

Effectiveness Diabetic Foot Exercises with Video in Reducing Risk of Diabetic Foot Ulcer in Patients with Diabetes Mellitus Type 2

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Abstract

Type 2 diabetes is a chronic metabolic disorder characterized by elevated blood glucose due to impaired glucose uptake or insulin production. This condition can lead to complications, namely diabetic foot ulcers. Handling diabetic foot wounds can be done by doing activities such as foot exercises. This study aims to determine the effectiveness of diabetic foot exercises using video in reducing the risk of foot wounds in patients with type 2 DM. The research method was quasi-experiment with pretest-posttest with control group. Sampling using purposive sampling technique. A total of 64 participants were enrolled and divided into an intervention group (n = 32) and a control group (n = 32); the intervention group performed diabetic foot exercises using video guidance for 3 weeks, three times per week, with a duration of 10 minutes per session. Measurements were made with ABI and monofilament test before and after intervention. The data analysis used was the Independent T-Test test. The was that the Monofilament of the right foot and left foot has a P-Value of 0.001 as well as the ABI value data on the right foot has a P-Value of 0.002 and the left foot P-Value of 0.001. Diabetic foot exercises with video media are proven to be effective in reducing the risk of diabetic foot wounds in patients with type 2 diabetes mellitus. For future research, we recommend a longer study duration to allow for a larger sample size and the analysis of additional relevant variables..

Keywords: Diabetic foot exercise, Diabetes Mellitus Type 2, Video, Risk of diabetic foot ulcer

Introduction

Sleep is an essential human requirement. Diabetes Mellitus (DM) is a metabolic disorder characterized by uncontrolled increases in blood glucose due to impaired glucose absorption into cells (LeMone et al., 2016). American Diabetes Association (2021) defined DM as a chronic metabolic disease resulting in hyperglycemia due to issues with insulin release, absorption, or both. DM is a leading cause of global mortality, ranking as the 9th highest worldwide with 1.5 million deaths annually due to complications. The global prevalence of DM in 2023 was 6.42% and is projected to rise to 10.8% by 2030 (World Health Organization, 2024). WHO reported that over 529 million people worldwide suffer from DM, with the majority being Type 2, and this figure is predicted to reach 783.7 million by 2045. Indonesia ranks 7th globally with over 19.5 million DM sufferers, 90% (17.5 million) of whom have Type 2 DM. Provinces with the highest prevalence of Type 2 DM include DKI Jakarta (3.1%), DI Yogyakarta (2.9%), Kalimantan Timur (2.3%), Banten (1.9%), and Jawa Barat (1.7%) (Kementerian Kesehatan Republik Indonesia, 2023). In the last 5 years (2019-2023), 828,616 cases were recorded. Cities in West Java with the most Type 2 DM patients are Bandung, Depok, Bekasi, Cirebon, and Bogor (Dinas Kesehatan Provinsi Jawa Barat, 2024).

International Diabetes Federation (2020) stated that DM patients frequently experience hyperglycemia, nephropathy, and diabetic neuropathy. Diabetic neuropathy, particularly in the lower extremities, leads to nerve damage that can cause pain, tingling, or loss of sensation. This condition can prevent patients from noticing minor foot injuries, which can then become breeding grounds for bacteria.

Diabetic foot wounds are influenced by numerous factors such as ill-fitting footwear pressure, poor skin quality, inadequate foot care, and lack of physical activity. Insufficient activity can lead to glucose accumulation in the extremities, impairing peripheral blood vessels in the feet and triggering neuropathy (Wang et al., 2022).

To mitigate the risk of diabetic foot

wounds, it is crucial to control blood sugar and engage in regular physical activity to improve blood circulation and foot sensitivity (Yang et al., 2019). Physical activities like aerobics, gym workouts, and general exercises are highly effective in lowering blood sugar in Type 2 DM patients, thereby preventing complications such as neuropathy, peripheral artery disease, and diabetic foot wounds (Amanat et al., 2020). Previous studies demonstrated that foot exercises can improve the status of peripheral blood vessels in DM patients by 70-80%, significantly reducing the risk of diabetic foot wounds (Embuai et al., 2019). Diabetic foot exercises involve physical movements of the foot joints and muscles. The recommended frequency for diabetic foot exercises is 3-5 times per week, performed regularly, controllably, measurably, and continuously, to lower the risk of diabetic wounds (Erlina et al., 2022).

Previous studies indicated that diabetic foot exercises can alleviate neuropathy symptoms like tingling and numbness by improving blood circulation and strengthening foot muscles (Wang et al., 2022). Existing evidence found that foot exercises using audio-visual media for 4 weeks, three times a week, enhanced blood circulation, as evidenced by an increase in ABI (Ankle-Brachial Index) (Wang et al., 2022).

Prior research also showed that video-based health education and demonstrations were effective in improving respondents' knowledge and ability to perform foot exercises, as video media with visual demonstrations helped respondents focus better and absorb information more easily (Ambarwati et al., 2023).

A preliminary study conducted at Puskesmas Sindang Barang in West Bogor sub-district revealed that out of approximately 1138 DM patients in 2024, there were existing exercise groups for seniors, cardiac patients, and pregnant women, but diabetic foot exercises had never been implemented, nor was there any video media specifically for diabetic foot exercises. Previous research had only utilized video media to assess knowledge and ability to perform foot exercises. Therefore, this study aims to assess the extent to which diabetic foot exercises delivered through video-based

media can reduce the risk of diabetic foot ulcers among patients with Type 2 diabetes mellitus, highlighting the novel focus on the magnitude of risk reduction achieved through video-guided exercise.

Research Methodology

Study Design

This study employed a quasi-experimental research design utilizing a pre-posttest with a control group. The study population comprised patients diagnosed with Type 2 Diabetes Mellitus. Purposive sampling technique was used for sample collection. The inclusion criteria were: patients diagnosed with Type 2 diabetes mellitus in adulthood, pre-elderly, and elderly age groups and willingness to participate in the study.

The exclusion criteria were: patients with existing diabetic foot ulcers; patients experiencing severe shortness of breath; patients with severe depression; and patients with visual or hearing impairments, or those unable to read and write. Sample size calculation, based on Isaac and Michael's formula, resulted in a total of 64 respondents. These respondents were subsequently divided into two groups: an intervention group consisting of 32 respondents and a control group also with 32 respondents. Data collection was conducted between February and April 2025 at Puskesmas Sindang Barang, Bogor City.

Research Instruments and Procedures

The research instruments included a video of diabetic foot exercises detailing the step-by-step movements, the Simplified 60-Second Diabetic Screening Tool questionnaire, and an observation sheet for diabetic foot ulcer risk which recorded ABI and monofilament test values. The research implementation stages were as follows:

1. Screening for foot ulcer risk was performed on all respondents using The Simplified 60-Second Diabetic Screening Tool.
2. Initial data collection for the control group was conducted over 3 weeks, involving pre-test and post-test assessments. In this

group, the researcher did not provide the diabetic foot exercise intervention using video media.

3. The control group underwent a pre-test with monofilament and ABI measurements in the first meeting of Week 1. Subsequently, an evaluation was conducted with a post-test involving ABI and monofilament examinations in Week 3. After data collection, the control group received verbal education related to diabetes mellitus management.
4. Following data collection from the control group, the researcher proceeded with data collection for the intervention group. In the intervention group, the researcher conducted pre-test ABI and monofilament examinations before the commencement of the video-based diabetic foot exercises.
5. Subsequently, respondents in the intervention group performed diabetic foot exercises at a frequency of three times a week for a duration of three weeks. Respondents followed the exercise movements demonstrated in the video.
6. Upon completion of the three-week exercise period, a post-test assessment was conducted, including ABI and monofilament measurements

Data Analysis and Ethical Clearance

Data normality was assessed using the Kolmogorov–Smirnov test, and all variables showed p-values > 0.05 , indicating normal distribution. Homogeneity testing also showed p-values > 0.05 for most variables, confirming variance homogeneity. Therefore, parametric tests (Paired t-test and Independent t-test) were used for hypothesis testing. The Paired T-test was used to assess the relationship between pre-test and post-test values within each group, while the Independent T-test was employed to determine the difference in mean values between the control and intervention groups (Sutriyawan et al., 2023). This research underwent an ethical feasibility test at Poltekkes Kemenkes Tanjung Karang, resulting in an ethical clearance decision. The issuance of Letter No. 23/KEPK-TJK/II/2025 validated the ethical conduct and feasibility of this research.

Results

The demographics of the Type 2 Diabetes Mellitus respondents are detailed in Table 1 below. The results indicate that the majority of participants in the control group were elderly (≥60 years old), comprising 62.5% of that group. Conversely, in the intervention group, most respondents fell into the pre-elderly age category, accounting for 53.1%, followed by 46.9% in the elderly category. Regarding gender, the predominant demographic in both

groups was female, with 78.1% in the control group and 87.5% in the intervention group. In terms of random blood glucose levels, respondents with values of ≤200 mg/dL were prevalent in both cohorts, representing 84.4% of the control group and 81.2% of the intervention group. Furthermore, concerning the duration of Type 2 Diabetes Mellitus, the majority of respondents in both groups had suffered from diabetes for ≤5 years, specifically 87.5% in the control group and 93.8% in the intervention group (Table 1).

Table 1. Demographics of type 2 diabetes mellitus respondents

Variable	Control (f (%))	Intervention (f (%))
Age		
Adult: 19-44 years old	3 (9,4%)	0 (0%)
Pre-elderly: 45-59 years old	9 (28,1%)	17 (53,1%)
Elderly: 60 years and above	20 (62,5%)	15 (46,9%)
Gender		
Female	25 (78,1%)	28 (87,5%)
Male	7 (21,9%)	4 (12,5%)
Blood glucose		
≤ 200 mg/dL	27 (84,4%)	26 (81,2%)
>200 mg/dL	5 (15,6%)	6 (18,8%)
Duration of type 2 DM		
≤ 5 years	28 (87,5%)	30 (93,8%)
>5 years	4 (12,5%)	2 (6,2%)

The results presented in Table 2 for the control group indicate no significant average difference between pre- and post-intervention measurements for both monofilament and ABI values. Specifically, the monofilament test for the right foot showed a P-value of 0.325, and for the left foot, a P-value of

0.601. Similarly, the ABI values were 0.070 for the right foot and 0.672 for the left foot. Since all P-values are greater than 0.05, these findings suggest that there was no statistically significant change in monofilament sensation or peripheral arterial circulation within the control group over the study period (Table 2).

Table 2. Paired T-Test Outcomes for the Control Group (n=32)

Variable		Paired Sampel T Test	
		Mean ± Std	P-Value
Monofilament right foot	Pre	2,9 ± 1,4224	0,325
	Post	2,8 ± 1,3854	
Monofilament left foot	Pre	3,0 ± 1,4477	0,601
	Post	2,9 ± 1,3072	
ABI right foot	Pre	0,99 ± 0,1241	0,070
	Post	0,97 ± 0,0857	
ABI left foot	Pre	0,95 ± 0,0702	0,672
	Post	0,95 ± 0,0714	

Table 3 presents the results of the Paired T-Test conducted on the intervention group.

The findings indicate a highly significant change, with a P-value of 0.000 for both

the right and left foot monofilament tests. Similarly, the ABI values for both the right and left foot also yielded a P-value of 0.000. These results, where all P-values are less than 0.05, demonstrate a statistically significant

average difference between the pre- and post-intervention ABI and monofilament values, indicating a substantial improvement after the intervention (Table 3).

Table 3. Paired T-Test Outcomes for the Intervention Group (n-32)

Variable		Paired Sampel T Test	
		Mean ± Std	P-Value
Monofilament right foot	Pre	3,4 ± 1,6822	0,000*
	Post	7,7 ± 1,5290	
Monofilament left foot	Pre	3,4 ± 1,5850	0,000*
	Post	7,7 ± 1,5290	
ABI right foot	Pre	0,92 ± 0,0396	0,000*
	Post	1,02 ± 0,0382	
ABI left foot	Pre	0,95 ± 0,0702	0,000*
	Post	1,03 ± 0,0686	

Table 4 further illustrates the effectiveness of the intervention. For the monofilament test, the right foot showed a P-value of 0.000 and the left foot also had a P-value of 0.000. Correspondingly, the ABI values were 0.002 for the right foot and 0.000 for the left foot.

These results, with all P-values being less than 0.05, conclusively demonstrate that diabetic foot exercises utilizing video media are proven effective in reducing the risk of diabetic foot wounds in patients with Type 2 Diabetes Mellitus (Table 4).

Table 4. Independent T-Tes Outcome for comparison between intervention and control groups

Variable	Sample (n=64)	Paired Sampel T Test		
		Mean	Std	P-Value
Monofilament right foot	Control	2,8750	1,38540	0,000*
	Intervention	7,7187	1,52895	
Monofilament left foot	Control	2,9687	1,30716	0,000*
	Intervention	7,7187	1,52895	
ABI right foot	Control	0,9712	0,08574	0,002*
	Intervention	1,0250	0,03827	
ABI left foot	Control	0,9584	0,07144	0,000*
	Intervention	1,0380	0,06860	

Discussion

Characteristics of Respondents with Diabetes Mellitus at Risk of Diabetic Foot Ulcers

The research findings on respondent characteristics, specifically age, indicate that the majority of both control and intervention groups comprised elderly individuals (aged 60 years and above). This phenomenon is attributed to suggests that individuals over 60 years old or the elderly are at higher risk for diabetes mellitus complications, including diabetic foot ulcers. This is attributed to the

physiological decline in body function due to degenerative processes at this age, leading to reduced insulin secretion or increased insulin resistance, thereby suboptimal control of high blood glucose levels (Detty et al., 2020; Rubio et al., 2020)

Regarding gender characteristics, the majority of respondents were female. While women typically have estrogen during their fertile years, which can delay the onset of diabetes and its complications, the loss of estrogen after menopause significantly increases the risk of diabetes and its complications, such as diabetic ulcers, sometimes even surpassing the risk in men

of the same age (Ciarambino et al., 2022; Jalilian et al., 2020)

The study also examined the duration of Type 2 Diabetes Mellitus in relation to diabetic foot ulcer risk, categorizing it into ≤ 5 years and > 5 years. The majority of respondents in both groups had suffered from DM for ≤ 5 years. This finding is consistent with research by Dasong et al. (2019), which posits that the duration of DM is a significant risk factor for diabetic ulcers. Patients with diabetes for more than one year have an eight-fold higher risk of developing diabetic ulcers compared to those with recent onset.

Furthermore, the majority of Type 2 Diabetes Mellitus patients at risk of diabetic foot ulcers exhibited random blood glucose levels below 200 mg/dL. This aligns with studies by Wang et al (2022), which emphasize that persistently high blood glucose levels increase the risk of diabetic foot ulcers due to associated nerve and blood vessel damage.

Comparison of Changes in Diabetic Foot Ulcer Risk in Intervention and Control Groups Before and After Video-Based Diabetic Foot Exercise Intervention

The Paired T-test results for the control group, presented in Table 2, showed no significant changes in either monofilament sensation or ABI scores. Specifically, the monofilament score for the right foot had a P-value of 0.325, and for the left foot, a P-value of 0.601. Similarly, the ABI value for the right foot had a P-value of 0.070, and for the left foot, a P-value of 0.672. Since all P-values were > 0.05 , this indicates no statistically significant mean difference between pre- and post-intervention monofilament and ABI values in the control group.

In contrast, the intervention group, which performed video-based diabetic foot exercises, demonstrated significant pre-post intervention changes across all measured parameters. Monofilament sensitivity assessment of the right foot yielded a P-value of 0.000, indicating a highly significant improvement. A similar significant change with P-value = 0.000 was observed for the left foot. This finding is consistent with research by Brahmantia et al (2020) which reported changes in foot sensitivity after diabetic foot

exercise intervention with P-value = 0.001. Furthermore, this aligns with the study by Simamora et al (2020), where a reduction in diabetic neuropathy scores with P-value = 0.001 was observed following foot exercises. This can be attributed to regular foot exercises enhancing blood circulation, thereby improving ABI values and consequently improving nerve vascularization in the feet, which in turn enhances foot sensitivity. Optimal blood circulation, facilitated by diabetic foot exercises, delivers oxygen and nutrients to nerve tissues, thereby influencing optimal nerve cell function in DM patients and maintaining foot sensitivity.

Analysis of the Effectiveness of Diabetic Foot Exercises in Reducing the Risk of Diabetic Foot Ulcers in Patients with Type 2 Diabetes Mellitus

The effectiveness analysis of video-based diabetic foot exercises in reducing the risk of diabetic foot ulcers in Type 2 Diabetes Mellitus patients revealed significant improvements. A P-value of 0.000 was observed for both the right and left foot monofilament tests. These results P-value < 0.05 indicate a significant average change in pre-post foot sensitivity following the intervention. Furthermore, the ABI values also demonstrated significant improvement, with a P-value of 0.002 for the right foot and 0.000 for the left foot. These P-values < 0.05 signify a statistically significant average change in pre-post ABI values within the intervention group after engaging in video-based diabetic foot exercises.

These findings are consistent with Rahman et al (2021), who reported a significant influence of foot exercises on foot sensitivity in Type 2 diabetes patients P-value = 0.000. Another study by Heidari et al (2021) similarly found a significant increase in foot sensitivity scores in diabetic patients after exercise intervention P-value = 0.002, indicating substantial improvement in sensitivity and reduction in diabetic neuropathy.

Generally, Type 2 Diabetes Mellitus patients tend to experience changes in capillary elasticity, thickening of blood vessel walls, and the formation of plaques or thrombi due to hyperglycemia, leading to

impaired peripheral vascularization. This condition results in nerve cells in the foot area not receiving adequate circulation and nutrition, culminating in ischemia (Rossboth et al., 2021).

Following foot exercises, an improvement in blood circulation occurs. Muscle contractions, particularly calf pumping, enhance venous tone, increasing venous return to the right atrium, which in turn boosts right ventricular volume and cardiac output. This process induces vasodilation in the foot arteries. Increased vasodilation allows for greater blood flow to the muscles and, importantly, the nerves, ensuring optimal nutrient and blood supply. This enhanced vasodilation leads to the opening of more peripheral blood channels in the foot, resulting in complete revascularization of peripheral nerves. When nerves are adequately vascularized, nerve cells can function more effectively (Wiaro, 2021).

Based on the research results, an improvement in ABI values was observed in Type 2 Diabetes Mellitus patients. This is corroborated by Puryanti et al (2023), whose study showed that foot exercises in diabetic patients improved peripheral vascularization, evidenced by improved ABI values and P-values of 0.000 for the right foot and 0.002 for the left foot.

A prior study on diabetic foot exercises demonstrated a significant improvement in ABI values, with a P-value of 0.001 ($P < 0.05$), indicating a substantial change in mean pre-post ABI scores after the intervention (Trisna & Musiana, 2018).

This improvement is attributed to the routine practice of foot exercises, which enhances blood circulation, particularly in the lower extremities. Calf muscle (gastrocnemius and soleus) contractions are crucial for ankle movement. Individuals with reduced ankle mobility should perform these exercises to strengthen calf muscles and enhance calf pumping. This calf pumping is expected to facilitate venous return, positively impacting foot blood pressure. Furthermore, as muscle contraction increases, the muscle pump effect improves venous tone, augmenting venous return to the right atrium, leading to increased right ventricular volume and cardiac output. This cascade results in arterial vasodilation

in the foot. Vasodilation allows for increased blood flow to the muscles and improves ABI values. Other research indicates that during exercise, muscles become more active and responsive. Exercise movements can enhance the flexibility of foot muscles, joints, and ligaments, while also promoting more active venous blood return to the heart, thereby improving blood circulation in the feet and influencing blood pressure (Ramadhan et al., 2021).

This aligns with the current study's findings, which demonstrate a reduced risk of diabetic foot ulcers, evidenced by improved ABI values and enhanced foot sensitivity in Type 2 Diabetes Mellitus patients. In Type 2 Diabetes Mellitus patients (Nuriya & Taufik, 2022).

Conclusion

This study assessed diabetic foot ulcer risk using monofilament and ankle-brachial index (ABI) indicators rather than actual ulcer occurrence. In the control group, no significant pre-post differences were found in monofilament scores (right foot $p = 0.325$; left foot $p = 0.601$) or ABI values (right foot $p = 0.070$; left foot $p = 0.672$). In contrast, the intervention group showed significant pre-post improvements in both monofilament and ABI measurements for both feet (all $p < 0.05$), indicating improved foot sensitivity and peripheral circulation after the video-based diabetic foot exercise program. These results confirm that video-guided diabetic foot exercises effectively reduce the risk of diabetic foot ulcers as measured by monofilament and ABI indicators in patients with Type 2 diabetes mellitus.

This study has several limitations that should be considered. Some eligible participants refused to take part in the study, which prolonged the recruitment process. In addition, the schedule of the diabetic foot exercise sessions was not strictly standardized to specific days, which may have affected intervention consistency. The study was also conducted within a relatively short time frame, resulting in a limited sample size and restricted number of variables analyzed. Based on the completion of this research, the investigator puts forward the following

recommendations, derived from observations discussed herein. It is advised that future studies on this topic be conducted with a longer duration to facilitate the recruitment of a larger sample size. This extended timeframe would additionally permit the analysis of further relevant variables, such as quality of life, patient knowledge levels, and treatment adherence, thus ensuring more comprehensive research outcomes and a holistic understanding of the impact of diabetic foot exercises.

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