Association Between Foot Care and the Incidence of Diabetic Foot Ulcers in Patients with Diabetes Mellitus

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ARTICLE INFO	ABSTRACT/ ABSTRAK
	ABSTRACT. *Diabetes mellitus (DM) is a chronic disease that can lead to serious complications, one of which is diabetic foot ulcer (DFU). Inadequate foot care increases the risk of ulcer development; therefore, its association needs to be examined scientifically. This study aimed to analyze the association between foot care and the incidence of diabetic foot ulcers in patients with diabetes mellitus. A correlational analytical design with a cross-sectional approach was employed. The sample consisted of 60 patients with diabetes mellitus selected using purposive sampling. Foot care data were collected using the Nottingham Assessment of Functional Footcare (NAFF) questionnaire, while the incidence of diabetic foot ulcers was assessed through an observation checklist. Data were analyzed using Spearman's rho correlation test. The results demonstrated a statistically significant association between foot care and the incidence of diabetic foot ulcers ($p = 0.008 < \alpha = 0.05$). Patients with poor foot care tended to experience diabetic foot ulcers with greater severity. In conclusion, appropriate foot care plays an important role in the prevention of diabetic foot ulcers. Therefore, health education and the establishment of routine foot care practices should be strengthened to reduce the risk of complications and improve the quality of life of patients with diabetes mellitus.*
	ABSTRAK. Diabetes melitus (DM) merupakan penyakit kronis yang dapat menimbulkan komplikasi serius, salah satunya ulkus kaki diabetik. Perawatan kaki yang tidak adekuat meningkatkan risiko terjadinya ulkus, sehingga perlu dikaji hubungannya secara ilmiah. Penelitian ini bertujuan untuk menganalisis hubungan perawatan kaki dengan kejadian ulkus kaki diabetik pada pasien diabetes melitus. Penelitian menggunakan desain analisis korelasi dengan pendekatan *cross sectional*. Sampel berjumlah 60 pasien diabetes melitus yang dipilih menggunakan teknik *purposive sampling*. Data perawatan kaki dikumpulkan menggunakan kuesioner NAFF, sedangkan kejadian ulkus kaki diabetik dinilai melalui lembar observasi. Analisis data dilakukan menggunakan uji statistik Spearman Rho. Hasil penelitian menunjukkan adanya hubungan yang signifikan antara perawatan kaki dengan kejadian ulkus kaki diabetik ($p = 0{,}008 < \alpha = 0{,}05$). Pasien dengan perawatan kaki yang kurang cenderung mengalami ulkus kaki diabetik dengan derajat yang lebih berat. Kesimpulan penelitian ini menunjukkan bahwa perawatan kaki yang baik berperan penting dalam pencegahan ulkus kaki diabetik. Oleh karena itu, edukasi kesehatan dan pembiasaan praktik perawatan kaki secara rutin perlu ditingkatkan untuk menurunkan risiko komplikasi dan meningkatkan kualitas hidup pasien diabetes melitus.

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INTRODUCTION

Diabetes mellitus (DM) is a chronic disease that represents one of the major global health problems, with a markedly increasing prevalence trend. According to the World Health Organization (WHO, 2024), the number of people living with diabetes increased sharply from approximately 200 million in 1990 to 830 million in 2022, with faster growth occurring in low- and middle-income countries. This condition contributes substantially to the global burden of morbidity and mortality, as diabetes can lead to various serious complications, including blindness, renal failure, cardiovascular disease, stroke, and lower-extremity amputation. In addition, diabetes and its complications account for more than two million deaths annually, leading the WHO to classify diabetes as a priority chronic disease requiring sustained prevention and control efforts.

At the national level, Indonesia is among the countries with the highest number of people living with diabetes worldwide. According to the IDF Diabetes Atlas (2025), Indonesia ranked fifth globally, with approximately 20.4 million adults aged 20–79 years living with diabetes in 2024. This number is projected to increase to 28.6 million by 2050, indicating a significant upward trend. These data underscore that diabetes is a serious public health problem in Indonesia, characterized by a continuously increasing prevalence and a high risk of long-term complications. In 2021, the number of people with diabetes in Indonesia was estimated at around 19.5 million, and this figure is expected to rise further in the absence of effective control measures (Ministry of Health of the Republic of Indonesia, 2025).

At the regional level, diabetes mellitus also constitutes a prominent health concern. Data from the South Kalimantan Provincial Health Office indicate that diabetes is among the most prevalent diseases, with a year-to-year increase in cases, rising from 14,282 cases in 2021 to 15,874 cases in 2022 (South Kalimantan Provincial Health Office, 2023). This situation highlights the need for serious attention to the prevention and management of diabetes-related complications within healthcare services.

Diabetic foot (DF) is one of the most serious complications of diabetes mellitus and represents a major public health issue due to its risk of progressing to diabetic foot ulcer (DFU), severe infection, and lower-extremity amputation. The management of DFU requires close monitoring and high-quality care through patient education on glycemic control, wound care, dietary management, and appropriate footwear selection. Regular diabetic foot care, blood glucose monitoring, and periodic foot examinations have been shown to be effective in preventing and controlling DFU, with approximately 50–80% of diabetic foot infections reported to be preventable. Therefore, the prevention and management of DFU require a comprehensive approach and the involvement of a multidisciplinary team to reduce the risk of disability and improve the quality of life of patients with diabetes mellitus (Parveen et al., 2025).

Diabetic foot ulcers not only affect patients' physical condition but also increase economic and psychosocial burdens. Patients with DFU often require long-term treatment, incur high healthcare costs, and experience reduced mobility and quality of life. Consequently, the prevention of diabetic foot ulcers has become a key focus in diabetes mellitus management (Lo et al., 2021; Tauseef Raza et al., 2023).

Foot care is one of the main components of self-care in patients with diabetes and plays a direct role in preventing diabetic foot ulcers. Unlike other factors, such as glycemic control or disease duration, which largely depend on medical interventions, foot care represents a self-managed behavior that can be performed routinely by patients. Foot care

practices include maintaining foot hygiene, conducting regular foot inspections, using appropriate footwear, and preventing injury and infection (Ningrum et al., 2021).

Although foot care has been widely recommended, numerous studies have shown that foot care practices among patients with diabetes mellitus remain suboptimal. Poor practice is influenced by factors such as knowledge level, educational attainment, habitual behaviors, and a lack of continuous health education (H. S. Ningrum & Imamah, 2022). This indicates a gap between recommended foot care practices and patients' actual behaviors in the community.

Preliminary findings from the Diabetic Foot Clinic at RSUD dr. H. Moch Ansari Saleh Banjarmasin revealed that some patients with diabetes mellitus and diabetic foot ulcers had not implemented optimal foot care practices. This condition further confirms the existence of a gap in foot care practices within the local healthcare context and highlights the need for more in-depth scientific investigation.

Based on the above considerations, studies that specifically analyze the association between foot care and the incidence of diabetic foot ulcers among patients with diabetes mellitus at the healthcare service level remain limited. Therefore, this study aimed to examine the association between foot care and the incidence of diabetic foot ulcers as a basis for strengthening health education and preventive efforts against diabetes-related complications.

RESEARCH METHOD

This study employed a correlational analytical design with a cross-sectional approach, in which variables were measured at a single point in time to examine the association between patients' foot care behavior and the incidence of diabetic foot ulcers among patients with diabetes mellitus (DM). The study population consisted of patients with DM and diabetic foot ulcers who visited the Diabetic Foot Clinic at RSUD dr. H. Moch Ansari Saleh Banjarmasin between January and March 2025, totaling 71 patients. The sample size was determined using Slovin's formula, resulting in 60 respondents selected through non-probability sampling using a purposive sampling technique. The inclusion criteria were patients with type 2 diabetes mellitus and diabetic foot ulcers, aged ≥18 years, who were willing to participate in the study and provided written informed consent. The exclusion criteria included patients with cognitive impairment or decreased level of consciousness, patients in critical condition or undergoing intensive care, and those who declined to participate in the study.

Data were collected using the Nottingham Assessment of Functional Footcare (NAFF) questionnaire to assess patients' foot care behavior, which has been tested for validity and reliability in the local population with a Cronbach's alpha value of 0.82 (Ningrum et al., 2021). In addition, an observation checklist was used to assess the incidence of diabetic foot ulcers based on the Wagner classification (grades 0–5). The study was conducted between June and July 2025. Data collection procedures involved questionnaire completion and direct foot examinations performed by the researcher, in accordance with research ethics and with approval from the Ethics Committee of RSUD dr. H. Moch Ansari Saleh Banjarmasin (No. 129/007/IX/EC/KEP/LCBL/2023). Data analysis was performed using SPSS version 26, including descriptive analysis for respondents' characteristics and the distribution of foot care behavior and ulcer incidence, as well as bivariate analysis using Spearman's rho correlation test, as both variables were ordinal and did not meet the assumption of normality. A

significance level of α = 0.05 was applied, with p < 0.05 indicating a statistically significant association between foot care behavior and the incidence of diabetic foot ulcers.

RESULTS

Characteristics of Respondents

Table 1. Frequency Distribution of Respondents by Age

Age (years)	Frequency (n)	Percentage (%)
26–35	3	5.0
36–45	10	16.7
46–55	26	43.3
56–65	16	26.7
> 65	5	8.3
Total	60	100

Based on Table 1, the largest proportion of respondents was aged 46–55 years, comprising 26 respondents (43.3%), while the smallest proportion was aged 26–35 years, with 3 respondents (5.0%).

Table 2. Frequency Distribution of Respondents by Sex

Sex	Frequency (n)	Percentage (%)
Male	29	48.3
Female	31	51.7
Total	60	100

Table 2 shows that most respondents were female, totaling 31 respondents (51.7%), whereas male respondents accounted for 29 respondents (48.3%).

Table 3. Frequency Distribution of Respondents by Educational Level

Educational Level	Frequency (n)	Percentage (%)
No formal education	3	5.0
Elementary school	12	20.0
Junior high school	9	15.0
Senior high school	28	46.7
Diploma III	2	3.3
Diploma IV	2	3.3
Bachelor's degree	4	6.7
Total	60	100

As presented in Table 3, the highest proportion of respondents had a senior high school education, with 28 respondents (46.7%), while the lowest proportion was observed among those with a Diploma IV education, totaling 2 respondents (3.3%).

Table 4. Frequency Distribution of Respondents by Duration of Diabetes Mellitus

Duration of Diabetes Mellitus	Frequency (n)	Percentage (%)
< 5 years	39	65.0
≥ 5 years	21	35.0
Total	60	100

Based on Table 4, most respondents had been living with diabetes mellitus for less than five years, with 39 respondents (65.0%), while 21 respondents (35.0%) had a disease duration of five years or more.

Univariate Analysis

Table 5. Distribution of Foot Care

Foot Care	Frequency (n)	Percentage (%)
Poor	35	58.3
Good	25	41.7
Total	60	100

Table 5 shows that the majority of respondents had poor foot care, accounting for 35 respondents (58.3%), while 25 respondents (41.7%) reported good foot care practices.

Table 6. Distribution of the Incidence of Diabetic Foot Ulcers

Wagner Grade	Frequency (n)	Percentage (%)
Grade 0	2	3.3
Grade 1	26	48.3
Grade 2	17	28.3
Grade 3	7	11.7
Grade 4	4	6.7
Grade 5	4	6.7
Total	60	100

Based on Table 6, most respondents experienced diabetic foot ulcers classified as grade 1, with 26 respondents (48.3%). The lowest proportion was observed in grade 0, with 2 respondents (3.3%).

Bivariate Analysis

Bivariate analysis was conducted to examine the association between the independent and dependent variables using Spearman's rho correlation test, as the data were ordinal and did not meet the assumption of normality. A p-value of < 0.05 was considered statistically significant, indicating acceptance of the alternative hypothesis and rejection of the null hypothesis.

Table 7. Association Between Foot Care and the Incidence of Diabetic Foot Ulcers

Foot Care	Incidence of Diabetic Foot Ulcers													Total		p-value
	Grade 0		Grade 1		Grade 2		Grade 3		Grade 4		Grade 5					
	F	%	F	%	F	%	F	%	F	%	F	%	F	%		
Poor	0	0	11	31.4	13	37.1	5	14.3	4	11.4	2	5.7	35	100		
Good	2	8	15	60	4	16	2	8	0	0	2	8	25	100		0.008
Total	2	3.3	26	43.3	17	28.3	7	11.7	4	6.7	4	6.7	60	100		

Based on Table 7, the results of the Spearman's rho test showed a p-value of 0.008, which is lower than the significance level of $\alpha = 0.05$. Therefore, it can be concluded that there is a statistically significant association between foot care and the incidence of diabetic foot ulcers among patients with diabetes mellitus at the Diabetic Foot Clinic of RSUD dr. H. Moch Ansari Saleh Banjarmasin. Accordingly, the research hypothesis was accepted.

DISCUSSION

The majority of respondents in this study were aged 46–55 years, comprising 26 respondents (43.3%). Aging is associated with a decline in pancreatic beta-cell function responsible for insulin production, as well as increased insulin resistance, which in turn may trigger macroangiopathy and reduced blood circulation in the lower extremities, thereby increasing the risk of diabetic foot ulcers (Saputra et al., 2023). Physiologically, individuals over the age of 40 experience decreased glucose tolerance due to changes in insulin receptors, reduced induction of glucose transporters (GLUT), and anatomical, physiological, and biochemical degeneration that affects organ function, including the kidneys, ultimately contributing to the risk of diabetes-related complications (Ardiyati & Ernawati, 2024; Putri et al., 2025). These findings are consistent with previous studies reporting a higher prevalence of type 2 diabetes mellitus among individuals aged 46–65 years as a result of cumulative metabolic risk factors, reduced physical activity, and decreased muscle mass (Making et al., 2023).

The sex distribution of respondents showed a predominance of females, with 31 respondents (51.7%). Women have a higher risk of developing diabetes mellitus due to hormonal and lifestyle factors. Declining estrogen levels during menopause affect glucose and lipid metabolism and increase insulin resistance, while a history of gestational diabetes mellitus significantly elevates the risk of developing type 2 diabetes mellitus and cardiovascular disease. In addition, obesity and physical inactivity, reflected by a higher body mass index, play an important role in increasing diabetes risk among women (Bian et al., 2000; Cypryk et al., 2005; Kautzky-Willer et al., 2023; Sourij et al., 2012). These conditions increase women's vulnerability to diabetes-related complications, including diabetic foot ulcers (Rohmatulloh et al., 2024).

Most respondents had a senior high school educational background, accounting for 28 respondents (46.7%). Higher educational attainment is associated with better health knowledge, greater awareness of chronic diseases, and improved adherence to self-care practices (Nurdin, 2021; Firdiawan et al., 2022; Fadhilah et al., 2023). Such knowledge enables individuals to recognize symptoms of complications and to take appropriate preventive actions. Previous studies have emphasized that educational level plays a significant role in shaping patients' awareness and actions regarding foot care (Yusra, 2021).

The majority of respondents had been living with diabetes mellitus for less than five years (65.0%). Duration of diabetes influences the risk of chronic complications; the longer the disease persists without adequate glycemic control, the greater the likelihood of developing neuropathy and diabetic ulcers (Nisak, 2021; Selano, 2021; Sani et al., 2023). This finding highlights the importance of early glycemic control from the time of diagnosis to reduce complication risk and to maintain patients' quality of life.

Univariate analysis indicated that patients' foot care behavior remained suboptimal, with 35 respondents (58.3%) not performing foot care adequately. This finding is consistent with the study by Ningrum and Imamah (2022), which reported that most patients practiced foot care only in a general and non-routine manner, underscoring the need for education to improve foot care knowledge. Insufficient information regarding foot care contributes to poor patient adherence, which in turn increases the risk of ulcer development (Rahman et al., 2020; Mutiudin et al., 2022; T. P. Ningrum et al., 2021).

The distribution of diabetic foot ulcers showed that most respondents were classified as Wagner grade 1 (48.3%). Such ulcers are commonly associated with peripheral neuropathy, impaired tissue perfusion due to macroangiopathy and microangiopathy, and suboptimal

glycemic control (Darni & Agustin, 2023; Nisak, 2021; Rahmasari et al., 2023). These complications require careful management, as ulcers may progress to deeper wounds, secondary infection, osteomyelitis, or even amputation (Rosyid et al., 2020).

Bivariate analysis demonstrated a statistically significant association between foot care behavior and the incidence of diabetic foot ulcers ($p = 0.008$), indicating that better foot care is associated with a lower risk of ulcer development. This finding supports previous studies reporting a strong negative correlation between foot care behavior and the incidence of diabetic foot ulcers (Nestriani et al., 2023; Ramadhani & Situmorang, 2022). Patient education on ulcer prevention through proper foot care has been shown to improve adherence and reduce the incidence of ulcers.

Nevertheless, even among patients who practiced good foot care, higher-grade ulcers may still occur due to complex pathophysiological factors, including neuropathy that diminishes pain sensation, vascular impairment, foot deformities, secondary infection, and poor metabolic control (Bus et al., 2024; Raja et al., 2023). This underscores that foot care should be accompanied by adequate glycemic control and regular medical supervision.

Protective factors that help maintain ulcers at lower grades include early detection, wound location in non–weight-bearing areas, preserved neurological and vascular function, and adequate metabolic control (Bahati et al., 2025; Monteiro-Soares et al., 2024). Patients with superficial ulcers have a greater likelihood of faster recovery without serious complications when appropriate interventions are implemented.

The findings of this study emphasize the role of nurses in preventing diabetic foot ulcers through routine screening, patient education, and early detection of complications. Through holistic interventions, including glycemic control and proper foot care, the risk of serious complications can be reduced, thereby improving patients' quality of life.

Overall, these findings support previous studies indicating that age, sex, educational level, duration of diabetes, and foot care behavior are important factors influencing the risk of diabetic foot ulcers. The strong negative association between foot care behavior and the incidence of diabetic foot ulcers highlights the need for continuous education, routine monitoring, and effective diabetes management to prevent complications.

The limitations of this study include a relatively small sample size, which may limit generalizability; a cross-sectional design that does not allow causal inference; and reliance on self-reported foot care behavior data, which may be subject to reporting bias.

CONCLUSION

The results of this study demonstrate a statistically significant association between foot care behavior and the incidence of diabetic foot ulcers among patients with diabetes mellitus. Patients who performed appropriate foot care tended to experience ulcers of lower severity, whereas those with poor foot care were more likely to develop ulcers of higher severity. These findings confirm that foot care is a crucial factor in managing the risk of ulcer development in patients with diabetes mellitus. Although factors such as age, sex, educational level, and duration of diabetes also influence foot conditions, foot care remains an important modifiable factor in reducing the risk of complications.

Patients are encouraged to regularly inspect their feet, maintain daily foot hygiene, use comfortable and appropriate footwear, pay close attention to any changes in foot

condition, and incorporate foot care into their daily routine. These simple measures may help patients maintain overall foot health and reduce the risk of diabetic foot–related complications.

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