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CASE SERIES

Whole-Body Vibration Improves Functional Mobility, Flexibility, and Relative Risk for Falling in the Assisted Living Elderly: A Case Series

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ABSTRACT

Study Design: A randomized double blind repeated measures, case series study of whole body vibration (WBV) in the assisted living elderly. **Background:** A single exposure to WBV has been shown to have benefit with respect to muscle activity, strength, balance, and power in some studies while other studies have found no benefit. Its overall effectiveness is unknown due to the conflicting findings reported in the literature. **Case Description:** Six subjects (5 female, 1 male; mean age = 85.4) in an assisted living community volunteered to participate. Subjects were exposed to a single bout of WBV at 0, 2, 20, and 26 Hz. Dependent variables including timed get up and go, chair sit and reach, one-legged stance time, and counter-movement jump were collected ten minutes prior, and two, twenty, forty, and sixty minutes after exposure. Published times for predicting falls using the timed up and go test and one-legged stance time were used to determine the number of outcome measures predicting falls prior to WBV. This was then compared to the number of outcome measures that predicted falls after exposure to determine any change.

Outcomes: WBV had no statistically significant effect on mobility in the elderly. However, trends suggest mean timed get up and go may improve after 20 Hz and 26Hz. Mean chair sit and reach showed minimal improvement with time bilaterally following all frequencies of WBV. No trends were found for one-legged stance time and counter-movement jump. The fall risk assessment suggested improvements following 2 Hz of WBV, but findings were not significant. **Conclusion:** WBV had no significant effect on mobility in the assisted living elderly. Further research with larger sample size would be beneficial.

Background

Whole-body vibration (WBV) is becoming a popular modality used to improve power, muscle activity, strength, gait speed, balance, and flexibility¹⁻⁶. Documented benefits in older adults include improvement in balance^{1, 3, 7}, strength^{1, 3}, power⁶, and reduction in fall risk in older adults⁸. The risk of falls in the elderly is associated with muscle weakness and impaired balance⁹. In

2006 it was reported that 31% of all new admissions into nursing homes across the United States experienced a fall within the first thirty days¹⁰. Ten percent of all falls result in a major injury, of which 1% are hip fractures and 5% are other fractures⁹. It is estimated that treatment for hip fractures costs \$14 billion annually and that one of every five people who break their hip die within a year.¹¹

The purpose of this study was to investigate the effects of acute WBV on mobility, balance, flexibility, and power in the assisted-living elderly population. Time of exposure to WBV can be defined as acute or chronic exposure. Acute exposure to WBV is identified as exposure lasting less than a single day. Chronic WBV describes an intervention with repeated exposure taking place over a course of multiple days, weeks, or months. The secondary purpose of this study is to calculate the effect of acute WBV on fall risk

A possible explanation for the impact WBV has on muscle performance in relation to power, strength, and balance is through the tonic vibration reflex in which mechanical vibration stimulates muscle spindles that result in the activation of extrafusal muscle fibers through Ia afferents and α -motor neurons¹². Collectively, there is agreement that WBV does not induce dangerous effects on elderly subjects' balance and postural control. It has been safely administered as part of a long-term intervention program with no adverse effects.¹³

A few studies to date have examined the immediate benefit of a single session of WBV^{2, 4, 14, 15}. Acute WBV of 30 Hz improved jump height during the countermovement jump of athletes². Acute exposure to a frequency of 26 Hz improved peak torque of the hamstrings and quadriceps muscles during isokinetic testing of active males following an acute exposure¹⁴ as well as one-legged stance time in healthy elderly subjects⁷. Merriman et al⁴ found significant improvements in timed up and go and sit and reach following acute exposure to 2 and 26 Hz of WBV for healthy community-dwelling elderly. Torvinen et al¹⁵ found acute bouts of WBV of 15 Hz to 30 Hz to improve balance in young participants with improvements peaking at forty minutes following WBV. Additionally, chronic exposure to 20 Hz significantly improved timed five repetition

sit to stands in healthy elderly subjects³. While research for acute exposures of WBV in the geriatric population is still limited, the potential effectiveness of WBV to improve balance and mobility is promising. These findings were used in selection of frequency parameters and for selection of the appropriate outcome measures used in this study.

Other research has shown that acute bouts of WBV have no effect on muscle power^{16, 17}. Likewise, some chronic WBV studies have reported no impact on balance or muscle power^{17, 18}. When WBV did demonstrate improvements in power, benefits were not lasting and could not be detected sixty minutes following exposure¹⁵. Therefore this study measures outcomes for up to sixty minutes following exposure.

Time of exposure for acute studies also varies tremendously in the number of intervals and the length of a single interval. Exposures were as short as 50 seconds⁷ and as great as 6 minutes of total exposure in one session¹⁷. Both exposure times showed benefit.

This extensive review of the literature was used to select the parameters for this study. Parameters include machine type, amplitude, frequency, time of exposure, and outcome measures. Outcome measures were valid measurements of mobility, balance, power, and flexibility in the elderly population. The Timed Get Up and Go test (TGUG) has been validated as an objective mobility measurement with this population by Podsiadlo and Richardson¹⁸. One-Legged Stance test (OLST) is a valid measure to assess postural steadiness and is a logical measure of balance¹⁹. The test has a high specificity in identifying non-fallers¹⁹, and momentary balance in a single limb stance position is essential for activities of daily living such as dressing. Countermovement jump (CMJ) can be used to measure peak power and has been found to be a reliable

and sensitive measure of mobility performance in frail patients²⁰. The CMJ has a significant correlation with power produced during a sit to stand suggesting it is a strong predictor of disability²⁰. Using the Chair Sit and Reach test (CSR) to measure flexibility is supported by the American College of Sports Medicine Guidelines.²¹

This pilot study systematically investigates the acute effects of different frequencies of WBV on mobility, balance, flexibility, and power in the assisted-living elderly population. Calculated fall risk will be determined before and after WBV to determine if the intervention is effective enough to influence a change in fall risk. We hypothesize mobility, balance, flexibility, power, and fall risk will improve following a single bout of WBV at 0, 2, 20, or 26 Hz. The findings of this study will be used to determine the best parameters to use in future larger studies in older adults.

Case Description

Subject recruitment occurred at 10 Wilmington Place, a local assisted living facility. Subjects had to be sixty-five years of age or older, able to comfortably walk 150 feet without an assistive device, and score at least a 24 on the Mini Mental State Exam to be included in the study. Subjects were excluded if they had a major acute illness, current infectious disease, uncontrolled diabetes, neuromuscular disease, joint replacement, pacemaker, or implant due to the contraindications of WBV. Six subjects from an assisted living facility (1 male, 5 females, mean age = 85.4 years) met the requirements for the study. All subjects provided written informed consent to participate.

Subjects were exposed to one randomly assigned WBV frequency (0, 2, 20, or 26 Hz) each testing day (Table 1). There were

three testing days each at least one week apart. The subject wore a gait belt throughout testing and “cast” shoes on the WBV platform. Subjects were asked to stand on the Maxuvibe oscillating platform with feet shoulder width apart (Figure 1). They were exposed to four thirty-second bouts of WBV each separated by a sixty-second standing rest break on the platform. Subjects and testers were blinded to the WBV frequency used. TGUG, OLST right, OLST left, CMJ, CSR right, and CSR left were recorded ten minutes prior to exposure to determine a baseline measure for that day. Then two trials for each outcome measure were collected at two minutes, twenty minutes, forty minutes, and sixty minutes following WBV exposure (Figure 2). The two trials were averaged together.

Averages of the two trials were used in the statistical analysis which was performed using a multivariate general linear model in SPSS 19.0 with all dependent variables entered into one model with time post-WBV and frequency. The estimated marginal means reported the mean response for each frequency and time interval following exposure to WBV. Only four subjects completed the study, therefore intention to treat was included in the statistics.

To determine whether risk for falls was reduced following a single exposure to WBV published reference ranges for predicting falls were used for the timed up and go test and one-legged stance time. Outcome measures were compared prior to exposure and after exposure to the published values (Table 2). Outcomes were dichotomized into whether or not the subjects met the cutoff points or not for fall risk. For example, four subjects participated in data collection for 2Hz. Before WBV 4 outcomes indicated a risk for falls and this measure is used as the base line for 2 Hz. Two minutes after WBV, four outcomes continued to suggest fall risk. However, at twenty minutes following WBV, only two

measures were suggested to be a fall risk. Then at forty minutes, three values indicated fall risk, and at sixty minutes two values indicated fall risk. The mean fall risk was determined over the sixty minutes of data collection (11 outcome measures met the cut off \div 4 data collections = 2.75). Mean risk after WBV was compared to the baseline risk to determine change (Table 3). Although TGUG and OLST are valid measures used to predict fall risk, this method of averaging mean fall risk over time has not been validated.

Outcomes

No adverse events were experienced by any participant. Due to a small sample size, none of the statistical analyses of the estimated marginal means were found to be significant. Although insignificant, possible trends can be inferred using the graphs created by the data output.

Compared to the baseline mean, TGUG scores were slower following 2 Hz but were slightly faster with 20 and 26 Hz (Figure 3). Fastest times for these frequencies were recorded forty minutes following exposure. This improvement in TGUG times may be due to a learning effect since it would have been the fourth time participants had performed the TGUG test that day. This improvement in time for the TGUG was not statistically significant for any frequency therefore it must be stated that single exposure to WBV had no effect on mobility. CSR scores showed small improvement bilaterally with time following all frequencies when compared to baseline (Figure 4). Results were not statistically significant. The small improvement over time for each WBV frequency is likely due to repetitive stretching occurring during each time of data collection resulting in improved flexibility.

Performance on OLST and CMJ was very challenging for many subjects. Zeros were recorded if the subject was unable to lift a foot off the ground without losing balance during OLST, or if subjects were unable to leave the mat for CMJ. Acute exposure to WBV revealed no trends or statistically significant change in balance measured by the OLST when compared to baseline. CMJ following acute WBV also demonstrated no change in power produced by the subjects.

Significant differences in fall risk could not be established. Two Hz of WBV was the only frequency that showed any improvement when compared to baseline. Twenty Hz of WBV had no change on fall risk and after 26 Hz mean fall risk was actually higher than the control suggesting a decline in performance. Although findings were not significant, results suggest that 2 Hz of WBV may be most beneficial frequency in reducing fall risk in the assisted living elderly.

Discussion

The subject population selected for this research was elderly subjects residing in an assisted living facility. Many had balance and mobility deficits similar to those that can be seen in any physical therapy clinic. Fall reduction in this population is crucial in the field of physical therapy. Many frequencies and treatment protocols have been used with this population throughout the WBV literature. We hypothesized mobility, balance, flexibility, power, and fall risk would have been positively changed following a single bout of WBV at 0, 2, 20, or 26 Hz. However, this study found single exposures of WBV to have no effect on the mobility, balance, power, and flexibility. Most importantly validated measures for fall risk were not affected after exposure.

Table 1. Subject Description

Subject #	Age	Gender	wt (lbs)	ht (in)	BMI	MM Score	WBV Frequencies Tested
1	80	F	123.4	61	23.31	27	26, 2, 20
2	82	M	270.6	72.6	36.09	27	2, 20, 0
3	89	F	191.8	61.8	35.30	25	2, 26, 0
4	81	F	167.6	64.5	28.32	28	26, 0, 2
5*	90	F	100.4	60.6	19.22	30	20
6*	93	F	107.4	58.3	22.21	29	26

Abbreviations: wt, weight; ht, height; MM, Mini Mental; F, Female; M, Male

* Subject dropped out of the study

Table 2. Fall Risk Reference Values

Outcome Measure	Fall Risk for Men	Fall Risk for Women
One Legged Stance Time ²²	< 1.6 sec	< 0.5 sec
Timed Get Up and Go ²³	> 10.0 sec	> 10.0 sec

Table 3. Fall Risk Assessment

Frequency	Before Exposure	2 min After	20 min After	40 min After	60 min After	Mean Outcome
2 Hz	4	4	2	3	2	2.75
20 Hz	3	3	3	3	3	3
26 Hz	1	2	2	1	1	1.5

Figure 1. Standing position on WBV platform with “cast” shoes on



Figure 2. A schematic presentation of the experimental procedures

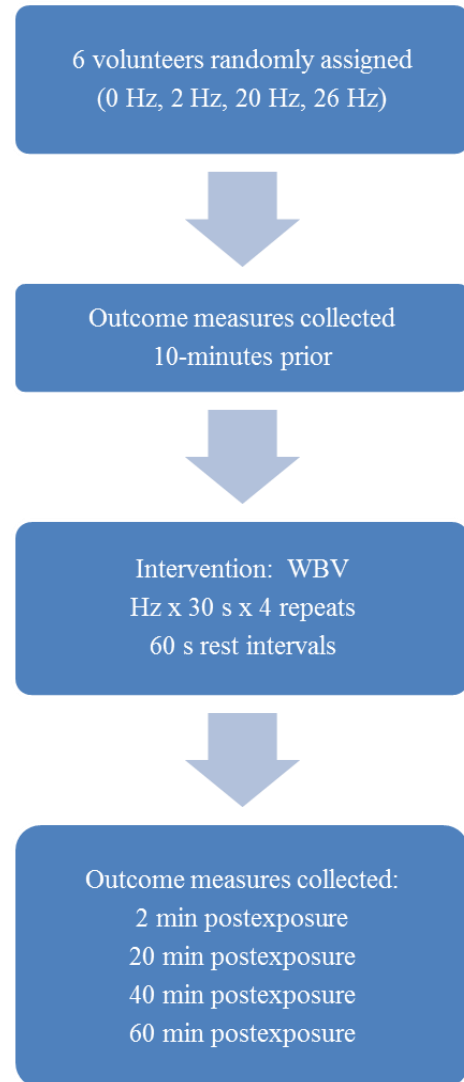
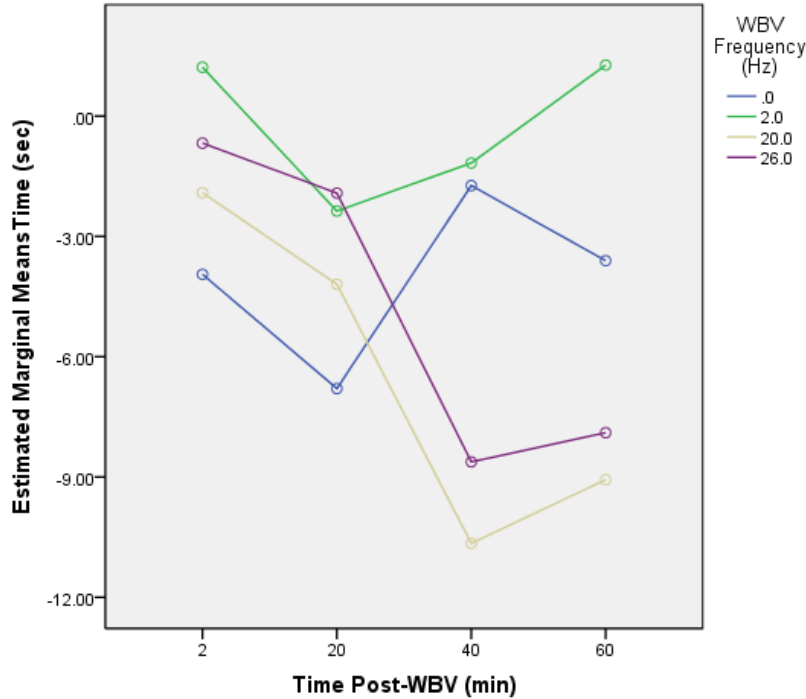
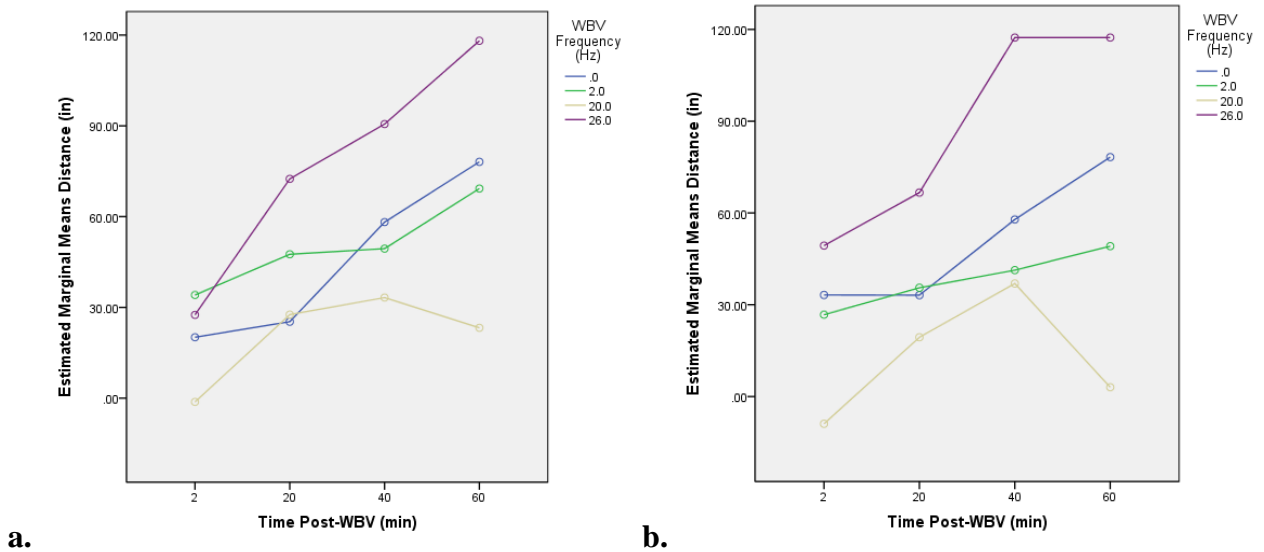


Figure 3. Estimated marginal means for TGUG after WBV



Line graph showing mean TGUG after WBV at 0, 2, 20, and 26 Hz at times 2, 20, 40, and 60 minutes post-WBV.

Figure 4. Estimated marginal means for Chair Sit and Reach (CSR)



Line graphs showing mean CSR trials on the right (a) and left (b) side at 2, 20, 40, and 60 minutes post treatments of 0, 2, 20, and 26 Hz.

A study performed by Furness et al.³ found that TGUG improved significantly in the elderly following repeated exposure to 20 and 26Hz. Intervention consisted of a total of 18 exposures. This finding suggests that the effectiveness WBV has on mobility may not be captured in the current study due to the limited exposure to the intervention. The same is true for OLST. Improvements in OLST with this age demographic following 26 Hz of WBV has been beneficial.⁷ Once again these results were found during a chronic study where each subject was exposed 24 times to the intervention before improvement was noted in balance. The research supporting WBV as an effective intervention for improving flexibility was also a chronic study consisting of three 15 minute exposures a week for a period of 8 weeks.¹ Acute exposure did not demonstrate these same results.

There is only minimal support for the effectiveness of acute WBV on improving power measured by the CMJ in the elderly population.⁴ Roelants et al. found power measured by CMJ better following 24 exposures to WBV in the elderly population once again supporting the general trend that repeated exposure is more beneficial.⁵ A majority of the participants in these studies were 60-70 years old. Participants in this study were much older with an average age of 85 years old possibly contributing to some of the difficulty experienced during the CMJ test.

Comparing fall risk before and after WBV has not been done before. The importance of implementing these standards to the research of physical therapy is crucial. Finding a statistically significant cause and effect relationship between an intervention and an outcome is important for all research in the field of physical therapy. More importantly however, is determining if the cause and effect relationship is enough to provide clinical improvement. Reduction in fall risk

determined by validated measure would be one important form of clinical improvement. Although the findings were not statistically significant in this study, this concept of assessing an intervention's effect on reducing falls is critical.

Study limitations include a small number of participants, the challenging nature of executing certain tests, and repeated measures testing. Many participants were interested in taking part in this research but the number of assistive-living residents who qualified for the study was limited due to the study's extensive exclusion criteria. Due to a small number of subjects in the study, only trends could be identified and the data produced no statistically significant differences. The outcome measures, CMJ and OLST, were chosen due to their use in previous literature. Participants of those studies were young and healthy or elderly community ambulators. As this study progressed, we found that the increased age and general deconditioning of these participants inhibited successful performance of the CMJ and OLST. Future studies with the assisted-living elderly should consider using other outcome measures such as the Romberg test to measure balance and the 5 repetition sit to stand test to measure muscle power. It is also possible that some improvements, specifically flexibility measured by the CSR, may have been produced due to the number of repetitions being performed. The method of assessing fall risk over time is not a validated method and would benefit from further testing. The ability to assess risk over time is important for the field of physical therapy in determining if interventions have a lasting effect on patient's mobility and ultimate reduction in falls.

Conclusion

In this study, acute WBV exposure was found to be safe with no adverse events in

older adults in an assisted living facility. WBV did not significantly improve mobility, flexibility, balance, or power. The study also suggests that 2 Hz of WBV may be beneficial in reducing falls in assisted living elderly, but again findings were not significant. This study included multiple limitations and further research with more participants would be beneficial.

References

1. Bissonnette D, Weir P, Leigh L, Kenno K. The Effects of a Whole-Body Advanced Vibration Exercise Program on Flexibility, Balance, and Strength in Seniors. *Phys Occup Ther Geriatr*. 2010;28(3):225-234.
2. Cormie P, Deane R, Triplett NT, et al. Acute effects of whole-body vibration on muscle activity, strength, and power. *J Strength Cond Res*. 2006;20:257-261.
3. Furness T, Maschette WE. Influence of whole body vibration platform frequency on neuromuscular performance of community-dwelling older adults. *J Strength Cond Res*. 2009;23(5):1508-1513.
4. Merriman HL, Braehler CJ, Jackson K. Systematically controlling for the influence of age, sex, hertz and time post-whole-body vibration exposure on four measures of physical performance in community-dwelling older adults: a randomized cross-over study. *Curr Gerontol Geriatr Res*. 2011:2011:747094.
5. Roelants M, Delecluse C, Vershueren SM. Whole-body vibration training increases knee-extension strength and speed of movement in older women. *J Am Geriatr Soc*. 2004;52:901-908.
6. Trans T. Effect of whole body vibration exercise on muscle strength and proprioception in females with knee osteoarthritis. *Knee*. 2009;16(4):256-261.
7. Rees SS. Effects of whole body vibration on postural steadiness in an older population. *J Sci Med Sport*. 2009;12:440-444.
8. von Stengel, S., et al. "[Effect of whole body vibration exercise on osteoporotic risk factors]." *Dtsch Med Wochenschr*. 2009;134(30):1511-1516.
9. Tinetti ME, Speechley M, Ginter SF. Risk factors for falls among elderly persons living in the community. *N Engl J Med*. 1988;319:1701-1707.
10. Leland NE, Gozalo P, Teno J, Mor V. Falls in Newly Admitted Nursing Home Residents: A National Study. *J Am Geriatr Soc*. 2012; 60: 939-945.
11. Fiechtner JJ. Hip fracture prevention: drug therapies and lifestyle modifications that can reduce risk. *Postgrad Med*. 2003;114(3):22-32.
12. Nishihira Y, Iwasaki T, Hatta A et al. Effect of an acute bout of whole body vibration stimulus and voluntary contraction on motoneuron pool. *Adv Exerc Sport Physiol*. 2002;8(4):83-86.
13. Carlucci F, Mazzà C, Cappozzo A. Does whole-body vibration training have acute residual effects on postural control ability of elderly women? *J Strength Cond Res*. 2010;24(12):3363-3368.
14. Siu PM, Tam BT, Chow DH et al. Immediate effects of 2 different whole-body vibration frequencies on muscle peak torque and stiffness. *Arch Phys Med Rehabil*. 2010;91:1608-1615.
15. Torvinen S, Kannus P, Sievänen H et al. Effect of a vibration exposure on muscular performance and body balance. Randomized cross-over study. *Clin Physiol Funct Im*. 2002;22:145-52.
16. Rønnestad B. Acute effects of various whole body vibration frequencies on 1RM in trained and untrained subjects. *J Strength Cond Res*. 2009;23(7):2068-2072.
17. de Ruiter C, Van Raak S, Schilperoort J, Hollander A, de Haan A. The effects of 11 weeks whole body vibration training on jump height, contractile properties and activation of human knee extensors. *Eur J Appl Physiol*. 2003;90(5-6):595-600.
18. Podsiadlo D, Richardson S. The Timed "Up and Go": A test of basic functional mobility for frail elderly persons. *J Am Geriatr Soc*. 1991; 39:142-148.
19. Thomas JI, Lane JV. A Pilot Study to Explore the Predictive Validity of 4 Measures of Falls Risk in Frail Elderly Patients. *Arch Phys Med Rehabil*. 2005;86:1636-1640.
20. Runge M, Rittweger J, Russo CR, Schiessl H, Felsenberg D. Is muscle power output a key gature in the age-related decline in physical performance? A comparison of muscle cross section, chair-rising test and jumping power. *Clin Physiol Funct Imaging*. 2004;24:335-340.
21. American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription*. 7th Edition. Lippincott Williams and Wilkins: Philadelphia; 2006.
22. El-Sobkey. Normative Value for One-Leg Stance Balance Test in Population- Based Sample Community-Dwelling Older People. *MEJSR*. 2011;7(4):497-503.
23. Boulgarides LK, McGinty SM, Willett JA, Barnes CW. Use of Clinical and Impairment-based Tests to Predict Falls by Community-dwelling Older Adults. *Phys Ther*. 2003;83:328-339.

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