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Research Paper

Nursing students' knowledge and attitude toward diabetic ulcer care and their contributing factors in Indonesia

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ABSTRACT

Objective: The prevalence of diabetic foot ulcer in Indonesia is far greater than the global prevalence. Nursing students are expected to have good knowledge and positive attitudes regarding diabetic ulcer care in order to deliver high-quality wound care during clinical practice. This study aimed to assess nursing students' knowledge and attitudes toward diabetic ulcer care and to investigate the factors related to them.

Methods: A cross-sectional study was conducted on 396 academic and clinical phases in three nursing schools in Indonesia from September 2021 to February 2022. Participants completed a survey including a questionnaire about knowledge and attitudes regarding diabetic ulcer care. The data were analyzed using a Chi-square test and multivariate logistic regression analysis.

Results: The results show that 43.2% (171/396) of nursing students had inadequate knowledge of diabetic ulcer care. However, 88.9% (352/396) had a favorable attitude toward the topic. Nursing students lacked knowledge about the characteristics of diabetic ulcers, diabetic neuropathy, wound infection, and adjunctive therapy for diabetic ulcers, and many of them believe that diabetic ulcer care is too time-consuming to carry out. Students in the clinical phase of their studies had significantly better knowledge than those in the academic phase (a$OR = 9.99$, 95% CI 4.96–20.08, $P < 0.001$). Male nursing students were significantly less likely to have positive attitude toward the topic than female students (a$OR = 0.42$, 95% CI 0.19–0.96, $P = 0.048$), and students accustomed to sharing with peers as a source of knowledge had better attitudes than those who were not (a$OR = 2.76$, 95% CI 1.40–5.41, $P = 0.003$).

Conclusion: Findings show that almost half of the nursing students have insufficient knowledge of diabetic ulcer care. Curriculum developers and educators need to improve the curriculum regarding diabetic wound care and provide strategic programs to improve students' knowledge and attitudes based on the factors discovered in this study.

What is known?

- Nurses' knowledge and their positive attitudes toward diabetic ulcer care are crucial for the delivery of high-quality wound care.
- Indonesia has the fifth highest number of diabetes mellitus cases in the world. The prevalence of diabetic foot ulcer in Indonesia is far greater than the global prevalence.

What is new?

- Nursing students' knowledge and attitudes in Indonesia were investigated, almost half of nursing students have insufficient knowledge regarding diabetic ulcer care, and most students have a favorable attitude toward diabetic ulcer care.

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- Nursing students' knowledge and understanding are lacking in terms of characteristics of diabetic ulcers, diabetic neuropathy, wound infection and the use of adjunctive therapy for diabetic ulcers.
- The most critical issue regarding the attitudes of nursing students is the perception that diabetic ulcer care is too time-consuming to carry out.

1. Introduction

Diabetes mellitus (DM) is one of the world's fastest-growing and most serious health problems [1,2]. Globally, an estimated 537 million people between the ages of 20 and 79 are currently living with DM. This number is predicted to rise to 643 million by 2030 and will reach a staggering 783 million by 2045 [3]. The disease is also on the rise in Indonesia. In fact, with 19.5 million DM patients, Indonesia has the fifth highest number of DM cases in the world. It is predicted that by 2045 there will be 28.6 million Indonesians living with DM [3].

The problems associated with DM include high financial burden, reduced quality of life, and morbidity and mortality due to complications [4–6]. One of the most common and most feared of DM complications is foot ulcer, as this can lead to amputation [7,8]. The prevalence of diabetic foot ulcer in Indonesia is 26%, far greater than the global prevalence of 6.3% [9,10]. Amputation rates due to diabetic foot ulcer are also high in Indonesia, reaching 39.5% [11].

Considering the high prevalence of diabetic foot ulcer in Indonesia, the disease must be taken seriously by healthcare providers so that amputations due to DM complications can be avoided. As healthcare providers, nurses play a crucial role in wound care management and are expected to deliver high-quality care for patients with diabetic foot ulcers [12–14]. Therefore, it is essential that nurses have sufficient knowledge and positive attitudes [15,16]. Knowledge should be a basis that guides nurses in the management of diabetic foot ulcers to prevent amputation [17,18]. Studies have shown that nurses with good knowledge and attitudes are more inclined to participate in diabetic foot ulcer care [17,19].

Considering that knowledge and attitude play a crucial role in nurses performing proper diabetic ulcer care, it is important to educate nursing students about diabetic ulcer care. Nursing students are expected to have good knowledge and positive attitudes since they must perform diabetic ulcer care accurately and effectively under the supervision of clinical instructors during their clinical practice. As knowledge and attitude are crucial factors related to high-quality management of diabetic ulcers, it is important to assess nursing students' knowledge and attitude toward diabetic ulcer care.

Although several studies have investigated the knowledge and attitudes of nurses toward diabetic ulcer care [17,20], to our knowledge no prior study has investigated these elements in nursing students or the factors affecting these variables in Indonesia or other countries. Studies of nursing students' knowledge have so far focused on knowledge related to DM, DM prevention, and DM self-management [21–25]. Studies on knowledge and attitudes also focused on nursing students' knowledge and attitude regarding pressure ulcer prevention [26–30]; therefore, the purpose of this study was twofold. First, we aimed to assess nursing students' knowledge and attitudes toward diabetic ulcer care and, second, we aimed to assess factors related to these variables.

2. Methods

2.1. Design and setting

A cross-sectional study was conducted from September 9, 2021 to February 25, 2022 in three colleges of nursing located on Java, Sulawesi, and Kalimantan islands. The Strengthening the Reporting of Observational Studies in Epidemiology Statement (STROBES) guidelines were used to guide the authors in preparing this article.

2.2. Participants

The subjects of this study were nursing students in three colleges of nursing located on Java, Sulawesi, and Kalimantan islands. The core curriculum of nursing education in Indonesia consists of two phases, the academic phase followed by the clinical phase, which should only be taken if the academic phase is completed successfully. The academic phase is taken over eight semesters, for a total of 144 credit points, while the clinical phase, also called a professional nurse program, is taken for two semesters, for 36 credit points. During the academic phase, students will study the concepts and skills of nursing in classrooms and laboratory settings, while in the clinical phase, nursing students will apply their knowledge and skills to a range of healthcare settings. To become a nurse in Indonesia, nursing students must take both the academic and clinical phases and they cannot be taken separately. Nursing students in Indonesia can take the clinical phase at the same university as the academic phase, or they can choose another nursing college.

The sample in this study was selected using a convenience sampling method. The inclusion criteria in this study were all second-, third-, and fourth-year undergraduate students (academic phase) and those in the clinical phase who agreed to participate. First-year students in the academic phase were excluded since their theoretical knowledge of diabetic wound care was deemed inadequate.

2.3. Sample size analysis

The total number of eligible of nursing students was 940, consisting of 586 students in years 2, 3, and 4 of the academic phase, and 354 students in the clinical phase. The sample size was determined using the following formula: $n = z^2/4d^2$ ($z = 1.96$, 95% CI, and $d = 5\%$) [31,32]. Considering a non-response rate of 4%, the total sample size was 396.

2.4. Data collection

Data were collected online via a questionnaire on Google Forms since data collection took place during the COVID-19 pandemic. A Google Form link was circulated through the online platform WhatsApp Messenger (WhatsApp). WhatsApp is a free social media platform based on mobile instant messaging to facilitate the sharing of text messages, multimedia files, and other documents [33]. The time to complete the questionnaire was between 15 and 20 min. No identifying information about individual students was collected, and written informed consent was collected from each participant. The online survey was performed in line with the Checklist for Reporting Results of Internet E-Surveys (CHERRIES).

2.5. Ethical considerations

Approval to conduct the study was received from the Faculty of Health Sciences, Universitas Jenderal Soedirman, Indonesia (No 464/EC/KEPK/VI/2021). The study's purposes were clearly explained on the Google Form. The form was designed in such a way that anyone who agreed to engage in the study had to click a proceed button to show that they had read and agreed to the consent to participate. All participation was voluntary.

2.6. Measurements

2.6.1. Socio-demographic characteristics

Data were collected on socio-demographic characteristics, including age, gender, education level, history of wound care training, interest in diabetic ulcer care, and the use of the following as sources of knowledge: books, guidelines, research articles or journals, magazines, seminars, and sharing with peers.

2.6.2. Content validity of the instruments

The questionnaire used to assess students' knowledge and attitudes regarding diabetic ulcer care was obtained from Kumarangsinghe et al. [34]. Permission to use the questionnaire was obtained from the original author [34]. Before using this questionnaire, it was translated into Bahasa by two experts in diabetic foot care and wound care management. The translated questionnaire was then back-translated by two bilingual experts (a native Australian and a USA native). Finally, eight experts in wound care (with doctorates in wound care or with wound ostomy continence nurse certification, and with at least 10 years of clinical experience) examined the final version, making any adjustments necessary. The experts then assessed the clarity and cultural equivalence of the questions by rating them on a four-point Likert-type scale (from not relevant to extremely relevant) [31]. The content validity index (CVI) for individual (I-CVI) and scale (S-CVI) was 1 for knowledge on diabetic ulcer care and 1 for attitude. To investigate the clarity and understanding of the questionnaire, a pilot study was conducted on 50 nursing students. The participants in the pilot study were excluded from the final analysis.

2.6.3. Knowledge of diabetic ulcer care

The questionnaire used to assess students' knowledge of diabetic ulcer care comprised of 15 multiple choice questions with three possible answers (true, false, and don't know) [34]. Correct answers scored 1, while false answers and don't know options scored 0. The questionnaire consisted of three questions about predisposing factors for diabetic ulcers; three questions about characteristics of diabetic ulcers; three questions about complications of diabetic ulcers; and six questions about diabetic ulcer management. Those scoring highly were categorized as having good knowledge, while those scoring below the mean were categorized as having poor knowledge. Cronbach's α coefficient for the original questionnaire for knowledge was satisfactory at 0.704 [34]. In this study, Cronbach's α for knowledge was 0.716.

2.6.4. Attitude toward diabetic ulcer care

The questionnaire used to assess students' attitude toward diabetic ulcer care comprised of 10 questions on a five-point Likert-type scale, ranging from strongly agree to strongly disagree. The questions covered perceived diabetic ulcer risk, clinical priority of diabetic ulcer, and professional interest regarding diabetic ulcer care. The highest total score was 50 and the lowest was 10. Since all the questions were worded negatively, those scoring 30 or less were classified as having a "favorable attitude" and those scoring more than 30 were categorized as having a "non-favorable attitude" [20,34]. Cronbach's α coefficient for the original questionnaire of attitude was 0.732 [34]. In this study, Cronbach's α for attitude was 0.740.

2.7. Data analysis

To analyze the data, SPSS version 21 was used. Descriptive statistics were used to describe the frequency, mean, and standard deviation of the variables. A Chi-square test was used to investigate the association of knowledge or attitude with socio-demographic characteristics, including age, gender, level of education, history of wound care training, interest in diabetic ulcer care, and the use of the following as sources of knowledge: books, guidelines, research articles or journals, magazines, seminars, and sharing with peers. Variables with *P*-values less than or equal to 0.2 in the bivariate analysis were then entered into a multivariate logistic regression model [17,35]. To investigate the strength of the association between dependent and independent variables, odds ratios (*OR*) with 95% confidence interval (CI) were determined. *P*-values of under 0.05 were considered statistically significant.

3. Results

3.1. Demographic characteristics of nursing students

The response rate of this study was 100%. The mean age of nursing students was 21.37 years. Most participants were female (88.1%), studying in the academic phase (73.0%). Most participants reported having an interest in diabetic ulcer care (61.1%). As sources of knowledge regarding diabetic ulcer care, participants used books (65.9%), sharing with peers (59.3%), and research articles and journals (89.9%). Most participants reported not using guidelines (76.7%), magazines (93.6%), or seminars (59.9%) as sources of knowledge regarding diabetic ulcer care (Table 1).

3.2. Knowledge of nursing students about diabetic ulcer care

Among the participants, 56.8% of them displayed adequate diabetic ulcer care knowledge, while 43.2% displayed inadequate knowledge. Of the 15 questions, four were not answered correctly by more than half of the participants, with question No. 5, 6, 8 and 12 (Table 2).

The association between knowledge and all socio-demographic characteristics was measured by the Chi-square analysis. The analysis showed that level of education, history of wound care training, interest in diabetic ulcer care, use of guidelines as a source of knowledge, or seminars as a source of knowledge, were variables with *P*-values less than or equal to 0.2, while other variables including age, gender, and the use of books, research articles or journals, magazines, and sharing with peers as a source of knowledge had a *P*-value of more than 0.2.

The variables of education level, history of wound care training, interest in diabetic ulcer care, and using guidelines or seminars as a source of knowledge were then entered into regression analysis. In the regression analysis, after adjusting for confounding variables, the education level was the only factor associated with knowledge of diabetic ulcer care. The students in the clinical phase had almost 10 times (a*OR* = 9.99, 95% CI 4.96–20.08, $P < 0.001$) better knowledge than those in the academic phase (Table 3).

3.3. Attitude of nursing students towards diabetic ulcer care

The proportion of nurses who had a favorable attitude toward

Table 1
Demographic characteristics of nursing students participated in the study ($n = 396$).

Characteristics		*n* (%)
Age, *Mean ± SD*		21.37 ± 1.13
Gender	Female	349 (88.1)
	Male	47 (11.9)
Level of education	Academic phase	289 (73.0)
	Clinical phase	107 (27.0)
History of wound care training	Yes	32 (8.1)
	No	364 (91.9)
Interest in diabetic ulcer care	Yes	242 (61.1)
	No	154 (38.9)
Use book as source of knowledge	Yes	261 (65.9)
	No	135 (34.1)
Use guideline as source of knowledge	Yes	92 (23.2)
	No	304 (76.8)
Sharing with peers as source of knowledge	Yes	235 (59.3)
	No	161 (40.7)
Use research article/journal as source of knowledge	Yes	356 (89.9)
	No	40 (10.1)
Use of magazine as source of knowledge	Yes	25 (6.3)
	No	371 (93.7)
Use of seminar as source of knowledge	Yes	159 (40.1)
	No	237 (59.9)

Note: Data are *n* (%), unless otherwise indicated.

Table 2
Frequency and percentage distribution of nursing students' knowledge on diabetic ulcer care ($n = 396$).

Questions		Correct	Incorrect	Don't know
1.	Neuropathy is the predominant factor responsible for diabetic ulcers.	302 (76.3)	21 (5.3)	73 (18.4)
2.	Sensory neuropathy results in unnoticed skin damages which lead to formation of ulcers.	312 (78.8)	29 (7.3)	55 (13.9)
3.	Autonomic neuropathy is associated with dry skin which predisposes to ulcer formation.	230 (58.0)	41(10.4)	125 (31.6)
4.	Diabetic neuropathic ulcers are typically found on weight bearing areas of the foot.	319 (80.6)	29 (7.3)	48 (12.1)
5.	Diabetic ischemic ulcers are less painful than diabetic neuropathic ulcers.	93 (23.5)	129 (32.6)	174 (43.9)
6.	Neuropathy can be excluded if the foot skin is cool and pulses are absent.	181 (45.7)	107 (27.0)	108 (27.3)
7.	The risk of amputation is higher when diabetic foot ulcer is associated with limb ischemia.	304 (76.8)	36 (9.1)	56 (14.1)
8.	Presence of slough is not an indication of infection in diabetic ulcers.	124 (31.3)	74 (18.7)	198 (50.0)
9.	Presence of osteomyelitis impairs healing of diabetic ulcers.	243 (61.4)	33 (8.3)	120 (30.3)
10.	Wound healing progress is unsatisfactory if the wound bed appears pink.	244 (61.6)	74 (18.7)	78 (19.7)
11.	Mechanical off-loading should be advised to facilitate ulcer healing.	338 (85.4)	28 (7.0)	30 (7.6)
12.	Hyperbaric oxygen therapy is recommended for ulcer healing even in a well-perfused foot.	66 (16.7)	181(45.7)	149 (37.6)
13.	Infected, highly exuding wounds should be cleansed daily.	265 (66.9)	72 (18.2)	59 (14.9)
14.	Iodine dressings are effective for wounds with clinical signs of infection.	220 (55.6)	67 (16.9)	109 (27.5)
15.	Hydrogel dressings are useful to rehydrate the wound bed and control the moisture in wounds.	299 (75.5)	20 (5.1)	77 (19.4)

Note: Data are *n* (%).

Table 3
Factors associated with nursing students' knowledge about diabetic ulcer care.

Variables	Level of knowledge			cOR	*P*	aOR	*P*
	Score (*Mean ± SD*)	Poor (*n*)	Good (*n*)				
Level of education							
Academic phase	8.40 ± 3.25	159	130	Reference		Reference	
Clinical phase	11.40 ± 1.88	12	95	9.68 (5.08–18.43)	< 0.001	9.99 (4.96–20.08)	< 0.001
History of wound care training							
No	9.17 ± 3.21	161	203	Reference		Reference	
Yes	9.65 ± 3.43	10	22	0.55 (0.23–1.31)	0.177	1.71 (0.73–3.99)	0.213
Interest in diabetic ulcer care							
No	8.89 ± 3.13	75	79	Reference		Reference	
Yes	10.25 ± 3.33	96	146	1.44 (0.96–2.17)	0.077	1.30 (0.84–2.04)	0.238
Use guideline as source of knowledge							
No	8.89 ± 3.13	145	159	Reference		Reference	0.746
Yes	10.25 ± 3.33	26	66	2.31 (1.39–3.84)	0.001	0.74 (0.48–1.68)	
Use seminar as source of knowledge							
No	8.90 ± 3.30	109	128	Reference	0.169	Reference	0.434
Yes	9.67 ± 3.07	62	97	1.33 (0.88–2.00)		1.20 (0.76–1.90)	

Note: cOR = Crude odds ratios. aOR = Adjusted odds ratio.

Table 4
Nursing students' attitudes towards diabetic ulcer care ($n = 396$).

	Questions	Strongly agree	Agree	Neither agree or disagree	Disagree	Strongly disagree
1	I think diabetic ulcer treatment is more important than ulcer prevention.	19 (4.8)	53 (13.4)	86(21.7)	177(44.7)	61(15.4)
2	I do not think it is necessary to assess diabetic ulcers regularly.	4 (1.0)	24(6.0)	26(6.6)	237(59.9)	105(26.5)
3	Diabetic wound care is too time consuming for me to carry out.	37(9.3)	220 (55.6)	97 (24.5)	33(8.3)	9(2.3)
4	In comparison with other areas of nursing care, diabetic ulcer care is a low priority task for me.	6 (1.5)	24(6.0)	97 (24.5)	220 (55.6)	49 (12.4)
5	If I have the opportunity, I would like to avoid caring for diabetic ulcers.	5 (1.3)	35 (8.8)	96 (24.2)	190 (48.0)	70 (17.7)
6	I do not have time to advise each patient individually on how to look after their ulcers	5 (1.3)	25 (6.3)	86 (21.7)	196 (49.5)	84 (21.2)
7	It is not my responsibility to educate patients with diabetic ulcers on how to reduce re-ulceration	3 (0.8)	20 (5.0)	29 (7.3)	230 (58.1)	114 (28.8)
8	I cannot think about pain when cleaning diabetic ulcers.	4 (1.0)	18 (4.6)	44 (11.1)	200 (50.5)	130 (32.8)
9	I do not like to care for diabetic ulcers in my practice.	5 (1.1)	22 (5.6)	99 (25.0)	192 (48.5)	78 (19.7)
10	I do not get satisfaction by caring for diabetic ulcers.	3 (0.8)	28 (7.0)	87 (22)	192 (48.5)	86 (21.7)

Note: Data are *n* (%).

diabetic ulcer care was 88.9%. However, surprisingly, 64.9% of participants considered diabetic ulcer care to be too time-consuming to carry out (Table 4).

In the Chi-square analysis, the association between attitude and all socio-demographic characteristics was assessed. The analysis showed that gender, history of wound care training, interest in diabetic ulcer care, the use of books as sources of knowledge, and sharing with peers as a source of knowledge, were variables which had *P*-values less than or equal to 0.2, while other variables including age, level of education, and the use of guidelines, research articles or journals, magazines, or seminars as sources of knowledge had *P*-values of more than 0.2.

The variables of gender, history of wound care training, interest in diabetic ulcer care, and using books and sharing with peers as a source of knowledge were then entered into logistic regression analysis. After controlling for the confounding variables, gender (a*OR* = 0.42, 95% CI 0.19–0.96, *P* = 0.048), and sharing with peers as a source of knowledge (a*OR* = 2.76, 95% CI 1.40–5.41, *P* = 0.003) were significantly associated with attitude toward diabetic ulcer care (Table 5). Male nursing students were 58% less likely to have a positive attitude than female students, and students accustomed to sharing with peers as a source of knowledge were 2.76 times more likely to have a positive attitude than those who were not.

4. Discussion

4.1. Nursing students' knowledge of diabetic ulcer care should be improved

Our study showed that almost half of nursing students still have low knowledge of diabetic ulcers and their management. Most participants answered incorrectly when asked about diabetic ulcer assessment and evidence-based practice related to diabetic ulcer treatment. This result indicated there is a gap in the wound care education system in Indonesia. These gaps in knowledge might be due to the topics not being covered in the nursing curriculum in Indonesia. The current curriculum only covers wound care management in patients with DM using conventional method. The current curriculum only covers wound care management in patients with DM using a conventional method. The conventional method of wound management is wound treatment by using gauze dressing or antiseptic regardless of the amount of exudate or the condition of the wound base [36]. The purpose of undergraduate education is to teach students to be competent in clinical nursing,

Table 5
Factors associated with nursing students' attitude about diabetic ulcer care.

Variables	Level of attitude			c*OR*	*P*	a*OR*	*P*
	Score (*Mean* ± *SD*)	Poor (*n*)	Good(*n*)				
Gender							
Female	37.34 ± 6.33	34	315	Reference	0.022	Reference	0.048
Male	35.59 ± 7.34	10	37	0.39 (0.18–0.87)		0.42 (0.19–0.96)	
History of wound care training							
No	37.59 ± 6.30	37	327	Reference	0.05	Reference	0.741
Yes	35.25 ± 8.00	7	25	0.40 (0.16–0.99)		1.29 (0.28–5.97)	
Interest in diabetic ulcer care							
No	35.87 ± 6.07	24	130	Reference	0.032	Reference	0.067
Yes	37.93 ± 6.60	20	222	2.05 (1.09–3.85)		1.85 (0.96–3.56)	
Use book as source of knowledge							
No	35.91 ± 6.21	22	113	Reference	0.02	Reference	
Yes	37.13 ± 6.47	22	239	2.11 (1.12–3.97)		1.73 (0.89–3.33)	0.101
Sharing with peers as source of knowledge							
No	36.10 ± 6.78	29	132	Reference	0.001	Reference	0.003
Yes	37.84 ± 6.16	15	220	3.22 (1.66–6.23)		2.76 (1.40–5.41)	

Note: c*OR* = Crude odds ratios. a*OR* = Adjusted odds ratio.

and therefore nursing students should be provided with the knowledge and skills required to practice as a competent professional nurse [37]. Considering that nursing students have to assess and manage wounds during their clinical program, it is crucial they have a good understanding of these topics so their patients can be accurately assessed with regard to the condition of their ulcers and have access to the best possible treatment and care. Our study makes it clear that Indonesia's education developers must add the topics of diabetic ulcer assessment and evidence-based practice of the treatment of diabetic ulcer care into the nursing curriculum to improve the competence of nursing students in performing wound assessments and treating wounds using evidence-based techniques.

We found that students in the clinical phase have 10 times better knowledge about the topic than those in the academic phase. This might be due to the characteristics of nursing education in Indonesia. Students in the clinical phase have experienced clinical practice in many different settings and are likely to have performed wound care on patients. However, those in the academic phase have not yet had any clinical experience and this may explain why their knowledge is lower than those in the clinical phase. Our findings correspond to a study in Turkey which found nursing students in their final year had more knowledge about prevention of pressure injury than those in lower academic years [26]. Our study's findings show that students' knowledge must be improved, especially in the academic phase. This can be done in several ways. In addition to teaching in a classroom setting, simulation laboratories with various kinds of wound condition models are needed to enhance the knowledge and clinical skills of nursing students. Studies have shown that laboratory simulation significantly improves learning outcomes by bolstering the students' feeling of being prepared for clinical practice [38,39]. Wound care training or workshops could also be offered to students to improve their knowledge of diabetic ulcer care. Studies show that wound care training can significantly improve the competency to perform wound care practice [40].

4.2. Nursing students' attitudes toward diabetic ulcer care

We found that most participants had a favorable attitude toward diabetic ulcer care; however, the majority of participants considered diabetic ulcer care to be too time-consuming to carry out. This is possibly due to most hospitals in Indonesia, including the one in which nursing students take their clinical phase, still using conventional wound dressing (saline-soaked gauze dressings), and not having adopted modern wound dressing techniques. Conventional wound dressings are changed daily or even more frequently according to the amount of wound exudate, and therefore are time-consuming for nurses. Conversely, modern wound dressings (foam, film, hydrocolloid, alginate, and foam dressings) can be changed every few days, shortening the time nurses must spend on each patient. Previous studies also showed that the use of modern wound dressings can significantly reduce pain and shorten healing time [41–44]. Although modern wound dressing has been used extensively since the 1980s in U.S. and European hospitals [45], it was only introduced to Indonesian hospitals in the early 2000s, and remains rare. Nursing students should be taught the most up-to-date evidence on diabetic wound care management. A more positive attitude toward diabetic ulcer care could be achieved among nursing students if the gaps in their knowledge were filled and they better understood that modern diabetic ulcer care does not take long to perform.

We also found that the main factors related to the attitudes of nursing students toward diabetic ulcer care are gender and sharing with peers as a source of knowledge. We found that male nursing students were less likely to have a positive attitude than female nurses in this regard. However, these findings do not correspond with a previous study that found either no association between gender and attitude toward diabetic foot care [20], or that males have more positive attitudes than females toward the prevention of pressure injury [46]. Our analysis of this item in the questionnaire of this study showed that the percentage of male participants who agreed or strongly agreed that diabetic ulcer care is time-consuming was significantly higher than the percentage of females (data not shown). This could be why the male participants were less likely to have a positive attitude, but further study is needed to confirm this.

We found that participants who were accustomed to sharing with peers as a source of knowledge were almost three times more likely to have a positive attitude than those who were not. These results are in line with another study which found that peer engagement can support improvement of professional development, self-confidence, communication, and interpersonal relations [47]. This might explain why the participants in our study who were accustomed to sharing with peers as a source of knowledge also had better attitudes toward diabetic ulcer care than those who did not. The implication of our findings is that, to improve the attitude of nursing students in Indonesia, they need to use various methods of sharing with peers that involve both genders, such as study groups, peer-to-peer learning partnerships, and group work either in a classroom setting or laboratory simulation. Future studies are needed to confirm this.

4.3. Strengths and limitations

This study is the first to assess nursing students' knowledge and attitudes regarding diabetic foot ulcer care and to investigate the related factors. The study had a high response rate and used a questionnaire which was adapted and validated for use in Indonesian settings. However, this study also had some limitations. First, it was carried out in only three institutions nationwide, and this limits its generalizability, yet participants came from the three biggest islands in Indonesia (Java, Sulawesi, and Kalimantan Island), a fact that could strengthen its external validity. Second, the study's cross-sectional design makes it difficult to draw possible causalities. It is recommended to perform a longitudinal study as a follow-up.

5. Conclusion

Through this study, we gained data that many Indonesian students have inadequate knowledge of diabetic ulcer care. The factor related to nursing students' knowledge of diabetic ulcer care is their education level, while the factors related to nursing students' attitudes are gender and sharing with peers as a source of knowledge. Nursing students' low knowledge indicated that there is a need for curriculum developers and policy makers to improve existing nursing curricula in Indonesia by adding topics which are not covered. Our study also showed there is a need to improve students' knowledge, especially in the academic phase, and we have proposed several approaches. In addition to learning in the classroom setting, demonstrations of wound care in a clinical skill laboratory with various models of wound conditions are needed to enhance the clinical skill of nursing students. To improve their attitude in this regard, the learning method of sharing with peers as a source of knowledge is needed, either in classrooms or laboratory settings to improve nursing students' emotional support, self-confidence, and communication skills. Wound care training or workshops could be offered to improve the knowledge and attitudes of nursing students toward diabetic ulcer care.

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Declaration of competing interest

The authors declare that they have no potential competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRediT authorship contribution statement

Yunita Sari: Methodology, Formal analysis, Writing – original draft, Writing – review & editing, Funding acquisition. **Arif Setyo Upoyo:** Methodology, Formal analysis, Validation, Writing – review & editing. **Annas Sumeru:** Investigation, Software, Formal analysis, Writing – review & editing. **Saldy Yusuf:** Investigation, Formal analysis, Writing – review & editing. **Haryanto:** Investigation, Formal analysis, Writing – review & editing. **Nuriya:** Data curation, Formal analysis, Writing – review & editing. **Agis Taufik:** Data curation, Formal analysis, Writing – review & editing.

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Appendix A. Supplementary data

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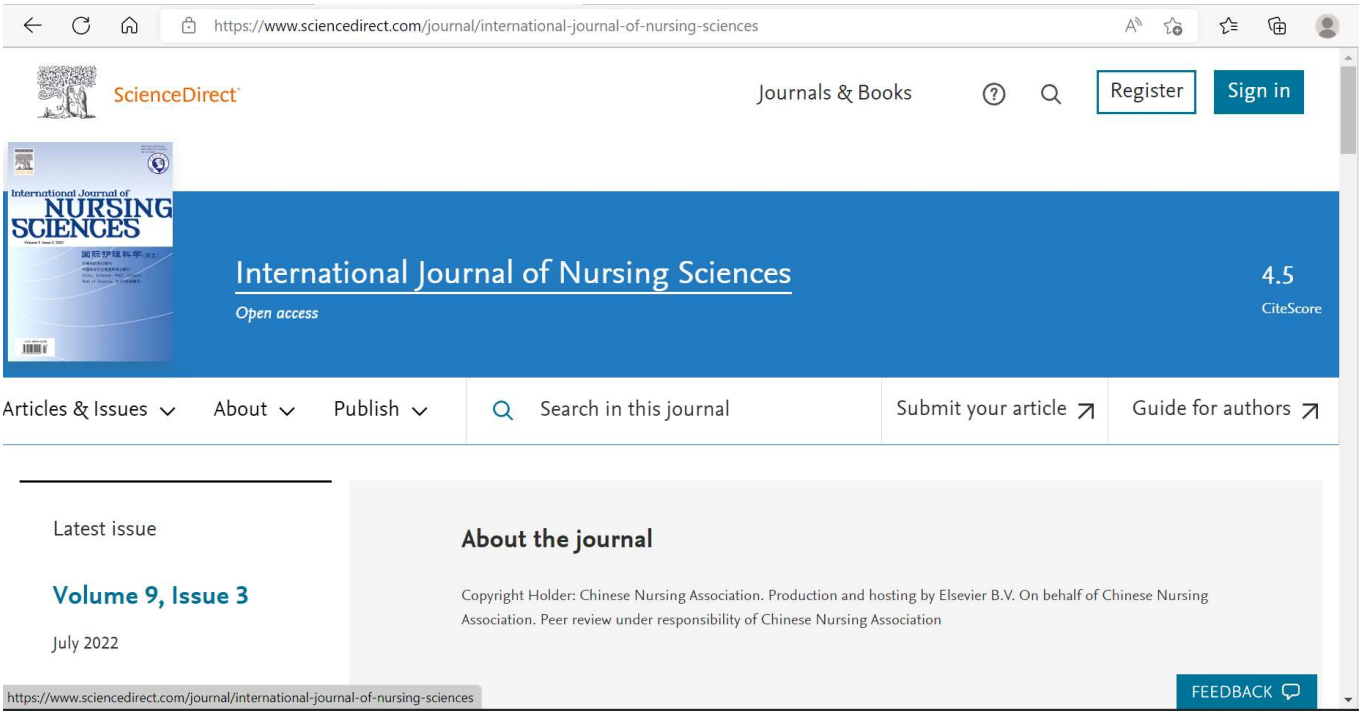
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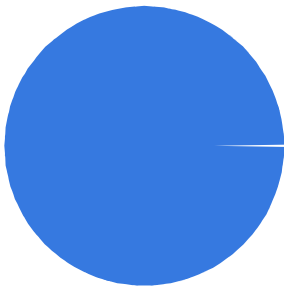

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