Development of A Telenursing-Based Self-Assessment Questionnaire for Diabetic Foot Ulcer Risk

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Abstract

Development of a Telenursing-Based Self-Assessment Questionnaire for Diabetic Foot Ulcer Risk. Early identification of the risk of diabetic foot ulcers (DFU) is crucial in preventing ulcers. Caring for diabetic patients, including early detection of the risk of DFU with telenursing, will improve accessibility to health facilities and also help the work of nurses. Currently, there are many instruments or tools to detect the risk of DFU, but instruments that apply telenursing and can be used independently and easily by patients are still limited. This study aimed to develop a digital self-assessment questionnaire for DFU risk in type 2 Diabetes Mellitus (DM) patients and conduct validity and reliability tests. This study was carried out in three stages. The first stage was the planning stage by conducting a literature study; the second stage was the construction by determining the questionnaire items and testing the content validity index (CVI) by six experts; and the final stage was the validation stage by conducting a psychometric test in the form of a construct validity test with factor validity and internal consistency reliability with Cronbach-alpha on 40 respondents who had type 2 DM. The CVI score by the expert was 0.93, making it included in the very high validity category. The validity and reliability test results for the DM patients obtained a Cronbach alpha score of 0.83 and a validity of 0.43-0.68. Two items were deleted due to invalid results. The self-assessment tool for DFU risk has good validity and reliability values. This questionnaire is simple and easy for DM patients to use independently.

Keywords: diabetic foot, primary prevention, self-assessment, self-report, telenursing

Abstrak

***Pengembangan Instrumen Deteksi Dini Mandiri Berbasis Telenursing terhadap Risiko Ulkus Kaki Diabetes.** Deteksi dini risiko ulkus kaki diabetes dapat memudahkan perawat dalam mencegah komplikasi ulkus pada pasien. Saat ini telah banyak instrumen atau alat untuk mendeteksi risiko ulkus kaki diabetes namun instrumen yang dapat diaplikasikan secara mandiri dengan mudah oleh pasien masih terbatas. Penelitian ini bertujuan untuk mengembangkan kuesioner deteksi dini mandiri risiko ulkus kaki diabetes berbasis digital pada pasien diabetes melitus tipe 2 (DMT2) dan melakukan uji validitas dan reliabilitas. Pengembangan kuesioner dilakukan melalui tiga tahapan. Tahap pertama yaitu perencanaan dengan melakukan studi literatur dan menentukan definisi operasional; tahap kedua yaitu konstruksi dengan menentukan item-item kuesioner dan uji content validity index (CVI) oleh enam orang pakar yang terdiri dari tiga perawat berpengalaman dalam merawat pasien diabetes, dua dosen keperawatan dengan area penelitian diabetes, dan dokter spesialis penyakit dalam yang berpengalaman mengobati pasien diabetes; tahap terakhir yaitu validasi dengan melakukan uji psikometrik berupa uji validitas dan reliabilitas konsistensi internal dengan Cronbach-alpha kepada pasien DMT2. Terdapat 13 item yang disusun berdasarkan studi literatur. Skor CVI yaitu 0,93 dan termasuk dalam kategori validitas sangat tinggi. Hasil uji validitas dan reliabilitas kepada pasien DM didapatkan skor Cronbach alpha sebesar 0,83 dan validitas sebesar 0,43-0,68. Dari total 13 item, dua item dihapus karena tidak valid. Self-Assessment Tool for DFU Risk memiliki nilai vailidtas dan relibilitas yang baik, sehingga dapat digunakan untuk deteksi dini secara mandiri risiko ulkus kaki diabetes. Kuesioner ini sederhana dan mudah digunakan secara mandiri oleh pasien DM.*

***Kata Kunci:** deteksi mandiri, laporan mandiri, pencegahan primer, telenursing, ulkus kaki diabetes*

Introduction

Diabetic foot ulcers (DFU) are the most common complication of poorly controlled diabetes. DFU can occur due to poor glycaemic control, neuropathy, peripheral vascular disease, or

inadequate foot care in diabetes mellitus (DM) patients. Untreated DFU can lead to osteomyelitis and amputation (Armstrong et al., 2023). Globally, as many as 40 to 60 million DM patients experience DFU (International Diabetes Federation [IDF], 2021). The IDF (2021) states that diabetic patients have a risk of experiencing DFU 10 to 20 times more than non-diabetic patients. In addition, an amputation due to ulcers occurs every 30 seconds for all diabetic patients worldwide. The prevalence of DFU globally was 6.3%, and the highest prevalence was in North America at 13%, followed by African countries at 7.2%, Asia at 5.5%, and Europe at 5.1%. The lowest prevalence was in Oceania at 3% (Zhang et al., 2017). In Indonesia, the prevalence of type 2 Diabetes Mellitus (T2DM) patients with DFU was 7.3% (Syahrul & Narmawan, 2021). Meanwhile, other data showed that DFU patients were primarily over 50 years old (75.6%) and confirmed with T2DM for 5 years, with poorly managed diabetes (82.7%) and peripheral neuropathy (91.3%). Ulcers were predominantly detected on the front of foot (62.5%) and resulted from physical trauma (46.2%) (Yunir et al., 2021).

DFU affects DM patients, physically, mentally, and financially. DM patients with foot ulcers have an average length of hospitalization of 13 days, for 21 days if accompanied by minor amputation, and 60 days if accompanied by major amputation (Lo et al., 2021). DFU has an impact on the patient's mental condition, specifically, DFU is closely related to anxiety and depression experienced by patients (Al-Ayed et al., 2021). In terms of the financial impact of DFU, on average, it costs USD 1782.6 per year per patient. These costs are used for inpatient costs (45.6%), debridement (14.5%), and intensive care costs (10.4%) (Alshammary et al., 2020).

Prevention of diabetic foot complications is an important diabetes intervention to improve glycaemic control (McDermott et al., 2023). One study in Indonesia showed that DFU prevention behavior was still relatively low, especially indicators of nail care and wound care in DM patients (Oktorina et al., 2019). Early detection of the risk of DFU is a top priority in preventing diabetic foot complications. Currently, several instruments can be used as screening modalities for the risk of DFU, but in their application, patients must come to a health facility, and these instruments can only be implemented by health workers (Akila et al., 2021; Al-Mohaithef et al., 2022). This contradicts the current reality that the number of DM patient visits to healthcare facilities is still relatively low (Rachmawati, 2017). To increase the number of patients that receive health services, telenursing can be a solution to improve health outcomes and behavior change, especially in patients with diabetes mellitus (Rosyida et al., 2023).

Telenursing is used by implementing technology and making it easier for patients to get treatment or for health workers to provide health services (AkbariRad et al., 2023; Mamaghani et al., 2021). Telenursing could be defined as the utilization of telecommunication technology in nursing care to enhance patient care and is designed to provide an intervention that is accessible anytime and anywhere. Although it cannot substitute direct services and physical examination by nurses, it may reinforce patient-nurse relationships, save costs and time, and help patients accomplish their health outcomes (Yang et al., 2019). There are several kinds of telenursing, while the best-known one requires both the nurse and the patient to communicate in real-time via a computer or mobile device, including the telephone. The configuration of telenursing is known as synchronous (or live) telenursing. Other configurations could be asynchronous telenursing in which the nurse and the patient do not connect in real time but via e-mail or other similar means. Telenursing assists nurses in monitoring health parameters in distant areas, making the analysis, and helping them determine the best care needed by patients (Navarro-Martínez et al., 2024).

Since the COVID-19 outbreak, Indonesia has developed a telehealth program to enhance the

quality of care for patients. Accessibility is the main benefit, especially for remote areas (Ministry of Health, Republik Indonesia, 2022). However, the program still focuses on telemedicine, which involves only physicians giving a treatment remotely. To support comprehensive telehealth in Indonesia, some studies have evidenced that telenursing is effective in improving both physical and behavioral outcomes, including blood glucose, HbA1C, self-efficacy, self-empowerment, and self-care behaviour in DM patients (Rosyida et al., 2023). Giving a health education remotely is effective in increasing foot care behavior in DM patients (Mutiudin et al., 2025). To facilitate DM patients in conducting foot ulcer risk screening, it is necessary to develop an early detection questionnaire for the risk of DFU that can be applied independently by diabetic patients by implementing telenursing. This study aimed to develop an independent early detection questionnaire for the risk of DFU based on telenursing in T2DM patients, and conduct validity and reliability tests on the developed questionnaire. The instrument was developed in the planning phase, i.e., creating the contents of the instrument, followed by the construction phase which involved the diabetes experts, and lastly, the validation phase for obtaining data from the patients themselves.

Methods

This study aimed to develop an independent early detection questionnaire for the risk of DFU digitally. Ethics approval was obtained from the Ethics Committee (reference: DP.04.04/F.XXV /2615/2024), and all the participants gave an informed consent before the start of the study. The questionnaire developed was a digital questionnaire using the Google Form platform. The research stages followed the stages in developing research instruments or questionnaires (Kishore et al., 2021; Willis, 2020), specifically:

The planning phase consisted of selecting the target group, namely DM patients who could operate smartphones, conducting a literature review, and then formulating the questionnaire items. In the construction phase, the researcher compiled initial items with YES or NO questions assessed by six experts to obtain the CVI score. The experts involved were nurses who were experienced in treating diabetes patients (3 experts), nursing lecturers with diabetes research areas (2 experts), and an internal medicine specialist who was experienced in treating diabetes patients (1 expert). The experts provided objective assessments individually and filled out an assessment form using a 4-point scale with the following provisions: score 1 (irrelevant), score 2 (quite relevant), score 3 (relevant), and score 4 (very relevant) for each questionnaire item. Objective assessments were based on three things: relevance, clarity, and representativeness. The experts provided objective assessments of the questionnaire items and provided recommendations on whether the questionnaire items could be used, improved/changed, or removed. Some recommendations for the instruments were: adding a picture to clearly describe the physical condition of the feet, giving a specific foot region, for instance, left or right foot, and giving a detailed explanation on the method for examining the sensation of the foot.

Next, in the validation phase, the researcher conducted a pilot test on the T2DM patients using the questionnaire items with 40 respondents. Consequently, the psychometric test was a factor validity test with Pearson Product-Moment and an internal consistency reliability test with Cronbach's alpha. The inclusion criteria for the respondents were: diagnosed with T2-DM and able to operate a smartphone.

Results

This study designed a self-assessment questionnaire based on literature discussing the detection and risk of ulcers in diabetic patients. Several formulas were obtained for the questionnaire, including 1) Medical history: medical history that can be assessed includes a history of previous ulcers and amputation; 2) Foot examination: In diabetic patients, a physical examination of the foot is important. Some physical examinations of the foot that can be done inde-

Table 1. Characteristics of Respondents (n = 40, CI = 95%)

Characteristics		N	%
Gender	Male	13	32.5
	Female	27	67.5
Occupation	Self-employed	7	17.5
	Public employee	2	5
	Retired	4	10
	Housewife	20	50
	Private sector employee	2	5
	None	3	7.5
	Other	2	5
Footwear	Slippers	35	87.5
	Shoe	5	12.5
	Barefoot	0	0
	Other	0	0

n: sample size; CI: confidence interval

Table 2. Description of Respondents' Foot Conditions (n = 40)

Characteristic			n	%
History of foot problems	History of ulcers	No	38	95
		Yes	2	5
	History of leg amputation	No	40	95
		Yes	0	0
Physical description of the foot	Deformity	No	38	100
		Yes	2	5
	Abnormal nails	No	39	97.5
		Yes	1	2.5
	Callus	No	38	95
		Yes	2	5
	Dry foot skin	No	21	52.5
		Yes	19	47.5
	Foot erythema	No	37	92.5
		Yes	3	7.5
	No palpable pulses	No	26	65
		Yes	14	35
	Narrow footwear	No	38	95
		Yes	2	5
	Often not using footwear	No	38	95
		Yes	2	5
	Difficult/painful toe joints when moved	No	34	85
		Yes	6	15
Foot sensation	Numbness/burning/tingling sensation	No	21	52.5
		Yes	19	47.5
	The tip of the toe is not palpable to the touch	No	36	90
		Yes	4	10

n: sample size

pendently by diabetic patients include: a) Patients need to assess the shape of the foot, whether it is normal or there are protrusions. Protrusions on the foot increase pressure on the skin or tissue integrity, which correlates with DFU risk; b) Abnormal nail growth, specifically ingrown, is one of the DFU risks; c) The formation of calluses on the feet causes hardening of the skin on the feet, thereby reducing skin elasticity. Inelastic skin increases the risk of wounds. Calluses usually appear on the heels and sides of the toes; d) Erythema are associa-

ted with skin integrity problems that are at risk of becoming ulcers; e) Peripheral artery disease is one of the risk factors for ulcers, and pulse examination is one of the indicators of peripheral artery disease problems; f) The use of footwear that is too narrow and made from hard materials triggers pressure on the feet, which can increase the risk of DFU; 3) Foot sensation: Based on the literature, foot sensation is one of the indicators of the risk of DFU. Sensations that need to be checked include numbness, burning, and tingling; 4) It is recommended to get foot sensation examinations; one that can be done easily and independently by patients is the Ipswich touch.

Content Validity Index. In this study, the questionnaire testing by experts to obtain the CVI score was conducted by three nurses who had experience in caring for diabetes patients, two nursing lecturers with research experience on diabetes, and one internal medicine specialist who had experience in treating diabetes patients. The CVI score obtained based on the calculation was 0.93, or included in the very high validity category (> 0.80).

Validity and Reliability Test with Respondents: Pilot Study. There were 40 respondents in this study. The average age of respondents was 60 years (SD = 9.5), and the respondents suffered from diabetes for an average of 4.5 years

(SD = 4.2). There were more female than male respondents; more respondents who work-ed as housewives than in other occupations; more respondents used slippers to carry out daily activities. More complete characteristics of the respondents are shown in Table 1.

A description of the respondents' foot is shown in Table 2. All the respondents had no history of amputation; 5% (n = 2) of the respondents had a history of foot ulcers, deformities, calluses, wearing narrow footwear, and not wearing footwear during daily activities. In addition, 2.5% (n = 1) had abnormal nail shapes (growing inward and thickening), 47.5% (n = 19) had dry skin around the feet, 7.5% (n = 3) had erythema on the feet, 35% (n = 14) had impalpable pulses, and 15% (n = 6) of the respondents had complaints of difficulty or painful toe joints when moved. In addition, the assessment of the sensation function in the feet showed that 47.5% (n = 19) felt numbness, burning, and tingling in the feet, and 10% (n = 4) complained that the tips of the toes were numbed when touched with the Ipswich Touch examination.

The initial validity test was performed on 30 respondents, and the reliability test results were obtained based on the Cronbach alpha value of 0.70, making it included in the high-reliability category. The validity test results obtained a score between -0.01 and 0.8. There were several

Table 3. Validity and Reliability of the Self-Assessment for DFU Risk

No. item	Item	r	Result	Cronbach alpha
1	History of right or left leg ulcer	0.58	Valid	0.83
2	History of right or left leg amputation	0.00	No valid	
3	Abnormal right or left leg shape (there is a bulge)	0.64	Valid	
4	The right or left foot has an ingrown nail.	0.58	Valid	
5	The skin of the right or left leg has calluses	0.58	Valid	
6	Dry skin around the right or left leg	0.59	Valid	
7	Reddish right or left leg	0.68	Valid	
8	The right or left leg does not have palpable pulse.	0.43	Valid	
9	Too narrow footwear for the right or left foot.	0.11	No valid	
10	Often not wearing footwear when performing an outdoor activity	0.64	Valid	
11	The right or left toe joint cannot move freely	0.61	Valid	
12	Numbness, burning, tingling sensation in the right or left leg	0.59	Valid	
13	No sensation at ≥2 points of the right or left foot touch location	0.53	Valid	

r: correlation coefficient

invalid items (< 0.3), specifically item numbers 2, 5, 6, 8, 10, and 12. From these results, the second validity and reliability tests were conducted by increasing the number of respondents to 40. The reliability test results with Cronbach's alpha were obtained at 0.83 and were included in the high-reliability category. The validity test result was 0.43-0.68 (> 0.3). There were 2 invalid questionnaire items, specifically items 2 and 9, so the items were deleted. Based on the test results, the questionnaire items were valid and reliable for screening DFU risks. The results of the validity and reliability test for the 40 respondents can be seen in Table 3.

Discussion

Along with an increasing prevalence of diabetes mellitus, the prevalence of DFU complications also continues to rise (Sorber & Abularrage, 2021). Regarding this phenomenon, it is important that nurses involve the patients actively in the screening for the DFU preventive strategy. Therefore, the telenursing-based questionnaire that can be applied by patients independently is crucial to develop. This study focused on the development of a self-assessment questionnaire that can be filled out independently by diabetic patients. To the best of our knowledge, this has not been previously undertaken.

Questionnaire Design. The questionnaire was designed based on the literature on the early detection of DFU and the risk factors of DFU (Collings et al., 2020; Reardon et al., 2020; Rehman et al., 2023; Schaper et al., 2024; van Doremalen et al., 2019; Zhou et al., 2018). This self-assessment questionnaire is useful for early detection of ulcer risk in diabetic patients to prevent DFU. Patients complete a questionnaire by providing "YES" or "NO" responses. The yes/no responses were one of the types of responses that were appropriate to gather a definite answer with no need for an opinion (Taherdoost, 2022). The questionnaire items covered information on a history of foot problems, physical condition, and sensations in the feet. Once the questionnaire had been filled out completely,

the patient could see the assessment results in the form of either DFU risk or no risk and information regarding recommendations for foot examination at healthcare facilities. The questionnaire used simple sentences that were easy to understand for the community. As of the secondary survey, most respondents found it easy to understand and complete all the questionnaire items. For the sensation examination, Ipswich Touch was selected because it is easy, has high specificity, and offers a simple method of assessing the sensation of the foot in diabetic patients (Hu et al., 2021; Sharma et al., 2014). Patients were trained by health personnel during the initial implementation of Ipswich Touch until they could practice appropriately and independently. This online questionnaire also attached some images about the steps of performing the Ipswich Touch test for patients as a reference.

Validity and Reliability. The self-assessment questionnaire in the online version had a high reliability and good validity. Validity measures the extent to which the questionnaire assesses what it states to be assessed. When a questionnaire is reliable, it yields consistent results when measured repeatedly, even by different researchers, and when there are any discrepancies among the respondents (Ranganathan & Caduff, 2023). This study showed two invalid items, specifically items about amputation history and information on narrow footwear. Based on the results of the study, there were no respondents with amputation history and these respondents wore comfortable footwear. This result affected the diversity of the questionnaire results.

The telenursing-based questionnaire was designed using an online form and made accessible by patients at home. In the first implementation of the self-assessment, patients may need mentoring from health personnel. The mentoring session includes completing the questionnaire, checking the pulse of the legs, and performing sensation examination using the Ipswich touch. Due to limited resources, some respondents ex-

perienced poor internet connection and found difficulties in accessing the online questionnaires using Google Forms. In addition, some diabetic patients are elderly with limited technological literacy; hence, they may need assistance of their relatives. Other challenges found in other developing countries include limited internet access and lack of technological literacy in society (Bali, 2018; Ye et al., 2023).

This questionnaire consists of simple questions and examination of images of the pulse and sensation foot; therefore, it can help patients to be actively involved in efforts to prevent diabetic ulcers. Health personnel can assist at the beginning of self-assessment before patients conduct the self-assessment regularly. Health personnel should follow up and remind patients to carry out the self-assessments regularly. This questionnaire is simple and easy to use by diabetic patients, and it can help health personnel prevent DFU. Some interventions can be made to overcome barriers in the implementation of the self-assessment, such as to improve technology literacy, or at least, involve families or relatives with good technology skills. In addition, the development of internet facilities should be carried out in remote places so this self-assessment can be used properly for DM patients.

This research has several limitations. First, the telenursing-based self-assessment has not been fully implemented due to the limited literacy of respondents to technology. Second, the sample size was small, thus it needs to be refined with a larger number of respondents. Third, the telenursing was not fully implemented due to the need for assistance during the initial use. Fourth, during the research process, some of the respondents faced limited internet access and poor connection quality, negatively influencing their ability to complete the online questionnaire easily. Lastly, this pilot study needs a further study design to validate the findings.

Conclusion

The self-assessment questionnaire for early de-

tection of DFU risk has a high validity and reliability result. It is a simple questionnaire that can be used easily by diabetic patients. Patients have the time and place flexibility to do the self-assessment, and health personnel can monitor the result remotely. This questionnaire is beneficial for preventing DFU risk and improves patient outcomes, treatment costs, and quality of life. Further research needs to be conducted to optimize the implementation of self-assessment with a larger sample and determine factors that can support the implementation of early detection of DFU risk independently based on telenursing, especially in developing countries with limited resources and technological literacy.

Acknowledgements

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