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Health Promotion and Diabetic Foot Exercises: Improving Foot Sensitivity in Elderly Diabetic Patients

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Abstract

Diabetes mellitus increases the risk of impaired blood circulation and foot sensitivity in peripheral areas, which can lead to diabetic ulcers. This can be prevented by controlling glucose levels through education, physical activities, and diet management. One of the efforts to improve foot sensitivity is through diabetic foot exercises. Education through health promotion is essential to evaluate the compliance of diabetes mellitus patients in performing diabetic foot exercises. Therefore, this study aims to determine the effect of health promotion on compliance with diabetic foot exercises in increasing foot sensitivity in people with diabetes mellitus in Magelang Regency. This study used a quasi-experimental design with pre and post-tests and a control group. The sampling technique used proportional random sampling with a total of 124 respondents, consisting of 62 respondents in the intervention group and 62 in the control group. Foot exercises were conducted for 12 weeks, and foot sensitivity was measured before and after the intervention. The results showed a difference in compliance with diabetic foot exercises and foot sensitivity before and after health promotion in both the intervention and control groups, with a p-value of 0.000. In the intervention group, foot sensitivity increased with an average score of 1.661 before the intervention and 2.161 after the intervention. No significant increase was observed in the control group ($p = 0.083$). Additionally, there was a significant difference in HbA1c levels between the intervention and control groups after the intervention ($p = 0.000$). In conclusion, health promotion significantly influences compliance with diabetic foot exercises and foot sensitivity in patients with diabetes mellitus. It is recommended to implement an appropriate health promotion model for diabetes mellitus management.

Keywords: Diabetes Mellitus, Health Promotion, Diabetic Foot Exercises, Foot Sensitivity.

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, which was 1.4% in 2019, and in the 75-79-year-old age range, the prevalence of diabetes was 19.9% in 2019, so it is predicted to increase to 20.4%, and 20.5% in 2019, 2030 and 2045 (Al-Taie & Khattak, 2024). 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; 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% [29]. DM cases in Magelang Regency in 2023 were

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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 between 55-64 years and 65-74 years. Areas with many diabetes mellitus sufferers are urban areas at 1.9% compared to rural areas at only 1.0% [4]. 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% exercised, 7.87% did not comply with the doctor's advice [3]. Foot care is an effort to primarily prevent wounds on diabetic feet and 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 abnormalities early is to massage the venous veins and diabetic foot exercises, cut nails properly, wear suitable footwear, and maintain foot hygiene [20].

Diabetic foot exercises are activities or exercises carried out by diabetes mellitus patients to prevent injuries and help improve blood circulation in the feet [17]. Meanwhile, according to [19], diabetic foot exercises are one of the therapies a nurse or health worker provides. This diabetic foot exercise aims to improve blood circulation so that nutrition reaches the tissues more smoothly, strengthen small, calf, and thigh muscles, and overcome the limited joint movement often experienced by diabetes mellitus sufferers [21]. This diabetic foot exercise can be given to all diabetes mellitus sufferers of type 1 or 2. However, it should be provided from the time the patient is diagnosed with diabetes mellitus as an early preventive measure against 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 they 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 [20]. This study aims to determine the effect of health promotion in doing foot exercises on increasing foot sensitivity and HbA1c levels in Magelang Regency in 2024. In addition to blood sugar levels, an indicator often used to assess the level of diabetes mellitus disorder is based on HbA1c levels. In fact, the current developmental HbA1c level examination results are used to enforce the occurrence of diabetes mellitus if the HbA1c level is more than 6.5%.

The purpose of the diabetes mellitus diet is to help people with diabetes feel comfortable, prevent more serious complications, and improve eating habits. Education on proper diet control should be provided by paying attention to the 3 J principles, namely the right type, number, and schedule. The right kind of foods are proper to consume, and that must be avoided or limited so that blood sugar levels do not increase, especially in foods that contain high sugar such as sugar, brown sugar, candy, dodol, chocolate, jam, honey, syrup, lemonade, soft drinks, sweetened condensed milk, ice cream, sweet cakes, tarts, canned fruit, jerky, shredded and so on. Granulated or brown sugar can still be used as a condiment in cooking. Meanwhile, the restricted foods include rice, rice cakes, corn, bread, sweet potatoes, cassava, taro, potatoes, sago, bulgur, noodles, vermicelli, macaroni, and other foods made from flour. The right amount and the food

setting are based on height, weight, type of activity, and age to regulate the number of calories needed. On schedule, arrangements are made for meal times; for people who do not experience diabetes mellitus, they usually eat 3 times, namely morning, noon, and night, while for those who experience diabetes mellitus, the number of food volumes is consumed in 6 times, namely in the morning at breakfast (07:30), at 10:00 p.m. 10.00 Meal interlude, noon at noon. 12:30 Lunch, at 1:00 p.m. 15.00 snacks and pk. 18:00: Dinner.

Methods

This study aims to determine the effect of health promotion in conducting proper diet control and foot exercises on increasing foot sensitivity in the elderly Magelang Regency in 2024. Data was collected directly from 124 respondents, including 62 respondents in the intervention group who were given foot exercises and 62 respondents in the control group. The foot exercise intervention was carried out for 12 weeks, and the foot's sensitivity at the beginning before and after the intervention was also carried out with the control group. Furthermore, the data is processed using SPSS.

Results

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

a. Characteristics of Respondents Based on Age

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

Table 1. Characteristics of Respondents Based on Age, Gender, Length of Suffering from Diabetes

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. There were 25 (40.3%) male respondents in the intervention group and 37 (59.7%) female respondents. Meanwhile, in the control group, there were 28 male respondents (45.2%) and 34 (54.8%) female respondents. In 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 sustained for 1-5

years, 23 (37.17%) had suffered for 6-10 years, and 10 (16.1%) had suffered for >10 years.

b. 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

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

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

c. 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

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

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

d. Characteristics of Respondents Based on Foot Sensitivity Before Being Given Foot Exercises

Category	Intervention group		Control group	
	f	%	f	%
Bad	8	12,9	6	9,7
Not good	17	27,4	19	30,6
Pretty good	25	40,3	23	38,1
Good	12	19,4	14	22,6
Amount	62	100	62	100

Table 4. Characteristics of Respondents Based on Foot Sensitivity

Based on table 4. In the intervention group, 8 (12.9%) respondents had poor foot sensitivity, 17

(27.4%) were not good, 25 (40.3%) were moderately good, and 12 (19.4%) were good. Meanwhile, in the control group, respondents whose foot sensitivity was not good were 4 (6.5%), 11 (17.7%) were not good, 18 (29%) were quite good, and 29 (46.8%) were good.

e. Characteristics of Respondents Based on Foot Sensitivity After Being Given Foot Exercises

Category	Intervention group f %		Control group f %	
Bad	4	6,5	9	14,5
Not good	11	17,7	20	32,3
Pretty good	18	29	22	35,5
Good	29	46,8	11	17,7
Amount	62	100	62	100

Table 5. Characteristics of Respondents Based on Foot Sensitivity

Based on table 5. In the intervention group, 8 (12.9%) respondents had poor foot sensitivity, 17 (27.4%) were not good, 25 (40.3%) were moderately good, and 12 (19.4%) were good. Meanwhile, in the control group, respondents whose foot sensitivity was not good were 4 (6.5%), 11 (17.7%) were not good, 18 (29%) were quite good, and 29 (46.8%) were good.

f. Effect of Foot Exercises on Foot Sensitivity in the Intervention Group

Foot Sensitivity	Mean	Mean Different	Sd	p value
Before	1.661	0,5	0.939	0
After	2.161		0.944	0.000

Table 6. Effect of Foot Exercises on Foot Sensitivity Before and After Actions in the Intervention Group

*Uji Wilcoxon

Table 6 shows that 62 respondents experienced an increase in the level of foot sensitivity before and after being given foot exercises. The average result of the level of foot sensitivity before being given foot exercise therapy was 1.661, with a standard deviation of 0.939. After being given foot exercise therapy, the average level of foot sensitivity was 2.161, with a standard deviation of 0.944. Before and after being given foot exercise therapy, the difference was 0.5 with $p=0.000$. This means a p-value of < 0.05 , indicating a significant increase between before and after giving foot exercise therapy. From the table, it is known that there is an effect of foot exercise therapy to increase foot sensitivity.

g. Effect of Foot Exercises on Foot Sensitivity in the Control Group

Foot Sensitivity	Mean	Mean Different	Sd	p value
Before	1.693	0,48	0.951	0,083
After	1.645		1.009	

Table 7. Effect of Foot Exercises on Foot Sensitivity in the Control Group

*Uji Wilcoxon

Table 7 shows that there were 62 respondents in the control group. The average result of the sensitivity level of the foot before was 1.693 with a standard deviation of 0.951; after, the average level of foot sensitivity was 1.645 with a standard of 1.009. The difference between the initial and final measurements was 0.48, with $p = 0.083$. This means a $p\text{-value} > 0.05$, indicating no significant increase between the initial and final measurements in the control group. From the table above, it can be seen that there is no significant influence between the initial measurement and the final measurement of the control group.

h. Effect of Foot Exercises Before and After Actions in the Intervention Group and Control Group

Intervention	Mean	Mean Different	p value
Intervention group	2.161	0.516	0.002
Control group	1.645		

Table 8. Effect of Foot Exercises Before and After Actions in the Intervention Group and Control Group

*Uji Mann Withney

Table 8. shows that there were 62 respondents in the intervention group and 62 respondents in the control group who experienced an average increase in the level of foot sensitivity before and after the intervention group was given 2,161, while in the control group, 1,645, the difference before and after the treatment was 0.516 with $p\text{-value} = 0.002$. This means a $p\text{ value} < 0.05$ indicates a significant difference between the provision of foot exercise therapy and those without foot exercise on the level of foot sensitivity in the respondents. From the table above, it can be seen that foot exercise therapy significantly influences the level of foot sensitivity in respondents. ($p\text{-value} = 0.002$).

i. Effect of Health Promotion on Post-Action HbA1c Levels in the Intervention Group and Control Group

HbA1c levels	Mean	Mean Different	p value
Intervention group	70.887	205	0.000
Control group	71.092		

Table 9. Effect of Health Promotion on HbA1c Levels After Action in the Intervention Group and Control Group

*Uji Mann Withney

Based on table 9. shows that there were 62 respondents in the intervention group and 62 respondents in the control group who experienced an average decrease in HbA1c levels in the intervention group of 70,887, while in the control group of 71,092, the difference in HbA1c levels between the intervention group and the control group of 205 with $p\text{-value} = 0.000$. This means a $p\text{ value} < 0.05$ indicates a significant difference between HbA1c levels between the intervention group and the control group after being given health promotion.

Discussion

The intervention provided was in the form of health promotion regarding the management of

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diabetes mellitus, especially in the control of diabetes and the importance of doing foot exercises, which were carried out 3 times a week for 12 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 determine the effect on foot sensitivity, while another study conducted by Deddy, 2021 describes the application of diabetic foot exercises to blood sugar levels.

Based on the research results above, most respondents were aged 60-65, 48.4% in the intervention group and 54.8% in the control group. This is because when entering old age at 60, there are significant changes in body structure and lifestyle. Most respondents were female, 59.7% in the intervention group and 54.8% in the control group. This is because women experience hormonal changes that affect the endocrine system's balance. Most respondents had diabetes mellitus for 1-5 years, 51.6 in the intervention group and 46.8% in the control group. This is due to the increasing prevalence of new cases of people experiencing diabetes mellitus. Before being given health promotion, most respondents were in the obedient category, 24.2% in the intervention group and 29% in the control group. This is because before health promotion was given, understanding and awareness in managing diabetes mellitus were still lacking. After being given health promotion, respondents were 59.7 in the intervention group and 37.1% in the control group. Health promotion influences compliance in doing leg exercises and controlling blood sugar levels, with $p=0.000$.

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 mainly 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, 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 through 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, including 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 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 [14].

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 minor impacts. If a wound occurs, it will make it easier for germs to enter and cause infection. If this infection is not treated correctly, it will progress to decay (gangrene) and can even result in amputation [14].

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].

Changes in the power of vasodilatation-vasoconstriction blood vessels in the lower leg area increase or decrease, making the joints stiff. In a further situation, there is a change in the shape of Charcot's foot, which causes changes in new pressure areas of the foot and risks injury [14]. Blood vessel disorders result in blockage of blood vessels, thereby obstructing blood flow and disrupting the supply of oxygen, food, or antibiotic drugs, which can interfere with the wound healing process. If treatment for this infection is not perfect, it can cause gangrene. Extensive gangrene can also occur due to extensive blockage of blood vessels, making it possible to amputate the leg above the knee [25].

Diabetic foot exercises are physical exercises chosen, created, planned, and arranged systematically to form and develop the person in harmony [16]. Based on its definition, gymnastics is a type of aerobic exercise that uses movement of some of the body's muscles, where oxygen needs can still be met [17]. Physical exercise is one of the principles in managing diabetes mellitus. Daily physical activity and regular exercise (3-4 times a week for approximately 30 minutes) are pillars of managing diabetes. The physical exercises in question are walking, cycling, jogging, gymnastics, and swimming. This physical exercise should be adjusted to age and physical fitness status [7].

Diabetic foot exercises are activities or exercises carried out by diabetes mellitus patients to prevent injuries and help improve blood circulation in the feet [18]. Foot exercises can help improve blood circulation, strengthen the small muscles of the feet, and prevent foot deformities. It can also increase the strength of the calf and thigh muscles and overcome limitations in joint movement [13]. Physical activity is body movement that substantially increases energy use and can take the form of daily activities (walking, doing housework, gardening) and sports activities, namely swimming, cycling, gymnastics, and fitness [1].

According to Lemon et al. [6], 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 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 [21].

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 inactive elderly people [22]. The opinion of [5] reinforces that in immobilization, approximately 3% of muscle strength decreases daily, meaning that elderly people experience deterioration more quickly due to disuse.

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 follows the opinion 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 [23]. 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 [24].

The goal obtained after doing these foot exercises is to improve blood circulation in the feet of diabetic patients so that nutrients are distributed smoothly into the tissues [10]. The benefits of diabetes exercise on the heart organ are that it becomes more assertive, and the heart chambers become more prominent so that the beats are strong and have a large capacity. Both of these things will increase the efficiency of the heart's work. With high work efficiency, the heart does not need to beat too often [6]. In blood vessels, the elasticity of the blood vessels will increase due to reduced fat deposits and increased contractility of the muscles of the blood vessel walls. High elasticity of blood vessels will facilitate the flow of blood and prevent the emergence of hypertension [6]. The elasticity of the lungs will increase so that the ability to expand and collapse will also increase [6]. Flexibility and muscle endurance will increase. This is caused by an increase in the size of muscle fibers and an increase in the energy supply system in the muscles. Ligaments and tendons will get stronger, as will the attachment of tendons to bones [6].

The indications for this foot exercise can be given to all people with diabetes mellitus type 1 or 2. However, it should be given when 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 research results are used as input for public health services in managing 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

Health promotion has a significant impact on the management of diabetic foot conditions, as well as the influence of foot exercises on foot sensitivity.

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