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Impact of Electronic Balance Training on Postural Instability in Postmenopausal Women: a Randomized Controlled Trail

電子平衡訓練對絕經後婦女姿勢不穩定性的影響：隨機對照試驗

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Abstract

Purpose. Determination of Electronic Balance Board effect on Balance in Women in their postmenopausal period was the aim of this study. Subjects and Methods. Our study design was a randomized, single blind controlled trial. A total of 40 sedentary, medically stable women in their postmenopausal stage complained of poor life quality. The range of the participated women ranged between 50 to 65 years that were randomly allocated into 2 equal number groups: group (A), that participate in the electronic balance board training program in addition to balance rehabilitation program and aerobic exercise, and group (B), which received balance rehabilitation program and aerobic exercise. Each group received 3 sessions weekly for one month. The stability index, AP index and ML index was recorded before and after the intervention. Results. There were a significant reduction in overall stability index, AP index and ML index in group A in compared to group B at the stage of post treatment. Conclusion. A program of four weeks' electronic balance board besides balance rehabilitation program and aerobic exercise yield improvement in the balance of the Biodex Balance System than a balance rehabilitation program alone in treating problems of postmenopausal balance.

Key words:

Balance, Electronic balance, Aerobic exercises, Menopause

摘要

目的：确定电子平衡板对绝经后女性平衡的影响为本研究的目的。主题和方法。我们的研究设计为随机单盲对照试验，共 40 名惯于久坐、健康稳定且处于绝经阶段的女性抱怨其生活质量差，年龄在 50 至 65 岁之间的参与女性被随机分配至均等两组：A 组除了平衡康复方案和有氧运动外，还参与电子平衡板训练计划，B 组则接受平衡康复计划和有氧运动。每组每周接受 3 次疗程，持续一个月。干预前后记录其稳定性指数、AP 指数和 ML 指数。结果。治疗后 A 组与 B 组相较下，稳定性指数、AP 指数和 ML 指数均显著降低。结论。除了平衡康复计划和有氧运动外，为期四周的电子平衡板在 Biodex 平衡系统上比单独的平衡康复计划更能改善绝境后的平衡问题。

关键词：

平衡、电子平衡、有氧运动、更年期

Introduction

Menopause is the period that women passed usually from 49 to 52 years of their age [1]. This period is associated with many intrinsic factors that favor fall like postural instability, decreased physical functioning and more fear against falling. Additionally; women in their menopause encounter more limitations in range of motion, grip and leg strength, flexibility, gait and walk analysis and functional performance than premenopausal women [2]. After menopause, several of woman's body composition usually changes like bone loss, increase in the mass of body fat and a reduction in lean body mass. The most probable cause of these changes is the sudden decrease in the production of endogenous estrogen at menopause time. Falls and their consecutive fractures have been contributed to the reduction in lean body mass occurring with age. It has been reported that 33% of women in their postmenopausal stage experience one fall per year. It was estimated that 5-10% of falls lead to fracture and also 80% of all non-spinal elderly fractures are caused by falling [2]. Estrogen receptors that receive estrogens will be distributed with estrogen deficiency in articular cartilages, synovial membrane, and ligaments, which are thought to be associated with degenerative changes. Progesterone has its receptor in osteoblast in bone tissue and acts positively on the severity of degeneration directly. [3]. Spinal degeneration can disturb postural control and predispose people to fall because of damage to mechanoreceptors in the apophyseal joints. Degeneration can also affect proprioception in joints. 'Proprioception'' is the term which describe the sensory information from receptors in the muscles, tendons and joints provide feedback regarding joint position sense, movement (kinesthesia) and touch. This input from the lower limbs is arguably the most important contributor to standing balance [4]

The constant small deviations in center of mass position, which is the commonly used measure of balance standing named as" Postural sway". Control of postural sway involves continuous muscle activity (primarily about the leg and hip) in response to integrated sensory inputs [5]. Because of the economic burden of these falls and their related injuries, applying an effective intervention strategy could considerably reduce the overall incidence of falls, decrease both the rate and the risk of falling and also decrease concomitant costs of health care [6]. Thus, the first step recommendation is to start programs of physical activity in a safe environment, ensuring sufficient fitness levels and self-confidence to decrease fear from falls and prevent their occurrence. [7]. Physical therapists usually perform traditional exercises of balance that decrease risk of falling. To accomplish this, designing intervention strategies for improving or maintaining gait and balance is considered necessary to minimize the overall number of falls and fear of falling in elderly. Physical activities which promote balance can be adapted for a geriatric group with much success [8]. Studies have also explored that physical exercise regimens including a balance element help decrease fears of falls in the elderly who had experienced a fall within the last year [9]. Researchers have shown a lot of ways to reduce falls and improve balance in elderly. These studies show a discrepancy beginning from strength training and task-specific training ending in tai chi and even video game systems using recently [10]. Systematic reviews have recommended that perturbation-based balance training (also called reactive balance training) perhaps decreases rates of falling by 46-48% [11]. Numerous methods have been applied to create perturbations such as a low-friction plate on a walkway [12], treadmill accelerations [13], waist/ankle-cable pulls or motor-driven surface translations [14]. While systems of over-ground, possibly will be similar to actual life threats (i.e. have strong ecological validity), the perturbation frequently takes place at a fixed location and may possibly lead to loss of "unpredictability" [15]. Technologies used in the context of physical activity for the elderly can take many forms, from interactive television to virtual reality and Kinect-based applications, both at home and institutionalized settings [16]. Exergaming might be applied as a perfect strategy for exercise behavior alteration in adults [17] and appears to be appropriate, effective, and safe for older adults [18]. Moreover, the Wii-based exercises- can be performed either alone by their selves at home, or by participating with others in a group, which may make the exercises easier and more attractive to a lot of elderly [19]. Moreover, the Wii-based exercises- can be performed either alone by their selves at home, or by participating with others in a group, which may make the exercises easier and more attractive to a lot of elderly[20]. Studies have illustrated that Wii-based training can enhance balance in elderly with both normal [21] and inappropriate balance [22]. Additionally, it is very hopeful in improving the balance to use the technology to Nintendo Wii-fit plus which is considered the latest technology of exergaming. It has the advantage to be cost effective and less expensive tool to help balance training in the elderly. The intensity and repetition of exergaming have an important role of improving the functional activity skills. Also, the patient Motivation level is high because of the pleasure gained from the usage of games in treatment purposes [23]. Accordingly, the aim of our study was to analyze the effects of both aerobic exercise and electronic balance board in enhancing balance in women in their postmenopausal stage.

Subjects and Methods

Our study design was a randomized, prospective, pre–post-test, single-blind, controlled trial. An appropriate sample of 40 women in their postmenopausal stage was collected from the outpatient clinic of obstetrics and gynecology department, faculty of physical therapy, Cairo University. They were enrolled and evaluated for their suitability to participate in our study. We only include women that complain from a decline in their physical function, whose range of their ages is from 50 to 65 years, their body mass index (BMI) ranged from 25 to 30 kg/m2 and they didn't report any leisure-time physical activity participation throughout the last year. Exclusion criteria were Postmenopausal women whose visual or hearing impairment did not allow the possibility of interaction with the system, postmenopausal women with any mental, neurological, vestibular, cardiovascu-

lar disorders and metabolic disease or postmenopausal women who have been received hormonal replacement therapy or any drug known to affect the balance. We obtained a written informed consent from all women prior any evaluation. Additionally, we gathered an ethical approval from the institutional review board at Faculty of physical therapy, Cairo University prior the study initiation with number P.T.REC/012/001500. Our study was performed in the duration from January 2018 and February 2019 following the Guidelines of Declaration of Helsinki on conduction of human research.

Intervention

After a short orientation session with the participants to discuss the study nature and the tasks to be accomplished, they were randomly allocated into two equal number groups (group (A) and group (B)) by an independent and a blinded research assistant who opened closed envelopes that contained cards which were randomized by computer. No participants dropped out of the study after randomization. Group (A) participated in the electronic balance board program and a balance rehabilitation program in form of fall-specific training program (i.e., forward-directed stepping response to backward-directed postural perturbations) and aerobic exercise (cycling and treadmill).Group (B) a balance rehabilitation program in form of fall-specific training program (i.e., forward-directed stepping response to backward-directed postural perturbations) and aerobic exercise (cycling and treadmill) three sessions per week for two months.

Treatment Procedures

Balance rehabilitation program

Each postmenopausal woman in both groups (A & B) received a balance rehabilitation program in the form of fall-specific training program (i.e., forward-directed stepping response to backward-directed postural perturbations) 15 min per session, 3 sessions/ weeks for 4 weeks.

Aerobic exercise program

Each postmenopausal woman in both groups (A & B) received aerobic exercise (treadmill) for 30 min per session, 3 sessions / weeks for 4 weeks.

Before starting the treatment, complete explanation about what was going to be done during the treatment sessions and how to use the treadmill to be confident that the treadmill was safe for her.

Each training session started with five minutes of warm-up walking at comfortable speed. Then, the speed was gradually increased to the level of workload at which participants felt 'somewhat hard' (12-14 on Borg scale) for two 15 minutes sessions with one to two minute break in between (total 30 minutes) followed by a five minute cool down period.

Electronic balance board

Group (A) participated in electronic balance board program for 15 min per session, 3 sessions /week for 4 weeks.

• When post-menopausal woman step on the balance board and begun to play, an avatar appears on the screen and imitated the postmenopausal woman's movements.

• During this session, the system gives the patient auditory feedback with a positive reinforcement when the patient accomplishes his/her goal throughout the sessions and a different reinforcement when the patient performs an incorrect action.

• Activities included balance games (e.g. Tablet tilt, Soccer heading, Ski Slalom) in which the postmenopausal woman had to shift her weight laterally on the balance board. When she performed each program, she had to move her center of gravity without changing the position of her feet on the balance board.

• Postmenopausal women's score was continuously displayed on the screen at the end of each game and finally we calculate the final score and the final Game score give them motivation.

Outcome measures

Balance was evaluated by Biodex Balance System before and after the intervention in both groups. The stability index, AP index and ML index was recorded before and after the intervention.

Testing procedures

Balance was evaluated by Biodex Balance System before and after the intervention in both groups. The overall stability index, AP index and ML index was recorded before and after the intervention:

The woman weight and height were entered to control screen display located in front of the subject, the woman asked to leave hand rail when the test proceed, the woman was centered by informing her to stand on both feet, the test duration was set for 30 sec. through level (7), the test duration instructed to try to achieve a centered position on the platform to which is easy to keep the cursor on the visual feedback screen directly in front of the woman. Keeping the cursor in the center of screen grid meant that the platform was kept leveled beneath to woman's feet while standing in a comfortable up right position.

Statistical analysis

All statistical measures were performed via the Statistical Package for Social science (SPSS) program version 20 for windows. Descriptive analyses exhibited that the data were normally distributed and not violates the parametric assumption for the all measured dependent variables (A-P stability index, M-L stability index and overall stability index). Furthermore, testing for the homogeneity of covariance using Box's test shown that there was no statistically significant difference with p values of > 0.05. The box and whiskers plots of the tested variables were done to detect the outliers. Normality test of data using Shapiro-Wilk test was used, reflecting that the data was normally distributed for all dependent variables. All these findings helped the researchers to conduct parametric analysis. So, 2×2 mixed design MANOVA was used to compare the tested variables of interest at different tested groups and measuring periods. The alpha level was set at 0.05.

Results

As indicated by the independent t test, there were no statistically significant differences ($P > 0.05$) between subjects in both groups concerning age, weight, and height (Table 1).

Table 1. Demographic characteristics of patients in both groups

Characteristics	Group A (n = 15)	Group B (n = 15)	t-value	P-value
Age (years)	55.1 ± 2.63	56.75 ± 2.93	-1.871	0.069
Body mass (Kg)	79.45 ± 10.74	79.9 ± 11.47	-0.128	0.899
Height (cm)	162.4 ± 5.23	163.3 ± 3.27	-0.652	0.519
BMI (Kg/m^2)	30.08 ± 3.25	29.93 ± 4.07	0.124	0.902

Significant level is set at alpha level < 0.05

Statistical analysis using mixed design MANOVA analyzed forty patients assigned into two equal groups. It shown that there was statistical significance within subject effect (F = 219.725, p = 0.0001) and treatment*time effect (F = 18.959, p = 0.0001). As well as, there was no statistical significance between subject effect (F = 2.657, p = 0.063). Table 2 presents descriptive statistic (mean ± SD) and multiple pairwise comparison tests (Post hoc tests) of all investigated variables. In the same context regarding within subject effect, the multiple pairwise comparison tests revealed that there were significant decreases (p < 0.05) in the A-P stability index, M-L stability index and overall stability index in the post-treatment condition compared with the pre-treatment in both groups. Regarding between subject effects multiple pairwise comparisons revealed that there was no significant difference in the pre-treatment period between groups (A) and (B) in the all dependent variables (p > 0.05). However, the A-P stability index, M-L stability index and overall stability index decreased significantly in group (A) compared with group (B) in post-treatment period (p < 0.05).

Table 2. Descriptive statistics and multiple pairwise comparison tests (Post hoc tests) of the dependent variables for both groups

	Group A		Group B	
	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment
A-P stability index	3.75 ± 0.58	1.28 ± 0.4	3.4 ± 0.7	1.7 ± 0.49
M-L stability index	3.36 ± 0.97	1.02 ± 0.35	3.32 ± 0.53	1.72 ± 0.21
Overall stability index	4.74 ± 1.16	1.88 ± 0.42	4.66 ± 0.85	2.21 ± 0.5
Within groups (pre vs. post)				
p-value	**A-P stability index**	**M-L stability index**	**Overall stability index**	
Group A	0.0001*	0.0001*	0.0001*	
Group B	0.0001*	0.0001*	0.0001*	
Between groups (Group A vs Group B)				
p-value	**A-P stability index**	**M-L stability index**	**Overall stability index**	
Pre-treatment	0.0001*	0.0001*	0.0001*	
Post-treatment	0.0001*	0.0001*	0.0001*	

**Significant at the alpha level (p < 0.05).*

Discussion

Falls in elderly are considered of important public health concern. Since they occur frequently in people aged 65 and older, and constitute the main cause of hospitalization due to injuries in this age. Usually injuries following falls are complicated with loss of independence, disability, and even elevated mortality rates [24]. Women have a higher possibility of falls than men [25]. This may be caused by decreased levels of estrogen during menopause that impair protective reflexes [26]. Also women at this stage usually have different changes in many of their body composition like elevated body fat mass, decreased lean body mass and bone loss. At menopause, the sudden decrease of endogenous levels of estrogen is the believed cause for these changes. Researches claimed that the decline in lean body mass with age perhaps contribute to falls and their subsequent fractures. One third of females in their postmenopausal stage encountered at least one fall per year. Among numerous consequences, 5-10% of falls yield in a fracture and 80% of all non-spinal fractures in the elderly are caused by a fall [27]. Accordingly, the aim of our study was to analyze the effects of both aerobic exercise and electronic balance

board in enhancing balance in women in their postmenopausal stage. In the present study, results revealed improvement in balance in both post intervention groups when compared to pre intervention scores however significant improvement in balance in subjects treated with electronic balance board were recorded after treatment when compared to controls. Such observations agree with others [28], reported that evidence analysis show the great effect of training by virtual reality in the treatment of mobility and balance in the elderly. Also, the findings on the usage of virtual reality treatment for balance training and recovery seem to be hopeful and promising. The observed improvement in balance in this study is supported by other authors [29], who reported improvement in balance through four studies examining the effects of Wii-based exercise programs in comparison with no exercise indicating that Wii-based training may assist as a tool to enhance balance control and self-confidence in elderly, the result of this study is also in line with [30] who is stated that there is good evidence that appropriate exercise can improve balance and reduce falls in older people In this study, remarkable improvements were recorded in the electronic balance board group. Such observation may be attributable to that the system of Wii Fit encourages movement of the body mass center of individuals through stimuli provided via games. As said by the author, the bodily challenges are identical to those seen in Tai Chi, that is believed to decrease falls hazard. The system of Wii Fit adds benefits in both dynamic and static balance [30]. The program of Nintendo Wii Fit has the advantages to be simple and individuals can perform it at home. Additionally, this program could be a preference for services of public health to prevent and even treat falls because it has a lower cost if compared to other modalities as reported [31]. Another argument about the intervention program to prevent falling in old females found a surprise that reduced proprioception or neuropathy has only occasionally been mentioned as a cause of instability or falls. Studies by Nevitt et al. [32], Wolfson et al. [33] and Grisso et al. [34] found no significant associations between measures of impaired peripheral sensation and falls. In contrast, a strong association has been found between documented lower limb neuropathy and falls [35,36]. Disagreement on the effect of proprioception loss on falling appears to be due to the insensitivity of some assessments, or inability to detect anything less than marked sensation loss. Although the current study reveals objective data with statistically significant differences, there are some limitations. The main limitation of this study was short term effect. Therefore, longitudinal studies are needed to evaluate long-term effect.

Conclusion

At the end, it can be concluded that, in postmenopausal women, 12-week program of electronic balance board addition to aerobic exercises yielded significant improvement in balance when matched to aerobic exercises only.

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