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Original Article

Comparison of Combination of Foot Exercise with and without Hydrotherapy to the Range of Motion on Active Knee Joints and Ankle Joints in The Elderly

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Abstract

Background : Aging results in a decrease in various body functions, one of them is in the aspect of mobility. Increasing age can reduce the range of motion of the joints. One of the easy physical activities for the elderly is foot exercise and hydrotherapy (warm water soaks) in order to minimize the decrease in ROM. This study was aimedt o compare the combination of foot exercises with hydrotherapy and without hydrotherapy on active ROM of the lower extremities in the elderly.
Methods : This research is an experimental study with parallel 3 groups pre and post-test design. The research subjects were 21 elderly people in RW 04 Karang Wetan, West Ungaran, Semarang Regency. Active ROM of the lower extremity was measured before and after intervention using a goniometer. analyzing the data of this study using the Paired T test and One Way ANOVA method.
Results : There was no significant increase in the active ROM of the lower extremities in the control group, p=0.114 (p>0.05). The range of active motion of the lower extremities (pre test to post test) in the combination treatment group of foot exercise and hydrotherapy p < 0.001 (p < 0.05) and the treatment group of foot exercise p = 0.001 (p <0.05) experienced a significant increase . However, there was no significant difference in the increase in active ROM of the lower extremities in the combination treatment group with foot exercises and hydrotherapy, p=1.00 (p<0.05) and the foot exercise treatment group.
Conclusion : Physical activity in the form of a combination of foot exercises with hydrotherapy and without hydrotherapy performed 3 times a week for 5 weeks has been shown to increase the active ROM of the lower extremities in the elderly. However, there was no significant difference between the two which was more effective in increasing the active ROM of the lower extremities in the elderly.

Keywords : Foot exercise, hydrotherapy, Range of Motion

INTRODUCTION

Elderly (elderly) is a person with an age of more than sixty years.[1] The number of elderly people in 2014 was 18.781 million people and is predicted to increase to 36 million people in 2025.[2] The percentage of elderly people in Indonesia has increased by around 25 million people or around 9.6% in a span of almost five decades (1971–2019).[3] Aging is a continuous process that causes cumulative changes in which the immune system declines in response to internal stimuli as well as external.[2] Aging occurs due to the accumulation of various kinds of cellular and molecular damage over time which will cause a gradual decline in mental and physical capacity, an increased risk of disease and death.[4] In the aging process, body composition will change, including a reduction in muscle mass, an increase in body mass, centralization of fat, and an increase in intramuscular fat.[5] Loss of muscle fiber in the elderly is due to atrophy of myofibrils and replacement of fibrous tissue that begins in the fourth decade of life.[14] Diseases that often occur in the elderly include hypertension, osteoporosis, visual and hearing impairment, dementia, etc. One aspect affected by the aging process is joint flexibility.[2] Decreased joint flexibility has the potential to affect normal functions in everyday life, such as dressing, reaching for objects, maintaining a normal gait and for activities that involve bending and reaching down. While loss of flexibility with age is often caused by a decrease in physical activity.[6] *Range of Motion* (ROM) is one of the physical indicators related to the role of the movement function. Range of Motion (ROM) is defined as the maximum degree of movement in a particular joint.[7] Active ROM is the range of motion that can be achieved when the muscles are contracted and the antagonist muscles are relaxed. Active ROM is achieved when the opposing (antagonist) muscles contract and relax, resulting in joint movement.[15] Some causing Range of motion reduction in the elderly includes related connective tissue restructuring, age genetics, trauma, diseases such as arthritis, and reduced activity levels.[16] Knee joint ROM includes flexion and extension movements. The ankle joint ROM includes dorsiflexion, plantarflexion, inversion and eversion.

Gymnastics is a body exercise that is made and selected with a plan that is arranged systematically with the aim of forming and developing a harmonious personality.[9] Foot gymnastics a purposeful leg exercise that increase blood circulation and strengthen the small leg muscles and strengthen the calf muscles, thigh muscles and reduce the limitations of joint movement.[10] Hydrotherapy, formerly known as hydropathy, is a method of therapy by utilizing water as a medium to treat or relieve pain.[11] Warm water has a good physiological impact on the body, including improving blood circulation, stabilizing blood flow and heart function. The loading factor in the water can also increase the strength of the muscles and ligaments associated with the body's joints.[12]

Therefore, this study was conducted to determine the effect and comparison of foot exercises with hydrotherapy and without hydrotherapy on active ROM of the knee and ankle joints.

METHODS

This research is a Quasy experimental research using 3 parallel groups pre and post test design with control group method.The research subjects used in this study were the elderly in RW 04 Karang Wetan, West Ungaran, Semarang Regency who were selected by purposive sampling based on inclusion and exclusion criteria.

The inclusion criteria are (1) Elderly and domiciled in RW 04 Karang Wetan, West Ungaran, Semarang Regency, (2) aged 60–80 years, and (3) willing to participate in the study by filling out and signing an informed consent form. The exclusion criteria for the research subjects were (1) unable to speak, unable to hear, unable to see, (2) unable to use and understand Indonesian, (3) had a psychiatric disorder, and (4) had a disability. The research subjects were grouped into three groups: treatment group 1 (combination of foot exercise with hydrotherapy), treatment group 2 (foot exercise), and the control group. The treatment group was given intervention for 5 weeks with a frequency of 3 times a week.

The foot exercise intervention was carried out for 9 minutes which was demonstrated live with video guidelines and direct directions from the researcher. The hydrotherapy intervention of soaking the feet using warm water was carried out for 15 minutes which was divided into 2 sessions namely, soaking in the first minute then resting 1 minute by removing the feet from the bucket, then putting them back in the bucket for the second 7½ minute. Performed 3 times a week for 5 weeks.

Measurement of active ROM of the knee and ankle jointsusing a goniometer to measure the range of motion of the joints actively in both feet. Measured ROM is at the knee joint (Articulatio Genu) namely flexion and extension movements. The ankle joints (Articulatio Talocruralis) that are measured are dorsiflexion, plantarflexion, inversion, and eversion. The research data are units of degrees, and the higher the number of degrees indicates the wider the range of motion of the joints. Active ROM was then totaled and accumulated for each research subject. Data analysis is descriptive analysis and hypothesis testing. To test the increase in the pretest and posttest hypothesis for each group, a paired t-test was performed and to find out the difference in increase between groups, an unpaired t-test/Oneway ANOVA with Bonferroni's post hoc was used to determine the difference in increase between groups.

Research Ethics was obtained from the Medical and Health Research Ethics Commission (KEPK) Faculty of Medicine, Diponegoro University (No. 206/EC/KEPK/FK-UNDIP/VI/2021).

RESULTS

Characteristics of Research Subject Groups

The research subjects were 21 elderly in The RW 04 Karang Wetan area, West Ungaran, Semarang Regency with the characteristics shown in Table 1.

Active Range of Motion comparison

Based on Table 2, shows the Range of Motion data pre-test, post-test, and delta (difference) based on treatment. After the data normality test was carried out, the data were found to be normally distributed p>0.05, so a paired t test was carried out. In the control group, the results of the difference test between the pre-test and post-test showed p value = 0.114, which means that there was no significant increase in the Range of Motion pre-test and post-test because p> 0.05. In the treatment group 1, namely the foot exercise group with warm water foot

TABLE 1
Characteristics of Research Subject Groups

Characteristics		Group			p
		Control (n=7)	Treatment 1 (n=7)	Treatment 2 (n=7)	
Age		65.57±3.55	65.43±8.94	61.71±2.75	0.129**
Gender	Man	4 (14%)	2 (28.57%)	0 (0%)	
	Woman	3 (42.86%)	5 (71.43%)	7 (100%)	
Height		1.64±0.06	1.59±0.04	1.61±0.04	0.211*
Weight		64±6.81	64.43±4.93	62.71±4.35	0.831*
BMI		23.76±2.18	25.35±1.78	24.24±1.52	0.400**

§Table values are mean ± standard deviation; Median (min–max) *One Way ANOVA test **Kruskal Wallis test

TABLE 2
Table of differences in active ROM of the knee joint and ankle joint pre-test, post-test, and delta based on treatment

Group	RoM		p	Delta
	Pre-test	Post test		
Treatment 1	34.01±2.87	40.47±2.43	<0.001¶*	6.45±1.74
Treatment 2	35.07±3.97	40.67±2.09	0.001¶*	5.60±2.39
Control	37.29±3.13	39.13±4.05	0.114¶	1.85±2.64
p.s	0.142§	0.588§		0.003§*

Description: * Significant (p <0.05); § One Way ANOVA; ¶ Paired t tests

TABLE 3
Post Hoc Bonferroni different test between groups

Group		p	Description
Pre-test	Post test		
Treatment 1	Treatment 2	1.000	Not significant
	Control	0.004	Significant
Treatment 2	Control	0.020	Significant

TABLE 4
Table of average active ROM of the lower extremities for each movement in the treatment group 1

Group	Right foot		Left Foot	
	Pretest	Postest	Pretest	Postest
Knee Flexion	120.51±11.83	127.43±9.90	120.86±10.04	120.86±5.55
Knee Extension	0	0	0	0
Inversion	15.86±3.76	20.71±6.58	18.14±7.69	25.71±5.25
Eversion	8.14±3.76	14.14±5.34	10.57±4.61	12.71±2.43
dorsiflexion	9.71±6.68	13.43±5.65	12.71±3.25	12.714±3.25
Plantar flexion	46.29±17.53	62.14±9.48	45.29±12.85	68.43±5.38

TABLE 5
Table of the average active ROM of the lower extremities for each movement in the 2nd treatment group

Group	Right foot		Left Foot	
	Pretest	Postest	Pretest	Postest
Knee Flexion	118.14±16.96	124.43±9.24	118.00±11.27	123.71±12.80
Knee Extension	0	0	0	0
Inversion	17.86±3.93	24.29±3.86	19.43±5.74	23.00±2.71
Eversion	7.14±2.48	12.71±2.69	9.57±3.10	13.86±3.48
dorsiflexion	9.57±5.47	16.00±5.94	11.71±7.65	18.14±4.60
Plantar flexion	50±10.13	65.43±4.61	59.43±10.18	66.43±8.79

TABLE 6
Table of average active ROM of the lower extremities for each movement in the control group

Group	Right foot		Left Foot	
	Pretest	Postest	Pretest	Postest
Knee Flexion	126.86±10.70	126.86±14.57	124.86±6.12	125.86±4.53
Knee Extension	0	0	0	0
Inversion	20.14±3.29	24.29±10.39	18.00±5.26	22.14±7.56
Eversion	9.29±2.50	9.57±2.15	10.57±6.40	11.43±4.76
dorsiflexion	12.71±6.75	15.43±5.83	15.57±4.20	14.57±3.10
Plantar flexion	54.57±9.76	54.28±9.48	54.86±11.81	65.14±39.55

soaks, it was found that the results of the difference test between the pre-test and post-test showed a p value <0.001 so that p <0.05, which means that there was an significant increase in the Range of Motion pre-test and post-test. Then in treatment group 2, namely the leg exercise group, the results of the different test between the pre-test and post-test showed a value of p = 0.001 so that p <0.05, which means that there was a significant increase in the Range of Motion pre-test and post-test .

Comparison of active Range of Motion between groups

Differences in pre-test and post-test differences between groups were tested for unpaired differences in normal distribution using the One Way ANOVA test with Post HocBonferroni. Based on Table 3, there appears to be a significant difference between the treatment group 1 and the control group with p value = 0.004 because p <0.05. There was a significant difference between the treatment group 2 and the control group with p value = 0.020 because p <0.05. However, the difference between groups 1 and 2 was not significant because the p value = 1.000.

DISCUSSION

This study showed the results of a significant increase in the active Range of Motion of the knee and ankle joints in both treatment groups, both those who were given a combination of foot exercise interventions with hydrotherapy and without hydrotherapy which were carried out routinely with a frequency of 3 times for 5 weeks. In the treatment group 1 (a combination of foot exercise with hydrotherapy) and the treatment group 2 (foot exercise) there was a significant increase in the active Range of Motion of the knee joint and ankle joint from pre-test to post-test. The results of the mean difference between pre-test and post-test in the treatment group combining foot exercise with hydrotherapy showed Range of Motion active knee joints and ankle joint higher when compared to the foot exercise treatment group, but the difference in ROM did not show a significant value between the two groups after the Bonferroni Post Hoc statistical test.

An increase in active ROM of the knee joints and ankle joints in the elderly is possible because in foot exercises there is a process of exercise or physical activity by moving the lower extremities, for example bending the knees, straightening the knees, pushing the soles of the feet forward, pulling the soles of the feet back , turning the soles of the feet inward, and turning the soles of the feet outward. This is in line with research by Filantip, Arif in 2015 which shows after training Active ROM of the lower extremities in the elderly found an increase in ROM in the movements of thigh extension, thigh flexion, knee abduction, knee adduction, knee flexion and knee extension as well as an increase in motor movement abilities.[13] The difference in this study lies in the intervention used, which in this study used active ROM exercise interventions while in this study the intervention was foot exercises with warm water immersion.

The results of this study are also in line with the research of Nindawi, *et al*. in 2021 where there was a significant increase in the range of motion of the foot joints in knee flexion, knee extension, plantarflexion, dorsiflexion and leg muscle strength in the elderly who were given active ROM exercise interventions.[17] The first difference in this study were samples, the samples in this study were elderly people with osteoarthritis while in this study were the elderly. The second difference is the frequency of interventions. In that study, active ROM exercises were carried out 5 times a day for 2 weeks, whereas in this study, foot exercise interventions were carried out with hydrotherapy 3 times a week for 5 weeks. Exercise can trigger a stimulus that can increase the chemical activity of the neuromuscular and muscular. Neuromuscular stimulation can increase the stimulus on the extremity nerves, especially in the parasympathetic system which will trigger an increase in the production of the neurotransmitter acetylcholine for muscle contraction. Exercise also triggers an increase in mitochondrial metabolism of the limb muscles which produces ATP which is used by the limb muscles as energy for muscle contraction and increased metabolism increases limb muscle strength.[18]

An increase in active ROM of the lower extremities in the elderly is also possible due to an increase in muscle strength by hydrotherapy interventions or warm baths. The higher the muscle strength, the movement in the joints will be better and more optimal. This is in line with research by Setiyawan, *et al*. in 2019 which showed that there was a significant increase in muscle strength in non-hemorrhagic stroke patients in the group given a warm bath compared to the control group.[18] The difference in this study lies in the sample used, the sample in this study were non-hemorrhagic stroke patients at dr. Soediran Mangun Sumarso Wonogiri, while the sample in this study was the elderly.

Hydrotherapy by soaking the feet in warm water occurs heat transfer from the water into the body through the feet which has the effect of increasing circulation (cells) due to the transfer of heat energy through convection (movement through liquids). This triggers vasodilation throughout the body which has a positive effect on increasing muscle strength due to increased smoothness of blood flow and increased transfer of oxygen and nutrients to brain and muscle cells. It also has an important role as a transfer of nutrients and potassium and calcium substances needed by myocytes. The increase in calcium ions in the cytoplasm occurs due to the release of more ions from the sarcoplasmic reticulum so that muscle mass can be maintained and allows for an increase in muscle strength. Increased blood circulation will increase oxygen supply to myocytes. Oxygen is required by mitochondria for aerobic cell metabolism. Aerobic cell metabolism will produce more ATP where ATP is needed for muscle contraction.[18] Increased limb muscle strength can move joints even better.

The limitation of this research is the difficulty of getting research subjects due to activity restrictions due to the existence of social distancing so that researchers are looking for alternative research subjects. In addition, researchers cannot control the daily activities of research subjects during the study.

CONCLUSION

The conclusion of this study is that the combination of foot exercises with hydrotherapy and foot exercises can increase the active Range of Motion of the lower extremities. However, no significant difference was found between the combination of foot exercises with hydrotherapy and only foot exercises. This research still needs to be done with larger subjects and a more even distribution of sexes.

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