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HELIOTHERAPY AND WALKING THERAPY TO REDUCE GLUKOSA LEVELS IN TYPE 2 DIABETES MILLETUS (T2DM): A COMPARATIVE STUDY

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ABSTRACT
Diabetes Mellitus is a chronic disease that has bad complications for the sufferer's health, so it requires non-pharmacological treatment. The aim of this study is to explain the effectiveness of non-pharmacological therapies such as heliotherapy and walking therapy in reducing random glucose levels (RBS) in patients with type 2 diabetes mellitus (DM). This study used a Pre-Post Test With Two Group Design research design. The population for this study consisted of 32 respondents, divided into two groups: the heliotherapy intervention group and the walking intervention group, each with 16 respondents. The research subjects were selected based on the criteria for diabetes mellitus patients. The independent variables were heliotherapy and walking therapy, while the dependent variable was the reduction in RBS levels. Research instruments included heliotherapy standard operating procedures (SOP), walking therapy SOP, Glucometer, and observation sheets. Data analysis was performed using paired t-tests and independent t-tests. The statistical test results showed a p-value of 0.353 (α>0.05), indicating that there is no significant difference in effectiveness between heliotherapy and walking therapy in reducing RBS levels in patients with type 2 diabetes mellitus (DM). It can be concluded that the reduction in RBS levels is higher with walking therapy compared to heliotherapy in patients with type 2 DM.

Keywords: diabetes mellitus type 2; glucosa level; heliotherapy; walking

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INTRODUCTION

Diabetes Mellitus (DM) is a chronic disease characterized by changes in the body's metabolism and can cause an increase in blood glucose levels, thereby causing other conditions and diseases such as the heart, blood vessels, kidneys and nerves (Ernawati et al., 2021; Faselis et al., 2020). The criteria for diagnosing DM are a fasting plasma glucose examination of ≥126 mg/dl, a temporary plasma glucose examination of ≥200 mg/dl accompanied by typical complaints (Soelistijo, 2021). The most common form of DM is Type 2 Diabetes Mellitus (T2DM) and usually attacks adults (Wang et al., 2019). T2DM sufferers are at risk of experiencing a number of health problems that can be detrimental or even life-threatening (Jaelani et al., 2023). The worsening of this condition is caused by irregular eating and medication patterns and also because the patient does not regularly see a doctor to control his glucose so that his glucose is not controlled properly (Susilowati & Susaldi, 2024). T2DM sufferers must undergo treatment, including activity, pharmacology, and diet that must be adhered to forever, so that patients who undergo treatment and diet continuously will cause fatigue during treatment (Alzahrani et al., 2024; Arifin et al., 2020).

According to data from the International Diabetes Foundation (IDF) (2019), an estimated 463 million (9.3%) adults live with DM. Diabetes ranks second as a cause of death, with annual global health expenditure estimated at USD 760 billion (Yenny et al., 2022). It is estimated that around 231.9 million (one in two) adults with diabetes are undiagnosed in the world (IDF, 2019). Population data from the Center for Cardio Metabolic Risk Reduction in South Asia (CARRS) shows that 6 out of 10 adults in South Asia suffer from DM or pre-diabetes (Abuelmagd, 2020). Indonesian basic health research data in 2018 explains that the national prevalence of DM is 8.5 percent or around 20.4 million Indonesians diagnosed with DM (Salam et al., 2022). The prevalence of T2DM is generally higher in men; however, the prevalence is higher in women aged ≥65 years. The prevalence of DM is around 50% in those aged >80 years (Sheen et al., 2019). In 2021, the East Java Provincial Health Service stated that there were 929,810 DM sufferers. Meanwhile, in Gresik Regency itself there are 44,071 people suffering from DM. Several research results show that heliotherapy therapy can reduce random sugar levels (Andini et al., 2020; Isworo, 2020; Andini, Kardina dan Anita, 2021; Andinia et al., 2021). And several other research results show that walking can also be an alternative for lowering random glucose in diabetes milletus patients (Fauzi, 2013; Isrofah, Nurhayati dan Angkasa, 2017; Fahrunnisa, Setiawati dan Nyoman, 2019; Dahliana dan Juwita, 2021; Permana, Kamillah dan Wisnusakti, 2021).

Diabetes Mellitus is a chronic disease that occurs when the pancreas does not produce enough insulin or when the body cannot use the insulin produced effectively (Nursa et al., 2022). Insulin is a hormone that regulates glucose. Hyperglycemia is a common effect of uncontrolled diabetes and over time causes severe damage to many body systems, especially the nerves and blood vessels in the retina, kidneys, or peripheral nerves (Egan & Dinneen, 2019). T2DM sufferers must undergo regular treatment and control (Faselis et al., 2020). The procedure consists of medication, increased activity, diet, and weight loss (Narulita et al., 2019). Medication treatments include oral (metformin) and injection (insulin) (J. Y. Kim et al., 2019; Martinez et al., 2019). T2DM is caused by abnormalities in insulin secretion, insulin action, or both. It begins with cell resistance to the effects of insulin (Ardika et al., 2024). In type 2 diabetes patients, there is an abnormality in the binding of insulin to the cell membrane receptors that cells use to respond to insulin. The result is an abnormality of the interface between the insulin receptor complex and the glucose transport system, with post-receptor abnormalities that may interfere with insulin action (Liberty, 2023; Siahaan et al., 2022). Ultimately, beta cell depletion occurs when circulating insulin levels decrease and there is an inability to maintain normal blood glucose levels (Andini et al., 2020). DM management consists of five pillars, namely education, nutritional therapy, physical activity, pharmacological management, and glucose control (Marzel, 2021). Education with the aim of promoting healthy living needs to be carried out as part of prevention efforts and is a very important part of holistic DM management. Then nutritional therapy is carried out. Then it is recommended to carry out physical therapy and management by carrying out pharmacological interventions and regular glucose control (Narulita et al., 2019).

An intervention that can be said to be safe in controlling random glucose levels in T2DM is using non-pharmacological therapy. Using non-pharmacological therapy is one solution so that T2DM sufferers don't get bored by always taking medication. Non-pharmacological therapy such as walking can be another alternative for reducing random glucose levels in T2DM sufferers (Permana et al., 2021). Heliotherapy contains ultraviolet (UV) which helps the formation of vitamin D, so that when the arms, face and knees and backs of the legs are exposed to direct morning sunlight it can have an effect on reducing glucose levels (Isworo, 2020). Based on the data above, research discussing non-pharmacological therapy for adult

T2DM focuses on individual independence in carrying out exercise. The aimed of this study was to examining the comparison of heliotherapy and walking therapy in reducing random glucose levels in patients with T2DM.

METHOD

This research is a quantitative research with a pre-experimental research design using a pre-post-test method with two group design which was carried out in November-December 2023. This research focuses on comparing heliotherapy with walking therapy as one of the most effective forms of non-pharmacological therapy for has an influence on random sugar levels in patients with T2DM. The population in this study were T2DM sufferers in Mangadu Village, Mangarabombang District, Takalar Regency, South Sulawesi with a total population of 64 people with T2DM. The sample in this research plan is part of the population suffering from T2DM, divided into two groups, namely group 1 which is given heliotherapy and group 2 which is given walking therapy by fulfilling the criteria 1) sufferers who take OAD (anti-diabetic) drugs such as Glimepiride and Glibenclamide; 2) random glucose levels ≥130-300 mg/dl; 3) adults to the elderly with an age range (31-70 years); 4) suffered from T2DM for ≥1 year; 5) able to carry out activities independently without the help of other people and tools. The criteria for respondents to drop out were respondents who did not participate in heliotherapy or walking therapy exercises or interventions more than 3 times in a row, withdrew from the sample for certain reasons and suffered from illness or injury. In this research, the sample was selected using a non-probability sampling method with purposive sampling. The sample size found from sample size calculations was 36 respondents, then divided into two groups, so that 18 respondents in group 1 heliotherapy and 18 respondents in group 2 walking therapy.

The independent variables in this study were heliotherapy and walking therapy which were given to T2DM sufferers using standard operating procedure (SOP) guidelines for each intervention. This exercise was carried out every day for 1 week by each group. The duration of each intervention is 10 minutes with the intensity of the intervention being moderate, not too light and not too heavy, as evidenced by the way that during the intervention you can still speak fluently without any intermittent speech disorders (talk test) and there are no signs of physiological symptoms. leads to hypoglycemia. The dependent variable is random glucose levels which are measured using a Nesco glucometer and using an observation sheet for assessing random glucose levels. The research implementation procedure begins with the preparation stage by submitting a research application letter to the institution and completing the research ethics test. After obtaining permission, researchers collected data on the population of T2DM sufferers and divided the respondents into group 1 heliotherapy and group 2 walking therapy. During the implementation of the research and providing interventions, respondents gathered at the Mangadu Village Hall at 07.00 WITA. Before the intervention was carried out, respondents were given an explanation regarding the purpose of the research, the benefits of the research, the time span of the research, the rights of the respondent and the time contract for the research process, and asked for the respondent's agreement to sign an informed consent as a willingness to become a respondent. After the respondent was willing to become a research subject, the researcher provided a description or simulation assisted by an enumerator who was also a nurse at the Mangarabombang sub-district health center to help provide and direct the respondent in the heliotherapy and walking therapy intervention process. Before and after the heliotherapy and walking therapy intervention was given, the researcher, assisted by an enumerator, measured the respondent's blood pressure and pulse.

Descriptive analysis of research data is presented in a frequency distribution table and presented in descriptive analysis in the form of median, standard deviation, minimum and maximum values for each variable. The inferential analysis used in this research is a homogeneity test using Lavene's test, data is said to be homogeneous if the value based on the mean shows >0.05. The normality test was carried out using the Shapiro Wilk test and data was said to be normally distributed if the significance value was >0.05. Hypothesis testing uses Paired Sample T-Test with a significance level of p≤0.05. Meanwhile, to test significant differences between the pre-test and post-test of the two groups, the Independent T-Test was used. The implementation of this research has received ethical approval from the Health Research Ethics Committee, Faculty of Nursing, Airlangga University, Surabaya with No. 2635-KEPK, as an effort to protect the human rights and welfare of health research respondents. Prospective respondents have received an explanation and understand the purpose, benefits of research and possible dangerous effects of research. The confidentiality of information provided by respondents as research subjects is guaranteed by the researcher. Respondents have the right to refuse or stop, not to continue as respondents and researchers highly uphold honesty in conducting research.

RESULTS

Table 1.
Characteristics of Research Respondents with T2DM (n=36)

Respondent Characteristics	*Heliotherapy Group*		Walking Group		Homogenity Test
	f	%	f	%	
Age					
31-40 Years	7	38,9	4	22,2	0,512
41-50 Years	2	11,1	3	16,7	
51-60 Years	8	44,4	9	50,0	
61-70 Years	1	5,6	2	11,1	
Gender					
Woman	18	100	18	100	0,267
Man	0	0,0	0	0,0	
Education					
Elementary School	4	22,2	8	44,4	0,439
Junior High School	7	38,9	3	16,7	
Senior High School	5	27,8	5	27,8	
Bachelor	2	11,1	2	11,1	
Work					
Housewives	10	55,5	8	44,4	0,288
Private	5	27,8	7	38,9	
Civil servants	3	16,7	3	16,7	
Sports Activities					
Never	13	72,2	15	83,3	0,305
Sometimes	4	22,2	3	16,7	
Often	1	5,6	0,0	0,0	
Suffering from DM					
1-5 Years	5	27,8	4	22,2	0,525
6-10 Years	7	38,9	12	66,7	
11-15 Years	5	27,8	2	11,1	
>16 Years	1	5,6	0,0	0,0	

Table 1 shows that the majority of respondents in the heliotherapy group were in the pre-elderly category, namely 51-60 years, with 8 respondents (44.4%) with all genders being women, namely 100%. The education level of respondents in the heliotherapy group was mostly at junior high school level, 7 respondents (38.9%) and most respondents worked as housewives, 10 respondents (55.5%). The characteristics of sports activities show that the majority of respondents, 13 (72.2%) have never done sports activities. The duration of suffering from DM in the heliotherapy group was mostly in the range of 6-10 years, as many

as 7 respondents (38.9%). The walking group showed that the majority were in the 51-60 year age range, 9 respondents (50.0%) with all genders being women, namely 100%. At the educational level, most of the walking respondents were elementary school, 8 respondents (44.4%) with the majority of respondents working as housewives, 8 respondents (44.4%). The sports activities of the walking group showed that the majority of 15 respondents (83.3%) had never done sports activities. The duration of suffering from diabetes among respondents in the walking group was mostly 6-10 years, 12 (66.7%).

Table 2.
Differences in Glucose Levels Before and After Heliotherapy (n=36)

Random Glucosa Level	*Pre-test*		*Post-test*	
	f	%	f	%
Hypoglycemia	0	0,0	3	16,7
Glycemia	10	55,5	10	55,5
Hyperglycemia	8	44,5	5	27,8
Mean	208,3		180,12	
Standard Deviation	66,463		75,320	
Difference in average Glukosa levels	28,2 mg/dl			
Paired T-test	*p*=0,003			

Table 3.
Differences in Glucose Levels Before and After Walking (n=36)

Random Glucosa Level	*Pre-test*		*Post-test*	
	f	%	f	%
Hypoglycemia	0	0,0	2	11,1
Glycemia	7	38,9	8	44,5
Hyperglycemia	11	61,1	8	44,5
Mean	241,12		203,81	
Standard Deviation	60,870		66,562	
Difference in average Glukosa levels	37,3 mg/dl			
Paired T-test	*p*=0,008			

Table 2 it is shown that the random glucose levels in respondents showed 44.5% in hyperglycemic conditions, but after being given heliotherapy the random glucose levels showed a decrease to 27.8% in hyperglycemic conditions. Meanwhile, in table 3, before being given walking intervention, the random glucose levels of most respondents were in the hyperglycemic category (201-250 mg/dl), namely 11 respondents (68.75%), but after being given walking therapy the hyperglycemic state decreased to 8 respondents (44.5%). The statistical test results in the heliotherapy group showed the mean pre-test = 208.31, post-test = 180.12, standard deviation pre-test = 66.463, post-test = 75.320 and the average Random glucose levels decreased by 28.2 mg /dl. Statistical test results in the walking group showed the mean value before test = 241.12, post-test = 203.81, standard deviation before test = 60.870, post-test = 66.562 and an average decrease in random glucose levels of 37.3 mg/dl. The results showed that the average reduction in random glucose levels was greater in the walking intervention group than in the heliotherapy intervention group. This is because physical activity such as walking can cause the glucose system to burn in the cells due to the action of insulin, which will later have an impact on changes in glucose levels and controlling glucose levels in diabetes sufferers.

DISCUSSION

After being given the heliotherapy intervention, the Random glucose levels of respondents fell the most in the euglycemia category (101-200 mg/dl), namely 7 respondents (43.75%), the least Random glucose levels of respondents fell in the hypoglycemia category (70-100

mg/dl) by as much as 3 respondents (18.75%), and the remainder remained in the hyperglycemia category (201-250 mg/dl) as many as 6 respondents (37.50%). The results of the paired t-test show a p-value = 0.003 ($\alpha<0.05$), which means there is a significant difference in Random glucose levels before and after the heliotherapy intervention. Heliotherapy can reduce Random glucose levels because sunlight used for sunbathing is natural insulin which can facilitate the absorption of glucose into the body's cells and stimulate the body to convert glucose into glycogen thereby lowering glucose by stimulating the storage of sugar levels in the muscles and liver, thus making it stable (Andini et al., 2021). Vitamin D controls the flow of calcium through membranes in pancreatic beta cells and insulin-targeting peripheral tissues. In addition, vitamin D also stimulates insulin receptor expression thereby increasing the insulin response to glucose transport and improving systemic inflammation through direct effects on cytokines (Isworo, 2020).

This study provided heliotherapy therapy for 10 minutes for 1 week in the morning. The results of the study showed that there was a decrease in glucose levels after intervention with an average decrease in Random glucose levels of 28.2 mg/dl. Blood glucose levels in treatment respondents before and after receiving sunbathing therapy in the morning for 7 days showed a decrease in the average blood glucose level of around 105.2 mg/dl from 316.1 ± 99.3 mg/dl to 210.9 ± 81. 9 mg/dl significantly with p-value = 0.00 ($p<0.05$). However, after being given heliotherapy intervention, there were 2 respondents who actually experienced an increase from 140 mg/dl to 152 mg/dl, and 225 mg/dl to 239 mg/dl in their Random glucose levels . This is because when basking in the sun, the 2 respondents like to move from place to place, which greatly influences the effectiveness of sunlight entering the respondent's body (Isworo, 2020)

After the walking intervention, the Random glucose levels of respondents decreased to the Euglycemia category (101-200 mg/dl) as many as 6 respondents (37.50%), and the remaining Random glucose levels of respondents remained in the Hyperglycemia category (201-250 mg/dl) as many as 8 respondents (50.00%). The results of the paired t-test show a p-value = 0.008 ($\alpha<0.05$), which means there is a significant difference in Random glucose levels between before and after giving the walking intervention. Walking has an important role in regulating blood glucose levels. The main problem in type 2 DM is a lack of response to insulin (insulin resistance) so that glucose cannot enter the cells. Physical activity in the form of walking is useful for controlling glucose and reducing weight in type II DM. Moderate intensity walking can reduce blood glucose because it can increase glucose uptake by muscles compared to hepatic glucose release during activity. Based on research conducted in the USA, it was stated that cases of type II DM were higher in the group who walked less than once per week compared to the group who walked more than once per week (Jiwintarum et al., 2019).

This study provided walking therapy for 10 minutes for 1 week. The results of the study showed that there was a decrease in glucose levels in respondents with an average decrease in Random glucose levels of 37.3 mg/dl. Research result Rehmaitamalem dan Rahmisyah (2021), which explains that there is a difference between glucose levels (KGD) before and after walking 6 times in 2 weeks with a duration of 30 minutes with a p value of 0.000 ($p<0.05$) the average decrease in glucose levels is as much as 31.6 mg/dl. However, after being given the walking intervention, there was 1 respondent who experienced an increase from 216 mg/dl to 231 mg/dl in his Random glucose levels . This happened because when the intervention was given, the respondent stopped walking to talk to someone he met on the street for ± 5 minutes. This influences the effectiveness of walking interventions in reducing Random glucose levels .

The results of the independent t-test statistical test for Random glucose levels in both groups showed p-value = 0.353 (α> 0.05), which means there was no difference between the heliotherapy group and the walking group. The results of the paired t-test statistical test in both groups showed that the p-value = 0.003 and in the walking group the p-value = 0.008. However, based on the average difference, the decrease in Random glucose levels in the walking group was greater than in the heliotherapy group. Heliotherapy is a practical and efficient way to get vitamin D that involves exposure to sunlight (Wijaya dan Makiyah, 2021). This therapy is carried out by basking in the sun, which is believed to cure several diseases. Heliotherapy contains ultraviolet (UV) which helps the formation of vitamin D, so that when the arms, face and knees and backs of the legs are exposed to direct morning sunlight it can have an effect on reducing glucose levels (Isworo, 2020). Heliotherapy can convert pro vitamin D into vitamin D to control the flow of calcium through membranes in pancreatic beta cells and insulin peripheral tissue. In addition, vitamin D can also stimulate insulin receptor expression, thereby increasing the insulin response to glucose transport and improving systemic inflammation through direct effects on cytokines. The results of this study show that heliotherapy intervention can reduce Random glucose levels by 28.2 mg/dl (Andini et al., 2020).

Walking is a recommended daily physical activity. If walking is carried out according to the recommendations of the American College of Sports Medicine (ACSM), it can help a person change from an inactive lifestyle to an active lifestyle. Walking with a certain frequency can even reduce the risk of DM (Permana et al., 2021). When walking occurs, there will be contractions between skeletal muscles which can influence the increase in insulin's ability to activate sugar transport to muscles through insulin-independent pathways resulting in a decrease in plasma glucose levels. Then the muscles will experience additional adaptation in the form of hexokinase II synthesis so that insulin increases, glucose is transported to cells, glucose levels decrease and energy is produced (Amelia et al., 2018). Insulin sensitivity is closely related to physical activity such as walking. This is because people who do the physical activity of walking have balanced blood glucose levels due to the effectiveness of insulin in converting glucose into energy (Andini et al, 2021). The results of this research are in line with research by Rahanmitu, (2019) which shows that walking is more effective in reducing glucose levels than leg exercises with a p-value = (<0.005) and an average reduction value of 19.8 mg/dl. Meanwhile, heliotherapy intervention only relies on exposure to sunlight entering the body to form vitamin D which will later influence a decrease in glucose levels. This requires more time to get more specific reduction results. According to Setiati's research (2008), it was stated that after exposure to sunlight at a specific time and duration of 6 weeks with a p-value = 0.00 and an average decrease of 15.5 mg/dl (Isworo, 2020).

CONCLUSION

Based on the research that has been conducted, it can be concluded that the Random glucose levels of respondents in the heliotherapy group before the intervention were mostly normal (euglycemic) and after the intervention the Random glucose levels were mostly normal (euglycemic); the Random glucose levels of respondents in the walking group before the intervention were mostly hyperglycemic and after the intervention the Random glucose levels were mostly normal (euglycemic); and there is no difference in effectiveness between phototherapy and walking in reducing Random glucose levels in people with type 2 diabetes.

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