.664	42.500
	History of previous DFU	1.737	0.815	4.547	1	0.033	5.680	1.151	28.035
	Random blood glucose	1.328	0.765	3.016	1	0.082	3.755	0.843	16.903
	Constant	-6.737	2.157	9.754	1	0.002	0.001		

Binary Logistic Regression

Note: AOR = Adjusted Odds Ratio; CI: Confidence Interval; DFU: Diabetic Foot Ulcers

According to Table 5, the multivariate analysis results showed that there was a significant relationship between claudication (AOR: 8.409, 95% CI 1.664-42.500, p value

0.010) and history of previous DFU (AOR: 5.680, 95% CI 1.151-28.035, p value 0.033) with DFU.

Table 6. Multivariate analysis of factors associated with the risk of falling in patients with type 2 DM at BLUD RSUD dr. Ben Mboi (n=51)

Variable		B	S.E	Wald	df	p value	Exp (B)/AOR	95,0% C.I. for Exp (B)	
								Lower	Upper
Step 1a	Hipertension	-1.882	.868	4.703	1	0.030	0.152	0.028	0.834
	DFU	2.433	1.117	4.746	1	0.029	11.392	1.277	101.651

Variable	B	S.E	Wald	df	p value	Exp (B)/AOR	95,0% C.I. for Exp (B)	
							Lower	Upper
Constant	-2.868	2.288	1.572	1	0.210	0.057		

Binary Logistic Regression

Note: AOR = Adjusted Odds Ratio; CI: Confidence Interval; DFU: Diabetic Foot Ulcers

The results of the analysis are shown in Table 6 and there is a significant relationship between hypertension (AOR: 0.152, 95% CI 0.028-0.834, p value 0.030) and DFU (AOR: 11,392, 95% CI 1.277-101.651, p value 0.029) with the risk of falling for patients with type 2 DM.

DISCUSSION

Our bivariate analysis results showed that one factor that was significantly associated with the risk of DFU was random blood glucose level. A study conducted by Almaramhy et al. (2018) reported that 144 (57.1%) patients had fasting blood sugar levels of more than 220 mg/dl and only 14 (5.6%) patients had fasting blood sugar levels that were within normal limits. In addition, as many as 131 (51.9%) patients had grade 4 and grade 5 DFU according to the Meggitt-Wagner Ulcer Classification System. Research conducted by Stratton et al. (2010) also showed that there was a significant relationship between hyperglycemia with the risk of microvascular and macrovascular complications in patients with type 2 DM.

Diabetic foot ulcers are one of the microvascular complications of type 2 DM. Our results showed that the mean random blood glucose of the patient was 402 mg/dl and of the 19 patients (37.3%) with the random blood glucose level of > 402, as many as 10 patients (52.6%) had DFU. This indicates that poor blood sugar control and hyperglycemic conditions can cause type 2 DM patients to have a higher risk of developing DFU with an odds ratio of 3.698.

Hyperglycemia is a risk factor that causes the development of DFU. This occurs due to the contribution of hyperglycemia to peripheral neuropathy and microvascular complications. However, based on the results of our multivariate analysis of random blood glucose, it did not significantly affect DFU. This is because the results of measuring random blood glucose can be influenced by several factors, including the quantity and quality of the food consumed. Thus, it could not reliably reflect glycemic control in type 2 DM patients. In addition, a more effective way of controlling the glycemic levels associated with DFU is by measuring the value of HbA1c and fasting blood sugar levels. This is supported by a study conducted by Fawzy et al. (2019) who reported that there was a significant relationship between poor glycemic control and HbA1c values and DFU (OR 1.1, 95% CI (1.05-1.3) p value 0.002.

Next, based on our results, one of the factors that significantly affects the occurrence of DFU is the suspected Charcot foot. This is supported by Yazdanpanah et al. (2018)'s study which reported that there was a significant relationship between foot deformity and DFU with a p value of 0.001. Foot deformities and structural abnormalities such as Charcot foot have an important role during DFU. Charcot foot contributes to abnormal plantar pressure that predisposes to ulcers (Alexiadou & Doupis, 2012).

Another risk factor for DFU is a history of previous ulcers or amputations (Alexiadou & Doupis, 2012; Yazdanpanah et al., 2018). Our results showed that there is a significant relationship between history of ulcers and DFU. This study is

in line with a study conducted by Yazdanpanah et al. (2018) which reported that there was a significant relationship between a history of previous ulcers and amputation with DFU with a p value of 0.003. This occurred because patients with a history of DFU were likely to experience micro-macrovascular disorders and peripheral neuropathy, which are risk factors for DFU.

Our study indicated that another significant factor associated with DFU is claudication. Claudication is one of the signs and symptoms of peripheral artery disease (PAD), which is characterized by pain in the calf, thigh, and buttocks area. Pain will disappear when resting and will reappear during activities such as walking or exercising. Some patients may also experience extreme symptoms such as pain during rest accompanied by ulcers and gangrene (Thulasikumar & Vijayasathy, 2017). Patients with DM have 2-8 times the risk of developing peripheral artery disease compared to individuals who do not have diabetes nor a predictor of DFU (Alexiadou & Doupis, 2012). In this study, claudication reflects the presence of peripheral artery disease that contributes to DFU. Diabetic foot ulcers can occur due to peripheral arteriosclerosis which can inhibit blood flow in the lower extremities (Alexiadou & Doupis, 2012; Khan et al., 2018).

Diabetic foot ulcers can also occur due to non-modifiable risk factors, including the duration of DM (≥ 10 years) (Prabowo et al., 2017). However, our results showed that there was no significant relationship between the duration of diabetes (p value 0.652) with DFU. Our study showed that most respondents (74.5%) have had DM for < 5 years and as many as 12 of these respondents (31.6%) had DFU, while out of the 13 respondents (25.5%) that have had DM for ≥ 5 years, five respondents (38.5%) had DFU. This suggests that DFU does not only occur in patients who have been long diagnosed with type 2 DM (≥ 5 years), but that it can also occur in patients who are newly diagnosed with DM (< 5 years). Conversely, Cardoso et al. (2019), reported that there was a significant relationship between the duration of DM and DFU with a p value of 0.037. Another study also found that the duration of DM has a significant relationship to the risk of complications in DM patients, one of which is the risk of DFU (almost 6.5 times) (Fawzy et al., 2019). Although a long period of suffering from DM is not a modifiable risk factor for DFU, the results indicate that DM needs to be identified early and precautions must be made against DFU in all DM patients regardless of the duration since their diagnosis (Fawzy et al., 2019).

Peripheral neuropathy is not only a common complication of DM but also a major cause of DFU (Ji et al., 2016). However, our results have shown that there was no significant relationship between neuropathy (p value 0.842) and DFU. In our study, 28 respondents (54.9%) had neuropathy, and out of these respondents, nine of them (32.1%) had DFU. Meanwhile, 23 respondents (45.1%) did not experience neuropathy and out of these respondents as many as eight respondents (34.8%) had DFU. This suggests that DFU could occur in not only DM patients with neuropathy, but also in DM patients without neuropathy. This study found that there was no significant relationship between neuropathy and DFU.

This is most likely because the number of respondents who experience DFU is too small (33.3%), therefore it cannot represent the population of DM patients who experience DFU.

However, previous research has shown that there is a significant relationship between peripheral neuropathies with DFU (Abdissa et al., 2020; Yazdanpanah et al., 2018). The results of this study are not consistent with a study conducted by Mariam et al. (2017) which reported that neuropathy has a strong association with DFU in diabetic patients. Diabetic patients who have neuropathy are 21.7 times more likely to experience DFU compared to DM patients without neuropathy (AOR = 21.76; 95% CI: 8.43, 57.47) (Mariam et al., 2017).

Diabetic neuropathy is a neurological disorder associated with diabetes. Hyperglycemia causes nerve damage, including to the peripheral nerves which can cause peripheral neuropathy (Mariam et al., 2017; Yazdanpanah et al., 2018). Peripheral neuropathy causes mechanical or temperature disturbances to the extremities by reducing sensation in the legs. In addition, peripheral neuropathy also causes hyperextension in the metatarsophalangeal joints, which occurs due to loss of function of the leg muscles and further increases pressure on the toes, thereby contributing to the risk of developing DFU (Ji et al., 2016). Therefore, because peripheral neuropathy is one of the modifiable risk factors for DFU, it is necessary to identify neuropathic disorders in DM patients and control their glycemic levels to prevent complications from hyperglycemia and DFU.

Furthermore, previous studies have found that a smoking habit is a risk factor for developing DFU in DM patients (Prabowo et al., 2017; Xia et al., 2019). However, our results showed that there was no significant relationship between smoking (p value 0.227) and DFU. In this study, 21 respondents smoked (41.2%) and out of these respondents, nine of them (42.9) had DFU. Meanwhile, there were 30 (58.8%) non-smoking respondents and from these respondents, as many as eight individuals (26.7%) had DFU. This indicates that the incidence of DFU not only occurs in DM patients who have a smoking habit but also in diabetic patients who do not smoke.

The results of this study were supported by research conducted by Mariam et al. (2017), Fawzy et al. (2019), and Cardoso et al. (2019) who reported that there was no significant relationship between smoking and DFU. According to Xia et al. (2019), research that directly examines the effect of smoking on DFU in DM patients is still very limited. Nevertheless, smoking has a broad effect on all stages of diabetic foot ulceration, from the initial stage to the healing stage. Smoking can trigger microvascular disorders such as vasodilation disorders, and the nicotine content in cigarettes can stimulate the sympathetic nervous system and trigger atherosclerosis in blood vessels in the lower extremities. In addition, smoking can exacerbate sensory, motor, autonomic, and peripheral neuropathy, which can lead to DFU. Therefore, it is necessary to control risk factors such as smoking in diabetic patients to prevent the development of DFU.

The results have shown that hypertension is significantly associated with the risk of falling in type 2 DM patients. The results of this study were supported by the research conducted by Rashedi et al. (2019) which reported that there was a significant relationship between hypertension and the risk of falling for patients with DM with a p value of 0.004.

Hypertension can have a negative effect on balance, damage large arteries, and reduce microcirculation in certain functional areas. This will result in impaired reception of stimuli from the periphery and the environment, thereby reducing the ability to maintain a stable posture and disrupting mechanisms for controlling postural balance. The symptoms that arise due to hypertension such as headaches, chest pain, shortness of breath, blurred vision, and limb weakness are factors that can affect anatomical and functional changes that affect postural balance. Postural balance is an important factor in preventing the risk of falling (Acar et al., 2015). This risk is increased in DM patients with hypertension compared with DM patients without hypertension. This is because hypertension increases micro- and macrovascular complications in DM patients (Tsimihodimos et al., 2018). One of the microvascular complications that can increase the risk of falls in DM patients is retinopathy and neuropathy.

Based on our study, another factor that has a significant association with the risk of falling for patients with type 2 DM is DFU. Type 2 DM patients with DFU have 9,905 times the risk of falling compared with diabetes patients without DFU. The results of this study were supported by Reeves et al. (2019) which reported that diabetic patients with active leg ulcers have a higher risk of falling compared to diabetic patients without active ulcers.

Peripheral neuropathy is a risk factor for DFU in DM patients. Peripheral neuropathy results in sensory deficits that contribute to cumulative pressure in the plantar area. Sensory deficits in diabetic feet with and without neuropathy contribute to the risk of falls with an odds ratio (OR) of 15.0 in the neuropathy group compared with the control group (Reeves et al., 2019).

In this study, age and gender did not have a significant relationship with the risk of falling for patients with type 2 DM with a p value of 0.935 and p value of 0.104. The results of this study are not in line with the research conducted by Azidah et al. (2012) and Roman de Mettelinge et al. (2013) who reported that there was a significant relationship between age and the risk of falling for patients with type 2 DM with a p value of < 0.05. According to Azidah et al. (2012) and Roman de Mettelinge et al. (2013), diabetic patients of elderly age of > 75 years have a higher risk of falling. This is because elderly diabetic patients would have many other complications that worsen their physical condition and cognitive abilities. This puts elderly diabetic patients at risk for impaired balance which contributes to their risk of falling (Hewston & Deshpande, 2016; Roman de Mettelinge et al., 2013). In this study, the average age of the respondents is in the early elderly category (> 45 years). This does not represent a condition of old age that is associated with the risk of falling for patients with type 2 DM. However, the risk of falling needs to be identified in DM patients of all ages because DM patients have decreased sensorimotor function as well as musculoskeletal or neuromuscular disorders that contribute to the risk of falling (Crews et al., 2013).

Furthermore, another study conducted by Azidah et al. (2012) reported that there was a significant relationship between sex and the risk of falling in diabetic patients with a p value of 0.009. According to Azidah et al. (2012), women have a higher risk of experiencing falls compared to men with an OR of 2.54.

CONCLUSION AND RECOMMENDATION

The limitations of this study are the small number of respondents and the non-probability sampling method used because the results obtained can lead to bias in decision making. Nevertheless, the selection of respondents in this study was based on inclusion and exclusion criteria to ensure that the research results could accurately represent the population.

Overall, the prevalence of DFU in type 2 DM patients at BLUD dr. Ben Mboi is high. Random blood glucose level, history of DFU, claudication, and suspected Charcot foot are factors associated with DFU. Moreover, only claudication and history of previous DFU are factors that can predict DFU. Therefore, nurses need to conduct an assessment for DFU for all DM patients with or without neuropathy to minimize the incidence of DFU.

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