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Blood Pressure and Oxygen Saturation Post Deep Breathing Exercise and Head Up in Stroke Patients

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Abstract

According to Basic Health Research (Riskesdas) data from the last 12 years, the prevalence of strokes in Indonesia is still relatively high. Hypertension prevention aims to keep blood pressure under control. Non-pharmacological management is also required to supplement pharmacological therapy. Deep breathing exercises and head-up 30 degrees are two interventions that can be implemented. This study aimed to measure the influence of deep breathing exercises and head up 30 degrees on stroke patients' oxygen saturation and blood pressure. This research used a quasi-experiment with a pretest-posttest control group design involving the recruitment of 60 respondents using a consecutive sampling technique. Head-up 30-degree positions and continuous deep breathing were measured using a digital sphygmomanometer, protractor, and oximeter. Data were analyzed using Wilcoxon and Mann-Whitney. The results showed that there was a significant difference in systolic blood pressure which was p=0.000 (p <0.005), and oxygen saturation showed p=0.001 (p <0.005). But there was no significant difference in diastolic blood pressure which was p=0.836 (p> 0.005). Deep breathing exercises and head-ups 30 degrees help control blood pressure in stroke patients.

Introduction

Strokes are a non-communicable disease that is increasing in both developed and developing countries (Setyopranoto *et al.*, 2019). Stroke prevalence in Indonesia remains relatively high, according to statistics from the Indonesian Basic Health Research for the last 12 years (Saefurrohim *et al.*, 2022). Strokes accounted for 10.9 percent of all illnesses identified by doctors in Indonesia in 2018. Yogyakarta Special Region has the highest number of sufferers, accounting for 14.7% of those over the age of 15 (Arifin *et al.*, 2022). A stroke is a disorder characterized by signs or symptoms that correspond to a damaged focal area of the brain (Murphy & Werring, 2020). Patients suffering from the effects of strokes on a long-term basis may have impaired oxygen transfer (cerebral blood flow), resulting in diminished tissue perfusion and ischemia. Stroke patients have circulatory disturbances such as low blood pressure and oxygen saturation. Proper monitoring and treatment are required to ensure that oxygen delivery in the body does not impair heart function (Bao *et al.*, 2024; Salaudeen *et al.*, 2024).

Hypertension is one of the predisposing factors. The findings reveal that elderly people with hypertension have a 19-fold increased risk of stroke (Fahrina *et al.*, 2021; Murphy & Werring, 2020). The goal of hypertension prevention is to keep blood pressure under control. There are pharmacological and non-pharmacological treatments. The patient's blood pressure is influenced by pharmacological management, which means drugs are used. Non-pharmacological management is also required to supplement pharmacological therapy (Carvalho *et al.*, 2020; Kuriakose & Xiao, 2020). Deep breathing exercises and

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head-up 30 degrees are two interventions that can be implemented.

In stroke patients, using the head-up position 30 degrees can improve hemodynamic conditions. It facilitates increased cerebral blood flow and maximizes cerebral tissue oxygenation. One study has found that using the head-up 30-degree position increased oxygen saturation values. According to research, a higher head position can promote increased cerebral blood flow and maximize cerebral tissue oxygenation (Carvalho *et al.*, 2020; Summers *et al.*, 2015). As self-management interventions for health conditions such as hypertension, deep breathing techniques can cause benefits in terms of baroreceptor stimulation and autonomic and emotional modulation (Gholamrezaei *et al.*, 2021).

Deep breathing stimulates the release of endorphin neurotransmitters in the autonomic nervous system. It reduces the work of the sympathetic nerves while increasing the work of the parasympathetic nerves. Thus, the heart rate is slow and this causes vasodilation in blood vessels. This technique is a type of nursing care where the patients are taught how to take deep breaths, slow breaths (hold inspiration for as long as possible), and exhale slowly. Deep breathing is used to increase alveolar ventilation, maintain gas exchange, prevent lung atelectasis, reduce stress (both physical and emotional), and ultimately lower blood pressure (Russo *et al.*, 2017).

A meta-analysis of a systematic review finds that respiratory muscle training effectively improves respiratory function in stroke patients. The study's criteria complied with nineteen randomized controlled trials (RCTs). Respiratory muscle training improves first-second forced expiratory volume (FEV1), forces vital capacity (FVC), peak expiratory flow (PEF), maximal expiratory pressure (MEP), maximal inspiratory pressure (MIP), and walking ability (6-minute walk test), but not the Barthel index, Berg balance scale, or dyspnea. Respiratory muscle training interventions are effective in improving post-stroke patients' pulmonary function and functional mobility (Pozuelo-Carrascosa *et al.*, 2020).

The preliminary study was conducted at a hospital in Yogyakarta. According to medical records, there were 74 stroke patients (both hemorrhagic and non-hemorrhagic) in June and July 2019. According to the findings of an interview with the head of the ward, stroke patients did not receive non-pharmacological interventions to treat cases of high blood pressure and low oxygen saturation. With this background, the researchers wanted to investigate the effect of deep breathing exercises and using stroke patients' head-up 30 degrees position as a non-pharmacological intervention. This study aimed to examine how deep breathing exercises and a 30-degree head-up position affected oxygen saturation and blood pressure in stroke patients.

Method

The study used a pretest-posttest quasi-experimental research design with a control group and was conducted in hospitals in Yogyakarta, Indonesia. A consecutive sampling method was utilized to recruit the sample of stroke patients who met the criterion for inclusion, which was that they had a stable hemodynamic status. Meanwhile, the exclusion criteria included patients with cervical trauma, mental illness, communication problems, and respiratory diseases. Sixty participants met the inclusion and exclusion criteria and were selected. They were then separated into two groups of thirty: the intervention group and the control group.

In this study, blood pressure was measured using a digital sphygmomanometer, a protractor to measure angles, and an oximeter to measure oxygen saturation. Pre-tests and post-tests were conducted on both groups on the first, second, and third days, respectively. All respondents in both groups had their blood pressure and oxygen saturation measured. The intervention was started by using a head-up 30-degree position, followed by a deep breathing exercise 30 times. This intervention was carried out three times a day for three days. Meanwhile, the control group received the standard intervention, in other words: no intervention.

The mean difference before and after the intervention was analyzed using a paired t-test, and the mean differences between the intervention and control groups were compared using Wilcoxon and Mann-Whitney. Before the study, every participant who participated to participate was informed about the study's aims, advantages, and procedures. They were also asked to complete an informed consent form. During the study, respondents' confidentiality and anonymity were protected, as were fair training, benefits, and avoiding harmful acts. The ethics and research committee of the Faculty of Medicine at Achmad Yani University in Yogyakarta, Indonesia, approved this study with the following approval number: Skep/04/KEPK/II/2020.

Result And Discussion

The results of this study suggest that more than half of the respondents in both the intervention and control groups are male and over 60 years old. This, and the proportion of respondents who had a hemorrhagic stroke, is shown in =Table 1.

Analysis of the effect of deep breathing exercise and head up 30 degrees position on the blood pressure of stroke patients in the intervention and control groups is shown in Table 2 and Table 3. Table 2 shows that there is a decrease in systolic and diastolic blood pressure values in the intervention group compared to the control group as evidenced by the p-value. <0.05. There is a greater decrease in median systole and diastole after the intervention compared to the control group. There is a significant difference in systolic p=0.000 (p<0.05) and diastolic p=000 (p<0.05) in the intervention and control groups (Table 2).

Analysis of systolic and diastolic differences after deep breathing exercise intervention and head-up 30 degrees are presented in Table 3. The data used indicate the difference between systolic and diastolic in the intervention and control groups for the three days of observation. The results of the analysis

Table 1. Characteristics of Respondents (n=60)

Characteristic	Intervention	Control	Total
	f (%)	f (%)	f (%)
Age			
18 – 45 years old	5 (16.67)	6 (20.00)	11 (18.33)
46 – 60 years old	12 (40.00)	10 (33.33)	22 (36.67)
> 60 years old	13 (43.33)	14 (46.67)	27 (45.00)
Gender			
Male	16 (53.33)	20 (66.67)	36 (60.00)
Female	14 (46.67)	10 (33.33)	24 (40.00)
Classification Stroke			
Hemorrhagic stroke	21 (70.0)	22 (73.33)	43 (71.67)
Non haemorrhagic stroke	9 (30.0)	8 (26.67)	17 (28.33)

Source: Primary Data

Table 2. Differences in Blood Pressure of Stroke Patients (n= 60)

Blood pressure	Intervention Group		Control Group	
	Median (Min-Max)	p	Median (Min-Max)	p
Systole				
Pre-test	178.00 (129.00-216.00)	0.000*	175.00 (129.00-215.00)	0.000*
Post-test	160.00 (133.00-172.00)		152.00 (133.00-183.00)	
Diastole				
Pre-test	93.50 (85.00-152.00)	0.000*	100.00 (61.00-150.00)	0.000*
Post-test	85.00 (76.00-99.00)		84.50 (59.00-100.00)	

**Wilcoxone, p* < 0.05 significance value

Table 3. Effect of Deep Breathing Exercise and Head-up 30 Degrees on Blood Pressure of Stroke Patients (n= 60)

Blood Pressure	Intervention Group	Control Group	
	Median (Min-Max)	Median (Min-Max)	p
Systole			
Pretest – Post test	19.5 (60.00-80.00)	16.00 (62.00-21.00)	0.000
Diastole			
Pretest – Post test	7.50 (62.00-9.00)	7.00 (71.00-10.00)	0.836

**Mann-Whitney, $p < 0.05$* significance value

Table 4. Differences in Oxygen Saturation of Stroke Patients (n= 60)

Oxygen Saturation	Intervention Group		Control Group	
	Median (Min-Max)	p	Median (Min-Max)	p
Pre-test	98.00 (94.00-100.00)	0.000*	98.00 (92.00-100.00)	0.162*
Post-test	99.00 (97.00-100.00)		98.00 (96.00-100.00)	

**Wilcoxon*

Table 5. Effect of Deep Breathing Exercise and Head Up 30 Degrees on Oxygen Saturation of Stroke Patients (n= 60)

Oxygen Saturation	Intervention Group	Control Group	
	Median (Min-Max)	Median (Min-Max)	p
Pretest – Posttest	1.00 (1.00-9.00)	0.00 (2.00-4.00)	0.001

**Mann-Whitney, $p < 0.05$* significance value

of the difference test on systolic blood pressure show a value of p=0.000 (p <0.005). This shows that deep breathing exercises and head-up 30-degree interventions affect systolic blood pressure values compared to standard hospital interventions. The decrease in diastolic blood pressure in the intervention group is higher than in the control group. However, there is no significant difference in diastolic between the intervention and control groups with the results of the analysis of the difference test on diastolic blood pressure showing a value of p=0.836 (p> 0.005). This shows that deep breathing exercises and a head-up 30-degree position do not affect the value of diastolic blood pressure compared to standard hospital interventions.

Analysis of the effect of deep breathing exercise and head-up 30 degrees position on the oxygen saturation of stroke patients in the intervention and control groups is shown in Table 4 and Table 5. There was a greater decrease in the median oxygen saturation after the intervention compared to the control group. Table 4 shows that there was an increase in oxygen saturation in the intervention group. There was also a significant difference in oxygen saturation in the intervention group with a value of p = 0.000 (p <0.05) (Table 4). Meanwhile, the control group did not show a significant difference with a value of p = 0.162 (p> 0.05).

The analysis of differences in oxygen saturation values after deep breathing exercise intervention and head-up 30 degrees position is presented in Table 5. The data used are the difference in oxygen saturation in the intervention and control groups for three days of observation. The results of the analysis of the difference test on oxygen saturation showed a value of p = 0.001 (p <0.005). This shows that there is an effect of deep breathing exercises and head-up 30-degree position interventions on oxygen saturation values compared to standard hospital interventions.

The results of this study indicate that stroke patients are more often male sex than female. This is in line with other research indicating that the majority of stroke patients are male and have ischemic stroke (Shetty *et al*., 2020). This research aligns with another study that shows that 65% of stroke sufferers are male (Yuwanda *et al*., 2020). This is because women have more estrogen than men before menopause (Mahayani & Putra, 2019). Research conducted on 1,060 respondents shows that as many as 658 respondents were male with an average age of 57.47 years, while 560 (52.8%) of the respondents suffered from hemorrhagic strokes (Tangkudung *et al*., 2019). The aging process will cause atherosclerosis, so blood flow and tissue nutrients are obstructed. When atherosclerosis appears, it will interfere with tissue perfusion, thereby increasing peripheral vascular pressure (Libby *et al*., 2019)

The results show that the intervention was effective for three days. This is evidenced by the p-value <0.05 on the pretest day 1 and posttest day 3. Research on interventions with progressive muscle relaxation therapy and breath relaxation in patients with hypertension has shown significant results. The statistical test results obtained a p-value of 0.000 (≤0.05), so it can be concluded that there is a significant difference between the average between systolic and diastolic blood pressure before and after using deep breath relaxation techniques (Ikhwan *et al*., 2019). Another study on the use of breathing exercises has resulted in a significant difference in systole and systole values (Orcioli-Silva *et al*., 2024).

The head-up 30-degree position setting has a significant effect on the level of consciousness and Mean Arterial Pressure (MAP) which moves from an average of 80.42 to 93.46. A stable MAP will maintain adequate perfusion. The head-up 30-degree position is a position that matches the anatomy of the human body and so can affect hemodynamics. The MAP value is determined by systolic and diastolic blood pressure. MAP must be maintained above 60 mmHg to ensure perfusion of the brain, coronary arteries, and kidneys during the head-up position. The study finds a p-value of 0.031 (0.05) on mean arterial pressure, indicating that the head-up 30-degree position has a statistically significant effect on mean arterial pressure. The head-up 30 degrees position has a substantial impact on intracranial pressure changes (Pertami *et al*., 2017). When treating patients with heart and neuromuscular disease, it is essential to remember that body position impacts pulmonary physiology and function (Khanbabaee *et al*., 2023).

The results show that the intervention is more effective when it is carried out for three days. This is evidenced by the p-value <0.05 on the pretest day 1 and posttest day 3. Research on stroke patients shows that breathing exercises are effective in improving lung function, balance, and gait in patients with chronic stroke with a p-value ≤0.05. The results of using breathing exercises in stroke patients with restrictive ventilator disorders show that the endurance of their trunk muscles is increased, and the FVC is increased due to an increase in deep breathing capacity, and consequently, this increases the volume of breath. In addition, FEV1 is also increased because breathing exercises increase the strength and coordination of the body muscles and improve respiratory function. Breathing exercises lead to an increase in the exhalation muscle and FVC due to an increase in exhalation capacity thereby increasing exhalation volume. In addition, these exercises can improve the strength and coordination of the body's muscles in improving respiratory function (Lee *et al*., 2018)

Research in the form of a systematic review with a meta-analysis shows training to strengthen breathing in stroke patients improves lung function (Zhang *et al*., 2024). Other studies have also revealed that the strength of the diaphragm and external intercostal muscles increases after breathing exercises (Riri Maria, 2022). The results of RCT studies show that exercises strengthen breathing and improve stroke patient abilities such as motility, muscle strength, and endurance of the respiratory muscles, which are weakened by hemiplegia. The stability of the bar when walking also increases, consequently improving weight distribution and balancing ability, thereby increasing walking ability. The results of this study confirm that breathing exercises are effective for improving lung function, balance, and gait in chronic stroke patients (Jung & Bang, 2017).

Another study on the effect of breathing exercises on stroke patients explains that breathing exercises were effective in improving physical function ($p < 0.05$). Breathing exercises improve the function of the respiratory muscles. This is because it restores reduced lung volume which has a positive effect on physical function (Lee *et al.*, 2018). Another study on the use of training in patients with hypertension shows that it increased peak oxygen uptake. This demonstrates the effect of training on oxygen saturation (p-value < 0.001)(Muller *et al.*, 2024). There is research on determining the differences in respiration rate (RR) and oxygen saturation (SaO2) in the head-up positions, semi-fowler and fowler with pre-experimental design. The results reveal that the average value of SaO2 increased from the head to the semi-fowler and fowler positions. The results show that the SaO2 levels differ between these positions (p-value 0.002). The difference in SaO2 value between the head-up and Fowler positions can be seen (p-value 0.033) (Khasanah & Yudono, 2019)

According to some research, there is an increase in the mean value of cerebral blood flow after intervention. The result showed a mean increase in cerebral blood flow (CBF) velocity of 8.5 cm/s in the ischaemic middle cerebral artery (Carvalho *et al.*, 2020). In theory, the prone position combined with a head-up position indicates that the return of blood from the inferior part to the right atrium is quite good because the blood vessels' resistance and the right atrium's pressure are not too high. Hence, the volume of blood entering (venous return) to the right atrium is quite good, and the right ventricular filling pressure (preload) increases, which can lead to an increase in stroke volume and cardiac output. Patients in the head-up 30° position will experience increased blood flow in the brain and maximize cerebral tissue oxygenation (Lam *et al.*, 2020).

A study has been conducted on stroke patients to determine the efficacy of head elevation models ranging from 30° to 45° in increasing oxygen saturation. A quasi-experiment with a non-randomized pretest-posttest control group design approach has been used in this study. The samples consisted of 22 people who were treated for four weeks with head elevations ranging from 30 to 45 degrees. The statistical test result achieved a p-value of 0.000 less than alpha ($p<0.05$), concluding that elevation influences increasing oxygen saturation. The 30-degree head elevation models were more influenced to raise oxygen saturation in ischemic stroke patients. (A. W. Pakaya & Nurliah, 2020).

This study also follows previous research which shows that a higher head position, like 15 degrees or 30 degrees, can increase oxygen saturation. However, there is no significant difference in the oxygen saturation value in stroked patients before and after head elevations of 15 or 30 degrees (Kiswanto & Chayati, 2022). Other studies suggest that head elevation measures can facilitate increased blood flow to the cerebral and maximize cerebral tissue oxygenation. However, the height of the head position cannot be identified with certainty. The study shows that there was an effect of head elevation therapy on oxygen saturation (p-value <0.05). It indicates that the treatment group shows an increase in oxygen saturation values with a difference of 2.48. (Pertami *et al.*, 2020). Research shows that deep breathing exercises that are carried out three times a week for four weeks with a duration of 15 minutes per exercise can increase the average oxygen saturation from 96.9% to 98.2% with a p-value of 0.018 (<0.05) (Destanta *et al.*, 2019).

Deep breathing exercises are exercises that focus on optimizing the expansion of the auxiliary muscles, especially the diaphragm, during the inspiratory phase resulting in an increase in the alveolar ventilation volume due to increased inspiratory volume and capacity, causing stretching of the alveolar wall (N. Pakaya & Nento, 2023). This stretching will promote the production of alveolar type II surfactant resulting in a decrease in alveolar tension and an impact on increasing the lung's capabilities. Effective inspiration due to deep breathing is also supported by the addition of intra-alveolar volume which opens chronic pores in the alveolar wall and causes collateral ventilation effect. Optimization of the inspiratory lung volume and capacity leads to an increase in the efficiency of gas exchange at the alveolar-capillary level. In principle, the rate of transfer and exchange of gases is also influenced by the surface area effect. The increase in alveolar surface area due to stretching that occurs will increase gas transfer, in particular the exchange of O^2 and CO^2, with the pulmonary capillaries, thus having an effect on the oxygen saturation value in the circulation (Birdee *et al.*, 2023).

Oxygen saturation increases from an average of 93.76% to 96.24% with a p-value of 0.000 between the elevation of the pillow or bed to 30 degrees and afterward in hemorrhagic and non-hemorrhagic stroke patients. The head elevation aims to influence venous return to the maximum so that blood flow to the brain is smooth, to increase the cerebral tissue metabolism, and maximize brain tissue oxygenation, so that the brain can work according to its function (Pertami *et al.*, 2020). Breathing exercises had positive outcomes in pulmonary function and maximal respiratory pressures in stroke subjects. Breathing exercises can maximize the air breathed out during expiration, optimize lung expansion, reduce space loss, and increase the diffusion process. This allows for an increase in the vital capacity of the lungs (Shetty *et al.*, 2020). Deep breathing exercises can train and strengthen the breathing muscles, the airways that were initially narrow will be dilated to maximize ventilation. Good ventilation will increase pulmonary oxygen and increase oxygen diffusion between the alveoli and pulmonary capillaries and a reduction in space loss which ultimately increases oxygen saturation. The oxygen saturation of patients who undergo deep breathing exercise increases from its initial value with a p-value <0.001, and 15 minutes after resting with a p-value of 0.004, but there is no significant difference when compared with the control group.

Conclusion

The results of this research show that there was a significant difference in systolic blood pressure which was p=0.000 (p <0.005), and oxygen saturation showed p=0.001 (p <0.005). But there was no significant difference in diastolic blood pressure which was p=0.836 (p> 0.005). Deep breathing exercises and head-ups 30 degrees help control blood pressure in stroke patients.

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