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Effect of Progressive Muscle Relaxation and Slow Deep Breathing on Blood Pressure and Heart Rate on Hypertensive Clients

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Abstract

Background: Conclusions/Importance.Indicators of hypertension can be seen through the blood pressure (BP) and heart rate (HR). Several attempts continue to be made to control BP and HR, such as progressive muscle relaxation (PMR) and slow deep breathing (SDB). **Objectives:** The purpose of this study was to analyze the effect of PMR and SDB to control BP and HR on the hypertension clients. **Methods:** The research utilized a quasi-experimental design with pre-post test nonequivalent control group. Sample of 91 respondents were selected during May-July 2016 through convenience sampling techniques. The researcher used parametric statistical regression multiple linear regression to analyze the effect of PMR, SDB, and combination of PMR and SDB on BP and HR. **Results:** In the intervention group, PMR, SDB, and combined PMR-SDB are given twice a day for four days. The results showed the influence of PMR, SDB, combined PMR-SDB techniques to BP and HR ($p<0.05$). PMR and combined techniques (PMR-SDB) simultaneously and partially have a significant influence on BP and HR ($p<0.05$). SDB simultaneously only have a significant influence on diastolic BP and HR ($p<0.05$), but partially have a significant influence on BP and HR ($p<0.05$). **Conclusions:** The research concluded that there is significant influence of PMR, SDB, and combined PMR and SDB on BP and HR. PMR and SDB programs need to be developed as independent nursing interventions on the nursing care of patients with hypertension.

Keywords: Hypertension, Progressive Muscle Relaxation, Slow Deep Breathing

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1. Introduction

According to the World Health Organization (WHO) 2013, the prevalence of hypertension throughout the world has increased by a year to year, it was significantly raised up from 972 million people to 1 billion people since 2000 to 2008[1]. Apart from that, there are about 9.4 million people die every year due to complications from hypertension, which is 45% die from heart disease and 51% die of stroke. In Southeast Asia around 35% of the adult population suffers from hypertension and approximately 1.5 million deaths every year or about 9.4% due to hypertension, and Indonesia is one of the countries in Southeast Asia that has an increase in hypertension population which was around 8% to 32% from 1995 to 2008 [2]. According to the Health Research and Development Agency Indonesia (2013), Bandar Lampung is one of the provinces on the Sumatra Island with the third largest number of hypertensive patients, which is about 24.7% after Bangka Belitung is about 30.9% and South Sumatra is about 26.1% [3]. As the C type private hospital, Bandar Lampung Adventist Hospital is the hospital which provides health services for the people in the capital city of Bandar Lampung Province. Based on data from the medical record department, hypertension patients raised up from 515 clients in 2014 to 1147 clients in 2015. Therefore, the increase in the prevalence of hypertension is global and will continue without intensive treatment.

The main indicator for hypertension detection is blood pressure, normally it is displaying an increase in systolic or diastolic pressure or both [4]. In addition, heart rate can also be used as an indicator of hypertension. Palatini, et al. (2006) argued that an increase in heart rate will increase blood pressure, this is associated with increased sympathetic nerve activity [5]. Furthermore, the heart rate correlates with blood pressure and both are indicators used in monitoring the condition of the cardiovascular system. Therefore, increasing the frequency of heart rate and blood pressure will affect the cardiovascular system in carrying out its function so that it will affect the other body organs and can even cause morbidity or death [6].

Pharmacological therapy is a treatment that is often done in patients with hypertension, unfortunately only one in three clients who get optimal benefits from the use of these treatments in controlling hypertension [7]. The action is used to be done by focusing attention on a muscle activity, by contracting the muscle for some time and then decreasing muscle contraction to get a feeling of relaxation [8]. This action is known as progressive muscle relaxation (PMR) technique. According to Shinde, Handee, and Bhushan (2013) stated that there were significant differences in the measurement of pre and post values of systolic blood pressure ($p<0.01$), diastolic blood pressure ($p=0.05$) and heart rate ($p<0.05$). In addition to PMR, there is a slow deep breathing (SDB) therapy, which is breathing slowly from 16-20 times per minute to 10 times per minute or less [9]. Deep and slow breathing will provide the body with the opportunity to diaphragmatic breathing and it can dramatically change the body's physiology because it activates relaxation centers in the brain. Besides, Pramanik, Sharma, Mishra, Mishra, Prajapati, and Singh (2009) argued that after SDB (breathing frequency 6x / minute) for 5 minutes, there is a significant decrease in systolic and diastolic blood pressure and a decrease in light heart rate [10]. The purpose of this study is to analyze the effect of progressive muscle relaxation and slow deep breathing techniques for controlling blood pressure and heart rate in hypertensive clients at Adventist Hospital in Bandar Lampung, Indonesia.

2. Methods

2.1. Study design

This study is a quasi-experimental quantitative research with nonequivalent control group pre and post test designs, a study that does a pre-test before the intervention and then post-test after giving intervention to two groups or more without respondent randomization [11].

2.2. Intervention

Progressive muscle relaxation (PMR) intervention consists of three stages, such as:

1. Stage of equipment preparation, environmental condition, and respondents in carrying out PMR technique, this preparation stage will take times of around 15 minutes.
2. The step of implementing a PMR intervention involving 14 contractions of muscle bundles for five seconds then relaxes the muscle collection for 10 seconds, for each movement to be repeated twice so that at this stage will take times around 15 minutes.
3. The phase of ending the intervention by returning or tidying up the tools and environment that have been used, setting the client's comfortable position and asking his/her feeling or condition (is there a complaint?), at this stage will take times around 10 minutes.

Slow deep breathing (SDB) intervention consists of three stages, such as:

1. Stage of equipment preparation, environmental condition, and respondents in performing SDB technique, this preparation stage will take times about 15 minutes.
2. Stage of implementation of the intervention SDB which involves two movements by drawing breath from both nostrils slowly and deeply until the lungs are fully filled for five seconds, then exhaling slowly through both nostrils for five seconds. Repeating the action for both inspiration and expiration stages. Each cycle in the

procedure of implementing SDB will take times around 10 seconds (five seconds of inspiration and five seconds of expiration) so that it will become 6x / minute, per SDB procedure is done 6x / minute then it is given a 10 second rest period and resumes the SDB 6x / minute of the procedure until reach 15 minutes. So the time needed at this stage is about 15 minutes.

3. The phase of ending the intervention by returning or tidying up the tools and environment that have been used, adjusting the comfortable position of the respondent and asking the feeling or condition (is there a complaint?), at this stage will take times about 10 minutes.

The combination of PMR and SDB interventions, the researcher performed the PMR procedure first and then the SDB procedure. Whereas in the control group, respondents get routine care based on procedures established by the hospital.

2.3. Sample

There were 91 hypertensive respondents who were hospitalized at Bandar Lampung Adventist Hospital with systolic blood pressure ≥ 140 mmHg and diastolic blood pressure ≥ 90 mmHg were selected through convenience sampling technique. Researchers use the rule of thumb formula to determine the size of the sample. The sample was divided into four, namely PMR intervention group with 23 respondents, SDB intervention group with 23 respondents, combination of PMR and SDB intervention group with 23 respondents, and control group with 22 respondents.

2.4. Instrument or measurement

The equipment used in data collection in this study are spigmomanometer and stethoscope, observation sheet, stationery and computer equipment. Spigmomanometer and stethoscope to determine systolic and diastolic blood pressure, and hours to determine the heart rate in the pre-test and post-test in the control and intervention groups. Researchers used a mercury spigmomanometer from Adventist Hospital in Bandar Lampung that had been calibrated by a calibration institution accredited by the National Accreditation Committee, namely PT. MEDCALINDO. Observation sheet used to record the characteristics of respondents and the results of measurements of systolic pressure, diastolic, and heart rate in pre-test and post-test interventions in the control and intervention groups. Stationery and computer equipment used in research operations and research data processing.

2.5. Data collection procedure

Data collection was carried out during May-July 2016 for medical inpatient rooms in the Adventist Hospital in Bandar Lampung, Indonesia. The researcher divided respondents into four groups, namely 23 respondents in the PMR intervention group, 23 respondents in the SDB intervention group, 23 respondents in the combined group (PMR & SDB), and 22 respondents in the control group. The researcher conducted an intervention on the intervention group twice a day for four days in accordance with the established intervention procedures as the following:

2.6. Data analysis

The researcher used parametric statistical regression multiple linear regression to analyze the effect of PMR intervention, SDB intervention, and a combination of PMR and SDB intervention on systolic blood pressure, diastolic blood pressure, and heart rate.

3. Results

Table 1: Results of descriptive analysis of the dependent variable in the PMR, SDB intervention groups and Combination.

		N	Min	Max	Mean	SD
PMR	Post systolic	45	110	170	136.58	14.133
	Post diastolic	45	60	100	85.42	11.050
	Post HR	45	60	104	77.18	7.978
SDB	Post systolic	45	110	170	139.42	12.832
	Post diastolic	45	60	100	86.40	10.327
	Post HR	45	60	104	76.29	8.027
Combination	Post systolic	45	110	170	138.84	15.079
	Post diastolic	45	60	100	87.78	9.266
	Post HR	45	62	104	76.58	8.330

The results of the multiple linear regression analysis that is shown in Table 2 states that in the PMR intervention group, significant values of partial and simultaneous effects of progressive muscle relaxation (PMR) on systolic blood pressure, diastolic blood pressure, and heart rate which is $p<0.05$. This explains that PMR has a significant effect on blood pressure and heart rate, both partially and simultaneously. Table 2 also shows that in the combined intervention group PMR and slow deep breathing (SDB), significant values of partial and simultaneous effects of the combination both

Table 2: Results of multivariate analysis of intervention groups PMR, SDB, Combination of blood pressure and heart rate.

		Partial Test		Simultaneous Test	
		t	Sig.	F	Sig.
Systolic	PMR	-4.238	0.000	6.795	0.001
	SDB	-2.752	0.009	2.581	0.066
	Combination	-2.852	0.007	3.600	0.021
Diastolic	PMR	-4.179	0.000	6.502	0.001
	SDB	-3.786	0.000	5.151	0.004
	Combination	-3.262	0.002	3.665	0.020
HR	PMR	-5.252	0.000	11.934	0.000
	SDB	-5.742	0.000	12.425	0.000
	Combination	-5.109	0.000	10.832	0.000

PMR and SDB on systolic blood pressure, diastolic blood pressure, and heart rate which is p<0.05. Therefore, this data explains that the combined intervention of PMR and SDB has a significant effect on blood pressure and heart rate, both partially and simultaneously. Whereas in the SDB intervention group, table 2 shows that the significant value of the partial effect of SDB on systolic blood pressure, diastolic blood pressure, and heart rate which is p<0.05, but the simultaneous effect of SDB only has a significant value of p<0.05 on blood pressure diastolic, and heart rate. Thus, SDB intervention has a significant effect on blood pressure and heart rate partially. Furthermore, simultaneously, SDB intervention only has a significant effect on systolic blood pressure and heart rate.

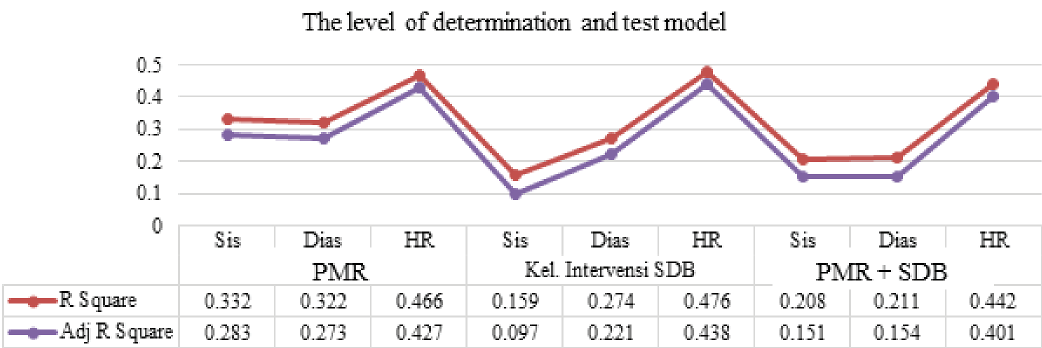

Figure 1: The Level of Line chart analysis of determination and test model of intervention groups PMR, SDB, and the Combination.

Figure 1 is the level analysis result of determination and a test model, the determination of model predictions and the suitability level of multiple linear regression models that are best found in the heart rate variable when compared with systolic blood pressure and diastolic blood pressure, as well as the best intervention in multiple linear regression models of the heart rate. This rate is slow deep breathing (SDB), which is about 47.6% for the determination of model predictions and about 43.8% for the model suitability.

4. Discussion

According to Purwanto, 2013 stated that progressive muscle relaxation (PMR) intervention involves contraction of several muscle groups in the body, then reduce the contraction to a relaxed state, and this is done by the individual consciously [12]. When contracting a muscle group, this will be a stimulus to tension or stress on the body that affects the autonomic nervous system, which increases the work of the sympathetic nerve to adjust to the stimulus. Furthermore, when stretching the muscle contraction to a relaxed state, this also affects and helps the autonomic nervous system, which decreases the work of the sympathetic nervous system and increases the parasympathetic nerves to create relaxed conditions [13]. In decreasing blood pressure (BP) and heart rate (HR), PMR relaxation technique stimulates the autonomic nerves that function as regulators in the vascular to reduce peripheral resistance and increase blood vessel elasticity. In addition, PMR makes blood circulation smoother and facilitates oxygen transport, thus triggering vasodilation of peripheral blood vessels. In other autonomic nerve mechanisms, progressive muscle relaxation affects neurogenic control by stimulating baroreceptors to inhibit impulses into the central vasomotor sympathetic nerve in the brainstem, thereby reducing the heart rate and reducing the strength of heart contractions [14 - 16]. So, with this mechanism, PMR can help our body to regulate BP and HR. The findings in this study are in line with the results of experimental studies of Shinde, Khatri, Hande, and Bhushan (2013) to 105 respondents regarding the effect of Progressive Muscular Relaxation (PMR) on hypertension, namely there were significant differences in systolic blood pressure ($p<0.01$) and diastolic blood pressure ($p=0.05$) in pre and post measurements after PMR [9]. Likewise with the experimental experiments of Jose and D'Almeida (2013) on 40 hypertensive patients about the effectiveness of PMR on blood pressure, the results state that the mean decrease in systolic blood pressure from 155.8 ± 10.14 to 121.7 ± 4.47 and diastolic blood pressure from 92.7 ± 4.52 to 79.9 ± 62.63 after administration of PMR [17]. Then the research of Khanna, Paul, and Sandhu to 125 respondents about the effect of PMR on increasing distress tolerance (2007) also stated that giving PMR exercise significantly reduced heart rate ($p<0.05$) [18].

Slow deep breathing (SDB) intervention is a breath pattern modification that will cause relaxation in the individual who does it, this condition helps the body to regulate blood pressure and heart rate. Psychologically, breath pattern modification usually induces an increase in focus on internal sensations. While physiologically, breathing pattern modification will cause the development of the chest cavity so that the lungs are filled with oxygen. This causes an increase in oxygen levels in the body's tissues, increased oxygen will activate chemoreceptors which are sensitive to change in oxygen level in body tissues, then chemoreceptors will transmit nerve signals to the respiratory center precisely in the medulla oblongata which also becomes the medullary cardiovascular center. Signals transmitted to the brain causes increased parasympathetic nerve activity and decreases the work activity of the sympathetic nerves [19]. This statement is supported by Anderson, Mcneely, and Windham (2010) and Jerath, Edry, Barnes, and Jerath (2006) who stated that the SDB technique will produce signals that activate baroreceptor reflexes through increased arterial pressure in vessels due to increased volume and bulk stroke heart in the left heart. As a result, there will be a decrease in blood pressure from activation of the baroreceptor reflex which sends a signal to the medullary cardiovascular center in the medulla oblongata which causes an increase in the work of the parasympathetic nerve and a decrease in the work of the sympathetic nerve [20, 21]. So this SDB mechanism helps the body regulate blood pressure reduction and decrease heart rate. The findings of this study are also corroborated by other studies. Anderson, Mcneely, and Windham's (2010) experimental study of 40 respondents about the effect of SDB exercise on blood pressure stated that SDB affects the body's autonomic system in regulating short-term blood pressure ($p<0.05$) [20].

Next, the researcher combined PMR and SDB interventions, the result was a significant effect of the combined intervention on BP and HR. There were not many studies that combined these two interventions, the researcher got the Gupta (2014) experimental study of 40 respondents stating that giving a combination intervention of PMR and SDB after doing aerobic exercise in hypertensive patients had a significant effect on reducing systolic and diastolic blood pressures ($p<0.05$) [22]. The procedure for the combination of PMR and SDB is a combination of the two techniques alternately, namely PMR intervention and then continued with SDB intervention. In a statistical test in this study, this combined intervention did not produce an effect which was the accumulation of the results of these two interventions if carried out individually, but still had a significant difference in effect when compared with the control group. So it is necessary to develop or carry out further studies on the procedure for implementing joint interventions for PMR and SDB to get maximum results for controlling blood pressure and heart rate.

Based on the results of multiple linear regression analysis, the best effect of PMR, SDB intervention, and combined PMR and SDB were found at the heart rate variable when compared with systolic blood pressure and diastolic blood pressure, and the best intervention for heart rate was SDB. This can be seen in Figure 1.1. Heart rate is an indicator of heart contraction or activity, the heart contracts to meet the needs of oxygen and other important substances for the body, especially vital organs (heart and brain), and those responsible for regulating heart contraction are the autonomic nervous system [6, 23]. PMR and SDB relaxation techniques both provide a stimulus to the autonomic nervous system by reducing the work of the sympathetic nervous system to reduce the heart rate or restore it under normal conditions [14, 20]. The advantage of SDB, in this case, is that SDB involves relaxation activities through voluntary breathing patterns through improved lung function, thereby increasing oxygen levels in tissues and reducing oxygen consumption of organs (especially the heart). Then chemoreceptors transmit neural signals to the respiratory center precisely in the medulla oblongata which also serves as the place for the medullary cardiovascular center and will cause increased parasympathetic nerve work activity and reduce the activity of sympathetic nerves [19, 21]. In other words, the stimulus given by SDB to increase oxygen levels by the lungs is better than PMR which involves contraction and stretching of a collection of several muscles throughout the body. While on the other hand, PMR interventions have a better influence on blood pressure control than SDB interventions and joint interventions.

Blood pressure describes the interrelations of cardiac output, peripheral vascular resistance, blood volume, blood viscosity, and arterial elasticity. A person's cardiac output is the volume of blood pumped by the heart (volume) for one minute (heart frequency), while blood pressure depends on cardiac output and peripheral vascular resistance. The peak of the maximum pressure during ejection by the heart is called systolic blood pressure, whereas when the ventricle breaks, the blood that remains in the arteries creates a minimum pressure called diastolic blood pressure [24, 25]. The PMR technique involves contraction in a collection of muscles that become a stimulus to tension or pressure on the body that affects the autonomic nervous system, which increases the work of the sympathetic nerve to adjust to the stimulus. Furthermore, when stretching the muscle contraction to relax, this also affects the autonomic nervous system, which decreases the work of the sympathetic nervous system and increases the parasympathetic nerves to create a relaxed state. This stimulates the autonomic nerves which function as regulators in the vascular to reduce peripheral resistance and increase the elasticity of blood vessels and make blood circulation smoother, as well as facilitate oxygen transport, thus triggering vasodilation of peripheral blood vessels. In addition, PMR also influences neurogenic control by stimulating baroreceptors to inhibit impulses into the central vasomotor sympathetic nerve in the brainstem, thereby reducing the heart rate and reducing strength.

The researcher could not use the same room to carry out the intervention in this study, this only adjusted to the room where the client was being treated, and there were some differences from those rooms (type and number of beds in the room). The intervention in this study was conducted twice a day for four days, the researcher could not equate the time span in the implementation of twice-daily interventions for each respondent because the activities of health and nursing services of each respondent were different. For example, on the schedule of drug administration, doctor's visit schedule and supporting examination procedures. The use of antihypertensive drugs for each respondent could not be controlled by the researcher because each respondent had different types, quantities, and doses of antihypertensive drugs based on the doctor's provisions who treated the clients.

The PMR and SDB techniques or the combination of PMR and SDB can be used by hypertensive patients as an alternative therapy to control BP and HR. The PMR and SDB techniques or a combination of PMR and SDB can be used by academics, especially nursing students by involving them in medical-surgical courses to increase the vocabulary of independent nursing interventions in the nursing care of clients with hypertension in controlling BP and HR. The PMR & SDB techniques or a combination of PMR and SDB can be used in the standards of nursing care for clients hospitalized with hypertension in hospitals, especially in controlling BP and HR. The results of this study can be the basic data or additional data for further research, especially the use of PMR & SDB interventions, or a combination of PMR and SDB to control BP and HR.

5. Conclusion and Recommendations

Progressive muscle relaxation (PMR) intervention had a significant effect ($p<0.05$) on blood pressure (BP) and heart rate (HR) simultaneously and partially. Slow deep breathing (SDB) intervention did not have a significant effect ($p> 0.05$) on systolic blood pressure ($p = 0.066$), but had a significant effect ($p<0.05$) on diastolic blood pressure ($p = 0.004$) and heart rate ($p=0.000$). Partially the SDB intervention had a significant effect ($p<0.05$) on BP and HR. The combined intervention of PMR and SDB had a significant effect ($p<0.05$) on simultaneous and partial BP and HR.

Statistical calculations show that the PMR and SDB interventions have a significant influence in controlling BP and HR, therefore, it is hoped that these two complementary therapies can be socialized to the nurses and even applied in nursing intervention especially in controlling BP and HR on clients with hypertension. The result of this study can be used as a nursing evidence base for academics, especially nursing students for the development of nursing science, especially nursing intervention in controlling BP and HR for clients with hypertension. Further research needs to be done by involving other confounding variables that have not been included in this study because there are still more than 50% of other factors that can affect BP and HR, such as family history, gender, ethnicity, DM, stress, obesity, and nutrition. In addition, it is necessary to do research using random sampling method in a larger sample of this study (minimum 100 respondents for each experimental group) to meet the criteria of multivariate analysis with a good result so that it can produce evidence base that has better quality than this research.

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