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THE EFFECT OF PROGRESSIVE MUSCLE RELAXATION ON BLOOD SUGAR LEVELS IN PATIENTS WITH TYPE 2 DIABETES MELLITUS

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ABSTRACT
One of the most complex chronic diseases is diabetes, which requires ongoing medical care aimed at reducing multifactorial risks beyond glycaemic control. Diabetes and stress are interrelated, where stress results in increased cortisol production, cortisol itself inhibits the work of insulin, this triggers an increase in blood sugar levels. One of the ways to control blood sugar levels by providing non-pharmacological therapy is to provide music therapy, relaxation and guided imagery. Progressive Muscle Relaxation (PMR) is one of the relaxations that can be applied to patients with diabetes mellitus. This relaxation technique can speed up the body's metabolism by physiologically increasing blood flow. This study aims to determine the effect of progressive muscle relaxation on blood sugar levels in patients with type 2 diabetes mellitus. This research is a quasi-experimental. The research design used is nonrandomised pretest - posttest with control group design. The research sample was divided into two groups, the intervention group and the control group. Blood sugar level measurements were carried out in the intervention group twice, namely before (pretest) and after (posttest) being given progressive relaxation therapy, while the control group did not receive any actions. The population in this study were patients with type 2 diabetes mellitus at Dr Moewardi Surakarta Hospital. Data analysis using the parametric paired t-test because the data is normally distributed. The blood sugar level in the control group before the relaxation intervention was an average of 237.90 mg/dl and after the relaxation intervention was an average of 218.57 mg/dl. The average blood sugar level in the control group before relaxation was 238.10 mg/dl and after relaxation was 231.43 mg/dl. The p-value for the intervention group based on the paired sample t-test statistic is 0.000 ($p < 0.05$) with an average decrease in blood sugar level of 19.33 mg/dl. These results indicate that progressive muscle relaxation exercises have an effect on changes in blood sugar levels in patients with type 2 diabetes mellitus. Based on the above description, it can be concluded that progressive muscle relaxation has an effect on changes in blood sugar levels in patients with type 2 diabetes mellitus.

Keywords: blood sugar levels; diabetes mellitus; progressive muscle relaxation

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INTRODUCTION

One of the degenerative diseases that causes the highest mortality rate and has an increasing number of sufferers is diabetes mellitus. The disease poses a significant economic burden on society and the healthcare system (Najafi Ghezeljeh et al., 2017a). One of the four non-communicable diseases is diabetes, which is the leading cause of death in Indonesia besides cancer, and chronic obstructive pulmonary disease (COPD) (Badan Kebijakan Pembangunan Kesehatan, 2023). The estimated global percentage of diabetes sufferers aged 20-79 in 2021 was 10.5% (536.6 million people), and this number is projected to increase to 12.2% (783.2 million people) by 2045 (Rochmah et al., 2023). According to IDF data, 537 million people globally suffer from diabetes. This number is predicted to rise to 643 million by 2030, and 783 million in the next 26 years. IDF reported that in 2021, 541 million people are predicted to be glucose intolerant. Deaths directly related to diabetes are estimated to be over 6.7 million among those aged 20-79 years (International Diabetes Federation, 2021).

Based on the results of the Indonesian Health Survey (IHS) in 2023, there is an increase in the prevalence of diabetes and the possibility of undetected diabetes cases in the community. Based on the 2018 Riskesdas data, the prevalence of diabetes diagnosed by a doctor showed an increase, from 1.5% in 2018 to 1.7% in 2023 in all age groups, and from 2.0% to 2.2% in the ≥15 years age group. The three provinces with the highest prevalence of diabetes based on doctor's diagnosis in 2023 are DKI Jakarta, DI Yogyakarta, and East Kalimantan. The lowest prevalence was found in East Nusa Tenggara, Papua, and Maluku (Badan Kebijakan Pembangunan Kesehatan, 2023)

Diabetes is a complex chronic disease that requires long-term medical management, as well as a risk management strategy involving multiple factors, not just limited to controlling blood glucose levels (American Diabetes Association, 2024). The pancreas in healthy individuals produces the hormone insulin through beta cells that play a role in maintaining balanced blood sugar levels. In addition to insulin, the body also produces other hormones that have opposing effects, such as glucagon, epinephrine, and cortisol. These hormones stimulate the body to release glucose into the blood, leading to an increase in blood sugar levels. Insulin plays an important role as a ‘key’ to get sugar into cells and convert it into energy when there is an increase in blood sugar levels. Insulin function in diabetics is impaired due to problems with the pancreas, which causes the body to be unable to regulate blood sugar levels effectively. As a result, hyperglycaemia occurs as glucose cannot be optimally absorbed by the cells (Anisah et al., 2023).

Factors that can influence the condition of diabetes include significantly elevated blood glucose levels, diet, physical activity limitations, disabling conditions, and the development of vascular disorders. Stress is closely related to increased blood sugar levels, with the neuroendocrine system and the sympathetic nervous system becoming active when a person experiences stress through the hypothalamic-pituitary-adrenal (HPA) axis. This process of activity causes hormones such as epinephrine, thyroid hormones, cortisol, and glucagon to be released. These hormones affect blood sugar levels. Increased stress levels can increase the production of cortisol, which works by inhibiting the action of insulin in the body. As a result, blood sugar levels tend to rise (Ibrahim & Aisyah, 2023)

Nurses have an important role as health workers in helping control blood sugar levels in patients with diabetes mellitus (DM) to prevent further complications. One of the efforts that can be made is through the provision of therapy, especially non-pharmacological therapy. This approach includes relaxation and education techniques, such as music therapy, relaxation exercises, and guided imagery. These methods aim to reduce stress levels and improve patients' quality of life, which in turn can contribute to maintaining stable blood sugar levels (Buzatto et all, 2019). Relaxation helps individuals focus their attention more easily and reach a relaxed state more quickly. The body in a relaxed state receives an optimal supply of oxygen, which supports the adrenal glands to work in a balanced way to produce calming hormones, such as endorphins. This process contributes to a decrease in stress levels. Such a decrease in stress indirectly helps control blood sugar levels, as controlled stress can prevent hormonal surges that trigger an increase in glucose in the blood (Hidayah et al., 2023).

One form of physical exercise accompanied by relaxation techniques that can be used in patients with diabetes mellitus is progressive muscle relaxation (Progressive Muscle Relaxation/ PMR) (Najafi Ghezeljeh et al., 2017a). The blood sugar levels of diabetes patients decrease when they engage in relaxation, as this triggers the release of hormones that cause an increase in glucose, such as adrenocorticotropic hormone (ACTH), epinephrine, glucagon, cortisol, thyroid hormones, and corticosteroids. A relaxed and calm state leads to a decrease in the secretion of corticotropin hormone in the hypothalamus. This affects the adenohypophysis system, causing a reduction in the production of ACTH hormone into the bloodstream. The decrease in cortisol levels can inhibit the process of gluconeogenesis and increase the amount of glucose used by the body's cells, which is beneficial in the development of blood sugar levels (Sari & Harmanto, 2020).

Progressive muscle relaxation performed regularly on diabetic patients can have a lowering effect on blood sugar levels. Relaxation techniques create a relaxed state in the body, thereby reducing insulin resistance and slowing down glucose synthesis to meet energy needs. Physically, progressive muscle relaxation can also enhance blood circulation, thus effectively speeding up the body's metabolic processes (Putriani & Setyawati, 2018). Based on the background description, this study aims to determine the effect of progressive muscle relaxation intervention on blood sugar level changes in patients with type 2 diabetes.

METHOD

This research is included in the type of quasi experiment with a nonrandomised pretest-posttest with control group design. The research sample was divided into two groups, namely the intervention group and the control group. In the intervention group, fasting blood sugar levels were measured twice: before being given progressive muscle relaxation therapy (pretest) and after giving therapy (posttest). Diabetes Mellitus patients receiving treatment at Dr. Moewardi Hospital in Surakarta are the population in this study, with a sample size of 21 people using purposive sampling technique. The inclusion criteria in the study include: type 2 diabetes mellitus patients with blood sugar levels above normal, patients without complications, and willing to become respondents. Meanwhile, the exclusion criteria included type 2 diabetes mellitus patients who could not participate in the entire series of research activities and patients with complications such as heart disease, stroke, and severe hypertension. The measuring instrument used in this study was the observation sheet of blood sugar levels, with measurements made using a calibrated glucometer. The intervention group received progressive muscle relaxation training twice a day for three consecutive days for 15-20 minutes, while the control group did not receive such treatment. Blood sugar levels were measured before and after the implementation of progressive muscle relaxation training over three days. The Shapiro-Wilk test was conducted to determine the normality of the data, using the parametric paired samples test if normally distributed in the intervention group and using the nonparametric Wilcoxon test if not normally distributed in the control group.

RESULT

Table 1.
Characteristics of Respondents

Gender	Control		Intervention	
	f	%	f	%
Man	13	61,9	12	57,1
Woman	8	38,1	9	42,9
Medication Consumption				
Orderly	10	47,6	10	47,6
Irregular	11	52,4	11	52,4
Age	Min	Max	Mean	Standar Deviasi
Control	47	62	54,38	5,220
Intervention	45	62	54,24	5,088
Long Suffering	Min	Max	Mean	Standar Deviasi
Control	2	6	3,52	1,250
Intervention	2	6	4,05	1,396

The gender of the respondents is mostly female, with 12 people (57.1%) in the intervention group. The majority of respondents have irregular medication consumption, with 11 people (52.4%). The average age of the intervention group is 54.24 years. Most respondents have suffered from diabetes for 4.05 years in the intervention group.

Table 2.
Blood Sugar Levels Before Progressive Muscle Relaxation

Blood Sugar Levels	Control		Intervention	
	Pre	Post	Pre	Post
Min	210	200	200	180
Max	255	250	270	240
Mean	238.10	231.43	237.90	218.57
Standard Deviation	11.670	11.952	17.475	14.760

The average blood sugar levels in the intervention group before progressive muscle relaxation intervention 237.90 mg/dl and after progressive muscle relaxation 218.57 mg/dl. The average blood sugar levels in the control group before 238.10 mg/dl and after progressive muscle relaxation 231.43 mg/dl.

Table 3.
Data normality test

Group		P value
Control	Pre	0,006
	Post	0,060
Intervention	Pre	0,728
	Post	0,190

The results of the normality test of the data using the Shapiro-Wilk test showed that the data in the intervention group were normally distributed, so a parametric paired samples test was used. If the data in the control group were not normally distributed, the Wilcoxon parametric test was used.

Table 4.
Effect of Progressive Muscle Relaxation Technique Training on Blood Sugar Levels in Type 2 Diabetes Mellitus Patients in the intervention group

Blood Sugar Levels	Mean Pre	Mean Post	p-Value
Preters-Posttest	237.90	218.57	0.000

The p value = 0.000 ($p < 0.05$) from the paired sample t-test statistical test and the average change in blood sugar levels of 19.33 mg/dl in the intervention group indicates that progressive muscle relaxation has a positive effect on blood sugar levels in patients with type 2 diabetes.

Table 5.
Blood sugar levels in type 2 diabetes mellitus patients in the control group

Blood Sugar Levels	Mean Pre	Mean Post	p-Value
Preters-Posttest	238.10	231.43	0.000

Blood sugar levels changed by 6.67 mg/dl and the p-value was 0.000 in the control group, indicating that progressive muscle relaxation has a positive impact on blood sugar levels in type 2 diabetes patients.

DISCUSSION

Respondent Characteristics

The results of the study (Putriani & Setyawati, 2018b) showed that female respondents were more than male respondents, with 63.0% women and 37.0% men with a total of 27 respondents. Women are more at risk of developing diabetes mellitus, as during the premenstrual syndrome or postmenopausal period, the body's hormonal process tends to accumulate more easily and is likely to experience an increase in body mass index. The level of estrogen hormone in women decreases during menopause, leading to an imbalance in blood sugar levels and increased fat storage. The blood sugar levels before and after progressive muscle relaxation, based on statistical tests, showed a P value of 0.016; since $P < 0.05$, it can be concluded that progressive muscle relaxation can bring about changes in the blood sugar levels of patients (Wowor et al., 2023). As a person ages, they become more at risk of diabetes mellitus, this is due to the increase in blood sugar levels while the body experiences insulin resistance as a result of decreased activity, changes in diet, and a decline in neurohormonal function (Karokaro & Riduan, 2019).

Blood Sugar Levels Before and After Progressive Muscle Relaxation

The blood sugar levels of type 2 DM patients at Suka Makmur Health Center experienced changes after Progressive Muscle Relaxation exercises, with an average blood sugar level of 172.63 mg/dL before the relaxation technique was performed, while the average blood sugar level after the relaxation technique decreased to 130.88 mg/dL. The p value = 0.00, which means that progressive muscle relaxation has a positive impact on blood sugar levels (Anisah et al., 2023).

The relaxed body becomes relaxed during progressive muscle relaxation for 15-20 minutes performed twice a day, resulting in changes in nerve impulses along the afferent pathways to the brain. The body's metabolism increases, breathing patterns improve, muscles become relaxed, blood pressure stabilizes, and there is an increase in alpha waves if progressive muscle relaxation is practiced regularly. This has a positive impact where blood sugar levels stabilize, and this condition can control the release of hormones that can potentially increase blood sugar levels such as epinephrine, cortisol, glucagon, adrenocorticotropic hormone (ACTH), corticosteroids, and thyroid hormones. A calm body condition brings about positive changes, namely the dominance of the sympathetic nervous system and reduces the release of corticotropin-releasing hormone (CRH) in the hypothalamus. The decrease in CRH release affects the adenohypophysis system, which reduces the release of adrenocorticotropic hormone (ACTH) into the bloodstream towards the adrenal cortex. This decrease inhibits gluconeogenesis and increases the use of glucose by the body's cells (Ibrahim & Aisyah, 2023; Najafi Ghezeljeh et al., 2017b; Rochmah et al., 2023).

The progressive muscle relaxation intervention, which is easy to remember, is divided into three stages, with 14 movements in each stage. First stage: performing relaxation techniques for the mouth and neck, as well as the forehead, eyes, and jaw twice. Second stage: performing relaxation techniques for the shoulders, arms, and hands twice. Final stage: relaxation methods for the back, chest, and abdomen, legs, and soles of the feet, done twice. Regular progressive muscle relaxation can be beneficial for the health of the body, in addition to improving physical fitness, this technique can relax the body so that it can control blood glucose levels (Simanjuntak et al., 2020).

Effect of Progressive Muscle Relaxation on Blood Sugar Levels

Progressive muscle relaxation (PMR) is an exercise that combines breathing exercises and repeated relaxation by stretching and calming the muscles. This therapy focuses on achieving relaxation from the head to the feet. The relaxed condition of the muscles gradually reduces pain (Juniarti, Nurbaiti, & Surahmat, 2021). The results of the study conducted by (Juniarti, Nurbaiti, Surahmat, et al., 2021) indicate that the analysis of the difference in average blood glucose levels before and after progressive muscle relaxation was performed using the Wilcoxon test with $\alpha = 0.05$, yielding a p-value of 0.0001. This shows a significant difference in the average blood glucose levels of patients with Type II diabetes mellitus before and after undergoing progressive muscle relaxation exercises at RSUD Dr. H. Ibn Sutowo Baturaja. The average blood glucose level of 32 respondents shows that the majority had blood glucose levels ≤ 200 mg/dl, with 24 respondents (75.0%) and 8 respondents (25.0%) had blood glucose levels ≥ 200 mg/dl.

Research conducted by (Simamora et al., 2020)indicates that one type of mind-body therapy based on how the sympathetic and parasympathetic nervous systems work is relaxation. Progressive muscle relaxation is a procedure for achieving relaxation in muscles through two steps: first, applying tension to a muscle group, and then releasing that tension while focusing attention on the muscles to allow them to relax, feeling the sensation of relaxation and the disappearance of tension. Reducing stress levels has an impact on controlling blood sugar levels. The research results (Nurani & Fitriyanti, 2023) indicate that the blood sugar levels of 114 respondents with type 2 diabetes have decreased, with a p-value of 0.000 ($\alpha<0.05$). This means that progressive muscle relaxation has a positive impact on controlling blood sugar levels. The provision of progressive muscle relaxation can control blood sugar levels by suppressing hormone release.

Epinephrine secretion is suppressed during Progressive Muscle Relaxation, so blood sugar levels are controlled. Controlled epinephrine can inhibit the conversion of glycogen to glucose, suppress cortisol and glucose metabolism, allowing amino acids, lactate, and pyruvate to remain stored in the liver as glycogen and preventing the conversion of glycogen in the liver to glucose. ACTH and glucocorticoids in the adrenal cortex can be regulated through Relaxation, which can reduce the formation of new glucose by the liver; in addition, lipolysis and carbohydrate catabolism can be suppressed, which can lower blood sugar levels (Suzanne C. Smeltzer et al., 2016).

The body becomes relaxed and the stress feedback pathways are inhibited during progressive muscle relaxation. The dominance of the parasympathetic system during relaxed states stimulates insulin secretion and causes a decrease in heart contractions. The hypothalamus is stimulated to reduce the secretion of corticotropin releasing hormone (CRH) due to the dominance of the parasympathetic nervous system. The adenohypophysis is also influenced by the decrease in CRH, resulting in the secretion of adrenocorticotropic hormone (ACTH). In this state, the adrenal cortex may not release cortisol hormone. The high blood sugar levels will gradually return to normal as the decrease in cortisol hormone will inhibit the process of gluconeogenesis and increase glucose usage by cells (Kobayashi & Koitabashi, 2016; Simanjuntak et al., 2020). Researchers concluded that progressive muscle relaxation (PMR) can improve peripheral vascularization and lead to feelings of relaxation, normal blood pressure, and gradually normalize blood glucose levels.

CONCLUSION

The blood sugar levels in the intervention group on average experienced a change after being given progressive muscle relaxation training from 237.90 mg/dl to 218.57 mg/dl, whereas in the control group the average blood sugar levels changed from 238.10 mg/dl to 231.43 mg/dl without the provision of progressive muscle relaxation. The change in blood sugar levels in the intervention group averaged 19.33 mg/dl with a p-value = 0.000 ($p < 0.05$) from the paired sample t-test, indicating that progressive muscle relaxation exercises have a very positive impact on changes in blood sugar levels in type 2 diabetes patients. The average change in blood sugar levels in the control group was 6.67 mg/dl with a p-value of 0.000 from the Wilcoxon test, indicating that there was a change in blood sugar levels, although not significant.

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