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The Glucose Reducing Effects of a Physical Regimen Combining Putu Sila and Tai Chi in Individuals with Type 2 Diabetes Mellitus in the Public Health Center of Bima

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Abstract

Diabetes mellitus hyperglycemia is a chronic disease characterized by the absence of insulin or a relative decrease in cell insensitivity to insulin that requires continuous treatment and ongoing self-management to prevent acute complications and reduce the risk of chronic complications. Type 2 diabetes mellitus is particularly by physical activity. This study aims to understand the difference between two exercise regimens on blood glucose levels reduction in patients with type 2 diabetes mellitus. This was a quasi-experimental study with a pre-test post-test control group design. 60 respondents were selected via random sampling and divided evenly into two groups of 30 individuals: 1) the treatment group; and 2) the control group. A Wilcoxon test performed on the treatment group yielded P-value = 0,005 < α = 0,05 and a Wilcoxon test performed on the control group yielded P-value = 0,046 < α = 0,05. The conclusion that can be drawn from this study is that physical activity has an effect of reducing blood glucose levels in patients with type 2 diabetes mellitus, and, when comparing the differences in blood glucose level reduction, a combined regimen of putu sila and Tai Chi is more effective than Tai Chi alone.

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1 Introduction

Diabetes mellitus hyperglycemia is characterized by the absolute absence of insulin or a relative decrease in cell insensitivity to insulin. Another definition describes diabetes mellitus as a chronic disease that requires continuous treatment, ongoing self-management, and adequate support to prevent acute complications and reduce the risk of chronic complications (ADA, 2010). Based on global studies, the total number of people diagnosed with type 2 diabetes mellitus reached 366 million in 2011 and is estimated to increase to 552 million by 2030. In 2006, more than 50 million people in Southeast Asia had diabetes mellitus. The International Diabetes Federation (IDF) estimates that 183 million people are not aware that they have diabetes mellitus. The majority of those with diabetes mellitus are aged 40-59 years old (Trisnawati, 2013).

The number of medically diagnosed cases of diabetes in West Nusa Tenggara (NTB) is 0.9% and cases where symptoms indicate diabetes make up 1,3% (Riskesdas, 2013). The rate of diabetes mellitus in the city of Bima increased from 506 in 2012 to 848 people in 2014 consisting of 35.49% men, and 64.51% women (NTB Health Service, 2015). Physical exercise or sports can be a solution, this is found in a study conducted by (J. Larry Durstine et al., 2001; Hussein et al., 2011; Rajput et al., 2012; Mustika et al., 2017) that recommended physical activity be included in diabetes treatment regimens for those suffering from diabetes but do not have comorbid contraindications. There are many benefits of physical activity for those with diabetes, including increased insulin sensitivity, positive change in the profile of cardiovascular risk factors, decreased adiposity, increased functional capacity, and longer life expectancy. The ACSM and *American Diabetes Association* (ADA) agree that people with diabetes can participate in most modes of physical activity provided they take appropriate precautions. Recommended for diabetics include low-impact and weight-free exercises such as swimming, rowing, cycling, and aerobics (Romano et al., 1998; Seshiah et al., 2007; Cosson et al., 2006).

Based on this the researcher wants to examine how a physical exercise regimen combining Putu Sila and Tai Chi can affect blood sugar levels in patients with type 2 diabetes mellitus. Interviews with health center workers revealed an existing exercise program known as Prolanis which was comprised of health check activities, blood tests, and aerobic workouts. This research aims to identify the averages before and after physical activity and analyze the effect of a combined regimen of putu sila and taichi on the reduction of blood glucose levels in patients with type 2 diabetes mellitus in the Bima Health Care Center.

2 Materials and Methods

The research method used was a quasi-experimental method with a pre-test and post-test control group design. Samples were chosen via random sampling. A total of 60 respondents were broken into two groups of 30 respondents, a control group and a treatment group. Participants in the study were randomly selected among a pool of patients that fulfilled the necessary criteria, which were: 1) active members in the Prolanis program (Chronic Illness Management program) of the Bima Health Care Center; 2) normal vitals for their age; 3) diagnosed with type 2 diabetes mellitus with a blood sugar level of no less than 90mg/dl; 4) have had diabetes mellitus for at least 1 year; 5) had no bone or joint issues that would affect their ability to participate in physical activities; 6) did not suffer from severe complications (hypoglycemia, hyperglycemia, ulcers in the feet, liver failure, congestive heart failure, etc.). This study received ethical clearance from the University Of Mataram Faculty of Medicine's Ethics Committee. The study was conducted in the Bima Health Care Center (Puskesmas) between July to December of 2019. Data was collected via a questionnaire where respondents were asked to write an 'x' or a checkmark in response to the questions. The questionnaire was divided into two sections: the first section contained questions about the respondent's age, level of education, gender, occupation, and blood sugar levels, and the second section contained questions about their diagnosis. The normality test is done by using Shapiro-Wilk if the sample is ≤ 50. Data are normally distributed if significance (p) > 0.05 are obtained. This study uses statistical tests *Wilcoxon Signed Rank test.*

3 Results and Discussions

Table 1 shows that most respondents in the treatment group (10 individuals) fell into the 56-65year age group (33.3%). 15 individuals in the control group fell into the 56-65year age range (50%). Most of the treatment group

were women (21 individuals, 70%). Women also made up the majority of the control group (16 individuals, 53.3%). On the level of education, 16 respondents in the treatment group had completed junior high school (53.3%). In the control group, 16 had completed senior high school (53.3%). Regarding occupation, 11 individuals in the study were stay-at-home mothers (36.7%) compared to 13 in the control group (43.3%). 18 individuals in the treatment group (60.0%) had suffered from diabetes for 1-3 years whereas 18 individuals (60.0%) from the control group had diabetes for 1-2 years. 17 individuals in the treatment group were diagnosed with diabetes compared to 16 individuals in the control group (53.3%).

Respondent Data

Table 1
Respondent Characteristics Data at the Bima City Health Center

Variables	Intervening Group		Control Group	
	n	%	n	%
Age (Mean ± SD)	58.57 ± 8.577		57.13 ± 7.215	
Late adulthood 36-45 years	3	10.0	3	10.0
Early old age 46-55 years	9	30.0	9	30.0
Late old age 56-65 years	10	33.3	15	50.0
Elderly 66 years or older	8	26.7	3	10.0
Sex				
Male	9	30.0	14	46.7
Female	21	70.0	16	53.3
Highest Completed Level of Formal Education				
None	1	3.3	2	6.7
SD	3	10.0	4	13.3
Junior High School	5	16.7	5	16.7
Senior High School	16	53.3	16	53.3
Diploma	2	6.7	2	6.7
Bachelor's Degree (or equivalent)	3	10.0	1	3.3
Occupation				
Civil Servant	6	20.0	4	13.3
Private Sector Employee	9	30.0	8	26.7
Farmer	4	13.3	5	16.7
Housewife	11	36.7	13	43.3
Time Since Diagnosis				
1-3 years	18	60.0	18	60.0
4-6 years	8	26.7	8	26.7
7 or more years	4	13.3	4	13.3
Diagnosis				
DM	17	56.7	16	53.3
HT and DM	13	43.3	14	46.7

Frequency Distribution of Glucose Levels in Control Group and Treatment Group Respondents Before and After Physical Activity

Table 2
Distribution of Blood Glucose Frequency in Bima Public Health Center

Variables	Intervening Group						Control Group					
	Pre 1	Post 1	Pre 2	Post 2	Pre 3	Post 3	Pre 1	Post 1	Pre 2	Post 2	Pre 3	Post 3
Blood Glucose Level	n %	n %	n %	n %	n %	n %	n %	n %	n %	n %	n %	n %
Mean SD	188.83 47.021	186.50 46.029	183.70 45.080	180.80 44.336	177.57 42.884	173.50 42.444	184.22 46.229	184.11 46.340	183.14 44.488	182.33 44.615	182.44 44.138	181.50 44.359
Minimum	125	125	125	123	118	112	125	125	127	125	128	127
Maximum	296	294	290	289	285	280	293	293	293	293	290	288
Good	5 16.7	5 16.7	7 23.3	8 26.7	8 26.7	13 43.3	5 16.7	5 16.7	5 16.7	5 16.7	5 16.7	7 23.3
Moderate	10 33.3	10 33.3	8 26.7	7 23.3	7 23.3	5 16.7	10 33.3	10 33.3	10 33.3	10 33.3	11 36.7	11 36.7
Poor	15 50.0	15 50.0	15 50.0	15 50.0	15 50.0	12 40.0	15 50.0	15 50.0	15 50.0	15 50.0	14 46.7	12 40.0

Table 2 shows, before participating in combined putu sila and tai chi physical activities, of the 30 treatment group respondents, 15 respondents were categorized with poor glucose levels (50.00%), 10 respondents were categorized with moderate glucose levels (33.33%), and 5 respondents were categorized with good glucose levels (16.67%). The highest measured value of 296mg/dl dropped to 280mg/dl and the lowest measured value of 125mg/dl dropped to 112mg/dl.

15 individuals in the control group were categorized into the "poor" blood glucose levels group (50.0%), 10 respondents in the "moderate" group (33.3%), and 5 respondents in the "good" group (16.7%). After calisthenics, the post-test blood glucose levels of the respondents after the third week of the study were: 7 respondents with good blood glucose levels (23.3%), 11 were moderate (36.7%), and 12 were "poor" (40.0%). The mean values pre-test were 184.22 with a standard deviation of 46.229 and at the end of the third-week post-test, the mean was 181.50 with a standard deviation of 44.359. The maximum value of 293mg/dl dropped to 288mg/dl and the minimum value of 125mg/dl rose slightly to 127mg/dl.

The difference in Average Blood Glucose Before and After Physical Activity

Table 3
The difference in Mean Blood Glucose in Control and Treatment Group Respondents Before and After Physical Activity

Group		N	Mean Rank	P
Intervening				
Post-Test Week 1 Intervening - Pre-Test Week 1 Intervening	Negative Ranks	0[a]	.00	.005
	Positive Ranks	0[b]	.00	
Second week - Second week	Negative Ranks	0[d]	.00	.005
	Positive Ranks	1[e]	1.00	
Third week - third week	Negative Ranks	0[g]	.00	.005
	Positive Ranks	8[h]	4.50	
Control				
First week - first week	Negative Ranks	0[a]	.00	.046

	Positive Ranks	0[b]	.00	
Second week - Second week	Negative Ranks	0[g]	.00	.046
	Positive Ranks	0[h]	.00	
Third week - third week	Negative Ranks	0[d]	.00	.046
	Positive Ranks	4[e]	2.50	

Table 3 shows the results of the Wilcoxon tests to calculate significant differences between the two groups. Test results were significant in the treatment group (0.005), meaning there was a notable change in blood glucose levels before and after physical activity. In the control group the test results were also significant (0.0046) meaning a notable difference in blood glucose levels before and after physical activity with a significance of 0.05. P-value < 0.05, thus Ho is rejected indicating a significant difference between the pre-test and post-test results between the treatment and control groups.

There is a difference (positive) in the treatment group (intervention) between the results of blood glucose for pre-test and post-test, there are 8 positive data points (N) which means that 8 respondents experienced improved blood glucose levels from pre-test to post-test. The mean rank was 4.50. In the control group, there was also a difference (positive) between the results of blood glucose for pre-test and post-test, namely, there were 4 positive data points (N), which means 4 respondents experienced an improvement from pre-test to post-test. The mean rank was 2.50. Test results calculated with SPSS showed that a combined regimen of putu sila and tai chi was more effective in reducing blood glucose levels in respondents with diabetes mellitus.

Discussion

Results showed that before participation in the combined regimen of putu sila and taichi, 15 respondents in the treatment group prior (50.0%) were categorized with "poor" blood glucose levels, 10 respondents with "moderate" (33.3%), and 5 with "good" (16.7%) blood glucose levels. After finishing the combined regimen of putu sila and tai chi, post-test results in the second week found 8 respondents with "good" blood glucose levels (26.7%). After the third week of the study, post-test results showed that 13 respondents had "good" blood glucose levels. In the control group, before physical activity, 15 respondents (50.0%) were categorized with "poor" blood glucose levels, 10 with "moderate" (33.3%), and 5 with "good" (16.7%). After calisthenics activities, post-test results in the third week of the study showed that 7 respondents were categorized with "good" blood glucose levels (23.3%), 11 with moderate (36.7%), and 12 with poor (40.0%). This shows that physical activity plays a significant role in the reduction of blood glucose levels in patients with type 2 DM. There is a gradual decrease in blood glucose in patients with type 2 diabetes mellitus so that physical exercise can be done routinely without fear of a rapid decrease in blood glucose. A combined regimen of putu sila and tai chi is one possible option for physical activity in patients with type 2 diabetes mellitus. Physical activity is very important and can become a lifestyle in daily life to maintain health. This is supported by a study by Ernawati et al. (2013) that found that the primary issue in type 2 DM was the reduced insulin sensitivity of receptors (insulin resistance). This issue results in reduced glucose transfer to the cells. This response only occurs during physical exercise and is not permanent nor longstanding, necessitating regular exercise

Results of the Wilcoxon Signed Rank Test showed that the average difference between pre-test and post-test blood glucose levels in treatment group respondents for the first week of the study was 118.83 with a standard deviation of 47.021. At the end of the third week, the average was 173.50 with a standard deviation of 42.444 and a significance of 0.005. These results show a statistically significant difference between pre-test and post-test scores in the treatment group after a combined regimen of putu sila and tai chi.

Results of the Wilcoxon Signed Rank Test on the control group returned an average score of 184.22 with a standard deviation of 46.229 for pre-test in the first week of the study and 181.50 with a standard deviation of 44.359 in post-tests in the third week with a significance of 0.046. In the control group, there was a difference between pre-test and post-test scores though it was not significant.

This study finds a correlation between physical activity and blood glucose level reduction. A combined physical regimen of putu sila and tai chi has a greater effect on the reduction of blood glucose levels in patients with type 2 diabetes mellitus than a regimen comprised of only tai chi as conducted by the control group. This supports the findings of Srywahyuni et al. (2019) who found that tai chi and calisthenics both lead to the reduction of blood sugar

levels in patients with type 2 diabetes mellitus. The same study also reported a greater effect from calisthenics than tai chi.

Putu sila is a martial art from Bima that involves slow movements and focuses on body balance and posture as well as regulated breathing patterns. Every movement in putu sila is designed to tighten the muscle and stimulate the muscles in the hands and feet with slight movements. This combination of balancing the body's position, slow movements, and regulated breathing patterns create a relaxing and calming effect. In putu sila, there are no quick movements and a regulated breathing pattern is a necessary component. Tai chi is also a physical exercise or art that is performed slowly and benefits physical health and mental balance. A combined regimen of putu sila and tai chi is recommended for its ability to increase the body's sensitivity to insulin and reduce blood glucose levels. This combined regimen of putu sila and tai chi is a non-pharmacological form of therapy that can be performed to reduce blood sugar levels through escalated physical activity that is also relaxing. Theoretically, relaxation calms the brain and revitalizes the body. Regular relaxation can be used to reduce stress.

Through relaxation, the hypothalamus will regulate and reduce the sympathetic nervous system and cause arteriolar dilation (Glickman-Simon & Richard, 2007). Calisthenics for patients with diabetes mellitus can increase insulin sensitivity in the muscles and liver and cause a reduced need to consume oral treatments for hypoglycemia. Other studies have also found that physical exercise is an alternative (J. Larry Durstine et al., 2001). The recommends physical activity be included in treatment regimens for those with diabetes that do not have contraindicative comorbidity. The largest age group in the treatment group of this study was 56-65 years old (10 individuals, 33.3%). The largest age group in the control group was also 56-65 years old (15 individuals, 50.0%). This shows that individuals between the ages of 45-65 years old are at risk of diabetes mellitus.

Sujaya (2009) found that individuals above the age of 30 are at risk of type 2 DM and anatomical, physiological, and biochemical changes. These changes begin at the cell level up to the tissue level and finally at the organ level and can result in homeostasis. Once an individual has reached 40 years of age, they are at risk of DM because at this age their glucose intolerance rises. The aging process causes the reduced capacity of the beta cells in the pancreas to produce insulin. Theoretically, type 2 NIDDM (Non-insul Dependent Diabetes Mellitus) is a type of diabetes mellitus where the individual experiences a reduced sensitivity to insulin, or insulin resistance, and the failure of beta cells to produce insulin. This occurs in obese individuals over the age of 30 (Smeltzer & Bare, 2008). Soegondo (2009) found that type 2 diabetes mellitus does not require insulin, has a slow onset, does increase the risk of ketoacidosis, and is more likely in individuals older than 45 years. The aging process after 30 years of age causes anatomical, physiological, and biochemical changes.

In this study, the largest gender group was women with type 2 diabetes mellitus. In the treatment group, 21 individuals were women (70.0%). In the control group, 16 individuals were women (53.3%). Based on gender prevalence, men and women have the same likelihood of developing diabetes. However, regarding risk, women are more likely to suffer from diabetes because physically women have a higher likelihood for great body mass index. Additionally, pregnant women experience hormonal imbalance and high progesterone which increases the ability of the body's systems to stimulate cell development (including in the fetus). The body also sends hunger signals and, at its peak, this causes the reduced absorption of calories by the body's metabolism and uses these calories efficiently. Ultimately, this creates an increase in blood sugar levels during pregnancy (Damayanti, 2010).

Women have a higher likelihood of developing obesity than men. Women have higher LDL triglycerides than men; fat makes up 15-20% of total body weight in men and 20-25% in women. Thus, the increase of lipids in women is higher than in men leading to an increased risk of diabetes mellitus that is 3-7 times higher than in men (Haryati & Geria, 2014). The findings support those of previous research (Smeltzer, 2008) that found that more women suffered from diabetes mellitus than men. This is triggered by an accumulation of fat in women's bodies that is larger than in men and is the factor for the lowered insulin sensitivity in the muscles and liver. Women also have an increased risk for developing diabetes after menopause. This is linked to estrogen and progesterone that influence the body's response to insulin. Estrogen is a hormone in women, when this hormone rises, the body's resistance to insulin also increases. The more fat in the body, the more resistant the body to insulin, which reduces the effectiveness of insulin and leads to a reduced capability to transport glucose into cells. This glucose collects in the blood vessels and increases the blood glucose levels (Marewa, 2015).

The largest last level of education group in the treatment group was the senior high school with 16 individuals (53.3%). In the control group, it is the same group, senior high school with 16 individuals (53.3%). This shows that a low level of education is a factor for diabetes mellitus.

According to Soekidjo (2007), education is very important and is the process through which community behaviors transform and offers the opportunity to individuals to discover new ideas and values. A high level of

education is a significant factor in the improved quality of respondents' health. An individual with a high education level will be more active in pursuing healthy lifestyle habits that help preserve healthy levels of blood glucose.

Results of this study showed that the majority of respondents in the treatment group were stay-at-home mothers (11 individuals, 36.7%). In the control group, the majority of respondents were also stay-at-home mothers (13 individuals, 43.3%). This indicates that a lack of activity and a poor lifestyle influenced the glucose levels in respondents. Their line of work also was closely linked to the onset of diabetes mellitus. A person's job is linked to their level of physical activity. Univariate analysis showed that a significant portion of respondents was unemployed. Most respondents were unemployed women. This group is a stay-at-home mother. An individual's line of work is linked to their level of physical activity.

There were respondents in this study with both type 2 diabetes mellitus and hypertension. 17 respondents in the treatment group (56.7%) had been diagnosed with diabetes compared to 16 individuals in the control group (53.3%). 13 individuals in the treatment group had both diabetes and hypertension (43.3%) compared to 14 in the control group (46.7%). A previous study conducted by Raza et al. (2018) found that patients with type 2 diabetes mellitus and hypertension were at high risk for dyslipidemia. The most common type of lipid abnormality in these patients was low-level HDL.

How long an individual suffered from diabetes was a factor in the emergence of additional complications that further reduced the ability capability to control blood sugar levels. In the intervention group, 18 individuals (60.0%) had diabetes for 1-3 years. In the control group, 18 individuals (60.0%) had diabetes for 1-2 years. With regular physical activity and blood glucose level checks, their blood glucose levels had reduced to normal levels. This shows that the earlier one introduces regular physical activity into their lifestyle, the easier it is to control blood sugar levels and create a long-lasting reduction of blood sugar levels. The longer one suffers from DM without taking measures to control their blood sugar levels, the higher their risk of developing complications such as damage to blood vessels throughout the body and even exacerbating vital organ functions. With enough time, glucose levels in the blood will damage the walls of capillaries that are directly related to nerves. According to Smeltzer (2008), Bare (2008) the longer one suffers from type 2 DM the greater the risk of suffering from complications. The specific cause and pathogenesis of each complication are still under investigation, but the increase in blood glucose levels appears to play a role in the appearance of neuropathic abnormalities and microvascular complications. It is also a risk factor for macrovascular complications. Along with complications that occur, the longer one suffers from DM, the higher the incidence of complications experienced by patients. In a long period, glucose levels in the blood will damage the walls of capillaries that connect directly to nerves. 68.8% of respondents were elderly. Age is very closely related to the increase in blood sugar levels and duration of DM; the older the individual, the greater their glucose tolerance. To the point that those who suffer from diabetes mellitus can only maintain their blood sugar levels to remain normal.

4 Conclusion

Physical exercise combining putu sila and Tai Chi has an effect of reducing blood glucose levels in respondents. There are a significant influence and difference in respondent's blood glucose level after a combined regimen of putu sila and tai chi both pre-and post-treatment (*p value*= 0.005). Further studies could expand upon these findings by widening the area of research with sessions that are longer or of higher intensity so that the level of generalization is higher.

Conflict of interest statement
The authors declared that they have no competing interests.

Statement of authorship
We are willing to submit the necessary data in the process of submitting this journal without any coercion and the data we provide is the correct data.

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