Effects of Lower Limb Exercises using a Chair on Sleep Quality, Fitness, and Risk of Falls in the Elderly

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Abstract

Low physical activity levels can cause several degenerative diseases, especially for the elderly. Thus, the research objective was to examine the effects of the lower limb exercises program using a chair on sleep quality, fitness, and the risk for falls in the elderly. The experimental method with a *pretest-posttest control group design* approach was used in this research with a total of 20 male participants with average (age 66.85 ± 5.63 years, weight 45.75 ± 2.62, height 154.82 ± 5.18 cm, and BMI 19.16 ± 1.86). After doing lower limb exercises for eight weeks, the results showed sleep duration, fitness marked by the 6MWT test, and balance in the experimental group. There were significant differences, while there were no significant differences in the control group. Thus, hopefully, it was found in the research results that the exercise of using a chair for the elderly could help improve aerobic ability and balance. It was positively correlated with decreasing sleep duration problems in the elderly. It had the potential to reduce the risk of getting a history of other diseases that could interfere with the daily lives of the elderly.

Keywords: elderly, sleep duration, fitness

INTRODUCTION

The age distribution of the world's population is in constant change. The increasing number of elderly makes maintenance and independence in maintaining physical activity an interesting topic discussed in several kinds of literature (Bangsbo *et al.*, 2019; Cunningham *et al.*, 2020). The absence of physical activity in the elderly can cause a decrease in neuromuscular function by 3% per day (Kortebein *et al.*, 2016). Aging is also associated with a reduction in the physical and cognitive parts of the human body. However, it can also involve the possibility of age-related diseases such as dementia, obesity, diabetes, the risk for falls, and cardiovascular disease (Cunningham *et al.*, 2020).

Previous studies have reported that sedentary behavior in the elderly is at risk for decreased cognitive and psychomotor function (Ikai *et al.*, 2017; Sexton & Taylor, 2019). Besides, based on the cognitive aspect, it can lead to an increase in dementia (Fitri et al., 2020). Moreover, based on the psychomotor element, it can cause an increase in the risk for falls, osteoporosis, and decreased mobility due to reduced muscle mass. These are obstacles that must be faced by the elderly (Ikai *et al.*, 2017). Furthermore, sedentary behavior is also associated with depression and

fitness status levels, which can make a person susceptible to disease because of the low immune system possessed by the body. In addition, low physical activity can also cause disturbances in sleep quality which is characterized by a too-short sleep duration (Scarlett *et al.*, 2020).

Awareness of the importance of the benefits of physical activity should be encouraged again under WHO recommendations, which are to do physical activity at least three times a week and be accompanied by strength training twice per week (World Health Organization, 2020). The benefits of physical activity for the elderly in the future can reduce the risk of degenerative diseases and can maintain physical and mental function (Bangsbo *et al.*, 2019). Several innovations in providing exercise specifically for the elderly have also been implemented, such as the elderly age group, which is above 65 years (WHO, 2016), usually relying on the benefits of walking. Previous research describes dynamic walking stability specifically for the elderly (Gao *et al.*, 2019). In addition, several models such as a combination of resistance training and stretching (Gavin *et al.*, 2019), weight training alone (Miller *et al.*, 2021), or physical activity and food intake interventions for obese elderly (Muollo *et al.*, 2019). So far, the most recent innovation model has been implemented in Taiwan, where the training innovation provided is using exergames (Yu *et al.*, 2020) using digital media while doing sports in front of a screen.

However, the problem is that not all the elderly can move actively and freely. Many elderly aged 65 years old and over experience a fear of being prone to falling (Gao *et al.*, 2019), so there needs to be a form of exercise that can facilitate the elderly who do not independently of the active elderly, who experience a significant decrease in abilities due to aging (Seco *et al.*, 2013). On the other hand, there are not many practitioners who can facilitate the elderly in helping to maintain body composition, strength, balance, and cardiovascular abilities that are incorporated in one exercise model. Most trainers or supervisors for the elderly only use the form of exercise with a sitting position or media chair as a variation of the form of exercise. If we can try to separate again, the elderly sometimes find it difficult to follow the

instructions, so the consistency of the frequency and participation of the elderly during this research is a challenge in itself. The long-term effect will undoubtedly impact increasing the risk of falling and the independence of the elderly.

Physical exercises recommended for the elderly are aerobic exercise, flexibility training, muscle strength, and balance training (Prima et al., 2020; Sawada et al., 2017). In line with various previous research and the benefits of physical activity on the elderly, it turns out that there is still a need for research that focuses on the effectiveness of this form of exercise, which is expected to have positive effects on the fitness components related to the health and mobility of the elderly. Therefore, this research attempted to investigate the effects of lower limb exercises using a chair on sleep quality, fitness, and decreased risk for falls in the elderly.

METHOD

This research used a quasi-experimental method with a pretest-posttest control group design approach. The whole subject would be divided into two groups (experimental and control groups) and given different treatments. The group of elderly was split into two groups using A-B-A-B pattern, based on all subject fitness. The experimental group would be assigned a lower limb exercises program using a chair twice a week with a duration of 20 minutes per training session and carried out for eight weeks. In contrast, the control group was not given any training or treatment during the same period. Furthermore, the research parameters measured included age, weight, height, BMI, sleep duration, aerobic endurance (VO_{2max}), and balance tests. These parameters were taken before and after running the exercise treatment.

Subjects who met the inclusion criteria were included in this research. The allowed criteria were participants who did not smoke, were male, over 60 years old, and were not currently on drug intervention. The total research subjects consisted of 20 people from the Tresna Werdha Budi Luhur social institution, Jambi City. Furthermore, the 20 participants were divided into two groups (ten for the experimental group and ten for the control group).

Before the research was conducted, all participants were given an oral explanation regarding the research procedures.

The Measurement and Research Procedure

Anthropometry

The data collection was obtained from secondary data at the Tresna Werdha Budi Luhur social home in Jambi City. Meanwhile, it was done using a stature meter for height, which was directly guided by the research team. Furthermore, the researcher used a SECA 762 brand scale for the participant's weight. The data collection procedure was carried out by the subject standing upright on the unit by placing their feet on the scales barefoot.

Aerobic Endurance (VO_{2max})

Aerobic endurance data collection (VO2max) in this research used the field method, namely the six-minute walk test (6MWT), which was adapted to the guidelines of the American Thoracic Society (Person et al., 2018). The 6MWT was carried out along a 20 meter closed straight and flat corridor. The starting line and the turning point were both marked with cones. Then, each participant was asked to walk back and forth along the corridor at their own pace for six minutes. The distance covered in six minutes was recorded.

Balance Test

The balance bag in this research used the TAKEI BALANCE-1 TKK 5407c JAPAN tool. This tool worked because the subjects were asked to put one foot on the reaction stand with the other foot placed on the floor. After the signal sounds, the issue was required to close both eyes and immediately lift the leg from the floor to knee height. Then, the position of both hands has held on the waist and kept until the subjects no longer maintained the balance position. The trial was carried out two times, where

the results of the two tests would be taken as the mean score as the balance data output.

Exercise Program

The exercise program given to the experimental group was in the form of lower limb exercises using a chair as a tool and carried out twice a week for eight weeks. Each movement item was carried out for three sets x eight repetitions, with the duration of each test item ranging from four until six minutes. The lower extremity movements included extended leg raises, leg kicks, sit-to-stands, seated calf raises, knee extensions, and heel slides. The total minutes that the subject did in each exercise ranged from 30 minutes. See Table 1.

Table 1. Lower Limb Exercises Program

Item Test	Difficulty	Sets/Reps	Time
Extended leg raises	Medium	3/8	4 minutes
Leg kick	Advanced	3/8	5 minutes
Sit-to-stands	Easy	3/8	5 minutes
Seated calf raises	Easy	3/8	5 minutes
Knee extensions	Easy	3/8	5 minutes
Heel slides	Easy	3/8	6 minutes

The procedures carried out in this research included, at the initial stage, all participants would take measurements related to anthropometry such as (weight, height, and BMI). Furthermore, participants would be divided into two groups (experimental and control groups). Each group would receive a different treatment. The experimental group would receive lower limb exercises such as extended leg raises, sit-to-stands, modified squats, seated calf raises, and knee extensions using a chair. These exercises were performed twice a week for eight weeks. Meanwhile, the control group was not given any treatment for eight weeks.

Data Analysis

The research data was displayed in the two groups' mean score, standard deviation, and significance value. Furthermore, the pre and post-

test data on the parameter 6MWT, sleep duration, and the balance test would be analyzed using one-way ANOVA to compare the two groups. Further testing between groups is carried out using the two-way ANOVA test. Additionally, the statistical analysis used the SPSS version 25 application with a significance level of $p < 0.05$.

RESULT

The results of anthropometric data for all subjects were displayed in the form of the mean score, standard deviation, and significance value between the two groups. The results showed that the two groups' average age, weight, height, and BMI did not show any significant difference (see Table 2).

Table 2. Anthropometric Data

Variable	Total Sampling (N=20)	Group		*P*-value
		Experiment (*n*=10)	Control (*n*=10)	
Age (years old)	66.85 ± 5.63	66.70 ± 6.39	67.00 ± 5.09	0.909
Weight (kg)	45.75 ± 2.62	44.80 ± 2.83	46.70 ± 2.14	0.108
Height (cm)	154.82 ± 5.18	155.04 ± 5.39	154.6 ± 5.24	0.855
BMI (kg/m^{-2})	19.16 ± 1.86	18.73 ± 2.21	19.58 ± 1.43	0.325

BMI = *Body Mass Index*

Table 3. Comparison of pre and post-test post-treatment

Variable	Experiment		Control		*Time* x *Group* *P*-Value
	Pre	Post	Pre	Post	
Sleep Duration (hours)	3.90 ± 0.21	5.02 ± 0.39*	3.88 ± 0.20	4.08 ± 0.52	0.000*
6MWT (m)	523.35 ± 22.57	555.54 ± 25.88*	522.82 ± 24.12	526.75 ± 22.80	0.050*
Balance (sec)	9.60 ± 1.77	11.93 ± 1.84*	9.90 ± 1.63	10.28 ± 1.47	0.046*

The results in Table 2 show that sleep duration, fitness level as indicated by the 6MWT test, and balance values between the two groups experienced significant differences (sleep duration 0.000, 6MWT 0.050, and

Balance 0.046), where the experimental group always experienced an increase in each variable after running the lower limb exercises treatment using a chair. Meanwhile, the control group did not show a significant difference among the three variables was.

DISCUSSION

Sleep duration, aerobic ability, and balance experienced a significant increase in the experimental group compared to the control group. It proved that giving treatment with exercise using a chair could increase significantly because the entire control group has improved but only slightly and had the potential to decrease if the elderly stop exercising. Giving treatment for 16 sessions, for eight weeks, twice a week, followed the implementation of several previous research (Hama & Magied, 2014). Previous research has reported that the elderly with moderate or high physical activity tended not to have problems with sleeping time. The duration was too short or too long compared to those who only reported low physical activity (Scarlett *et al.*, 2020). The problem of sleep duration could be solved if the consumption of food and drink changed (Pereira *et al.*, 2020). The elderly who were accustomed to moderate or high physical activity tended not to experience problems with sleeping patterns, either exceeding or less than the recommended time of six-seven hours per day, compared to those who only did low physical activity (Scarlett *et al.*, 2020).

In addition to the domain of sleep duration, this research also investigated routine aerobic exercise activities that had been shown to have positive effects on the cardiovascular system, slowing and fighting the decline in effectiveness with aging that occurred in the elderly (Eckstrom *et al.*, 2020). Aerobic exercise improves respiratory function, maintains stroke volume, and lowers blood pressure at rest, especially in the elderly (Porcari *et al.*, 2015). In addition, regular aerobic exercise has been shown to reduce blood fat levels concerning weight management (Villareal *et al.*, 2017), and improve glucose tolerance (Malin & Kirwan, 2012) and insulin sensitivity (Prior *et al.*, 2012). Research has shown a significant reduction in oxygen

transfer efficiency in ordinary people compared to people who were active in sports (Van Schaardenburgh *et al.*, 2016). In addition, exercise could significantly affect aerobic endurance (Mekari *et al.*, 2020) in long-term performance.

Based on the physical activity aspect, one of the components related to motor skills is balance. In this research, the discussion of balance experienced a very significant change in the experimental group after eight weeks of treatment in a row, twice a week. Balance training and strength training can help minimize the risk of falling (Cress *et al.*, 2004; Seco *et al.*, 2013). Balance and strength are essential for the elderly above other biomotor training goals (Porcari *et al.*, 2015). Without these two things, the elderly experience deficiencies or difficulties in carrying out basic daily activities. Independence is lost, and self-confidence also decreases (Eckstrom *et al.*, 2020). As a solution, regular exercise should help the nervous system work in the elderly to stay awake, such as streamlining movement and reaction time (Jehu *et al.*, 2017).

Extended leg raises, Leg kicks, Sit-to-stands, Seated calf raises, Knee extensions, and Heel slides are six easy movements to implement for an older adult, even in a practical setting, the elderly were need controlled or supervised by a trainer. Sit-to-stands also give balance improvement to the elderly. The last is walking aerobics accomplished by subjects due to their ability, representing cardiovascular endurance in older adults.

Therefore, based on the research results, hopefully, exercising using a chair for the elderly could help improve aerobic ability and balance. Consequently, it was positively correlated with decreasing sleep duration problems in the elderly. It had the potential to reduce the risk of getting a history of other diseases that could interfere with the daily lives of the elderly.

CONCLUSION

This research provided evidence that lower limb exercises using a chair as a tool could help improve sleep quality, fitness, and the risk for falls

in the elderly. Thus, the exercise program carried out for eight weeks could be used as a recommendation for the elderly in maintaining fitness and as a reference for social institutions in making an exercise program for the elderly.

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