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ORIGINAL ARTICLE

Foot self-care behaviour in primary care patients with diabetic foot ulcers: Structural equation modelling of psychological predictors

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Abstract

Diabetic foot ulcers (DFUs) are one of the most prevalent and costly diabetes complications, associated with diminished quality of life and poor prognosis. Management of DFUs relies heavily on patients' foot self-care behaviour. This study aims to explore psychological determinants of this important behaviour among primary care patients. A total of 186 patients with active DFUs self-reported their illness perception, diabetes distress, self-efficacy, and foot self-care behaviour. Structural equation modelling was performed to examine inter-relationships among measured variables. The final model demonstrated satisfactory fit, CFI = 0.933, TLI = 0.913, RMSEA = 0.050, SRMR = 0.073, $\chi^2(95) = 132.256$ ($p = 0.004$), and explained 51.1% of the variance of foot self-care. Illness threat perceptions (i.e., consequence, timeline, identity, concern, and emotion) had a direct positive effect on foot self-care behaviours, but also indirectly decreased foot self-care through increasing diabetes distress. Control perceptions (i.e., personal control, treatment control, and coherence) were not directly associated with foot self-care behaviours, but indirectly improved foot self-care by reducing diabetes distress and increasing foot care confidence. These findings suggest illness perceptions, diabetes distress, and self-care confidence as modifiable predictors to be targeted in self-management interventions for patients with DFUs.

KEYWORDS

diabetes distress, diabetic foot ulcer, foot care confidence, foot self-care behaviour, illness perception

Key Messages

- Diabetic foot ulcers (DFUs) are believed to continue to be highly prevalent. Management of DFUs relies heavily on patients' foot self-care behaviour.
- Patients' beliefs about DFU have been shown to be critical drivers of foot self-care behaviours. Underpinned by the Common-Sense Model of Self-Regulation, we performed a structural equation modelling (SEM) analysis to explore psychological determinants of this important behaviour among primary care patients.
- The SEM results showed that threat perceptions (i.e., consequence, timeline, identity, concern, and emotion) and control perceptions (i.e., personal control, treatment control, and coherence) were associated with diabetic foot self-care behaviours through diabetes distress and foot care confidence.
- The findings suggest illness perceptions, diabetes distress, and self-care confidence as modifiable predictors to be targeted in self-management interventions for patients with DFUs.

1 | INTRODUCTION

Diabetic foot ulcers (DFU) are a source of physical dysfunction, emotional distress, and diminished quality of life, affecting around 20 million people globally each year.[1] DFUs are complex to treat, take months to years to heal, with high recurrence rates reaching 40% within one year of wound closure.[2] More than 85% of diabetic lower extremity amputations (DLEA) are precipitated by a foot ulcer.[3] DFU is considered the most prevalent and costly among all diabetes complications and is associated with a five-year mortality rate of 50%.[4] Additionally, DFUs significantly impact patients' mental well-being,[5–7] resulting in high levels of depression and anxiety,[8] which can further compromise foot self-care behaviour[7,9] and wound healing,[10] and increase risk of mortality.[11]

DFU management relies heavily on patient activation and foot self-care behaviours such as performing regular foot self-inspections, foot skin care, adhering to recommended footwear, seeking immediate advice from healthcare professionals for any (pre-) ulcerative lesion, maintaining optimal foot and skin care (including skin colour and temperature),[12,13] in addition to the demands of optimal diabetes self-management. Patients' beliefs about diabetes and DFU have been shown to be critical drivers of diabetes and foot self-care behaviour.[14] One theoretical model that describes how patients' interpretations of their illness relate to self-care is the Common Sense Model of Self-Regulation (CSM).[15] According to the CSM, experience of illness/symptoms drives an individual to assign interpretations to the health problem, which generates cognitive and emotional representations of the illness. These representations might not align with medical models of the illness but are important in shaping patients' responses to the illness. Previous research identified multiple dimensions of illness representations, some of which capture negative aspects related to illness threat (e.g., identity consequences, timeline, concern, and emotional representations), whereas others capture positive perceptions about the controllability of illness (e.g., personal control, treatment control, and illness coherence).[16] Prior work found that lower perceived threat and higher perceived control were both associated with better psychological well-being, treatment adherence, and various health outcomes.[16,17]

A vast literature has documented associations between illness perceptions and general self-care behaviour in diabetes such as medication adherence, exercise, and diet.[17–19] Some other studies have also found a link between illness perceptions and foot-specific self-care behaviours, but with a primary focus on patients at risk of ulcers, but ulcer-free.[18,20] This is a critical research gap since evidence from ulcer-free patients is unlikely to be generalised to those with active ulcer(s) due to their distinct illness experiences and different levels of perceived relevance of foot self-care. To date, only one study investigated the role of illness perceptions in foot-specific self-care in patients with active ulceration. This longitudinal study showed that identity, coherence, and personal control over ulceration measured at baseline predicted subsequent foot self-care behaviours (24 weeks).[21]

Apart from illness perceptions, psychological distress and self-efficacy are also important determinants of self-care behaviours. Diabetes distress refers to the emotional distress associated with adjusting to and living with diabetes, and may relate to control over the treatment

regimen, worries/fears about long-term outcomes, and feeling unsupported by health professionals.[22] Self-efficacy denotes the belief in one's ability to plan and perform desired activities and reflects confidence in the ability to exert control over one's own motivation, behaviour, and social environment.[23] Prior work in patients with diabetes have found that better foot self-care was predicted by lower diabetes distress[24] and higher self-efficacy.[25] These two constructs were also found to be negatively correlated with each other[26] and associated with illness perceptions.[27]

Despite promising evidence from previous research regarding the effects of illness perceptions, diabetes distress, and self-efficacy on foot-specific self-care behaviours, most studies assessed these constructs in isolation and used conventional analytical methods such as linear regressions. There is a paucity of research that provides a comprehensive account of the complex direct and indirect relations among these variables. Structural equation modelling (SEM) is a more powerful statistical technique than regression that simultaneously accounts for multiple interactive relationships among variables.[28,29] The current study aimed to use SEM to map relationships among cognitive, emotional, and behavioural variables related to foot self-care in patients with active DFU. This understanding is pivotal because it would allow for the future development of interventions that target the potential barriers and facilitators of diabetic foot self-care behaviour, which is currently lacking according to international DFU management guidelines.[12] The following hypotheses will be examined:

i. threat perceptions have direct effects on diabetic foot self-care behaviour, diabetes distress, and foot care confidence;
ii. control perceptions have direct effects on diabetic foot self-care behaviour, diabetes distress, and foot care confidence;
iii. diabetes distress and foot care confidence have direct effects on diabetic foot self-care behaviour;
iv. diabetes distress has a direct effect on foot care confidence.

2 | MATERIALS AND METHODS

2.1 | Study design, settings and participants

A cross-sectional study was conducted between April and September 2022 in National Healthcare Group Polyclinics (NHGP) in Singapore. NHGP consists of seven polyclinics that serve the central and northern parts of Singapore and provides a comprehensive range of health services including diabetic foot wound care management. NHGP is part of Diabetic Foot in Primary and Tertiary (DEFINITE) Care[30] that is an inter-institutional and multi-disciplinary team care at a healthcare cluster in Singapore with an aim to provide optimal care for patients with DFU. Nurses at NHGP actively participate in regular DFU wound care dressings and patient education on wound/foot self-care behaviours every 3–5 days until wound closure.

Participants from six clinics were recruited subject to the following inclusion criteria: 21 years of age or older with an active DFU receiving wound care at NHGP, and fluent in either English, Mandarin, or Malay. Individuals were excluded if they were unable to give consent due to cognitive or psychiatric diagnoses. The sample size was calculated based on rules-of-thumb for performing SEM,[31,32] that is, 10 cases per observed variable. A total sample of 176 participants was determined for 16 variables for this study allowing 10% cases with incomplete data.

2.2 | Recruitment procedures

Trained research staff who were fluent in the participants' preferred languages approached each eligible patient in the waiting area of the wound care services of the participating clinics. All eligible participants were asked to participate in a one-time anonymous survey during one of their routine wound care visits. The survey was self-administered or assisted by the designated clinical research coordinators upon request by participants. A grocery voucher reimbursement was provided to each participant upon completion of the survey. All willing participants were recruited consecutively in the six participating clinics.

Ethical approval was provided by The National Healthcare Group Domain Specific Review Board ethics committee (Ref No. 2021/01074) and the Nanyang Technological University Institutional Review Board (Ref No. NTU IRB-2022–338).

2.3 | Measures

A structured questionnaire battery was developed to obtain information related to participants' socio-demographic and clinical information of diabetes and DFU, and patient-reported outcome measures (PROM) related to illness perception, distress, self-care confidence, and self-care behaviour.

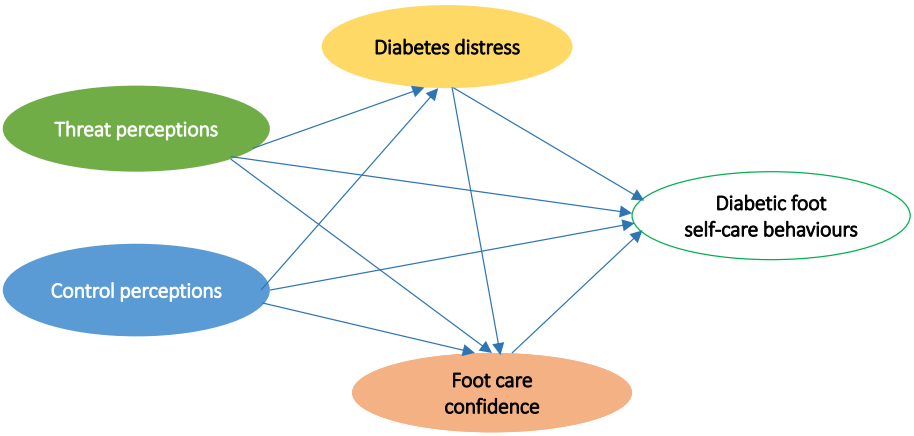

FIGURE 1 Hypothesised pathways of the relationships among illness control- and threat-related perceptions, diabetes distress, and foot care confidence, and diabetic foot self-care behaviours.

2.3.1 | Brief Illness Perception Questionnaire (BIPQ)

The BIPQ[33] consists of eight illness representation items that are rated on a 0 to 10 ordinal scale. Following the previous study,[34] higher scores on the consequences, identity, timeline, concern and emotional representations indicate higher perceived threat (Cronbach's alpha = 0.66), whereas higher scores on the treatment control, personal control, and illness coherence items indicate higher perceived control (Cronbach's alpha = 0.52).

2.3.2 | Foot Care Confidence Scale (FCCS)

The FCCS[35] consists of 12 statements about the confidence level perceived by the participants in undertaking various foot-care activities using a five-point Likert scale response. A higher total score represents greater self-efficacy. Cronbach's α in the present study was 0.71. The two subscales of the FCCS consist of foot self-care aspect and clinical aspect of foot care.[36]

2.3.3 | Diabetes Distress Scale (DDS)

The DDS[22] consists of 17 items with four subscales including emotional burden, physician-related distress, regimen-related distress, and interpersonal distress. All items were rated on a 6-point Likert scale where a higher score indicates greater distress. Cronbach's α in the present study was 0.85.

2.3.4 | Diabetes Foot Self-Care Behaviour Scale (DFSBS)

The DFSBS[37] contains seven items divided into two parts (subscale A: items related to care of foot bottom and toes, subscale B: items related to care of foot skin and footwear) measuring foot self-care behaviours. Items were rated on a 5-point Likert scale where higher scores represent better diabetic foot self-care behaviours. Cronbach's α was 0.90 in the present study.

2.4 | Data analysis

Pearson correlation analysis was used to analyse the inter-correlations among the PROM variables. A hypothesised model (see Figure 1) that was informed by prior work[15–17,19,38] was constructed with five latent variables: threat perceptions, control perceptions, diabetes distress, foot care confidence, and diabetic foot self-care behaviour. SEM was performed to examine the hypothesised relationships among the latent variables as illustrated in Figure 1. We first tested the baseline measurement model, and then tested the full structural model containing all hypothesised regression paths. Satisfactory model fit can be inferred if fit indices are above 0.90 for Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI), below 0.08 for root mean square error of approximation (RMSEA), and below 0.08 for Standardised Root Mean Square (SRMR).[39,40] Analyses were performed using IBM SPSS and the lavaan package in R.[41] A two-tailed p value <0.05 was considered statistically significant.

3 | RESULTS

3.1 | Sample characteristics

A total of 186 patients participated in this study. The demographic characteristics are shown in Table 1. Most patients were aged between 51 and 70 years old (64.5%), were male (73.7%), and of Chinese ethnicity (53.2%). Most patients had been living with diabetes for more

TABLE 1 Sociodemographic and clinical characteristics.

Variables	*n* (%) or mean (± standard deviation)
Age	
21–50 years	13 (7.0)
51–70 years	120 (64.5)
≥71 years	53 (28.5)
Gender	
Male	137 (73.7)
Female	49 (26.3)
Ethnicity	
Chinese	99 (53.2)
Malay	33 (17.7)
Indian	54 (29.0)
Duration of diabetes	
≤5 years	14 (7.5)
>5 years	172 (92.5)
Duration of DFU*	
≤3 months	58 (31.2)
>3 months	128 (68.8)
Location of DFU	
Toe	107 (57.5)
Above toe level	79 (42.5)
First-DFU	
Yes	93 (50.0)
No	93 (50.0)
History of amputation	
Yes	84 (45.2)
No	102 (54.8)
HbA1c (past 3 months)	
<7.0% (53 mmol/mol)	51 (27.4)
≥7.0% (53 mmol/mol)	135 (72.6)
Number of DFU	
1	116 (62.4)
>1	70 (37.6)
Type of DFU	
Neuropathic	90 (48.4)
Ischaemic	28 (15.1)
Neuroischaemic	68 (36.6)

*DFU: diabetic foot ulcer.

than five years (92.5%) and living with DFU for more than three months (68.8%). Patients with toe ulcers made up 57.5% of the study population. Half of the study population (50.0%) had their first DFU and 54.8% of them had at least one episode of prior amputation. Up to 72.6% of them had HbA1c 7.0% (53 mmol/mol) and above. Slightly more than one third of the study population (37.6%) had more than one DFU. Nearly half of DFUs were neuropathic (48.4%).

3.2 | Patient Reported Outcome Measure (PROM) variables and correlations

The average score for threat perception and control perception was 25.5 (SD: 11.4; range 0–50) and 21.4 (SD: 6.5; range 0–30), respectively. The average DDS score was 2.0 (SD: 0.8; range 1–6) indicating moderate distress of diabetes. The average FCCS score was 37.9 (SD: 8.9; range 12–60) and the average DFSBS score was 23.8 (SD: 8.2; range 7–35), indicating a moderate level of foot care confidence and foot self-care behaviour. Significant correlations were shown between diabetic foot self-care behaviour and cognitive and psychological factors (see Table 2).

3.3 | SEM results

3.3.1 | Measurement model

The measurement model was first constructed, with underlying constructs (i.e., latent variables) being measured by multiple observed variables (i.e., indicators). We constructed five latent variables, namely control perceptions, threat perceptions, diabetes distress, diabetic foot self-care behaviour and foot care confidence. The respective subscale or domain scores were used as the manifest indicators of the latent constructs. Specifically, *threat perceptions* were indicated by item scores of consequences, identity, timeline, concern and emotional representation, while *control perceptions* were indicated by item scores of personal control, treatment control, and coherence. The mean scores of two subscales of FCCS were used as indicators of *foot care confidence*. The mean scores of two subscales of DFSBS were used as indicators of *foot self-care behaviour*. Finally, the scores of each domain of DDS were used as indicators of *diabetes distress*. Full information maximum likelihood estimation was used for the current study.

The initial measurement model did not show optimal acceptable fit: CFI = 0.88, TLI = 0.85, RMSEA = 0.07 (90% confidence interval 0.049 to 0.082), SRMR = 0.08, $\chi^2(94) = 165.331$ ($p < 0.001$). All indicator variables loaded significantly onto their corresponding latent variables; factor loadings ranged from 0.42 to 0.67 for threat perceptions, 0.43–0.62 for control perceptions, 0.71–0.87

TABLE 2 Inter-correlations among study variables.

Variables		1	2	3	4	Mean (SD)
1	Threat perceptions					25.5 (11.4)
2	Control perceptions	−0.018				21.4 (6.5)
3	Foot care confidence	−0.042	0.304**			37.9 (8.9)
4	Diabetes distress	0.430**	−0.166*	−0.185*		2.0 (0.8)
5	Diabetic foot self-care behaviour	0.023	0.200**	0.453**	−0.283**	23.8 (8.2)

Abbreviation: SD, standard deviation.
**Correlation is significant at the 0.01 level (2-tailed).
*Correlation is significant at the 0.05 level (2-tailed).

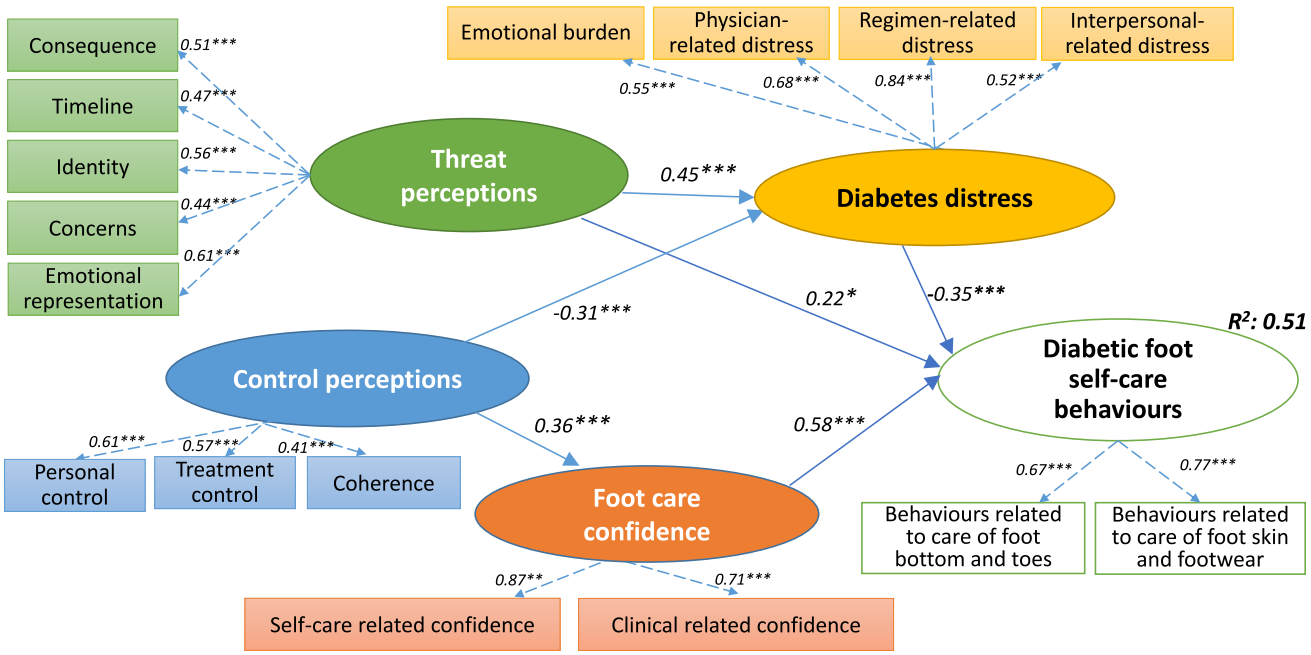

FIGURE 2 Final model of the associations among illness perceptions, diabetes distress, foot care confidence, and diabetic foot self-care behaviour. Ellipse indicates latent variables. Box indicates observed variables. Straight line with arrowhead denotes direct and indirect effects. Dashed line with arrowhead denotes factor loadings. Non-significant path parameters are not presented for clarity. $^{**}p < 0.005$, $^{***}p < 0.001$.

for foot care confidence, 0.52–0.82 for diabetes distress, and 0.67–0.77 for foot self-care behaviour.

Error covariance was then added to the model based on modification indices and theoretical assumptions, aiming to improve the goodness of fit of the measurement model. We allowed the residual term of the emotional distress subscale in the DDS to freely covary with the residual terms of the "illness consequence" and "emotional representation" items in the BIPQ because the wording of these items were similar. The fit indices of the modified measurement model improved to a level deemed satisfactory: CFI = 0.93, TLI = 0.91, RMSEA = 0.05 (90% confidence interval 0.029 to 0.066), SRMR = 0.07, $\chi^2(92) = 132.254$ ($p = 0.004$).

3.3.2 | Full structural model

The full structural model with hypothesised regression paths between latent variables was then examined. The direction of paths was determined based on relevant theories including the CSM model,[15,16,38] as well as prior work documenting these associations.[17,19,21,42–44] The full structural model (see Figure 2) had satisfactory fit: CFI = 0.93, TLI = 0.91, RMSEA = 0.05 (90% confidence interval 0.029 to 0.068), SRMR = 0.07, $\chi^2(95) = 132.256$ ($p = 0.004$). All indicator variables had significant factor loadings on the corresponding latent variables; the factor loadings ranged from 0.44 to 0.61 for threat perceptions, 0.41–0.61 for control perceptions, 0.71–0.87 for foot

care confidence, 0.52–0.84 for diabetes distress, and 0.67–0.77 for foot self-care behaviour. This model explained 51.1% of the variance of diabetic foot self-care behaviour (indicated by an R^2 of 0.511).

Threat perceptions (i.e., consequence, timeline, identity, concerns, and emotion) appeared to have both direct and indirect effects on diabetic foot self-care behaviour. On one hand, greater perceived threat positively predicted diabetic foot self-care behaviour ($\beta = 0.22$, $p = 0.049$). On the other hand, this relationship was mediated by diabetes distress, where threat perceptions increased diabetes distress ($\beta = 0.45$, $p < 0.001$), which in turn resulted in poorer diabetic foot self-care behaviour ($\beta = -0.35$, $p = 0.001$). These findings suggest diabetes distress as a suppressor mediator in the relationship between threat perceptions and diabetic foot self-care behaviour.

Interestingly, threat perceptions did not predict foot care confidence, but control perceptions (i.e., personal control, treatment control, and coherence) positively predicted foot care confidence ($\beta = 0.36$, $p < 0.001$). Foot care confidence also had a positive effect on diabetic foot self-care behaviour ($\beta = 0.58$, $p < 0.001$), suggesting an indirect effect of control perceptions on foot self-care behaviour through foot care confidence. Additionally, control perceptions negatively predicted diabetes distress ($\beta = -0.31$, $p = 0.001$), which negatively predicted foot self-care behaviour. Figure 2 illustrates the final structural model with all statistically significant regression paths among the latent variables.

4 | DISCUSSION

The present study used SEM to elucidate the complex associations among various psychological indices and foot-specific self-care behaviour outcomes among primary care patients with active DFU. Consistent with prior work and theoretical postulations,[16,17,21,38] the study findings indicate that illness perceptions, diabetes distress, self-care confidence, and their interplay, are associated with diabetic foot self-care behaviour.

The SEM results showed a direct positive relationship between threat perceptions and diabetic foot self-care behaviour. This finding accords with our recent qualitative work, which identified low perceived threat (i.e., illness consequence) as a barrier to DFU foot self-management.[45] This finding suggests that threat perceptions may not necessarily be maladaptive in the context of self-care but may instead activate patients to take actions to prevent and manage their foot ulcers. It is noteworthy, however, that our SEM also showed an indirect association between threat perceptions and foot self-care through diabetes distress. In particular, threat perceptions increased diabetes distress, which in turn resulted in poorer foot self-care. This appears somewhat inconsistent with the direct effect, and suggests that diabetes distress may be a potential suppressor mediator in the relationship between threat perceptions and foot self-care. It is possible that the awareness of illness threat is necessary for patients to engage in foot self-care behaviours, but when the level of perceived threat becomes overwhelming and causes significant psychological distress, an opposite effect on foot self-care behaviour may be observed.

A previous SEM study on patients with diabetes revealed an indirect effect of threat perceptions on self-care behaviour (including foot care) through self-efficacy.[19] However, the current study on patients with active DFU only revealed a positive association between self-efficacy and foot self-care behaviours, and did not replicate the negative relation between threat perceptions and self-efficacy. This suggests that for patients with active DFU, lower perceived threat does not necessarily entail greater foot care confidence. Indeed, foot care routine for patients with active ulcers involves relatively more specific and potentially more complex activities (e.g., performing foot skin care, nail and toe care, and using customised footwear, etc.) compared to ulcer-free patients whose goal is to prevent, rather than to manage, ulceration. Patients with active ulcers may hence be generally less confident about foot self-care, regardless of level of perceived threat, due to the complexity of these activities.

Another important finding was the indirect effects of control perceptions (i.e., personal/treatment control and understanding of DFU) on diabetic foot self-care behaviour through diabetes distress and foot care confidence. More specifically, higher control perceptions increased confidence and decreased diabetes distress, which in turn improved diabetic foot self-care behaviour. A recent SEM study on patients with diabetes also suggested that control perceptions increased self-efficacy which in turn increased general self-care behaviour in patients with diabetes.[19] Our study extends this finding to an active DFU population and suggests an additional indirect pathway of control perceptions on foot self-care through lowering diabetes distress. These findings suggest the importance of emphasising patients' ability to control/manage ulcers and improving their understanding of DFU in self-management interventions.

Taken together, our SEM study suggests that threat and control perceptions about DFU, diabetes distress, and foot care confidence, are all directly and/or indirectly associated with foot self-care behaviours in patients with active DFU, each playing a distinct role in influencing

the behavioural outcome. Threat and control perceptions were found to underlie patients' psychological and behavioural responses to their ulcers (i.e., psychological distress, self-care confidence and behaviour). It may therefore be important to target or modify these illness perceptions in self-management interventions. Indeed, a systematic review[46] of 12 randomised controlled trials (RCT) for patients with type 2 diabetes mellites (T2DM) concluded that most illness perception domains were modifiable through behaviour change techniques. Some studies in the review also provided preliminary evidence that modification of illness perceptions was associated with improvements in glycaemic control. This was also supported by a recent RCT[47] for patients with T2DM suggesting that illness perception-based intervention is effective in improving self-care (including general diet, foot self-care, exercise and blood glucose monitoring) for patients with T2DM.

It is of note however that interventions targeting illness perceptions in the context of DFU should also address patients' diabetes distress. This is because we identified a direct and an indirect (through distress) pathways from threat perceptions to self-care behaviours. On one hand, interventions may need to provide information and change inaccurate threat perceptions about DFU in order for patients to be aware of the consequences associated with poor foot self-care. On the other hand, the distress resulting from threat perceptions should be assessed and managed throughout these interventions because it could compromise foot self-care. Interestingly, control perceptions were found to negatively predict diabetes distress and positively predict confidence, suggesting the importance of empowering patients with knowledge and skills to manage their DFU and emphasising their strengths and capabilities in clinical settings.

Study limitations warrant acknowledgement. Firstly, study participants were recruited from the nurse-led wound care services that focus on wound management and patient/caregiver education rather than therapeutic footwear assessment. Hence, the study participants may not be representative of all DFU population and caution should be exercised when generalising the study findings to a wider population. Secondly, information related to coping behaviour was not collected; hence, we were unable to advance the theoretical understanding of the distinct roles of threat and control perceptions in coping responses that also underlies diabetes self-care behaviours and outcomes. Future longitudinal CSM-based research is warranted to comprehensively evaluate and verify the associations among psychological factors, coping strategies, self-care behaviour, and clinical outcomes. Finally, although assumptions about directionality were made among latent variables in the current study, causal relationships cannot be established due to the cross-sectional study design. It is important to note that SEM is not inherently a causal statistical method.[29] Hence, caution is needed when interpreting the significant paths in the model. Future studies with prospective design and larger confirmatory samples are required to validate this preliminary model.

This is the first study that adopts SEM to systematically evaluate the interrelationship among cognitive, psychological, and behavioural variables in primary care patients with active DFU. Our study suggests that DFU-specific illness perceptions are critical components of foot self-care. The findings call for actions to adequately address illness perceptions and leverage the impact of diabetes distress and foot care confidence to improve diabetic foot self-care behaviour. The findings provide important insights into the existing knowledge on the care for patients with active DFU, while also creating new opportunities to healthcare professionals in primary care pertaining to patient educational intervention in behaviour change. Future studies should adopt longitudinal designs including healing outcomes to confirm the current findings.

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CONFLICT OF INTEREST STATEMENT

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

DATA AVAILABILITY STATEMENT

Data available on request due to privacy/ethical restrictions.

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REFERENCES

1. Zhang Y, Lazzarini PA, McPhail SM, van Netten JJ, Armstrong DG, Pacella RE. Global disability burdens of diabetes-related lower-extremity complications in 1990 and 2016. *Diabetes Care*. 2020;43(5):964-974. doi:10.2337/dc19-1614
2. Armstrong DG, Boulton AJM, Bus SA. Diabetic foot ulcers and their recurrence. *N Engl J Med*. 2017;376:2367-2375. doi:10.1056/NEJMra1615439
3. Apelqvist J, Larsson J. What is the most effective way to reduce incidence of amputation in the diabetic foot?—Apelqvist—2000—diabetes/metabolism Research and Reviews—Wiley online library. *Diabetes Metab Res Rev*. 2000;16(Suppl 1):s75-s83. doi:10.1002/1520-7560(200009/10)16:1+3.0.co;2-8
4. Armstrong DG, Cohen K, Courric S, Bharara M, Marston W. *Diabetic Foot Ulcers and Vascular Insufficiency: Our Population Has Changed, but Our Methods Have Not*. Vol 5. 2011 www.journalofdst.org. Accessed October 23, 2020
5. Khunkaew S, Fernandez R, Sim J. Health-related quality of life and self-care management among people with diabetic foot ulcers in northern Thailand. *SAGE Open Nurs*. 2019;5:237796081982575. doi:10.1177/2377960819825751
6. Pouwer F, Mizokami-Stout K, Reeves ND, et al. Psychosocial Care for People With Diabetic Neuropathy: Time for Action. 2023. doi:10.2337/dci23-0033
7. Pouwer F, Perrin B, Lavender A, Najafi B, Ismail K, Vileikyte L. The quest for wellness: how to optimise self-care strategies for diabetic foot management? *Diabetes Metab Res Rev*. 2023;e3751:1-8. doi:10.1002/DMRR.3751
8. Jiang FH, Liu XM, Yu HR, Qian Y, Chen HL. The incidence of depression in patients with diabetic foot ulcers: a systematic review and meta-analysis. *Int J Low Extrem Wounds*. 2020;21(2):161-173. doi:10.1177/1534734620929892
9. Coffey L, Mahon C, Gallagher P. Perceptions and experiences of diabetic foot ulceration and foot care in people with diabetes: a qualitative meta-synthesis. *Int Wound J*. 2019;16(1):183-210. doi:10.1111/iwj.13010
10. Da Silva J, Santos D, Vilaça M, et al. Impact of psychological distress on physiological indicators of healing prognosis in patients with chronic diabetic foot ulcers: a longitudinal study. *Adv Wound Care*. 2023;1-14. doi:10.1089/WOUND.2023.0043/ASSET/IMAGES/MEDIUM/WOUND.2023.0043_FIGURE5.JPG
11. Ismail K, Winkley K, Stahl D, Chalder T, Edmonds M. A cohort study of people with diabetes and their first foot ulcer: the role of depression on mortality. *Diabetes Care*. 2007;30(6):1473-1479. doi:10.2337/dc06-2313
12. Bus SA, Sacco IC, Monteiro-Soares M, et al. Guidelines on the Prevention of Foot Ulcers in Persons with Diabetes IWGDF. 2023 Update. 2023. www.iwgdfguidelines.org. Accessed June 19, 2023
13. Schaper C, van Netten JJ, Apelqvist J, et al. Nicolaas IWGDF Practical Guidelines IWGDF Guidelines IWGDF Practical Guidelines IWGDF Guidelines 2023 Update. 2023 www.iwgdfguidelines.org Accessed April 17, 2024.
14. Vileikyte L, Rubin RR, Leventhal H. Psychological aspects of diabetic neuropathic foot complications: an overview. *Diabetes Metab Res Rev*. 2004;20(Suppl 1):S13-S18. doi:10.1002/DMRR.437
15. Leventhal H, Meyer D, Nerenz DR. The common sense representation of illness danger. In: Rachman S, ed. *Medical Psychology*. Vol 2. 2nd ed. Pergamon Press; 1980:7-30. https://www.researchgate.net/publication/303283742_The_common_sense_representation_of_illness_danger Accessed December 4, 2022.
16. Hagger MS, Orbell S. The common sense model of illness self-regulation: a conceptual review and proposed extended model. *Heal Psychol Rev ISSN*. 2022;16(3):347-377. doi:10.1080/17437199.2021.1878050
17. Fall E, Chakroun-Baggioni N, Böhme P, Maqdasy S, Izaute M, Tauveron I. Common sense model of self-regulation for understanding adherence and quality of life in type 2 diabetes with structural equation modeling. *Patient Educ Couns*. 2021;104(1):171-178. doi:10.1016/J.PEC.2020.06.023
18. Pereira MG, Pedras S, Ferreira G. Self-reported adherence to foot care in type 2 diabetes patients: do illness representations and distress matter? *Prim Heal Care Res Dev*. 2018;20:e40. doi:10.1017/S1463423618000531
19. Xin M, Chan VWY, Kong APS, et al. Using the common-sense model to explicate the role of illness representation in self-care behaviours and anxiety symptoms among patients with type 2 diabetes. *Patient Educ Couns*. 2023;107:107581. doi:10.1016/J.PEC.2022.107581
20. Indrayana S, Guo SE, Lin CL, Fang SY. Illness perception as a predictor of foot care behavior among people with type 2 diabetes mellitus in Indonesia. *J Transcult Nurs*. 2019;30(1):17-25. doi:10.1177/1043659618772347
21. Vedhara K, Dawe K, Wetherell MA, et al. Illness beliefs predict self-care behaviours in patients with diabetic foot ulcers: a prospective study. *Diabetes Res Clin Pract*. 2014;106(1):67-72. doi:10.1016/j.diabres.2014.07.018
22. Polonsky WH, Fisher L, Earles J, et al. Assessing psychosocial distress in diabetes: development of the diabetes distress scale. *Diabetes Care*. 2005;28(3):626-631. doi:10.2337/DIACARE.28.3.626
23. Bandura A. *Social Foundations of Thought and Action: A Social Cognitive Theory - Albert Bandura - Google Books*. Prentice Hall; 1986 https://books.google.com.sg/books/about/Social_Foundations_of_Thought_and_Action.html?id=eaK3AAAAIAAJ&redir_esc=y Accessed November 15, 2020
24. Asuzu CC, Walker RJ, Williams JS, Egede LE. Pathways for the relationship between diabetes distress, depression, fatalism and glycemic control in adults with type 2 diabetes. *J Diabetes Complications*. 2017;31(1):169-174. doi:10.1016/J.JDIACOMP.2016.09.013
25. Perrin BM, Swerissen H, Payne C. The association between foot-care self efficacy beliefs and actual foot-care behaviour in people with peripheral neuropathy: a cross-sectional study. *J Foot Ankle Res*. 2009;2(1):3. doi:10.1186/1757-1146-2-3

26. Lin PY, Lee TY, Liu CY, Lee YJ. The effect of self-efficacy in self-management on diabetes distress in young people with type 2 diabetes. *Healthcare*. 2021;9(1736):1-11. doi:10.3390/HEALTHCARE9121736
27. Nouwen A, Urquhart Law G, Hussain S, McGovern S, Napier H. Comparison of the role of self-efficacy and illness representations in relation to dietary self-care and diabetes distress in adolescents with type 1 diabetes. *Psychol Health*. 2009;24(9):1071-1084. doi:10.1080/08870440802254597
28. Carter SL, Murji S, Rourke SB, Shore D, Rourke BP. Cognitive complaints, depression, medical symptoms, and their association with neuropsychological functioning in HIV infection: a structural equation model analysis. *Neuropsychology*. 2003;17(3):410-419. doi:10.1037/0894-4105.17.3.410
29. Mueller H. Best practices in structural equation modeling. In: Osborne J, ed. *Best Practices in Quantitative Methods*. SAGE Publications; 2008:488-508.
30. Lo ZJ, Tan E, Chandrasekar S, et al. Diabetic foot in primary and tertiary (DEFINITE) care: a health services innovation in coordination of diabetic foot ulcer (DFU) care within a healthcare cluster—18-month results from an observational population health cohort study. *Int Wound J*. 2022;20:1609-1621. doi:10.1111/IWJ.14016
31. Wolf EJ, Harrington KM, Clark SL, Miller MW. Sample size requirements for structural equation models: an evaluation of power, bias, and solution propriety. *Educ Psychol Meas*. 2013;76(6):913-934. doi:10.1177/0013164413495237
32. Wang J, Wang X. Sample size for structural equation modeling. In: Wang J, Wang X, eds. *Structural Equation Modeling*. UK; 2019:443-481.
33. Broadbent E, Petrie KJ, Main J, Weinman J. The brief illness perception questionnaire. *J Psychosom Res*. 2006;60:631-637. doi:10.1016/j.jpsychores.2005.10.020
34. Hagger MS, Orbell S. A meta-analytic review of the common-sense model of illness representations. *Psychol Health*. 2003;18(2):141-184. doi:10.1080/088704403100081321
35. Sloan HL. Developing and testing of the foot care confidence scale. *J Nurs Meas*. 2002;10(3):207-218. http://www.ncbi.nlm.nih.gov/pubmed/12885146 Accessed October 6, 2019.
36. García-Inzunza JA, Valles-Medina AM, Muñoz FA, Delgadillo-Ramos G, Compean-Ortiz LG. Validity of the Mexican version of the combined foot care confidence / foot-care behavior scale for diabetes. *Pan Am J Public Heal*. 2015;38(1):35-41.
37. Chin YF, Huang TT. Development and validation of a diabetes foot self-care behavior scale. *J Nurs Res*. 2013;21(1):19-25. doi:10.1097/jnr.0b013e3182828e59
38. Hagger MS, Koch S, Chatzisarantis NLD, Orbell S. The common sense model of self-regulation: meta-analysis and test of a process model. *Psychol Bull*. 2017;143(11):1117-1154. doi:10.1037/BUL0000118
39. Anderson JC, Gerbing DW. Structural equation modeling in practice: a review and recommended two-step approach. *Psychol Bull*. 1988;103:411-423. doi:10.1037/0033-2909.103.3.411
40. Bentler PM. Comparative fit indexes in structural models. *Psychol Bull*. 1990;107(2):238-246. doi:10.1037/0033-2909.107.2.238
41. Rosseel Y. Lavaan: an R package for structural equation modeling. *J Stat Softw*. 2012;48(2):1-36. doi:10.18637/jss.v048.i02
42. Griva K, Myers LB, Newman S. Illness perceptions and self efficacy beliefs in adolescents and young adults with insulin dependent diabetes mellitus. *Psychol Health*. 2000;15(6):733-750. doi:10.1080/08870440008405578
43. Kim H, Sereika SM, Lingler JH, Albert SM, Bender CM. Illness perceptions, self-efficacy, and self-reported medication adherence in persons aged 50 and older with type 2 diabetes. *J Cardiovasc Nurs*. 2021;36(4):312-328. doi:10.1097/JCN.0000000000000675
44. Gonzalez JS, Shreck E, Psaros C, Safren SA. Distress and diabetes treatment adherence: a mediating role for perceived control. *Health Psychol*. 2015;34(5):505-513. doi:10.1037/HEA0000131
45. Zhu X, Lee ES, Lim PXH, Chen YC, Frederick CHF, Griva K. Exploring barriers and enablers of self-management behaviours in patients with diabetic foot ulcers: a qualitative study from the perceptions of patients, caregivers, and healthcare professionals in primary care. *Int Wound J*. 2023;20(7):2764-2779. doi:10.1111/IWJ.14153
46. Alyami M, Serlachius A, O'Donovan CE, van der Werf B, Broadbent E. A systematic review of illness perception interventions in type 2 diabetes: effects on glycaemic control and illness perceptions. *Diabet Med*. 2021;38(3):e14495. doi:10.1111/DME.14495
47. Chan VWY, Kong APS, Lau JTF, Mak WWS, Cameron LD, Mo PKH. An intervention to change illness representations and self-care of individuals with type 2 diabetes: a randomized controlled trial. *Psychosom Med*. 2021;83(1):71-84. doi:10.1097/PSY.0000000000000883

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