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Factors influencing foot care behavior among patients with type 2 diabetes mellitus who have a high-risk diabetic foot in China

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ABSTRACT

Background & Aim: Foot ulceration and amputation have increased significantly among Chinese patients with type 2 diabetes mellitus. Proper foot care behavior is an important strategy for reducing the risk of diabetes-related foot issues. The current study aimed to assess foot care behavior and its influencing factors, including self-efficacy, foot care knowledge, and social support, among patients with type 2 diabetes mellitus who have a high-risk diabetic foot in Wenzhou, China.
Methods & Materials: This research used a correlational predictive design. In total, 107 participants who were eligible for the study were randomly selected. Five self-reported questionnaires, including the demographic questionnaire, Diabetes Self-Efficacy Scale, Foot Care Knowledge questionnaire, Perceived Social Support Scale, and Chinese version of the Nottingham Assessment of Functional Footcare, were utilized. Descriptive statistical and standard multiple linear regression analyses were performed to evaluate data.
Results: Approximately 90.7% of participants had poorly controlled diabetes (HbA1c≥ 7%), and 95.3% presented with foot deformities. Further, 51.4% of participants reported moderate foot care behavior, and 42.1% had poor foot care behavior. The multiple regression analysis revealed that self-efficacy, foot care knowledge, and social support significantly explained 31.1 % of the variability in foot care behavior. However, self-efficacy could predict foot care behavior (β= .490, p< .001).
Conclusion: It is important to improve foot care behavior among patients with type 2 diabetes who have a high-risk diabetic foot. Nursing interventions to enhance foot care behavior should focus on improving self-efficacy and providing foot care education regularly.

Introduction

With the country's development and improvement in living standards, diabetes mellitus (DM) has become a threat to people's lives. China has the largest proportion of patients with diabetes worldwide, and 95% with type 2 DM. In 2021, approximately 140 million people had diabetes, and the number of Chinese patients with DM will reach 174 million by 2045 (1). A diabetic foot ulcer is a major complication of diabetes (2). The global prevalence of diabetic foot ulceration was 6.3%, and its prevalence rates in Asia and China were 5.5% and 4.1%, respectively (3). One patient with diabetes undergoes lower limb amputation every 30 seconds globally (3). Diabetic foot ulcers can have a physical and psychological impact, leading to significant economic burdens and a high amputation and mortality rate (4, 5).

High-risk diabetic foot is defined as peripheral neuropathy without foot ulcers, regardless of foot deformity, peripheral arterial disease, or a lower extremity or toe amputation history. A previous study has shown that patients with high-risk feet were more likely to develop ulcerations, and low-risk feet could immediately progress into the

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high-risk foot (6). Approximately 47.1% of Chinese patients with DM have high-risk diabetic feet (7). Several prevention strategies are necessary to prevent the development of diabetic foot ulcers among patients with T2DM who have a high-risk diabetic foot.

Foot care behavior is one of the most effective strategies for preventing the development of diabetic foot ulcers. This includes foot examination, foot cleaning and protection, shoe and sock selection, and medical help-seeking (2). Previous studies have shown that proper foot care behavior effectively prevents diabetic foot ulcers and subsequent amputation (2). Nevertheless, foot care behavior was always disregarded and the least explored in the literature (8). Further, approximately 37%–52% of patients with T2DM performed foot care behavior, as well as the situation in China (9-12). Foot care behavior is influenced by several factors, including personal (self-efficacy and foot care knowledge) and environmental (social support) factors (10, 13, 14). However, information on foot care behavior and its influencing factors among patients with high-risk diabetic foot were still limited (15, 16).

The conceptual framework of this study was based on Bandura's social cognitive theory (SCT) (17). This theory shows that human behavior has a triadic dynamic interaction with behavior, personal, and environmental factors (17). Further, self-efficacy is a key component of behavioral change, knowledge is the precondition for behavior change, and social support plays a significant role in shaping people's behavior (18). The SCT has been successfully used in foot care behavior and studies involving high-risk populations. If patients have adequate foot care knowledge and strong self-efficacy and social support, they may have good foot care behavior. Therefore, this study used the SCT as a theoretical basis.

Most Chinese studies have investigated self-care behavior. However, they have some limitations. Previous reports have focused on preventing and treating diabetes and foot ulcers. However, only a few studies have examined the foot care behaviors of patients with T2DM who have high-risk diabetic foot, and foot care knowledge has been the most widely discussed aspect. Nevertheless, the multidimensional aspects of foot care behavior have not been fully explored. In addition, the investigation of influencing factors lacks a sufficient theoretical framework.

Furthermore, no study has determined whether self-efficacy, social support, and foot care knowledge can predict foot care behavior among patients with T2DM who have a high-risk diabetic foot in China. Hence, in an effort to fill this gap, the current study aimed to describe foot care behavior. Moreover, self-efficacy, foot care knowledge, and social support can predict foot care behavior among patients with T2DM who have a high-risk diabetic foot in Wenzhou, China.

Study findings can be used to understand foot care behavior and its predictors in Wenzhou, China, and other countries globally. Furthermore, the current study results may provide a theoretical basis for the nursing strategies of foot care behavior in patients with diabetes who have high-risk diabetic feet. This then allows health professionals to adopt targeted nursing interventions to control blood glucose levels and improve high-risk diabetic foot care behavior, thereby reducing the incidence of diabetic foot ulcers. In addition, our findings can be used as a basis to develop interventions that can improve foot care behavior and prevent the development of foot ulcers among patients with T2DM who have a high-risk diabetic foot.

Methods

The current study had a correlational predictive design. The participants were recruited from the Diabetes Outpatient Department (OPD) of one hospital in Wenzhou, China. Patients who visited the department between June 2021 and August 2021 were invited to participate in the research.

The sample size was determined based on the rule of thumb ("$N \geq 104+m$," where N is the number of participants and m

is the number of independent variables) (19). In this regard, 107 patients with T2DM who have high-risk diabetic feet were recruited using the simple random sampling method. The inclusion criteria were as follows: patients aged 18–60 years, those diagnosed with T2DM for at least 6 months, those with Gavin's weighted score of 9–13 for diabetic foot risk factors, those with an ability to understand, read, write, and speak Chinese, and those with a good orientation to place and time and without a history of mental illness. Patients with T2DM who underwent amputations of both feet were excluded.

Information was collected from the participants using five self-reported questionnaires. The demographic data questionnaire was developed by the researcher. It comprised 20 items, and it was divided into two parts (general and health information).

Self-efficacy was measured based on self-efficacy of the foot care subscale of the Diabetes Self-Efficacy Scale (DSES), which was translated and revised by Jingxuan Wang (20). The original version of the DSES was developed by Hurley and Shea in 1992 in the United States (21). The DSES scale comprises five subscales with 26 items, which included self-efficacy of diet control, exercise, drug and blood glucose monitoring, foot care, and hyperglycemia and hypoglycemia prevention. However, in this study, only the foot care subscale was used. Self-efficacy of the foot care subscale contained five items about the confidence level of patients in performing foot care, using the 5-point Likert scale. The score was marked from 1 to 5, with 1 indicating "strongly disagree" and 5 "strongly agree." The total score ranges from 5 to 25. A high score suggested a high self-efficacy level (20). The DSES can be psychometrically sound with adequate reliability (α= .82) and strong validity (21). Further, the Chinese version of the DSES was reliable, with a Cronbach's alpha coefficient of .87, and the foot subscale was .91 (20).

Foot care knowledge was assessed using the Foot Care Knowledge questionnaire, developed in Chinese by Rao Li, Li Yuan, and their colleagues in 2014 (22). This questionnaire included 24 items with six sub-categories, including foot examination, foot care, foot nail trimming, foot problem treatment, shoe type selection, and foot skin processing. Each item has "true," "false," and "do not know" options. A true answer equals 1 point, and the other options were assigned a score of 0. The total scores ranged from 0 to 24. Higher scores indicated good foot care knowledge (22). The questionnaire uses a standard score for the analysis, and the standard score = (the actual score/the highest possible score)*100. A standard score of < 60 indicates poor knowledge; 60–80, medium knowledge; and ≥ 80, high knowledge (22). The foot care knowledge questionnaire had strong content validity and strong reliability, with a Cronbach's alpha of .85 (22).

Social support was evaluated using the Chinese version of the Perceived Social Support Scale (PSSS) by Qianjin Jiang (23) from the original version of the PSSS developed by Blumenthal et al. in 1987 in the United States (24). The PSSS has 12 items, which comprises two subscales, including family support and support outside the family. The 7-point Likert scale (1= very strongly disagree, 7= very strongly agree) was used. The total score ranged from 12 to 84, and a high score indicated high social support (23). The PSSS was psychometrically with good reliability (α = .88) and adequate stability (24). It was successfully translated into the Chinese version and was reliable enough, with a Cronbach's alpha coefficient of .88 (23).

Foot care behavior was assessed using the Chinese version of the Nottingham Assessment of Functional Footcare (NAFF) by Li and Xing (12) from the original version, which was developed by Lincoln and Jeffcoate (25) in 2007 in the United Kingdom. It comprises 24 items with four subscales, including the content of foot examination (item 1), foot cleaning and protection (items 2–7, 14, 17–21), shoe and sock selection (items 8–13, 15, 16), and medical help-seeking (items 22–24). Each item was rated using the 4-point Likert scale (0–3) to record

responses to questions based on the frequency of occurrence of specific foot care behaviors; for example, the categories were 'Never', 'Rarely', 'Sometimes' or 'About once a week', with the actual categories determined by the nature of the specific foot care behavior. The researcher determined the correct answers. The total score was the sum of each item's scores, ranging from 0 to 72. The questionnaire used a standard score for the analysis, and the standard score= (the actual score/the highest possible score)*100. A standard score of< 60 indicated poor behavior; 60–80, moderate behavior; and > 80, high behavior (12). The NAFF had moderate reliability (0.53). The scale was successfully translated and revised into the Chinese version. The author invited five specialists to evaluate the content validity of the Chinese version of the NAFF. The CVI was .92, which indicated that the scale had good validity. The scale was reliable, with a Cronbach's alpha of .77 (25).

After informed consent was obtained, data were collected using self-reported questionnaires, and the whole process was completed within 25 minutes. In total, 107 patients participated in this study. Sociodemographic information, including age, sex, education, marital status, and history of smoking and drinking, was self-reported by the participants. Clinical data, such as body mass index, comorbidities, and history of diabetes, were collected from the patient's medical records. The physicians assessed the Gavin scores of patients.

The current study (G-HS 110/2563) was approved by the Institutional Review Board of Burapha University and the First Affiliated Hospital of Wenzhou Medical University (2021-092). Written informed consent was obtained voluntarily from each participant before data collection. The participants were informed about the purpose, methods, risks, and benefits of the study, and they could withdraw from the study at any time.

Data were analyzed using the Statistical Package for the Social Sciences software version 20. Descriptive statistics, including means, percentages, standard deviations, and frequencies, were used to describe demographic data and the study variables. From the literature review, foot care knowledge, self-efficacy, and social support were strongly associated with foot care behavior among T2DM patients. This study was based on a literature review and the SCT. The SCT illustrated that personal factors (like self-efficacy and foot care knowledge), environmental factors (like social support), and behavior interact. These variables (modifiable factors) were important and related to behavior. Therefore, the study objective was to examine whether self-efficacy, foot care knowledge, and social support together can predict foot care behavior among this population. Therefore, this study first tested the correlations among self-efficacy, foot care knowledge, social support, and foot care behavior, then used multiple regression analysis, enter method, to test whether these independent variables could predict foot care behavior. Assumptions testing for multiple regression analysis were evaluated, including normality, linearity, multicollinearity, homoscedasticity, homogeneity, and independence of residuals. Results showed that all of them were met. Though this study did not include the demographic variables in the model, most of them were non-modifiable factors; however, it was used to describe sample characteristics and foot care behavior of the sample.

Results

In total, 107 patients with T2DM who have high-risk diabetic feet participated in the study. The participants were aged 37–60 years, with a mean age of 54.53 years (*SD*= 5.28). Approximately 57% of the participants were female. Further, 51.4% had completed primary school or lower, 38.3% earned 5.000–9.999 yuan per month, 29.0% smoked cigarettes, and 31.8% drank alcohol.

Results showed that the average duration of diabetes diagnosis was 15.1 years (*SD*= 4.8). Approximately 39.3% of participants were diagnosed with T2DM for 11–15 years. About 62.7% of participants had

normal body weight (body mass index: 18.5–24.9 kg/m^2). Meanwhile, 35.4% were overweight and had obesity. About 90.7% had uncontrolled T2DM (HbA1c of ≥ 7%). Moreover, 39.3% of participants had hypertension, and 4.7% had chronic kidney disease.

All participants had diabetes-related complications, and 72.0% presented with one complication. Among them, 53.2% had peripheral neuropathy. About 95.3% had foot deformities, 37.9% presented with hallux valgus, and 25.2% with pes cavus. About 18.7% had a history of diabetic foot ulcers, and 16.9% had a previous history of one ulcer. Approximately 47.7% of participants received foot care education from their friends or other patients with T2DM. Meanwhile, 48.6% of participants received foot care education from physicians and registered nurses.

Table 1 shows the description of foot care behavior and its subscale. A mean score of 61.81 of 100 indicated that the participants had foot care behavior at a moderate level (*SD*= 12.65). For the subscales, all participants reported scores at a moderate level when selecting shoes and socks (*M*= 67.99, *SD*= 14.15) and foot cleaning and protection (*M*= 62.75, *SD*= 13.35). A low score was obtained for seeking medical help (*M* = 56.69, *SD*= 36.50) and the content of the foot examination (*M*= 16.51, *SD*= 29.09).

Table 1. Distribution of foot care behavior for each subscale (N= 107)

Foot care behavior and subscales	Possible score	Actual score	Mean	SD	Meaning
Foot care behavior	0–100	34.72–94.44	61.81	12.65	Moderate
Content of foot examination	0–100	0–100	16.51	29.09	Poor
Foot cleaning and protection	0–100	25.00–94.44	62.75	13.35	Moderate
Shoe and sock selection	0–100	33.33–95.83	67.99	14.15	Moderate
Seeking medical help	0–100	0–100	56.69	36.50	Poor

Error! Reference source not found. depicts that the mean self-efficacy score was 19.46 of 25 (*SD*= 3.45), and the score of foot care knowledge was at a moderate level (*M*= 64.91, *SD*= 16.14). The mean social support score was 66.67 of 84 (*SD*= 7.61).

Based on the correlation matrix, foot care behavior was significantly correlated with self-efficacy ($r = .565$, $p < .01$), foot care knowledge ($r = .426$, $p < .01$), and social support ($r = .201$, $p < .05$). Table 3 shows the correlation analysis results.

Table 4 depicts the summary of multiple regression analysis for predicting foot care behavior. A standard multiple linear regression analysis revealed that self-efficacy, foot care knowledge, and social support could explain the 31.1% variability in foot care behavior among patients with T2DM who have a high-risk diabetic foot in Wenzhou, China (Adj $R^2 = .311$, $F_{(3, 103)} = 16.979$, $p < .001$). Only self-efficacy could significantly predict foot care behavior ($\beta = .490$, $p < .001$).

Table 2. Range, mean, and standard deviation of independent variables (N= 107)

Independent variables	Possible score	Actual score	*M*	*SD*
Self-efficacy	5–25	11–25	19.46	3.45
Foot care knowledge	0–100	25.0–91.67	64.91	16.14
Social support	12–84	46–82	66.67	7.61

Table 3. Correlation matrix among the independent and dependent variables (N= 107)

	Foot care behavior	Self-efficacy	Foot care knowledge	Social support
Foot care behavior	1.000			
Self-efficacy	.565**	1.000		
Foot care knowledge	.426**	.608**	1.000	
Social support	.201*	.347**	.435**	1.000

*** $p < .05$; ** $p < .01$**

Table 4. Summary of multiple regression analysis for predicting foot care behavior (N= 107)

Predictive variables	B	SE	β	t	*p*-value
Self-efficacy	1.796	.374	.490	4.797	< .001
Foot care knowledge	.111	.083	.141	1.327	.187
Social support	–.052	.150	–.031	–.344	.732
Constant= 23.119, $R^2 = .331$, Adj $R^2 = .311$, $F_{(3, 103)} = 16.979$, $p < .001$					

Discussion

The participants in this study had foot care behavior at the lower borderline of the moderate level. The lowest scores were found on the subscale of foot examinations, foot protection, and seeking medical help. Participants may not realize that they are at high risk for diabetic foot ulcers and may have insufficient knowledge of how their lifestyle habits affect their feet. Hence, they lack the motivation to change their habits and lifestyles (18). Furthermore, their behavior requires long-term persistence to achieve outcomes. Thus, they may lack the desire to persist in foot care behavior (22).

In addition, the total score of foot care behavior was at the lower borderline of the moderate level, and 41.7% of participants exhibited poor foot care behavior. The reasons were as follows:

First, education level affects foot care behavior significantly (10, 14). Participants with a higher education level had better foot care behavior. Among the participants in this study, about half gained a primary school education or lower. Although they can read and write, they may have difficulties understanding the significance of engaging in foot care and seeking medical help when they have foot problems (22).

Second, all participants were adults (≤ 60 years old). They were the foundation of the workplace and family and may need to pay more attention to their work and family (26). Consequently, they had less time to care for their feet.

Third, the source of foot care information may also affect foot care behavior. The current study showed that 51% of participants received foot care education from WeChat, friends, or other patients with T2DM. Meanwhile, 49% obtained details from physicians and nurses. The information gained from non-health personnel may not be clear enough. Therefore, they may not understand how to perform foot care correctly and not realize the importance of performing foot care consistently.

Finally, 35.4% of participants were overweight or obese, which could limit their abilities to perform foot care behavior, particularly foot examination. Moreover, some had already developed diabetes complications, such as retinopathy (33.3%)

and peripheral neuropathy (53.8%), which may affect their abilities to perform foot care behavior. Patients with retinopathy could not inspect their feet clearly. Hence, they may have issues examining their own feet, and patients with peripheral neuropathy may lose protective sensation. In addition, complications could pose limitations in performing foot care behavior (2).

Results showed that only self-efficacy could predict foot care behavior. Participants who had a higher self-efficacy could perform more foot care behavior than those with a lower self-efficacy. This study result was consistent with previous studies (13, 26), and the SCT proposes that individuals with high self-efficacy will be motivated to perform specific tasks to reach their outcome expectations. Therefore, in this study, patients with T2DM who have a high-risk diabetic foot and believe in their ability to prevent foot ulcers could be more motivated to perform foot care behavior. Moreover, self-efficacy can come from mastery of experience, vicarious experience, and emotional and physical state and can determine how people feel, think, motivate themselves, and behave (18). Therefore, patients with prolonged diabetes acquire relevant foot care behavior skills. In addition, observing patients with DM or hearing their success stories may motivate the participants to believe that they could also perform foot care behavior to prevent diabetic foot (27).

Results showed that foot care knowledge and social support could not predict foot care behavior. These results were inconsistent with previous studies results (10, 22). Interestingly, the study findings revealed that though most of the participants knew how to perform foot care, more than half never performed some foot care behavior such as foot examinations, application of moisturizing cream, and drying between toes. One reason could be a lack of acceptance or importance of foot care practices due to the absence of foot symptoms such as numbness/tingling and pain. Although several patients had foot deformities such as hallux valgus and pes cavus, these did not adversely affect their daily activities. In addition, the participants' mean scores of foot care knowledge were only 65%, which may not be enough to motivate them to realize the importance of foot care practice. Therefore, they performed less self-care for their feet (28). Further, foot care knowledge could not predict foot care behavior.

In this study, social support could not predict foot care behavior. This result was inconsistent with that of previous studies (10, 29). This may be explained by the SCT (17). That is, the participants in this study did not develop foot ulcers or undergo amputations. Therefore, they did not require any support from others. In addition, all of them were under the age of 60 years. They could perform self-care by themselves, which included foot self-care. Therefore, they did not want others' support, specifically on foot care practice (30). This reason was confirmed by the study result showing that there was a minimal association between social support and foot care behavior ($r = .201$, $p < .05$). Another reason could be the social support measurement used in this study. The instrument asked about getting social support in general, not specific to the support for foot care practice, which resulted in the ability of social support to predict foot care behavior.

The current study showed that self-efficacy was strongly correlated with foot care knowledge and could predict foot care behavior. Therefore, developing an intervention for promoting foot care behavior should focus more on enhancing confidence/self-efficacy. The study findings imply that nurses and other health personnel could help them gain mastery experiences, such as foot examinations and foot cleaning and protection, and could help them gain vicarious experiences, including the introduction of others' successful experiences and make a cautious and constant explanation of the importance of behavior in patients with T2DM who have a high-risk diabetic foot. Official foot care education is another efficient way to help patients. Health personnel could educate the patients on how to control blood sugar after a therapeutic regimen and patients to do annual foot screening, perform proper

and regular inspections, and examine the at-risk foot. Foot care knowledge will enhance the patients' self-efficacy to help them perform foot care behavior.

The current study had several limitations. First, this study was cross-sectional in nature, and it could not determine cause-and-effect relationships between foot car behavior and its influencing factors. Second, as this study was conducted only at one hospital in China, future research should include participants from a broader geographical area and a larger sample size to generalize the study results.

Conclusion

Chinese patients with T2DM who have high-risk diabetic foot are at risk of developing diabetic foot ulcers. The findings were in accordance with the SCT as results revealed that foot care knowledge, self-efficacy, and social support were related to foot care behavior and that self-efficacy was the most significant predictor of foot care behavior among patients with T2DM who have a high-risk diabetic foot. Therefore, in future studies, healthcare providers should develop a program focusing on the promotion of self-efficacy to improve foot care behavior in this population.

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Conflict of interest

The author declares no conflict of interest, financial or otherwise.

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