

# The Effectiveness of Diabetic Foot Exercise to Peripheral Neuropathy Symptoms and Fasting Blood Glucose in Type 2 Diabetes Patients

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## ABSTRACT

**Introduction:** Peripheral neuropathy is a nerve disorder in the foot caused by chronic diabetes, and damage the sensory nerves. Initially, patients will complain of numbness, and gradually have an impact on the inability to feel the stimulation of pain that triggers gangrene wounds and even infections. This study aimed to determine the effect of diabetes foot exercises on the symptoms of neuropathy and fasting blood glucose in type 2 diabetes patients. **Method:** The study design used a quasi-experimental pretest-posttest design without control group. There were 30 diabetes patients chosen using purposive sampling technique. Patients were given leg exercises for 2 weeks, 5 times per week with a duration of exercise 15-30 minutes each; neuropathy symptoms were measured using The Michigan Neuropathy Screening Instrument (MNSI) test. **Results:** Using the Wilcoxon statistical test, there were no significant differences in the symptoms of neuropathy pre-posttest intervention (p value = 0.83), and fasting blood glucose (p value = 0.166), however there is a MNSI's mean score decreased of 1.43 after the intervention. In addition, the variables of gender and BMI have good correlation with the symptoms of neuropathy. **Conclusion:** Diabetes foot exercise could be an effective program because it help to reduce the symptoms of neuropathy even not statistically significant. It is recommended that diabetic foot exercises become one of the hospital protocols in reducing hyperglycemia and decrease DM complications such as symptoms of peripheral neuropathy.

**Keywords:** *fasting blood sugar, foot exercises, peripheral neuropathy*

## 1. INTRODUCTION

Diabetes is disease that may cause a burden and the number of cases of diabetes has been steadily increasing over the past few decades. About 422 million people worldwide have diabetes and the majority living in low-and middle-income countries, moreover, 1.6 million deaths are directly attributed to disease each year [1]. Indonesia as a lower-middle income country also experiences an increasing of incidence of diabetes, where the incidence in line by increasing the age of the individual. In 2018, DKI Jakarta is the city which has the highest prevalence of diabetes diagnosed by a physician with 3.4%; and there is an elevation of diabetes case of 2.5% in 2013 [2].

Diabetes is a chronic, metabolic disease characterized by elevated levels of blood glucose, which leads to serious damage to the heart, kidney, blood vessels and nerves. Neuropathy, one of the diabetes complications, and according to ADA, it refers to the presence of symptoms and/or sign of peripheral nerve dysfunction in people with diabetes after exclusion of other causes [3]. Moreover, up

to 50% of diabetic patients with type 2 diabetes mellitus suffer from neuropathy [4].

There are two major categories of diabetic neuropathy namely sensory neuropathy and autonomic neuropathy. Sensory neuropathy, which focuses on this study, characterise as distal symmetric neuropathy include loss of sensation, abnormal sensation, pain and paraesthesia [5]. Painful diabetic neuropathy affects 25% to 30% of patients with diabetes in both hospital and clinic settings. Patients are reluctant to report their symptoms, and many of them do not take their medications. Few patients report complete relief of pain, and 30 to 50 % reduction is considered a meaningful response [6].

Complete or partial loss of sensitivity to touch and temperature is common symptoms reported by patient with diabetes neuropathy. Untreatable Diabetic neuropathy will lead to the loss of protective sensation in the lower extremities, and coupled with other factors, may cause significantly increase the risk for complications such as foot injury and ulcerations, that result in the lower limb amputation. A prior study reported that diabetes neuropathy has resulted in more than 80% amputations after foot

ulceration [7]. Diabetic foot ulcers, infections, gangrenes and amputations are associated with higher mortality and poor prognosis. In addition, 50% of patients with amputations and foot ulcers die within five years [6].

The interventions arise to prevent and to decrease the symptoms of peripheral neuropathy. The interventions have a goal to decrease the muscle spasm and increase blood circulation to the foot. A prior study applied effleurage massage to improve the sensation of foot protection of diabetes patients which measured using monofilament 10 gr. After 4 weeks, the study found out a significant difference on foot protection sensation before and after intervention ( $p < 0.05$ ) and effleurage massage give strong effect on foot protection sensation as 40.7% simultaneously [8]. Many researches also recommended to performing foot exercise. Diabetic foot exercise is a non-pharmacological therapy that can be done by diabetes patients because this intervention is easy to do, can practice anywhere and need only short duration of time. Regular activity may reduce body weight, improves blood glucose control and insulin sensitivity.

Foot exercise positively influences other pathological factors associated with peripheral neuropathy, by promoting microvascular function and fat oxidation, by reducing oxidative stress and increasing neurotrophic factors [4]. Aside from that foot exercise may improve peripheral perfusions thus may prevent the worsening of neuropathy diabetes. A prior study found out a significant difference in Ankle Brachial Index between before and after intervention of diabetic foot exercise for 30 minutes in 3 days on type 2 diabetes patients with p value 0.05 [9]. Therefore, this study aimed to determine the effect of diabetes foot exercises on the symptoms of neuropathy and fasting blood glucose in type 2 diabetes patients.

**2. METHOD**

The study used quasi-experimental with pre and post-test non-control group design. The study conducted at out-patient department, Budha Tzu Chi Hospital, Jakarta. In this study, non-probability method, purposive sampling technique was applied and using Slovin’s formula, there were 30 type 2 diabetes patients met the inclusion and exclusion criteria. The inclusion criteria were: adult patients, diagnosed with type 2 diabetes more than 3 years, able to perform activity; while the exclusion criteria were: have diabetes ulcer, develop impairment at musculoskeletal and lower vascular diseases.

The respondents who visited outpatient department were gathered in the room and given health education and demonstration diabetes foot exercise. Respondent was given a leaflet on the procedure and steps on performing diabetes foot exercise. Respondents were asked to practice diabetes foot exercise 5 times per week with a duration of exercise 15-30 minutes for 2 weeks in their home regularly. Home visit also performed by researchers and research

assistances three times a week to monitor the intervention was performed regularly as scheduled.

Research data was collected over two weeks using datasheet for demographic profile or respondents. Michigan Neuropathy Instrument Screening (MNSI) was used to measure the level of peripheral neuropathy diabetes patients and the score  $\geq 7$  defined as abnormal [10]. MNSI is self-administered questionnaire used to assess distal symmetrical peripheral neuropathy in diabetes and there are two separate assessments. It is the common screening tool which have better specificity and sensitivity. Before utilize the tools, researcher adopt ‘trans cultural adaptation’ approach to translate the tools. Translation and back translation was conducted by language expert and nurses. In this study, researcher only utilized 1<sup>st</sup> chapter of MNSI assessment which consist of a-15 item questions due to resource limitation, and all these process have been asked for permission. To measure fasting blood glucose, researcher use calibrated Accu-Check Active blood glucose meter test with stick strips.

The study was approved by Ethic Commission of Health, Sint Carolus School of Health sciences with No. 081/KEPPKSTIKSC/XII/2019. Pearson correlation was used to find the correlation of confounding variables to neuropathy symptoms; Wilcoxon statistical test was used to determine whether there are statistically significant differences before and after intervention of fasting blood glucose and peripheral Neuropathy.

**3. RESULT**

Table 1. Frequency distribution of the respondent and the correlation to MNSI

Variables	N	%	Pearson Correlation
<b>Age</b>			
35-45 years old	2	6.7	0.13
46-55 years old	19	63.3	
>55 years old	9	30.0	
<b>Gender</b>			
Male	10	33.3	0.00
Female	20	66.7	
<b>BMI</b>			
Normal	18	60.0	0.00
Obese	4	13.3	
Overweight	8	26.7	
<b>Anti hyperglycemia</b>			
Oral	29	96.7	0.06
Injection	1	3.3	
<b>TOTAL</b>	<b>30</b>	<b>100</b>	

Table 1 shows frequency and percentage distribution of respondents. Most of the respondent were age between 46-55 years old, female, normal BMI and take oral anti-

hyperglycemia medication. The variables of gender and BMI show good correlation with the symptoms of neuropathy.

Table 2 presents the frequency and percentage of peripheral neuropathy and fasting blood glucose. Most of the respondents have normal score for peripheral neuropathy as measured by MNSI, but there were 10% respondent had score >7 before intervention. After 2 weeks of intervention, 100% diabetes patients had normal score for peripheral neuropathy. In terms of fasting blood glucose level, respondents who have high blood glucose decreased from 83.3% to 76.7% after 2 weeks intervention.

**Table 2. Frequency and percentage of peripheral neuropathy and fasting blood glucose**

Variables	Pre		Post	
	Intervention		Intervention	
	N	%	N	%
Neuropathy				
Normal	27	90.0	30	100
Abnormal	3	10.0	0	0
Blood glucose				
Normal	5	16.7	7	23.3
Hyperglycemia	25	83.3	23	76.7
<b>Total</b>	<b>30</b>	<b>100</b>	<b>30</b>	<b>100</b>

**Table 3. Significant difference before and after intervention of peripheral neuropathy and fasting blood glucose**

Variables	Mean	Median	P value
Neuropathy pre-test	4.23	4.5	0.83
Neuropathy post-test	2.80	3.0	
Blood glucose pre-test	196.03	186.0	0.166
Blood glucose post-test	169.33	165.0	

Table 3 shows the mean of peripheral neuropathy and fasting blood glucose before and after the intervention. The means score of Peripheral neuropathy decrease 1.43 after 2 weeks of intervention of diabetic foot exercise even it is not significantly different with  $p>0.05$ . For fasting blood glucose, there was a decrease in blood glucose score of 83 even it is not significantly difference with  $p>0.05$ .

#### 4. DISCUSSION

The result of respondent's profiles and the correlation between confounding variables to neuropathy symptoms were in line with theory of type 2 diabetes and neuropathy. Type 2 diabetes is, by far, the most prevalent type of diabetes, accounting for over 90% of patients with diabetes. This type usually occurs in people over 40 years old and 80-

90% of patients are overweight at the time of diagnosis [11]. A large number of women who have type 2 diabetes, caused by the decrease of estrogen hormones, especially when they are menopause because estrogen and progesterone hormones are able to enhance the insulin response in the blood [12].

The present study found out that BMI and gender have good correlation with neuropathy symptoms. Obesity and overweight are an index of insulin resistance which become an indicator for poor glycaemic control and predispose to neuropathy and other complications. Some studies found out that age, diabetes and weight were significantly associated with peripheral neuropathy with OR 1.09 [13]. Most of the respondents in this study have condition of hyperglycaemia, both pre and post-test at measurement. During the data gathering, the location was hit by flood, thus most of respondents stated they were stressed by the impact of the flood. Most of the respondents also reported that they were not taken anti-hyperglycaemia drugs regularly because of forgetfulness they and feel no specific symptoms. Even though they performed diabetic foot as scheduled, the condition of stress and not consuming anti-hyperglycaemia drugs keep making blood sugar to above normal level. One of the chief injuries arising from hyperglycaemia is injury to vasculature, which is classified as either small vascular injury (microvascular disease) or injury to the large blood vessels of the body (macrovascular disease).

The pathological changes in the diabetic microvasculature alter organ perfusion, including organs heavily dependent on their microvasculature supply, such as retina, kidneys and peripheral nervous system. Microvascular disease also contributes to peripheral vascular disease, reduced myocardium vascularization, and poor wound healing [14]. In terms of gender, a study revealed that neuropathic pain appears to be greater among females compared to males independent of the presence of neuropathy [15].

A study found out that poor glycaemic control and longer duration were significantly associated with diabetic neuropathy [16] and it was revealed that prevalence of polyneuropathy were in those with duration of DM > 5 years, or present in as 36% of people with duration of diabetes greater than 10 years [17]. In the present study, most of the respondents have duration of DM ≤ 3 years, therefore, only 10% of respondents develop symptoms of neuropathy. This situation which might cause the result found not statistically significant. However, table 1 shows the good correlation between gender and BMI to the incidence of neuropathy.

Before intervention, 10% respondents complained that they feel hurt when bedcovers touch the skin, not able to difference hot and cold water during shower and experience open wound in their foot. The manifestation of distal symmetric neuropathy include loss of sensation, abnormal

sensation, pain and paraesthesia [5]. Painful diabetic neuropathy affects 25% to 30% of patients with diabetes. Complete or partial loss of sensitivity to touch and temperature is also common symptoms reported by patient with diabetes neuropathy. Untreatable Diabetic neuropathy will lead to the loss of protective sensation in the lower extremities, and significantly increase the risk of foot injury and ulcerations.

Peripheral neuropathy may cause sensory and proprioceptive loss in the extremities and decreased range of motion [18]. Decrease range of motion lead to joint stiffness and gait abnormalities which increase the risk of injury of fall. Therefore, patients of diabetes need to perform foot exercise to improve blood circulation in the legs. Foot exercise positively influences other pathological factors associated with peripheral neuropathy, by promoting microvascular function and fat oxidation, reducing oxidative stress and increasing neurotrophic factors [4]. A prior study found out that significant differences in sensory peripheral neuropathy as measured using monofilament 10 g Semmes after receiving 4 weeks intervention of diabetic foot exercise [19].

Diabetic foot exercise performed in this study focuses on the range of motion of ankle and knee. The respondents was asked to sit and performed passive and active dorsiflexion of the ankles and metatarsophalangeal joints, plantar flexion, active subtalar joint pronation and supination, flexi and extension of legs and draw score from 0 to 9. In line with the intervention, a prior study also performing the same intervention and after 1 month of therapy, the author reported a statistically significant average decrease of 4.2% in peak plantar pressures and reduction in the joint limitation in the subjects performing the range-of-motion exercises [20]. Moreover, a study applied a-12 week supervised training program for joint mobility and muscular strength at the ankle revealed that ankle mobility of plantar flexion reduced about 36% and dorsal flexion by about 23% in diabetic patients [21].

Patients diagnosed with diabetes should be instructed in a home exercise program such as diabetic foot exercise, because it focuses on maintaining and improving range of motion in the ankle and foot. In addition, through the foot exercise, there is an enhancement of blood supply to extremity, potentially leading to formulation of new vascular structures [22]. Hence, the impairment in blood supply to peripheral nerves could be prevented or even reversed by exercise [23].

## 5. CONCLUSION

Diabetic foot exercise is an effective intervention to improve peripheral Neuropathy symptoms because it brings contribution to decrease neuropathy symptoms even not

statistically significant. The variables of gender and BMI have good correlation with the symptoms of neuropathy. This research recommend for diabetic patients the need for performing diabetic foot exercise 5 times per week and following healthy eating meal with active participation and support from family or peer thus will help diabetic decrease the symptoms of peripheral neuropathy and decrease of fasting blood glucose. It would be better if the respondents have > 5 years duration of DM and the neuropathy symptoms are more visible thus the results will be more manifested.

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