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ORIGINAL ARTICLE

Slow, Deep Breathing Exercise Lowers Blood Pressure and Stress in Medical Students

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ABSTRACT

Background. Medical students have a high academic load and have the potential to experience stress and blood pressure abnormalities. Therefore, a method that can be used to reduce stress levels and improve blood pressure is needed. The relaxation technique of the slow deep breathing exercise (SDBE) method is thought to be able to reduce stress levels. **Objectives.** Researchers are interested in the effect of slow, deep breathing exercise on stress levels and blood pressure. **Methods.** The study used a quasi-experimental design. The research subjects, totaling 40 people, were selected using purposive sampling. Subjects were divided into 2 groups: a control group of 18 people and an intervention group of 22. The control group used the simple relaxation technique, while the intervention group used SDBE. SDBE intervention was carried out every day for 3 weeks. Data on stress levels and blood pressure were taken before and after the intervention. Measurement of stress level using Perceived Stress Scale. Measurement of blood pressure using auscultation methods. Data were analyzed using dependent t-test and independent t-test. **Results.** There was a significant decrease in stress level (p=0.000), systolic blood pressure (p=0.019), and diastolic blood pressure (p=0.000) after SDBE intervention. While in the control group, there was only a significant decrease in diastolic blood pressure (p=0.039). Compared to the control group that used simple relaxation techniques, the SDBE intervention group reduced stress levels better (p=0.000). **Conclusion.** Slow, deep breathing exercise reduce stress levels and blood pressure in medical faculty students. Slow, deep breathing exercise is more effective in reducing stress than simple relaxation techniques.

KEYWORDS: ***Slow Deep Breathing Exercise, Stress Level, Systolic Blood Pressure, Diastolic Blood Pressure, Medical Students.***

INTRODUCTION

Stress is a mental disorder that is often experienced by someone due to stressors, usually due to excessive worry about something. This stress can trigger bodily responses, both physical and mental. The body's response to stress can include rapid breathing and heart palpitations, muscle stiffness, and often increased blood pressure (1). Previous research suggests that stress levels in medical students are higher than those in other majors (2). The stress level experienced by medical students negatively correlates with academic achievement, whereas students with high stress levels will get poor academic results (3). In addition, medical students are also at risk of experiencing health problems caused by stress, such as increased blood pressure (4).

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The prevalence of stress is currently relatively high. According to the World Health Organization (WHO), the prevalence of stress globally occurs in 350 million people. Stress levels in Asia alone reached 39.6-61.3% and in Indonesia reached 36.7-71.6% (5). In university students, the stress level is relatively high, reaching 38-71% (6). Therefore, a method or alternative is needed to reduce stress levels. Relaxation methods have been widely used to relieve stress. Relaxation techniques are a set of strategies to improve physiological stress response. The body's physiological factor most affected by stress is blood pressure. However, the effectiveness of simple relaxation techniques, such as blood pressure, has not been widely seen in body physiology (7). One method of relaxation that is thought to affect blood pressure is the slow, deep breathing exercise. Slow deep breathing exercise is a breathing relaxation technique whose effectiveness has not been consistently proven for stress levels and physiological factors in the body that are affected during stress, such as blood pressure.

Slow, deep breathing is one part of a relaxation technique that is done consciously. By definition, slow, deep breathing is a technique where we breathe deeply and slowly. This technique is done six times per minute for 15 minutes (8). Breathing relaxation techniques can create a subconscious relaxation atmosphere that relaxes the body (1). As a result, negative thoughts and stress experienced disappear. It is thought that breathing exercises can also make the stress experienced more controlled. Previous research on final-year students found that the dhyana method relaxation technique helped students control their anxiety levels related to their final project (9).

Furthermore, a decrease in stress levels will improve the body's physical condition, such as blood pressure. Reducing stress and improving body physiology are very important for medical students with excessive academic loads. Good stress coping will indirectly affect students' academic achievement and ability to undergo the educational process. Slow deep breathing exercises, as one of the relaxation techniques, can be an alternative to effective methods in reducing stress and improving body physiology, such as blood pressure (10, 11). Therefore, researchers are interested in examining the effect of slow, deep breathing exercises on stress and blood pressure in Medical Faculty Jenderal Soedirman University students.

MATERIALS AND METHODS

The study used a quasi-experimental design. Subjects of as many as 44 preclinical students of the Faculty of Medicine, Jenderal Soedirman University, were obtained through purposive sampling. The criteria for research subjects were males aged 18-22 years not experiencing mental disorders and not doing breathing exercises. Exclusion criteria were subjects who could not complete the research intervention for three weeks. Subjects were divided into two groups: 22 subjects were in the control group, who received simple relaxation techniques, and 22 were in the intervention group, who received slow deep breathing exercise intervention. During the implementation of the research, four subjects in the control group dropped out because they could not complete the intervention. So, at the end of the study, there were 40 subjects divided into 18 subjects in the control group and 22 in the intervention group.

Intervention. The results of a systematic review and meta-analysis of both stress and blood pressure variables stated that the research was carried out over 5-12 weeks with a duration of 10-75 minutes; however, several studies stated that the effects of the intervention began to appear in the third week with an average duration of 15 minutes (12-14). In this research, the intervention will be carried out every day for three weeks, lasting 15 minutes. Subjects in the control group received simple relaxation technique treatment, namely doing relaxation breathing without trying to regulate the rhythm and breathing or breathing as standard for 15 minutes every day for three weeks. Subjects in the intervention group received slow deep breathing intervention. Slow deep breathing intervention is a breathing technique that involves deep and slow breathing. This technique is a breathing technique in Bhramari Pranayama yoga. The treatment given to the intervention group consisted of exercises to regulate normal breathing rhythm ten times/minute for 15 minutes every day for three weeks.

Variable measurement. Before and after the intervention, subjects were measured for stress level and blood pressure (Figure 1). Stress levels were measured using the Perceived Stress Scale questionnaire (PSS questionnaire). The Perceived

Stress Scale (PSS) is the most widely used psychological instrument for measuring the perception of stress. Compiled by Cohen (15), it measures the degree to which situations in one's life are appraised as stressful. The subjects in this study used Indonesian as their mother tongue, so the questionnaire was translated into Indonesian, and validity and reliability tests were carried out. Validity is assessing how accurate the research method is in measuring what it wants to measure, while reliability assesses the consistency of the measuring method. The Perceived Stress Scale (PSS) used in this research was assessed as valid (r=0.429–1) and reliable (Cronbach's Alpha =0.950) (16). The subjects were instructed to read the questions at least twice before answering. They were asked to circle or tick the option they felt was the appropriate response to the provided question. The subjects were invited to complete the ten questions at a time and were not allowed to discuss among them. Blood pressure was measured using the auscultation methods. The subjects were made to lie down on a couch in a supine posture. After 10 min of supine, systolic and diastolic blood pressure were measured using a pocket aneroid sphygmomanometer and stethoscope from ABN™.

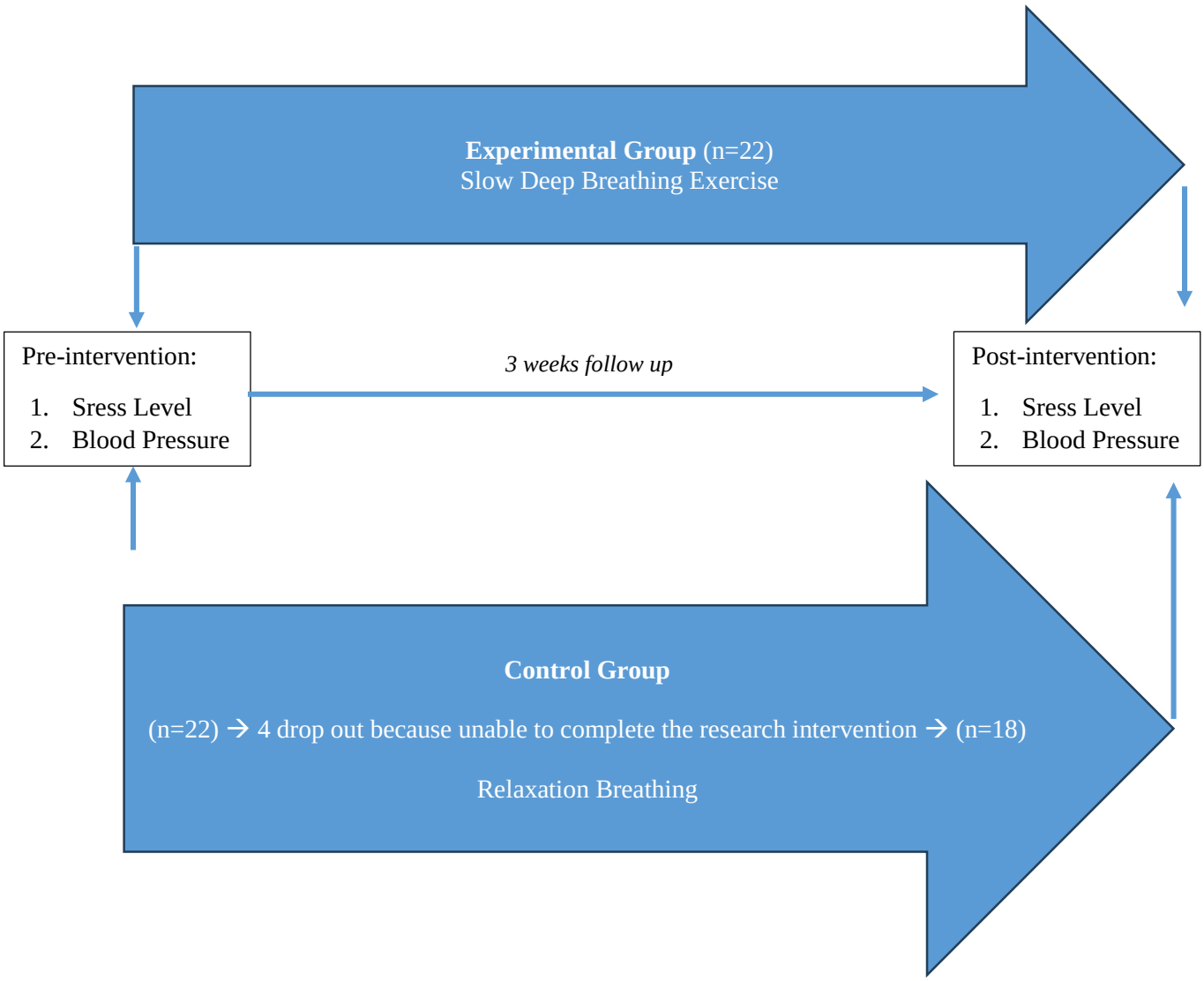

Figure 1. Flow chart depicting the study procedure. Subjects were divided into two groups: the intervention and control groups. Stress level and blood pressure were measured before and after the research intervention, which lasted three weeks.

Data Analysis. The data were analyzed using SPSS version 22 software with a significance level of $p<0.05$. Bivariate analysis using a dependent t-test was conducted to determine the difference in the mean of the research variables (stress level and blood pressure) before and after intervention, both in the control and intervention groups. The independent t-test was used to see the difference in mean stress levels and blood pressure changes in the control and intervention groups.

Ethical Considerations. The study has received an Ethics Committee Approval from the Medical Research Ethics Commission of Jenderal Soedirman University (Ref. No: 007/KEPK/PE/IX/2022).

RESULTS

Univariate analysis aims to provide an overview of the characteristics of respondents based on age and gender. The number of respondents in this study was 44 people. Four dropouts left 40 subjects, 22 in the intervention group and 18 in the control group. The following Table displays the characteristics of the study subjects.

The study's results based on Table 1 showed that the average stress level before the intervention was 15±3.63 in the control group and 17.5±3.17 in the intervention group. After the intervention, the control group had an average stress level of 13.33±4.45 and the intervention group of 10.41±2.67. The control group who received simple relaxation techniques experienced a decrease in stress levels by 1.67±4.56, while the intervention group who received slow deep breathing exercises experienced a decrease in stress levels by 7.09±2.56.

Table 1. Characteristics by Age, BMI, Stress Level, and Blood Pressure

Subject Characteristics	n	Mean±SD	Median (Min-Max)	95% CI
Age (years)				
Control	18	20.22±1.16	21.00 (18-22)*	19.64–20.80
Intervention	22	19.95±0.84	20.00 (18-22)*	19.58–20.33
BMI (kg/m^2)				
Control	18	24.45±4.75**	23.05 (18-35)	22.09–26.82
Intervention	22	22.53±4.21**	21.80 (15-32)	20.66–24.40
Stress Level				
Control Pretest	18	15±3.63**	15 (10-23)	13.19–16.80
Control Posttest	18	13.33±4.45**	12 (7-21)	11.12–15.54
Intervention Pretest	22	17.5±3.17**	17 (9-24)	16.09–18.90
Intervention Posttest	22	10.41±2.67**	10.5 (6-15)	9.23–11.59
Changes Stress Level				
Control	18	1.67±4.56**	2 (-7-11)	-0.6–3.94
Intervention	22	7.09±2.56**	7 (3-12)	5.96–8.23
Systolic Blood Pressure (mmHg)				
Control Pretest	18	103.33±5.78**	102 (94-114)	100.46–106.21
Control Posttest	18	100.28±11.29**	100 (80-120)	94.66–105.89
Intervention Pretest	22	103.82±6.47**	102 (92-116)	100.95–106.69
Intervention Posttest	22	96.64±14.25**	100 (70-132)	90.32–102.96
Diastolic Blood Pressure (mmHg)				
Control Pretest	18	66.89±6.88**	67 (50-78)	63.61–70.16
Control Posttest	18	60.78±10.45**	61 (40-78)	55.58–65.98
Intervention Pretest	22	67.09±6.72	68 (48-78)*	64.11–70.07
Intervention Posttest	22	59.18±11.85**	59 (32-82)	53.93–64.44

*: Data is not normally distributed; **: Normally distributed data.

Based on Table 2, most Medical students experienced moderate stress in the control group (61.1%) and the intervention group (90.9%). After receiving treatment, there was a change in the percentage of stress levels; the majority became low stress, both the group that received simple relaxation techniques (55.6%) and the group that received slow deep breathing exercises (86.4%).

Table 2. Stress Level of Medical Students (Perceived Stress Scale Questionnaire)

	Pre-Intervention		Post-Intervention	
Stress Level	**Control (n=18)**	**Intervention (n=22)**	**Control (n=18)**	**Intervention (n=22)**
Low	7 (38.9%)	2 (9.1%)	10 (55.6%)	19 (86.4%)
Medium	11 (61.1%)	20 (90.9%)	8 (44.4%)	3 (13.6%)
High	-	-	-	-

In addition to stress levels, Table 1 also shows a decrease in systolic blood pressure in the control group (103.33±5.78 mmHg to 100.28±11.29 mmHg) and the intervention group. SDBE (103.82±6.47 mmHg to 96.64±14.25 mmHg). The diastolic blood pressure of the Medical students also decreased due to treatment both in the control group (66.89±6.88 mmHg to 60.78±10.45 mmHg) and the intervention group (67.09±6.72 mmHg to 59.18±11,85 mmHg).

Tables 3 and 4 show the bivariate analysis results using dependent t-test and independent t-test. There was a significant decrease in stress level (p=0.000), systolic blood pressure (p=0.019), and diastolic blood pressure (p=0.000) after the Slow Deep Breathing Exercise intervention. While in the control group, there was only a significant decrease in diastolic blood pressure (p=0.039). Compared to the control group that used simple relaxation techniques, the SDBE intervention group reduced stress levels better (p=0.000). While a decrease in blood pressure was observed, neither systolic nor diastolic differences were observed between the control and intervention groups.

Table 3. Effect of Control and Intervention Group Treatments on Variables

Variables	Mean±SD	p-value
Stress Level		
Control Pretest	15±3.63	0.140
Control Posttest	13.33±4.45	
Intervention Pretest	17.50±3.17	0.000*
Intervention Posttest	10.41±2.67	
Systolic Blood Pressure (mmHg)		
Control Pretest	103.33±5.78	0.271
Control Posttest	100.28±11.29	
Intervention Pretest	103.82±6.47	0.019*
Intervention Posttest	96.64±14.25	
Diastolic Blood Pressure (mmHg)		
Control Pretest	66.89±6.58	0.039*
Control Posttest	60.78±10.45	
Intervention Pretest	67.09±6.72	0.000*
Intervention Posttest	59.8±11.85	

*: significant (p<0.05).

Table 4. Analysis of Differences in Changes in Stress Levels and Blood Pressure between Groups

Variable Change	Mean±SD	p-value
Stress Level		
Intervention	1.67±4.563	0.000*
Control	7.09±2.562	
Systolic Blood Pressure (mmHg)		
Intervention	3.06±11.38	0.304
Control	7.18±13.27	
Diastolic Blood Pressure (mmHg)		
Intervention	6.11±11.59	0.608
Control	7.91±10.37	

*: significant (p<0.05).

DISCUSSION

The study found a significant decrease in stress levels, systolic blood pressure, and diastolic blood pressure after the slow, deep breathing exercise intervention. In the control group, there was only a significant decrease in diastolic blood pressure. Breathing can directly affect the autonomic nervous system (17). Physiologically, breathing exercises like those in this study can balance the sympathetic and parasympathetic nervous systems to achieve a relaxed atmosphere. Relaxation increases endorphin substances and decreases adrenaline so that the body becomes more relaxed, characterized by a decrease in heart rate, blood pressure, and stress levels (18-20).

Blood pressure is regulated by a dynamic balance between the sympathetic and parasympathetic systems (21). During inhalation, the cardiovascular center inhibits vagal outflow, thus resulting in sympathetic predominance and increasing blood pressure (22). Conversely, the vagal outflow is restored during exhalation, slowing down the heart rate (22). Giving slow, deep breathing exercise treatment will increase the sensitivity of the baroreceptor located on the carotid artery. During inspiration, intrathoracic pressure will increase, which causes a decrease in pressure in the central vein. This will cause an increase in venous return as well as an increase in volume in the central veins so that the stroke volume will increase. The increased stroke volume will cause an increase in cardiac output, which will stimulate baroreceptors. This leads to stimulation of cardioinhibitory centers and inhibition of cardioacceleratory centers, which causes a decrease in cardiac output. In addition, stimulation of baroreceptors can also cause inhibition of vasomotor centers, resulting in vasodilation of blood vessels (20, 23). The decrease in cardiac output and vasodilation in blood vessels causes a decrease in blood pressure.

The study's results also found that compared to the control group, which used simple relaxation techniques, the SDBE intervention group could reduce stress levels better. Slow deep breathing exercise plays a role and focuses on relaxation in the brain so that it affect a person's psychological condition and can reduce stress levels. The breath is a bridge between the mind and body, and pranayama is a tool to manipulate the bridge. "Pranayama consists of three phases: Purak (inhalation), Kumbhaka (retention), and Rechak (exhalation) that can either be practiced in a slow or fast manner" (24). The various physiological and psychological effects of pranayama are believed to be due to the difference in the duration of different breath cycles. It also depends on the involvement of the usage of the mouth, nostrils, laryngeal muscle constriction, glottis position, and the tidal capacity of that particular individual (25). Previous studies also found that slow, deep breathing exercise is more effective in reducing elderly stress levels than other methods, such as simple breathing and progressive muscle training (26, 27).

In this study, there were changes in stress levels in the research subjects. Before the SDBE intervention, research subjects with moderate stress levels were 90.9%, and after the intervention, several subjects decreased their stress levels so that the percentage of moderate stress levels decreased to 13.6%. The reduced perceived stress reported by the intervention group highlights the psychological benefits of practicing slow breathing regularly. Consciously controlling one's breath may induce greater relaxation and mindfulness, counteracting cognitive and emotional stress. These psychological effects likely reinforced the physiological stress-reducing mechanisms. A decrease in stress levels will affect the dominance of the parasympathetic nervous system, which can further affect the physiological body, such as a decrease in blood pressure. Slow, deep breathing exercises create a more relaxed atmosphere that causes a decrease in cardiovascular parameters, which is one of the signs of stress (28, 29). This study also found a decrease in blood pressure after the slow deep breathing exercise intervention, although the decrease was as effective as the control group, which received simple relaxation techniques. The decrease in systolic and diastolic blood pressure did not differ between the control and intervention groups. However, there was a tendency for the decrease in the SDBE intervention group to be better than the control group. This indicates that the decrease in stress levels occurred earlier than the decrease in blood pressure.

Stress increases sympathoadrenal activity, eventually increasing blood pressure due to vasoconstriction (18). Chronic stress has the effect of decreasing the baroreceptor reflex response, which can increase blood pressure and lead to an increased risk of cardiovascular

disease. Slow Deep Breathing Exercise is a relaxation technique that involves deep breathing. Deep breathing increases oxygen supply to the mitochondria, increases endorphin substances, and decreases adrenaline, making the body more relaxed, further reducing stress. Decreased stress will reduce sympathoadrenal activity, lowering blood pressure (18). As in this study, the decrease in stress due to SDBE occurred first, followed by the decrease in blood pressure.

The limitation of this study was that it did not exclude any psychological conditions, as it requires a detailed evaluation of the subject. Psychological conditions such as depression, anxiety, or post-traumatic stress disorder (PTSD) can affect the results of the study. Different psychological conditions among the study subjects will likely affect the effectiveness of breathing exercise interventions on stress levels and blood pressure. Furthermore, the biochemical parameters for assessing stress levels can be used in future studies. Lastly, the study period of breathing practice could be extended by more than three weeks to see if any clinically significant results concerning blood pressure could be obtained.

CONCLUSION

Slow, deep breathing exercises reduce medical faculty students' stress levels and blood pressure. Slow, deep breathing exercise is more effective in reducing stress than simple relaxation techniques. Students can use the slow, deep breathing exercise technique to reduce stress levels in connection with the high academic load. It is hoped that reducing stress levels and improving the body's physiological conditions, such as blood pressure, will help students deal with academic loads and positively affect academic grades.

APPLICABLE REMARKS

- It is suggestible that students use the slow, deep breathing exercise technique to reduce stress levels in connection with the high academic load.
- Reducing stress that occurs in medical students affects blood pressure stability positively.

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AUTHORS' CONTRIBUTIONS

Study concept and design: Susiana Candrawati. Acquisition of data: Erlangga Aditya Ganesha, Rizqi Hendra Setiawan. Analysis and interpretation of data: Susiana Candrawati. Drafting the manuscript: Susiana Candrawati. Critical revision of the manuscript for important intellectual content: Susiana Candrawati, Dyah Woro Dwi Lestari, Wiwiek Fatchurohmah. Statistical analysis: Susiana Candrawati. Administrative, technical, and material support: Susiana Candrawati, Erlangga Aditya Ganesha, Rizqi Hendra Setiawan, Dyah Woro Dwi Lestari, Wiwiek Fatchurohmah. Study supervision: Susiana Candrawati, Erlangga Aditya Ganesha, Rizqi Hendra Setiawan, Dyah Woro Dwi Lestari, Wiwiek Fatchurohmah.

CONFLICT OF INTEREST

The authors have no competing interest to declare.

FINANCIAL DISCLOSURE

The authors have no financial interests related to the material in the manuscript.

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ETHICAL CONSIDERATION

The study has received an Ethics Committee Approval from the Medical Research Ethics Commission of Jenderal Soedirman University (Ref. No: 007/KEPK/PE/IX/2022).

ROLE OF THE SPONSOR

The funding organizations are public institutions and have no role in the design and conduct of the study, collection, management, and analysis of the data or preparation, review, and approval of the manuscript.

ARTIFICIAL INTELLIGENCE (AI) USE

This article is the original work of the author. The author did not use AI technology to write scientific conclusions or provide clinical recommendations.

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