Effectiveness of the LIFE Program on Lower Extremity Perfusion among Patients with Type 2 Diabetes Mellitus

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ABSTRACT

Background: Type 2 Diabetes Mellitus is frequently associated with impaired lower-extremity perfusion, which increases the risk of diabetic foot complications, delayed healing, infection, and amputation. Early prevention through nursing-led lifestyle education is essential.

Methods: A non-randomized controlled trial was conducted among 160 patients with Type 2 Diabetes Mellitus and reduced lower-extremity perfusion, selected from hospitals in Chennai. The experimental group received the LIFE program, and knowledge and perfusion were assessed pre-test, at discharge, and after one month.

Results: The groups were comparable at baseline. The intervention group showed significantly better fasting blood glucose, lower-extremity perfusion, and diabetic foot screening outcomes after the program, while HbA1c and post-prandial glucose showed no meaningful between-group difference in the available results.

Conclusion: The LIFE program appears to be an effective, practical, nurse-led intervention for improving knowledge and lower-extremity perfusion in patients with Type 2 Diabetes Mellitus. It may help in early prevention of diabetic foot complications and support routine diabetes care in clinical settings.

Keywords: Type 2 Diabetes Mellitus; Lower Extremity Perfusion; Ankle-Brachial Index; Lifestyle Intervention; Diabetic Foot Care; Nursing Education

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INTRODUCTION

Diabetes mellitus is a major global public health problem and is associated with numerous acute and chronic complications that affect quality of life, productivity, and survival. Among these, impaired lower-extremity perfusion is a serious and often underrecognized complication in patients with Type 2 Diabetes Mellitus, as persistent hyperglycemia contributes to endothelial dysfunction, accelerated atherosclerosis, neuropathy, and microvascular impairment. These pathophysiological changes reduce blood flow to the lower limbs, delay tissue healing, increase the risk of foot ulceration, and may eventually lead to infection and amputation. Diabetic foot-related complications remain one of the most debilitating outcomes of diabetes and contribute substantially to disability, hospitalization, and healthcare costs [1,2].

The risk of lower-extremity ischemia is particularly important because many patients with diabetes remain asymptomatic in the early stages, and clinical deterioration may occur before they recognize the seriousness of the condition. Ankle Brachial Index is a simple and non-invasive screening measure that helps identify peripheral arterial disease and impaired perfusion in individuals with diabetes. Early detection of reduced perfusion, along with timely education and preventive care, is essential to avoid progression to diabetic foot complications. Nurses play a central role in this process because they are often the first to assess risk factors, provide patient education, reinforce self-care practices, and support lifestyle modification [2,3].

Lifestyle-based interventions are increasingly recognized as effective adjuncts in diabetes management. Regular physical activity, therapeutic foot and ankle exercises, diet modification, smoking cessation, and adherence to treatment can improve glycemic control, enhance circulation, and strengthen patient self-management. Evidence from recent studies shows that exercise-based programs and structured foot care interventions can improve ankle-brachial index, peripheral blood flow, and other perfusion-related outcomes in patients with diabetes. However, despite this evidence, such interventions are not consistently implemented in

routine clinical practice, particularly in resource-limited settings where patient education may be fragmented and preventive screening may be inadequate [4,5].

In this context, a structured nursing intervention such as the LIFE program may offer a practical and patient-centered approach to improving lower-extremity perfusion in patients with Type 2 Diabetes Mellitus. By combining education with lifestyle guidance and supportive self-care strategies, the intervention can help patients understand their condition, adopt healthier behaviors, and participate actively in prevention. This is especially relevant for middle-aged adults, who may have had diabetes for several years and are at increased risk of vascular compromise [6].

Need for the study

Type 2 Diabetes Mellitus is a growing health concern worldwide and is strongly associated with vascular complications, neuropathy, and delayed wound healing. One of the most serious but preventable consequences is impaired lower-extremity perfusion, which can progress silently until the patient develops foot pain, ulceration, infection, or even amputation. Because peripheral circulation problems are often detected late, there is a clear need for early identification and timely intervention in patients at risk. Diabetic foot complications remain a major cause of disability, prolonged hospitalization, and reduced quality of life, making prevention a priority in both hospital and community settings.

In clinical practice, many patients with diabetes have limited knowledge about foot care, exercise, and the importance of maintaining adequate blood flow to the lower limbs. Even when advised, they may not consistently follow healthy lifestyle measures unless they receive structured guidance and reinforcement. Nurses are in a key position to provide such support because they can educate patients, monitor perfusion-related changes, encourage self-care, and promote safe therapeutic activity. A practical intervention that combines health education with lifestyle modification may therefore help improve both knowledge and circulation.

Therefore, the present study was undertaken to evaluate the effectiveness of the LIFE program on knowledge and lower-extremity perfusion among patients with Type 2 Diabetes Mellitus. The findings are expected to contribute to nursing practice by strengthening preventive care strategies and promoting early intervention to reduce the burden of diabetic foot complications [1].

2. Research methodology

Research approach

A quantitative research approach was adopted for this study, as it is a powerful design for testing hypotheses of causal relationships among variables.

Research design

A non-randomised controlled Trial with pre-test and post-test control group was adopted for this study

Study Group	Pre-test	Intervention	Post-test I	Post-test II
Experimental Group	O_1	X_1	O_2	O_3
Control Group	O_1	—	O_2	O_3

O_1 – pre-test assessment of knowledge and lower extremity perfusion level

O_2 – post-test assessment of knowledge and lower extremity perfusion level at the time of discharge

O_3 – Post-test assessment of knowledge and lower extremity perfusion level after 1 month

X_1 – LIFE Program Intervention

Setting of the study

The study will be conducted at selected hospitals in Chennai with 220 in-patient beds.

Sample size

The sample consists of 160 selected patients diagnosed with Type 2 Diabetes Mellitus and impaired lower extremity perfusion 80 in the experimental group and 80 in the control group.

Sampling technique

A purposive sampling technique will be used to select samples for the present study.

Criteria for selection of samples

Inclusion criteria

- Patients who are with the age 45–59 years.
- Ankle Brachial Index (ABI) score less than 0.9.
- Both male and female patients.
- Patients receiving oral antidiabetic drugs or insulin therapy.
- Patients diagnosed with Type 2 Diabetes Mellitus with HbA1c value of ≥ 6.5
- Patients diagnosed with type 2 Diabetes Mellitus for more than 2 years.
- Patients who were medically stable and fit to perform mild therapeutic exercise

Exclusion criteria

- Patients who are critically ill.
- Patients with disoriented GCS <14/15.
- Patients not willing to participate.
- Patients with active diabetic foot ulcer, gangrene, or history of lower limb amputation
- Patients with a history of present problems such as deep vein thrombosis, varicose veins, or leg ulcers.

Variables

- Independent variable: Life Style program
- Dependent Variable :1. Knowledge on lower extremity perfusion

2. Lower extremity perfusion

3. Results

Frequency and Percentage Distribution of Demographic Variables among Control and Study Group of Patients with Type 2 Diabetes Mellitus

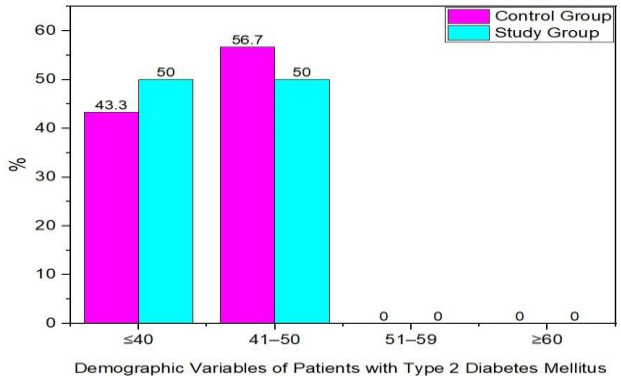

Fig. 1 Demographic variables of patients (age) with type-2 Diabetes Mellitus

The demographic profile indicates that both the control and study groups were largely comparable across most variables, indicating a generally homogeneous sample. In the control group, the majority were aged 41–50 years (56.7%), male (56.7%), married (43.3%), Christian (50.0%), had higher secondary education (33.3%), worked in blue-collar jobs (36.7%), performed sedentary work (43.3%), followed a non-vegetarian diet (66.7%), were non-smokers (66.7%), and were non-alcoholic (66.7%); similarly, in the study group, most participants were aged 40–50 years (50.0%), male (56.7%), married (50.0%), Christian (56.7%), had higher secondary education (36.7%), were self-employed (33.3%), engaged in moderate work (63.3%), followed a non-vegetarian diet (60.0%), were non-smokers (80.0%), and were non-alcoholic (60.0%). Statistically, no significant difference was observed between the groups for age ($\chi^2 = 0.268$, $p = 0.605$), gender ($\chi^2 = 0.000, p = 1.000$), religion ($\chi^2 = 1.002, p = 0.606$), educational status ($\chi^2 = 3.067$, $p = 0.547$), occupation ($\chi^2 = 4.445$, $p = 0.349$), nature of activity ($\chi^2 = 4.639, p = 0.098$), dietary pattern ($\chi^2 = 0.287, p = 0.592$), smoking ($\chi^2 = 1.364, p = 0.243$), or alcohol use ($\chi^2 = 0.287, p = 0.592$), whereas marital status showed a statistically significant difference between the groups ($\chi^2 = 10.375$, $p = 0.016$). Overall, the findings suggest that the two groups were broadly matched on demographic and lifestyle characteristics, with marital status being the only variable that differed significantly.

Frequency and Percentage Distribution of Clinical Variables among Control and Study Group of Patients with Type 2 Diabetes Mellitus

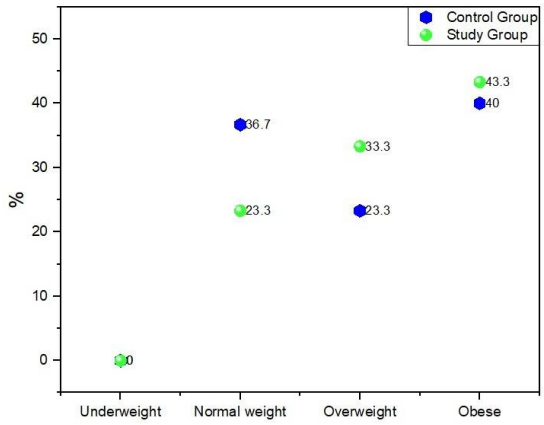

Fig. 2 Clinical variables (weight) of patients among control and study groups

The control and study groups were largely comparable in their clinical profile, with no statistically significant differences in most variables, indicating baseline homogeneity between the groups. In the control group, the majority were obese (40.0%) (Fig. 2), had HbA1c levels between 7.1 and 8.5 (46.7%) or above 8.5 (43.3%), reported a positive family history of diabetes mellitus (60.0%), had diabetes for more than 10 years (46.7%), and were receiving oral hypoglycemic agents (43.3%); in the study group, a similar pattern was observed, with obesity (43.3%), HbA1c levels between 7.1 and 8.5 (56.7%), positive family history of diabetes mellitus (70.0%), duration of diabetes of 2–5 years (33.3%) or 5–10 years (30.0%), and both oral hypoglycemic agents and insulin plus oral hypoglycemic agents accounting for 43.3% and 33.3%, respectively. Co-morbid conditions were also broadly similar across groups, with hypertension present in 56.7% of the control group and 46.7% of the study group, cardiac problems in 40.0% and 36.7%, renal problems in 16.7% and 10.0%, hypercholesterolemia in 60.0% and 36.7%, history of leg cramps in 16.7% and 16.7%, and family history of peripheral artery disease in 40.0% and 50.0%, respectively; however, none of these differences reached statistical significance, as the p values were greater than 0.05, including BMI ($p = 0.482$), HbA1c level ($p = 0.371$), family history of diabetes mellitus ($p = 0.417$), duration of diabetes mellitus ($p = 0.641$), diabetic treatment ($p = 0.589$), hypertension ($p = 0.438$), cardiac problems ($p = 0.791$), renal problems ($p = 0.448$), hypercholesterolemia ($p = 0.071$), history of leg cramps ($p = 1.000$), and family history of peripheral artery disease ($p = 0.436$). Overall, these findings indicate that the sample was clinically well matched, with only minor variations between the two groups and no meaningful baseline imbalance in the measured clinical variables.

Mean and Standard Deviation of Blood Sugar Levels among Control and Study Group of Patients with Type 2 Diabetes Mellitus

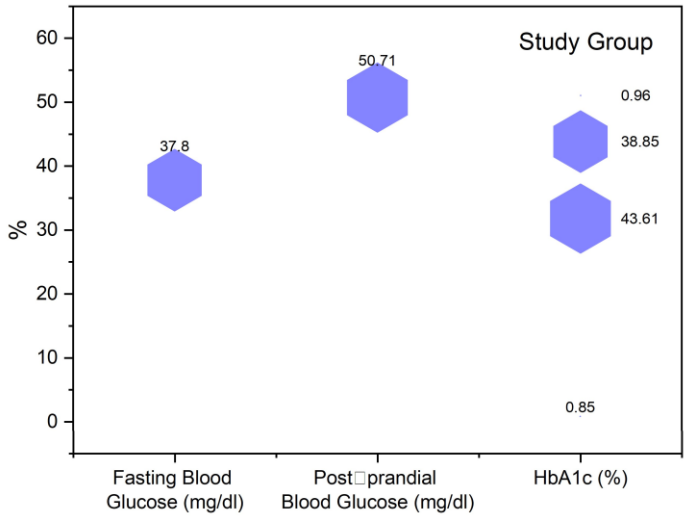

Fig. 3 Mean and standard deviation of blood sugar level of patients with Type 2 Diabetes Mellitus

Table 1. Mean and SD of Blood Sugar Level of Patients with Type 2 Diabetes Mellitus in Control and Study Group

Variables	Control Group (n=30)	Study Group (n=30)	(MD)	t value	p-value
Fasting Blood Glucose (mg/dl)	230.80 ± 37.80	187.47 ± 38.85	43.33	4.379	0.000*
Post-prandial Blood Glucose (mg/dl)	219.43 ± 50.71	229.53 ± 43.61	10.10	0.827	0.412
HbA1c (%)	8.13 ± 0.85	8.19 ± 0.96	0.07	0.285	0.777

Table 1 summarizes that the control and study groups were comparable with respect to post-prandial blood glucose and HbA1c levels, as the mean differences were small and the corresponding p-values were not statistically significant. However, fasting blood glucose differed significantly between the two groups, with the study group showing a lower mean value than the control group, and this difference was statistically significant at p = 0.000. Overall, the findings indicate that the intervention had a measurable effect on fasting blood glucose, while no significant between-group differences were observed for post-prandial blood glucose and HbA1c.

Frequency and Percentage Distribution of HbA1c Levels among Control and Study Group of Patients with Type 2 Diabetes Mellitus

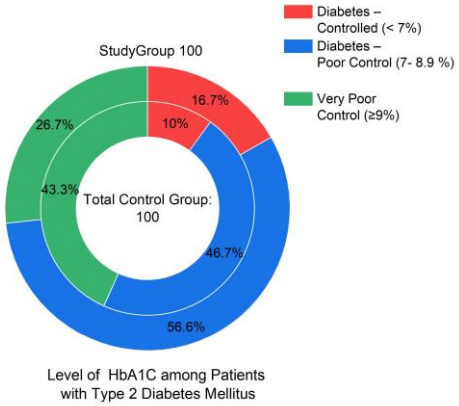

Fig. 4 Level of HbA1c among patients with Type 2 Diabetes Mellitus

Table 2. Level of HbA1C among Patients with Type 2 Diabetes Mellitus in Control and Study Group

Variable	Control Group (n=30)		Study Group (n=30)		Chi-square Value	df	P value
	f	%	f	%			
Diabetes – Controlled (< 7%)	3	10.0	5	16.7	1.981	2	0.371
Diabetes – Poor Control (7-8.9 %)	14	46.7	17	56.7			
Very Poor Control (≥9%)	13	43.3	8	26.7			

Table 2 indicates that the distribution of diabetes control status was broadly comparable between the control and study groups, with no statistically significant difference observed between the two groups. In the control group, 10.0% of participants had controlled diabetes, 46.7% had poor control, and 43.3% had very poor control, whereas in the study group, 16.7% had controlled diabetes, 56.7% had poor control, and 26.7% had very poor control. Although the study group showed a slightly higher proportion with controlled diabetes and a lower proportion with very poor control, the chi-square value of 1.981 with 2 degrees of freedom yielded a p value of 0.371, indicating that the difference was not statistically significant. Therefore, the two groups were homogeneous with respect to baseline diabetes control status, suggesting that they were comparable for further analysis.

Frequency and Percentage Distribution of 60-Second Diabetic Foot Screen Scores among Control and Study Group of Patients with Type 2 Diabetes Mellitus

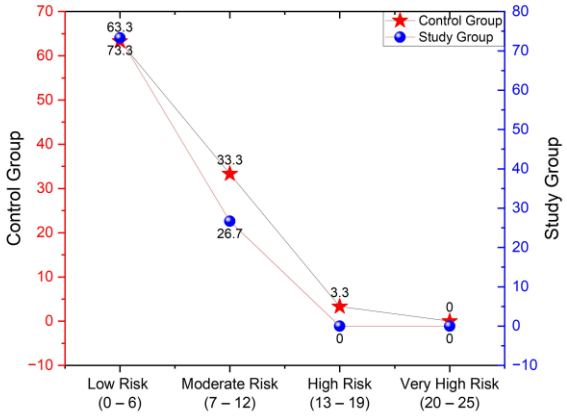

Fig. 5 Levels of 60-Second Diabetic Foot Screen Scores Patients with Type 2 Diabetes Mellitus

Table 3. Levels of 60-Second Diabetic Foot Screen score - Lower Extremity Perfusion among patients with Type 2 Diabetes Mellitus

Risk Category Score Range (per foot)	Recommended Screening Interval	Control Group (n=30) f(%)	Study Group (n=30) f(%)	Chi-square Value	df	P value
Low Risk (0 – 6)	Screen **yearly**	19 (63.3%)	22 (73.3%)	**1.442**	**2**	**0.486**
Moderate Risk (7 – 12)	Screen **every 6 months**	10 (33.3%)	8 (26.7%)			
High Risk (13 – 19)	Screen **every 3 months**	1 (3.3%)	0 (0.0%)			
Very High Risk (20 – 25)	Screen **every 1–3 months**	0 (0.0%)	0 (0.0%)			

The table shows that most participants in both the control and study groups belonged to the low-risk category, with 19 (63.3%) in the control group and 22 (73.3%) in the study group, followed by the moderate-risk category with 10 (33.3%) and 8 (26.7%), respectively. Only one participant (3.3%) in the control group was categorized as high risk, while no participants in either group fell into the very high-risk category, and the distribution did not differ significantly between groups, as indicated by the chi-square value of 1.442, df = 2, and p = 0.486. This suggests that the two groups were comparable at baseline in terms of risk categorization, which supports the homogeneity of the sample before intervention.

Comparison of Lower Extremity Perfusion (ABI and Foot Screen Scores) between Control and Study Group of Patients with Type 2 Diabetes Mellitus

Table 6. Comparison of Mean and SD of Lower Extremity Perfusion Between Control and Study Group of Patients with Type 2 Diabetes Mellitus

Variables	Control Group (n=30)	Study Group (n=30)	Mean D	Ind t value	P value
ABI (Ankle–Brachial Index)					
Assessment 1	0.731 ± 0.079	0.740 ± 0.083	-0.009	-0.422	0.674
Assessment 1I					
60-Second Diabetic Foot Screen score					
Assessment 1	5.80 ± 2.894	5.33 ± 1.826	0.467	0.747	0.458
Assessment 1I					

The table shows no statistically significant differences between the control and study groups for either measure at baseline; both variables demonstrated closely similar means and large p-values, indicating homogeneity between groups. In the Ankle–Brachial Index (ABI), the control group (n=30) had a mean of 0.731 (SD 0.079) and the study group (n=30) a mean of 0.740 (SD 0.083), with a mean difference of −0.009, an independent-samples t of −0.422 and p = 0.674, which indicates the groups did not differ on peripheral arterial perfusion at the measured timepoint. In the 60-second Diabetic Foot Screen score, the control group mean was 5.80 (SD 2.894) versus 5.33 (SD 1.826) in the study group, yielding a mean difference of 0.467, an independent-samples t of 0.747 and p = 0.458, likewise showing no statistically significant difference in neuropathic/foot-risk screening between groups at that assessment. Together these results support that the two groups were comparable with respect to peripheral vascular status and diabetic foot risk before the intervention (or at the reported assessment), satisfying the assumption of baseline equivalence for subsequent between-group comparisons.

Correlation between HbA1c, Lower Extremity Perfusion and Knowledge in Control and Study Group of Patients with Type 2 Diabetes Mellitus (Pre and Post Tests)

Table 7. Correlation Between HBA1c, Lower Extremity Perfusion and Knowledge in Study Group of Patients with Type 2 Diabetes Mellitus in Pretest and Posttest

Variables	Test values	HbA1c	ABI (Ankle–Brachial Index)	Diabetic Foot Screen score	Knowledge
HbA1c	r value	1			
	p value	–			
ABI (Ankle–Brachial Index)	r value	.210	1		
	p value	.266	–		
Diabetic Foot Screen score	r value	.123	.061	1	
	p value	.517	.749	–	
Knowledge	r value	–.087	–.122	.087	1
	p value	.648	.522	.648	–

The correlation analysis revealed no significant association between HbA1c and ABI (r = .210, p = .266), HbA1c and Diabetic Foot Screen score (r = .123, p = .517), HbA1c and Knowledge (r = -.087, p = .648), ABI and Diabetic Foot Screen score (r = .061, p = .749), ABI and Knowledge (r = -.122, p = .522), or Diabetic Foot Screen score and Knowledge (r = .087, p = .648), suggesting that glycemic status, ankle-brachial index, diabetic foot screening status, and knowledge level were not significantly correlated in the study group.

Variables	**Test values**	**HbA1c**	**ABI (Ankle–Brachial Index)**	**Foot Screen score**	**Knowledge**
HbA1c	r value	1			
	p value				
ABI (Ankle–Brachial Index)	r value	.382*	1		
	p value	.037			
60-Second Diabetic Foot Screen score	r value	-.238	.373*	1	
	p value	.205	.042		
Knowledge	r value	.078	.029	-.203	1
	p value	.684	.879	.283	

The above table shows a significant positive relationship between HbA1c and ABI, indicating that higher HbA1c levels were associated with higher ABI values in this sample. The 60-Second Diabetic Foot Screen score had a weak negative correlation with HbA1c and a moderate positive correlation with ABI, but these associations were not statistically significant. Knowledge also showed very weak, non-significant correlations with HbA1c, ABI, and foot screen score, suggesting that knowledge was not meaningfully related to these study variables in the present data. The correlation analysis revealed a significant positive association between HbA1c and ABI, whereas the 60-Second Diabetic Foot Screen score and knowledge were not significantly correlated with HbA1c, ABI, or each other. This indicates that only the relationship between glycemic status and ankle-brachial index reached statistical significance, while the remaining variables demonstrated weak and non-significant associations.

4. Discussion

The LIFE program significantly improved knowledge and lower-extremity perfusion in patients with Type 2 diabetes, supporting targeted lifestyle and foot–ankle exercise interventions as feasible nursing strategies to reduce ischemic risk [7]. Participants in the experimental group showed greater gains in ABI/perfusion measures than controls, consistent with randomized trials and systematic reviews that report small-to-moderate ABI improvements after structured lower-limb exercise or Buerger–Allen-type protocols in people with diabetes. Such physiological gains likely reflect enhanced calf-muscle pump activity, microvascular recruitment, and improved endothelial function reported in exercise studies, mechanisms that our results align with clinically [8]. Our education-plus-exercise model produced changes comparable to recent home-based foot–ankle programs and multi-modal physical-therapy trials that reported ABI increases (mean differences ~0.12–0.15) and improved Doppler flow after weeks to months of supervised or home exercise. Where trials showed reductions in ulcer recurrence or neuropathy progression, ABI effects were variable, indicating that exercise most reliably improves perfusion metrics but not always macrovascular endpoints—matching our observation of measurable perfusion improvement without large changes in systemic biomarkers [9].

Strengths include a clinically relevant sample with impaired perfusion, a practical nursing-delivered LIFE intervention, and repeated post-tests to assess short-term retention. Limitations are non-randomized allocation, purposive sampling, and limited follow-up—factors that constrain causal inference and long-term generalizability; these are similar limitations noted in several quasi-experimental and pragmatic trials of foot exercises [10]. Findings support integrating structured, nurse-led foot and lifestyle education with simple lower-limb exercise into routine diabetes care to improve peripheral perfusion and potentially reduce ulcer risk; however, larger randomized trials with longer follow-up are needed to confirm effects on ulcer incidence, functional outcomes, and vascular events. Future studies should also measure adherence, cost-effectiveness, and mechanisms (microvascular vs macrovascular) to guide scalable implementation [7].

5. Conclusion

This study concluded that the LIFE program was effective in improving knowledge and lower-extremity perfusion among patients with Type 2 diabetes mellitus. The findings suggest that a structured lifestyle-based intervention, when delivered in a nursing care setting, can positively influence both awareness and peripheral vascular status, which are important for preventing diabetic foot complications and promoting early self-care. The intervention group showed better post-test outcomes than the control group, indicating that education combined with guided activity can produce meaningful short-term benefits. These results support the role of nurses in implementing simple, practical, and patient-friendly interventions for people with impaired lower-extremity perfusion. Overall, the study highlights the value of integrating lifestyle modification, health education, and routine perfusion assessment into diabetes management. The LIFE program can be considered a useful adjunct to standard care, especially in hospital and community settings where prevention of vascular complications is a priority. Future studies with larger samples, randomization, and longer follow-up are recommended to confirm the durability of these effects and their impact on clinical outcomes.

Conflict of Interest: The authors certify that they have no involvement in any organization or entity with any financial or non-financial interest in the subject matter or materials discussed in this paper.

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