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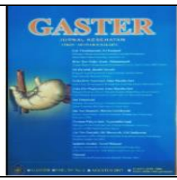

EFFECT OF NEURODYNAMIC SLIDER ON INCREASING HAMSTRING MUSCLE FLEXIBILITY IN RANTAYA PUTRI ALUS DANCERS

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ABSTRACT

Flexibility is influenced by many factors such as anatomical condition, gender, body mass index, age, physical activity, injury, and training experience. The hamstring muscles are primarily fast-twitch, so that the hamstrings are resistant to overloading but tire quickly on excessive repetitions. Excessive activity that involves contracting the hamstring muscles will cause decreased flexibility of hamstring muscles. The purpose of this study was to prove the difference in the effect of giving neurodynamic slider on increasing hamstring muscle flexibility. The method of research is experimental research with pre-test and post-test research design with control group design. The sample in this study was 32 dancers Rantaya Putri Alus at SMK N 8 Surakarta. where Group 1 given neurodynamic sliders and group 2 given nothing. Neurodynamic slider interventions were given 3 times/week for 4 weeks. Evaluation of hamstring muscle flexibility measurements using Active Knee Extension (AKE). The result in the treatment Group 1 is $p = 0.000$ ($p <0.05$) with a mean difference of 25.56 ± 7.36 with an increase in the AKE value 18.16%. Its concluded that the intervention of neurodynamic sliders can increase hamstring muscle flexibility.

INTRODUCTION

Rantaya Putri Alus dance is one of the traditional dances that has the basis of movement with the body as the main weight and the limbs as the main support. Princess Alus' Rantaya Dance Movements have a variety of positions, the most dominant of which is the "mendak" position, which is the movement of the lower legs / both knees in the bend facing outwards. The position is maintained during dancing with a duration of 15-30 minutes for each dance. (Gusyanti, 2013).

Dancers often experience fatigue, stiffness, cramps, and can even cause injury. This will certainly have a bad effect and can interfere with training activities and performance when dancing. For the dancers, injuries have become as great a threat as they are to athletes and sportsmen. During rehearsals and staging dancers are mostly from repetitive movements in dance performance which is the reason for the occurrence of overuse even to the point of traumatic injury (Allen et al., 2012)

Research conducted by (Martinez et al., 2014) states that according to a study conducted on 98 dancers, the incidence rate of acute injury to the hamstring is 34% and 17% for overuse injuries to the hamstrings with 88% reporting that injuries occur during dance practice. In addition, based on the results of observations made by (Fauzi, 2017) at the Omah Wayang Klaten studio, researchers found several injury problems that arise in dancers including cramps in the hamstring, ankle, and knee muscles.

The main cause of hamstring injury is because the hamstring muscle is too stretched or stretched beyond its ability/limit when performing certain activities. Another factor that can cause hamstring injuries is poor muscle flexibility/flexibility. If a person has poor muscle flexibility, it makes the muscles unable to withstand excessive weight or pressure if they do strenuous activities. (Yuliartha et al., 2017). A preliminary study conducted on students of SMKN 8 Surakarta, Department of Dance, found that 11 out of 14 students experienced a decrease in hamstring flexibility with an AKE score of less than 160^o. However, the students' lack of attention in responding to the condition of decreased hamstring flexibility because they considered the condition to be non-severe. This condition, if left untreated, will cause hamstring tightness which can be a risk of dancer injury during rehearsals and performances.

Flexibility is the ability of muscles to lengthen and allow one or more joints to move in any direction. The degree of flexibility of the hamstring muscles contributes to the proper gait of the knees. Insufficient flexibility predisposes a person to injuries and musculoskeletal dysfunctions so that it can greatly limit mobility. Increased flexibility to reduce the risk of injury, reduce pain, and improve athletic performance (Onigbinde, 2013).

Neurodynamic Slider (NS) is a type of nervous mobilization in which one end of the nervous system lengthens and the other end is sagging (Sharma et al., 2016). NS can be used to alter various movements where nerve tension is the thing that limits the scope of motion due to the tension that results in clinical symptoms. The slider technique uses an alternative motion that increases the tension at one of the nerve channel endings to continue the surrounding nerve impulses. Several studies have shown undera nerve mobilization increases the range of motion (Curtis & Retchford, 2015) Abnormal mechanical mechanisms can be overcome by the performance of neurodynamic sliders that result in execution and decreased tension of neural networks (Ellis et al., 2012). Research conducted by (Manasi et al., 2018) showed results that both interventions were effective in increasing hamstring flexibility, however neurodynamic sliders got better results in hamstring flexibility. (Park et al., 2014) also conducted a study and found that hamstring flexibility increased significantly after being given neurodynamic slider intervention.

Based on the literature above, the author is interested in proving neurodynamic sliding methods to increase hamstring flexibility by conducting research with a research proposal entitled "The Effect of Neurodynamic Slider Administration on Increasing Hamstring Muscle Flexibility in Dancers at SMK Negeri 8 Surakarta". The results of this study are expected to be applied as a dancer training program before doing dance exercises to support dance skills and reduce the risk of injury.

METHODS AND MATERIALS

This research is an experimental study with a pre-test and post-test research design with control group design. The subject in this research is students of SMKN 8 Surakarta. Research on students of SMKN 8 Surakarta majoring in dance was carried out in Ngentak Gadingan Village RT 04 RW 04, Mojolaban, Sukoharjo. The research was conducted in February-March 2021. Research subjects from populations that meet the criteria for inclusion and exclusion. Inclusion criteria: Subjects aged 16-18 years, female in gender, have an AKE test score of less than 160^o, a normal category BMI score, are not currently experiencing a lower extremity injury, are able to interpret the instructions given, are willing to be the subject of the study and sign informed consent. Exclusion Criteria: neurological symptoms or pain that spread and are examined by a physiotherapist. Have a history of acute and chronic and postoperative trauma to the vertebrae or lower extremities.

The number of subjects in the study was 32 subjects calculated using the Pocoock formula.

The technique of taking subjects in this study used a simple random sampling technique. The simple random sampling technique is a subject retrieval technique that is carried out by first calculating the number of subjects in the population chosen by the subject as the subject of the study.

In analyzing the data obtained from the results of measuring the flexibility of the hamstring muscles, there was a change in the flexibility of the hamstring muscles in dancers before and after being given exercises. Subsequently, the data was processed and analyzed using spss software version 22 copyright from ibm corporation in 2013. The influence test aims to analyze data on differences in hamstring muscle flexibility before and after training using paired sample T-tests because the data are normally distributed. The meaning limit used is $p = 0.05$. Ho is accepted if the value of $p>0.05$ and Ho is rejected if the value of $p<0.05$.

RESULT AND DISSCUSSIONS

This research was conducted on students of SMKN 8 Surakarta majoring in Dance Arts which is located at Jl. Sangihe, Kepatihan Wetan Jebres Surakarta, Central Java on February 22 - March 20, 2021. Due to the COVID-19 (Coronavirus Disease 2019) pandemic, the government issued a PJJ (Distance Learning) policy that must be applied to all educational institutions in

Indonesia including SMKN 8 Surakarta. The existence of the PJJ policy, students are not allowed to do dance practice at school, so with the initiative of the students to form groups to do dance exercises for subsequently the dance exams are carried out virtually by sending dance videos to the teacher.

Considering the PJJ policy by the government, the researcher decided to conduct a study at the home of one of the students whose address was in Ngentak Gadingan Village RT 04 RW 04, Mojolaban, Sukoharjo. The population of students majoring in Dance at SMKN 8 Surakarta is 87 people, who meet the inclusion criteria of 51 people. Then the research subjects were taken with simple random sampling with a random selection technique to make a draw of numbers 1-51 then the students took a lottery. 51 students who met these criteria, who were taken as research subjects, namely students who received lottery numbers 1-32 according to the sample size that had been determined in this study. The subject is then given informed consent as a sign of consent to participate in the study. The subjects of the study totaling 32 people performed the exercises during the study smoothly. The subjects followed the exercises as already scheduled by the researchers, none of the subjects suffered injuries and illnesses during the study so that of the 32 subjects who followed the study none dropped out.

To present more complete research results and strengthen the interpretation of hypothesis testing, the data description is in the form of characteristics of the research subject in the form of a table. The following is a description of the characteristics of the subject based on age, body mass index, durasai and frequency of dancing on the subject.

Table 5.1 Distribution of Subjects by Age

Age	Group 1 n=16	Group 2 n=16	Homogenity Test p value
	Frequency (%)	Frequency (%)	
16	4 (25)	4 (25)	
17	9 (56,3)	7 (43,8)	
18	3 (18,8)	5 (31,3)	0,635
Mean±SD	16,94±0,680	17,06±0,772	

Based on Table 5.1, it shows that in the distribution of subjects by age, a value of p=0.635 (p>0.05) was obtained. The results showed that both treatment groups had the same data variance. Treatment Group 1, subjects aged 16 years as many as 4 people (25.0%), those aged 17 years as many as 9 people (56.3%), and aged 18 as many as 3 people (18.8%) so that in treatment group 1 was dominated by subjects aged 17 years. Treatment Group 2, subjects aged 16 years as many as 4 people (25.0%), aged 17 years as many as 7 people (43.8%), and aged 18 years as many as 5 people (31.3%).

Based on the results of the study based on the age characteristics of the subjects, Treatment Group 1 had an average age (16.94±0.680) years and Treatment Group 2 had an average age (17.06±0.772) years. This shows that in adolescents, especially the dancer Rantaya Putri Alus experiences a decrease in the flexibility of the hamstring muscles. The flexibility of a person increases in childhood and decreases with age. The search for the environmental drivers of dysregulated muscle proteostasis regulating age-related muscle loss remains hotly researched (Atherton et al., 2016) that flexibility increases in childhood until adolescence then sedentary, then with age, there is a gradual decrease in mobility. Increasing age is a factor that can lead to a decrease in flexibility. Among many muscles, hamstrings are shortened most often, and many people experience difficulties due to shortened hamstrings. Moreover, decreased flexibility caused by shortening of hamstrings biomechanically increases the risk of injury during physical activities (Hwang, 2018).

Many reasons can lead to the development of hamstring muscle shortening such as genetic predisposition, muscle injury, and adaptive shortening due to some chronic conditions (Pietrzak & Vollaard, 2016). In addition, excessive activity in the hamstring muscles will cause the muscles to experience fatigue (fatigue). Overuse and trauma to the muscles will cause muscles to become stiff (tight) due to ischemia in some muscle fibers, thereby disrupting the circulation of nutrients in the surrounding muscle fiber area (Sherwood, 2016).

Table 5.2 Distribution of Subject Data by BMI

Characteristics of BMI	Average value and Standard Deviation		Homogeneity Test p value
	Group 1 n=16	Group 2 n=16	
Mean	20,1475	20,2950	
Median	19,9550	20,0050	
Modus	20,81	18,75	
SD	0,98030	1,52065	0,111
Min	18,73	18,51	
Max	21,50	23,73	

Based on Table 5.2 above, it shows that the research subjects in both groups had values in the range of 18.5-24.99 so that the BMI in both groups was included in the "Normal" category. Based on the table above, the value of p = 0.111 (p>0.05) is obtained, this shows that both groups have the same data variations. Treatment Group 1 had an average BMI value (20.1475±0.98030) with a median value of 19.9550 with a BMI value of at least 18.73 and a maximum of 21.50. Group 2 has an average BMI value (20.2950±1.52065) with a median value of 20.0050 with the lowest BMI value of 18.51 and the highest of 23.73.

Table 5.3 Duration of Dancing Subjects

Dance Duration/ week (hours)	Group 1 n=16	Group 2 n=16	Homogenity Test P-value
	Frequency (%)	Frequency (%)	
7,5	1 (6,3)	1 (6,3)	
8	2 (12,5)	1 (6,3)	
10	12 (75)	14 (87,5)	0,392
12,5	1 (6,3)	0 (0)	
Mean±SD	9,750±1,1402	9,719±0,7739	

Based on Table 5.3 above, the duration of the subject dance obtained a value of p=0.392 (p>0.05), which means that both groups have the same data variation. Treatment Group 1 had a dance duration range of 7.5-12.5

hours/week while in Treatment Group 2 it had a training duration range of 7.5-10 hours/week. The two Treatment Groups, most of the subjects, had a dance duration of 10 hours / week, in Treatment Group 1 as many as 12 (75%) people while in Treatment Group 2 as many as 14 (87.5%) people.

Based on the results of the analysis carried out on the characteristics of BMI, it was obtained that the values in Treatment Group 1 had an average BMI value (20.1475±0.98030), while in Treatment Group 2 it had an average BMI value (20.2950±1.52065). BMI values with a range of 18.5-24.99 so that the BMI in both groups falls into the "Normal" category. This is in accordance with research conducted by Noviyana (2011) with research on nutritional intake, physical activity, and bone density of dancers, it was found that of the 74 dancers, 51 (68.9%) of them had BMI with a normal category. The results of this study are also in accordance with a study conducted by (Rachmawati & Murbawani, 2015) entitled "The Relationship of Nutritional Intake, Physical Activity, and Body Fat Percentage with Menstrual Cycle Disorders in Dancers" and the results were obtained that of the 62 dancers, 44 (71%) of them had a normal category BMI, 12 (19.4%) dancers with the underweight category, 4 (6.5%) dancers with the overweight category and only 2 (3.2%) dancers were in the obes category I. Research conducted by (Fatmawati, 2013) showed that there were differences in BMI in students who participated in sports activities and students who did not actively participate in sports activities. The difference in BMI values in these two groups was due to differences in physical activity and the amount of nutritional intake. In the group of students who actively do sports, the intake consumed will be used as a source of energy in carrying out higher physical activity so that the nutritional status of BMI will tend to be normal.

Table 5.4 Frequency of Dancing Subjects

Dancing Frequency/week	Kelompok 1 n=16	Kelompok 2 n=16	Homogenity Test P-value
	Frekuensi (%)	Frekuensi (%)	
4	2 (12,5)	1 (6,3)	0,237
5	14 (87,5)	15 (93,6)	
Mean±SD	4,88±0,342	4,94±0,250	

Judging from Table 5.4, it can be seen that the frequency of dancing of the subject obtained a value of p=0.237 (p>0.05), which means that the frequency of dancing in the subject has the same variation. Both groups have the same range of 4-5 times/week. The subject performs a dance every Monday-Friday after school hours are over. Subjects in both Treatment Groups Mostly performed dance exercises 5 times/week, with 14 (87.5%) people in Treatment Group 1 and 15 (93.6%) in Treatment Group 2.

Based on the results of the study based on the characteristics of the duration and frequency of dancing in the subjects, Treatment Group 1 had an average dance duration of (9.750±1.1402) hours / week and Treatment Group 2 had an average dance duration of (9.719±0.7739) hours / week with an average of 1.5-2.5 hours / day for 4-5 times / week in both groups.

Based on research conducted by (Wahyuni et al., 2018) who conducted research on the percentage of heart rate reverse (HRR) in Legong Keraton Lasem dancers, it was found that dances carried out in a planned, structured manner, with a frequency of 3-5 times per week with a duration of 20 minutes by involving the dancer's body movements carried out repeatedly were enough to meet the dancer's sports needs.

Exercises performed with a long duration of time and repeatedly on the rantaya Pautri Alus Dance movements cause the hamstring muscles to contract for a long time. Excessive activity in the hamstring muscles will cause the muscles to experience fatigue. Overuse and trauma to the muscles will cause muscles to become stiff (tight) due to ischemia in some muscle fibers, thereby disrupting the circulation of nutrients in the surrounding muscle fiber area (Page et al., 2010).

To test the average increase in hamstring muscle flexibility before and after intervention in Groups 1 and Group 2, a test using a Paired Sample T-test was used because the data were normally distributed. The test result are listed in Table 5.6.

Table 5.6 Paired Sample T-Test Result

	Average Pre-test±SD	Average Post-test±SD	p-value
Kel	140,69±7,021	166,25±5,323	0,000

Based on the table, the results of differences in the average increase in hamstring muscle flexibility were analyzed with Paired Sample T-test before and after intervention in Treatment Group 1 with a value of p = 0.000 ($p < 0.05$) which means that there is a significant difference in influence on increasing the flexibility of the hamstring muscles before and after being given neurodynamic slider intervention.

The results of the study in Treatment Group 1 or the neurodynamic slider group showed that the increased flexibility of the hamstring muscles in the implementation of the pre-test had a mean of 140.69. In the post-test implementation in Treatment Group 1, it was shown that the increase in hamstring muscle flexibility had a mean of 166.25. This shows that the results of post-test measurements after neurodynamic slider treatment cause an increase in the flexibility of the hamstring muscles which is proven by an increase in the scope of joint motion in the knee joint when taking Active Knee Extension (AKE) measurements.

Based on hypothesis testing using paired sample T-test with a value of p = 0.000, the value of $p < 0.05$ this shows that there is a meaningful influence of the administration of neurodynamic sliders on increasing the flexibility of the hamstring muscles in the dancer Rantaya Putri Alus.

The results of this study are in accordance with a study conducted by (Ridder et al., 2020) entitled "Neurodynamic Sliders Promote Flexibility in Tight Hamstring Syndrome" in the study compared two interventions between neurodynamic slider and static stretching and the results were obtained that from the two interventions could increase the flexibility of the hamstring muscles, but the administration of neurodynamic sliders provides greater flexibility gains with 12.6º and 9.3º increase results.

First of all, the slider may affect the extraneural interface where adhesion between the neural and the surrounding tissue can limit the excursion of the neural network in the mechanical interface and can cause increased tension and stiffness during passive stretching (Ellis et al., 2012). Neurodynamic sliders cause linear movement of the sciatic nerve (Coppieters et al., 2015). which can prevent or modify adhesions, thereby causing a decrease in nerve mechanosensitivity and an increase in the viscoelasticity of nerve tissues, thereby increasing the mobility of the hamstring muscles. Another explanation in the observed increase in flexibility may be the analgesic effect of neurodynamic mobilization, which would delay the onset of painful sensations and hence related muscle contractions (Pérez et al., 2017). A similar effect has been described as a 'sensory theory' that is not related to direct analgesia but rather to an individual's perception of stretching or pain (strain tolerance) due to improved neurodynamic function. The neurodynamic slider technique uses a dynamic method and could be considered a dynamic stretching method that has the potential to affect nervous and non-neural structures (Nunes et al., 2017).

Viewed from a functional perspective, it is very important to strive for optimal hamstring muscle strength and its relationship with muscle length. Especially during explosive eccentrics of the end range, the hamstring muscles are prone to microscopic lesions that eventually reduce strain tolerance. If left untreated, this can make the hamstring more susceptible to injury tension (Opar et al., 2012).

According to research by (Castellote-Caballero et al., 2013) entitled "Effect of a Neurodynamic Sliding Technique on Hamstring Flexibility in Healthy Male Soccer Player. A Pilot Study" which divided football players with a decrease in hamstring muscle flexibility was then divided into two groups, namely the neurodynamic slider treatment group and the control group, it was found that there was a significant increase in hamstring muscle flexibility in the neurodynamic slider Treatment Group with an increase of 19.3º compared to the control group which increased by 0.2º. Another study conducted by (Vinod Babu, 2015) entitled "Immediate Effect of Neurodynamic versus Mulligan Bent Leg Raise Technique on Hamstring Flexibility in Asymtomatic Individual" states that the use of slider techniques is effective in increasing the flexibility of hamstring muscles that are experiencing limitations. This occurs due to an increase in tension in one nerve ending and a decrease in the other nerve endings, thereby increasing nerve excursion. When a neurodynamic slider is performed, the tension that occurs in the nervous system increases due to the expansion of the area and the axonal transport system, namely the lengthening of the sciatic nerve after shortening due to the influence of the surrounding structure that affects the hamstring muscles (Park et al., 2014).

Other studies have also concluded that the application of neural mobilization affects the performance of motor units, since it can reduce compression and adhesion that compromise nerve conduction, thereby improving muscle performance. The increase in the unit's motot is the result of balancing nerve impulses, facilitating contraction, and increasing muscle strength capacity. Neural mobilization can help in the synchronization of nerve impulses (Pérez et al., 2017).

CONCLUSIONS AND SUGGESTIONS

Based on the results of the analysis of research data that has been carried out and discussed, it can be concluded that the Neurodynamic slider can increase the flexibility of the hamstring muscles in the Rantaya Putri Alus Dancer. As for the suggestions that can be submitted based on the findings and studies in this study, there are several suggestions that are conveyed by the researcher as follows: It is hoped that in addition to doing flexibility exercises, the students also do strengthening exercises on the leg muscles so that it will maximize the function of the limbs as the main support for the body in dancing and it is necessary to do further research by improving some things that are the peculiarities that have been described in the weakness of this study is to obtain more valid results.

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