Effects of Balance-based Training on Blood Pressure and Postural Control Capacity in Older Elderly
平衡模式訓練對老年人血壓以及姿勢控制能力之影響

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Abstract

Objective: The purpose of this study was to evaluate the effects of Wii Fit balance training or Pilates-based training intervention for 10-weeks on blood pressure levels and the postural control system in older elderly. Method: Sixty older subjects volunteered to participate in a Wii-Fit exercise group (n=18), Pilates-based training group (n=22), and control group (n=20). The Wii-Fit and Pilates-based groups have training intervention program 3 times per week for 10 weeks. Postural control capacity and resting blood pressure were measured before and after training program. Results: The results showed that there were no significantly changes on blood pressure and MAP data neither after in the Wii-Fit training nor in the Pilates-based training. The Sensory Organization Test (SOT) composite scores tend to increase after Wii-Fit and Pilates-based training intervention. Conclusion: The results illustrated that balance exercise intervention change the postural control, but there are no effects on resting blood pressure.

Key words: blood pressure, balance-based training, Sensory Organization Test.

摘 要

目的：本研究目的在探討進行10週以Wii-Fit電子平衡遊戲訓練或是皮拉提斯平衡訓練模式對老年人血壓調控以及姿勢控制能力之影響。方法：共有60位受試者完成試驗 (Wii-Fit組18人、皮拉提斯組22人、控制組20人)，其中Wii-Fit組與皮拉提斯組需進行為期10週、每週3次之平衡模式訓練，控制組則不做任何訓練介入，在10週前後所有受試者皆需進行血壓檢測，並以感覺統合測試進行平衡能力之評估；結果：在10週平衡運動介入前後，三組受試者的血壓(收縮壓、舒張壓)以及平均動脈壓都沒有顯著性差異；在平衡能力結果上，Wii-Fit組與皮拉提斯組內比較其平衡能力有提升的趨勢，其中Wii-Fit組的平衡能力得分量又高於皮拉提斯組。結論：本研究顯示單純平衡訓練對老年人的血壓狀況並不影響，但卻可以提升其身體姿勢性的平衡能力。

關鍵詞：血壓、平衡運動訓練、感覺統合測試

Introduction

Previous studies have reported on the diminishing postural control with advancing age due to declining vestibular, visual, and somatosensory system (Taube, Gruber, & Gollhofer, 2008; Whipple, Wolfson, Derby, Singh, & Tobin, 1993). In addition, both muscle mass and muscular output, also decline with age (Gillespie et al., 2003; Whipple et al., 1993). These ages' related factors may provide a diminished or inappropriate capacity to maintain postural control (Gu, Jeon, Kim, & Eun, 2005). Impaired postural control is associated with an increased risk of falling, and falls have been identified as a leading cause of injury-related morbidity and mortality in older people (Gillespie et al., 2003). Inactivity could be the start of a downward spiral due to decreased muscular strength, decreased postural stability, and thus a heightened risk of falling. Physical inactivity is also firmly established as an important cause of cardiovascular disease, which may show up in individuals as increased blood pressure (BP), blood glucose, blood lipids, body weight, and obesity (Takata et al., 2011). Arterial blood pressure, one of the most common cardiovascular risk factor, is a factor that may affect postural stability in elderly adults (Hausdorff, Herman, Baltadjieva, Gurevich, & Giladi, 2003). Previous studies reported that adults with hypertension had dizziness and vertigo more frequently (41.5%) than people with normal BP (21.3%) (Prasansuk, Siriyananda, Nakorn, Atipas, & Chongvisal, 2004). However, many clinical trials discovered that regular exercise programs can decrease cardiovascular risk factors such as blood pressure (systolic and diastolic blood pressure), body composition, and lipid profiles in adults and older adults (Dunn et al., 1997; Kawasaki, Sullivan, Ozoe, Higaki, & Kawasaki, 2011; Taylor-Piliae, Haskell, & Sivarajan Froelicher, 2006). Researchers also proved that physical activity interventions, or exercise, help to improve and prevent the decline of muscle strength, balance, and endurance, which are all risk factors for falls in the elderly (Ballard, McFarland, Wallace, Holiday, & Roberson, 2004; Gillespie et al., 2003; Opdenacker, Delecluse, & Boen, 2011; Van Roie et al., 2010). The ideal exercise intervention is a program which includes strength, endurance, and balance exercises (Ballard et al., 2004; Kolbe-Alexander, Lambert, & Charlton, 2006; Opdenacker et al., 2011). It is well known that balance training will improve postural control for adults (Cyarto, Brown, Marshall, & Trost, 2008; Shubert, McCulloch, Hartman, & Giuliani, 2010). However, there is not known if only balance exercise alone may also contribute to the reduction in cardiovascular risk factors, such as blood pressure levels.

The Wii Fit system is a form of interactive gaming that has also been used for wellness. Balance training with the Wii Fit system, which involves upper limb and lower limb movements, has been reported to be an effective program to improve balance, strength, flexibility, and fitness for adults and older adults (Gil-Gomez, Llorens, Alcaniz, & Colomer, 2011; Nitz, Kuys, Isles, & Fu, 2010). Recent studies also indicate that a Will Fit video game program, whose exercise routine meets the American College of Sports Medicine guidelines for cardiorespiratory fitness, can be as an effective activity for improving and maintaining cardiorespiratory fitness and metabolic responses for middle-aged and older adults (Guderian et al., 2010; Worley, Rogers, & Kraemer, 2011). However, the effect of Wii-Fit balance games on postural control and blood pressure responses in older people is still unknown.

Pilates is described as a training method combining Oriental and Western philosophies including yoga, dance, durability-strength training, and gymnastics, and are becoming popular as an intervention for increasing muscular fitness (von Sperling de Souza & Brum Vieira, 2006). More recently, the traditional elements of the Pilates methodology have been updated and incorporated into rehabilitation and fitness. Studies indicate that the Pilates training program was effective in improving abdominal strength and upper spine posture, as well as stabilizing core posture and body flexion movements (Emery, De Serres, McMillan, & Côté, 2010; Phrompaet, Paungmali, Pirunsan, & Sitilertpisan, 2011). Cruz-Ferreira et al. (2011) demonstrated that 6 months of Pilates-based mat exercises improved total physical self-concept and perception of health status in adult women. The Wii Fit system and Pilates exercise, which can improve balance, strength, flexibility, and fitness, have become very popular recently. However, there are no studies indicated these training program's effects on cardiovascular risk factors such as blood pressure and postural control, especially in older adults. Furthermore, previous studies has focused on the long-term training program in young people, there are few study to evaluate the short-term effects on the postural control capacity and cardiovascular risk factor in older subjects. Therefore, the purpose of this study was to evaluate the effects of 10 weeks Wii Fit system or Pilates-based training program intervention on blood pressure levels and the postural control system.

Methods

Subjects

The criteria of participants were as follows: (1) community dwelling older people age 65 years or older; (2) able to communicate with others; and (3) independent in self-care of life. Demographic data included the subject's age, gender, and activities of daily living were collected. Participants were excluded if they had a previous history of peripheral or vestibular abnormalities or had experienced 2 or more documented falls in the previous six months. Additionally participants were excluded if they were unable to ambulate without an aide. Subjects were assigned to participate in either the Wii-Fitness exercise or a Pilates-based training program intervention 3 times per week for 10 weeks, and there were fifty healthy subjects volunteered to finish our study (Wii-Fitness, n=18; Pilates group, n=22). Twenty-two older subjects who did not receive training program were also investigated as a control group (control group, n=20) in order to compare the blood pressure and postural parameters with training elderly groups.

Experimental procedure

All participants were assessed their personal characteristics, postural control capacity, and resting blood pressure before and after 10 weeks training intervention. Blood pressure was measured on the right arm using a fully automatic blood pressure manometer (SunTech Tango, Medical Inc., USA), when participants placed in a sitting position for 5 minutes. Systolic (SBP) and diastolic (DBP) blood pressure were measured two times at 1-mintue intervals, and the mean of two measurements was used in the analysis. Mean arterial pressure (MAP) and heat rate were also collected.

The Sensory Organization Test (SOT) protocol objectively identifies abnormalities in the participant's use of the three sensory systems that contribute to postural control: somatosensory, visual and vestibular (NeuroCom, 2008). During the assessment, inaccurate information is delivered to the participant's eyes, feet and joints through "sway referencing" of the visual surround and/or the support surface. Each participant was fitted with a padded harness that is attached to the device's framework in order to protect him/her from a fall. Each condition was performed three times. Results from the SOT were used for all comparisons of the participants' postural stability. Effective use of the individual's sensory inputs is determined from the overall pattern of scores on each of the six conditions. The equilibrium composite score quantifies the postural stability under each trial for all conditions. It is the weighted average of scores on all sway conditions and characterizes an individual's overall level of performance. In addition, individual equilibrium scores on all conditions were compared to extreme responses under varying movement and sway referenced conditions. The resulting scores for composite score range from 0–100, with 100 indicating no anteroposterior sway.

Training intervention

The Wii exercise group performed exercises three days per week, 45 minutes per day using a Wii-balance board and weighted vests for 10 weeks. The intervention included a bout of walking for 5 to 10 minutes at a time, and Wii-Fit games with wearing the weight vest.

The weight of the vest began at two pounds, and was increased two additional pounds every two weeks until it reached the maximum of ten pounds. Participants were only allowed to wear the vest while playing the Wii Bowling or Wii boxing games. The Wii-Fit Plus balance board was also integrated into the program. Games played were focused on balance and body weight shifting. Participants did not wear the weighted vest while on the balance board. Every participant using the Wii balance board wore a gait belt in order for assistants to support them through the ensuing challenges to postural control.

The Pilates group also experienced a 45 minute class three times per week. The basic principles of the Pilates exercise which include breathing, pelvic placement, rib cage placement, scapular movement and stabilization, and head and cervical placement. The Pilates inspired exercises utilized a variety of Therabands (Hygenic Cooperation, Akron, OH, USA) and body or extremity weight as a resistive force. The 45 minute class began with breathing exercises emphasizing posterior and lateral expansion of the ribcage. Exercises were focused on quality over quantity in which participants addressed concentric as well as eccentric contractions. The exercise intervention includes 10-15 chair stands and calf raises while the instructor ensured proper form. Class ended with subjects stepping away from their chair transferring weight from one leg to the other while continually stabilizing through the core.

Statistical analyses

All data are expressed as mean± standard deviation (SD), and they were analyzed using SPSS 20.0 (SPSS, IBM Corporation, Somers, NY). The difference of variance before and after training in group was analyzed with ANOVA. The post hoc test of LSD was used to assess differences between groups. $P<.05$ was considered to be statistically significant.

Results

The characteristic data of the groups are outlined in Table 1. There was no significant difference in average BMI, height, age or weight among the groups at baseline ($p > 0.05$). There were also no significantly differences in mean BMI values after 10 weeks training intervention between groups.

Table 1. The subjects' characteristics at baseline (pre training) and after 10 week experimental period (post training).

	Wii-Fit group	Pilates group	Control group
Gender (Male/female), *n*	6/12, 18	14/8, 22	10/10, 20
Age (years)	73.7±5.1	75.1±6.2	75.2±4.1
Height (cm)	166.2±5.3	170.0±9.9	168.2±4.3
Body weight (kg)	4.1±14.5	78.8±15.5	75.1±12.5
BMI (kg/m^2)			
Pre-training	25.7±4.9	27.3±5.0	25.6±6.1
Post-training	25.3±4.9	27.5±4.6	26.6±5.1

Note: Values are mean ± SD.

Effects of training intervention on blood pressure

The effects of the intervention on resting blood pressure levels are shown in Table 2. There were no significant differences between the groups for any of the fitness components or time. However, the systolic blood pressure was a small decrease in Wii-Fit group after training.

Table 2. Levels of blood pressures followed 10 week exercise intervention.

	Wii-Fit group	Pilates group	Control group
SBP (mmHg)			
Pre-training	142.2±12.9	137.8±19.1	138.4±13.4
Post- training	137.7±10.7	138.1±18.8	145.4±13.4
DBP (mmHg)			
Pre-training	70.4±8.1	70.3±9.9	71.3±7.9
Post- training	71.4±9.4	71.4±7.9	73.3±7.8
MAP (mmHg)			
Pre-training	86.1±18.6	91.8±13.7	91.6±12.7
Post- training	92.5± 8.1	93.0± 9.5	93.6±10.7
HR (b/min)			
Pre-training	68.8±13.7	71.7±11.8	72.1±10.8
Post- training	72.8±14.2	70.1±11.3	73.7± 9.6

SOT scores

As shown in Figure 1, the mean SOT composite score in the Wii-Fit group and Pilates group were significantly increased after 10 weeks exercise intervention (pre vs. post exercise, $P<0.05$), and it was no significantly change within the control groups. Furthermore, Wii-Fit and Pilates exercise increase the SOT composite score by 10.5% and 1.5% respectively. The results suggest that participation in those two balance exercise programs have positive impact on postural control outcomes.

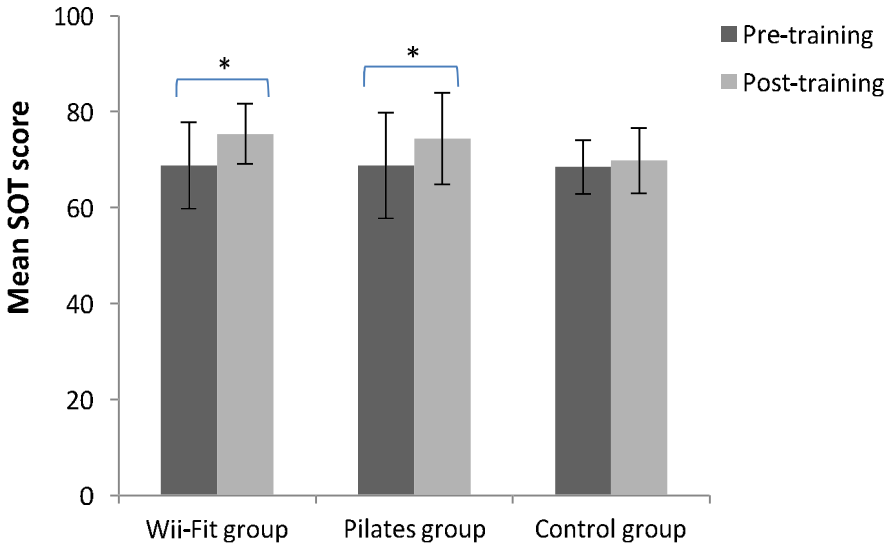

Figure 1. Mean composite Scores on the NeuroCom Sensory Organization Test (SOT) before and after 10-weeks of Wii-Fit, Pilates-based training, and control groups. * $p < 0.05$ when compared to the pre-exercise value in group.

Discussion

This study examined the blood pressure and postural control capacity after 10 weeks of Wii-Fit training and Pilates-based training intervention. The results demonstrated that there were no significantly changes on blood pressure and MAP data neither in the Wii-Fit training nor in the Pilates-based training group. The SOT composite scores increased after training intervention both two groups. However, Wii-Fit training tends to improve balance capacity.

The result of this study was shown that blood pressure is not significantly change after 10 weeks of Wii-Fit exercise and Pilates-based training intervention. However, the average BP at rest was 142/70 before Wii-Fit exercise intervention. After 10 weeks of Wii-Fit exercise the average resting BP was 137/71, with a decrease of 4.4 mmHg in SBP, and a small increase of 0.9 mmHg DBP. After Pilates-based training the average resting BP was 139/71, which an increase of 1.3 mmHg in SBP, and a small increase of 1.1 mmHg DBP. Lower

the blood pressure has been considered to decrease the incidences of stroke, hypertension, and cardiovascular disease. Previous studies have reported reductions in mean SBP from 7 to 16 mmHg, and in DBP from 2 to 9 mmHg, among some exercise intervention for adults, such as in Tai Chi exercise programs (Han et al., 2010; Taylor-Piliae et al., 2006) and aerobic training intervention (Cornelissen, Verheyden, Aubert, & Fagard, 2010; Kawasaki et al., 2011).

The BP results in our study is not similar with others studies, because the training program design is not the same. Some studies may focus on the training intensity in the various ranges 30 to 90% maximal oxygen uptake (VO2max) or combination with resistance training (Kawasaki et al., 2011; Serber et al., 2016; Takata et al., 2012). However, the training programs in our study focused on the balance training intervention. In another reason that caused the resting BP responses unchanged in this 10-weeks training duration is the short-term training period not causing any physiology adaptation. Some meta-analyses conclude BP decrease significantly in the response in exercise training (training type, intensity, and training period) (Pescatello et al., 2004). The effect of training on BP and MAP was quite differences among individual studies, which may reflect differences in baseline BP, demographic characteristics, inadequate controls, BP assessment limitations, and diseases (Le, Mitiku, Sungar, Myers, & Froelicher, 2008; Santschi, Chiolero, Burnand, Colosimo, & Paradis, 2011).

The SOT is a dynamic posturography assessment tool, and it is known that SOT score can comprehensively evaluate dizziness in subjects with respect to their somatosensory, vision, and vestibular functions. SOT score can also be beneficial to plan and monitor a course of postural control in adults with balance capacity (NeuroCom, 2008). In previous studies has shown that functional mobility of older adults has correlated with stance stability to various extents (Nocera, Horvat, & Ray, 2009; Tang, Moore, & Woollacott, 1998). Following the intervention in this study, results indicated no statistical difference between individuals with Wii-Fit training and Pilates-based training group ($P>0.05$). However, the percentage change of SOT score is higher in the Wii-Fit training than in the Pilates-based training. It illustrate that the exercises in this intervention, particularly in the Wii-Fit training, was benefit to improve stance stability and balance capacity.

Limitations and future research directions

This study has some limitations. This study design allowed evaluating heart rate variability without the confounding effects of drugs, including β-blockers, which may interfere with autonomic modulation. On the other hand, the sample size is smaller in Wii-Fit group than in Pilates-based training group, the subject's personal variation may affect the results.

Conclusion

The results from our study suggest that there were no significantly changes on blood pressure and MAP levels neither in the Wii-Fit training nor in the Pilates-based training in adults. But the postural control by SOT score were increase after training intervention, especially with Wii-Fit balance training intervention. These results provide evidence that balance training may be a useful tool to improve postural control in the adult, even though the blood pressure is not change individuals.

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