EFFECT OF COMBINATION OF ACTIVE STRETCHING AND LIGHT WALKING ON BLOOD SUGAR LEVELS IN PATIENTS WITH TYPE 2 DIABETES MELLITUS AT SUKAMERINDU HEALTH CENTER, BENGKULU CITY

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Abstract

Type 2 diabetes mellitus is a chronic metabolic disorder characterized by hyperglycemia caused by insulin resistance and pancreatic β-cell dysfunction. Pharmacological treatment alone is not sufficient; lifestyle modification, especially physical activity, plays a crucial role in controlling blood glucose levels. This study aimed to examine the effect of combining active stretching and light walking on blood glucose levels among patients with type 2 diabetes mellitus at Sukamerindu Health Center, Bengkulu City. A quasi-experimental design with pre–posttest and control group was employed. Purposive sampling was used to recruit 44 participants, divided equally into intervention (n=22) and control (n=22) groups. The intervention group performed active stretching and light walking twice a week for three weeks, while the control group received only pharmacological therapy. Blood glucose levels were measured before and after the intervention using a digital glucometer. Data were analyzed using Independent Sample T-test. Results revealed a statistically significant reduction in blood glucose levels among the intervention group compared to the control group (p = 0.000). This study concludes that the combination of active stretching and light walking effectively reduces blood glucose levels in patients with type 2 diabetes mellitus. These findings suggest that integrating simple physical activities into diabetes management programs may serve as an effective non-pharmacological strategy to improve glycemic control.

Keywords: Diabetes Mellitus, Blood Glucose, Active Stretching, Light Walking

INTRODUCTION

Diabetes mellitus is a chronic metabolic condition that threatens global health. In 2021, the worldwide mortality rate due to diabetes mellitus was approximately 6.7 million, meaning one person died every five seconds. According to statistics from the International Diabetes Federation, Indonesia held the fifth position among nations with the most diabetes cases, totaling 19.5 million in 2021. This figure is projected to increase to 28.6 million by 2045. In the same year, diabetes mellitus was estimated to have caused 236,711 deaths in Indonesia (International Diabetes Federation, 2021). In Bengkulu

Province, a total of 6,571 individuals have been diagnosed with diabetes mellitus by medical professionals across all age groups.

The most common type of diabetes worldwide is Type 2 diabetes mellitus, accounting for more than 90% of all diagnosed cases. Proper management of this condition is crucial to avoid complications. Blood sugar levels can be regulated through both medicinal and non-medicinal treatments. Non-medicinal approaches include dietary guidance, medical nutrition, stress management, and physical activity (Galicia-garcia *et al*., 2020) Engaging in physical activity, whether through structured exercise or simple movements, for at least 30 minutes daily or a minimum of 2 to 5 times per week, helps boost the body's metabolism. This process enhances the body's ability to utilize blood sugar as an energy source (Lontoh et al., 2022).

One type of physical exercise that can be done anywhere with a short and easy time is active stretching. Active stretching is a light muscle stretch for 10 minutes at least 2-5 times a week which is done independently without the help of tools or other people (Damanik, D. *et al.*, 2024). For patients with diabetes mellitus active stretching is beneficial in increasing the use of glucose by cells in the body as a source of energy so that blood sugar levels decrease (Kusra et al., 2022). Another simple physical activity that can affect blood glucose levels is leisurely walking. Leisurely walking done regularly twice for 20 - 45 minutes is beneficial for burning calories so that the use of blood sugar decreases (Wibowo et al., 2022).

According to the findings from the initial research, the Sukamerindu health facility recorded the highest prevalence of individuals diagnosed with type 2 diabetes mellitus in comparison to other healthcare centers. The results of interviews during the posyandu on June 8, 2023 at the Sukamerindu puskesmas on 10 people with diabetes mellitus found 7 people who said that they did not do physical activity or exercise regularly and at the Sukamerindu puskesmas did not have a special program to overcome the problem of physical activity in people with type 2 diabetes mellitus.

The *American Diabetes Association (ADA, 2022)* and *World Health Organization (WHO, 2020)* recommend at least 150 minutes of moderate-intensity physical activity per week for adults with diabetes, in addition to muscle-strengthening exercises. However, many patients, particularly older adults and those in low-resource communities, struggle to adhere to intensive exercise programs due to fatigue, comorbidities, limited access to facilities, or lack of motivation (Fisher, 2023).

The primary treatment approach implemented at Sukameridu Health Center focuses on pharmacological management, where antidiabetic drugs like metformin, glibenclamide, or glimepiride are prescribed according to the unique medical needs of patients with type 2 diabetes mellitus,

ensuring optimal blood sugar control. Given the circumstances outlined in the background, the researcher aims to explore the topic of “The effect of a combination of active stretching and leisurely walking on blood sugar levels in patients with type 2 diabetes mellitus at the Sukamerindu Health Center, Bengkulu City”.

Previous studies demonstrated the benefits of active stretching and light walking separately in reducing blood glucose levels. However, limited research has investigated the combined effect of these two exercises performed within a shorter duration. Considering that Sukamerindu Health Center reports the highest prevalence of T2DM cases in Bengkulu, with 370 patients in 2023, exploring innovative and simple physical activity interventions is essential. Therefore, this study aims to analyze the effect of combining active stretching and light walking on blood glucose levels among patients with type 2 diabetes mellitus at Sukamerindu Health Center, Bengkulu City.

MATERIALS AND METHODS

This research employs a quantitative approach with a quasi-experimental design, which includes both pre- and post-assessments, as well as a control group for comparison. The main intervention consists of a planned routine that combines dynamic stretching exercises and moderate-paced walking. The study's outcome measure examines changes in blood glucose levels in individuals diagnosed with type 2 diabetes mellitus. Conducted at the Sukamerindu Health Center in Bengkulu City in 2024, the study involves a total of 284 participants. The sample size was determined using a hypothesis testing formula, requiring at least 22 participants per group, resulting in a total minimum of 44 participants. A purposive sampling method was employed, ensuring that participants met specific inclusion and exclusion criteria.

The participants included in this research were individuals diagnosed with type 2 diabetes mellitus by a physician who did not engage in structured physical exercises such as gymnastics, aerobics, or casual walking. They voluntarily agreed to participate, were between 30 and 60 years old, capable of walking, and were prescribed biguanide-class antihyperglycemic medication (metformin) or sulfonylurea drugs like glibenclamide or glimepiride. Additionally, their current blood glucose levels exceeded 180 mg/dl. At the same time, patients with type 2 diabetes mellitus were excluded if they had other complications, suffered from decreased awareness, relied on injectable blood sugar-lowering medications (like insulin), stopped treatment due to passing away or moving elsewhere, or were unable to finish the intervention.

The research data were divided into primary data obtained through questionnaires, interviews and observations, and secondary data obtained through documents and previous reports. The collected data underwent univariate analysis to outline the characteristics of each research variable. Afterward, a two-variable analysis was conducted to investigate the relationship among factors such as blood glucose levels, dynamic stretching, and leisurely walking. This study obtained ethical clearance from the Ethics Committee of Poltekkes Kemenkes Bengkulu through letter No. KEPK/656/11/2024, guaranteeing that participation was entirely voluntary and without any monetary incentives.

RESULTS AND DISCUSSION

Results

Table 1 illustrates the respondents' mean age, which stood at 46 years within the intervention group. This figure is projected to account for 95% of the respondents' average age, spanning from 43.35 to 50.29 years. Conversely, the control group exhibited an average age of 47 years, with a 95% confidence interval ranging between 43.75 and 51.52 years. Regarding the duration of diabetes mellitus, the intervention group had a mean duration of 5.09 years, with a 95% confidence interval of 3.72 to 6.47 years. Similarly, in the control group, the mean duration was 5.18 years, with 95% confidence that the true mean falls within the range of 3.69 to 6.68 years.

Most of the study participants were female, with 63.4% assigned to the intervention group and 59.1% to the control group. Within the intervention group, 68.2% of individuals used a combination therapy consisting of biguanide (metformin) and sulfonylurea (glimepiride/glibenclamide), whereas 59.1% of those in the control group were prescribed biguanide (metformin) alone. Before the intervention took place, the majority of participants in both groups were involved in light physical activities (MET below 600). A total of 54.5% of participants in the intervention group and 68.2% in the control group took part in these activities. After the intervention, the percentage of individuals involved in moderate activities increased to 63.6% in the intervention group, while the control group showed no variation.

Table 1. Characteristics of Respondents (n = 44)

Variable	Group		P Value
	Intervention	Control	
Age			
Mean	46.82	47.64	0.541 *
Median	49	46.50	
Min-Max	33-57	35-59	
SD	7.829	8.764	
95 % *CI for mean*	43.35-50.29	43.75-51.52	
Duration of Diabetes Mellitus			0.953*
Mean	5.09	5.18	
Median	5	4.50	

Min-Max	1-12	1-12	
SD	3.100	3.375	
95 % *CI for mean*	3.72-6.47	3.69-6.68	
Gender			
Male	8 (36.4%)	9 (40.9%)	1.000**
Female	14 (63.4%)	13 (59.1%)	
Antidiabetic Medication			
Biguanide (metformin)	7 (31.8%)	13 (59.1%)	
Combination of Biguanide (metformin), Sulfonylurea *(glimepiride/glibenclamide)*	15 (68.2%)	9 (40.9%)	0.130**
Physical Activity Score (Pre)			
Light (MET<600)	12 (54.5%)	15 (68.2%)	0.759**
Moderate (MET 600-3000)	10 (45.5%)	7 (31.8%)	
Physical Activity Score (Post)			
Light (MET<600)	8 (36.4%)	15 (68.2%)	0.070**
Moderate (MET 600-3000)	14 (63.6%)	7 (31.8%)	

Table 2. Differences in Mean Blood Glucose Levels Before and After Intervention

Group	Variable					*P-Value*
	Mean	Median	Min-Max	SD	95% *CI for mean*	
Intervention						
Blood Sugar Levels *Pre*	228.94	229.00	176-300	28.734	216.20-228.05	0.953*
Blood Sugar Levels *Post*	155.85	153.50	114-209	24.031	145.19-166.50	0.623*
Control						
Blood Sugar Levels *Pre*	225.94	223.00	178-294	32.809	211.39-240.49	0.462*
Blood Sugar Levels *Post*	196.71	194.58	155-255	31.195	182.88-210.54	0.204*

Table 2 presents the findings of the normality test for blood sugar levels in the intervention group both before and after the treatment. The p-value exceeded 0.05, suggesting that the 95% confidence interval for the mean ranged from 216.20 to 228.05 before the intervention and from 145.19 to 166.50 afterward. Similarly, in the control group, the p-value remained above 0.05, signifying no significant variation. Prior to the intervention, the 95% confidence interval for the mean was between 211.39 and 240.49, whereas post-intervention, it ranged from 182.88 to 210.54.

Table 3. Differences in Mean Blood Glucose Levels Before and After Intervention

Group	Blood Sugar Level		Mean Difference	95% *CI of the Difference*	*P-Value*
	PRE	*POST*			
	Mean (SD)	Mean (SD)			
Intervention	228.9394 (28.73440)	155.8485 (24.03111)	73.09091	68.03675-78.14507	0.00*

Control	225.9394 (32.80883)	196.7121 (32.19215)	29.22727	24.52078-33.93377	0.00*

Table 3 shows a notable alteration in blood glucose levels following the intervention for both groups, with a p-value of 0.00 (P < 0.05), indicating statistical significance.

Table 4. Effect of Combination of Active Stretching and Leisure Walking on Blood Sugar Levels

Variable	Blood Sugar Level Differences		Mean Difference	CI 95%	P Value
	Mean	SD			
Blood Sugar Level					
Intervention	73.0909	11.39929	43.86364	37.16178-5056549	0.00*
Control	29.2273	10.61515			

Table 4 displays the outcomes of the statistical analysis, revealing a p-value of 0.00 (p < 0.05). This implies that the alternative hypothesis (Ha) is supported, indicating that incorporating active stretching and relaxed walking exercises has a meaningful effect on blood sugar levels in individuals diagnosed with type 2 diabetes mellitus.

Discussion

The findings indicated that individuals in the intervention group had an average age of 46.82 years, while those in the control group had a mean age of 47.64 years. This aligns with the notion that individuals within this age range face a heightened risk of developing diabetes due to a natural decline in physiological functions, including reduced insulin sensitivity and pancreatic performance. In addition, habits like consuming too many carbohydrates, lacking regular exercise, and experiencing high stress levels play a role in the advancement of the illness (Astutisari et al., 2022).

The average duration of diabetes mellitus among individuals in the intervention group was 5.09 years, while those in the control group had an average disease duration of 5.18 years (Restika et al., 2023). The longer the duration of a person's diabetes, the greater the likelihood that his or her organs will experience a decline in function. If uncontrolled, this condition can develop into serious complications that damage small (microvascular) and large (macrovascular) blood vessels, and the impact will get worse over time (Seta et al., 2022)

Based on gender, both groups had a majority of female respondents. Women have the hormone estrogen to help the body be more sensitive to insulin, but hormonal fluctuations during menstruation, pregnancy, or menopause can change blood sugar levels (Galicia-Garcia et al., 2020). Generally,

men's activities use more muscles so they are more efficient in using glucose than women's activities tend to be lighter, which can increase the risk of diabetes mellitus (Pramesti & Susilowati, 2023) .

Most respondents in the intervention group (68.2%) used a combination of Biguanide (metformin) and Sulfonylurea, while most respondents in the control group (59.1%) only used BiguanideBiguanide or metformin works by increasing insulin sensitivity in the liver and muscles, while sulfonylurea works to stimulate insulin secretion from pancreatic beta cells so that both work well together. Prior to the implementation of the intervention, the majority of individuals involved in this study engaged primarily in low-intensity physical activities (MET below 600). Specifically, 54.5% of those in the intervention cohort and 68.2% of those in the control cohort fell into this category (Mishu et al., 2021). However, after the intervention was introduced, there was an increase in the proportion of participants in the intervention group who engaged in moderate-intensity physical activities (MET ranging from 600 to 3000), reaching 63.6%. Engaging in regular physical activity enhances the body's metabolism, allowing for more efficient utilization of blood glucose as an energy source, which in turn aids in regulating blood sugar levels (Ega Safitri et al., 2022).

The analysis of the average blood sugar levels (calculated from individual values recorded between session 1 and session 6) revealed a reduction in mean glucose levels following the intervention. Specifically, in the intervention group, post-intervention measurements showed an average of 155.85 mg/dL, a notable decrease from the pre-intervention average of 228.94 mg/dL. This decline was also reflected in the narrowing range of minimum and maximum values in the post-measurement data. Similarly, the control group experienced a reduction in mean blood sugar levels, with post-intervention values averaging 196.71 mg/dL, compared to a pre-intervention average of 225.94 mg/dL. The decrease observed in the control group was less pronounced compared to the intervention group. Additionally, the difference between the minimum and maximum values in the control group diminished to a smaller degree than in the intervention group.

The findings indicate that prior to the intervention, both the intervention and control groups exhibited a tendency toward increased blood glucose levels. This aligns with previous research, which suggests that individuals with diabetes mellitus often experience elevated blood sugar levels before receiving any form of treatment or intervention (Ega Safitri et al., 2022). A study by Selvina Lindarti et al., (2023) also highlights that diabetic patients exhibit fluctuating blood sugar levels, with a tendency to rise before undergoing proper medical intervention. Similarly, Triska, (2023) reported that individuals who engaged in light walking three times per week for three weeks showed significant reductions in blood glucose levels compared with baseline measurements ($p < 0.05$)

A statistical examination of the research findings revealed a significant variation in the average blood sugar levels between the two groups before and after the intervention, as indicated by a p-value of 0.00 ($p < 0.05$). Nevertheless, the decline in blood sugar levels was notably greater in the intervention group compared to the control group. This suggests that, statistically, a significant distinction exists between the two groups. These results support the notion that interventions centered on lifestyle modifications, especially enhanced physical activity, are essential for maintaining blood sugar regulation (Thomas et al., 2024).

The reduction in blood glucose levels observed in the control group, even though they only received diabetes medication without extra interventions, may also be associated with behavioral changes triggered by their participation in the study. This phenomenon is commonly known as the Hawthorne effect, where respondents tend to improve their habits because they feel they are being observed (Farmaki et al., 2021).

A statistical evaluation utilizing the Independent Samples T-Test was conducted to assess the effect of integrating active stretching with casual walking on blood glucose levels among individuals with type 2 diabetes mellitus. The findings revealed a significant variation in post-intervention blood glucose levels between the experimental and control groups, as evidenced by a p-value of 0.000 ($p < 0.05$). This finding necessitates rejecting the null hypothesis (H_0) and accepting the alternative hypothesis (H_a). Accordingly, this study confirms that the integration of active stretching and casual walking affects blood glucose levels in type 2 diabetes mellitus patients at the Sukamerindu Health Center in Bengkulu City.

This research aligns with the findings of Damanik, D. *et al.*, (2024) This suggests that engaging in active foot stretching plays a crucial role in lowering blood sugar levels among individuals with type 2 diabetes mellitus, as indicated by a p-value of 0.001 ($p < 0.05$). Additionally, these findings align with the research by Abidin et al., (2023), which also found that active foot stretching helps reduce blood sugar levels in type 2 diabetes patients, with a reported p-value of 0.001 ($p < 0.05$).

Another study by Thomas et al (2024) is believed to also support these findings, stating that interventions in the form of exercise, such as stretching, have an influence on improving glycemic control in people with diabetes. As explained by Khalyfa et al (2021), participating in exercises such as walking and stretching can improve how the body responds to insulin while reducing resistance to it, both of which play a vital role in maintaining stable blood sugar levels..

The findings of this research align with previous studies, demonstrating that engaging in dynamic stretching routines and moderate walking can play a crucial role in regulating blood sugar levels in

individuals diagnosed with type 2 diabetes mellitus. The notable difference between the intervention and control groups underscores the effectiveness of this approach in controlling glucose levels among patients with type 2 diabetes ($p < 0.05$).

CONCLUSION

Combining active stretching with leisurely walking significantly reduces blood sugar levels in individuals with type 2 diabetes mellitus. This simple yet effective intervention can complement pharmacological treatment and contribute to better diabetes management. Health centers should consider incorporating such physical activity programs for patients living with Type 2 Diabetes Mellitus to improve their glycemic control and overall health.

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