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THE EFFECT OF DIAPHRAGM MUSCLE STRENGTHENING EXERCISE USING INCENTIVE SPIROMETRY ON BODY BALANCE

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Abstract: *Based on data that has been reported by WHO, every year it is estimated that 684,000 people die cause of falls, which means that there is a failure in postural control. Postural control is known to have a relationship with diaphragmatic muscle contraction, with the intra-abdominal pressure produced by each contraction causing eccentric muscle contractions that affect postural stability. This study was conducted to determine the effect of diaphragmatic muscle strengthening exercises on body balance. This study used a pre-experimental design with one group pre and post test types. This study included 21 students. The diaphragmatic muscle strengthening exercises was held 4 weeks online. The pre-test and post-test of balance were held in the Faculty of Medicine and Health Sciences, Bengkulu University. Sampling techique that has been used is non-probability purposive sampling. The impact of two variables was analyzed using Paired T-Test. The results showed that diaphragmatic muscle strengthening exercises had a significant effect on body balance with a significance value of 0.000. The static and dynamic balance of the students of the Faculty of Medicine and Health Sciences, Bengkulu University was normal and increased after being given diaphragmatic muscle strengthening exercises. Diaphragm muscle strengthening exercises have a significant effect on student body balance.*

Keywords: *diaphragm strengthening exercise, body balance, incentive spirometry*

INTRODUCTION

Falls are the second cause of accidental injury death worldwide. Based on data that has been reported by WHO, every year it is estimated that 684,000 people die from falls globally, of which more than 80% are in low- and middle-income countries. Falls are influenced by the body's intrinsic factors (musculoskeletal system and nervous system) and extrinsic factor (contextual effects). These two factors must interact with each other to achieve balance control (WHO, 2021).

Balance is an ability to maintain body position in static and dynamic conditions (Rejeki et al, 2018). Daily activities, simple or complex, involve a lot of static and dynamic body balance. Activities such as standing involve static balance, while walking and turning involve dynamic balance (Kocjan et al, 2018). If there is a disturbance in the balance of the body, it can disturb and decrease person's activity, which can occur due to dysfunction of the physiology and anatomy of the vestibular, visual, proprioceptor and exteroceptor systems. This system plays a role in maintaining the balance of the body so as not to fall when standing, walking or doing activities so that it can maintain good postural stability (Wiszomirska et al. 2015).

The body's ability to maintain balance in various positions is called postural control. Postural control is an important thing in life, because in practice we need balance to achieve a productive life. Postural control is also needed as an exercise or medical rehabilitation for patients who have balance disorders to achieve a postural stability. Postural control is known to have a relationship with diaphragmatic muscle contraction, with the increase in intra-abdominal pressure produced by each contraction causing eccentric muscle contractions that affect postural stability (Kocjan et al. 2018).

Increasing the strength of the diaphragm muscle can be done with various exercises. Exercise can be done using a tool, it is incentive spirometry, this tool will encourage a person to take deep and long breaths and slowly. Incentive volume oriented spirometry is known to reduce the respiratory burden and increase diaphragm activity and make it easier for the subject to determine the quality of

breath and the appropriate inspiratory volume (Alaparthi, G. K, et al. 2016).

Research conducted by Miketa, T. et al showed a significant improvement in balance in 15 days of muscle strengthening exercises performed 3 times a week for 10 minutes. Another study by Kocjan, J et al stated that the greater the thickness of the diaphragm correlates with the better static balance parameters. There are quite a lot of studies on improving balance, but just a few in relation to diaphragmatic muscle strengthening exercises. Therefore, in this study, researchers tried to identify the effect of diaphragmatic muscle training on balance.

METHODS

This study used a pre-experimental design with one group pre and post test types carried out on one group without a control or comparison group. The sample in this study were students of the Faculty of Medicine and Health Sciences, Bengkulu University, who were physically and mentally healthy. The sampling technique used is non-probability sampling with purposive sampling method. Samples are taken by means of all subjects who meet the inclusion criteria will be included in the study until the number of samples is met. Inclusion criteria in this study were 18-24 years old, able to move independently and walk alone, normal body mass index (18.5-24.9 kg/m2)

The independent variable in this study was diaphragmatic muscle strengthening exercises with incentive spirometry and the dependent variable in this study was body balance. The research subjects were willing Faculty of Medicine and Health Sciences, Bengkulu University students who were selected according to inclusion and exclusion criteria. Subjects will be given an explanation of the research conducted, then subjects who are willing to be asked to fill out and sign the consent form, as well as the research subject data sheet.

Researchers measured body balance with 6 methods before starting a series of diaphragmatic muscle strengthening exercises: Sharpened Romberg test, Stork Stand Test, Five Time Sit to Stand Test, Four Square Step Test, Time Up and Go Test, The Dynamic Leap and Balance Test right leg and left on the research subject. Furthermore, the diaphragmatic muscle strengthening exercise, incentive spirometry, was carried out for 4 weeks which would be carried out 3 times in 1 week, each of which consisted of three sets of exercises and then body balance measurements were carried out again after the series of exercises were carried out.

In this study the data obtained will be analyzed using univariate analysis (descriptive analysis) aims to describe or describe each data characteristic of the study. The use of bivariate analysis in this study to see the effect of diaphragmatic muscle strengthening exercises using incentive spirometry on body balance before and after muscle strengthening exercises, using a paired t test if the data is normally distributed or if the data is not normally distributed using the Wilcoxon test. To determine the normality of the distribution of research data, the analysis of the Saphiro-Wilk test was used. The data have a normal distribution if the p value > 0.05.

RESULTS AND DISCUSSION

Characteristics of Research Subjects

The frequency distribution of subject data can be seen in table 1.

Table 1. Data Characteristics of Research Subjects

Characteristic Data		Frequency		
		N	***%***	
Age				20 (18 - 21)*
Gender	Woman	16	76,19%	

	Man	5	23,80%
IMT			21,27 (18,79-24,8)*

* Abnormal Data Distribution is using median and minimum-maximum values

The results of study indicate that the most age distribution in the subjects of this study was 20 years with a normal body mass index.

Bivariate Analysis

In Tables 2 and 3 the results of statistical tests regarding the effect of diaphragmatic muscle strengthening exercises using incentive spirometry on body balance

Table 2. Effect of Diaphragm Strengthening Exercises Using Incentive Spirometry on Static Body Balance

Variable	N			P value
		Before	After	
Sharpened Romberg Test	21	2.24 (24,88 - 36,00)*	5,35 (33,00 - 55,00)*	0.000**
Stork Stand Test Right Foot	21	36,9	54,2867	0.000
Stork Stand Test Left Foot	21	16,7 (5,26 - 58,00)*	57,7	0.000**

Tabel 3. The Effect of Diaphragm Strengthening Exercises Using Incentive Spirometry on Dynamic Body Balance

Five Time Sit Stand	21	9,46	7,15	0.000
Dynamic Leap Right Foot	21	20,2	13,929	0.000
Dynamic Leap Left Foot	21	20,1	13,2752	0.000
Four Square Step Test	21	8,1	5,9857	0.000
Time Up And Go Test	21	2,24 (4,83 - 16,10)*	5,7114	0.005**

Note : Normal distributed data will use the mean while the abnormal distribution data will use the standard deviation and minimum maximum range.

* = Data distribution is not normal (using Saphiro wilk)

** = Using Wilcoxon test

The results in the table show that there is a significant relationship between diaphragmatic muscle strengthening exercises using incentive spirometry on the body balance of the students of the Faculty of Medicine and Health Sciences, Bengkulu University because the p value <0.05.

An overview of the balance before and after the Diaphragm Strengthening Exercise

In this study, the average value of the Pre and Post Sharpened Romberg Test Eyed Closed was normal. This is supported by a 2017 study, subjects were able to maintain an upright position with the heel of one foot touching the toe of the other and arms crossed on the shoulder for at least 30 seconds (Laura, 2017). This study is in line with Stephen, it is known that there is an increase in static balance with the Tandem examination after the diaphragmatic breathing exercise intervention for 8 weeks with a p value = 0.039 (Stephens et al., 2017).

In the pre-Stork Stand Test of the right and left feet, the average value of the subjects in this study achieved a very good score, while in the post-Stork Stand Test of the right and left feet the subjects in this study achieved very good scores. The results of this study are supported by research

by Rahman, namely the assessment on the Stork Stand Test is divided based on several levels, namely, very good (> 50), good (40-50), medium (25-39), moderate (10-24), poor (<10) (Rahman, K, A. 2017). The increase in Single Leg Stance static balance after diaphragmatic breathing exercises was also found by Stephens, it was known that the p value = 0.01 (Stephens, R, J. et al. 2017). Interventions in the form of exercises that target the trunk muscles, especially the inspiratory muscles (diaphragm and intercostals), have been shown to contribute to balance. Inspiratory muscle contraction increases intra-abdominal pressure which helps stabilize the lumbar spine during static (e.g. standing on tiptoe) and dynamic (e.g. walking with head turned) movements (Ferraro et al., 2020).

In measuring the dynamic balance of the Five Time Sit Stand, the average subject in the study showed good results in the pre and post tests, which were included in the normal category. The results in this study are in line with research conducted by Hyuma Makizako, if the subject scores more than 12 seconds, the possibility of a person experiencing an imbalance is greater (Makizako, 2017). This study is also in line with Ferraro, it is known that there is an increase after 8 weeks of Inspiratory Muscle Training intervention, the exercise is carried out the same as in this study, which is 30 times in one set, but the study by Ferraro et al. p = 0.03 (Ferraro et al., 2020).

The results of the Four Square Step Test in this study showed a normal average in the pre and post test because it was obtained <15 seconds for each subject. The results obtained are in accordance with previous studies, it is known that normal adults will usually be able to pass the four boxes provided in less than 15 seconds, if >15 seconds, the risk of falling increases (Moore, 2017).

In this study, the average Time Up and Go Test showed results in the normal category because there were no subjects that exceeded 14 seconds. In previous studies, it is known that the risk of falling will increase if the subject being examined takes more than 14 seconds (Makizako, 2017). This is supported by research in 2020, it is known that there is an increase in TUG dynamic balance after interventions in the form of Inspiratory Muscle Training (IMT) and Otago Exercise Program (OEP), increasing balance with BMI intervention is known to be better than OEP, with a significance value of p = 0.02 (Ferraro et al. 2020). Diaphragm exercises will affect intra-abdominal pressure, abdominal muscle endurance, and movement efficiency, which affect dynamic balance, resulting in an increase in each dynamic balance examination (Otadi et al., 2021).

The Effect of Diaphragm Strengthening Exercises Using Incentive Spirometry on Body Balance

In this study, an increase in balance was found in each test performed. Paired T test analysis in this study (can be seen in table 2) shows a statistically significant effect between diaphragmatic muscle strengthening exercises and incentive spirometry on body balance, both static and dynamic. Another study conducted in 2018, it is known that diaphragmatic movement during quiet breathing and deep breathing is associated with better balance due to thickening of the diaphragm muscle, it is known that there is thickening in each group of subjects with p-values in each group <0.05 (Kocjan, J. et al, 2018).

This study was also strengthened by Stephens in 2017, that diaphragmatic breathing exercise for 8 weeks could be associated with an increase in balance parameters, the significance value in this study showed a significant increase, namely p = 0.001 (Stephens et al., 2017). The results of this study are also in line with research in 2017, which stated that there was an effect of abdominal breathing exercises on postural stability, with a significance value of <0.05 in the initial and final measurements of the two groups in all variables (Miketa et al., 2017). It is also known that diaphragmatic breathing in a simple way, namely Slow Abdominal Respiration (SAR), which is integrated into the exercise program, shows a good effect on balance, with a statistical test value showing p = 0.049. Diaphragmatic breathing exercises activate core muscles including the transversus abdominis and pelvic floor muscles, which contribute to stabilization of the lumbar posture thereby improving body balance (Han et al., 2019). Contraction of the diaphragm will increase the stability of the trunk by reducing pressure

in the chest cavity and maintaining the abdominal muscles, while the stability of the spine increases due to tension in the thoracolumbar fascia due to increased intra-abdominal pressure. This increases the body's postural functions that affect static and dynamic balance (Kocjan et al., 2018).

CONCLUSION

The static and dynamic balance of the students of the Faculty of Medicine and Health Sciences, Bengkulu University, was included in the normal category and increased after being given diaphragmatic muscle strengthening exercises. Diaphragmatic muscle strengthening exercises with incentive spirometry have a significant effect on body balance.

The researchers would like to provide some suggestions for future research. Researchers should measure the height and weight of research subjects directly and they should do the exercises directly, not through zoom media.

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