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[Original Research]

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The Combination of Progressive Muscle Relaxation and Aromatherapy on Blood Sugar Levels in Type 2 Diabetes

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Abstract

Background: Type 2 Diabetes Mellitus (T2DM) is a chronic disease with increasing prevalence in Indonesia, largely due to lifestyle changes. Blood glucose control in T2DM patients not only relies on pharmacological therapy but can also be supported by non-pharmacological interventions such as progressive muscle relaxation and lavender aromatherapy. These therapies are believed to lower blood glucose levels by reducing stress and promoting relaxation. **Aims:** To examine the effect of a combination of progressive muscle relaxation and lavender aromatherapy on blood glucose levels in T2DM patients. **Method:** A quasi-experimental design with a pretest-posttest control group approach was used. A total of 30 hospitalized T2DM patients at a hospital in Tasikmalaya were recruited through incidental sampling and divided equally into intervention and control groups. The intervention group received progressive muscle relaxation for 30 minutes and lavender aromatherapy for 5 minutes twice daily over three consecutive days. The control group received standard hospital care. Random blood glucose levels were measured before and after the intervention. **Results:** A significant reduction in the intervention group from 265.93 mg/dL with an SD of 41.24 to 220.40 mg/dL with an SD of 51.67 ($p = 0.000$), while the control group showed a non-significant decrease from 281.13 mg/dL with an SD of 45.55 to 268.87 mg/dL with an SD of 51.01 ($p = 0.205$). A significant difference was also observed between the two groups after the intervention ($p = 0.015$). **Conclusion:** the combination of progressive muscle relaxation and lavender aromatherapy was effective in lowering blood glucose levels in T2DM patients. It can be considered as a complementary non-pharmacological therapy in diabetes management.

Keywords: Blood Glucose, Lavender Aromatherapy, Progressive Muscle Relaxation, T2DM

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Introduction

Technological and industrial advancements in the modern era have brought significant changes to human life, particularly in lifestyle and behavioral patterns. These changes include shifts in dietary habits and reduced physical activity, both of which contribute to the rising prevalence of non-communicable diseases, notably Type 2 Diabetes Mellitus (T2DM). T2DM is a chronic metabolic disorder characterized by impaired insulin production or reduced insulin sensitivity, resulting in persistent hyperglycemia. Among the different types of diabetes, T2DM accounts for approximately 90% of all cases in Indonesia (Hidayati, 2018).

Globally, the prevalence of diabetes continues to increase. According to the International Diabetes

Federation (IDF), 537 million adults were living with diabetes in 2021, and this number is projected to rise to 783 million by 2045 (Husain et al., 2022). Indonesia ranks fifth globally in the number of T2DM cases (IDF, 2021). National data also indicate a growing trend, with prevalence increasing from 6.9% in 2013 to 8.5% in 2018 (Riskesdas, 2018). However, only 25% of individuals with diabetes are aware of their condition (Wowor et al., 2023). In West Java, the prevalence among individuals aged ≥15 years reached 1.74%, with 3,254 diagnosed cases reported in Tasikmalaya City alone (Dinkes Kota Tasikmalaya, 2018).

The increasing number of T2DM cases is closely associated with the rising incidence of complications, affecting not only physical health—such as retinopathy, neuropathy, and cardiovascular diseases—but also psychological and socioeconomic well-being (Yusnita, 2021; Janah & Prajayanti, 2023). Hyperglycemia, when left unmanaged, can lead to progressive clinical symptoms such as polyuria, polydipsia, fatigue, and weight loss, eventually resulting in serious complications like blurred vision, paresthesia, nephropathy, and cardiovascular risks (LeMone et al., 2015; Nur & Anggraini, 2022). In clinical settings, T2DM patients often face challenges in controlling blood glucose due to restricted physical activity, dietary non-compliance, and psychological stress (Hardayanti et al., 2019, Perkeni, 2021, Lenggogeni et al., 2023). Elevated stress levels contribute to hyperglycemia by stimulating cortisol release, which impairs insulin sensitivity (Subiyanto, 2019; Lenggogeni et al., 2023).

Management of hyperglycemia involves both pharmacological and non-pharmacological approaches. While pharmacological treatments such as oral hypoglycemic agents and insulin remain the primary strategies, non-pharmacological interventions like dietary regulation, physical activity, and relaxation techniques are increasingly recognized as effective complementary therapies. One such method is Progressive Muscle Relaxation (PMR), which involves systematic contraction and release of specific muscle groups to reduce physical tension and promote relaxation. This technique has been shown to alleviate stress and improve physiological regulation. A study by Bistara & Susanti (2022) demonstrated a significant reduction in blood glucose levels following PMR, with a p-value of 0.016, suggesting its potential as an adjunctive therapy for T2DM management.

In addition to receiving pharmacotherapy (oral hypoglycemic agents or insulin) as part of routine diabetes management, the intervention group was given progressive muscle relaxation (PMR) combined with lavender aromatherapy. Lavender (Lavandula angustifolia) has gained attention for its calming effects on the nervous system and is commonly used in aromatherapy due to its ability to reduce anxiety, regulate the autonomic nervous system, and lower cortisol levels (Kusuma & Anggraeni, 2024). A study conducted by Sari et al. (2024) reported an average reduction of 128 mg/dL in blood glucose levels after one week of lavender aromatherapy among elderly T2DM patients, highlighting its potential as a non-pharmacological support in glycemic control.

While both PMR and lavender aromatherapy have independently shown effectiveness in reducing blood glucose levels, there is limited research examining the combined impact of these interventions. The integration of both methods is hypothesized to yield synergistic effects by targeting both psychological stress and physiological tension, leading to improved glycemic outcomes. Supporting this, Cahyati et al. (2020) found that combining relaxation techniques with lavender aromatherapy significantly decreased blood glucose levels. Similarly, Nursalehah et al. (2022) reported that the combination of PMR and diabetic foot exercises produced a notable reduction in blood glucose levels.

Based on this evidence, it is necessary to further investigate the combined effect of progressive muscle relaxation and lavender aromatherapy as a complementary approach in managing blood glucose among patients with T2DM. This integrated method is expected to offer a holistic and practical alternative for enhancing glycemic control and improving the overall quality of diabetes care.

Methods

This study employed a quantitative approach using a quasi-experimental design with a control group pretest-posttest structure. Participants were divided into two groups: an intervention group that received a combination of Progressive Muscle Relaxation (PMR) and lavender aromatherapy and a control group that received deep breathing relaxation. Blood glucose levels were measured in both groups before and after the intervention period to evaluate the effect of the treatment.

The study sample consisted of 30 respondents selected through non-probability incidental sampling. The sample size was calculated using the independent t-test sample size formula with a significance level of 5% (α = 0.05) and power of 90% (β = 0.10). The population in this study consisted of patients with type 2 diabetes mellitus who were hospitalized at Dr. Soekardjo Regional General Hospital, with a total of 71 patients admitted in the past three months, the total sample included 15 individuals in the intervention group and 15 in the control group. Participants were selected from a population of patients

diagnosed with type 2 diabetes mellitus at Dr. Soekardjo Regional General Hospital, Tasikmalaya City. The research was conducted from March to April 2025.

Inclusion criteria were: (1) diagnosed with T2DM and undergoing treatment for at least 3 days, (2) random blood glucose levels ≥200 mg/dL, (3) receiving either oral hypoglycemic agents or insulin, and (4) no allergy or aversion to lavender essential oil. Exclusion criteria included (1) metabolic instability, (2) olfactory dysfunction, and (3) unwillingness to participate or incomplete participation. All selected respondents met the inclusion criteria and completed the study.

The primary instrument used for data collection was a calibrated EasyTouch glucometer to measure random blood glucose levels (in mg/dL). In addition, a structured questionnaire was used to collect demographic data and information on variables such as age, sex, education level, physical activity, dietary compliance, glucose monitoring behavior, and duration of diabetes.

The interventional procedure for the intervention group included PMR sessions conducted twice daily for three consecutive days. Each session lasted approximately 30 minutes and followed the standard PMR sequence of tensing and relaxing muscle groups from head to toe. After each PMR session, participants underwent 5–10 minutes of lavender aromatherapy using three drops of Lavandula angustifolia essential oil placed on the gauze for direct inhalation. The control group received routine care and a brief breathing relaxation session to simulate a placebo condition. Blood glucose was measured three hours after medication administration, both before (pretest) and after (posttest) the 3-day intervention period.

Ethical approval was obtained from the Health Research Ethics Committee of the Polytechnic of Health, Tasikmalaya (ID: DP.03.03/5.9/XLII.20/KEPK/0328/2025). Normality testing was conducted using the Shapiro-Wilk test, while homogeneity was tested using Levene's test. Paired t-tests were used to compare pretest and posttest values within groups, and an independent t-test was used to assess differences between the intervention and control groups. A p-value ≤0.05 was considered statistically significant.

Results

Table 1. Respondent Characteristics (N = 30)

Variable	Control	Intervention
Age	56 – 65 33.3%	56 – 65 46.7%
Gender		
Male	66.7%	46.7%
Female	33.3%	53.3%
Education level		
Elementary school	53.3%	46.7%
Physical activity		
Yes	40.0%	53.3%
No	60.0%	46.7%
Diet compliance		
Yes	46.7%	46.7%
No	53.3%	53.3%
Blood glucose check		
Routine check-up	46.7%	40.0%
No	53.3%	60.0%
Duration of diabetes		
<6 months	6.7%	13.3%
≥6 months	93.3%	86.7%

The majority of participants were male, predominantly within the age range of 56–65 years, and had been diagnosed with diabetes for more than six months. Most had only completed elementary school, did not engage in physical activity, were non-adherent to dietary recommendations, and did not routinely monitor their blood glucose levels.

Table 2. Descriptive Analysis of Average Blood Glucose Levels Pre- and Post-Intervention in Both Control and Intervention Groups

Blood Glucose Levels	Mean (mg/dL)	SD	SE	P-Value
Control				
Pretest	281.13	45.549	11.761	0.205
Posttest	268.87	51.005	13.170	
Intervention				
Pretest	265.93	41.241	10.648	0.000
Posttest	220.40	51.668	13.534	

The mean random blood glucose level in the control group decreased from 281.13 mg/dL (SD = 45.549; SE = 11.761) before the intervention to 268.87 mg/dL (SD = 51.005; SE = 13.170) after the intervention. However, this decrease was not statistically significant (p = 0.205).

In contrast, the intervention group showed a significant reduction in mean blood glucose levels, from 265.93 mg/dL (SD = 41.241; SE = 10.648) before the intervention to 220.40 mg/dL (SD = 51.668; SE = 13.534) after the intervention, with a p-value of 0.000, indicating a statistically significant effect of the combination of progressive muscle relaxation and lavender aromatherapy on blood glucose control.

Table 3. Differences in post-intervention blood glucose levels between the control and intervention groups among patients with type 2 diabetes mellitus.

Group	Mean (mg/dL)	SD	SE	P-Value
Control	268.87	51.668	13.341	0.015
Intervention	220.40	51.005	13.170	

The comparison of post-intervention blood glucose

levels between the two groups showed that the mean blood glucose level in the control group was 268.87 mg/dL (SD = 51.668; SE = 13.341), while the intervention group had a lower mean of 220.40 mg/dL (SD = 51.005; SE = 13.170). The statistical analysis using an independent t-test revealed a significant difference between the two groups (p = 0.015), indicating that the combination of progressive muscle relaxation and lavender aromatherapy had a more substantial effect in lowering blood glucose levels in patients with type 2 diabetes mellitus.

Discussion

1. Respondent's Characteristics

Based on age, both the intervention and control groups were within the 45–54-year age range. In individuals over 40 years old, degenerative processes associated with aging may lead to physiological changes, including damage to pancreatic beta cells (Suastika, 2022; Rohmatulloh et al., 2024). Beta cells play a key role in insulin production, and as age increases, both insulin production capacity and sensitivity to insulin tend to decline. The combination of these two factors makes it more difficult for the body to control blood glucose levels optimally, thus increasing the risk of hyperglycemia (Rohmatulloh et al., 2024).

In terms of sex, the intervention group was dominated by females (46.7%), while males made up the majority in the control group (66.7%). Overall, male respondents were more prevalent. According to Johnson et al. (2023), many men have diabetes due to the predominant distribution of visceral fat in males, which leads to increased insulin resistance. Furthermore, lifestyle patterns such as smoking, alcohol consumption, unhealthy eating habits, and lack of physical activity are key components in the pathogenesis of type 2 diabetes mellitus.

Regarding education level, most respondents had only completed elementary education. According to Afifah et al. (2022), individuals with basic education tend to have limitations in understanding health-related issues. As a result, they are at greater risk of developing type 2 diabetes mellitus and are more likely to experience delays in diagnosis and treatment.

Based on physical activity, most respondents in the intervention group engaged in regular physical activity, whereas the majority in the control group did not. These findings are consistent with Shah et al. (2021), who stated that lifestyle interventions—especially increased structured physical activity—significantly improve glycemic control and reduce the risk of developing type 2 diabetes mellitus.

Most respondents in this study did not adhere to the recommended dietary guidelines for type 2 diabetes mellitus. Noncompliance with diet can lead to poor blood glucose control (Rahmatiah et al., 2022). In terms of blood glucose monitoring, the majority of respondents did not routinely check their blood glucose levels. Through self-monitoring of blood glucose (SMBG), people with diabetes can now manage their therapy more effectively to achieve optimal blood glucose control. This approach not only enables early detection of hypoglycemia but also aids in its prevention and management (Cahyati et al., 2020).

Most respondents had been diagnosed with diabetes mellitus for ≥6 months. If diabetes continues for more than six months, persistent hyperglycemia can cause various pathophysiological changes in the body, contributing to the development of long-term complications. Chronic hyperglycemia contributes to damage in both small and large blood vessels. Microvascular damage includes diabetic retinopathy (affecting the retina), diabetic nephropathy (damaging kidney function), and diabetic neuropathy (damaging peripheral nerves). Macrovascular damage contributes to an increased risk of atherosclerosis, hypertension, coronary heart disease, and stroke (Elsayed et al., 2023).

2. Effectiveness of Progressive Muscle Relaxation and Lavender Aromatherapy

The average random blood glucose level in the intervention group before receiving the combination of PMR and lavender aromatherapy was 265.93 mg/dL, with a standard deviation of 41.241 mg/dL. In the control group, the average pre-intervention level was 281.13 mg/dL, with a standard deviation of 45.549 mg/dL. Both groups showed high random blood glucose levels above the diagnostic threshold set by Perkeni (2021), which is ≥200 mg/dL. This indicates that all respondents were in a state of hyperglycemia, suggesting uncontrolled type 2 diabetes mellitus. Elevated random blood glucose reflects suboptimal glucose control, which, if not addressed, increases the risk of microvascular complications such as nephropathy, retinopathy, and neuropathy, as well as macrovascular complications like coronary heart disease and stroke (Perkeni, 2021).

These findings are consistent with Wowor et al. (2023), where the average pre-intervention random blood glucose was also very high (>200 mg/dL). Hyperglycemia in patients with diabetes mellitus generally occurs due to impaired insulin production or function. Physiologically, insulin produced by pancreatic beta cells plays an important role in facilitating glucose entry into cells for energy use or storage as glycogen. However, in type 2 diabetes mellitus, a combination of insulin resistance and decreased insulin secretion disrupts this process, causing

glucose to accumulate in the bloodstream and lead to hyperglycemia (Guyton & Hall, 2021).

After receiving the combination intervention, the intervention group's average blood glucose level decreased to 220.40 mg/dL (SD ± 52.417 mg/dL), whereas the control group's average was 268.87 mg/dL (SD ± 51.005 mg/dL). Both groups experienced reductions in blood glucose after the intervention, but the intervention group showed a more substantial and clinically meaningful decrease. This finding indicates that combining PMR and lavender aromatherapy has a greater therapeutic effect in helping reduce blood glucose levels in patients with type 2 diabetes mellitus.

Studies by Janah and Prajayanti (2023) confirmed that PMR alone can lower blood glucose in T2DM patients. PMR is a relaxation technique targeting large muscle groups, helping individuals recognize the difference between tense and relaxed muscle states, ultimately achieving full-body relaxation. Relaxation contributes to blood glucose reduction by inhibiting the release of stress hormones—such as epinephrine, cortisol, glucagon, ACTH, corticosteroids, and thyroid hormones—that elevate glucose levels (Janah & Prajayanti, 2023).

Soewondo supports this in Avianti et al. (2016), who stated that PMR affects both physiological and psychological conditions. Physiologically, PMR reduces blood pressure, heart rate, and oxygen consumption and improves oxygen flow to the brain. These effects stabilize adrenal gland activity, thereby lowering blood glucose. Moreover, the process of tensing and releasing muscles mimics physical activity. When performed correctly and consistently, this increases cellular glucose uptake and enhances carbohydrate metabolism, helping glucose levels approach normal or remain stable (Avianti et al., 2016).

PMR is also known to reduce fatigue symptoms. One mechanism involves suppressing cortisol secretion. Lower cortisol levels reduce gluconeogenesis (the liver's production of glucose from non-carbohydrates like amino acids and lactate). When gluconeogenesis is suppressed, blood glucose decreases naturally, and anaerobic metabolism is reduced, limiting lactic acid accumulation and intracellular H^+ ions—further alleviating fatigue symptoms (Timby & Smith, 2010; Antoni et al., 2023).

Lavender aromatherapy is a complementary therapy using essential oil from Lavandula angustifolia, known for its relaxing, anxiolytic, and sedative effects on the central nervous system via olfactory pathways (Andrade & Pereira, 2022). Chronic stress increases cortisol secretion through HPA axis activation. Cortisol stimulates gluconeogenesis, leading to elevated blood glucose (Antoni et al., 2023). Lavender aromatherapy reduces HPA axis activation, lowering cortisol levels and inhibiting glucose production (Sundara et al., 2022).

Özkaraman et al. (2018) showed that 5–15 minutes of daily lavender inhalation significantly decreased cortisol and improved relaxation in chronic patients. Its active compounds, linalool and linalyl acetate, regulate parasympathetic activity, lowering heart rate, blood pressure, and metabolic rate—supporting glucose stability (Faridah et al., 2020).

The study concludes that PMR combined with lavender aromatherapy is more effective in reducing random blood glucose levels in T2DM patients than the control intervention. This is evident in the significant average reduction in the intervention group. Thus, the hypothesis is accepted—there is a significant difference in post-intervention blood glucose levels between the groups.

This effectiveness was supported by participants' compliance and consistency in the intervention group, who performed PMR and inhaled aromatherapy once daily for three consecutive days (30 minutes per session). Compliance contributed to physiological effects such as parasympathetic activation, reduced stress hormones, improved glucose absorption, and decreased gluconeogenesis.

The control group received deep breathing relaxation, which may indirectly reduce blood glucose by lowering stress and cortisol levels, as both hormones trigger gluconeogenesis and insulin resistance (Pebrianti et al., 2023). Anggraini (2021) showed significant reductions in glucose using slow, deep breathing exercises ($p = 0.000$).

However, in this study, although the control group experienced a reduction in blood glucose levels, the change was not statistically significant. This may be attributed to factors such as inadequate self-care, unmanaged stress, or a lack of lifestyle modification. Similarly, a study by Hayani et al. (2021) in Aceh Tamiang found that deep breathing techniques did not yield a statistically significant effect on blood glucose levels, despite a numerical decrease. These findings suggest that the effectiveness of such techniques may vary depending on contextual and individual patient factors. Moreover, Obaya et al. (2023) emphasized that relaxation techniques like deep breathing are more effective when combined with other interventions, such as aerobic exercise or mindfulness meditation, which together can produce a more substantial improvement in glycemic control. Therefore, the combination of progressive muscle relaxation and lavender aromatherapy represents a promising non-pharmacological approach for managing blood glucose levels in patients with type 2 diabetes mellitus.

3. Study Limitations

This study has two main limitations. First, the relatively small sample size and the use of a single healthcare facility limit the diversity and representativeness of the population, reducing the generalizability of the findings. Future studies should include a larger sample and multiple study sites. Second, external variables such as diet, daily physical activity, and stress levels were not fully controlled. Incorporating tools to monitor these variables—such as dietary, activity, and stress questionnaires—could help minimize their influence and improve the validity of future research.

Conclusion

This study concludes that before the intervention, the mean blood glucose levels in the control and intervention groups were 281.13 mg/dL and 265.93 mg/dL, respectively. After the intervention, the control group showed a slight decrease to 268.87 mg/dL, while the intervention group experienced a more significant reduction to 220.40 mg/dL. No statistically significant difference was found in the control group before and after the intervention ($p = 0.205$). In contrast, a significant difference was observed in the intervention group ($p = 0.000$) with a mean reduction of 45.53 mg/dL.

Additionally, there was a significant difference in post-intervention blood glucose levels between the intervention and control groups ($p = 0.015$), confirming that the combination therapy had a more substantial impact than deep breathing relaxation alone. These findings support the research hypothesis and emphasize the potential of non-pharmacological interventions in diabetes management.

It is recommended that future researchers conduct studies with larger sample sizes. Studies should be carried out across multiple healthcare facilities to improve generalizability. Extending the duration of the intervention and incorporating an analysis of patients' stress levels may also enrich the research findings.

Declaration of Conflicting Interest

No conflict of interest to declare.

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Author's Contribution

RNM was responsible for the conception and design of the study, data collection, data analysis, and interpretation of the results. YC drafted and revised the manuscript. DA and AK have read and approved the final version of the manuscript.

Data Availability Statement

The dataset generated during and analyzed during the current study is available from the corresponding author upon reasonable request.

Declaration of Use of AI in Academic Writing

Nothing to declare

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