

ปัจจัยที่มีอิทธิพลต่อพฤติกรรมการดูแลเท้าในผู้ป่วยเบาหวาน กลุ่มเสี่ยงสูงต่อการเกิดแผลที่เท้า Factors Influencing Foot Care Behaviors Among Diabetic Patients with A High Risk of Diabetic Foot Ulcer

นิพนธ์ฉบับ

Original Article

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บทคัดย่อ

วัตถุประสงค์: เพื่อศึกษาพฤติกรรมการดูแลเท้าและปัจจัยที่มีอิทธิพลต่อพฤติกรรมการดูแลเท้าในผู้ป่วยเบาหวานกลุ่มเสี่ยงสูงต่อการเกิดแผลที่เท้า **วิธีการศึกษา:** การศึกษาความสัมพันธ์เชิงทำนายของปัจจัยต่อพฤติกรรมการดูแลเท้าที่มีตัวอย่างเป็นผู้ป่วยเบาหวานชนิดที่ 2 ที่มีความเสี่ยงสูงต่อการเกิดแผลที่เท้าที่ได้รับการรักษาที่คลินิกเบาหวาน แผนกผู้ป่วยนอกโรงพยาบาลพระปกเกล้า จันทบุรี จำนวน 97 รายจากการสุ่มอย่างง่าย รวบรวมข้อมูลโดยใช้แบบสอบถามข้อมูลส่วนบุคคล แบบบันทึกข้อมูลโรคเบาหวาน แบบประเมินสภาวะเท้า แบบสอบถามพฤติกรรมการดูแลเท้าผู้ป่วยเบาหวานกลุ่มเสี่ยงสูงต่อการเกิดแผลที่เท้า ความรอบรู้ด้านสุขภาพ การสนับสนุนทางสังคม การรับรู้ความสามารถของตนเองในการปฏิบัติพฤติกรรมการดูแลเท้า และความคาดหวังในผลของการปฏิบัติพฤติกรรมการดูแลเท้า วิเคราะห์ข้อมูลด้วยวิธีการถดถอยพหุคูณ **ผลการศึกษา:** กลุ่มตัวอย่างมีพฤติกรรมการดูแลเท้าระดับปานกลาง (ค่าเฉลี่ย 73.42 ± 12.09 จาก 95 คะแนน) ปัจจัยความรอบรู้ด้านสุขภาพ การสนับสนุนทางสังคมและการรับรู้ความสามารถของตนเองร่วมกันทำนายความแปรปรวนของพฤติกรรมการดูแลเท้าได้ร้อยละ 32 (adj. R² = 0.32, P-value < 0.001) การรับรู้ความสามารถตนเองทำนายพฤติกรรมการดูแลเท้ามากที่สุด ($\beta = 0.41$, P-value < 0.001) ตามด้วยการสนับสนุนทางสังคม ($\beta = 0.193$, P-value = 0.034) และความรอบรู้ด้านสุขภาพ ($\beta = 0.192$, P-value = 0.043) **สรุป:** พฤติกรรมดูแลเท้าของผู้ป่วยเบาหวานกลุ่มเสี่ยงสูงต่อการเกิดแผลที่เท้าอยู่ในระดับปานกลาง และทำนายได้ด้วยการรับรู้ความสามารถตนเองในการดูแลเท้า การสนับสนุนทางสังคม และความรอบรู้ด้านสุขภาพ

คำสำคัญ: พฤติกรรมการดูแลเท้า; ผู้ป่วยเบาหวานกลุ่มเสี่ยงสูงต่อการเกิดแผลที่เท้า; ความรอบรู้ด้านสุขภาพ; การรับรู้ความสามารถตนเอง; การสนับสนุนทางสังคม

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Abstract

Objective: To determine foot care behaviors of patients at high risk of diabetic foot ulcer (DFU) and the associations with its influencing factors.

Method: This predictive correlational research examined the predictive factors of foot care behaviors including health literacy, social support, perceived self-efficacy and outcome expectation. The participants were 97 patients with type 2 diabetes mellitus at high risk of DFU, treated at the outpatient department at Phrapokklao Hospital, recruited by a simple random sampling. Questionnaires collected demographic data and diabetic personal health record, and assessed diabetic patients' foot care behaviors, diabetic patients' health literacy, social support, perceived self-efficacy, and outcome expectation. Data were analyzed by multiple linear regression. **Results:** The foot care behaviors were at a moderate level (mean = 73.42 ± 12.09 out of 95 points). Health literacy, social support and perceived self-efficacy explained 32% of the behavior variance (adj. R² = 0.32 P-value < 0.001). Perceived self-efficacy was the most effective predictor of the behaviors ($\beta = 0.41$, P-value < 0.001), followed by social support ($\beta = 0.193$, P-value = 0.034) and health literacy ($\beta = 0.192$, P-value = 0.043). **Conclusion:** The foot care behaviors among diabetic patients at high risk of DFU were at a moderate level and could be predicted by perceived self-efficacy, social support and health literacy.

Keywords: foot care behaviors; diabetic patients at high risk of diabetic foot ulcer; health literacy; self-efficacy; social support

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Introduction

Diabetes is a non-communicable disease that is a problem of public health systems worldwide. It is estimated that there will be 578 million people with diabetes in 2030, and 700 million people in 2045.¹ In Thailand, in 2017, there were 4.4 million people with diabetes, and the number of people with diabetes is projected to rise to 5.3 million people in 2040.² In the area of the Health Office Region 6 (Eastern Region) of Thailand, Chanthaburi province had the highest rate of diabetic patients per 100,000 population with 9,227, 9,750

and 10,244 people in 2017 to 2019, respectively.³ Diabetes is a common cause of complications in various organs such as macrovascular complication, including coronary artery disease and microvascular complications such as diabetic nephropathy, diabetic retinopathy, and diabetic foot. Foot is the only organ that is prone to chronic complications caused by both macrovascular and microvascular complications.⁴

Diabetic foot is caused by chronically high blood sugar levels causing the arteries to harden and constrict. It also

results in degeneration of the peripheral nervous system and/or peripheral arterial disease leading to foot numbness, deformed foot and foot ulcers.⁵ Foot ulcers usually cause a 7-20% chance of amputation.⁶ Based on the incidence of foot or leg amputation worldwide, every 30 seconds, a person with diabetes has a foot or leg amputated, accounted for 70% of all amputation cases.¹ In Thailand, the prevalence of diabetic foot ulcers was found at 1.27% of all diabetic patient. Type 2 diabetes mellitus is usually found in people aged 30 years and over.⁸ If not diagnosed and treated, it will cause high blood sugar levels leading to various complications. People with diabetes of more than 10 years had a risk of developing diabetic ulcers 4.54 times of those of less than 10 years (95%CI = 1.90-10.80, P-value < 0.05),⁷ due to long-standing high blood sugar levels. Diabetic foot ulcers usually require a long and costly treatment and could negatively affect both physical and mental health, and public health system. It was found that although diabetic foot ulcers were completely cured, the 1-, 3-, and 4-year recurrence rates were 40% and 65%,⁵ and 67%, respectively.¹¹ The mean duration of diabetic foot ulcer recurrence was about 1 year and 4 months.¹² Diabetic patients with a history of foot ulcers had a 5.7-fold risk of diabetic foot ulcer recurrence [adjusted odds ratio (adj. OR) = 5.77; 95%CI = 2.23 - 14.0].¹³

Most patients with foot ulcers usually have HbA1C greater than 8%.^{14,15} For effective ulcer healing, diabetic patients with foot ulcers must control their HbA1C in the range of 7 - 8%.¹⁶ In addition, diabetic patients should have proper foot care behaviors, such as cleaning the feet, examining for foot abnormalities, preventing and managing foot ulcers, putting on shoes and promoting blood circulation around the feet, especially among the high-risk groups having foot numbness with deformed foot or those having a history of toenail, foot or leg amputation.⁴ These groups have a higher chance of having ulcers than other groups. Therefore, the high-risk groups that do not have proper foot care and or well-controlled blood sugar levels will result in chronic foot complications which may lead to disabilities. For diabetic patients with proper foot care behaviors, the incidence of diabetic foot ulcers can be reduced by 85%.⁶

Previous research indicates that promoting effective foot care behaviors in diabetic patients involves many factors. Albert Bandura, an American psychologist, believes that a person's good behavior depends on many factors, namely 1) personal factors such as biological and intellectual

characteristics and 2) environmental factors such as social characteristics.¹⁷ The personal factor that promotes good foot care behaviors is health literacy which is a person's ability to understand health information and use it appropriately.¹⁸ A study on health literacy revealed that health literacy was found to be the most important predictor of diabetic foot care behaviors ($R^2 = 0.43$, P -value < 0.001).¹⁹ Also, a similar study under the conceptual framework of Bandura suggested that health literacy can jointly predict foot care behaviors ($R^2 = 0.28$, P -value < 0.001).²⁰ A study also found that people with higher health literacy scores had a lower risk of diabetic foot disease (OR = 0.96; 95% CI = 0.93 - 0.99).²¹ However, some studies have indicated that health literacy is not associated with self-care behavior of diabetic patients.^{22,23} It can be seen that study results are still in conflict. Therefore, health literacy was studied in our present research.

The environmental factor that encourages diabetic patients to have foot care behaviors is social support which is interpersonal interaction that includes giving positive expressions, reassurance and assistance of one person to another.²⁴ Social support was found to be positively associated with foot care behaviors among diabetic patients at a high level ($r = 0.489$, P -value < 0.001; $r = 0.522$, P -value < 0.01, respectively).^{25,26} It can also predict foot care behaviors among diabetic patients ($\beta = 0.179$, P -value < 0.05).²⁷ In addition, social support can predict preventive behaviors for foot ulcers ($R^2 = 0.45$, P -value < 0.01).²⁸ Based on the literature review, social support helps promote foot care for diabetic patients and was subject to testing for predictive power in this present study.

Perceived self-efficacy is people's belief about their capacities to do something which has an influence on their lives¹⁷ such as having proper foot care behaviors. The literature review indicated that self-efficacy was positively associated with foot care behaviors of diabetic patients at a high level ($r = 0.582$, P -value < 0.01).²⁶ A study of the foot care behavior promoting program in diabetic patients applying Bandura's self-efficacy theory revealed that after participating in the program, the mean score of foot care behaviors was significantly higher than that of before the program ($t = 15.05$, P -value < 0.001) (95%CI = 7.20 - 9.43).²⁹ However, a study in Thailand suggested that self-efficacy was negatively associated with diabetic foot ulcers. ($r = -0.415$, P -value < 0.05).³⁰ Another study also found that self-efficacy was not correlated with foot care behaviors of diabetic patients.³¹ With

inconclusive associations, self-efficacy was tested in this present study.

Outcome expectation is a belief in which a person evaluates a specific behavior that will lead to the expected outcome. It is the expectation that something will happen as a result of the behavior that has been done, such as the outcome of having proper foot care behaviors. From the literature review, a study on the outcome expectations of chronic kidney disease (CKD) patients on food control program at an out-patient CKD clinic found that after the intervention, the patients' outcome expectation and food control behaviors were significantly higher than those of before the intervention (P -value < 0.001).³² According to Bandura's theory of self-efficacy, outcome expectation is related to individual behavior.¹⁷ As a result, outcome expectation was tested in this present study.

Theoretically, outcome expectation is related to patient behavior and cannot be separated from perceived self-efficacy.¹⁷ In addition, only an overview study of foot care behaviors among general diabetic patients was conducted; it was not specific to high-risk groups. Although a study of foot care promotion program was conducted, there were some limitations in the characteristics of the participants who were patients at low risk of foot ulcers and able to take good care of themselves. It was not specific to those with foot ulcers or those with even more dependence. Therefore, it is advisable to study other factors that may be related to the foot care behaviors of different groups of patients especially those with wounds that are at high risk of developing foot ulcers or having abnormal foot conditions.²⁹ For this reason, the researcher recognized the importance of foot care behaviors in diabetic patients at high risk of foot ulcer because they are more prone to foot ulcers than other groups. If diabetic patients at high risk of developing ulcers have proper foot care behaviors, the occurrence of ulcers can be prevented. It will also help reduce exposure to various effects from the occurrence of ulcers and the incidence of disabilities. Therefore, it was crucial to examine the influence of health literacy, social support, perceived self-efficacy and outcome expectation of foot care behaviors on the foot care behaviors among diabetic patients at high risk of diabetic foot ulcer. The findings could be useful for establishing guidelines for promoting effective foot care skills.

Bandura's social cognitive theory (1997) was employed in this study. It is people's belief about their capacities and effort

to perform behaviors. Albert Bandura believes that people's behaviors change due to personal factors such as intelligence, health literacy and other internal things and environmental factors.¹⁷ Based on the social cognitive theory, Bandura believes that humans must analyze conditions and stimuli that reinforce those conditions. People have perceived self-efficacy, which is a judgment of their abilities on which level of task they can perform. They also have outcome expectations, which are the beliefs in which people evaluate specific behaviors that they perform, which will lead to the expected outcomes. If people have perceived self-efficacy and outcome expectations, they will perform the behaviors to achieve the goal. Personal factors including health literacy that contributes to determining behaviors of people, perceived self-efficacy and outcome expectation of foot care behaviors, and environmental factor which was social support were expected to be positively with foot care behaviors of diabetic patients at high risk of diabetic foot ulcer.

Specifically, this study aimed to 1) determine the level of foot care behaviors among diabetic patients at high risk of diabetic foot ulcer and 2) examine the factors influencing such behavior including health literacy, social support, perceived self-efficacy and outcome expectation of foot care behaviors. It was hypothesized that health literacy, social support, perceived self-efficacy and outcome expectation of foot care behaviors could jointly predict foot care behaviors among diabetic patients at high risk of diabetic foot ulcer.

Methods

In this predictive correlational research, the study population included patients diagnosed with type 2 diabetes mellitus by a doctor and at high risk of diabetic foot ulcer. They were those with foot numbness, deformed foot or a history of toenail, foot or leg amputation which could be identified from medical records of diabetic patients receiving care at the outpatient department of Phrapokklao Hospital.

The study sample was those in the study population who met the eligibility criteria and receiving care from September 2021 to May 2022. To be eligible, they had to be aged 35 years old and over, have full consciousness, be with a score of less than 8 points of the 6-item cognitive function test-Thai version³³, have no history of foot or leg being amputation, and be able to speak, read and write Thai language. Participants

who had severe complications such as inflamed wounds, life-threatening hyperglycemia or hypoglycemia were excluded.

The sample size was calculated using the G*Power software program. With a type I error of 5%, a power of 80% and an effect size of 0.13 from a previous study³⁴, a sample size of 97 participants was required.

Research instruments

Two sets of questionnaires were employed. The first set was questions asking demographic and clinical characteristics. The first part asked demographic characteristics including gender, age, education level, occupation, and caregivers. The second part asked about diabetic health including duration since diabetes was diagnosed, comorbidities such as hypertension, hyperlipidemia, heart disease and end-stage renal disease, and latest hemoglobin A1C and fasting plasma glucose. The third part was the diabetic patient's foot assessment form consisting of history of foot ulcers, causes of foot ulcers including sudden onset of blisters, stepping on the materials or having shoe bites due to foot numbness, hard skin and wounds under the skin and other causes, types of foot ulcers, history of toenail/foot/leg amputation, foot abnormalities, nail abnormalities, palpation of foot pulses, examination of foot sensation using 10 gm monofilament and styles of shoes. The third part was assessed by the researcher.

The second set consisted of five parts. The first part was the diabetic patients' foot care behaviors questionnaire.³⁵ The 19 items covers five aspects of the behavior namely foot self-examination, wearing appropriate shoes, foot exercise, foot cleaning, and ulcer care as recommended by the doctor. It consists of 15 and 4 positive and negative questions, respectively. The response is a 5-point rating scale ranging from 5-everyday (performing the behavior 7 days a week), to 4-almost every day (5 - 6 days a week), 3-sometimes (3 - 4 days a week), 2-occasionally (1 -2 days a week) and 1-never for positive statements and in the opposite direction for negative statements. With the possible total score of 19 - 95 points, proper behavior was categorized as low, moderate and high for 19 - 56 (or 60%), 57 - 75 (or 60 - 79%), and 76 - 95 points (or 80% or more), respectively.

In the second part, diabetic patients' health literacy was measured using the Thai-language questionnaire³⁶ developed from the ABCDE-Health Literacy Scale of Thai Adults based on the health literacy concept of Nutbeam (2008).³⁷ This

questionnaire was modified to suit diabetic patients.³⁶ The questionnaire consists of 6 components namely knowledge and understanding, access to health information and services, health communication, self-management, media and information literacy, and decision-making among patients with type 2 diabetes. Of the 19 items, 9 items are with a multiple choice, and 10 with a 5-point rating scale. With a possible total score of 13 - 68 points, health literacy was categorized as low, moderate and high for less than 40.80 (or 60%), 40.80 - 54.39 (or 60% - 79%), and 54.40 - 68.00 points (or more than 79%), respectively.

The third part assessed social support using a 20-item Thai-language questionnaire.³⁸ It consists of 4 aspects namely emotional, informational, appraisal and instrumental support. The response was a 4-point rating scale ranging from 4-absolutely true, to 3-mostly true, 2-slightly true, and 1-absolutely not true. With the possible total score of 20 - 80 points, social support was categorized as low, moderate, and high (20 - 40, 41 - 60, and 61 - 80 points, respectively).³⁸

The fourth part evaluated diabetic patients' perceived self-efficacy questionnaire for foot self-care behaviors.³⁵ The 19-item questionnaire contains 19 items of 5 aspects namely foot self-examination, wearing appropriate shoes, foot exercise, foot cleaning, and ulcer care as recommended by the doctor.³⁵ The response was a 5-point rating scale ranging from 1-not at all confident, to 2-slightly confident, 3-not sure, 4-quite confident, and 5-completely confident. With the possible total score of 19 - 95 points, perceived self-efficacy was categorized into low, moderate and high levels (19 - 56, 57 - 75, and 76 - 95 points, respectively).³⁵

In the fifth part, outcome expectation of foot care was assessed using a questionnaire of Iamsomboon.³⁵ Of the 14 questions, 10 were positive and 4 were negative statements. The response was a 5-point rating scale ranging from 1-strongly disagree to 2-disagree, 3-not sure, 4-agree, and strongly agree for positive statements and in the opposite direction for negative statements. With the total score of 14 - 70 points, outcome expectation was categorized as low, moderate, and high (14 - 41, 42 - 55 and 56 - 70 points, respectively).³⁵

Research instruments quality assurance

All 5 questionnaires in the second set were tested for internal consistency reliability with 30 individuals with characteristics comparable to the participants. The internal

consistency reliability of questions on the diabetic patients' foot care behaviors, diabetic patients' health literacy, social support questionnaire, diabetic patients' perceived self-efficacy, and outcome expectation of foot care was at an acceptable level (Cronbach's alpha coefficients of 0.70, 0.85, 0.83, 0.89 and 0.76, respectively).

Participants ethical protection

This research was approved by Burapha University Research Ethics Committee (approval number: G-HS025/2564; approval date: June 7, 2021) and Phrapokklao Hospital Research Ethics Committee (approval number: 054/64; approval date: July 6, 2021). The researcher clarified the research objectives, the benefits obtained from the research and allowed the participants to participate voluntarily. They could withdraw at any time with no negative consequence on the care they received. Measures to prevent covid-19 infection were followed strictly. Any adverse events such as fainting, dizziness, headache, palpitation, trembling, or sweating, if emerging, would warrant immediate discontinuation. Data collection could be resumed once the symptom was resolved.

Data collection procedure

The researcher had diabetic clinic nurses for participant recruitment. Patients were screened for eligibility and written informed consent. The researcher examined the feet and read and filled in the questionnaire for the participant. The whole process took about 20 – 30 minutes to complete.

Data analysis

Descriptive statistics including mean with standard deviation and frequency with percentage were used to summarize demographic and clinical characteristics of the participants and study factors. Multiple linear regression analysis was used to determine the association between foot care behaviors and health literacy, social support, perceived self-efficacy and outcome expectation of foot care behaviors. All assumptions for linear regression were met. Statistical significance was set at a type I error of 5% (i.e., P-value < 0.05). All statistical analyses were performed using software program SPSS version 20.

Results

Most of the participants were women (57.7%), older than 60 years old (40.2%) with an average age of 57.59 years \pm 9.42 years. Most participants had elementary school education (57.7%), were unemployed (54.6%) and taken care of by caregivers (57.7%) (Table 1).

Table 1 Demographic characteristics of the participants (N = 97).

Characteristics	N	%
Gender		
Men	41	42.3
Women	56	57.7
Age (years) (Min = 35, Max = 70, M = 57.59, SD = 9.42)		
≤ 40	8	8.2
41 - 50	16	16.5
51 - 60	34	35.1
> 60	39	40.2
Education level		
No formal education	3	3.1
Elementary school	56	57.7
Secondary school	28	28.9
Associate degree	2	2.1
Bachelor's degree	8	8.2
Occupation		
No job	53	54.6
Small business	11	11.3
Farmer	11	11.3
Labor	11	11.3
Government employee	7	7.2
Others	4	4.1
Having caregiver		
No	41	42.3
Yes	56	57.7

For clinical characteristics, the majority of the participants had diabetes for 6 -10 years (39.18%). The average duration of having diabetes was 14.08 years. As high as 82.47% had co-morbid illness including hypertension and hyperlipidemia (28.86%), hypertension (21.65%), and hyperlipidemia and heart disease (11.34%), respectively. Most participants had the fasting plasma glucose in a range of 70 - 180 mg/dl (77.32%), and HbA1C of greater than 8.0 (39.18%) (Table 2).

Most participants had foot ulcers before (91.8%) (89 out of 97) which were mostly caused by etiology other than diabetes-related causes such as accidents (37.1%) (33 out of 89) (Table 3). Infected ulcers were found in most participants (72.0%) (64 out of 89). Moreover, 48.5% (47 out of 89) of the participants had a history of toenail/foot/leg amputation. All of them had a history of toenail/foot/leg amputation (47 out of 89). They mostly had toenail amputation (85.1%) (40 out of 47). The foot abnormality mostly found was callus: 45.2% (24 out of 53) were on the right foot and 45.1% (23 out of 51)

were on the left foot. In terms of nail abnormalities, thick toenail was mostly found: 77.1% (37 out of 48) were found on the right foot and 78.3% (36 out of 46) on the left foot. Most of the participants had lighter pulses. The dorsalis pedis pulse of the right foot was lighter than normal (53.2%) (50 out of 94), and that of the left foot was 50.5% (48 out of 95). The posterior tibial pulse of the right foot was lighter than normal (54.2%) (52 out of 96) and that of the left foot was 52.6% (51 out of 97). The 10 g monofilament test revealed that 94.3% (82 out of 87) of the participants had loss of protective sensation [LOPS] on the right foot and 93.3% (83 out of 89) had it on the left foot. In addition, the participants mostly wore half cut shoes (61.9%) (60 out of 97), and 51.5% (50 out of 97) of the shoes were made of rubber. Also, 73.2% (71 out of 97) wore shoes fitting their feet. Furthermore, 64.9% (63 out of 97) of them did not wear socks (Table 3).

Foot care behaviors were at a moderate level (mean score of 73.42 out of 95 points). The aspect of foot care behaviors with the highest score was ulcer care as recommended by the doctor, wearing appropriate shoes, foot cleaning, foot self-examination, and foot exercise (29.97, 17.10, 15.64, 6.95, and 6.22 points, respectively) (Table 4).

Table 2 Clinical characteristics of the participants (N = 97).

Characteristics	N	%
Duration of having diabetes (years)		
(Min = 1, Max = 35, M = 14.08, SD = 8.05)		
≤ 5	12	12.37
6 - 10	38	39.18
11 - 15	11	11.34
16 - 20	20	20.62
21 - 25	7	7.21
26 - 30	8	8.25
> 30	1	1.03
Comorbidities		
No	17	17.52
Yes	80	82.47
Hypertension	21	21.65
Hyperlipidemia	2	2.06
Hypertension and hyperlipidemia	28	28.86
Hypertension and end-stage renal disease	6	6.18
Hypertension and heart disease	2	2.06
Hypertension, hyperlipidemia and heart disease	11	11.34
Hypertension, hyperlipidemia and end-stage renal disease	6	6.18
Hypertension, hyperlipidemia, heart disease and end-stage renal disease	4	4.12
Fasting plasma glucose (mg/dl)		
(Min = 60, Max = 422, M = 155.99, SD = 68.86)		
< 70	1	1.03
70 - 180	75	77.32
181 - 250	13	13.40
> 250	8	8.25
Hemoglobin A1C (%)		
(Min = 5.1, Max = 14.1, M = 8.33, SD = 0.21)		
< 7.0	25	25.77
7.0 - 8.0	34	35.05
> 8	38	39.18

Table 3 Foot characteristics (N = 97).

Foot characteristics	N	%
History of foot ulcers		
Never	8	8.2
Already had foot ulcers before	89	91.8
Cause of foot ulcers (N = 89)		
Blister	26	29.2
Numbness and stepping on hazardous materials or the shoes pinch	20	22.5
Ulcer under the corn or callus	10	11.2
Other causes such as accidents	33	37.1
Type of ulcers (N = 89)		
Ischemic ulcer	14	15.7
Neuropathic ulcer	11	12.3
Infected ulcer	64	72.0
History of toenail/foot/leg amputation (N = 89)		
Never	50	51.5
Ever	47	48.5
Part of amputation (N = 47)		
Toenail	40	85.1
Foot	6	12.8
Leg	1	2.1
Foot abnormality (Right foot) (N = 53)		
Corn	1	1.9
Charcot foot	1	1.9
Claw toe	10	18.9
Bunions	2	3.8
Callus	24	45.2
Hallux deformity	15	28.3
Foot abnormality (Left foot) (N = 51)		
Corn	1	2.0
Charcot foot	2	4.0
Claw toe	11	21.5
Bunions	4	7.8
Callus	23	45.1
Hallux deformity	10	19.6
Nail abnormalities (Right foot) (N = 48)		
Thick toenail	37	77.1
Ingrown toenail	4	8.3
Onychomycosis	7	14.6
Nail abnormalities (Left foot) (N = 46)		
Thick toenail	36	78.3
Ingrown toenail	4	8.7
Onychomycosis	6	13.0
Pulses		
Dorsalis pedis (Right foot) (N = 94)		
Normal	44	46.8
Lighter pulses	50	53.2
Dorsalis pedis (Left foot) (N = 95)		
Normal	46	48.4
Lighter pulses	48	50.5
Posterior tibial (Right foot) (N = 96)		
Normal	44	45.8
Lighter pulses	52	54.2
Posterior tibial (Left foot) (N = 97)		
Normal	46	47.4
Lighter pulses	51	52.6
The 10g monofilament test (Right foot) (N = 87)		
Normal	5	5.7
Loss of protective sensation (LOPS)	82	94.3
The 10g monofilament test (Left foot) (N = 89)		
Normal	6	6.7
Loss of protective sensation (LOPS)	83	93.3
Shoes		
Flip flop	11	11.3
Half cut shoes	60	61.9
Shoes	10	10.3
Others	16	16.5
Materials		
Rubber	50	51.5
Plastic	9	9.3
Artificial leather	3	3.1
Leather	24	24.7
Others	11	11.3
Shoes fitting their feet		
Fitting	71	73.2
Tight	6	6.2
Loose	19	19.6
Shoes pinch	1	1.0
Socks		
Always wearing socks	17	17.5
Not wearing socks	63	64.9
Sometimes wearing socks	17	17.5

Health literacy was at a high level (59.76 out of 68 points). The highest score of health literacy aspect was health communication (13.36 points) followed by self-management, correct decision-making by strictly focusing on the behaviors good for their own health and others, media and information literacy, ability to find information from many sources that are reliable enough to make decisions, health knowledge and understanding sufficient for sustainable good health behaviors (12.90, 10.39, 9.22, 8.89, and 4.91 points, respectively) (Table 4).

For social support, it was at a high level (mean = 70.61 out of 80 points). The highest aspect of social support was informational support (18.77 points) followed by emotional support, instrumental support, and appraisal support (18.45, 18.14, and 15.24 points, respectively).

Perceived self-efficacy was at a high level (mean = 86.98 out of 95 points). The individual aspect of self-efficacy with the highest score was ulcer care as recommended by the doctor, followed by wearing appropriate shoes, foot self-examination, and foot exercise (28.87, 23.86, 9.52, and 8.72 points, respectively).

For outcome expectation, it was at a high level (mean = 66.04 out of 70 points) (Table 4). The aspect with the highest score was dirty and damp bandages cause the ulcers to be infected easily (mean = 4.97 points) followed by proper care of feet and foot ulcers will prevent diabetic patients from the spread of ulcers and amputation and foot exercise improves blood circulation to legs and the ulcers will be healed quickly (mean = 4.96 and 4.94 points, respectively) (Table 4).

It was found that foot care behaviors were significantly, positively correlated with health literacy, social support, and perceived self-efficacy ($r = 0.326, 0.362, \text{ and } 0.523$, respectively, $P\text{-value} < 0.01$ for all), but not with outcome expectations (Table 5).

For the influence of predictive factors, health literacy, social support, perceived self-efficacy and outcome expectation could significantly explain 32% of variance of foot care behaviors ($Adj. R^2 = 0.32, P\text{-value} < 0.001$). The most influencing factor was perceived self-efficacy ($\beta = 0.41, P\text{-value} < 0.001$) followed by social support ($\beta = 0.193, P\text{-value} = 0.034$) and health literacy ($\beta = 0.192, P\text{-value} = 0.043$). Outcome expectation had no significant influence on foot care behaviors (Table 6).

Table 4 Levels of foot care behavior and its influencing factors (N = 97).

Factors	Mean	SD	Level
1. Foot care behaviors	73.42	12.09	Moderate
1.1 Foot self-examination	6.95	3.08	
1.2 Wearing appropriate shoes	17.10	3.44	
1.3 Foot exercise	6.22	2.70	
1.4 Foot cleaning	15.64	2.92	
1.5 Ulcer care as recommended by the doctor	29.97	4.73	
2. Health literacy	59.76	4.68	High
2.1 Health knowledge and understanding sufficient for sustainable good health behaviors	4.91	1.06	
2.2 Ability to find information from many sources that are reliable enough to make decisions.	8.89	1.53	
2.3 Health communication	13.36	1.72	
2.4 Self-management	12.90	1.89	
2.5 Media and information literacy	9.22	1.41	
2.6 Correct decision-making by strictly focusing on the behaviors good for their own health and others	10.39	1.47	
3. Social support	70.61	5.94	High
3.1 Informational support	18.77	1.95	
3.2 Emotional support	18.45	2.19	
3.3 Instrumental support	18.14	2.10	
3.4 Appraisal support	15.24	3.20	
4. Perceived self-efficacy	86.98	9.50	High
4.1 Foot self-examination	9.52	0.92	
4.2 Wearing appropriate shoes	23.86	2.22	
4.3 Foot exercise	8.72	1.73	
4.4 Foot cleaning	18.40	1.94	
4.5 Ulcer care as recommended by the doctor	28.87	2.26	
5. Outcome expectation	66.04	3.32	High

Table 5 Pearson's correlation coefficients (N = 97).

Factors	1	2	3	4	5
1. Foot care behaviors	1				
2. Health literacy	0.326 [*]	1			
3. Social support	0.362 [*]	0.243 [*]	1		
4. Perceived self-efficacy	0.523 [*]	0.276 [*]	0.312 [*]	1	
5. Outcome expectation	-0.012	0.307 [*]	0.073	-0.002	1

* P-value < 0.01.

Table 6 Predictive power of factors influencing foot care behaviors (N = 97).

Factors	b	SE	β	t	P-value
Constant	-10.83	24.50		-0.442	< .001
Health literacy	0.507	0.247	0.192	2.051	0.043
Social support	0.401	0.187	0.193	2.146	0.034
Perceived self-efficacy	0.533	0.119	0.410	4.496	< 0.001
Outcome expectation	-0.314	0.330	-0.084	-0.950	0.345

$R = 0.59, R^2 = 0.34, \text{ Adjusted } R^2 = 0.32, F_{1,92} = 12.28, P\text{-value} < 0.001.$

Discussions and Conclusion

The study in Thai diabetic patients at high risk of diabetic foot ulcer found that the foot care behaviors were at a moderate level (mean = 73.42 out of 95 points). It is possibly because diabetes is a chronic disease that requires frequent follow-up. The participants were diabetic patients at risk for diabetic foot ulcer, regularly followed-up at the Outpatient

Department at Phrapokklao Hospital with a long mean duration of having diabetes mellitus of 14.08 years. Therefore, they have had experiences in taking care of their own feet. The participants have also received foot care advice and have their feet examined. In addition, 91.8% of them had had foot ulcers before, and 40% of them had a history of toenail/foot/leg amputation. They also received advice and wound dressing services from the surgery clinic. However, 75.3% of the participants wore inappropriate shoes. Only 24.7% of them wore leather shoes suitable for the feet of diabetic patients at high risk of diabetic foot ulcer. The foot care behaviors of the participants were at a moderate level.

According to the social cognitive theory of Bandura,¹⁷ people's behaviors change due to personal factors. It was found that most of the participants had an average age of 57.59 years, which is adulthood. But 40.2% of them were the elderly, which is an age where there is a deterioration of the body, such as eye problems, which can affect their foot self-care. Moreover, as high as 57.7% of the participants had elementary school level, which is a basic education allowing for the ability to read and receive information from medical personnel. More than half of the participants (54.6%) were unemployed because they were dependent due to diabetic foot ulcers or a history of toenail/foot/leg amputation. Most of the participants (57.7%) needed caregivers, lived at home, and did not work. They had caregivers closely taking care of and giving them advice. As a result, the foot care behaviors of the participants were at a moderate level.

A moderate level of variance of foot care behaviors could be simultaneously explained by health literacy, social support, and perceived self-efficacy (*Adj. R*² = 0.32, *P*-value < 0.001). Health literacy was the third most effective predictor of diabetic foot care behaviors (β = 0.192, *P*-value = 0.043). The participants' overall health literacy was 59.76 points. Based on the correlation study, health literacy was positively and significantly correlated with foot care behaviors (*r* = 0.326, *P*-value < 0.01). It is because most of the participants can read and receive information from medical personnel. They have also gained knowledge from follow-up appointments and continuous foot examination from the diabetes clinic. As a result, most of the participants had a high level of health literacy. This is consistent with the social cognitive theory where people's behaviors change due to personal factors such as intelligence, health literacy and other internal things.¹⁷ It also aligns with a study by Sarpooshi et al (2020), which

found that health literacy was significantly related with self-care (*P*-value < 0.001).³⁹ The study of Lael-Monfared et al (2019) revealed that health literacy can jointly predict diabetic patients' foot care behaviors (*P*-value < 0.001).¹⁹ It can help predict foot care behaviors.²⁰ A study by Chen et al (2019) also pointed out that people with higher health literacy scores had a lower risk of diabetic foot disease (OR = 0.96; 95%CI = 0.93 - 0.99).²¹

Social support also had an influence on foot care behaviors among diabetic patients at high risk of diabetic foot ulcer (β = 0.193, *P*-value = 0.034). Most of the participants had a high level of social support (70.61 ± 5.94 out of 80 points). Social support was significantly, positively correlated with perceived self-efficacy (*r* = 0.312, *P*-value < 0.01). It is because the participants have received information provided by doctors, nurses and other medical personnel when receiving services at the hospital. They can also access more information from various media nowadays. Moreover, most of them (57.7%) were taken care of by caregivers. They also have recognized the care and attention of close family members. This is consistent with the social cognitive theory believing that people's behaviors change due to personal and environmental factors.¹⁷ It is also consistent with the study results of Mohebi et al (2018) and Sen et al (2019) which found that social support had a high positive correlation with diabetic foot care behaviors (*r* = 0.489, *P*-value < 0.001 and *r* = 0.522, *P*-value < 0.01, respectively).^{25,26} A study by Sari et al (2020) also found that social support can predict diabetic foot care behaviors (β = 0.179, *P*-value < 0.05).²⁷ Furthermore, social support can predict preventive behaviors for foot ulcers (*R*² = 0.45, *P*-value < 0.01).²⁸

The participants' perceived self-efficacy was at a high level (86.98 ± 9.50 out of 95 points). Perceived self-efficacy had a high positive correlation with foot care behaviors among diabetic patients at high risk of diabetic foot ulcers (*r* = 0.523, *P*-value < 0.01). It was also the most effective influence of foot care behaviors among diabetic patients at high risk of diabetic foot ulcer (β = 0.410, *P*-value < 0.001). This is because the mean duration that the participants were diagnosed with diabetes was 14.08 years ± 8.05. Additionally, 91.8% of the participants had had foot ulcers before, so they were more confident in the practice of foot care behaviors. The research results are also consistent with the social cognitive theory stating that perceived self-efficacy is persons' belief in their capacity to perform a behavior which has an

influence on their lives.¹⁷ The findings are also in line a study by Sen et al (2019) revealing that perceived self-efficacy was positively correlated with foot care behaviors of diabetic patients at a high level ($r = 0.582$, P -value < 0.01).²⁶

Outcome expectation was not correlated with foot care behaviors among diabetic patients at high risk of diabetic foot ulcer although the participants had a high score on the outcome expectation of foot care behaviors (66.04 ± 3.32 out of 70 points). This is probably because most of the participants believe that behavioral practices should at least help slow down the incidence of ulcers. However, they do not expect that good foot care behaviors will never cause foot ulcers again. From the study, it was found that even the ulcers were healed, the recurrence rate in 1 year was 40% and that in 3 years was 65%.⁵ Most of the participants know that even with foot care, foot ulcers can still occur because of other factors such as blood sugar levels, cell deterioration with increasing age, and comorbidities such as hypertension and hyperlipidemia that result in increased deterioration of the blood vessels flowing to various organs including the feet. The participants had many comorbidities including hypertension and end-stage renal disease (6.18%), hypertension, hyperlipidemia and end-stage renal disease (6.18%) and hypertension, hyperlipidemia, heart disease and end-stage renal disease (4.12%). Hypertension results in hardening and narrowing of the arteries. A very high accumulation of fat in the blood causes the constriction of blood vessels, resulting in poor circulation.^{4,0} Moreover, end-stage renal disease causes dry and cracked skin⁴¹ resulting in foot ulcers.

However, the participants' foot care behaviors were at a moderate level. It was also found that HbA1C of 39.18% of the participants was higher than 8.0%. Nevertheless, HbA1C should be less than 7%.^{4,42} Moreover, most of the participants (91.8%) had had foot ulcers before. Abnormalities of feet and toenail were found. They also had lighter pulses and loss of protective sensation on both feet, which is at risk for the reoccurrence of foot ulcers. A study revealed that diabetic patients with previous history of ulceration had a 5.7 times higher risk of recurrence (adjusted OR = 5.77; 95%CI = 2.23 - 14.0).¹³ Therefore, the program to delay the recurrence of ulcers in high-risk diabetic patients is very important especially in promoting perceived self-efficacy, social support and health literacy, along with continuous monitoring and control of patients' blood sugar levels. As a result, diabetic patients at high risk of diabetic foot ulcer will perform foot care behaviors

regularly and continuously resulting in the reduction of the recurrence of ulcers and disabilities in the future.

Based on our study findings and conduct, nurses can use the results of this research to develop a care program for diabetic patients at high risk of foot ulcer. Bandura's social cognitive theory can be employed as a basis for creating a program or nursing practice for this group of diabetic patients. The foot care behaviors, health literacy, social support and perceived self-efficacy of diabetic patients at high risk of foot ulcer should be assessed so that each patient can be effectively promoted with the foot care skills by the program. For nursing administrators, data obtained from this research could help them determine the guidelines for caring for diabetic patients at high risk of foot ulcers by assessing their foot care behaviors, perceived self-efficacy and social support along with controlling blood sugar levels and avoiding other factors such as smoking. The data can also be used to design the nursing guidelines, considering family and community participation in order to make the nursing process most effective for patients according to the context and location of each service unit.

For further research, researchers could develop and test the program based on factors influencing foot care behaviors among diabetic patients at high risk of foot ulcers, namely perceived self-efficacy, social support and health literacy. Studies on the outcome expectation of foot care behaviors including the incidence and recurrence rates of ulcers among diabetic patients at high risk of foot ulcers should be conducted.

In conclusion, the foot care behaviors among diabetic patients at high risk of DFU were at a moderate level and could be predicted by perceived self-efficacy, social support and health literacy.

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