

(REVIEW ARTICLE)



Application of diabetic foot exercises in diabetic mellitus patients: A systematic review

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Open Access Research Journal of Science and Technology, 2024, 12(01), 010–017

Publication history: Received on 16 July 2024; revised on 26 August 2024; accepted on 29 August 2024

Article DOI: <https://doi.org/10.53022/oarjst.2024.12.1.0111>

Abstract

A complication of diabetes that often occurs in the legs is diabetic foot with ulcers, which will reduce the quality of life, increase morbidity and mortality. Diabetic mellitus patients have a 15-20% risk of developing diabetic foot ulcers in 5 years with a recurrence rate of 50-70%, and 85% will undergo amputation. Self management that can be applied is with foot gymnastics. This foot exercise has many benefits for both patients who have neuropathy and those who have not experienced it. Among them can strengthen small muscles, calf muscles, and thigh muscles, as well as overcome joint mobility limitations that are often experienced by DM sufferers. This review aims to find out the benefits of applying foot exercises to patients with type 2 diabetes mellitus. The research method used is systematic review. Literature is searched through Google Scholar, PubMed, and sciencedirect databases. A total of 88 articles were obtained and then selected through the stages of title, abstract, keywords and advanced selection in the full text. The results of the selection were obtained 4 articles that met the set criteria. Survey reporting uses the Optional Reporting Items for Systematic and Meta-Analysis (PRISMA) reviews. Based on the systematic review that has been carried out, effective results were obtained in the application of foot exercises in patients with type 2 diabetes mellitus.

Keywords: Diabetes Mellitus Type 2; Foot Exercises; Literature Study; Diabetic Ulcer

1. Introduction

Diabetes mellitus is a condition in which the body cannot produce the hormone insulin according to the body's needs or the body cannot optimally utilize the insulin produced. In this case, there is a spike in blood sugar levels that exceed normal [1]. Diabetes Mellitus is a disease that causes premature death, and is the leading cause of blindness, heart disease, and kidney failure in the world with its prevalence increasing. This disease can be said to be a chronic disease because it can occur chronically. And this diabetes is a disease that can kill a person slowly and silently so that diabetes mellitus is called a "silent killer" [2].

According to data from the International Diabetes Federation (IDF) in 2017 [3], the prevalence of diabetes mellitus in the world reached 424.9 million people and is expected to reach 628.6 million by 2045, the prevalence of diabetes mellitus in Indonesia ranks third in Southeast Asia with a prevalence of 11.3% [4]. Based on Riskesdas (2018), the prevalence of diabetes mellitus based on doctor's diagnosis in people of all ages and ≥ 15 years in Central Java Province is above the prevalence of DM nationally. Almost all provinces have increased from 2013. Diabetes mellitus is one of the top priorities for NCD control. The proportion of new DM cases reached 13.4%. If this disease is not managed properly, it will cause advanced diseases [5], [6]. Based on recapitulation data in 2023 at the Bulu Health Center, Sukoharjo there are 733 people with diabetes mellitus, and data in 2024 in January-May there are a total of 255 people with diabetes mellitus.

A complication of diabetes that often occurs in the legs is diabetic foot with ulcers, which will reduce the quality of life, increase morbidity and mortality. Diabetic mellitus patients have a 15-20% risk of developing diabetic foot ulcers in 5

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years with a recurrence rate of 50-70%, and 85% will undergo amputation. To minimize the complications of DM in the legs, it is necessary to be given management as early as possible (PERKENI, 2019). The risk of diabetic foot injuries can be prevented by early detection, but it is often less of a concern from the caregiver due to time constraints, where treatment focuses more on the care of other body systems that are considered more important [7].

Exercise is one of the most important treatment methods besides diabetes mellitus treatment. Several studies have shown that physical exercise is an important non-pharmacological intervention in the management of patients with diabetes mellitus. Among the various forms of physical exercise, foot gymnastics is the most accepted form of exercise by DM2 patients due to its low cost, safety profile, and comfort [8]. Self-care for diabetics, as defined by the ADA, is the process of imparting diabetes knowledge and skills to individuals that are necessary for self-care, crisis management, and lifestyle changes [9], one of the *self-management* that can be applied is with foot exercises. This foot exercise has many benefits for both patients who have neuropathy and those who have not experienced it. Among them can strengthen small muscles, calf muscles, and thigh muscles, as well as overcome joint mobility limitations that are often experienced by DM sufferers. Diabetic foot exercises are activities that are carried out to improve blood circulation, strengthen small muscles and prevent injuries to the legs. The effects of foot exercises can prevent injuries and help improve blood circulation in the legs [10].

Meanwhile, based on data recorded at the Bulu Health Center, it is known that diabetes mellitus is also one of the diseases that ranks fourth in the list of the top 10 most diseases. In the results of data collection from 13,054 people, there were 733 people who had a history of diabetes mellitus. Based on observations and interviews with the elderly in Bulu District, Sukoharjo Regency, there are several families experiencing symptoms of diabetes mellitus, one of which is feeling often tingling in the legs and often sciatica in the legs. It is said that most families who experience these symptoms are because they often do not wear footwear when outside the house, especially in the elderly. Based on these problems, from the description above, the author delves deeper into the case of Diabetes Mellitus as a follow-up action, so that it can implement nursing care properly and raise a final report with the title "Application of Diabetic Foot Exercises in Families with Diabetes Mellitus Patients".

2. Method

The research method used was a systematic review using the PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analysis) reporting guidelines regarding foot exercise therapy in patients with type 2 diabetes mellitus. The literature search was carried out in May – June 2024. Some of the steps taken in this study are: 1) determining eligibility criteria, 2) determining information sources, 3) selection of studies, 4) data collection process, 5) selection of data items.

The data used in this study is secondary data obtained not from direct observation, but obtained from the results of research that has been carried out by previous researchers. Article and journal searches use keywords that are used to expand or define the search, making it easier to determine which article or journal to use

2.1. Eligibility criteria

The eligibility criteria consist of inclusion criteria and exclusion criteria. The inclusion criteria were set as review guidelines, namely:

1. Journals published in 2018-2024,
2. Journals using english or indonesian,
3. Research that discusses foot exercises to lower blood glucose in people with diabetes mellitus
4. Full text is available. Meanwhile, the exception criteria for selecting this article are articles published before 2018.

2.2. Resources

The articles used in this study were obtained from online database sources from PubMed (20 articles), Google Scholar (63 articles), Science Direct (5 articles). Articles that are not in full text will be omitted by the author. In addition, the researcher also adapted the article to the research questions that had been made.

2.3. Study selection

The selection of studies is carried out in three stages, namely:

1. Keywords used in article searches include: PubMed database "((Foot diabetes) AND (Preventive care) AND (Foot-related exercise) AND (Foot exercise))", Google Scholar "foot exercises to lower sugar levels in diabetics", Science Direct (Type 2 diabetes; Glycemia; Blood glucose; Practice;).
2. Article selection uses the publication year filter, i.e. 2020-2024
3. The selection of articles is based on abstract content, titles and keywords in the article about foot exercises to lower blood glucose in people with diabetes mellitus.
4. Articles that have been selected based on title, abstract, and other inclusion criteria will then be critically analyzed using the CONSORT instrument to determine the eligibility of the article.
5. Articles that were completely or partially removed in the previous review process will be carried out to determine whether the article should be included in the review or deleted according to the set criteria.

2.4. Data collection process

Data collection is carried out manually, consisting of article type, article title, year of publication, method. Collection of articles by reading data through full text. The article obtained is assessed by the researcher whether the article is relevant or not.

3. Results

3.1. Study Selection

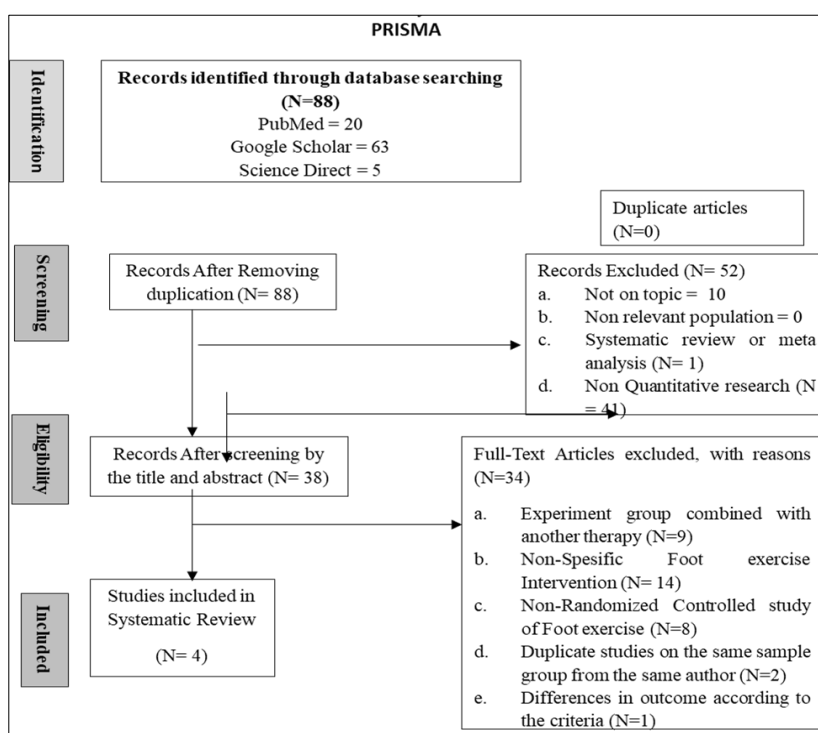


Figure 1 Results of the Systematic Review

The results of the article selection were obtained with a total of relevant articles in accordance with the criteria that have been set, namely as many as 4 articles from 2018 to 2024. In the first stage, the author obtained 88 articles according to the set criteria. After that, the researcher reviewed the search results by adjusting the title, abstract and keywords, and obtained 38 articles that met the criteria, as many as 50 articles did not meet the criteria. Of the 38 articles that have been reviewed by the author from the abstract, then the author reviews by looking at the full text and there are only 4 articles that are suitable and 34 articles that are not in accordance with the eligibility that has been determined. After the review process carried out by the author, as many as 4 articles were obtained in this study.

3.2. Characteristic Study

A total of 4 articles found from several online databases obtained results that have been adjusted to the criteria that have been set are illustrated in the following table.

Table 1 Journal Analysis Results

Author	Year	Participant	Participant Age	Instrument	Hasil validitas instrumen	Study design	Intervensi	Detail Topic and Activity (week)
Rahmawati, et al. 2023 [11]	2023	I: 10 C: 10		The instrument in this study is a blood glucose level research observation sheet		RCT	Foot exercises	This study used two groups, namely the intervention group and the control group, where the intervention group was given Diabetic Foot Exercises by consuming medication and the control group only consumed medication
Silva, et al. 2018 [12]	2018	I: 21 C: 24	be 18 years of age or older who have been diagnosed with type 2 diabetes for at least 5 years	Portable glucose meter, infrared thermography camera, and the baropodometer evaluates the variable	GPower 3.0.10 statistical software (Franz Faut, Universität Kiel, Kiel, Germany) is used, with a power effect of 0.80 and an effect size of 0.68 ($\alpha = 0.05$)	RCT	Foot Reflexology	Three therapy sessions per week are provided, which totals 12 sessions over a 30-day period. These sessions take place systematically and scheduled in advance, on designated days and at designated times, in an attempt to reduce the possibility of distractions caused by daily routines. The therapy is applied in bed, with the participant remaining in a supine position and with the head resting on a pillow throughout the session. The app follows the principles set forth by Eunice Ingham, the first reflexologist who mapped the foot pressure points and their corresponding effects on the rest of the organism. To maintain uniformity and standardization of the technique, the left foot is massaged first, followed by the right foot, stimulating the pressure points according to a predetermined order: joints, lateral sections, medial sections, and plantar surfaces.
Kumar, et al. 2024[13]	2024	I: 80 C: 80	aged between 30-65 years with type 2 diabetes mellitus	Fasting Insulin Levels, Homa-IR, Six-minute walking test (6MWT), WHOQOL-BRIEF Questions	(Cron- bach's $\alpha = 0.73-0.81$ GPAQ (Cronbach's $\alpha = 0.83-0.96$).	RCT	Training Program	Participants underwent a 12-week intervention consisting of an individualized and structured exercise program The first week to the 6th week participants underwent a supervised structured exercise program in a hospital setting (10-minute warm-up session, minimum 20-minute walk on the treadmill, 10-minute cool-down period). All exercises were performed on a scale of 4-6 out of 10 on the perceived exertion rating (RPE) scale.

				Concentrations GPAQ				Walking, initially starting at 30-45 minutes per session, At the six-week mark, the intensity or duration of exercise is adjusted based on the evaluation of the 6-minute walking distance (6 MWD)
Istianah, et al. 2022 [14]	2022	I: 16 C: 16		questionnaire sheets and observation sheet, SOP for Harvard physical exercise and diabetic foot exercises as well as Blood Set Glucose		RCT	Leg exercises with Harvard test physical exercises	The procedure for implementing the Harvard test and diabetic foot exercises starts from the pre-interaction stage, explaining the purpose and objectives of the research, measuring blood glucose during the period (pre-intervention), dividing the intervention group with the MSOP technique diabetic foot exercises were carried out in group 1 and Harvard test exercises were carried out in group 2 and after that blood glucose levels were re-measured (post intervention). This intervention was carried out once a day for 5 days

4. Discussion

The results of the analysis and search of the journal obtained 4 artifacts that met the criteria. Research by Rahmawati, et al. 2023 The population in this study is Type 2 Diabetes Mellitus patients who will be subjected to diabetic foot exercises as a total of 206 respondents who visited the Simpang Empat Care Health Center. The sample in this study was 20 respondents, in the intervention group there were 10 respondents and in the control group there were 10 respondents using *the simple random sampling method*. The results of the intervention group study before being given foot exercises and drugs all had poor blood glucose levels, after being given foot exercises and drugs almost all had moderate blood glucose levels. In the control group before being given the drug, all blood glucose levels were poor, after being given the drug, most of the blood glucose levels were moderate. Foot exercises are better at lowering blood glucose levels compared to those who do not do foot exercises for people with Type II Diabetes mellitus. There is leg stretching in foot exercises which are considered effective in improving blood circulation to the leg area, maximizing insulin action and dilating blood vessels where insulin works to resist the lipolysis process, namely the breakdown of triglycerides into excess fatty acids from adipose tissue into the blood, minimizing the risk of arterosclerosis, and being able to increase blood flow to the lower extremities and contribute to increasing systolic pressure in the legs.

Silva, et al. 2018 The number of samples used in this study of 45 people with type 2 diabetes mellitus was grouped into 2 groups: the treatment group (n = 21), who received education about independent foot care and received 12 foot reflection sessions; and the control group (n = 24), who received only education about independent foot care. The inclusion criteria in this study were a person aged 18 years or older who was diagnosed with type 2 diabetes for at least 5 years. The exclusion criteria are as follows: the presence of leg ulcers, lower limb amputations, uncontrolled hypertension, thrombosis, cognitive deficits, and prior reflexology treatments. The results in this study showed that there were no significant differences between the intervention and control groups with respect to the following analyzed variables: capillary blood glucose, foot tissue temperature, and foot plantar pressure. However, the researchers observed that after 12 sessions of therapy tested, participants in the intervention group showed more "normal" results than the control group regarding the subvariables of static analysis (mean pressure, maximum pressure, and distribution of centers of gravity). The effect of foot reflexes on capillary blood glucose, the researchers said that although the intervention group showed lower blood glucose levels than the control group at the end of the study, there was no significant difference between the two groups. Glucose levels are affected by both intrinsic and extrinsic factors, by implementing daily foot reflex sessions and systematic monitoring of factors affecting blood glucose levels can help control capillary blood glucose.

Kumar, et al. 2024 with a total of 160 participants divided into 2 groups. The inclusion criteria included participants who had been diagnosed with type 2 diabetes mellitus and were currently receiving treatment with an oral hypoglycemic agent with or without insulin therapy. The age range for inclusion is 30–65 years, and both men and women are eligible to participate. The exclusion criteria include: a person with type 1 diabetes mellitus, a confirmed respiratory disease, coronary artery disease, neurological disorders, musculoskeletal problems that may hinder physical exercise, uncontrolled hypertension (systolic blood pressure > 180 mmHg or diastolic blood pressure > 120 mmHg), pregnancy, thyroid disorders, or lack of desire to participate in the study. The results of this study were that a 12-week structured exercise program effectively improved insulin resistance, quality of life, functional capacity, and glycemic control in individuals with type 2 diabetes mellitus.

Istianah, et al. 2022 The total number of samples of the two groups is 32 respondents with group division using the Matched Subject Ordinal Pairing (MSOP) technique, namely subjects whose results are the same or almost the same as the initial test and then paired so that two groups are formed, namely experimental group 1 and experimental group 2. The results of this study were that there was a significant difference in the average blood sugar level between respondents who were given diabetic foot exercise intervention and Harvard test intervention. It can be concluded that there is a significant effect of diabetic foot exercise intervention on the reduction of blood glucose levels of diabetics with a p value of 0.01, while in the Harvard test intervention there is no effect on the reduction of blood glucose levels of diabetics with a p value of 0.37. The effects of acute physical exercise on the body can last until after the activity is complete (the muscles store energy by converting excess glucose into glycogen). Blood sugar can drop two hours or more after a Workout Exercise plays a major role in regulating blood glucose levels, during exercise insulin resistance will decrease. Insulin sensitivity during exercise can increase because during exercise there is an increase in blood flow, this causes the capillary network to open so that more insulin receptors are available and active.

5. Conclusion

5.1. Implications for Practice/Healthcare

Providing foot exercise therapy for people with type 2 diabetes mellitus has a significant effect in lowering blood sugar levels. The authors found a combination of foot exercise therapy against type 2 diabetes mellitus.

5.2. Implications for Research

The author analyzed that foot exercise therapy is a type of therapy that can be useful in lowering the blood sugar level of diabetic mellitus patients. Therefore, it is hoped that future researchers can develop the research more effectively and efficiently.

Compliance with ethical standards

Disclosure of conflict of interest

The author has no conflict of interest in this study.

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