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# Exercise intervention to reduce the risk of diabetic foot ulcers in diabetics with the health belief model approach: Quasi-experimental studies

**Mulyaningsih**
Public health sciences, Graduate School, Universitas Sebelas Maret, Surakarta, Indonesia | Faculty of health sciences, Universitas 'Aisyiyah Surakarta, Indonesia
*Corresponding author email: mulyaningsih@aiska-university.ac.id

**Isna Qadrijati**
Public health sciences, Graduate School, Universitas Sebelas Maret, Surakarta, Indonesia

**Sri Mulyani**
Public health sciences, Graduate School, Universitas Sebelas Maret, Surakarta, Indonesia

**Vitri Widyaningsih**
Public health sciences, Graduate School, Universitas Sebelas Maret, Surakarta, Indonesia

***Abstract***---Diabetic foot ulcers are common complication in diabetics. This study aims to explore the effect of exercise on the risk of diabetic foot ulcers in diabetics using the Health Belief Model approach. One of the essential benefits of this study is to reduce the risk of developing diabetic foot ulcers, thereby reducing disability rates. The problem of diabetic foot ulcers can be prevented by implementing exercise interventions. In this experimental study, there were three groups, with 161 diabetics as respondents. Group one and group two were given different interventions, while group three was the control group. In this study, changes in the ankle-brachial index and the effect of Health Belief Model on activeness in the intervention were measured. Follow-up was done after three months of intervention. All aspects of the Health Belief Model scale were different in the three groups. Perceptions of obstacles showed the most significant difference (p=<0.001). All aspects of the Health Belief Model scale also affect the activity of diabetics in doing exercise (p=0.001). The results of the ankle-brachial index measurement showed that there were differences


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between the three groups (p=0.019) and the "MULDA" exercise group had the highest median value. Exercise intervention based on the Health Belief Model principle led to a significant increase in reducing the risk of diabetic foot ulcers. Further research is needed to confirm the effectiveness of this intervention.

***Keywords*---**exercise, diabetic foot ulcers, diabetics, ankle-brachial index.

## Introduction

Diabetes mellitus has been recognized as a cause of mortality and morbidity in the world. Diabetes can affect almost all vital organs in the body. Around 415 million people in the world are diagnosed with Diabetes Mellitus, and it is estimated that by 2040 will increase (Syafril, 2018;Hart, Milner, and Cifu, 2017). Diabetic foot ulcers are a common complication in diabetics. Diabetic foot ulcers can cause substantial disability, which can reduce life expectancy (Abbas and Boulton, 2022). Research result of Almobarak et al. (2017) showed that the prevalence of diabetic foot ulcers in type 2 Diabetes Mellitus was 18.1%. Adem et al. (2020) also said that 85% of lower limb amputations in diabetes were preceded by foot ulcers.

Diabetics can take precautions against diabetes complications. Bossman et al. (2021) stated that there needs to be promotion of self-management practices, especially foot care and clear dietary guidelines. Multidisciplinary care can be taken to prevent diabetic foot ulcers, including physical activity, regular diet and foot care education (Matos et al. 2018). However, it turns out that the implementation of self-care practices in diabetic patients is very low (Melanda, Berhe, and Handebo, 2021). Diabetics can do regular physical exercise to prevent diabetic foot ulcers. Physical exercise has been proven to improve physiological and psychological conditions, but not all diabetics want to do sports because there are many obstacles encountered(Jenkins and Jenks, 2017). Physical exercise can also increase muscle strength, because in diabetics, muscle fatigue can occur where muscle fatigue is a problem in everyday life (Triwiyanto et al., 2018).

Applying the health belief model (HBM) has been shown to be effective in increasing the motivation of diabetics in preventing diabetic foot ulcers. However, perceived severity, perceived obstacles, perceived benefits, and self-efficacy are important factors influencing self-care. So it is necessary to strive to reduce obstacles to self-care practice, by increasing the perception of perceived severity, benefit and patient self-efficacy (Melanda, Berhe, and Handebo, 2021). Various studies have been conducted to determine the effect of exercise on the risk of diabetic foot ulcers, but these studies have not linked to the health belief model. Therefore, this study aims to explore the effect of exercise on the risk of diabetic foot ulcers in diabetics using the Health Belief Model approach. The main contribution of this study is to see the effect of Health Belief Model in the activity of diabetics in doing exercise to reduce the risk of diabetic foot ulcers.

## Method

### Design and Sample

This study used an experimental study approach in diabetics. The samples were 161 which were divided into 3 groups. Group 1 was given the “MULDA” exercise intervention with a total of 55 respondents, group 2 was given a foot exercise intervention with a total of 52 respondents and group 3 as a control group that consist of 54 respondents. Participants were recruited according to predetermined criteria. Data were collected between February and October 2021. The inclusion criteria set were taking medication according to the standard regularly, adhering to the Diabetes Mellitus diet, not smoking, and not having diabetic foot ulcers. While the exclusion criteria are unable to carry out activities independently. Geographic information and Health Belief Model measurements were carried out once before the intervention was given, while the detection of diabetic foot ulcers by measuring the ankle brachial index (ABI) was carried out twice, namely before and 12 weeks after the intervention

### Measures
### Demographics

Demographic information was collected about gender, occupation, age, and duration of diabetes.

### Health belief model scale

The Health Belief Model subscale was used to measure participants' beliefs about exercise to reduce the risk of diabetic foot ulcers. The questions in this study to investigate about perception of susceptibility to diabetic foot ulcers (seven items), severity of diabetic foot ulcers (seven items), perceived benefits of exercise to reduce the risk of diabetic foot ulcers (nine items), perceived obstacles to exercise (nine items), and efficacy self about exercise done to reduce the risk of diabetic foot ulcers (eight items).

### Inspection Ankle Brachial Index (ABI)

To detect the risk of diabetic foot ulcers, an ABI examination is carried out. The ABI is an efficient method for detecting the presence of peripheral arterial disorders of the lower extremities (Yang et al. 2021). The ABI is the ratio between lower extremity systolic blood pressure, specifically the ankle, and upper extremity. This ratio compares the vascular resistance, with one of the main factors being the diameter of the vessel (McClary and Massey, 2021). The examination is carried out by trained health personnel. The tool used to perform ABI examination with vascular doppler and sphygmomanometer. The inspection was carried out according to a standardized procedure.

### Intervention

Exercise is an intervention that will be given to groups of people with diabetes. The intervention was carried out independently with video guidance. There are 2

kinds of intervention given to two groups. The intervention in the first group, namely "MULDA" exercise, is an exercise that combines aerobics, balance training, resistance training, and leg exercises. Exercise is given for 12 weeks with a frequency of exercise 2 times per week. The time used for doing exercise in each session is 40 minutes. While the second group was given foot exercise intervention. Leg exercise is done independently by sitting for 24 training sessions for 12 weeks. Each session lasts 30 minutes

**Statistical Analysis**

Data analysis was performed by using SPSS version 25. The main variables analyzed were gender, occupation, age, length of illness, Health Belief Model and Ankle-Brachial Index. To test the distribution of the data used Kolmogorov Smirnov Goodness of Fit Test. The chi square test was used to explain the relationship between age and occupation with the group, while the Kruskall Wallis test was used to assess differences in age, length of illness, Health Belief Model, and the effectiveness of the intervention on the measurement results of Ankle-Brachial Index.

**Ethics Statement**

This research protocol has been approved and registered with health research ethics committee of Sebelas Maret University (UNS) No. 075/UN27.06.6.1/KEPK/EC/2020. All participants have been given an explanation of the objectives and procedures of the research to be carried out. In addition, participants are required to sign informed consent.

**Result**

Table 1
Characteristics of the sample (n=161)

| Characteristics | Exercise "MULDA" (n=55) | Foot Exercise (n=52) | Control (n=54) | value |
|---|---|---|---|---|
| Gender, male: female | 16:39 | 17:35 | 18:36 | 0.877 |
| Work, work:not work | 21:34 | 19:33 | 12:42 | 0.149 |
| Age | 61,000 (10.00) | 60,500 (14.50) | 63,000 (10.50) | 0.404 |
| Duration of illness | 5,000 (8.00) | 5,000 (8.00) | 5,000 (10.50) | 0.226 |

The values presented are median and IQR

Table 1 shows that participants are dominated by female diabetics and diabetics who do not work. The results of the analysis showed that there was no difference between the sexes (p=0.877), occupation (p=0.149), age (p=0.404), and length of illness (p=0.226).

Table 2
Differences in scores in the Health Belief Model domain between groups

| Construct | Exercise "MULDA" (n=55) | Foot Exercise (n=52) | Control (n=54) | value |
|---|---|---|---|---|
| Vulnerability perception | 25.00 (20.00-34.00) | 26.00 (22.00-32.00) | 26.00 (11.00-31.00) | 0.002 |
| Severity perception | 24.00 (19.00-29.00) | 25.00 (18.00-30.00) | 26.00 (20.00-33.00) | 0.007 |
| Perception of benefits | 33.00 (30.00-42.00) | 34.00 (27.00-40.00) | 35.00 (18.00-43.00) | 0.001 |
| Obstacle perception | 27.00 (19.00-36.00) | 30.00 (18.00-38.00) | 32.00 (12.00-45.00) | <0.001 |
| Self efficacy | 30.00 (24.00-40.00) | 30.00 (23.00-34.00) | 31.00 (26.00-38.00) | 0.012 |

The values presented are median and IQR

Table 2 describes the Health Belief Model construction between groups Exercise "MULDA", the leg exercise group, and the control group. The results of the analysis on the Health Belief Model subscale show that there is a significant difference between perceptions of vulnerability, perceived severity, perceived benefits, perceived obstacle, and self-efficacy. The Health Belief Model subscale that showed the strongest difference was perceived obstacles (p=<0.001)

Table 3
The relationship between perceived vulnerability, perceived severity, perceived benefits, perceived obstacle and self-efficacy have a relationship with exercise activity

| Variable | Exercise | | | | |
|---|---|---|---|---|---|
| | b (regression coefficient) | 95% CI | | □ | □ |
| | | Lower limit | Upper limit | | |
| Vulnerability Perception | 0.06 | 0.02 | 0.11 | 0.007 | 0.26 |
| Severity perception | -0.01 | 0-.06 | 0.03 | 0.498 | -0.07 |
| Perception of benefits | -0.01 | -0.04 | 0.02 | 0.532 | -0.06 |
| Obstacle perception | 0.03 | 0.01 | 0.06 | 0.005 | 0.29 |
| Perception of self-efficacy | -0.03 | -0.07 | 0.01 | 0.155 | -0.13 |
| Constant | 0.49 | -1.49 | 2.47 | 0.626 | |
| Number of samples | 161 | | | | |
| *$R^2$ square* | 0.18 | | | | |
| □ | 0.001 | | | | |

Table 3 explains that there is a jointly significant relationship between perceptions of vulnerability, severity, benefits, obstacle, and self-efficacy with exercise activity. The relationship shows a parallel or direct relationship. Based on the value of $R^2$ square, it can be seen that 18% of exercise activity can be

explained by five variables, namely perceptions of vulnerability, severity, benefits, obstacle, and self-efficacy.

Table 4
Differences in Ankle-Brachial Index measurement results between groups

| Group | n | median (minimum-maximum) | value |
|---|---|---|---|
| Exercise "MULDA" | 55 | 1.19 (0.75-1.44) | 0.019 |
| Foot exercise | 52 | 1.09 (1.00-1.36) | |
| Control | 54 | 1.11 (0.76-1.44) | |

Table 4 explains that the physical exercise group has the highest median value. The results of the analysis also showed that there were significant differences between groups in the results of the Ankle-Brachial Index measurement.

**Discussion**

This study shows that physical exercise based on Health Belief Model is effective in increasing Ankle-Brachial Index so that it can reduce the risk of developing diabetic foot ulcers, including perceptions of vulnerability, severity, benefits, and obstacle to preventive behavior. In addition, self-efficacy also affects prevention behavior against the risk of diabetic foot ulcers. Health Belief Model can influence diabetics to do exercise actively to increase Ankle-Brachial Index. Although this research has a significant contribution to knowledge, there are some limitations to this research. Diabetic foot ulcers can be detected in various ways, including checking blood glucose, HbA1c (Miranda, Da Ros, and Marfella 2021), ankle brachial index (ABI) (Yang et al. 2021), monofilament examination (Baldursdottir et al. 2020), TcPO2 . examination (Fagher and Löndahl 2021) as well as regular foot checks. However, in this study only the Ankle-Brachial Index examination was used. In addition, exercise is also carried out independently by diabetics so that it cannot be monitored directly. This is done to reduce physical contact with people with diabetes during the COVID-19 pandemic.

The state of emergency of the COVID-19 epidemic has seriously limited the possibility of attending supervised training in hospitals as well as undertaking structured home-based programs outdoors (Lamberti et al. 2021). This condition also affects people with diabetes. Diabetics are a group that is vulnerable to being exposed to COVID-19, so it is recommended to reduce activities. Low physical activity can reduce functional ability (Najafi, Patel, and Armstrong 2018), but can increase the percentage of diabetes complications (El Bilbeisi, Hosseini, and Djafarian 2017) thereby increasing the risk of diabetic foot ulcer. Regular exercise can reduce the risk of diabetic foot ulcers. In diabetics who are able to exercise, it is effective to improve the condition so that it can reduce the risk of diabetic foot ulcers. Exercise has been shown to reduce pain, improve balance, improve mobility, restore tactile abilities, and improve quality of life (Dai and Li 2019). By increasing this ability, diabetics can perform daily activities well.

In another study designed to assess the impact of a physical activity program on reducing the risk of diabetic foot ulcers. Doing Exercise that involve all members

of the body, require more energy (Sigal et al. 2018)thus lowering blood sugar levels. Exercise can also improve motor function so that it can reduce the risk of falling (Dai and Li 2019) which can cause ulcers. Exercise can also increase Ankle-Brachial Index, because Diabetics with a low Ankle-Brachial Index have a higher risk of developing foot ulcers (Yang et al. 2021). For this reason, it is important to carry out routine Ankle-Brachial Index examinations to detect peripheral arterial diseases and angiography to prevent amputations (Ravidas, P., and G. 2020).

Diabetics with a good Health Belief Model can affect their active participation in the intervention program. Findings from Mohamadian and Ghannaee Arani (2014) states that the health promotion model can predict behavior in physical activity. Sharma (2022) also explained that individuals who have low perceptions of vulnerability and severity require stronger action cues to achieve effective outcomes. This study shows that perceived obstacles have the strongest effect on active participation in the intervention program. Obstacle perceived by a person can act as an obstacle to healthy behavior. Health-related behavior is also a function of perceived barriers to taking action. Of all constructs, perceived barriers are the most significant in determining behavior change (Jans et al., 1984).

## Conclusion

This study aims to explore the effect of exercise on the risk of diabetic foot ulcers in diabetics using the Health Belief Model approach. The results of this study indicate that the Health Belief Model aspect is related to exercise activity by diabetics. In addition, the results of the Ankle-Brachial Index measurement also showed that there were significant differences between groups after the exercise intervention was given.

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