ORIGINAL ARTICLE

The Effect of Aerobic Exercises on Estradiol Plasma, Quality of Sleep, and Cognitive Function in Menopausal Women

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ABSTRACT

Introduction: Menopausal women show some changes physically and psychologically. Decreased plasma estradiol, decreased sleep quality and cognitive function are some of the main problems in women with menopause. The purpose of this study was to determine the effect of aerobic exercises in the Menopausal woman. **Methods:** This study was conducted using a quasi-experimental with control group pre-post test design. The aerobic exercise is done with a frequency of 2x90 minutes per week for 12 weeks. The subjects consisted of 24 women mean aged 53.12 years old. The inclusion criteria of this study were women who menopause, did not have severe disease, had good hearing and vision, and did not exercise at least 3 months before the study. Subjects were divided into two groups, namely the aerobic exercises group (n = 12) and the control group (n = 12). ELISA method with an HPLC tool used to measure estradiol plasma, the Global Pittsburgh Sleep Quality Index scores used to measure the quality of sleep, The Montreal Cognitive Assessment (MoCA) used to measure cognitive function. Wilcoxon test and paired t-test used to find out differences before and after the intervention. **Results:** The findings suggest that aerobic exercises can improve sleep quality (0.040) and cognitive function (0.002) in Menopausal women compare to the control group. **Conclusion:** Future studies should be carried out with a larger number of respondents and a longer period for a significant increase in plasma estradiol.

Keywords: Aerobic exercise, Centella asiatica, Cognitive function, Estradiol, Menopause, Quality of sleep

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INTRODUCTION

Menopause is a special period in women that involves physical, psychological and physiological changes in their bodies (1,2). Symptoms of menopause experienced by women in general include insomnia, fatigue, pain, sleep disturbances, cognitive impairment, symptoms of vasomotor disorders such as hot flushes and dyspareunia (2,3). This is subjective in terms of the type of symptoms experienced, the duration and quality of the disturbance and depends on the hormonal, physical, psychological, and social conditions of the individual (1–4).

The physical symptom that most often occurs in Menopausal women is sleep disturbances and is felt by nearly 60% of women (1,5–9). The prevalence of sleep disturbances, irrespective of the consequences of aging or other confounders, is higher in women after menopause than before. Insomnia is the most frequent sleep disorder in menopause. Sleep disturbances experienced cause stress, disruption in daily activities, decreased quality of life, and can even be one of the risks of dementia or Alzheimer's (5,6). PostMenopausal

women who experience sleep disturbances or further experience insomnia are prone to depression (6).

In addition, hormonal changes in women who experience menopause also cause a cognitive impairment (10–12). Estrogen levels affect the function of the brain regions in learning and receiving information. The reduction in estrogen levels in Menopausal women will be followed by a decrease in the density of the spinal cord and the formation of synapses in the brain. This causes a decrease in the levels of cholinergic and serotonergic hormones which have a direct effect on cognitive power (10,11,13). These physical and psychological symptoms are caused by decreased plasma estradiol levels in Menopausal women (14,15).

Another effort to increase estradiol levels in Menopausal elderly can be done through exercise. Exercise intervention plays an important role in improving muscle strength, raising bone metabolism, functional capacity, and decreasing obesity, (16) so that the quality of life can be improved. It can be interpreted that exercise intervention provides benefits for individuals to also overcome sleep problems, insomnia and client cognitive function. Purpose of this study is to determine the effect of aerobic exercise on plasma estradiol levels, sleep quality, and cognitive function in Menopausal women.

MATERIALS AND METHODS

Participants and study design

This study used a quasi-experiment design with pre and post-test methods with a control group for 12 weeks. The subjects consisted of 24 women mean aged 53.12 years old. The inclusion criteria of this study were women who menopause, did not have severe disease, had good hearing and vision, and did not exercise at least 3 months before the study. After fulfilling the criteria, the subjects were asked for their willingness by signing informed consent. The study was conducted at the Ethics Committee of Padjadjaran University (No.1266/UN6.KEP/EC/2018). Subjects were divided into two groups, namely the aerobic exercises group (n = 12) and the control group (n = 12).

Data collection

Sociodemographic data collection was done by historical and physical examination. Sociodemographic data include age, education, and marital status. Education was divided into low education (elementary and junior high school) and high education (senior high school and university). Physical examination was done by history, blood pressure, and anthropometry (weight and height). After taking anamnesa and physical examination, the next day the subject blood was taken, and cognitive tests and fitness tests for 15 minutes were also administered. The test was done two times before and after the intervention.

Measurement of estradiol plasma

Biochemical examination is the examination of estradiol by using the ELISA method with a HPLC tool from the Molecular and Genetic Laboratory of Medicine Faculty of Padjadjaran University. Blood was taken as much as 3 ml from the brachial vein in a state of fasting, then it was put into EDTA tubes with heparin, it was placed at room temperature for 1 hour, then put in a cool temperature of -8^{o}C. At the laboratory, centrifugation was carried out for 10 minutes, then the plasma was put into a tube and stored at -80^{o}C for later analysis.

Measurement of quality of sleep

Sleep quality was measured using self-rated sleep questionnaire namely Global Pittsburgh Sleep Quality Index scores (17). It contains seven components produce a total of 19 questions, each with a score varying from 0 (no difficulty) to 3. (severe difficulty). Subjective sleep quality, sleep latency, sleep length, normal efficiency of sleep, sleep disruptions, sleep medication use, and daytime dysfunction are the components. To create a global Pittsburgh Sleep Quality Index score (ranging from 0 to 21), the seven component scores are also summed up, with a score of more than 5 suggesting clinical sleep disability (18). A global PSQI score> 5 yielded 89.6 percent diagnostic sensitivity and 85.6 percent specificity (17).

Measurement of cognitive function

Measurement of cognitive function using the MoCA-Ina (Montreal Cognitive Assessment-Indonesian version) (19). MoCA test is performed to assess the seven cognitive domains, including executive function, naming, verbal and learning memory recording, concentration, abstraction, 5-minute verbal memory, and orientation (20). MoCA ratings range from 0 to 30, with a higher rating indicating global cognitive function. MoCA is available in 56 languages and dialects including Indonesia, and is referred to as MoCA-Ina. The Indonesian version of the MoCA (MoCA-Ina) test is accurate in accordance with cross-cultural and effective validation principles. The MoCA test validation is carried out using the principle of the WHO, which consists of 7 steps. The total Kappa value between the 2 doctors (inter-rater) was 0.820 from the results of this study. Whereas the following are in each domain: visuospatial/executive 0.817; 0.985 naming; and 0.969 focus. Meanwhile, 0.990 for the language domain; 0.957 for abstraction; 0.984 for memory, and 1.00 for orientation.

Intervention

Aerobic exercises were performed 2x90 minutes per week for 12 weeks. The movements included 15-minute warming-up, 60-minute aerobic exercise, and 15-minute cooling-down. Core movements include such gymnastics as brain gymnastics, *poco-poco* gymnastics, cardiovascular gymnastics, and rheumatism exercises.

The control group only did daily activities and did not consume memory enhancing supplements for 12 weeks.

Data Analysis

Data were analyzed using SPSS version 25 with a confidence level of $p < 0.05$. The data normal distribution test used the Shapiro-Wilk test to find out whether or not the data are normally distributed. One way anova and kruskal wallis test used to determine the differences between the four groups. Wilcoxon test and paired t-test used to find out differences before and after the intervention.

RESULT

There were no significant differences in age, weight, height, sistole, diastole, education, marital status, menopause status, menarche age, number of children, and hormonal contraception between the four groups (Table I).

Table.I Characteristic of menopouse women

Characteristics	Aerobic Exercises (n=12)	Control Group (n=12)	p
Age, mean (sd), yr	53.00 (4.86)	53.25 (5.75)	0.999
Weight, mean (sd), kg	58.82 (8.91)	57.50 (6.86)	0.626
Height, mean (sd), cm	152.18 (5.02)	152.75 (3.91)	0.519
Sistole, mean (sd), mmHg	115.45 (11.28)	121.67 (15.28)	0.711
Diastole, mean (sd), mmHg	76.36 (6.74)	78.33 (7.17)	0.919
Education, n (%)			
Low	3 (17.6)	6 (35.3)	0.200
High	9 (29.0)	6 (19.4)	
Marital status, n (%)			
Married	12 (25.5)	12 (25.5)	0.382
Widowed	0 (0.0)	0 (0.0)	
Menopause status, n (%)			
Perimenopause	5 (33.3)	4 (26.7)	0.785
Postmenopause	7 (21.2)	8 (24.2)	
Menarche age, mean (sd), yr	13.55 (2.30)	13.17 (1.80)	0.956
Number of children, mean (sd), score	3.00 (0.78)	3.08 (2.15)	0.718
Hormonal contraception, n (%)			
Yes	9 (36.0)	4 (16.0)	0.235
No	3 (13.0)	8 (34.8)	

*p<0.05; p-value were derived from Kruskal Wallis or ANOVA test and chi-square

The results of the study showed that the aerobic exercises have significant difference on the quality of sleep (0.040) and cognitive function (0.002) compared to the control group. Meanwhile, the aerobic exercises could increase plasma estradiol although it was not significant (0.239), and the control group had a decrease in plasma estradiol although it was not significant in Menopausal women (0.388) (Table II).

Table.II Comparison of estradiol plasma, quality of sleep, and cognitive function in menopause women

Characteristics	Aerobic Exercises/AE (n=12)		Control group (n=12)	
	Mean, sd	p	Mean, sd	p
Estradiol plasma (ng/ml)				
Pre-test	23.03 (15.35)	0.239	20.97 (22.51)	0.388
Post-test	43.70 (68.42)		13.16 (8.51)	
Quality of sleep (score)				
Pre-test	7.17 (1.75)	0.040*	5.92 (3.12)	0.551
Post-test	5.58 (2.19)		5.75 (2.86)	
Cognitive function (score)				
Pre-test	23.08 (3.97)	0.002*	23.42 (6.42)	0.180
Post-test	27.00 (2.26)		23.67 (6.43)	

*p<0.05; data are expressed as mean ± SD; p-value were derived from paired t-test or wilcoxon test

DISCUSSION

Effect of aerobic exercises on estradiol plasma

The results of the study found that aerobic exercises could increase plasma estradiol although it was not significant, and the control group had a decrease in plasma estradiol although it was not significant in Menopausal women. The results of a study stated that physical activity in Menopausal women showed an increase in plasma estradiol levels (21). A meta-analysis study of postMenopausal women ages 58 to 61 who were given a combination of calorie-lowering intervention and exercise with duration varying from 16 to 52 weeks, gave the greatest beneficial effect on the therapeutic effect ratio of estrone, estradiol, and free estradiol compared to controls. There is a substantial limit effect of exercise without dietary improvement versus regulation on androstenedione, total estradiol, and free testosterone (23). A 12-week aerobic and anaerobic exercise program based on the American College of Sports Medicine (ACSM) has been shown to increase plasma estradiol levels in Menopausal women

(22,23). Anaerobic exercise in this research associated with increasing lean mass, whereas aerobic exercise plays a key role in reducing the fat mass and estradiol plasma level (22).

Effect of aerobic exercises on quality of sleep

The results showed that aerobic exercise could improve the sleep quality of Menopausal women compared to the control group. This is consistent with research showing that resistance training improves all aspects of sleep, with the main advantage being sleep quality (24). Regular exercise had a small beneficial effect on total sleep time and sleep efficiency, a small to moderate beneficial effect on sleep initiation latency, and a moderate beneficial effect on sleep quality. Effects were influenced by participant gender, age, level of baseline physical activity, as well as type of exercise, time, duration, and adherence (25). A sports training program consisting of moderate-intensity aerobic exercise or high-intensity strength training. Participants randomized to an exercise program had a higher global Pittsburgh Sleep Quality Index score than the control group. In middle-aged and older adults, participation in an exercise training program has a fairly positive impact on sleep quality (18,26).

The 12 weeks of exercise has modest therapeutic effectiveness in overweight / obese adults for reducing obstructive sleep apnea (30). Another study found moderate aerobic exercise for 6 months improved sleep quality, quality of life and mood in people with chronic primary insomnia (27). Aerobic exercise for respondents who experience rheumatoid arthritis has a positive effect on the quality of sleep of these respondents. Secondary effects studied included subjective sleep quality and sleep disturbances, fatigue, pain, depressive symptoms, physical function, quality of life related to cardiorespiratory health and fitness which also experienced significant improvements (28).

Effect of aerobic exercises on cognitive function

The results of this study showed that aerobic exercises can improve cognitive function in Menopausal women compared to control. This is in line with research show that physical exercise 45-60 minutes per session of moderate intensity can improve cognitive performance over the age of 50 years, regardless of the cognitive condition of the participants (29–31). (36–38). Physical activity such as walking can help improve cognitive performance in patients with vascular cognitive disabilities (32).

Intensive physical activity is known to increase the volume of the hippocampus by approximately 2% and the medial temporal lobe which mediates the increase in spatial memory, cerebral blood flow volume, and perfusion of the hippocampus (33). Several recent studies have shown the effects of moderate-intensity aerobic exercise, to be effective in preventing hippocampal volume loss. Several meta-analyzes have reported that physical activity is associated with increased attention, processing speed, and executive function in older adults with and without cognitive impairment (34,35).

CONCLUSION

The aerobic exercises in Menopausal women showed a positive effect on estradiol plasma, quality of sleep, and cognitive function. Further research is expected to be carried out with a larger number of research subjects and a longer study time so that the results of blood biochemical examinations become significant.

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