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# EFFECT OF LEG EXERCISE ON THE ANKLE BRACHIAL INDEX OF TYPE 2 DIABETES MELLITUS PATIENTS IN REJANG LEBONG REGIONAL HOSPITAL

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## ABSTRACT

**Introduction:** Peripheral arterial disease often occurs in patients with type 2 diabetes mellitus. Peripheral arterial disease in patients with type 2 diabetes mellitus occurs due to decreased blood circulation in the lower extremities. Looking at the value of the ankle-brachial index is one of the actions that can be taken to detect peripheral arterial disease. **Objective:** The purpose of this study was to determine the effect of a foot exercise intervention on the ankle-brachial index value of type 2 diabetes mellitus patients. **Methods:** This research was designed in quantitative research with a pre-experimental design, with one pre-test and post-test design. The research was carried out at Rejang Lebong Hospital from August to November 2020. The number of samples used in this study was 35 samples of patients experiencing type 2 diabetes mellitus for more than five years. The analysis used in this study was the Wilcoxon test. **Results:** The results showed a difference in the mean of the ankle-brachial index before (1.02) and after (1.12) the intervention. Thus, there was an increase of 0.10 in the average value of the ankle-brachial index. The analysis result of this study showed the value of $p = 0.001$ ($p < 0.05$). **Conclusion:** Foot exercise can be used as an alternative intervention to increase the value of the ankle-brachial index in patients with type 2 diabetes mellitus.

***Keywords: Foot Exercise; Ankle Brachial Index; Diabetes Mellitus Type 2***

## INTRODUCTION

Diabetes mellitus (DM) is a disease of glucose metabolism disorders that affects the macrovascular and microvascular systems; therefore, prevention of related complications is critical. Complications of glycemia with microvascular damage are now more in numbers and are also associated with the macrovascular disease. DM's increased cardiovascular risk is common in patients with poor metabolic control, longer duration of diabetes, or low ankle-brachial index (ABI). ABI is considered a risk modifier to increase stratification in patients with DM (Aboyans *et al.*, 2012).

Patients with DM with poorly controlled blood sugar levels have the potential to experience acute and chronic complications. Acute complications consist of hypoglycemia coma, ketoacidosis, nonketotic hypoglycemia coma; meanwhile chronic complications includes macroangiopathy that damages large blood vessels in the heart and brain (Ramadhan, Hadisaputro, & Rumahorbo, 2020).

DM is a severe disease and continues to increase. If action not taken immediately, it will cause various complications. Patients with type 2 DM often have difficulty controlling blood glucose levels, so it becomes a condition that dramatically affects the results of the ABI (Jumari, 2020).

Patients with type 2 DM have a higher risk of macrovascular disease, especially coronary heart disease, cerebrovascular disease, and peripheral arterial disease (PAD). PAD can lead to atherosclerosis. This disease becomes a cardiovascular risk factor (CV) with age (Potier *et al.*, 2011).

High Ankle Brachial Index (ABI) values are of clinical importance in diagnosing PAD in patients with type 2 DM (Li *et al.*, 2015).

Blood vessel diseases that often occur are coronary heart disease, cerebrovascular disease, and PAD. Vascular disease is a manifestation of atherosclerosis in patients with type 2 DM (Drachman & Beckman, 2015).

PAD is a frequent complication of type 1 and type 2 diabetes. It is complex pathogenesis of metabolic and vascular factors. Diabetes is a precursor to neuropathy, and hyperglycemia is only one of many major metabolic

events known to cause axonal and microvascular injury. Damage to tiny nerve fibres acts as a precursor to extensive nerve fibres damage that affects proprioception, innervates skeletal muscles, and mediates tendon reflexes (Johnson & Takemoto, 2019).

DM is a group of metabolic diseases characterised by hyperglycemia resulting from defects in insulin secretion, insulin action or both. Type 2 DM is a disease caused by a decrease in insulin sensitivity or a decrease in the amount of insulin production (Wahyuni, 2019). Type 2 DM is a group of diabetes accompanied by insulin resistance relative to insulin deficiency (Andarmoyo *et al.*, 2020).

Type 2 DM is a degenerative disease with an increasing number of sufferers characterised by hyperglycemia due to impaired insulin secretion, insulin performance, or both. Ineffective management in treating type 2 DM will cause complications such as PAD. One of the tests done to determine the condition of the lower leg blood vessels is the ABI (Mangiwa, *et al.*, 2017).

DM has become a global epidemic and accounted for the highest mortality rate in the world. One of its complications is PAD, a condition characterised by blockage of the arteries in the lower extremities. The PAD level of severity can be checked with non-invasive modalities such as ABI examination (Taufik *et al.*, 2015).

The most often complication that occurs in patients with type 2 DM is diabetic feet, and thus to prevent these complications, physical exercise in the form of diabetic foot gymnastics facilitates peripheral blood circulation (Trianto & Hastuti, 2017). Patients with type 2 DM are at high risk for PAD characterised by symptoms of intermittent claudication or critical limb ischemia (Gaikwad, 2015).

Complications occurring in patients with type 2 DM are related to macrovascular and microvascular dysfunctions. One of the interventions done to prevent complications of type 2 DM is lower extremity joint exercise. Early diagnosis is essential to assess the peripheral vascular disease. ABI is a non-invasive procedure performed on patients with type 2 DM to assess PAD (Hijriana *et al.,* 2016). An increased cardiovascular risk of diabetes mellitus is common in patients with poor metabolic control, a longer duration of diabetes, or a low ABI. ABI is considered a risk modifier for increasing stratification in patients with DM. The most likely diagnosis to detect and investigate PAD is to look at the value of the ABI (Potier *et al.*, 2011). The value of the ABI can be seen from the length of time the patient suffering from DM. Patients with DM for a long time will experience circulatory disorders in the upper and lower extremities (Suza *et al.*, 2020).

ABI is a tool used to predict cardiovascular events and functional disorders of lower limb PAD (Aboyans *et al.*, 2012). ABI is an accurate, simple, and non-invasive measurement for lower extremity arterial disease screening and is considered the most accurate non-invasive diagnostic method for PAD in DM patients (Li *et al.*, 2015). PAD can be diagnosed noninvasively by measuring the ABI (Høyer *et al.*, 2013) by detecting possible PAD in the lower limbs in people with DM (Devrajani & Sciences, 2017).

Most patients with PAD usually experience pain or discomfort in the calf muscles when walking and relieve it with rest. Measurement of ABI is recommended to evaluate patients with PAD (Hammad *et al.*, 2015). It is performed to look for functional impairment in PAD and its risk (Hammad *et al.,* 2019), and diagnose lower limb disorders and predict the risk of cardiovascular and cerebrovascular events (Kim *et al.*, 2012).

According to the Indonesian Association of Endocrinologists (PERKENI), the primary management of diabetics is to improve the quality of life of patients by controlling blood glucose, blood pressure, weight, and lipid profile through comprehensive patient management. The management of DM begins with implementing a healthy lifestyle (medical nutrition therapy and physical activity) and pharmacological interventions with oral and injection anti-hyperglycemic drugs (Soelistijo *et al.*, 2015). This study was conducted to see the effect of leg exercises on the ABI in patients with type 2 DM to save patients from various complications related to PAD.

## METHODOLOGY

### Study Design

This research was quantitative research using a pre-experimental design, with one group pre-test and post-test design. This study measured the ankle-brachial index (ABI) value by providing foot exercises before and after intervention in patients with type 2 diabetes mellitus. The sampling used in this study was simple random sampling.

### Subject

The number of samples used in this study was 35 samples. The sample criteria in this study were people

with type 2 DM for more than five years, having neuropathic symptoms, not smoking, experiencing severe pain and injuries in the lower extremity area, and were able to communicate verbally and understand the informed consent. The characteristics of this study included age, gender, education level, occupation, duration of suffering from diabetes mellitus. The research was carried out at RSUD Rejang Lebong from August to November 2020.

### Measurement

Peripheral arterial disease (PAD) was measured using an ankle-brachial index instrument using an 8 MHz Doppler ultrasound, and the ankle-brachial index (ABI) was measured with a sphygmomanometer. The measurement scale for ankle-brachial index scores and perfusion status was>1.3: Elevated / compressible vessels, 1.0 Normal, 0.9 (LEAD), 0.6 - 0.8 (Borderline), 0.5 (Severe ischemia), <0.4 (Critical ischemia, limb threatened). Data analysis was conducted after the data normality test. If the data was not normally distributed, the data analysis was carried out using Shapiro-Wilk to see the difference in the ABI value before and after leg exercises. Finally, the intervention was analysed using Wilcoxon data analysis. This research had passed the ethical test and obtained the Ethics Permit Number. DM.01.04/154/3/VI / 2020 by the Health Research Ethics Commission of the Bengkulu Ministry of Health.

## RESULTS

### Characteristics of Respondents

***Table 1: Respondent Characteristics***

| Respondent Characteristics | n | % |
|---|---|---|
| Age (Year): | | |
| < 57 | 13 | 37.1 |
| 57 | 22 | 62.9 |
| Mean (SD) | 4.816 | |
| Sex: | | |
| Male | 19 | 54.3 |
| Female | 16 | 45.7 |
| Education: | | |
| Junior High School and | 23 | 65.7 |
| Senior High School | 12 | 34.3 |
| D3/S1 | | |
| Profession: | | |
| Working | 26 | 74.3 |
| Unemployed | 9 | 25.7 |
| Duration of Diabetes Mellitus | | |
| < 5 Years | 12 | 34.3 |
| 5 Years | 23 | 65.7 |

Table 1 showed that this study involved 35 patients with type 2 DM. The age characteristics showed that 22 participants were 57 years old (62.9%), 19 males (54.3%), 26 working participants (74.3%), 23 participants (65.7%) had diabetes for more than five years.

***Table 2: Differences in ABI Value in Patients with Type 2 DM Before and After Foot Exercise***

| Measurement | Mean | SD | Z | *P-value* | Minimum-Maximum |
|---|---|---|---|---|---|
| Ankle Brachial Index (ABI) | | | | | |
| - Before Foot Exercise | -4.791087-1.36 | 0.139 | | 0.001 | 1.02 |
| - After Foot Exercise | 0.87-1.39 | 0.147 | | | |
| | 1.12 | | | | |

Table 2 indicated the difference average before and after doing the foot exercise intervention. The average ABI before the foot exercise intervention was 1.02, while after intervention reaching 1.12. There was an increase of 0.10 in the ABI. The analysis results with the Wilcoxon test explained as $p = 0.001$ ($p<0.05$). These results indicated a significant difference in ABI mean of patients with type 2 DM before and after the foot exercise intervention.

## DISCUSSION

This study shows a significant difference ($p= 0.001$) in the mean of ABI before and after the foot exercise intervention. The ABI before the foot exercise intervention was 1.02; meanwhile, after the foot exercise intervention, the ABI average becomes 1.12 showing an increase of 0.10. The result shows an influence of exercise intervention against the increase in mean ABI in DM type 2. Therefore, type 2 diabetic foot exercise can improve blood circulation in the legs and prevent PAD complications.

This finding follows previous research by Yang *et al.*, (2019), indicating that exercise therapy is vital for preventing and treating type 2 DM. Exercise therapy can increase the metabolism of patients with type 2 DM, resulting in increased absorption and utilisation of glycolipids, increased insulin sensitivity, more optimal body mass index, and DNA modulation.

Leg stretching exercises are therapeutic interventions to improve the operation of connective tissues, such as muscles, and increase joint range. Exercises performed using passive or active methods will relax the contracting muscles and increase the flexibility of the connective tissue as much as possible (Kim & Kim, 2019). Patients

with type 2 DM will experience endothelial dysfunction, increased sympathetic tone, cardiovascular disease, including hypertension, which causes increased morbidity and mortality. Exercises done can induce arterial walls, increase the release of vasodilating substances by the endothelium (e.g., nitric oxide, bradykinin), increase baroreflex sensitivity, and decrease sympathetic nerve activity in the nucleus of the solitary tract, which is beneficial for health, helps keep blood pressure low, and controls blood pressure (Asano, 2014).

Diabetic foot exercise is still not popular in the community, so it is hoped that health workers will educate people with type 2 DM during counselling and nursing care, so that type 2 DM patients can practice diabetic foot exercises in their daily lives preventing foot complications (Wahyuni, 2013). Active lower limb exercise affects muscle strength in patients with type 2 DM with the microvascular disease of the lower limbs (Widyawati *et al.*, 2010). Physical activity performed by people with DM can improve cardiorespiratory muscle strength, control blood sugar levels, reduce insulin resistance, better lipid profile, lower blood pressure (BP), and regulate weight loss (Sigal *et al.*, 2018). Foot exercise can be done to prevent diabetic foot ulcers and can be applied to people with type 2 DM (Mirtha, Ariono, & Putra, 2018).

For patients with type 2 DM, aerobic exercise such as walking is highly recommended for regulating glucose levels and microvascular and macrovascular complications. Foot exercise can reduce nerve cell damage due to hyperglycemia and neurovascular damage in type 2 DM patients (Do *et al.*, 2020). Foot exercise is an independent nursing intervention used as a preventive measure for complications of DM patients to increase peripheral vascularisation by 70-80% (Embuai *et al.*, 2019).

Lower limb exercise affects ABI and contributes to a 20% or more reduction in PAD, identifying an increased risk of death (Alqahtani *et al.*, 2018). Aerobic exercise significantly increases the percentage of oxygen saturation. ABI is significantly correlated with the percentage of oxygen saturation (Nwankwo *et al.*, 2014). It is an indicator for atherosclerosis which is associated with higher rates of coronary and cerebrovascular disease. ABI has an independent role in predicting cardiovascular events (Gaikwad, 2015). Diabetic foot exercises can increase the value of ABI as it helps improve blood circulation, strengthens the small muscles of the feet, prevents foot deformities, and overcomes the limitations of joint motion (Trianto & Hastuti, 2017).

## CONCLUSION

This study indicates a significant effect of foot exercise in patients with DM on ABI value. Foot exercise can be used to increase ABI score in patients with DM.

### Conflict of Interest

The authors states that this study has no conflict of interest.

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