

**FFECTIVENESS OF RESISTANCE EXERCISE AND DIABETIC FOOT SPA INTERVENTIONS ON FASTING BLOOD SUGAR LEVELS AND PERIPHERAL NEUROPATHY IN TYPE II DIABETES MELLITUS CLIENTS**

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| ***Keywords***:Diabetes, Resistance, Exercise, Foot, Spa, Neuropati | **ABSTRACT**Background: Diabetes mellitus is one disease that has a distinctive clinical sign, namely an increase in blood sugar levels beyond the normal range. DM can also cause complications such as peripheral neuropathy. Interventions that can be applied in dealing with the above problems are Resistance exercise and Diabetic Foot Spa. Objective: The purpose of this study was to determine the effectiveness of resistance exercise and diabetic foot spa on fasting blood sugar levels and peripheral neuropathy in Type II Diabetes Mellitus clients. Method: This study is a true experimental research using pre test and post test approach with control group design. Sampling was carried out using a simple random sampling technique and obtained 40 DM patients who sought treatment in the work area of the Srondol Health Center, which were divided into 2 groups (Intervention and Control). Statistical analysis Pre-Test Post-Test difference test using Paired T-Test difference test and Wilcoxon test then Inter-group difference test using Independent T-Test and Mann Whitney U-Test. Results: This study showed that there were significant differences before and after the combination treatment of Resistance exercise and Diabetic Foot Spa on fasting blood sugar levels values (p = 0.000), and peripheral sensory neuropathy responses (p = 0.031), Dorsiflexion (p = 0.003), Plantarflexion (p = 0.011), Inversion (p = 0.000), Eversion (p = 0.018), autonomic neuropathy (p = 0.108), while Resistance exercise and Diabetic Foot Spa did not have significant differences in motor neuropathy response foot deformity (p = 1,000) and autonomic neuropathy (p = 0.108). Conclusion: Resistance exercise and Diabetic foot spa interventions are effective against fasting blood sugar levels and peripheral sensory, motor neuropathy (joint area of motion) in type II diabetes mellitus clients. |

**INTRODUCTION**

Diabetes Mellitus (DM) is a chronic disease characterized by blood glucose levels exceeding normal and impaired carbohydrate, fat, and protein metabolism caused by relative and absolute lack of the hormone insulin. If this is left unchecked, acute metabolic complications and long-term vascular complications can occur, both microangiopathy and macroangiopathy (Vadivelu and Vijayvergiya, 2018).

The prevalence of Diabetes Mellitus patients in the world from year to year has increased, Based on the Indonesian Diabetes Federation (IDF) Diabetes (Atlas *et al.*, 2019), states the prevalence of DM in 2019, as many as 425 million people aged 20-79 years suffer from diabetes mellitus. As of May 14, 2020, the IDF reported that 463 million adults worldwide have diabetes with a global prevalence of 9.3% 2.3, 4. Indonesia is ranked 6th in the world with 10.3 million people with diabetes and is expected to increase in 2030 to 21.3 million people which will make Indonesia ranked 4th in the world after China, India and the United States (Fernandez, Almaazmi and Robinson, 2020).

The number of Diabetes Mellitus cases in Central Java Province in 2018 was 525,308 people and in 2019 there was an increase to 652,822 people, and 83.1 percent had been given 5.6 health services.

Type II diabetes mellitus is a group of metabolic diseases characterized by hyperglycemia, occurs due to abnormalities in insulin secretion, insulin work or both caused by insulin resistance or pancreatic beta cell dysfunction (Ozougwu *et al.*, 2013). The main problem in type II diabetes mellitus is the lack of receptor response to insulin due to the presence of this disorder insulin cannot help the transfer of glucose into cells (Nauck and Müller, 2023).

Nurses play a major role in the implementation of blood sugar management and peripheral neuropathy. Nurses as care providers or direct care providers to patients can make complementary therapy a form of nursing intervention (Heydari, Manzari and Pouresmail, 2023). Complementary therapy that can be done is complementary exercise therapy which is recommended to be done in conjunction with complementary therapy group manipulative therapy and body systems, namely hydrotherapy (Tabish, 2008).

Physical exercise has an important role in regulating blood glucose levels in patients with type 2 diabetes mellitus lack of response from insulin (insulin retention) so that glucose cannot enter the cells because the membrane permeability to glucose increases when muscles contract because muscle contractions have insulin-like properties, When body activity is high, the use of glucose by muscles will also increase. Endogenous glucose synthesis will be enhanced to keep blood glucose levels balanced.

The American Diabetes Association (ADA) and the Indonesian Society of Endrokrinology (PERKENI) have recommended resistance exercise for type 2 DM patients so that this resistance exercise has been proven to be good for DM12 patients. The results of the study on "Resistance Exercise to Diabetic Neuropathy Improvement in Type II DM Patients showed that resistance exercise has an influence on peripheral neuropathy, namely sensory response with neuropathy complaints p = 0.001 and foot protection sensation p = 0.001, autonomic response p = 0.040 and ankle brachial index p = 0.0018.

One of the factors that can affect peripheral blood circulation and improve diabetic peripheral neuropathy is with foot care included in the Diabetic foot spa range 13, 14. According to the theory of recovery (rest and recovery) after doing physical exercise activities it is recommended to do recovery to restore muscle strength, as well as to regenerate muscles that have been damaged during exercise, both actively and passively. Light running, leisurely swimming, low-intensity exercise are active recoveries, while passive recovery is spa (Greenfield, 2014). Research related to diabetic foot spa in type II Diabetes Mellitus patients with results in the treatment group after diabetic foot spa obtained sensory neuropathy results were P = 0.00014 (Geetha, 2019). Another study on diabetic foot spa in patients with type II diabetes mellitus showed there was a difference in the average increase in foot sensation in the treatment group of 4.3 and after being given diabetic foot spa for four weeks there was an average foot protection sensation score of 1.3. This showed a decrease in score after being given diabetic foot spa with an average of 2.9 where p = 0.023 given diabetic foot spa intervention and diabetic foot gymnastics compared to only diabetic foot exercises (Loureiro *et al.*, 2017).

Both resistance exercise and diabetic foot spa interventions showed statistically significant results but clinically have not shown significant results where previous studies mostly fasting blood sugar values of respondents have not been close to normal ranges, and have not maximized improvement in peripheral neuropathy where there are still symptoms of sensory, motor and autonomous neuropathy. The effect size obtained by researchers on the improvement of peripheral neuropathy (sensory and motor) was weak with an average of 0.246 – 0.375, and for a decrease in fasting blood sugar by 0.451 – 0.521

The duration of the implementation of resistance exercise intervention and diabetic foot spa recommended by PERKENI is for ± 30 minutes, with a frequency of 3x / week for 4 weeks The opening of capillary meshes in muscles that are actively moving during exercise which affects increased blood flow so that receptors become more active and / or the availability of insulin receptors takes ≥ 30 minutes8. The frequency of exercise must also be done regularly and regularly because this will affect the results to be achieved. Exercises that are not done regularly cause the condition of the muscles to return to their original state and stiff (Krzysztofik *et al.*, 2023). In exercises that aim to increase endurance can be done as much as 3 times a week, this is related to the recovery period of the energy supply system used in the exercise (Balducci *et al.*, 2014). According to PERKENI, the recommended exercise for patients with Type II diabetes mellitus is done regularly 3 times per week for about 30 minutes, for a total of 90 minutes per week (Utami and Kusumaningrum, 2021).

Based on the description above, it can show that resistance exercise and diabetic foot spa can improve fasting blood sugar levels and peripheral neuropathy (Jahantigh Akbari *et al.*, 2020). So far, the research carried out has only used one variable, namely resistance exercise and diabetic foot spa, each of which is aimed at fasting blood sugar and diabetic neuropathy.

Based on the description above, it is necessary to conduct research on the Effectiveness of Resistance exercise and Diabetic Foot Spa on Fasting Blood Sugar Levels and Peripheral Neuropathy.

**Problem Statement**

Based on the description above, various problems can be identified as follows:

1. The prevalence of Diabetes Mellitus patients in the world, Indonesia and Central Java Province has increased from year to year. On May 14, 2020, the IDF reported that 463 million adults worldwide have diabetes with a global prevalence of 9.3%5,2,3. Indonesia is ranked 6th in the world with 10.3 million people with diabetes and is expected to increase in 2030 to 21.3 million people 5.2 people. Central Java Province in 2018 was 525,308 people and in 2019 there was an increase to 652,822 people5, 6

2. The main problem in type II diabetes mellitus is a hyperglycemia condition where there is a lack of receptor response to insulin due to the presence of the disorder insulin cannot help the transfer of glucose into cells 16.

3. Clients with Type II DM have a triad of neuropathy namely peripheral/sensory neuropathy, motor neuropathy and autonomic neuropathy which are complications of diabetic foot8.

4. Provision of interventions Resistance exercise and diabetic foot spa interventions are activities that can be done by people with type II diabetes mellitus to lower fasting blood sugar levels and increase foot sensitivity.

Based on the background and problem identification, the problem formulation of the research is:

**General Problem Statement**

*Are resistance exercise and diabetic foot spa interventions effective against fasting blood sugar levels and peripheral neuropathy in Type II Diabetes Mellitus clients?*

**Special Problem Formulation**

*Is the intervention of resistance exercise and diabetic foot spa with a duration of ± 30 minutes for 3x a week for 4 weeks, effective against fasting blood sugar levels and Sensory, Motor and Autonomic Peripheral Neuropathy in Type II Diabetes Mellitus clients?*

**Research Objectives**

**General Purpose**

*The general objective of this study was to determine the effectiveness of resistance exercise and diabetic foot spa interventions on fasting blood sugar levels and peripheral neuropathy in Type II Diabetes Mellitus clients*

**Special Purpose**

a. Analyzing the effectiveness of resistance exercise intervention and diabetic foot spa with a duration of ± 30 minutes for 4 weeks on fasting blood sugar levels in type II diabetes mellitus clients

b. Analyzing the effectiveness of resistance exercise and diabetic foot spa interventions with a duration of ± 30 minutes for 4 weeks on sensory, motor and autonomous peripheral neuropathy in type II diabetes mellitus clients.

**RESEARCH METHODS**

Based on figure 3.1 of the theoretical framework and in accordance with the objectives in this study, the dependent variable is while the independent variables are Resistance exercise and Diabetic foot spa. There are Confounding variables in the form of Age, Gender, length of suffering from DM, and Body Mass Index. This study aims to analyze the effectiveness of Resistance Exercise and Diabetic Foot Spa Interventions on Sensory, Motor and Autonomous Peripheral Neuropathy.

**Hipotesis**

The hypotheses in this study are:

**Major Hypothesis**

Ha : Intervention of resistance exercise and diabetic foot spa is effective against fasting blood sugar levels and peripheral neuropathy in Type II Diabetes Mellitus clients.

**Hipotesis Minor**

a. Provision of Resistance Exercise and Diabetic Foot Spa Intervention with a duration of ± 30 minutes for 3 x a week for 4 weeks is effective against Fasting Blood Sugar levels.

b. Intervention Resistance Exercise and Diabetic Foot Spa with a duration of ± 30 minutes for 3 x a week for 4 weeks is effective against Sensory, Motor, and Autonomous Peripheral Neuropathy.

**Research Type and Design**

This type of research uses True-Experimental research with Pretest-Posttest Control Group Design. Researchers arranged two groups, namely the resistance exercise intervention group with diabetic foot spa and the control group of diabetic foot spa. Examination of fasting blood sugar levels and peripheral neuropathy is done 2 times, namely on day 1 (pre test), and day 28 (post test).

**RESULTS AND DISCUSSION**

This chapter describes the results of research that has been obtained during data collection carried out from April 13 to May 14, 2022 in the Working Area of the Srondol Banyumanik Health Center (Sidabalok, 2023). During this period, 40 respondents met the inclusion and exclusion criteria (Pearson *et al.*, 2019). Respondents were divided into two groups, namely the intervention group and the control group (Yuliar, Susanah and Nurhidayah, 2019). The intervention group received resistance exercise and diabetic foot spa interventions given 3x / week for 4 weeks with a duration of ± 30 minutes depending on the tolerance level of each client (Zeidabadinejad, Mangolian Shahrbabaki and Dehghan, 2021). While the control group was only given diabetic foot spa treatment (Chatchawan *et al.*, 2015).

**Research Site Overview**

This research was conducted in the Working Area of the Srondol Health Center in Semarang City which consists of three villages, namely Srondol Kulon Village (number of RW 11 and RT 63), Srondol Wetan Village (number of RW 18 and RT 48) and Banyumanik Village (number of RW 10 and RT 53). Banyumanik Village, which is one of the working areas of the Srondol health center, does not yet have a health post in the village, it's just scheduled in mobile puskesmas (kesling) activities every month. Banyumanik Village has 10 RWs and 53 RTs with a population of 139,927 people with a population based on male sex 69,203 people and female 70,724 people. The target population in this study is Diabetes Melittus type II sufferers while the research study population is Diabetes Melittus type II sufferers in Banyumanik with a total of 40 respondents. 20 respondents as an intervention and control group were in RW 4.

Researchers provide a combination intervention of resistance exercise and diabetic foot spa performed to lower fasting blood sugar levels and improve peripheral neuropathy (sensory, motor, autonomy). During the study, the consumption of pharmacological therapy in the form of anti-hyperglycemia drugs was still given according to a doctor's prescription because the research treatment was only complementary. During the research process, researchers and enumerators routinely check the monitoring sheet for compliance with the implementation of treatment.

This chapter discusses the results of research that has been carried out by comparing the results of research that has been described in chapter IV with other theories and research that has been done previously

**The Relationship of Respondent Characteristics and Confounding Variables**

against Fasting Blood Sugar Levels and Peripheral Neuropathy

**Gender**

The sex of respondents statistically in both groups was also the same or homogeneous (p = 1,000) where men amounted to 8 people and women amounted to 12 people in each group (n = 40). The results of this study are in line with Krismiyati's research where women who have experienced menopause and are said to suffer from type 2 diabetes based on the results of blood sugar levels of 30 people (88.6%), the results of this study are in line with Krismiyati's research (2019), it was found that the occurrence of type 2 diabetes mellitus in menopausal women was 33.3%.101

Basically, in the early adult phase, clients with male and female gender have the same risk of suffering from diabetes mellitus, but after the age of 30 years, the female gender is at greater risk of suffering from diabetes mellitus, especially for clients who have suffered from gestational diabetes mellitus. A study shows that diabetes mellitus is easily found in women, even the ratio reaches 2: 1, it happens because in women there is often a hormonal imbalance after menopausal clients. Such hormonal changes and imbalances in such women can affect insulin sensitivity in a person.

**Age**

The average age of respondents in this study was 56.20 (n = 20) in the intervention group and 58.20 (n = 20) in the control group. This is in line with research conducted by Fahmiyah which states that groups that have a risk of suffering from type 2 DM are generally over 45 years old. The average age of patients who had uncontrolled GDP levels was older than the age of patients who had controlled GDP, which was 54.76 years and 60.82 years respectively shown, while the average age of 50 patients was 56.82 years103.

The results of the logistic regression test showed that the β value for the age variable to fasting blood sugar levels was 0.937 which means that the age variable is not a confounding variable of fasting blood sugar levels.

Age is one of the factors that can affect blood sugar levels and cannot be modified. Fasting blood sugar levels and a person's age have a graph that is directly proportional, meaning that the higher a person's age, his blood sugar levels will also increase. Age is closely related to the increase in blood sugar levels, the older the risk for experiencing DM tpe II is higher.

The aging process can result in changes in the anatomical, physiological, and biochemical systems of the body, one of the impacts of which is an increase in insulin resistance which will cause diabetes mellitus. Cells in the elderly experience a lack of energy (glucose), as compensation there is a breakdown process of glycogen stored in the muscles, so that energy reserves in the muscles become reduced and muscle atrophy occurs, this is what causes a decrease in the effectiveness of insulin receptors which causes an increase in blood sugar levels, and if not handled properly it will cause various complications98.

**3. Education**

The majority of respondents' last education was elementary school as many as 19 respondents from both groups (n = 40). Education is one of the benchmarks of knowledge, habits and lifestyle. In addition, education also affects the ability of a respondent to receive new knowledge and information, one of which is about diabetes mellitus management. A person with higher education will generally seek information regarding medication and self-care. So it can be concluded that education is a basic factor in the success of a treatment.

The results of this study are in line with Irawan's statement (2010) which states that there is a relationship between the level of education and the incidence of diabetes mellitus. People with a high level of education will be more able to accept themselves as sick people if they experience symptoms related to a disease compared to lower education groups of society. People with higher levels of education are also indicated to seek help from health teams faster than people with lower social status. The group of people with higher education will usually have more knowledge about health and with this knowledge, the group of people who have high knowledge will have awareness in maintaining their health. Higher education levels tend not to get type two Diabetes Mellitus because they will usually have a lot of knowledge about health.

**4. Work**

The work of respondents in this study is mostly working as housewives. Respondents did less physical activity outside the home and only did light activities inside the house such as cooking, washing, sweeping, and others. A person's physical activity has a significant relationship with the occurrence of type II DM.

A person's physical activity contributes 30-50% to reducing the progression of type II diabetes. Physical activity can improve glucose tolerance in the blood and reduce risk factors for type II diabetes. In addition, less physical activity causes a decrease in blood flow, especially peripheral blood flow, causing a decrease in peripheral neuropathy values.

**5. Long Suffering from DM**

The majority of respondents in this study suffered from DM >5 years. The duration of suffering from DM can worsen the state of blood vessels. Diabetes mellitus can interfere with the function of the endothelial lining in the arteries. This layer is a biologically active organ because of its ability to produce vasodilator substances called endothelium derived relaxing factors (EDRF) also known as Nitric Oxide (NO) 45. NO is an important stimulus of vasodilation and reduces the occurrence of inflammation through modulating the interaction of leukocytes and blood vessel walls. The loss of NO will disrupt blood vessels which will cause atherosclerosis. Therefore, the increase in vascular complications in diabetics depends on the length of time the person has had diabetes mellitus and how their blood guda control. The longer a person suffers from diabetes mellitus, the risk of atherosclerosis increases and the tendency for peripheral neuropathy values to decrease so that it occurs kerusakan saraf perifer 76.

**6. Body Mass Index (BMI)**

In this research conducted shows that the percentage of BMI (Body Mass Index) respondents above the normal range is very large. Some respondents have BMI which is classified into the overweight group, and obesity. BMI (Body Mass Index) is one of the factors that can affect a person's blood sugar levels.

The results of research conducted by Wulandari showed that clients with BMI > 23 kg / m2 have a risk in the form of increased blood sugar levels up to 200 mg / dL. In relation to BMI (Body Mass Index), clients with BMI classified as obese are factors in the occurrence of type 2 diabetes mellitus and even contribute up to 55%. In clients with obese BMI there will be an increase in abdominal fat depositaswhich secrete adepokine hormones and substances that secrete inflammation, so that insulin receptors will and sensitivity will also decrease.

**Intervention of Resistance Exercise and Diabetic Foot Spa on Fasting Blood Sugar Levels of Type II DM Clients**

The bivariate analysis used in this study was the mann whitney u-test which showed that the average value of fasting blood sugar levels in the intervention group and the control group there was a significant difference p = 0.000, which means that the resistance exercise intervention and diabetes foot spa were effective for lowering fasting blood sugar levels in patients with type II diabetes mellitus.

The RRR value in the intervention group was 0.68, meaning that if resistance exercise and diabetic foot spa were used as treatment, fasting blood sugar levels could decrease by 68%. The above results are in line with another study where physical exercise was performed (Rubber Resistance Band Exercise) for 30 minutes 3 times a week for a month where among 32 respondents, 50% were equal between men and women. The average age of respondents 65 years (ranging from 46-75 years) showed that blood sugar levels ranged from 237.5 mg / dL to 180.5 mg / dL. The results showed blood sugar levels decreased by 57 mg / dL (p = 0.001).

The effect of resistance exercise on blood glucose levels of patients with type 2 diabetes mellitus occurs because foot exercises cause contraction of lower extremity muscles to increase such as hip flexor muscles, knee flexors and especially ankle drive muscles (dorsal flexor, plantar flexor, invertor, and evertor) and intrinsic muscles of the toes. These muscle contractions cause increases in Ca2+, AMP, ROS, and mechanical while insulin signals the insulin receptor substrate and PI 3-kinase which causes cooperation between insulin and exercise to phosphorylate AS160 and TBC1D1 in activating GLUT4 translocation so as to increase glucose uptake in muscle.

When there is an increase in GLUT4 translocation, it will increase the glucose uptake capacity in the tissue. In the tissues, glucose will be converted into ATP (energy). The more GLUT4 expression, the amount of glucose in the blood becomes reduced due to the increase in blood glucose transported into tissue 106.

In addition to resistance exercise, the recommended activity as complementary exercise companion therapy is hydrotherapy that effectively lowers fasting blood sugar levels where respondents are given diabetic foot spa therapy.

Diabetic foot spa is an action by soaking feet using water with a temperature of 380C to 400C which can increase glutathione metabolism, cell antioxidants to prevent oxidative damage that has an impact on preventing nerve damage / peripheral neuropathy and increased blood flow to the arteries so that glucose metabolism is well maintained and or can prevent diabetic neuropathy13. The biological effects of a warm water soak can lead to dilation of blood vessels which can result in improved blood circulation13. Both actions can improve peripheral circulation which is one way to lower blood sugar levels and can stimulate glucose use by active muscles13. This happens because the action of diabetic foot spa can improve blood circulation due to increased vasodilation of blood vessels as a result of the thermal effects of foot immersion13. While the mechanism of vasodilation in resistance exercise is caused by leg muscle activity with good and regular movements help increase arterial and venous blood flow by opening capillaries thereby increasing blood vessel dilation as a result of increased oxygen demand in tissues98. The control group in this study was only given pharmacological therapy and diabetic foot spa for 28 days. In this study, calorie intake and carbohydrate intake in both groups were not studied. This may affect fasting blood sugar levels in the control group so that it increases. The mechanism of action of diabetic foot spa to lower blood sugar levels is to help in the smooth running of peripheral circulation so that glucose transport increases, as well as the mechanism of action of drugs in lowering blood sugar levels is to stimulate the pancreas gland to increase insulin production, decrease glucose production in the liver, inhibit carbohydrate digestion so as to reduce glucose absorption and stimulate receptors.

There is another factor that also plays a role in lowering fasting blood sugar levels of people with diabetes mellitus during the study, namely the ability of individuals to do self-care. Diabetes self-care is an action that a person takes to control diabetes by taking medication and prevention of complications. Self care is very important to be done by patients with type II diabetes mellitus to prevent complications. Self-care carried out by patients with diabetes mellitus is closely related to the theory put forward by Orem in nursing theory.

Orem's theoretical view in the nursing service setting is addressed to the needs of individuals in carrying out independent nursing actions and managing all their needs. In the concept of nursing practice, Orem developed three forms of theory, namely self-care theory which describes why and how humans care for themselves, self-care deficit theory describes and explains why humans need nursing assistance, and nursing systems theory which describes how nursing care can be provided to humans.

Self Care theory is a relationship between therapeutic self care demans and the power of self care agency. Therapeutic self care demans are self-care needs that must be met within a certain period of time with the aim of meeting known self-care needs. While self-care agency is the ability or power possessed by an individual to identify, establish, make decisions and implement self-care. When there is an imbalance between therapeutic self care demans and self care agency, self-care deficit occurs. The ability of type II DM patients in carrying out didi treatment also refers to the theory of Orem.

Each patient has their own ability to perform self-care and the self-care needs of each patient are different. This difference in self-care ability in patients is what causes differences in fasting blood sugar level scores in type II diabetes mellitus patients. To compare the results of the researcher's research with other researchers, Cohen's effect size calculation was used. Cohen's effect size in research conducted by Pratiwi is 0.70 which means resistance exercise has a moderate influence on blood sugar levels. While the results of calculating Cohen's effect size in the study , resistance exercise intervention and diabetic foot spa to lower fasting blood sugar levels is 1.94, which means resistance exercise and diabetic foot spa have a strong influence on fasting blood sugar levels. The results of statistical tests conducted by pratiwi, and researchers both have significant differences (p = <0.05). However, judging from the results of calculating Cohen's effect size that the study conducted by Pratiwi has a lower effect size value of Cohen's compared to this intervention study, which means that the provision of resistance exercise and diabetic foot spa has a greater effect on fasting blood sugar levels than the provision of resistance exercise without intervention.

**Intervention of Resistance Exercise and Diabetic Foot Spa on Peripheral Neuropathy (Sensory, Motor, Autonomous) of Type II DM Clients**

**1. Intervention of Resistance Exercise and Diabetic Foot Spa on Sensory Neuropathy of Type II DM Patients**

After bivariate analysis, the average value of peripheral sensory neuropathy in both groups before and after treatment changed. The sensory peripheral neuropathy sensation of the intervention group increased after treatment and was included in the category of peripheral sensory sensation either because it felt more than 7 sensation points given on one or both legs (p = 0.000), while the average value of peripheral sensory neuropathy sensation in the control group was included in the sensory category less (p = 0.000).

The decrease in blood flow as a result of changes in viscosity spurs increases its compensation in perfusion pressure so that it will increase transudation through the capillaries and will further increase the viscosity of the blood. Further peripheral ischemia is due to an increased affinity of glycolated hemoglobin to oxygen molecules75. This is a trigger for the formation of microthrombosis and tissue hypoxia, resulting in disrupted axonal transport and decreased activity of Na+/K+ ATP ase, this can slow down the viscosity of nerve conduction. Provision of stimulation in the form of exercise can generate action potentials that cause depolarization which results in increased activity of Na+/K+ ATP ase, axonal transport is improved, patients feel sensory sensations or sensory responses.

Resistance exercise plays a role in controlling blood sugar levels. Decreased sugar levels in the blood will improve nerve myelin and axon function so that DM sufferers will be able to feel pain, heat, vibration and pressure or it can be said that nerve endings experience conduction repair and return sensitive in protection against risky conditions by being detected by examining foot protection sensations using the Seemes-Weinstein Monofilament Test 10gr8.

Diabetic foot spa can improve peripheral circulation and increase vasodilation which has an effect on increasing nitric oxide and inhibiting the activity of Aldose Reductase so as to prevent oxidative damage that affects nerve damage / peripheral sensory neuropathy and increase glutathione metabolism8.

 The results of this study prove that interventional resistance exercise therapy and diabetic foot spa can increase the value of sensory neuropathy seen from the value of Cohen's d Effect is 0.87 which means very strong. Because in previous studies no one has examined resistance exercise and diabetic foot spa on the value of sensory neuropathy, researchers can only compare this study with previous studies on resistance exercise to the value of sensory neuropathy studied by Affiani, et al. The results of statistical tests that Affiani, et al and researchers both have significant differences (p = <0.05)8.

However, when viewed from the average value of peripheral sensory neuropathy after treatment in the study conducted by Affiani, et al had an average value of <7 while in this intervention study the average value of sensory neuropathy >7 included in the normal category (no neuropathy occurred). This means that the administration of resistance exercise and diabetic foot spa has a greater effect on increasing the value of sensory neuropathy compared to the provision of resistance exercise alone without intervention.

**2. Intervention of Resistance Exercise and Diabetic Foot Spa against Motor Neuropathy (Foot Deformity) of Type II DM Clients**

Based on bivariate analysis in this study, it was found that the average value of peripheral motor neuropathy (leg deformity) did not change in both groups before and after treatment (p = 1,000),

The mechanism of developing foot deformity in people with DM is not well understood, but there are several theories that state that foot deformity occurs due to weakness of leg muscles and poor joint mobility. Motor neuropathy is believed to cause intrinsic muscles to become weak so that it can make the balance of movement between the toes, flexion and extension weak. Atrophy of the small muscles of the foot is the cause of plantarflexion movement of the toes which results in the development of hammer toes, claw toes, prominent metatarsal head and pes cavus. The area of the foot that has a deformity causes high foot pressure so this is what triggers the callus in the area 75.

Based on the results of these studies and theories, researchers concluded that the cause of no change in foot deformity after intervention is due to the process of the mechanism of formation of foot deformity which requires a relatively long time which begins with intrinsic muscle weakness causing imbalance of toe movement then in a long time the burden of a person's body will change and cause abnormal emphasis on the foot area and along Over time the toes and foot shape will change such as flat feet, hammer toe, overaapping toes, hallux vagus, prominent metatarsal head, clavus (fisheye) and callus (calluses) therefore based on this mechanism, intervention to reduce foot deformity requires a relatively long time so that with the intervention of resistance exercise and diabetic foot spa within a period of 4 weeks it is felt that it has not been able to change the shape of foot deformity.

**3. Intervention of Resistance Exercise and Diabetic Foot Spa against Motor Neuropathy (Dorsiflexion, Plantarflexion, Inversion and Eversion) of Type II DM Patients**

From the results of bivariate analysis, the average LGS dorsiflexion value changed in both groups before and after treatment (p = 0.000), the LGS Dorsiflexion value in the Intervention group increased after treatment and was included in the LGS Dorsiflexion Good category with LGS angle (>10º-15º) (p = 0.000), while the average value in the control group was also included in the Dorsiflex Good category (p = 0.000).

LGS Plantarflexion values changed in both groups before and after treatment, LGS Dorsiflexion values in the Intervention group increased after treatment and were included in the LGS Plantarflexion Good category with LGS angles (>25º- 37.5º) (p = 0.000), while the mean values in the control group were also included in the Good dorsiflexion category (p = 0.001).

The Inversion LGS value changed only in the Intervention group before and after treatment (p = 0.000), the Inversion LGS value in the Intervention group increased after treatment and was included in the Normal Inversion LGS category with LGS angle (26.25º-35º), while the average value in the control group was still included in the Good inversion category (17.5º- 26.25º) (p = 0.053).

LGS Eversion values changed only in the Intervention group before and after treatment (p = 0.000), LGS Eversion values in the Intervention group increased after treatment and were included in the Normal Inversion LGS category with LGS angles (> 11.25º), while in the control group included in the Good eversion category (>7.5º-11.25º) but not significant (p = 0.141).

The results of this pretest examination prove that the average joint area of motion is still in the normal and good category which means that joint motion can move fully and there are no obstacles, respondents do not feel complaints when the examination is carried out but there are several respondents with fair and poor categories of respondents stating that around the foot rim feels sore and uncomfortable when moved so that when examined with dorsiflexion movements, Plantarflexion, eversion and inversion of movement is not maximal or not full and movement there is resistance. The respondent's ankle was observed and the results found no swelling or redness, only complaints of sciatica in the ankle so that when the intervention will be carried out, researchers wait for the complaints felt by respondents to disappear or decrease. Intervention is carried out after complaints disappear or decrease and respondents feel able to intervene, there is no compulsion from researchers to intervene if respondents still have complaints due to resistance exercise movements and diabetic foot spa focuses on movement around the ankle joint.

This respondent's complaint was supported by Frykberg who explained that based on scientific evidence, DM sufferers tend to experience limited joint motion compared to non-diabetic patients. Somatosensory deficits in people with diabetes with neuropathy can include loss of spindle function of the lower leg muscles, loss of perception of movement in the ankle joint and loss of protective sensation of the sole of the foot. Limited joint mobility is often found in people with diabetes who experience increased stiffness of the articular capsule, ligaments and tendons. This can lead to postural instability and increase the risk of falling10. In addition, respondents in this study were most in the elderly age group where decreased flexibility in the elderly occurred in joints, connective tissue and bones that degenerated so that the elasticity of connective tissue and cartilage was reduced. Changes in the elasticity of muscle fibers also affect flexibility in which connective tissue within muscle fibers increases.

 According to the American College of Foot and Ankle Surgeons (2017) nerve damage that occurs includes sensory nerves (the ability to feel pain, temperature and sensation), motor nerves (strength and muscle tone), and autonomic nerves (unconscious body functions such as sweating so that the skin becomes dry and cracked), in type II DM patients these symptoms can develop at any time and often occur very early.

The intervention carried out is diabetic foot spa, which is an activity carried out by DM patients to help improve blood circulation in the legs, improve blood circulation and strengthen the small muscles of the legs, prevent foot deformities, The same is also explained by Widianti, that the purpose of diabetic foot spa is to improve blood circulation, in the joints will cause increased blood flow into the joint capsule and provide nutrients that allows bones to move smoothly and without pain or discomfort, strengthens small muscles, prevents foot deformities, increases calf and thigh muscle strength and overcomes joint motion limitations.

The second intervention is resistance exercise which can cause contraction of lower extremity muscles such as hip flexor muscles, knee flexors and especially ankle drive muscles (dorsal flexor, plantar flexor, invertor, and evertor) as well as intrinsic muscles of the toes. So it is expected that when respondents apply this intervention, the perceived complaints are reduced, the area of motion of the ankle joint can move freely without obstacles and change to the good and normal categories.

Zimny's study was randomized and controlled on the effects of a six-week home exercise program. The parameters measured were the first metatarsophalangeal LGS (MTP), talocular joints and gait in patients with type 2 DM. Ten respondents participated in a home exercise program developed according to American College of Sports Medicine guidelines. The exercise program consists of 5-10 minutes of warm-up walks, heel raises, toe raises and towel raises (dorsiflexion, eversion and inversion) performed three times a week for six weeks. The results of the study found only significant plantarflexion ROM to the exercise program but no significant change in gait76. This is due to the relatively short duration of the intervention. DM patients should be instructed in home exercise programs that focus on maintaining or increasing range of motion in the ankle and in the legs, one of which is the intervention carried out in this study, namely resistance exercise in the intervention with diabetic foot spa.

**4. Intervention of Resistance Exercise and Diabetic Foot Spa on Autonomic Neuropathy of Type II DM Patients**

Based on bivariate analysis in this study, the average value of Autonomic Neuropathy did not change where the intervention group (p = 0.007) and the control group (p = 0.157) did not experience an increase in hydrosis score (leg anhidrosis occurred), this is because autonon neuropathy is not only influenced by sweat glands, but blood pressure, digestive function and bladder function were not observed in this study.

Autonomic neuropathy or what is usually referred to as sudomotor neuropathy occurs due to increased distal artery flow and the pressure makes sympathetic nerve damage that affects the decrease in sweat gland production with symptoms such as anhydrosis, dry and cracked foot skin in the feet, especially between the toes so that it becomes a place of entry of bacteria into the body (Frykberg et al., 2006).

Inspection of the foot can detect autonomic neuropathy, 60% of patients who recover from an ulcer within one year will be at risk of becoming another ulcer because the pressure in the plantar increases and the skin cracks. Sweat has an important protective role and in the presence of autonomic neuropathy characterized by dry skin it will be a trigger in the pathogenesis of foot ulcers. When sweat gland function is lost due to autonomic neuropathy, the risk of foot ulcers is very high.

Resistance exercise and diabetic foot spa interventions can inhibit the activation of the enzyme aldose reductase resulting in a decrease in sorbitol levels. Decreased oxidative stress will improve Na+/K+ ATP-ase activity and signal transduction will improve and foot sensitivity will improve. Increased peripheral perfusion also makes sweat gland production increase, so it is hoped that this intervention can help respondents who at the time of initial examination of white prespiration test results improve with blue prespiration test results, which means the soles of the feet sweat.

**Research Limitations**

This research has several limitations or shortcomings and requires better research. Limitations in this study, include:

1. Researchers cannot control the food consumed and cannot control the stress experienced by respondents during the study so that it can affect the results of the study, especially in checking blood glucose levels.

2. This study uses various instruments and variables so that effective time adjustments are needed in the process of taking pretest and postest data

3. This study did not conduct examinations that can affect the occurrence of neuropathy such as HDL levels, LDL levels and triglyceride levels

**CONCLUSION**

Based on the research objectives obtained from the results of data analysis and discussion, the researchers' conclusions are as follows: 1) Resistance Exercise Intervention and Diabetic Foot Spa with a duration of ± 30 minutes for 4 weeks effective against fasting blood sugar levels in Type II Diabetes Mellitus clients with a value of (p = 0.000) where the average decrease that occurs is -29.41 mg / dL, And evidenced by the clinical significant results of effect size 1,949 which is included in the category of very strong effect size. 2) Resistance exercise and diabetic foot spa intervention with a duration of ± 30 minutes for 4 weeks effective against sensory neuropathy and motor area of motion (LGS) of type II diabetes mellitus clients with sensory values (p = 0.031), Dorsiflexion (p = 0.003), Plantarflexion (p = 0.011), Inversion (p = 0.000), Eversion (p = 0.018) with an average increase in sensory values (3 foot sensation points), Dorsiflexion (3,030), plantarflexion (6,820), inversion (6,800), eversion (7,690) and proven by clinically significant effect size results included in the effect size category are very strong, while resistance exercise intervention and diabetic foot spa with a duration of ± 30 minutes for 4 weeks were not effective in the variables motor neuropathy foot deformity (p = 1,000) and autonomic neuropathy (p = 0.108) and there was no difference in value increase before and after treatment was proven With clinically significant results of effect size foot deformity which is included in the category of low effect size (0.369) and moderate autonomic neuropathy (0.682)

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