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ORIGINAL ARTICLE

THE EFFECTS OF CORE STABILITY EXERCISE IN IMPROVING BACK MUSCLE STRENGTH, LIMB MUSCLES AND DYNAMIC BALANCE IN THE ELDERLY IN SINGARAJA, INDONESIA

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ABSTRACT

Balance disorders are a severe problem for the elderly. Exercise that can increase the power of the back muscles, leg muscles and dynamic balance is physical exercise in core stability exercise (CSE). This study aimed to analyse core stability exercise's effect on increasing back muscle strength, leg muscles, and dynamic balance in the elderly. Fifty-six elderly people aged 60-70 years were selected by simple random sampling as the sample in this study. The exercise program was given CSE (n: 28) for four weeks as the intervention group. The back and leg muscle strength were measured using the Back-leg dynamometer and balance measurement using the Time Up Go Test (TUGT). *T-test* and *Mann-Whitney* analyses were used to compare the results before and after the intervention. The different tests between the intervention and the control group obtained a p-value of 0.001, meaning an effect of CSE to increase the strength of the back muscles, leg muscles, and dynamic balance in the elderly existed. This study proved that CSE effectively increased back muscle strength, leg muscles and dynamic balance in the elderly. It is suggested to analyze the effectiveness of CSE based on the characteristics of the respondents.

Keywords: *Balance; core stability exercise; elderly; muscle strength*

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INTRODUCTION

Balance disorders are a severe problem for the elderly (Dhargave, Sendhilkumar, and James 2020; Kruschke and Butcher 2017; Qi et al. 2018). One of the causes of balance disorders is a decrease in the strength of the core muscles in the back and legs (Jamini and Lousiana, 2018; Murlasits and Reed, 2020; Nicholson et al., 2019). Good muscle strength training will increase the power of the core muscles, affecting dynamic balance (Amarya, Singh, and Sabharwal 2018; Murlasits and Reed 2020). Core stability exercise is a core muscle exercise that Focuses on the ability to control body position and movement through the core muscles of the back, abdomen, pelvis and legs to optimize flexion and extension movements and muscle elasticity (Arnold et al. 2015; Cabanas-Valdés et al. 2016).

Core stability is a strength exercise that utilizes maximum muscle tension in the muscles by using three types of muscle training classifications: isokinetic, isometric and isotonic (Akhtar, Karimi, and Gilani 2017; Aly, ElMohsen, and Hafez 2017; Cabanas-Valdés et al. 2017; Clifford et al. 2019; Coudeyre et al. 2016; Kakade and Kanase 2020). An increase in the activation of core stability will increase the strength and endurance of the back and leg muscles that work synergistically to maintain balance in the elderly (Kanik et al., 2017). Some older adults carry out challenging core stability exercises (Haruyama, Kawakami, and Otsuka 2017; Kakade and Kanase 2020). Therefore, the researchers made some adjustments by classifying it into several difficulty levels, making it easier to achieve the training goals, maximize the beneficial effects and practice compliance.

Compared with other muscle strengthening exercises, core stability exercise does not use weight, so it is safer to apply to the elderly. This exercise focuses on training maximum pressure on the core muscles to increase muscle strength (Akhtar et al., 2017). An increased risk of falling due to balance disorders due to decreased back and leg muscle strength is a major problem in the elderly. In this study, the researchers investigated the effect of core stability exercise on increasing back muscle strength, leg muscles and elderly dynamic balance.

METHOD

Study design

This research is quasi-experimental with pre and post with control group design. Respondents received baseline measurements and were followed up for four weeks to obtain the short-term effect of core stability exercise and then re-measured as a post-test. All respondents sent back their written informed consent.

Respondents

Researchers used simple random sampling to recruit 56 respondents at the Main Clinic Cortex Singaraja, as shown in Figure 1. The number of samples in this study was determined using a calculation formula against the average of two independent populations (Sastroasmoro and Ismael 2014) using the study's mean and standard deviation (Chen et al. 2020). Researchers also consider the number of samples with the possibility of dropout in specific subjects. The researchers randomized the sample using a web-based lottery application https://wheelofnames.com/id/. Respondents whose names came out on odd numbers will include in the intervention group (n=28), and respondents whose names came out on even numbers in the control group (n=28). All respondents involved were in the medical rehabilitation program at the clinic. Respondents in the intervention group follow the core stability exercise program twice weekly for 30 minutes (5 minutes warm-up, 20 minutes exercise, and 5 minutes cool down) for four weeks. Respondents in the control group did not get core stability exercise and dropped out during the study for the reasons listed in Figure 1. The intervention and control groups give A post-intervention for evaluation of the program.

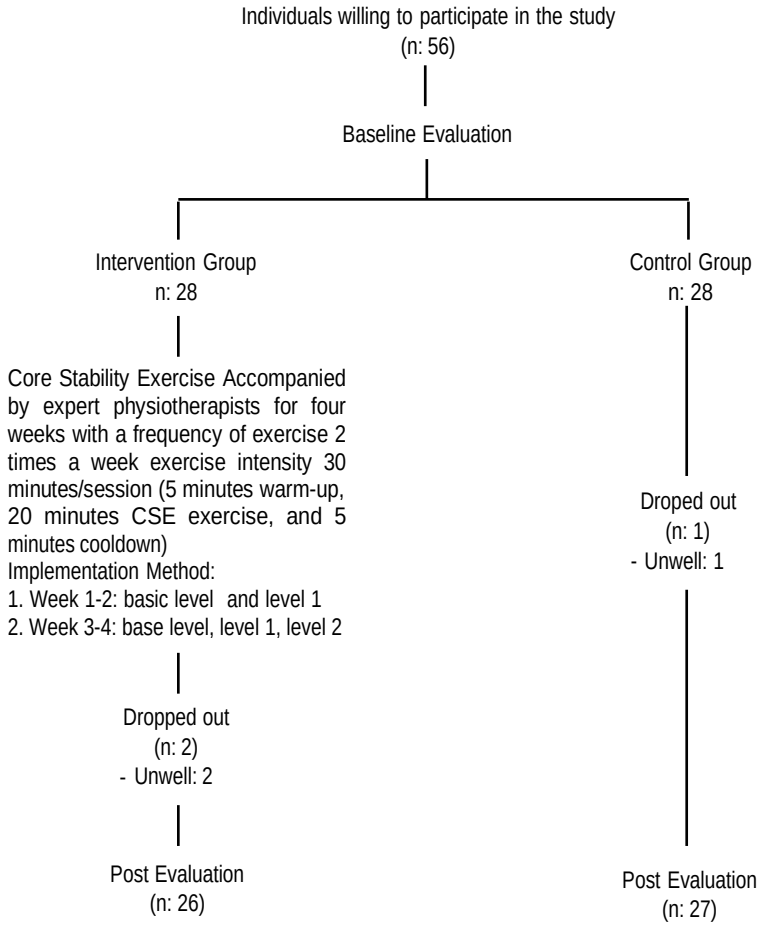

Figure 1. Flowchart explaining assignment of the participant to the study and control group

Inclusion criteria

The inclusion criteria in this study included: (a) having aged 60-70 years old; (b) being able to understand and follow simple verbal instructions to perform the exercises; (c) not having balance disorders; (d) being able to operate independently; (e) having good posture; (f) do not have spinal abnormalities; (g) being able to stand up from a chair independently. The researchers conducted the evaluation, and a certified physical therapist accompanied the process.

Exclusion criteria

Exclusion criteria in this study included: (a) having osteoarthritis/severe arthritis; (b) experiencing mental disorders; (c) having orthopaedic or cardiovascular disorders

that impair ambulation and ability to stand; (d) having a significant stroke; (e) having a disability/disability; (f) having a visual impairment.

Core stability exercise group

Researchers used a back-leg dynamometer to measure the strength of the back muscles in the intervention group. The time up and test (TUGT) measured leg muscles and dynamic balance. Furthermore, the intervention group was given a core stability exercise program two times in 1 week with a duration of 5 minutes of warm-up, 20 minutes of exercise and 5 minutes of cooling for four weeks. This study summarized the movement of core stability exercise in an exercise module and video. The researchers adjusted the core stability exercise so that the around 60-75 years old range can do it. The core stability exercise movement is adjusted based on the level of difficulty, divided into several training levels: base level, level one and level two. The base level is a fundamental movement technique for core stability exercises so respondents can maintain the spine position in a neutral position. Levels one and two are adjustments to the types of movements core stability exercise.

The control group

Participants in the control group first took initial back and leg muscle strength measurements using a back-leg dynamometer and dynamic balance measurements using the time up and go-test (TUGT). After the initial measurements, the researchers did not give the control group an exercise program and performed the final assessment four weeks later. Respondents who did not attend the last measure from the study were excluded (Figure 1).

Outcome measurements

The main results of this study were back muscle strength, leg muscle strength and dynamic balance. The researchers used a Back-leg dynamometer (Micro FET®3, Hoggan Health Industries) and the time up and go-test to measure the strength and emotional balance of the back and leg muscles. The researcher and a certified physical therapist measured the strength dan balance of the back and leg muscles at baseline and four weeks after the intervention. A measure of back muscle strength and leg muscles have different measurement methods. Therefore, this measurement procedure had been defined at the beginning. To obtain good data, the researchers measured each respondent twice, the most considerable value to input because of the measurement. The time up and go-test (TUGT) is a simple measurement that assesses a person's mobility and requires static and dynamic balance. This test measured the time it takes for the respondent to stand up from a chair, walk 3 meters forward at a comfortable pace, turn back into the chair and sit back in it. Three repetitions aimed to get the best results when measuring. Therefore, the researchers gave a lag time of approximately 1 minute for each repetition and analyzed the best results.

Data analysis

This study used paired t-test to compare the measurement results before and after treatment in each group and an independent sample T-test to see the difference between the initial and final measurements of the back-leg dynamometer and the time up and go-test (TUGT) in the intervention and control groups. This study used Statistical Product and Service Solution (SPSS) version 25 to analyze the outcome.

Ethics consideration

Stikes Buleleng approved this research with ethical clearance number: 087/EC-KEPK-SB/XI/2021, dated November 11th, 2021.

RESULTS

Demographic characteristics of participants in the two groups

The sample size was determined using a hypothesis sample calculation formula for the mean of two independent populations (Sastroasmoro and Ismael 2014) based on the study results (Penn et al. 2019). From the formula calculation, the researchers obtained 50 respondents. Sample size correction is needed to anticipate the possibility of Drop Out (DO) in selected subjects because they do not comply with the research program. The sample size is corrected by adding several respondents to fulfil the sample size (Sastroasmoro and Ismael 2014). The total number of respondents included in the study was 56 respondents. Figure 1 presents a flowchart.

The intervention group completed 8 exercise sessions (30 minutes each) conducted twice in 1 week for four weeks. A certified physical therapist administers the exercise program. In the control group, there was no intervention, but they were still following the medical exercise therapy program at the clinic. A total of 3 respondents dropped out due to illness, two respondents in the intervention group and one respondent in the control group. Finally, as many as 53 respondents underwent a post-intervention evaluation. The demographic characteristics of the respondents who completed the study are presented in Table 1. The homogeneity test results found no difference between the control and intervention groups based on the characteristics of the respondents.

Table 1. Demographic characteristics of participants

Characteristics	Intervention (n: 26) n (%)	Control (n: 27) n (%)	p*
Age			
60-65	17(65,4)	9(33,3)	0,127[b]
66-70	5(19,2)	15(55,6)	
71-75	4 (15,4	3(11,1)	
Sex			
Male	14(53,8)	13(48,1)	0,678[a]
Female	12(46,2)	14(51,9)	
Occupation			
Unemployed	5(19,2)	2(7,4)	0,286[a]
Farmer	1(3,8)	2(7,4)	
Trader	5(19,2)	7(25,9)	
Entrepreneur	3(11,5)	8(29,6)	
Retired	12(46,2)	8(29,6)	

Table 1. Demographic characteristics of participants (Continue)

Characteristics	Intervention (n: 26) n (%)	Control (n: 27) n (%)	p*
Education			
Elementary school	2(7,7)	2(7,4)	0,917[a]
Junior high school	4(15,4)	5(18,5)	
Senior high school	7(26,9)	9(33,3)	
University	13(50)	11(40,7)	

*p <0,05 based on chi square[a], independent t test[b]

Differences in back muscle strength, leg muscles and dynamic balance of respondents in the intervention group

Table 2 presents the differences in the variable of back muscle strength, leg muscle strength and dynamic balance before and after being given core stability exercise in the intervention group. The analysis obtained p-values on the three variables (0.001) <0.05, meaning a significant difference in the mean change between before and after in the intervention group with a 95% confidence level.

Table 2. Differences in the results of pre-test and post-test in the intervention group

Research variable	Before Intervention (n: 26) Min-Max	Mean±SD	After Intervention (n: 26) Min-Max	Mean±SD	P*
Back Muscle Strength (Kg)	39,6-48,3	44,50±2,65	45,4-54,8	50,05±2,60	0,001
Limb Muscle Strength (Kg)	52,2-61,3	56,43±2,62	53,3-64,7	60,11±3,04	0,001
Dynamic balance (seconds)	11,87-16,47	13,97±1,32	10,57-14,76	12,62±1,34	0,001

*p<0.05 based on dependent T-test

Differences in back muscle strength, leg muscles and dynamic balance of respondents in the control group

Table 3 presents the differences in the measurements of back muscle strength, leg muscles and dynamic balance at the initial size and measurement after the fourth week. The analysis showed a significant difference between before and after the intervention with a p-value (0.001) <0.05. Habits of activity, exercise and work can cause a reasonably significant bias because there are no restrictions on activities for the respondents of this study.

Table 3. Differences in the results of pre-test and post-test in the control group

Research variable	Before Intervention (n: 27) Min-Max	Mean±SD	After Intervention (n: 27) Min-Max	Mean±SD	P*
Back Muscle Strength (Kg)	39,3-48,3	43,78±2,50	41,9-52,5	45,62±2,52	0,001
Limb Muscle Strength (Kg)	52,8-62,8	57,065±2,87	53,7-63,3	57,59±2,57	0,001
Dynamic balance (seconds)	12,89-16,96	14,61±1,13	12,41-16,48	14,19±1,05	0,001

*p<0.05 based on dependent t-test

Effect of core stability exercise to improve back muscle strength, leg muscles and dynamic balance

The results for the correlation test in each group showed a significant change in the intervention group and the control group, so for further analysis, the researchers analyzed the value of delta (Δ) on each variable. Table 4 shows significant results on the variables of back muscle strength, leg muscle strength and dynamic balance p-value 0.001 (p<0.05).

Table 4. Differences resulted in the intervention group and the control group after the intervention

Research variable	Intervention Group (n: 27) Min-Max	Mean±SD	Control Group (n: 27) Min-Max	Mean±SD	P*
Value of delta (Δ) Back Muscle Strength (Kg)	3,40-7,90	5,55±1,20	-1,40-5,40	1,84±1,39	0,001[a]
Value of delta (Δ) Limb Muscle Strength (Kg)	0,50-6,90	3,67±2,042	-1,80-2,20	0,52±0,98	0,001[b]
Value of delta (Δ) Dynamic balance (seconds)	-2,50-(-0,20)	12,62±1,34	-1,86-0,57	-0,49±0,68	0,001[b]

*p<0.05 based on independent t-test[a], Mann Whitney[b]

DISCUSSION

Core stability exercise is the ability to control movement, position and pressure through the torso, pelvis, and lower extremities. These exercises focused on improving body balance to allow optimal force production and transfer and control forces in an integrated kinetic chain from the torso, hips to knees to the lower extremities. Increasing the activation level of core stability will result in good balance and improvements in postural function (Haruyama et al., 2017). Giving core stability exercises will increase flexibility and strength in the limbs from the back to the lower extremities to improve balance and increase the range of motion in the extremities, especially in the legs. Core stability exercise helps increase back and leg muscle strength, affecting balance and reducing the risk of falling in the elderly (Kim and Yim 2020; Pristanto and Farid 2018).

One previous study focused on the beneficial effect of providing core stability exercise on back muscle strength and leg muscles in the elderly (Jamini and Lousiana 2018). Meanwhile, other studies have reported the development of core stability exercises on dynamic balance in the elderly (Arnold et al., 2015; Cabanas-Valdés et al., 2016, 2017; Dello

Iacono, Padulo, and Ayalon, 2016). Thus, different results have been reported regarding core stability exercise movements, benefits, duration of the training and other assessment methods.

In this study, core stability exercise for four weeks compared to the control group increased back muscle strength, leg muscles and dynamic balance in the elderly. The researchers also found a significant improvement in the control group. These results may indicate one of the following. (a) no restrictions on the respondent's activities during the research; (b) exercise and work habits; (c) medical rehabilitation therapy which all respondents still accept. In this study, respondents in the intervention group often forgot to position their spine neutral. This condition can reduce the maximum tension in the core muscles so that the beneficial effect on core stability training is not fully obtained. Therefore, elderly participants may need some considerations to develop a core stability exercise program for them (Abdurachman et al., 2017; Coudeyre et al., 2016).

This study showed that the beneficial effect of the core stability exercise program was superior to that of the control group. Respondents in the control group were asked to do 10-15 repetitions of each movement in each training session. The repetition of each movement allows the respondent to perform the action well and feel the beneficial effects of a series of exercises (Martha and Djoar 2020). The core stability exercise is determined and tested on the elderly with an age range of 60-75 years, divided into several levels of movement. The training program is designed to be progressive and challenging. Respondents were given basic exercises level 1 in weeks 1 and 2 and a complete schedule (base level, level 1 and 2) at weeks 3 and 4. The previous study has not reported this exercise method. Therefore, the superior results observed in the intervention group may be due to the adjusted movements, graded intensity, and complexity modes of practice.

The results agreed with other studies that reported significant improvements in back muscle strength, leg muscles and balance. However, these results contradict those reported in the survey conducted by Woo et al. (Jamini and Lousiana 2018), suggesting that Tai-Chi training alone is insufficient to improve balance. This difference may be due to the intensity and duration of the core stability training program and the fact that muscle strength affects balance. Most previous studies reported that the elderly must exercise frequently and for relatively long periods, usually from 8 to 48 weeks, to benefit from various types of exercise, including core stability exercise (Arnold et al., 2015; Panchal et al., 2017; Toprak Çelenay and Özer Kaya, 2017). This study proved that short-term core stability exercise could increase back muscle strength, leg muscles and dynamic balance. If the elderly are given the practice with an intensity and complexity that suits them, they can perform a sequence of movements designed to improve muscle strength and balance.

The main limitation of this study is its quasi-experimental design. The researchers did not limit all respondents' activity and acceptance of medical rehabilitation therapy to control the risk of bias. The analysis was limited to determining the effect of core stability exercise on increasing the back muscles, leg muscles and dynamic balance. Hence, further researchers can analyze the impact of back muscle strength and leg muscles on improving dynamic balance in the elderly. In addition, an analysis to increase muscle strength and dynamic balance on the characteristics of the respondents also needs to be done.

CONCLUSION AND RECOMMENDATION

This study proved that core stability exercise for four weeks effectively increased back muscle strength, leg muscles and dynamic balance in the elderly compared to controls. Core stability exercises can be performed at home to maintain and improve back muscle strength, leg muscle strength, and dynamic balance.

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