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ORIGINAL RESEARCH

FOOT SELF-CARE IN TYPE 2 DIABETES MELLITUS: EFFECTIVENESS ON ANKLE-BRACHIAL INDEX AND FOOT SENSITIVITY

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ABSTRACT

Type 2 Diabetes Mellitus (T2DM) is associated with peripheral vascular disorders and diabetic neuropathy that may increase the risk of diabetic foot complications. Foot Self Care for Life is a comprehensive self-care intervention consisting of foot washing, drying, foot inspection, moisturizer application, nail care, and diabetic foot exercise. These interventions may improve peripheral circulation and sensory function. Determine the effectiveness of Foot Self Care for Life on Ankle Brachial Index (ABI) values and foot sensitivity among patients with Type 2 Diabetes Mellitus. Study employed a pre-experimental design using a one-group pretest-posttest approach. The study was conducted at RSUD Prof. dr. Soekandar from April 27 to May 23, 2026. A total of 40 patients with Type 2 Diabetes Mellitus were selected using accidental sampling. The intervention was administered for four weeks, seven times per week, with a duration of 45 minutes per session. ABI was measured using sphygmomanometer assessment, while foot sensitivity was assessed using a monofilament examination. Data was analyzed using Paired Sample t-Test and Wilcoxon Signed Rank Test. A significant increase in ABI values in the left foot ($t=-7.530$; $p<0.001$) and right foot ($t=-8.651$; $p<0.001$). Foot sensitivity also improved significantly in the left foot ($Z=-5.657$; $p<0.001$) and right foot ($Z=-5.382$; $p<0.001$). Foot Self Care for Life effectively improves peripheral circulation and foot sensitivity among patients with Type 2 Diabetes Mellitus. This intervention may be recommended as a non-pharmacological strategy to prevent diabetic foot complications. This study was approved by the Institutional Review Board (IRB) of Bina Sehat PPNI University Ethical Clearance Number: 175/KEP/UBS-PPNI/IV/2026.

Keywords

Ankle Brachial Index, Diabetes Mellitus, Diabetic Neuropath, Foot Self-Care, Foot Sensitivity.

INTRODUCTION

Type 2 Diabetes Mellitus (T2DM) represents an escalating global health concern and constitutes a primary etiology for a multitude of chronic complications, including peripheral vascular disorders and diabetic neuropathy. Recent epidemiological data published by the International Diabetes Federation (IDF) indicate that approximately 589 million adults globally were living with diabetes in 2024, a figure projected to exhibit a continuous upward trajectory through the year 2050. Indonesia occupies a significant position regarding the burden of this disease, demonstrating a diabetes prevalence of 11.3%, which corresponds to approximately 20.4 million cases within the adult demographic in 2024. Diabetic foot complications have emerged as a critical clinical concern due to their substantial contribution to elevated rates of morbidity, disability, and amputation among diabetic patients. Furthermore, the IDF reports that diabetic peripheral neuropathy and peripheral arterial disease (PAD) serve as the primary predisposing factors precipitating diabetic foot ulcers, subsequent infections, and ultimately, lower-extremity amputations (Duncan et al., 2025; IDF, 2025).

Peripheral perfusion impairments, characterized by a diminished Ankle-Brachial Index (ABI) and attenuated foot sensitivity secondary to diabetic neuropathy, frequently exhibit an insidious and progressive course without overt symptomatology during the early stages. Recent meta-analyses demonstrate that the prevalence of peripheral arterial disease (PAD) among patients with Type 2 Diabetes Mellitus (T2DM) reaches 35.7%, whereas diabetic peripheral neuropathy constitutes one of the most prevalent microvascular complications in patients with long-standing diabetes. These concurrent pathological conditions significantly elevate the risk of diabetic foot ulceration, which has an estimated annual global incidence of 18.6 million individuals and precedes approximately 80% of all diabetes-related lower-extremity amputations. The substantial clinical burden of these complications underscores the critical imperative for accessible, cost-effective, and sustainable preventive interventions aimed at preserving peripheral circulation and foot sensory function in patients with T2DM (Haile et al., 2025; Fuentes-Peñaranda et al., 2025).

One of the recommended non-pharmacological interventions is foot self-care, which constitutes a comprehensive regimen of independent foot maintenance practices encompassing routine foot inspection, adherence to foot hygiene, diabetic foot exercises, the utilization of appropriate footwear, and injury prevention strategies. Theoretically, foot self-care augments peripheral hemodynamics via the stimulation of foot muscular activity and preserves peripheral neural integrity through the early detection of foot pathologies. Several empirical studies have demonstrated that diabetic foot exercises and comprehensive foot care interventions possess the capacity to elevate Ankle-Brachial Index (ABI) values and attenuate the severity of peripheral neuropathy in patients with diabetes. Specifically, research by Pratiwi et al. (2025) delineated that diabetic foot exercises are efficacious in reducing the severity of peripheral neuropathy, whereas Heriyanto et al. (2024) reported an enhancement in ABI values following the implementation of a combined regimen of Buerger-Allen Exercises and diabetic foot exercises among the diabetic cohort. Furthermore, a study conducted by Susantiani et al. (2025) indicated that foot care-based interventions can effectively ameliorate peripheral circulation, as

evidenced by corresponding increases in ABI measurements.

Nevertheless, the majority of prior studies have predominantly investigated the efficacy of foot exercises, foot massage, or isolated interventions on a single clinical indicator—focusing on either the Ankle-Brachial Index (ABI) or peripheral neuropathy independently. Research that specifically evaluates the effectiveness of foot self-care as a comprehensive self-management behavior on two critical indicators simultaneously—namely, ABI and foot sensitivity in patients with type 2 diabetes mellitus (T2DM)—remains relatively scarce. Furthermore, most studies have utilized intervention designs centered on specific physical activities, often neglecting the self-management aspect, which is a fundamental cornerstone of long-term diabetes care. This gap in the literature underscores the necessity for further investigation to determine the extent to which foot self-care practices can contribute to the concurrent improvement of peripheral vascular status and foot sensory function in patients with T2DM.

Based on the aforementioned rationale, this study aims to analyze the effectiveness of foot self-care on changes in the Ankle-Brachial Index (ABI) and foot sensitivity among patients with type 2 diabetes mellitus (T2DM). This research is underpinned by Orem's Self-Care Deficit Nursing Theory, which posits that an individual's capacity to engage in self-care plays a pivotal role in health maintenance and the prevention of chronic disease complications. The hypothesis of this study asserts that foot self-care exerts a positive effect on the improvement of ABI values and foot sensitivity in patients with T2DM. Consequently, the formulated research questions are as follows: (1) Is foot self-care effective in improving the ABI among patients with T2DM? and (2) Is foot self-care effective in enhancing foot sensitivity among patients with T2DM? The findings of this study are anticipated to corroborate the scientific evidence regarding the utility of foot self-care as an easily implementable preventive strategy aimed at mitigating the risk of diabetic foot complications.

Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder characterized by hyperglycemia resulting from insulin resistance and impaired insulin secretion. Prolonged hyperglycemia can precipitate microvascular and macrovascular complications, including diabetic peripheral neuropathy and peripheral arterial disease (PAD), which constitute primary risk factors for the development of diabetic foot complications. In this study, the independent variable is foot self-care, whereas the dependent variables encompass the Ankle-Brachial Index (ABI) and foot sensitivity. Foot self-care is operationalized as a spectrum of self-management behaviors performed by individuals to maintain foot health, comprising daily foot inspection, hygiene maintenance, the utilization of appropriate footwear, nail care, and routine foot exercises. The ABI is defined as the ratio of ankle systolic blood pressure to brachial systolic blood pressure utilized to assess peripheral arterial perfusion, while foot sensitivity denotes the capacity of peripheral sensory nerves to respond to tactile, pressure, or vibratory stimuli. According to Orem's Self-Care Deficit Nursing Theory, an individual's capacity to engage in self-care plays a pivotal role in maintaining physiological functions and preventing chronic disease complications. This theory posits that robust self-care practices can aid in preserving tissue integrity, enhancing peripheral circulation, and mitigating the risk of neuropathic damage in patients with T2DM (Younas, 2023; Wang et al., 2024).

The association among foot self-care, the Ankle-Brachial Index (ABI), and foot sensitivity can be elucidated through both physiological mechanisms and health behaviors. Regular foot care facilitates the early detection of alterations in foot condition, thereby preventing injuries and infections that could potentially exacerbate peripheral vascular impairment. Furthermore, activities encompassed within foot self-care, such as diabetic foot exercises and joint mobilization, enhance lower extremity muscle contractions, which function as a muscle pump to optimize peripheral blood flow. This augmented blood circulation contributes to the improvement of ABI values and ensures the adequate supply of oxygen and nutrients to peripheral neural tissues. Theoretically, this physiological state preserves sensory nerve function and enhances foot sensitivity. From the perspective of Pender's Health Promotion Model, it is further posited that consistently practiced health behaviors yield superior health outcomes by enhancing physiological function and preventing chronic complications (Pender et al., 2022; Bonger et al., 2024).

Several prior studies corroborate these associations. A study by Heriyanto et al. (2024) demonstrated that a combination of Buerger Allen exercises and diabetic foot exercises significantly elevated ABI values in patients with T2DM following a four-week intervention. Similarly, research by Pratiwi et al. (2025) indicated that diabetic foot exercises were effective in mitigating the severity of peripheral neuropathy and enhancing foot sensitivity among elderly individuals with diabetes mellitus. Congruent findings were also reported by Susantiani et al. (2025), who revealed that a foot care intervention involving foot massage effectively enhanced peripheral circulation, as evidenced by a marked increase in ABI scores. Conversely, other investigations have yielded divergent outcomes. For instance, a study by Bonger et al. (2024) reported that proficient foot care behaviors do not invariably correlate directly with significant clinical improvements, particularly when influenced by confounding factors such as diabetes duration, glycemic control, and patient treatment adherence. These disparate findings underscore that the efficacy of foot self-care on the clinical indicators of diabetic foot risk warrants further validation through more comprehensive research.

Based on the literature review, the majority of prior studies have predominantly focused on isolated interventions—such as foot exercises, foot massage, or specific physical therapies—and have evaluated only a single outcome indicator, examining either the Ankle-Brachial Index (ABI) or peripheral neuropathy independently. Research investigating foot self-care as a comprehensive self-management behavior and concurrently evaluating its impact on both ABI and foot sensitivity remains scarce. This gap in the literature provides a critical rationale for conducting the present study to expand the empirical evidence regarding the therapeutic benefits of foot self-care in patients with T2DM. The conceptual framework of this study positions foot self-care as the independent variable that influences peripheral vascular status (measured via ABI) and sensory nerve function (measured via foot sensitivity). Consequently, higher proficiency in foot self-care practices is hypothesized to correlate with optimized peripheral perfusion and enhanced foot sensitivity among patients with T2DM. Grounded in this framework, this study tests the hypothesis that foot self-care exerts a positive effect on improving ABI values and enhancing foot sensitivity in patients with type 2 diabetes mellitus.

METHOD

The study utilizes a quantitative approach with a pre-experimental, one-group pretest-posttest design. The design was employed to evaluate changes in Ankle-Brachial Index (ABI) values and foot sensitivity prior to and following the implementation of the foot self-care intervention among patients with type 2 diabetes mellitus (T2DM). The study was conducted among outpatients with T2DM at a primary healthcare facility. Primary data were gathered directly from the respondents via ABI measurements and foot sensitivity examinations at baseline (pretest) and after the completion of the foot self-care program (posttest). The foot self-care intervention comprised education and independent care practices, encompassing daily foot inspection, hygiene maintenance, the utilization of appropriate footwear, nail care, and routine diabetic foot exercises, all of which aligned with the standard diabetic foot protocols recommended in clinical practice guidelines (Bus et al., 2023; American Diabetes Association [ADA], 2024).

The study population comprised all patients with T2DM who met the inclusion criteria, specifically: aged ≥18 years, clinically diagnosed with T2DM by a healthcare professional, capable of effective communication, and willing to participate throughout the entire study duration. The sample was selected utilizing an accidental sampling technique, recruiting respondents who fulfilled the eligibility criteria and were encountered during the data collection period. The sample size was determined based on the minimum requirement calculation for a paired difference test, assuming a 95% confidence interval and an 80% statistical power. The research instrumentation consisted of a demographic questionnaire, a foot self-care observation checklist, a handheld vascular Doppler device and a sphygmomanometer for ABI measurement, and a 10 g Semmes-Weinstein Monofilament to evaluate foot sensitivity. The content validity of the foot self-care observation tool was established through evaluation by an expert panel consisting of three specialists in medical-surgical and community health nursing. Subsequently, the internal consistency of the instrument was evaluated using Cronbach's alpha coefficient, where a value of ≥0.70 denoted acceptable reliability (Taherdoost, 2022; Boateng et al., 2021).

Data analysis was executed utilizing the latest version of the IBM SPSS Statistics software. Univariate analysis was employed to delineate respondent characteristics and the distribution of research variables, expressed as frequencies, percentages, means, and standard deviations. Prior to conducting bivariate analysis, data normality was assessed using the Shapiro-Wilk test. In the event that the data conformed to a normal distribution, the pre- and post-intervention differences in ABI values were analyzed using the paired t-test. Conversely, if the data deviated from normality, the Wilcoxon signed-rank test was utilized to analyze alterations in foot sensitivity or any other variables failing to meet the normality assumption. Hypothesis testing was conducted at a significance level (α) of 0.05 with a 95% confidence interval. The research hypothesis was accepted upon achieving a p-value < 0.05, indicating a statistically significant effect of foot self-care on changes in ABI values and foot sensitivity among patients with T2DM (Kim, 2022; Mishra et al., 2021).

RESULTS

This study involved 40 respondents diagnosed with type 2 diabetes mellitus (T2DM) who participated in a foot self-care program. The analysis of the research findings encompasses respondent

characteristics, as well as changes in the Ankle-Brachial Index (ABI) values and foot sensitivity prior to and following the intervention. The data indicates that the foot self-care intervention exerted a positive impact on the peripheral circulation and pedal sensory function of the respondents.

Table 1. Distribution of Respondent Characteristics.

Characteristics	Frequency (n)	Percentage (%)
Gender		
Male	11	27.5
Female	29	72.5
Duration of Diabetes Mellitus		
< 1 year	4	10
≥ 1 year	30	75
Not specified	6	15

Table 2. Age Distribution of Respondents

Variable	Mean ± SD	Median	Min–Max
Age (years)	56.18 ± 10.79	59	28–78

Based on Table 1 and Table 2, the mean age of the respondents was 56.18 ± 10.79 years, with an age range of 28–78 years. The majority of the respondents were female, accounting for 29 individuals (72.5%), and most had been suffering from diabetes mellitus for ≥1 year, totaling 30 individuals (75.0%). These demographic characteristics indicate that the respondents belong to an age cohort predisposed to developing vascular complications and diabetic neuropathy.

Table 3. Comparison of ABI Values Prior to and Following Intervention

Variable	Pretest Mean ± SD	Posttest Mean ± SD	p-value
Left Foot ABI	0.99 ± 0.17	1.10 ± 0.13	0.000
Right Foot ABI	0.97 ± 0.20	1.09 ± 0.15	0.000

The results demonstrate an increase in the mean ABI values for both feet following the foot self-care intervention. The left foot ABI increased from 0.99 to 1.10, while the right foot ABI increased from 0.97 to 1.09. The paired samples t-test revealed statistically significant differences between the pre- and post-intervention ABI values for both the left foot ($t = -7.530$; $p = 0.000$) and the right foot ($t = -8.651$; $p = 0.000$). These findings indicate that foot self-care is effective in improving peripheral perfusion in patients with T2DM.

Table 4. Comparison of Foot Sensitivity Prior to and Following Intervention

Variable	Pretest Median (Min–Max)	Posttest Median (Min–Max)	p-value
Left Foot Sensitivity	7 (3–9)	9 (5–10)	0.000
Right Foot Sensitivity	7 (4–10)	9 (6–10)	0.000

The analysis shows that the median sensitivity for the left foot increased from 7 to 9, and similarly, the right foot increased from 7 to 9 post-intervention. The Wilcoxon signed-rank test indicated significant differences in foot sensitivity for both the left foot ($Z = -5.657$; $p = 0.000$) and the right foot ($Z = -5.382$; $p = 0.000$). These findings suggest that foot self-care is capable of enhancing peripheral sensory function in patients with T2DM.

The research hypothesis asserted that foot self-care exerts a significant effect on ABI values and foot sensitivity in patients with type 2 diabetes mellitus. Based on the results of the paired samples t-test and the Wilcoxon signed-rank test, all variables yielded a p-value < 0.05. Consequently, the research hypothesis is accepted, confirming that foot self-care significantly influences the improvement of ABI values and pedal

sensitivity among patients with type 2 diabetes mellitus.

DISCUSSION

The findings of this study demonstrate that foot self-care is effective in increasing Ankle-Brachial Index (ABI) values in patients with type 2 diabetes mellitus (T2DM). The elevation of ABI values indicates an improvement in peripheral blood circulation post-intervention. This finding can be elucidated through Orem's Self-Care Deficit Nursing Theory, which posits that consistently practiced self-care actions are capable of maintaining physiological functions and preventing chronic disease complications. Foot exercises, routine foot examinations, and mobilization activities—which constitute integral components of foot self-care—can enhance lower extremity muscle contractions, thereby optimizing peripheral blood flow via the muscle pump mechanism. This physiological condition leads to increased arterial pressure in the peripheral vessels, as reflected by the elevated ABI values.

These research findings align with a study by Heriyanto et al. (2024), which reported that a combination of Buerger Allen exercises and diabetic foot exercises significantly increased ABI values in patients with diabetes mellitus. Congruent results were also reported by Susantiani et al. (2025), indicating that foot care interventions can improve peripheral perfusion in patients with T2DM. The consistency of these outcomes demonstrates that various forms of foot care contribute positively to the amelioration of peripheral vascular function. The improvement of ABI in this study suggests that foot self-care can serve as a simple, low-cost alternative intervention to prevent the progression of peripheral arterial disease (PAD) in diabetic patients.

Furthermore, this study identified a significant increase in foot sensitivity following the implementation of foot self-care. This outcome indicates an improvement in peripheral sensory nerve function after respondents engaged in routine foot care. The enhancement of pedal sensitivity may be attributed to the augmented blood supply to peripheral neural tissues, thereby adequately fulfilling the neural demand for oxygen and nutrients. Additionally, routine foot inspections facilitate the early detection of trauma, excessive pressure, or cutaneous abnormalities that could potentially exacerbate diabetic neuropathy. This finding lends support to the theory that robust self-care behaviors contribute to the prevention of neuropathic complications through continuous health monitoring.

The outcomes of this study are consistent with research by Pratiwi et al. (2025), which demonstrated that diabetic foot exercises can improve peripheral neuropathy and enhance foot sensitivity in diabetic patients. Nevertheless, several prior studies have reported that changes in sensory function are not always significant over short intervention periods, as they are influenced by factors such as age, diabetes duration, blood glucose levels, and patient adherence to the foot care regimen. These discrepancies are likely attributable to variations in respondent demographics, the specific type of intervention administered, the duration of the program, and the neurological assessment methods utilized across different studies.

A practical standpoint, the results of this study carry important implications for nursing services and diabetes management programs within healthcare facilities. Foot self-care can be integrated into routine education programs for diabetic patients as a preventive strategy to mitigate the risks of peripheral neuropathy, peripheral arterial

disease (PAD), diabetic foot ulcers (DFUs), and lower extremity amputations. In terms of academic and scientific development, this study strengthens the empirical evidence regarding the relationship between self-care behaviors and the improvement of vascular and neurological functions in patients with type 2 diabetes mellitus. This research also expands upon previous literature by concurrently evaluating two critical clinical indicators, namely ABI and foot sensitivity.

Nevertheless, several limitations of this study must be acknowledged. The pre-experimental, one-group pretest-posttest design lacked a concurrent control group; hence, external confounding factors that could influence the research outcomes could not be optimally controlled. The relatively small sample size and the utilization of an accidental sampling technique also limit the generalizability of the findings to a broader population. Therefore, future research is recommended to employ quasi-experimental or randomized controlled trial (RCT) designs with larger sample sizes and longer intervention periods. Additionally, subsequent studies should account for other confounding variables such as glycemic control, body mass index (BMI), physical activity, and patient compliance in executing the foot self-care program. Consequently, the effectiveness of the intervention can be evaluated more comprehensively, yielding more robust external validity.

CONCLUSIONS

The study demonstrates that foot self-care exerts a statistically significant effect on enhancing the Ankle-Brachial Index (ABI) and foot sensitivity in patients with type 2 diabetes mellitus (T2DM). The findings indicate an increase in the mean ABI values from 0.99 to 1.10 for the left foot and from 0.97 to 1.09 for the right foot following the intervention. Additionally, a post-intervention increase in median foot sensitivity from 7 to 9 was observed in both extremities. Statistical analysis revealed a p-value < 0.05 across all variables, thereby validating the research hypothesis. These insights suggest that regular implementation of foot self-care can optimize peripheral perfusion and pedal sensory function in individuals with T2DM.

The outcomes of this study corroborate the Self-Care Deficit Nursing Theory, which posits that consistently practiced self-care behaviors assist in maintaining physiological functions and preventing chronic disease complications. The concurrent improvement in ABI values and foot sensitivity underscores that foot self-care not only serves to maintain foot hygiene but actively contributes to the amelioration of peripheral vascular and neurological functions—both of which are critical determinants in mitigating diabetic foot complications.

A practical standpoint, these findings provide a robust scientific foundation for healthcare professionals, particularly nursing staff, to integrate structured foot self-care protocols into routine education and management regimens for patients with T2DM. Sustained adherence to foot self-care practices has the potential to lower the incidence of peripheral neuropathy, peripheral arterial disease (PAD), diabetic foot ulcers (DFUs), and subsequent lower extremity amputations. Furthermore, these findings offer valuable insights for healthcare policymakers tasked with designing patient empowerment-centered promotive and preventive initiatives within primary healthcare settings and chronic disease management programs.

Nevertheless, certain limitations of this study must be acknowledged, including the utilization of a pre-experimental one-group pretest-posttest design lacking a concurrent control group, alongside an accidental sampling approach, which may

restrict the external validity and generalizability of the findings. Additionally, this investigation did not control several potential confounding variables that could influence the outcomes, such as glycated hemoglobin (HbA1c) levels, physical activity, nutritional status, and the longitudinal adherence of respondents to the prescribed foot self-care protocol.

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