



SELF-REGULATION AND SELF-CARE MODEL ON DIABETIC FOOT ULCER PREVENTION BEHAVIORS

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ABSTRACT

Diabetic foot ulcer (DFU) remains a major complication of type 2 diabetes mellitus (T2DM), with high recurrence and amputation rates worldwide. Effective prevention relies on self-care behaviors, which are strongly influenced by patients' self-regulation capacity. However, many patients struggle with maintaining consistent self-care due to low levels of self-regulation. This study aimed to develop and examine a self-regulation model based on self-care theory in relation to DFU prevention behaviors among patients with T2DM. An explanatory cross-sectional design was employed with 125 purposively selected T2DM patients in Surabaya, Indonesia. Data were collected on demographic characteristics, social support, illness representation, emotional responses, symptom interpretation, coping, self-care agency (knowledge, skills, and motivation), and DFU prevention behaviors. Structural equation modeling was used to test the hypothesized relationships. The instrument used was a questionnaire, and SEM-PLS analysis was conducted. The next stage involved a Focus Group Discussion (FGD) and expert consultation for the development of the final module. Social support ($T = 3,579$, $p = 0.000$) and illness representation ($T = 7,059$, $p = 0.000$) had significant positive effects on self-care agency, while negative emotional responses reduced self-care capacity ($T = 4,788$, $p = 0.000$). Self-care agency positively influenced DFU prevention behaviors ($T = 7,696$, $p = 0.000$). Coping strategies also had a significant effect on prevention behaviors ($T = 2,093$, $p = 0.000$). Demographic factors showed no direct effect on self-care agency. The self-regulation model based on self-care theory demonstrates that psychosocial factors, particularly social support, illness representation, emotional regulation, and coping strategies, play a more crucial role than demographic characteristics in shaping DFU preventive behaviors. This study concludes that preventive behavior for diabetic foot ulcers among patients with type 2 diabetes mellitus is mainly influenced by psychosocial and behavioral factors, particularly self-care agency, illness representation, emotional responses, and social support.

Keywords: diabetic foot ulcer preventive behaviors; self-care; self-regulation; type 2 diabetes mellitus (T2DM)

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INTRODUCTION

Diabetes Mellitus (DM) is a chronic disease characterized by blood glucose levels that exceed the normal threshold (Jannah et al., 2024; Suraya et al., 2025). Type 2 Diabetes Mellitus (T2DM) is a condition of elevated blood glucose or hyperglycemia, and uncontrolled hyperglycemia over a prolonged period can lead to damage to the nervous and vascular systems (Jannah et al., 2023; Suraya et al., 2024). T2DM is a disease that has spread worldwide and is often accompanied by complications, one of which is diabetic foot ulcer (DFU) (Megallaa et al., 2019; Nurul Hidayati et al., 2025). Prevention of DFU can be achieved through the implementation of self-care behaviors, in which success is influenced by self-regulation. However, patients often face difficulties in self-care due to low levels of self-regulation (Fadli et al., 2024).

In 2021, it was recorded that 537 million adults were living with DM worldwide (IDF, 2021). The prevalence of diabetic ulcers in African countries ranges from 10%–30%, with amputation rates between 3%–35%. In the Middle East, the prevalence of diabetic ulcers is between 5%–20%, with

recurrence rates ranging from 31% in Egypt to 43% in Turkey, while amputation rates range from 0.2% in Saudi Arabia to 60% in Jordan. In Europe, the prevalence of diabetic ulcers varies from 1% in Denmark to 17% in Belgium, with recurrence rates of 7% in Germany to 42%. In Southeast Asia, the proportion of DM patients experiencing diabetic ulcers is around 15%, with recurrence rates of less than 14% (IDF, 2022).

Indonesia ranks seventh in the world for the highest number of DM cases, with 19.47 million people living with DM. This indicates a DM prevalence rate of 10.6%, with an estimated 4 million people suffering from diabetic ulcers (Kemenkes, 2020). East Java ranks fifth among 33 provinces, with a prevalence of DM at 2.4% (Kemenkes, 2020), while Surabaya City ranks highest in East Java, with 104,363 reported DM cases (Dinas Provinsi Kesehatan Jawa Timur, 2023). Data from Dr. Soetomo General Hospital Surabaya in 2016–2018 recorded 387 cases of diabetic ulcers, with an average patient age of 50 years, no gender dominance, and rates of lower extremity amputation and mortality of 11.4% and 40.93%, respectively (Hariftyani et al., 2021). A study by Sari & Simanjuntak (2021) reported that among 74 respondents with T2DM in Surabaya, 21 respondents (28.38%) had moderate self-regulation, and 4 respondents (5.41%) had low self-regulation (Sari & Simanjuntak, 2021). Low self-regulation values may influence adherence to foot care (Estuningsih et al., 2019). Meanwhile, poor foot care behavior can lead to complications, including DFU, which often results in amputation (Febrianti et al., 2024). Therefore, it is necessary to develop a self-regulation model based on self-care theory to improve preventive behaviors for diabetic foot ulcers.

METHOD

The research design used in the first stage was explanatory research with a cross-sectional approach. This stage identified conditioning factors, including individual and social support factors, illness representation, emotional response, symptom interpretation, coping, self-care agency, and diabetic foot ulcer preventive behaviors (self-care demands). The study aimed to examine the relationship between a self-regulation model based on self-care theory and the outcome of improved preventive behaviors for diabetic foot ulcers among patients with type 2 diabetes mellitus (T2DM). The study population consisted of T2DM patients in Surabaya who had received healthcare services in the city. Sampling was conducted using a non-probability purposive sampling method by selecting participants who met predetermined criteria. The inclusion criteria were T2DM patients aged 19–59 years, able to read, write, and cooperative. The exclusion criteria were T2DM patients with acute complications or severe cognitive impairment. The sample size was calculated using the rule of thumb, based on the minimum likelihood estimation of five times the number of parameters to be measured. Since the development of the self-regulation model based on self-care theory involved 25 parameters, the required sample size was $5 \times 25 = 125$ respondents. The instrument used was a questionnaire, and SEM-PLS analysis was conducted. The next stage involved a Focus Group Discussion (FGD) and expert consultation for the development of the final module. This research has received a certificate of ethical feasibility with the number: 4449/Ket/PPM/STIKES-AH/VII/2025 issued by the Health Research Ethics Team of STIKES Adi Husada

RESULT

The characteristics of the respondents in this study are presented to provide an overview of the profile of the sample involved. The characteristic data includes demographic aspects, social support, perceptions of illness, psychological conditions, and the health behaviors of respondents. This presentation is important for understanding the background context of respondents and as a basis for interpreting the results of structural model analysis in the next stage. Thus, information on respondent characteristics serves not only as an initial description, but also as part of external validation that supports the interrelationship between variables in the study.

The results (Table 1) of the study show that the majority of respondents were in the late adult to elderly age group (45–59 years), accounting for 70.4%, while the remaining were aged 19–44 years. This finding indicates that most respondents were in an age group at higher risk for diabetes

complications, including diabetic foot ulcers, which is consistent with the American Diabetes Association (2021) stating that the risk of complications increases with age. In terms of social support, most respondents reported good family support (69.6%) and good health worker support (63.2%). This suggests that the majority of patients received adequate external support, which can facilitate greater independence in self-care.

Table 1.
Respondent characteristics (n= 125)

Variable	f	%
Age		
Adult (19-44 years)	37	29.6
Elderly (45-59 years)	88	70.4
Family supports		
Good	87	69.6
Enough	36	28.8
Less	2	1.6
Health Workers supports		
Good	79	63.2
Enough	38	30.4
Less	8	6.4
Diseases identity		
Threat	55	44
Not threat	70	56
Causes		
Threat	52	41.6
Not threat	73	58.4
Consequences		
Threat	37	29.6
Not threat	88	70.4
Suffering long		
6 month – 1 years	49	39.2
1 years – 5 years	34	27.2
5 years – 10 years	38	29.5
>10 years	8	6.4
Control		
6 month – 1 years	48	38.4
1 years – 5 years	39	31.2
5 years – 10 years	31	24.8
>10 years	7	5.6
Stress		
High	9	7.2
Moderate	22	17.6
Light	43	34,4
Not	51	40,8
Anxiety		
High	9	7.2
Moderate	22	17.6
Light	44	35.2
Not	50	40,0
Depression		
High	11	8
Moderate	20	16
Light	28	22,4
Not	66	52.8
Knowledge		
Good	84	67.2
Enough	34	27.2
Less	7	5.6
Skills		
Good	71	56,8
Enough	35	28
Less	19	15.2

Variable	f	%
Motivation		
Good	83	66.4
Enough	32	25.6
Less	10	8
Precieved symptoms		
Heavy	77	61.6
Moderate	47	37.6
Light	1	.8
Social burden		
Heavy	69	55.2
Moderate	48	38.4
Light	8	6.4
Coping approach		
Heavy	22	17.6
Moderate	68	54.4
Light	35	28
Coping avoidance		
Heavy	22	17.6
Moderate	62	49.6
Light	41	32.8
Food behavior		
Good	92	73.6
Less	33	26.4
Physical activity		
Good	88	70.4
Less	37	29.6
Foot care		
Good	88	70.4
Less	37	29.6
Medication consumption		
Good	88	70.4
Less	37	29.6
Monitoring gula darah		
Good	99	79.2
Less	26	20.8

Regarding illness perception, most respondents tended to view disease identity, causes, consequences, and control as “non-threatening.” This interpretation can be understood as a form of adaptive mechanism, although in some cases it may lower patient vigilance toward potential complications. Psychologically, most respondents were in the mild to moderate range of stress, anxiety, and depression, while more than half reported no severe psychological distress. This finding aligns with Lazarus and Folkman’s (1984) theory that individuals with mild to moderate stress levels still retain the capacity to engage in adaptive coping strategies.

Furthermore, the majority of respondents had good levels of knowledge (67.2%), skills (56.8%), and motivation (66.4%). These internal factors indicate that patients possess supportive capacities for the development of self-care behavior. In terms of health behavior, nearly all respondents demonstrated positive practices, such as maintaining proper diet, engaging in physical activity, foot care, medication adherence, and blood glucose monitoring, with percentages above 90%. This illustrates that most patients had already implemented preventive behaviors consistent with clinical recommendations. Inner model evaluation is a stage for evaluating estimates for path coefficients, evaluating the coefficient of determination (R^2), evaluating predictive relevance (Q^2), and evaluating collinearity. Testing estimates for path coefficients is based on coefficient values or the direction of variable relationships in line with the hypothesis. The testing criteria state that if the T-statistics value is $\geq$ T-table (1.96) or the P-value is significant at 5% or 0.05, then it has a stronger influence on other variables.

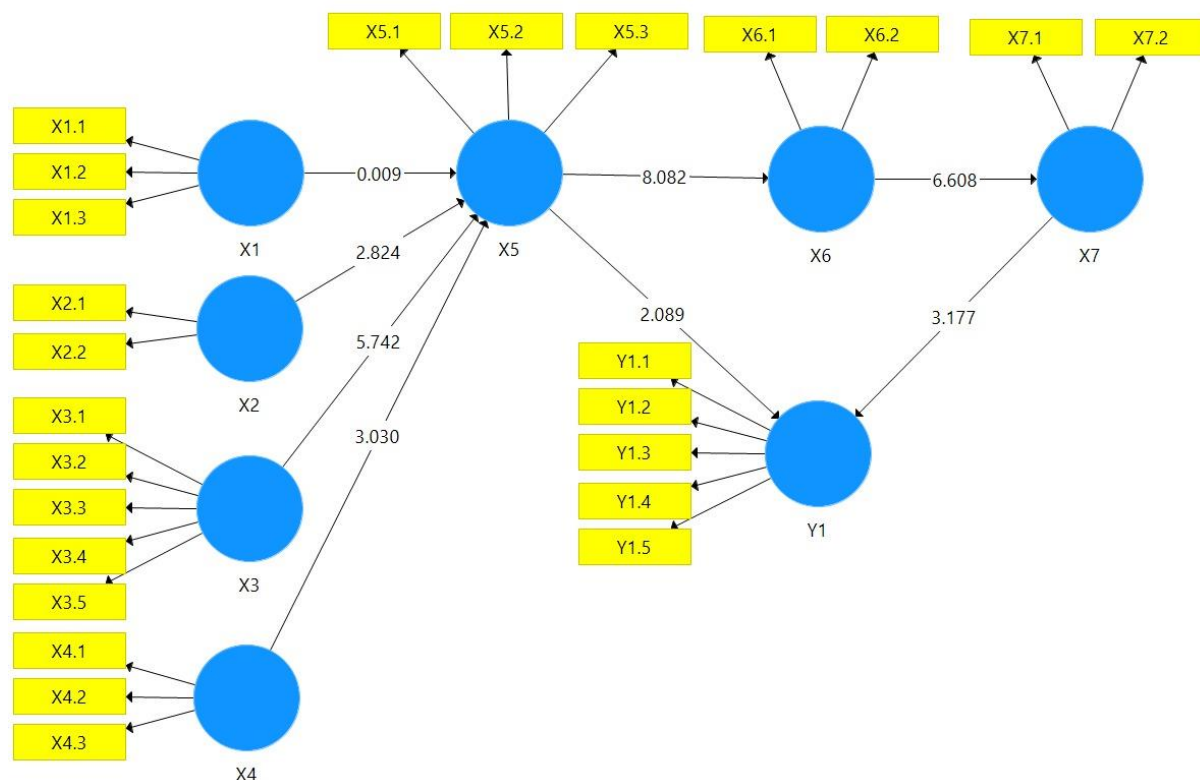


Figure 1. Inner Model

Table 2.
Result of Hypothesis

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P Values
X1 -> X5	-0.033	-0.030	0.021	1.529	0.127
X2 -> X5	0.187	0.183	0.067	3.579	0.000
X3 -> X5	0.455	0.458	0.070	7.059	0.000
X4 -> X5	0.365	0.364	0.058	4.788	0.000
X5 -> X6	-0.592	-0.598	0.077	7.696	0.000
X5 -> Y1	0.338	0.333	0.104	2.266	0.037
X6 -> X7	0.489	0.486	0.101	2.093	0.000
X7 -> Y1	0.372	0.366	0.104	6.700	0.024

The results of the estimate for path coefficients evaluation show variations in the strength and direction of the relationships between variables in the model. Individual factors (X1) do not have a significant effect on self-care agency (X5) ($T = 1,529$; $p = 0.129$), so it can be concluded that individual characteristics such as age, education, and experience are not sufficient to determine patients' independence in performing self-care. Conversely, social support (X2) has a significant positive effect on self-care agency ($T = 3,579$; $p = 0.000$), confirming that the higher the social support received by patients, the greater their ability to manage self-care. Disease representation (X3) also has a significant positive effect on self-care agency ($T = 7,059$; $p = 0.000$), meaning that patients' understanding of their illness strongly contributes to increasing their independence in self-

care. Emotional response (X4) in the table appears to have a positive effect on self-care agency ($T = 4,788$; $p = 0.000$), but the description of the results shows a significant negative effect ($T = 7,696$; $p = 0.000$), indicating that the worse the patient's emotional response (anxiety, stress, or fear), the lower their ability to perform self-care.

Furthermore, self-care agency (X5) has two directions of influence. First, self-care agency has a significant negative effect on symptom interpretation (X6) ($T = 7,696$; $p = 0.000$), which means that the higher the patient's independence, the lower their tendency to be overly focused or sensitive in interpreting the symptoms they experience. Second, self-care agency has a significant positive effect on diabetic ulcer prevention behavior (Y1) ($T = 2,266$; $p = 0.037$), indicating that patient independence in self-care encourages better preventive behavior. Symptom interpretation (X6) was found to have a significant positive effect on coping ability (X7) ($T = 2,093$; $p = 0.000$), meaning that patients who are able to understand their symptoms well tend to have more effective coping strategies. Finally, coping ability (X7) had a significant positive effect on diabetic ulcer prevention behavior (Y1) ($T = 6,700$; $p = 0.024$), confirming that good coping strategies encourage patients to be more disciplined in taking preventive measures against the disease.

DISCUSSION

Inner model evaluation is a stage for evaluating estimates for path coefficients, evaluating the coefficient of determination (R^2), evaluating predictive relevance (Q^2), and evaluating collinearity. Testing estimates for path coefficients is based on coefficient values or the direction of variable relationships in line with the hypothesis. The testing criteria state that if the T-statistics value is $\geq T$ -table (1.96) or the P-value is significant at 5% or 0.05, then it has a stronger influence on other variables.

Individual factors related to self-care

all of which could potentially influence self-care agency. However, the analysis revealed that age, gender, and socioeconomic status did not have a significant effect on self-care agency, consistent with Orem's theory (2001), which emphasizes that self-care ability is more strongly determined by adaptation, internal motivation, and social support (Maruca, 2023). This result is supported by studies conducted by Vellone et al. (2018) and Lin et al. (2025), which found that psychosocial factors such as family support, healthcare providers, and self-efficacy play a more dominant role than demographic characteristics in shaping self-care behavior, in line with Bandura (1997) perspective on the role of self-efficacy and self-regulation. Therefore, preventive and empowerment interventions should focus on strengthening psychological and social factors through education, mentoring, and therapeutic relationships, enabling all demographic groups to equally enhance knowledge, skills, and motivation in self-care.

Social support for self-care

Path coefficient analysis demonstrated that social support both from family and healthcare professionals had a significant positive effect on self-care agency, including knowledge, skills, and motivation. Family support was more dominant in motivating daily practices, while healthcare providers played a key role in enhancing knowledge and technical skills, in line with Orem's Self-Care Deficit Theory and House's framework (1981) on the emotional, instrumental, and informational functions of social support. This also aligns with Bandura's self-efficacy concept, where external support strengthens individuals' belief in their ability to carry out self care. Similar findings have been reported in previous studies (Baek et al., 2014; Vellone et al., 2018; Joelianina et al., 2019; Azmiardi et al., 2021; Lin et al., 2025). The practical implication is that integrated interventions involving both families and healthcare providers are essential to strengthen patients' self-management capacity through education, skill training, and emotional as well as practical support, thereby enhancing self-care agency comprehensively and positively impacting quality of life and independence among individuals with diabetes.

Illness representations related to self-care

These variations in illness representation influence self-care agency, as threat perception can foster motivation and adherence but may also increase stress and anxiety. Illness representations encompassing identity, cause, consequences, duration, and control are strongly associated with self-care knowledge, skills, and motivation. Clear understanding of illness identity and causes encourages information-seeking and behavior change, awareness of consequences fosters urgency in applying self-care, comprehension of duration promotes consistency in long-term care, and belief in control strengthens motivation and adherence (Hagger & Orbell., 2003; Kaptein et al., 2010; Broadbent et al., 2015; Leventhal et al., 2016; Haines et al., 2019). This aligns with the Common-Sense Model of Self-Regulation and is supported by studies such as Hale et al. (2007) and Kugbey et al. (2017), which confirm that positive illness perceptions enhance self-efficacy and self-care capacity. Thus, illness representation not only shapes patients' perspectives but also directly contributes to improving self-care agency in managing chronic disease.

Emotional responses to self-care

Negative emotional states affect self-care agency through cognitive, skill-based, and motivational pathways: stress, anxiety, and depression can impair attention, information processing, executive functioning, and learning initiative, thus hindering knowledge (Bandura, 1997; Folkman, 2013). Regarding skills, negative emotions reduce energy, consistency in practice, and increase procedural errors (DiMatteo et al., 2000; Jaarsma et al., 2021). In terms of motivation, mood disturbances lower self-efficacy and adherence to self-care regimens (DiMatteo et al., 2000; Jaarsma et al., 2021). These findings are consistent with Vellone et al. (2018), who found that reducing psychological symptoms enhances self-efficacy and strengthens self-care agency. The practical implication is that self-care education programs should be integrated with screening and management of stress, anxiety, and depression through technical education, psychosocial support, behavioral therapy, and strategies to enhance self-efficacy so that patients' knowledge, skills, and motivation can develop optimally.

Self-care related to symptom interpretation

Thus, overall self-care agency capacity was strong but required reinforcement in the skills domain. A strong self-care agency enables patients to recognize and interpret symptoms early, consistent with the Common-Sense Model Leventhal et al. (2016) and self-efficacy theory Bandura (1997), which highlight the importance of perception and self-belief in disease management. Adequate knowledge supports patients' understanding of early warning signs and their consequences, practical skills ensure accurate foot examination and care (Riegel et al., 2012), while motivation drives consistent preventive behavior (Martínez et al., 2021).. Empirical evidence also shows that improvements in knowledge, skills, and motivation reduce ulcer risk and enhance quality of life (Lincoln et al., 2008; Yazdanpanah et al., 2018; Manihuruk et al., 2024). Therefore, interventions emphasizing practical training and skill mentoring, combined with education and motivational enhancement, are key strategies to strengthen self-care agency and prevent diabetic foot ulcers.

Symptom interpretation related to coping

Symptom interpretation plays a critical role in diabetic foot ulcer prevention, consistent with the Common-Sense Model (Folkman, 2013), where perceiving symptoms as warning signals fosters coping approaches (routine checks, behavioral modification, seeking medical help), while misinterpretation or underestimation often leads to coping avoidance (delay, denial). Self-efficacy theory Bandura (1997) further supports that self-belief strengthens the preference for active strategies. Social burden can have a dual effect: when coupled with positive support, it motivates preventive actions, but more often it leads to avoidance due to shame or stigma (Carver et al., 1989). Empirical evidence demonstrates that foot-care education and training enhance active behaviors and reduce ulcer incidence (Lincoln et al., 2008), whereas high social burden correlates with poor adherence (Yazdanpanah et al., 2018). Thus, prevention programs should focus on improving symptom interpretation accuracy through education and practical training, reducing

social burden via counseling and support, and strengthening self-efficacy through repeated practice, feedback, and motivational strategies, thereby encouraging more active responses in diabetic foot ulcer prevention.

Coping related to diabetic foot ulcer prevention behavior

According to the stress-appraisal and coping theory Folkman (2013) and the self-efficacy concept Bandura (1997), coping approach supports adherence across all self-care demand domains diet, physical activity, foot care, medication adherence, and blood glucose monitoring since patients perceive the disease as controllable and believe they are capable of managing it. Conversely, coping avoidance is associated with delayed detection, poor adherence, and higher risk of complications (Yazdanpanah et al., 2018). In diet, avoidance leads to non-compliance; in physical activity, it promotes a sedentary lifestyle; in foot care, it delays response to symptoms; in medication, it increases nonadherence; and in blood glucose monitoring, it fosters avoidance to reduce short-term anxiety. Empirical evidence shows that interventions based on problem-solving, motivational interviewing, and self-efficacy enhancement through training and feedback effectively improve preventive behaviors (Lincoln et al., 2008; Riegel et al., 2012). Therefore, diabetic foot ulcer prevention programs should emphasize strengthening coping approach and reducing coping avoidance through technical education, psychosocial support, counseling, and family as well as healthcare provider involvement to optimize preventive behaviors and early detection.

Self-care related to diabetic foot ulcer prevention behavior

This study demonstrates that self-care agency, consisting of knowledge, skills, and motivation, has a positive effect on preventive behaviors for diabetic foot ulcers among patients with type 2 diabetes mellitus. Higher levels of self-care agency were associated with more optimal preventive behaviors. Knowledge plays a vital role in improving patients' understanding of risks and appropriate actions, skills enable the application of knowledge in real practices such as daily foot inspections and appropriate footwear selection, while motivation serves as an internal driver to sustain consistency in preventive behaviors. In line with previous studies (Febriana, 2014; Rohmah, 2019; Marbun et al., 2021; Aryani et al., 2022), these three components were shown to contribute significantly to patient adherence in performing foot ulcer prevention. In this study, respondents' knowledge and skills were moderate, while motivation was high, possibly influenced by their belief in their ability to prevent diabetic foot ulcers. These findings highlight the need for continuous educational interventions and practical skill training, combined with motivational strategies, to balance cognitive, psychomotor, and affective aspects of self-care agency and optimize diabetic foot ulcer prevention.

The results of this study have formed a new model, namely self-regulation of diabetic foot ulcer prevention behavior based on self-care theory. Based on the new findings, the results of the study appear that the best path is to start from the representation of the disease to the self-care agency and then through the interpretation of affecting coping until the prevention behavior of diabetic foot ulcers occurs. In addition, there are conditioning factors, social support factors, and emotional responses can increase self-care agency, then through interpretation, affect coping until diabetic foot ulcer prevention behaviors occur. There is another path, starting from the representation of the disease to the self-care agency directly affecting the prevention behavior of diabetic foot ulcers. So it can be concluded that the self-regulation of DMT2 sufferers can be built by social support, disease representation, and emotional response, self-regulation that DMT2 sufferers then possess can improve the self-care agency, interpretation, and coping of DMT2 sufferers. With high self-regulation and self-care agency, DMT2 sufferers can have good diabetic foot ulcer prevention behavior.

CONCLUSION

This study concludes that preventive behavior for diabetic foot ulcers among patients with type 2 diabetes mellitus is mainly influenced by psychosocial and behavioral factors, particularly self-care

agency, illness representation, emotional responses, and social support. While individual factors such as age, gender, and socioeconomic status showed no significant effect, self-care ability including knowledge, skills, and motivation proved to be the key determinant of preventive behavior. Based on these findings, this study successfully developed a self-regulation model based on self-care theory that integrates illness representation, emotional response, and social support to strengthen self-care capacity and coping strategies, thereby enhancing preventive behavior for diabetic foot ulcers.

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