

Empowering Patients with Type 2 Diabetes Mellitus Through Education and Diabetic Foot Exercises for Blood Glucose Control

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ABSTRACT

Background: Type 2 diabetes mellitus requires continuous self-management to maintain glycemic control and prevent complications. Limited knowledge, insufficient physical activity, and inadequate skills in performing independent exercise may hinder effective diabetes management. Diabetic foot exercises are simple movements that can be practiced independently and may support foot mobility, peripheral function, and overall physical activity.

Objectives: This community service program aimed to improve the knowledge and skills of patients with type 2 diabetes mellitus in performing diabetic foot exercises and to support blood glucose control.

Methods: Thirty patients with type 2 diabetes mellitus participated in health education, demonstration, and guided practice of diabetic foot exercises. The exercises were performed for 15–30 minutes per session over three meetings. Evaluation included pre-test and post-test knowledge assessments, a diabetic foot exercise skills checklist, and random blood glucose measurements before and after the program.

Results: The mean knowledge score increased from 57.3 to 86.0. Participants able to perform diabetic foot exercises correctly increased from 36.7% to 90.0%. Mean random blood glucose decreased from 268.4 mg/dL to 221.6 mg/dL. Participants also demonstrated greater independence in performing the exercises and better understanding of physical activity as part of diabetes self-management.

Conclusions: Education combined with diabetic foot exercise training was followed by improved knowledge, practical skills, and lower mean random blood glucose. Continued practice and follow-up are recommended to strengthen diabetes self-management.



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Introduction

Diabetes mellitus is a major global public health challenge that requires long-term management and continuous engagement by people living with the condition. The World Health Organization reported that approximately 830 million people were living with diabetes in 2022, with prevalence increasing more rapidly in low- and middle-income countries. Diabetes can result in cardiovascular disease, kidney disease, neuropathy, visual impairment, foot problems, and lower-limb amputation when inadequately managed. Lifestyle modification, regular physical activity, appropriate pharmacological therapy, glucose monitoring, and screening for complications are therefore central components of diabetes care.

The International Diabetes Federation estimated that approximately 589 million adults aged 20–79 years were living with diabetes globally in 2024, representing 11.1% of adults in this age group, with the number projected to exceed 850 million by 2050. For Indonesia, the 2025 IDF Diabetes Atlas estimated approximately 20.4 million adults aged 20–79 years living with diabetes in 2024. National data also demonstrate a considerable burden. The Indonesian Health Survey 2023 reported diabetes prevalence of 2.2% among people aged ≥15 years based on physician diagnosis but 11.7% based on blood glucose examination, suggesting a substantial gap between diagnosed and measured diabetes.

Effective management of type 2 diabetes extends beyond pharmacological treatment. Contemporary diabetes standards emphasize diabetes self-management education and support, nutrition, physical activity, behavioral strategies, and individualized risk-factor management. The American Diabetes Association recommends regular physical activity for people with type 2 diabetes and generally advises adults who are able to participate to accumulate at least 150 minutes of moderate-to-vigorous aerobic activity per week while reducing prolonged sedentary behavior. Evidence from randomized trials similarly demonstrates that appropriately structured exercise can improve glycemic control in adults with type 2 diabetes (Hou et al., 2023).

Patient education is equally important because diabetes management requires numerous daily decisions regarding medication, nutrition, activity, glucose monitoring, and complication prevention. A network meta-analysis of 108 trials involving 17,735 adults with type 2 diabetes found that diabetes self-management education and support improved several clinical outcomes, including HbA1c and fasting glucose, compared with usual care (Romadlon et al., 2024). This evidence supports community programs that combine knowledge acquisition with practical skills rather than providing information alone.

Foot-related health is an important component of diabetes care because prolonged hyperglycemia may contribute to peripheral neuropathy and vascular complications. Current ADA standards recommend comprehensive foot assessment and patient education, particularly regarding daily foot inspection, recognition of abnormalities, and timely referral. The International Working Group on the Diabetic Foot also recognizes a potential role for appropriately prescribed foot-ankle exercises among people at low or moderate risk of foot ulceration, while emphasizing assessment, appropriate supervision, and caution in people with active lesions or ulcers.

Diabetic foot exercises involve repeated movements of the toes, ankles, and lower extremities and are intended primarily to maintain mobility, muscular function, and circulation of the feet. In the source clinical work underlying the present community program, diabetic foot exercises were performed using a structured procedure in the sitting position, including repeated toe and ankle movements and exercises involving paper manipulated with the feet. KIA EVA HASYIANA KIA EVA HASYIANA The source case evaluation also documented lower random blood glucose values after individual exercise sessions in both participants, providing a clinical rationale for expanding education and practical training to a community-service format.

Educational demonstration is particularly relevant because patients must not only understand why physical activity is beneficial but also know how to perform the movements correctly and safely. Indonesian evidence has shown that demonstration-based diabetic foot exercise education can

improve patient knowledge (Ningrum et al., 2022), while other community and case-based reports have described the feasibility of diabetic foot exercise as part of self-management activities.

Accordingly, this community service program combined diabetes education, demonstration, guided practice, and blood glucose monitoring. The program aimed to improve patients' knowledge and ability to perform diabetic foot exercises independently and to describe changes in random blood glucose following the program.

Methods

Program Design/Approach

This community service program used a patient-empowerment approach combining health education, demonstration, guided practice, and program evaluation. The intervention was designed to strengthen both cognitive understanding and practical competence in performing diabetic foot exercises. Participants first received information regarding type 2 diabetes, the role of physical activity in self-management, foot health, and the purpose of diabetic foot exercises. The facilitator then demonstrated the movements, after which participants practiced them under supervision and received corrective feedback.

The intervention should be interpreted as a focused component of diabetes self-management rather than a replacement for comprehensive physical-activity recommendations, medication, dietary management, glucose monitoring, or routine medical care. Current diabetes guidelines recommend individualized physical activity and ongoing diabetes self-management support as part of an integrated treatment plan.

Community Partner and Target Population

The program involved 30 patients diagnosed with type 2 diabetes mellitus. Participants were individuals requiring support to improve their understanding of diabetes self-management and their ability to undertake simple exercise independently.

The needs assessment focused on limited knowledge of diabetes management, insufficient engagement in physical activity, lack of familiarity with structured diabetic foot exercises, and the need to strengthen self-management behaviors. The clinical foundation for the program originated from case-based nursing activities involving type 2 diabetes with unstable blood glucose and diabetic foot exercise. The original case work included older adults with hyperglycemia, symptoms including thirst, frequent urination, fatigue, and tingling of the extremities.

Community Service Intervention/Activities

The program was organized into five stages.

Stage 1 – Preparation and Needs Assessment. Participant needs were assessed in relation to diabetes knowledge, physical activity, ability to perform diabetic foot exercise, blood glucose monitoring, and independent self-management. The educational content was then adapted to address these needs.

Stage 2 – Program Planning and Preparation. Educational material, demonstration procedures, exercise equipment, skills-assessment procedures, and blood glucose monitoring were prepared. The diabetic foot exercise procedure was based on structured lower-extremity movements that could be performed while seated.

Stage 3 – Education and Skills Training. Participants received health education regarding type 2 diabetes, the importance of glycemic management, physical activity, foot care, and prevention of complications. The diabetic foot exercises were demonstrated step by step. Participants subsequently performed guided return-demonstrations and received feedback to correct movement techniques.

Each exercise session lasted approximately 15–30 minutes, and the program was conducted over three meetings. This schedule is consistent with the source clinical intervention, in which diabetic foot exercises were conducted over three sessions with a duration of 15–30 minutes.

The practical movements included toe flexion and extension, heel and toe lifting, ankle rotation, alternating leg extension, ankle dorsiflexion and plantar flexion, and coordinated manipulation of paper using the feet. The original standard operating procedure also incorporated participant preparation, explanation of the purpose of exercise, evaluation of the patient response, and documentation.

Stage 4 – Monitoring and Evaluation. Knowledge, practical skills, and random blood glucose were assessed before and after the program. Participant ability to perform the sequence correctly was observed using a skills checklist.

Stage 5 – Follow-up and Sustainability. Participants were encouraged to continue appropriate physical activity and diabetic foot exercises as part of their self-management routines while maintaining prescribed medication, nutrition, glucose monitoring, and routine healthcare. Repeated education and reinforcement during subsequent healthcare contacts were recommended.

Table 1. Components of the Diabetes Education and Diabetic Foot Exercise Program

Program Component	Main Content	Educational Strategy	Expected Competency
Understanding type 2 diabetes	Hyperglycemia, symptoms, complications, long-term management	Health education and discussion	Understand the need for continuous self-management
Blood glucose management	Importance of monitoring and adherence to treatment	Education	Understand factors influencing blood glucose
Physical activity	Role and safety of physical activity in diabetes	Education and discussion	Recognize exercise as part of diabetes management
Foot health	Foot inspection and prevention of injury	Education	Recognize basic foot-care needs and warning signs
Diabetic foot exercise	Toe, ankle, and lower-extremity movements	Demonstration	Understand the exercise sequence
Guided practice	Step-by-step exercise performance	Return-demonstration and feedback	Perform movements correctly
Independent exercise	Repetition of the full sequence	Supervised practice	Perform diabetic foot exercises independently
Evaluation	Knowledge, skills, and random blood glucose	Pre/post assessment	Demonstrate improvement in program outcomes

Instruments and Program Evaluation

Program outcomes comprised knowledge, practical skills, and random blood glucose. Knowledge was evaluated using pre-test and post-test assessments. The mean knowledge score was 57.3 before the program and 86.0 after the program.

Practical competence was evaluated using a diabetic foot exercise skills checklist. Before the program, 36.7% of participants were able to perform the exercises correctly. Following education, demonstration, and guided practice, this proportion increased to 90.0%.

Random blood glucose was measured before and after the program. Mean random blood glucose was 268.4 mg/dL before the program and 221.6 mg/dL after the program. Because random glucose can be influenced by meal timing, medication use, recent activity, stress, and other physiological factors, this measure was treated as a descriptive program indicator rather than a stand-alone measure of long-term glycemic control.

Data Collection

Data collection followed the sequence of baseline assessment, intervention, and post-program evaluation. Participants underwent knowledge assessment, skills assessment, and random blood glucose measurement before participating in the educational and practical activities. After completion of three sessions, the corresponding assessments were repeated. The source clinical

intervention similarly used blood glucose measurements before and after individual diabetic foot exercise sessions to monitor change.

Data Analysis

Data were analyzed descriptively. Mean scores were used for knowledge and random blood glucose, whereas frequency and percentage were used to describe the proportion of participants who correctly performed diabetic foot exercises. Pre-program and post-program values were compared descriptively. No inferential statistical significance, confidence interval, or causal effect estimate is reported.

Results

Program Implementation

Thirty patients with type 2 diabetes mellitus participated in the educational and diabetic foot exercise program. The activities combined health education, demonstration, guided practice, and evaluation over three meetings. Particular emphasis was placed on enabling participants to perform the exercises independently rather than merely observing the facilitator.

Changes in Knowledge

The mean knowledge score increased from 57.3 at pre-test to 86.0 at post-test, corresponding to an absolute increase of 28.7 points.

Table 2. Participant Knowledge Before and After the Program

Indicator	Pre-program	Post-program	Absolute Change
Mean knowledge score	57.3	86.0	+28.7

The increase indicated improved participant understanding of type 2 diabetes management, physical activity, diabetic foot exercise, and the importance of maintaining regular self-management behaviors.

Improvement in Diabetic Foot Exercise Skills

Before the intervention, 36.7% of participants were able to perform diabetic foot exercises correctly. Following demonstration and guided practice, 90.0% demonstrated correct exercise performance. This represented an increase of 53.3 percentage points.

Table 3. Diabetic Foot Exercise Skills Before and After the Program

Indicator	Before Program	After Program	Absolute Change
Participants able to perform diabetic foot exercises correctly	36.7%	90.0%	+53.3 percentage points

Participants demonstrated improved ability to complete the exercise sequence independently and showed greater understanding of how the exercises could be incorporated into diabetes self-management.

Changes in Random Blood Glucose

Mean random blood glucose decreased from 268.4 mg/dL before the program to 221.6 mg/dL after the program, corresponding to a descriptive reduction of 46.8 mg/dL, or approximately 17.4% from the baseline mean.

Table 4. Random Blood Glucose Before and After the Program

Indicator	Before Program	After Program	Change
Mean random blood glucose	268.4 mg/dL	221.6 mg/dL	-46.8 mg/dL

Although the post-program mean remained above a desirable glucose range, the downward change was consistent with the direction expected when physical activity is incorporated into comprehensive diabetes management. The result should nevertheless be interpreted cautiously because no control group or standardized long-term glycemic marker was available.

Discussion

The program produced a marked descriptive increase in participant knowledge, from 57.3 to 86.0. Diabetes is largely managed outside healthcare facilities, requiring patients to make daily decisions regarding activity, nutrition, medication, monitoring, and foot care. Therefore, improving patient knowledge represents an important component of empowerment. Recent network meta-analysis evidence indicates that structured diabetes self-management education and support can improve glycemic and other clinical outcomes in adults with type 2 diabetes (Romadlon et al., 2024).

The educational strategy used in the present program incorporated demonstration and return-demonstration. This method is particularly appropriate when the intended outcome involves psychomotor competence. Participants need not only to know that exercise is recommended but also to understand the sequence of movements and demonstrate that they can perform it independently. Ningrum et al. (2022) similarly reported increased knowledge following demonstration-based diabetic foot exercise education.

The proportion of participants capable of correctly performing diabetic foot exercises increased from 36.7% to 90.0%. This finding suggests that supervised practice and feedback were useful for translating health information into practical self-management skills. Education regarding diabetic foot health is supported by systematic-review evidence showing improvements in knowledge and foot self-care behavior, although education alone should not be assumed to prevent all foot complications (Ayaz et al., 2022). More recent evidence similarly indicates that multifaceted education is generally more defensible than relying on a single isolated intervention.

Foot exercises also have potential functional value beyond knowledge acquisition. Current IWGDF guidance suggests that selected patients at low or moderate risk of foot ulceration may benefit from structured foot-ankle exercise programs aimed at improving modifiable risk factors such as joint mobility, strength, neuropathic symptoms, and plantar-pressure distribution. However, professional assessment is important, particularly in patients with pre-ulcerative lesions, active ulcers, severe neuropathy, or other high-risk conditions. An RCT of a structured foot-ankle exercise program in people with diabetes-related peripheral neuropathy has also reported benefits for foot-related outcomes and function.

The decrease in mean random blood glucose from 268.4 to 221.6 mg/dL is another important program outcome. Skeletal muscle activity increases glucose utilization and can improve insulin sensitivity, which provides a physiological rationale for including regular activity in diabetes management. Current ADA standards identify physical activity as an essential component of diabetes care, and systematic evidence across a broad range of exercise modalities demonstrates improvements in glycemic control among adults with type 2 diabetes.

Nevertheless, diabetic foot exercise should not be portrayed as equivalent to the full amount of exercise recommended for type 2 diabetes. Foot movements undertaken for 15–30 minutes can be useful for teaching self-management, maintaining lower-extremity mobility, and increasing activity among relatively sedentary participants, but they should complement rather than replace broader aerobic, resistance, balance, and flexibility activities that are individually appropriate. ADA recommendations generally encourage most adults with type 2 diabetes to accumulate at least 150 minutes of moderate-to-vigorous activity each week.

The short-term reduction in random glucose must also be interpreted cautiously. Random blood glucose is affected by timing of food intake, medication or insulin, the interval between exercise and measurement, hydration, stress, illness, and baseline glucose level. The present community program did not establish that all of these factors were standardized. Consequently, the observed 46.8 mg/dL reduction should be reported as a descriptive pre-post change associated with the program, rather than evidence that diabetic foot exercises alone caused the reduction.

This interpretation is especially important because the original itself identified dietary control as an uncontrolled factor that could influence blood glucose changes. The source case study nevertheless provides useful clinical support: both original participants experienced lower GDA

values during the three-session exercise period. The community program expands this clinical concept toward empowerment, knowledge development, and independent skills rather than simply reproducing a two-patient case report.

The emphasis on patient empowerment is also consistent with contemporary diabetes care. Education is most useful when participants gain the confidence and ability to integrate recommended behavior into everyday routines. Repeated reinforcement is necessary because diabetes requires lifelong management. The ADA emphasizes that diabetes care involves collaboration among people with diabetes, caregivers, healthcare professionals, health systems, and community partners.

Foot safety should remain integral to future implementation. ADA guidance recommends regular comprehensive foot assessment and emphasizes education regarding foot inspection and recognition of abnormalities. Patients with wounds, marked loss of protective sensation, peripheral arterial disease, deformity, swelling, redness, or other high-risk findings should not simply be directed into a generic exercise program without clinical assessment.

Overall, the program demonstrates the feasibility of integrating health education with a simple practical exercise intervention in community diabetes care. Its greatest value may lie not only in the observed short-term change in blood glucose but also in strengthening patients' knowledge and ability to perform an appropriate self-management activity independently.

Implications, Sustainability, and Limitations

This program supports a practical role for nurses in linking diabetes education with skills training. Rather than instructing patients simply to "exercise regularly," nurses can demonstrate an accessible activity, observe patients performing it, correct errors, and evaluate whether they can continue independently. Education should simultaneously reinforce medication adherence, nutrition, routine glucose monitoring, general physical activity, foot inspection, and timely use of healthcare services.

Sustainability can be strengthened through refresher sessions, educational leaflets or videos, repeated skills assessment, family support, and integration of diabetic foot exercises into routine diabetes education at community and primary healthcare services. Participants should also be encouraged to progress toward broader individualized physical-activity recommendations when medically appropriate.

Several limitations should be considered. The program used a single-group descriptive pre-post evaluation without a control group, so causal effectiveness cannot be established. Long-term maintenance of knowledge and skills was not measured. Random blood glucose rather than HbA1c was used as the glycemic outcome, and the available program information does not establish whether meal timing, medication, or the timing of glucose measurement was standardized. The three-session program was also too short to determine sustained glycemic effects or changes in diabetic complications. Future programs could include longer follow-up, HbA1c where feasible, standardized measurement procedures, adherence monitoring, and broader assessment of diabetes self-management behaviors.

Relevance for Practice

Nurses and community healthcare providers can incorporate diabetic foot exercise training into a broader diabetes self-management education program by first assessing foot condition and exercise safety, providing concise education, demonstrating the exercise sequence, observing return-demonstration, correcting technique, and evaluating the patient's ability to continue independently. The intervention should complement—not replace—appropriate aerobic and resistance activity, medication, nutritional management, routine glucose monitoring, and regular foot assessment. Patients with active foot ulcers, significant neuropathy, vascular impairment, unexplained swelling, redness, or other high-risk abnormalities should receive appropriate professional evaluation before undertaking foot-loading exercises.

Conclusion

The patient-empowerment program combining health education, demonstration, and guided diabetic foot exercise practice was followed by improved knowledge and practical skills among patients with type 2 diabetes mellitus. Mean random blood glucose was also lower after the program, although this short-term descriptive change should not be interpreted as proof that diabetic foot exercise alone produced glycemic improvement. The program demonstrates the practical value of combining diabetes education with supervised skills training to strengthen patient participation in self-management. Regular reinforcement, appropriate clinical screening, continued exercise, and integration with comprehensive diabetes management are recommended.

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Author Contribution

Eva Hasyiana contributed to the conceptualization of the community service program, needs assessment, program planning, implementation of health education and diabetic foot exercise training, data collection, blood glucose monitoring, program evaluation, literature review, data interpretation, and preparation of the original manuscript.

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Declaration of Conflicting Interest

The authors declare no conflict of interest related to the implementation of this community service program or the publication of this manuscript.

Declaration of Use of AI in Scientific Writing

The authors declare that generative AI and AI-assisted technologies were used solely to support language editing, grammatical refinement, and improvement of the clarity and readability of the manuscript. The authors reviewed, verified, and revised all AI-assisted content and remain fully responsible for the accuracy, integrity, interpretation, and final content of the manuscript.

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