The effect of adding exergame boxing to balance functions of elderly women

Rizky Diah Kartikasari1, I Putu Alit Pawana2, Ditaruni Asrina Utami3, Soenarnatalina Melaniani4

ABSTRACT

Background: The average incidence of falls in elderly women exceeds that of elderly men in all age groups. Exercise had a consistent effect on reducing the risk of falls when prescribed correctly and was successful in reducing fall rates in the community, with an even greater effect seen in a balance-challenging exercise program. The exercise in question is a series of combined activities that maintain or increase flexibility, endurance, strength and balance. Programs that target at least two of the above components are proven to reduce the risk of falls.

Methods: This study is a true experimental research with pre and post-test randomized control group design. The research participants were 32 elderly women, with each group consisting of 16 elderly women. Participants in the treatment group received exergame boxing, which was carried out 3 times per week for 8 weeks. Participants in both groups are required to take part in conventional exercises programmed by Nursing Home 5x/week for ±15 minutes. The outputs were assessed at the beginning (initial value) and after 8 weeks of intervention (final value).

Results: There were significantly significant differences in the One Leg Stance (OLS) and Timed Up and Go (TUG) values in the control and treatment group (p<0.005), but the effect size was higher in the treatment group.

Conclusions: The addition of exercise boxing for 8 weeks can improve the static and dynamic balance function of elderly women as measured by OLS and TUG.

Keywords: dynamic balance, elderly women, exergame boxing, one leg stance, static balance, timed up and go.


INTRODUCTION

Compared to elderly men, elderly women also experience decreased motor function and a higher prevalence of osteoporosis, so the risk of falls and fractures is also greater.1-7 In Indonesia, the incidence of falls was recorded at 40.9%, with a prevalence in the age group 65-74 years of 67.1% and the age group over 75 years of 78.2%, with an average incidence rate of falls in elderly women exceeding the elderly man.8 An analysis study showed that exercise had a consistent effect on reducing the risk of falls when prescribed correctly and was successful in reducing fall rates in the community, with an even greater effect seen in a balance-challenging exercise program. The exercise in question is a series of combined activities that maintain or increase flexibility, endurance, strength and balance. Programs that target at least two of the above components are proven to reduce the risk of falls.9-12

In recent years, exergame has been developed as an alternative exercise. Exergame (exercise game; exertion game) is defined as video games that use or require the player’s physical movement beyond sedentary conditions with components of strength, balance, aerobicics and flexibility activities and can be used in various places for various age groups.13 The use of exergame has been widely studied to improve physical activity and cardiorespiratory fitness, lung functional capacity, prevent obesity, motor re-education, and improve cognitive function, postural control, balance and gait in various age groups and patient conditions. Compared to traditional sports, sports games are more interesting and challenging, are not affected by the weather, and being able to practice at home increases safety and comfort.13-17 Boxing is known as an empty-handed martial art that requires high strength, endurance, stamina, agility, speed, coordination and concentration. Exergame boxing is considered a fun and competitive fighting video game, so it has an effect on psychological and social interactions in the elderly.14-16

In this study, we analyzed the effect of adding exergame boxing on the balance function, static and dynamic of elderly women.

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Background: The average incidence of falls in elderly women exceeds that of elderly men in all age groups. Exercise had a consistent effect on reducing the risk of falls when prescribed correctly and was successful in reducing fall rates in the community, with an even greater effect seen in a balance-challenging exercise program. The exercise in question is a series of combined activities that maintain or increase flexibility, endurance, strength and balance. Compared to traditional sports, sports games are more interesting and challenging, are not affected by the weather, and being able to practice at home increases safety and comfort. Exergame boxing is considered a fun and competitive fighting video game, so it has an effect on psychological and social interactions in the elderly. The aim of this study was to evaluate the effect of adding exergame boxing on the balance function of elderly women.

Methods: This study is a true experimental research with pre and post-test randomized control group design. The research participants were 32 elderly women, with each group consisting of 16 elderly women. Participants in the treatment group received exergame boxing, which was carried out 3 times per week for 8 weeks. Participants in both groups are required to take part in conventional exercises programmed by Nursing Home 5x/week for ±15 minutes. The outputs were assessed at the beginning (initial value) and after 8 weeks of intervention (final value).

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In this study, we analyzed the effect of adding exergame boxing on the balance function, static and dynamic of elderly women.
METHODS

Participants
This study is a true experimental research with pre and post-test randomized control group design. The study duration was about 8 weeks starting from March 2023. The subject of this study was 32 women aged 60 years or older in Surabaya Nursing Home who fulfilled the inclusion and exclusion criteria. Subjects were randomly assigned into treatment and control groups, with 16 subjects in each group.

The inclusion criteria were as follows: 1) female age 60 years or above, 2) ability to walk with or without an assistive device, 3) stable hemodynamic (resting blood pressure ≤180/110 mmHg, pulse ≤100x/m, body temperature ≤37.5 °C, O2 saturation ≥ 95%), 4) good vision and hearing functions and 5) without or under-control comorbid disease (hypertension and diabetes mellitus). Participants were excluded if they presented with a musculoskeletal, cardio respiration, or neurological disease that affected physical performance during exercise. The participants will be categorized as dropping out if they were not willing to continue the research for any reason, attendance of less than 75% of the total attendance that should be followed, unable to complete the exercise according to the established research protocol, as many as 2 consecutive practice sessions in one week out of the total number of practice sessions during the 8 training weeks, sick so unable to continue training or died. The final assessment of the balance function with the One Leg Stance Test and the Timed Up and Go Test will be carried out 1 day after the subject has completed the last exercise.

Conventional exercise
Participants in both groups were required to take part in conventional training programmed by Griya Wredha, which was a combination of light-intensity aerobic activity and physical stretching 5x/week for 15 minutes, which was divided into components of 5 minutes of warm-up, 5 minutes of core, and 5 minutes of cool-down.

Exergame boxing protocol
Before starting the intervention, participants in the treatment group were asked to take part in 2 orientations regarding exergame boxing with the aim of providing guidance so that they are more familiar with the movements that will be carried out during exergame boxing. The exergame intervention was carried out with a duration of 25 minutes (5 minutes of warm-up, 15 minutes of exergame boxing and 5 minutes of cool-down) per session 3 times a week for 8 weeks according to the training protocol. Exergame boxing session is added 5 minutes incrementally each week. The researcher and three Griya Wredha staff were responsible for overseeing the safety of the participants during the intervention.

One Leg Stance (OLS) protocol
When the participant heard the word “begin”, the participant lifted one leg with the position of both hands on the hips, one leg raised with the position of flexion of the thigh and knee 60 degrees with eyes open for 1 minute. The stopwatch started when the participant started to lift her leg and stopped when the participant’s raised leg touched the floor, touched the other leg, the foot used to support changes in position, or the participant’s hand did not touch the participant’s hip. The test was carried out on both legs with 3 trials, and the best value was taken. The values are noted in seconds.

Timed Up and Go (TUG) protocol
It needed a room with a minimum length of 3 meters, a non-slippery floor and a standard chair (height 44-47 cm, armrest height 67 cm). Marked the floor (line shape) at 0 meters and at a distance of 3 meters. Placed a standard seat behind the first line. The participant sat in a standard chair, with her back against the chair, her buttocks against the back of the chair, her arms on the armrests and her feet behind the first marking line. When they heard the word “start”, the participant stood up from the chair, walked in a straight line 3 meters long to the second marker line, turned 360 degrees, walked back to the chair, and sat down. The participant was asked to walk at a comfortable and safe pace. She may stop and rest if necessary but may not sit, and there was no time limit. The stopwatch was on since the word “start” and stopped when the participants sat back in the chair. The values are noted in seconds.

Statistical analysis
All data were analyzed using SPSS statistics 26 (IBM, USA). Shapiro Wilk normality test was used to determine data distribution. Wilcoxon sign rank test was used to compare non-parametric data. The effect size was observed using Cohen’s formula to elaborate on the statistical effect of changes. The significance level was set at less than 0.05.

RESULTS
The characteristics of the study participants are summarized in Table 1. The mean age of the participants was 72.00 ± 10.88 years in the control group and 73.00 ± 7.05 in the treatment group. In addition, body mass index (BMI) was 22.77 ± 3.79 in the control group and 22.68 ± 4.31, which is categorized as normal.

Carlo formula, p >0.05
There was a significant difference in the OLS and TUG values before and after exercise in the control and treatment groups (p <0.05). In the control group, the OLS parameter has a large effect size (Cohen’s D = 0.9), and the TUG parameter has a large effect size (Cohen’s D = 1.13). In the treatment group, the OLS parameter has a large effect size (Cohen’s D = 2.38), and the TUG parameter has a large effect size (Cohen’s D = 2.84) (Table 2).

A comparison was made of the ΔOLS and ΔTUG values between the control group and the treatment group. There were significant differences in ΔOLS and ΔTUG between the control and treatment groups (p = 0.000 and p = 0.000) at the end of the study. In the effect size measurement, the ΔOLS parameter has a large effect size (Cohen’s D = 2.67), and the ΔTUG parameter has a moderate effect size (Cohen’s D = 3.34) (Table 3).

DISCUSSION
Based on body anthropometry, women tend to experience balance disorders.1 This is exacerbated in the elderly phase, when several changes will occur, including psychological, neuromuscular, musculoskeletal and cardiorespiratory systems. Changes in the neuromuscular and musculoskeletal systems occur in the nerves, muscles, joints and bones. Nervous
Table 1. Patient characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Control group (n=14)</th>
<th>Treatment group (n=15)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (year)</td>
<td>72.00 ± 10.88</td>
<td>73.00 ± 7.05</td>
<td>0.08</td>
</tr>
<tr>
<td>Body weight (kg)</td>
<td>52.29 ± 10.11</td>
<td>48.36 ± 10.71</td>
<td>0.54</td>
</tr>
<tr>
<td>Body height (m)</td>
<td>1.51 ± 0.08</td>
<td>1.46 ± 0.19</td>
<td>0.07</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>22.77 ± 3.79</td>
<td>22.68 ± 4.31</td>
<td>0.65</td>
</tr>
</tbody>
</table>

Notes: *Normality test using Monte

Table 2. The effect after 8 weeks of exercise in the control and treatment group

<table>
<thead>
<tr>
<th></th>
<th>Initial Value</th>
<th>Final value</th>
<th>P Value</th>
<th>Cohen’s D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Group</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OLS (second)</td>
<td>7.98 ± 7.52</td>
<td>8.47 ± 7.45</td>
<td>0.005*</td>
<td>0.9</td>
</tr>
<tr>
<td>TUG (second)</td>
<td>12.92 ± 4.14</td>
<td>12.57 ± 4.25</td>
<td>0.001*</td>
<td>1.13</td>
</tr>
<tr>
<td>Treatment Group</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OLS (seconds)</td>
<td>8.55 ± 9.52</td>
<td>11.78 ± 9.53</td>
<td>0.000*</td>
<td>2.38</td>
</tr>
<tr>
<td>TUG (seconds)</td>
<td>13.51 ± 3.40</td>
<td>10.73 ± 2.87</td>
<td>0.000*</td>
<td>2.84</td>
</tr>
</tbody>
</table>

Note: Test using paired t-test; *Significant if p < 0.05

Table 3. Comparison of ΔOLS and ΔTUG values between groups after 8 weeks of exercise

<table>
<thead>
<tr>
<th></th>
<th>Control group</th>
<th>Treatment group</th>
<th>P value</th>
<th>Cohen’s D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Δ OLS (seconds)</td>
<td>0.49 ± 0.54</td>
<td>3.23 ± 1.35</td>
<td>0.000*</td>
<td>2.67</td>
</tr>
<tr>
<td>Δ TUG (seconds)</td>
<td>-0.35 ± 0.31</td>
<td>-2.78 ± 0.98</td>
<td>0.000*</td>
<td>3.34</td>
</tr>
</tbody>
</table>

Note:*Significant if p < 0.05

tissue in the elderly will experience a decrease in nerve fibers, afferent and efferent impulses and the number of neurons. This will cause cognitive decline, motor responses and proprioception. Nervous tissue also experiences a decrease in motor units and the quality of neuromuscular junctions, which causes muscle contraction and muscular fatigue resistance to decrease. Muscle tissue in the elderly experiences a decrease in motor fibers I and II, which causes reduced muscle mass. Joints and bones in the elderly will experience an increase in proteoglycans and a decrease in osteoclasts. This causes a decrease in flexibility and a decrease in bone mass, which results in a decrease in bone strength. In the cardiorespiratory system, there will be a decrease in lung fitness and functional capacity, which affects the working system of muscles and nerves. The combination of decreased motor response, proprioception, muscle and bone strength, and flexibility is what causes a decrease in balance in elderly women.1-7

Exergame boxing has elements of rhythm and group activities, flexibility, strength, and aerobics, which stimulate the release of the Brain Derived Neurotropic Factor (BDNF), which is contained in the human nervous system. When this BDNF increases, the excitability of the mechanoreceptors and the efferent response also increase. Mechanoreceptor stimulation will forward the signal as an afferent response and then store it as an anticipatory mechanism.19-21 The efferent response that occurs will increase the quality and quantity of motor units and the Neuro Muscular Junction (NMJ), which causes increased muscle strength. Flexibility in exergame boxing will maintain or increase the range of motion of joints in the elderly. The combination of range of motion, anticipatory mechanisms and increased muscle strength will establish a postural control.20,21 This postural control is able to improve balance in elderly women, both static balance and dynamic balance.15-19

CONCLUSION
The static balance function of measuring the value of the OLS test and the dynamic balance function of measuring the value of the TUG test increased in elderly women, both of whom received conventional training only or with the addition of exergame boxing for 8 weeks. However, the function of static and dynamic balance in elderly women who received additional exercise boxing for 8 weeks was much better than the group that only received conventional training.

ETHICAL CONSIDERATION
This research was approved by the Health Research Ethics Committee, Faculty of Medicine, Airlangga University, Surabaya, Indonesia, with number 56/EC/KEPK/FKUA/2023.

CONFlict OF INTEREST
No conflict of interest.

FUNDING
This research received no grant from any funding agency in the public, commercial, or not-for-profit sectors.

AUTHOR CONTRIBUTION
Authors 1, 2, and 3 made concepts, designed the study, searched the literature, and acquired data. All authors analyzed data and statistics, discussed the results, and wrote, edited and reviewed the manuscript.

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