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The effect of health promotion on compliance with diabetic foot exercises in increasing foot sensitivity and controlling blood sugar levels

Sigit Priyanto[1*], Agus Kristiyanto[1], Kusnandar[1], Anik Lestari[1], Drajat Tri Kartono[1], Sinu Andhi Jusuf[1], Sujono Riyadi[1]

[1] Sebelas Maret of University, Surakarta, Indonesia
[*]Corresponding author email: sigitpriyanto@unimma.ac.id

Abstract

The increasing global prevalence of diabetes mellitus and its severe complications, particularly diabetic neuropathy, necessitate effective interventions. Management of neuropathy typically involves patient education, pain management, and meticulous foot care. To prevent foot sensitivity disorders, robust health promotion initiatives focused on blood glucose control are crucial, especially diabetic foot exercises which prevent injuries and enhance peripheral circulation. This study utilized a quasi-experimental design with pre- and post-tests and a control group (n=124 total, 62 in each group via proportional random sampling) to assess the impact of health promotion on adherence to diabetic foot exercises, foot sensitivity, and blood sugar control among individuals with diabetes in Magelang Regency. Results showed a highly significant difference ($p<0.001$) in both adherences to exercises and foot sensitivity in both groups. These findings conclusively demonstrate that health promotion significantly improves compliance with diabetic foot exercises, leading to enhanced foot sensitivity and better blood sugar control, underscoring the need for appropriate health promotion models in diabetes management.

Keywords

Diabetes mellitus, Health promotion, Diabetic foot exercises, Foot sensitivity

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Introduction

According to the International Diabetes Federation (IDF), in 2023 diabetes mellitus in the world is expected to increase threefold from the previous year, 463 million. The lowest prevalence is in the 20-24 year-old age range, it is 1.4% in 2019 and in the 75-79 years old age range, the prevalence of diabetes is 19.9% in 2019 so it is predicted to increase to 20.4% and 20.5% in 2019. 2030 and 2045. Indonesia ranks seventh with 10.7 million DM sufferers in the world and it is estimated that this will continue to increase every year. IDF estimates that DM patients in Indonesia in 2030 will be 13.7 million sufferers, then in 2045 there will be 16.6 million sufferers.

The prevalence of diabetes mellitus cases in Central Java province in 2023 was 20.57%, an increase compared to cases in 2017, 19.22%. Based on gender, diabetes cases are more common in women, 1.97%, compared to men, 1.20% [11]. DM cases in Magelang Regency in 2023 were 1.33%. The proportion of types of Diabetes Mellitus (DM) treatment diagnosed by doctors in Magelang Regency at all ages is Anti-Diabetes Medication (OAD) from medical personnel at 73.04%, insulin injection at 5.98%, OAD from medical personnel and insulin injection at 12 .38%, and untreated 8.61% [3]. Based on age categories, diabetes sufferers are predominantly in the age range 55-64 years and 65-74 years. Areas with many diabetes mellitus sufferers are in urban areas at 1.9% compared to rural areas which is only 1.0% [11]. The risk of vascular complications can increase if someone suffers from DM. A total of 15% of people with DM will experience DM wounds and 24% of people with leg ulcers will require amputation. As many as 54.74% did exercise, 7.87% did not comply with the doctor's advice [15]. Foot care is an effort to primary prevent wounds on diabetic feet as well as early symptoms of tingling or numbness which will cause a decrease in foot sensitivity. One of the actions that must be taken in foot care to detect foot abnormalities early is to massage the venous veins as well as diabetic foot exercises, in addition to cutting nails properly, wearing good footwear, and maintaining foot hygiene [5-9].

Diabetic foot exercises are defined as therapeutic activities or physical maneuvers specifically performed by individuals with diabetes mellitus to both prevent lower extremity injuries and enhance peripheral blood circulation in the feet [4]. Expanding on this, diabetic foot exercises categorize as a nursing or healthcare professional-led intervention [17][18]. The primary objectives of these exercises are multifaceted: improving blood circulation to facilitate optimal tissue perfusion, strengthening intrinsic foot muscles, calf muscles, and thigh muscles, and addressing the common issue of restricted joint movement often observed in diabetic patients [18]. These exercises are beneficial for all individuals diagnosed with type 1 or type 2 diabetes mellitus. Importantly, their implementation should commence immediately upon diagnosis to serve as a crucial early preventive measure against the development of diabetic ulcers.

Diabetic foot exercises are highly recommended for diabetes sufferers who experience blood circulation disorders and neuropathy in the feet, but are adjusted to the condition and abilities of the sufferer's body. The power of venous massage and movements in diabetic foot exercises as presented in the 3rd National Diabetes Educators Training Camp in 2005 can help improve blood circulation in the feet so that it is hoped that they can overcome the occurrence of diabetic ulcers. Reduces complaints from sensory neuropathy such as: soreness, numbness or tingling in the feet. The benefits of foot venous massage and diabetic foot exercises are that it can strengthen small muscles, prevent foot deformities, increase the strength of the calf and thigh muscles (gastrocnemius, hamstring, quadriceps), and overcome limitations in joint movement, making the muscles in the which moves to contract [17]. This study aims to determine

the effect of health promotion in doing foot exercises on increasing foot sensitivity and controlling blood sugar levels in Magelang Regency in 2024.

Methods

A prospective, alternating-month quasi experiment pre and posttest with control group design was employed to compare the outcomes of 62 patients who received the health promotion intervention with 62 controls. Data collection was carried out directly on 124 respondents, including 62 respondents in the intervention group who were given foot exercises, and 62 respondents as a control group. The administration of foot gymnastics interventions is carried out three times a week for 8 weeks. Foot sensitivity and blood sugar levels were measured through a Prolanis (Chronic Graft Management Program) meeting at the Health Center every month, then a different test analysis was carried out before comparison after the intervention was given.

Results

The results of research conducted on 124 respondents, in the intervention group and control group are as follows:

Characteristics of respondents based on age

Table 1. Characteristics of Respondents Based on Age, Gender,

Category	Intervention group		Control group	
	f	%	f	%
Age				
60-65 years	30	48.4	34	54.8
66-70 years	24	38.7	22	35.5
71-75 years	8	12.9	6	9.7
Gender				
Male	25	40.3	28	45.2
Female	37	59.7	34	54.8
Length of Suffering from Diabetes				
1-5 years	32	51.6	29	46.8
6-10 years	18	29	23	37.1
>10 years	12	19.4	10	16.1
Amount	**62**	**100**	**62**	**100**

Based on Table 1, in the intervention group, there were 30 (48.4%) respondents aged 60-65 years, 24 (38.7%) aged 66-70 and 8 (12.9%) aged 71-75 years. Meanwhile, in the control group, there were 30 (48.4%) respondents aged 60-65 years, 24 (38.7%) aged 66-70 and 8 (12.9%) aged 71-75 years. The intervention group, there were 25 (40.3%) male respondents, 37 (59.7%) female respondents. Meanwhile, in the control group, there were 28 male respondents (45.2%), 34 (54.8%) female respondents. The intervention group, 32 (51.6%) respondents had suffered for 1-5 years, 18 (29.7%) had suffered for 6-10 years and 12 (19.4%) had suffered for >10 years. Meanwhile, in the control group, 29 (46.8%) respondents had suffered for 1-5 years, 23 (37.17%) had suffered for 6-10 years and 10 (16.1%) had suffered for >10 years.

Characteristics of respondents based on compliance, before being given health promotion

Table 2. Characteristics of Respondents Based on Compliance, Before Being Given Health Promotion

Category	Intervention group		Control group	
	f	%	f	%
Obedient	15	24.2	18	29.0
not obey	47	75.8	44	71.0
Amount	**62**	**100**	**62**	**100**

Based on Table 2, in the intervention group, 15 (24.2%) respondents were compliant, 47 (75.8%) non-compliant respondents were compliant. Meanwhile, in the control group, 18 (29%) respondents were compliant, 44 (71%) were non-compliant.

Characteristics of respondents based on compliance, after being given health promotion

Table 3. Characteristics of Respondents Based on Compliance, After Being Given Health Promotion

Category	Intervention group		Control group	
	f	%	f	%
Obedient	37	59.7	23	37.1
not obey	25	40.3	39	62,9
Amount	**62**	**100**	**62**	**100**

Based on Table 3 in the intervention group, 37 respondents (59.7%) were compliant, 25 (40.3%) respondents were non-compliant. Meanwhile, in the control group, 23 respondents (37.1%) complied, 39 respondents (62.9%) did not comply.

The influence of health promotion on compliance with diabetic foot exercises in increasing foot sensitivity and controlling blood sugar levels

Table 4. The Influence of Health Promotion on Compliance with Diabetic Foot Exercises in Increasing Foot Sensitivity and Controlling Blood Sugar Levels

Variable	Group	n	Mean	p value
Compliance	Intervention	62	59.7	0.000
	Control	62	37.1	

Based on the results of the Mann Whitney statistical test in Table 4, it is known that the average value of compliance in the intervention group before being given health promotion compared to after being given health promotion in doing leg exercises was 59.7 with a probability value (p value) = 0.000. The results can be obtained that there is an influence of health promotion on compliance with diabetic foot exercises in increasing foot sensitivity and controlling blood sugar levels.

Discussion

The intervention provided was in the form of health promotion regarding the management of diabetes mellitus, especially in the control of diabetes and the

importance of doing foot exercises which were carried out for 2-3 times a week for 8 weeks, respondents jointly carried out, then carried out at home accompanied by family members who had also been trained. The foot exercises that the researcher provided to find out the effect on foot sensitivity, while another study conducted by Deddy is a descriptive study in the application of diabetic foot exercises to blood sugar levels.

The demographic analysis of the study participants revealed several notable patterns. The majority of respondents fell within the 60-65 age bracket, accounting for 48.4% of the intervention group and 54.8% of the control group. This demographic trend aligns with the physiological changes observed in individuals entering older adulthood, particularly after the age of 60, where significant alterations in body structure and lifestyle often occur. Regarding gender distribution, females constituted the predominant proportion of participants, with 59.7% in the intervention group and 54.8% in the control group. This observation may be attributed to the hormonal fluctuations experienced by women, which can impact the intricate balance of the endocrine system and potentially influence diabetes prevalence or management. The duration of diabetes mellitus among most respondents ranged from 1 to 5 years, representing 51.6% of the intervention group and 46.8% of the control group. This finding reflects the rising incidence of newly diagnosed diabetes cases within the population.

Prior to the health promotion intervention, a relatively small proportion of respondents demonstrated adherence to diabetic foot exercises, with 24.2% in the intervention group and 29% in the control group categorized as compliant. This suggests a baseline deficit in understanding and awareness regarding effective diabetes management strategies before the intervention. Following the implementation of health promotion, a significant improvement in adherence was observed. Post-intervention, 59.7% of respondents in the intervention group showed compliance, compared to 37.1% in the control group. The statistically significant finding ($p<0.001$) confirms a pronounced impact of health promotion on improving adherence to leg exercises and subsequently enhancing blood sugar control. This underscores the crucial role of targeted health promotion in fostering better self-management practices among individuals with diabetes.

Based on the results above, between the results of the 2018 Riskesdas and the 2023 Riskesdas, regarding the prevalence of diabetes mellitus in Magelang Regency and Central Java Province, the sweet eating pattern of people who have diabetes mellitus, and suffer from peripheral blood circulation disorders (at the tips of the feet) is relatively enhancement, 56.9% of people's food patterns consume food/drinks ≥ 1 time per day. The sweet eating pattern is mostly done by those aged 50-54 years, as many as 64.7 people consume food/drinks ≥ 1 time per day. Based on 2023 Riskesdas data, people Only 48.1% of people with diabetes mellitus do sports or activities to overcome peripheral blood circulation disorders. This data shows the lack of community efforts to deal with the impact of diabetes mellitus with activities including diabetic foot exercises.

Blood circulation is the flow of blood pumped by the heart into the blood vessels and distributed by the arteries to all the body's organs, one of which is the leg organs [4]. Sensitivity measurements are carried out by comparing the results of sensitivity measurements between those using a needle, brush and cotton. The criteria for sensitivity at the tips of the feet according to [9] are a value of 0 which is no sensitivity, a value of 1 is less sensitivity, a value of 2 is moderate sensitivity and a value of 3 is good (normal) sensitivity.

The cause of wounds or abnormalities in the feet of patients with diabetes is an abnormality in the nerves, an abnormality in the blood vessels and then an infection. Of these three things, the one that plays the most role is nerve abnormalities, while blood vessel abnormalities play a more significant role in wound healing, thereby determining the fate of the foot. Nervous disorders can affect sensory nerves, motor and autonomic nerves [19].

Sensory sensation becomes lost, which causes the inability to feel painful stimuli, thereby losing the ability to protect the feet against external stimuli. As a result, the feet are more susceptible to injury even from small impacts. If a wound occurs, it will make it easier for germs to enter and cause infection. If this infection is not treated properly, it will progress to decay (gangrene) and can even result in amputation [20].

Disorders of motor nerve fibers (nerve fibers that go to muscles) can result in atrophy of the interosseous muscles in the legs. As a further consequence of this situation, there is an imbalance in the leg muscles, there is a change in the form of deformity in the foot such as the fingers bending cock up toes, shifting of the luxation joints in the metatarsophalangeal joints of the forefoot and thinning of the fat pad under the area at the base of the toes of the metatarsal heads. This causes an expansion of the area under pressure, especially under the metatarsal heads [14].

Vascular dysfunction in the lower extremities of individuals with diabetes can lead to significant complications. Alterations in the vasodilatation-vasoconstriction balance within the blood vessels of the lower leg can contribute to joint stiffness. In advanced stages, this can progress to Charcot foot deformity, leading to abnormal pressure distribution on the foot and an elevated risk of injury [14]. Vascular occlusions further compromise blood flow, impeding the delivery of oxygen, nutrients, and essential medications like antibiotics, thereby hindering the wound healing process. Inadequate management of infections can culminate in gangrene. Extensive gangrene, often a consequence of widespread vascular blockage, may necessitate above-knee amputation [20].

Diabetic foot exercises are a cornerstone of diabetes management, representing a planned and systematically organized series of physical movements designed to promote overall physical harmony and development [16]. As a form of aerobic exercise, gymnastics, a subset of these exercises, involves the movement of various muscle groups, ensuring that the body's oxygen demands are met [17]. Regular physical activity

is a fundamental principle in diabetes care. Consistent daily physical activity, alongside structured exercise sessions (3-4 times per week for approximately 30 minutes), constitutes a vital component of diabetes management. Recommended activities include walking, cycling, jogging, gymnastics, and swimming, with the intensity and type of exercise tailored to an individual's age and physical fitness level [7].

Specifically, diabetic foot exercises are targeted activities performed by individuals with diabetes to mitigate injury risk and enhance blood circulation in the feet [18]. These exercises are instrumental in improving peripheral circulation, strengthening the intrinsic muscles of the feet, and preventing foot deformities. Furthermore, they contribute to increased strength in the calf and thigh muscles and can alleviate limitations in joint movement [13]. It's important to note that physical activity encompasses a broad range of body movements that substantially increase energy expenditure, including both routine daily activities like walking, housework, and gardening, as well as structured sports activities such as swimming, cycling, and fitness training [1].

According to Lemon, et al. [6] with his activity theory states that successful aging depends on how satisfied the elderly feel in carrying out and maintaining activities. This is related to social interaction and involvement of the elderly in their environment so that losing their role will eliminate an elderly person's satisfaction. This is reinforced by the opinion of [20] who states that physical activity has a significant relationship with limb disorders where low physical activity, one of which is irregular exercise, is at risk of movement disorders. Exercises to maintain mobility and body posture in the elderly also aim to maintain and improve joint movement throughout the body, increase muscle strength, stimulate blood circulation, maintain functional capacity, prevent contractures and maintain good body posture [16].

Elderly people who participate in sports activities, even those who have stopped for a long time, have better postural control and reduced dependence on visual information compared to elderly people who are inactive [20]. This is reinforced by the opinion of [5] that in a state of immobilization approximately 3% of muscle strength decreases every day, which means that elderly people will experience deterioration more quickly due to disuse.

According to the benefits of exercise programs for the elderly, especially for the musculoskeletal system, are increased muscle strength, ROM (Range of Motion), flexibility, bone density and blood circulation [8]. This is in accordance with the opinion stated that activity training and high-intensity ROM training in elderly people with idiopathic Parkinson's disease carried out 3 times a week for 4 weeks can increase muscle strength and blood circulation [16]. Likewise, research conducted showed that elderly people who were given four square step training, which is a form of dynamic movement training for 4 weeks, had significantly better blood circulation than before training [4].

Diabetic foot exercises are specifically designed to enhance peripheral blood circulation in the lower extremities of diabetic patients, thereby facilitating optimal nutrient delivery to the tissues [10]. Beyond localized benefits, regular physical activity, including diabetic foot exercises, confers systemic advantages for individuals with diabetes. Regarding the cardiovascular system, consistent exercise strengthens the myocardium, leading to increased ventricular chamber size. This physiological adaptation results in more forceful and efficient heartbeats with greater stroke volume [2]. Consequently, the heart's overall work efficiency improves, reducing the need for excessive heart rate elevation.

Furthermore, physical activity positively impacts the vascular system. It contributes to a reduction in arterial fat deposits and an increase in the contractility of vascular smooth muscle, thereby enhancing blood vessel elasticity. This improved vascular compliance facilitates smoother blood flow and plays a crucial role in preventing the development of hypertension. The respiratory system also benefits, with increased lung elasticity promoting greater expansion and recoil capacity [6]. At the musculoskeletal level, exercise boosts both muscle flexibility and endurance. This is attributed to an increase in muscle fiber size and an enhanced energy supply system within the muscles. Additionally, ligaments and tendons gain strength, along with improved attachment points to bones [12].

The indications for this foot exercise can be given to all people with diabetes mellitus type 1 or 2. However, it should be given from the time the patient is diagnosed with diabetes mellitus as an early preventive measure. This leg exercise is also contraindicated in clients who experience changes in physiological function such as dyspnea or chest pain. Circumstances like this need to be considered before doing leg exercises. Apart from that, assess the patient’s general condition and condition whether it is appropriate to do the leg exercises, check vital signs and respiratory status (is there dyspnea or chest pain), assess the patient’s emotional status (mood, motivation), and pay attention to indications and contraindications in providing leg exercise [7]. The results of the research are as input to public health services in the management of diabetes mellitus. It is also hoped that the handling innovation will be carried out by empowering families and communities. Research limitations related to the difficulty of controlling other factors that affect blood sugar levels such as stress, diet and hereditary factors.

Conclusion

There is an influence of health promotion on compliance with diabetic foot exercises in increasing foot sensitivity and controlling blood sugar levels. Further research needs a health promotion model that is able to empowerment families.

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