International Journal of Applied Research

ISSN Print: 2394-7500
ISSN Online: 2394-5869
Impact Factor: 8.4
IJAR 2021; 7(1): 25-30
www.allresearchjournal.com
Received: 11-12-2020
Accepted: 15-01-2020

Purvi Shah
Post Graduate, Student of Neurophysiotherapy, SKN College of Physiotherapy, Narhe, Pune, Maharashtra, India

Parag Ranade
Head of Department of Neurophysiotherapy at SKN College of Physiotherapy, Narhe, Pune, Maharashtra, India

Rahul Bisen
Associate Professor of Neurophysiotherapy at SKN College of Physiotherapy, Narhe, Pune, Maharashtra, India

Corresponding Author:
Purvi Shah
Post Graduate, Student of Neurophysiotherapy, SKN College of Physiotherapy, Narhe, Pune, Maharashtra, India

Effectiveness of weighted torso balance training as an adjunct to conventional balance training on anticipatory and reactive balance in elderly individuals: An experimental study

Purvi Shah, Parag Ranade and Rahul Bisen

DOI: https://doi.org/10.22271/allresearch.2021.v7.i2a.8230

Abstract

Background: Most of falls in elderly occur in the event of unexpected external perturbations. For this reason the Anticipatory and Reactive balance should be emphasized upon. Weighted torso balance training (WTBT), though a novel concept, has proved its merit on improving balance in patients with neurological deficits like Stroke, MS etc. This study thus aims towards determining the effectiveness of WTBT on anticipatory and reactive balance in elderly individuals.
Subjects and Methods: In this comparative study, 36 patients aging 60-75 yrs and those meeting the selection criteria were selected. Anticipatory and reactive balance was measured using MiniBESTest. Subjects were randomly divided into two groups. Both groups received comprehensive balance training 3 times a week for 3 weeks. The experimental group performed the same exercises while wearing a weighted vest. MiniBESTest was administered post 3 weeks of exercises, data upon checking for normalcy, was analyzed using t-test.
Results: Within group analysis of 33 subjects (3 dropouts) for MiniBESTest and its 4 sub components showed statistically significant results ($p<0.01$) for both groups. Between group analysis showed that WTBT was statistically more significant ($p<0.0001$) than conventional balance training in improving anticipatory balance, reactive balance, sensory orientation and overall MiniBESTest scores.
Conclusion: This study concluded that WTBT as an adjunct to conventional balance training is more effective than conventional balance training alone in improving anticipatory and reactive balance in elderly individuals.

Keywords: Anticipatory balance, elderly, MiniBESTest, reactive balance, weighted torso, weighted vest

Introduction

India has earned the label of "the ageing nation" with 7.7% of its population over 60 years of age and it has been projected that by the year 2050 the population would reach 324 million [1]. Falls are found to be more common in women than in men [2]. Balance impairment is one of the most important risk factors contributing to falls which may result in dire consequences like fractures, long-standing pain, poor quality of life, social withdrawal, loss of confidence, head injuries and even deaths [3].

Balance or postural stability are the terms used to describe the dynamic processes by which the body's position is maintained in equilibrium [4]. Postural control or balance control, depends on sensory system (chiefly the proprioceptive system), visual system and vestibular system [4]. These systems undergo regressive changes with ageing [5]. With ageing, the sensitivity of the semi- circular canals decreases, number of hair cells in the sensory epithelium and number of first order neurons to the vestibular nucleus decline [6]. Initially, compensation occurs by reduction in the inhibitory system mediated by the cerebellum. Long term however, the range of response is greatly reduced. The result is that the elderly respond fairly well to slower ranges of head, gait, movement and posture but more rapid movements cannot be satisfactorily compensated for [6]. Ageing also has a profound impact on human visual function also affecting the functionality of many structures of the central nervous system that support visual system and performance, visually aided ADL's and vision related cognitive abilities [7].

Along with these changes, deterioration of joint proprioceptors leads to decrease in Joint position sense and an increase in movement detection threshold further leading to postural imbalance [8]. These physiological changes lead to an overall deterioration of Balance function. Ageing also impairs the connective tissue integrity surrounding the muscles, leading to subsequent leaking of troponin into the bloodstream which in turn leads to sarcopenia and reduced muscle contraction efficacy [9]. A large amount of literature also state that sway amplitude increases with ageing which lead to increased number of falls [9].

Crucial for maintaining dynamic postural control is a) reactive balance control (the ability to respond to unpredictable perturbations), b) the ability to anticipate to a perturbation. This can be achieved reactively and predictively by the central nervous system (CNS) [10].

Anticipatory and compensatory postural adjustments (APAs and CPAs, respectively) are two main postural mechanisms used by the CNS to maintain and restore balance during perturbations. The APAs are related to activation of the postural muscles in a feed-forward manner in preparation to body perturbations. The CPAs are associated with postural muscle activation in a feedback manner after a perturbation has happened. Small and/or predicted perturbations can only be counteracted with APAs. Whereas, with large and/or unexpected perturbations, CPAs are the main mechanism of balance restoration. These two types of postural adjustments interact to maintain equilibrium [11].

Numerous studies have shown that application of weights have been effective along with balance training to improve balance in patients with neurological deficits, but most of these studies have opted for applying weights to the extremities. Axial loading through the use of a weighted vest is relatively a newer concept. These vests are easy for elderly individuals to wear, provide well- distributed loading on the pelvic and lumbar spine regions, and permit the applied force to be increased gradually. WTBT has been found to show immediate improvements in postural control and general stability in patients with MS, post-menopausal women etc. [12-14]. Other noted improvements were seen in gait velocity, cadence, double and single limb support parameters etc.

Previous study by K. K. Horn et.al. analyzed the effect of WTBT on standing balance and falls during sensory organization test in participants with MS and found that with one time application reduced falls by 35% suggesting increased level of postural stability [12]. Another research by T. Roghani *et al*. studied the effects of aerobic exercise with and without a weighted vest on bone metabolism and balance in post-menopausal women with osteoporosis and found increased balance improvement in the weighted vest group adding merit to the concept of axial loading for enhancement of balance function [14].

Based on the possible positive effects suggested by previous studies, this study aims to study the effects of weighted torso balance training on anticipatory and reactive balance in elderly participants.

Methods

Subjects

Subjects were recruited by the means of purposive sampling. Around 50 subjects were screened and subjects those who met the following criteria were selected- a. Aged around 60-75 years b. were independent in activities of daily living c. were able to walk without the help of assistive devices d. had a minimum score of 23 on Mini Mental scale e. Had a normal BMI. Subjects were excluded if they had a. any cognitive impairment, b. any neuro-musculoskeletal condition interfering with the treatment c. history of vestibular disorders d. scored less than 21 on Berg Balance Scale. 36 subjects who met the screening criteria were selected for the study. They were explained about the study procedure and risks and benefits were discussed and written consents were obtained. Baseline MiniBESTest scores were recorded. They were randomly allocated into 2 groups by means of computer generated randomization. Group A was the experimental group receiving WTBT and group B received the conventional balance training protocol.

Intervention

The balance exercise protocol consisted of balance exercises under four domains- Static balance training, Dynamic balance training, Dual task training and functional balance training. Exercises were performed 3 times a week for 3 weeks. Subjects were asked to continue with their normal routines during the study and were encouraged to take 20 minutes walks on the days when the protocol was not being administered.

Table 1: Protocol [15-18]

Static balance training	Dynamic balance training	Dual task balance training	Functional balance training
Standing with wide BOS	Perturbation	Ambulation with verbal tasks	Stair climbing
Standing with narrow BOS	Sit to stand	Retrowalking with verbal tasks	Placing foot on an inverted cup
Tandem standing	Walking	Walking with a glass of water	Transfers
Unilateral standing (right)	Walking sideways	Walking while bouncing a ball	Picking objects from the floor
Unilateral Standing (left)	Braiding	Walking in a circle with therapist in the center	Catching and throwing ballwith the therapist
Moving and planting activities			

*progression was made based on individuals' performance

*assistance for any of the exercises, when needed was provided

*rest periods were provided every 15 minutes and as and when required by the participant. Group A (weighted torso balance training)

Subjects in the experimental group were asked to keep the weighted vest on during the entire duration of the session. For the first week 4% of the subjects' body weight was applied and was increased to 6% and 8% in the consecutive weeks. Application of weights was done in a strategic manner in a 2:1 extensors to flexors ratio so as to facilitate extensors and reduce the flexor torque. 2 subjects dropped out due to personal reasons in group A [14].

Group B (conventional balance training)

Subjects in the conventional balance training group were asked to perform the exercise protocol in a similar manner but without any external load. Group B has one dropout.

Fig 1: Inside view of weighted best

Outcome measure

The Mini Balance Evaluation Systems test is a 14 item scale with a total score of 28 points, divided among 4 categories- a. Anticipatory Balance, b. Reactive Postural control c. Sensory orientation d. Dynamic gait. The total MiniBESTest score as well as all four sub components' scores were compared within and between groups [19].

Data analysis

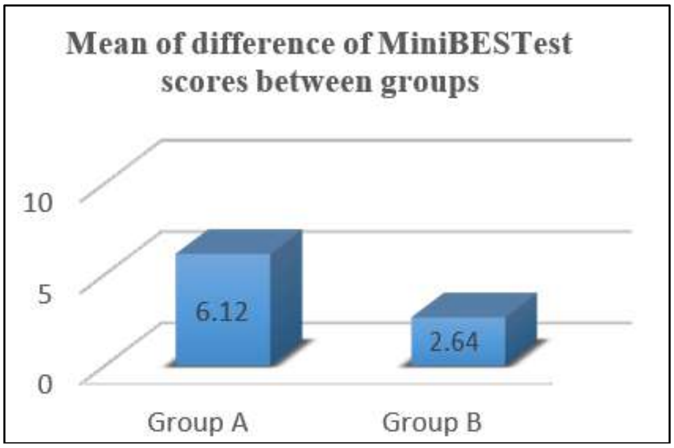
36 subjects were recruited for the study. Descriptive statistics were performed for age group, gender and environmental status. Data was analyzed using SPSS software version 27. MiniBESTest data was checked for normality in both groups and was found to be approximately normally distributed. Paired t-test was used for within group analysis and unpaired t-test was used for between group analyses.

Results

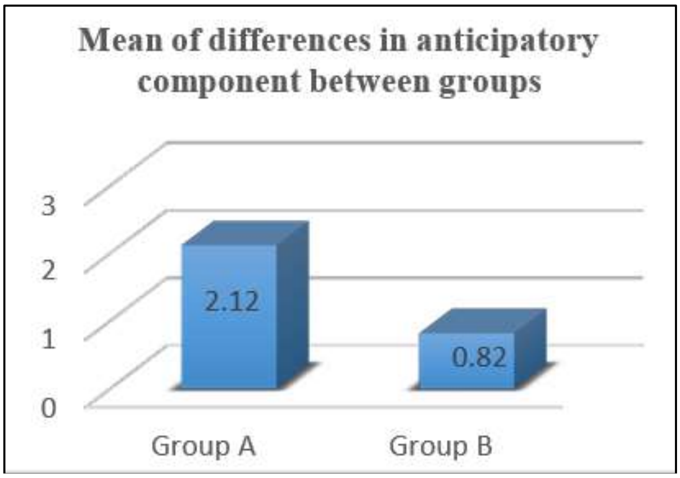
Out of the 36 participants 21 belong to the 60-65 age group, 7 belonged to 66-70 age group and 8 belonged to 71-75 age group. Out of the 36 participants 17 were females and 19 were males and 16 were institutionalized and 20 were community dwelling elderly.

Within group analysis using paired t-test: Within group analysis showed that both, WTBT and conventional balance training were statistically significant in improving all four balance components and the overall MiniBESTest scores ($p<0.05$).

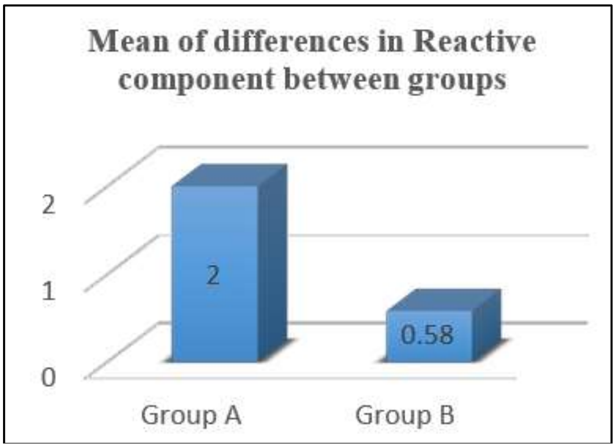
Between group analysis using unpaired t-test: Between group analysis suggested that WTBT showed significantly better results than conventional balance training in improving anticipatory balance, Reactive balance, Sensory orientation and overall MiniBESTest scores ($p<0.05$). Dynamic gait component improved equally in both groups suggesting that both groups were equally effective in improving dynamic gait (p=0.717).



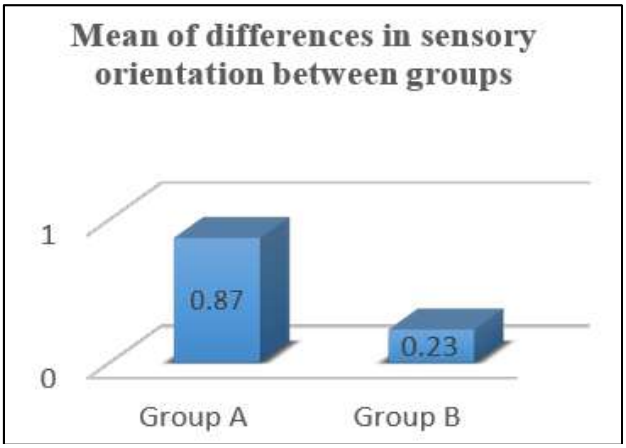
Graph 1: Between group MiniBESTest analysis. Group A scores had a mean of 6.12 ±1.5 whereas group be showed a mean of 2.64 ± 1.12 (*p*<o.o5)



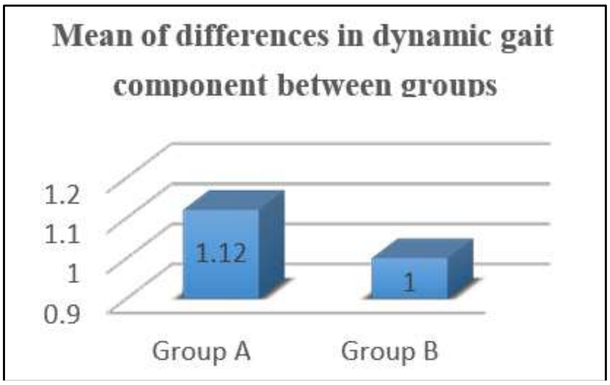
Graph 2: Between group Anticipatory component analysis. Group A mean was 2.12 ± 0.61 whereas, group B showed a mean of 0.82 ±0.72 ($p<0.05$)



Graph 3: Between group reactive component analysis. Group A mean was 2 ±0.81 Group B mean was 0.58 ±0.61 ($p<0.05$)



Graph 4: between group sensory orientation component analysis showed, group A mean 0.87±0.71, whereas group B was 0.23 ±0.43 ($p<0.05$)



Graph 5: Between group dynamic gait component analysis showed Group A mean 1.12 ±1.14, whereas group B was 1.00 ±0.79 ($p<0.05$)

Discussion

This study focused on a comprehensive balance training approach targeting improvement in static and dynamic balance inclusive of proactive and reactive strategies, balance and stability under dual task conditions and functional balance improvement. Combining balance training under all four domains and creating real life situation (e.g. Bed to chair transfers, dual task conditions, perturbation training, etc.) ensured balance improvements in both the groups in all four domains of Anticipatory Balance, Reactive balance, Sensory orientation and dynamic gait [15-17].

In this study, the experimental group has shown statistically significant improvements in balance over the conventional training group. This can be attributed to the beneficial effects of torso weighting and its role in enhancing postural control. A study by Gail Weidner assessed the effects of torso weighting on patients with cerebellar ataxia and found that the standing stability of patients with ataxia significantly improved with torso weighting. She attributed this to enhanced sensory input which improved perception of self-motion and position [20].

Sway increases when sensory inputs (e.g., vision, proprioception) are reduced or degraded, and this indicates the importance of feedback in limiting sway (Lief Johnnsen 2007). As a lot of literature regarding weighted vest seem to suggest that weighted vest, because they occupy large surface area of the trunk and the weights provide some means of compression, the sensory input to the brain is augmented. This augmented sensory input may increase the accuracy of postural feedback thereby limiting postural sway [21, 22]. Similar study testing the effects of weighted vest training on balance in paraplegics was conducted by Hyuk Jae Choi where he concluded that torso weighting improved stability and reduced sway excursion as compared to the non-weighted group [23].

Postural responses at the trunk as well as trunk proprioception are thought to be associated with balance and falls. An investigation found that, older adults with balance impairment demonstrate errors in trunk repositioning accuracy [24]. A study by song, Petrofsky et al. on balance in patients with diabetic neuropathy, indicated that improving trunk proprioception can effect balance even in the presence of impaired foot sensation. Therefore, use of torso weighting for improvement of trunk proprioception and in turn balance and postural control form important rationale [25].

Better Improvements in the experimental group more than the conventional training group could be a result of torso weighting which was related to augmenting sensory stimulus to the trunk where the weights were placed. Possible mechanisms of action can be joint compression, increased conscious awareness of the weighted area, or increased sensory input perceived by the central nervous system to modify motor output (Crittendon *et al.*, 2014; Widener *et al.*, 2009).

Joint and skin sensory input can also be thought to stimulate receptors that provide information to the central nervous system on the relative orientation and movement of the body in space in order to maintain or modify posture [26, 27].

Previous studies using torso weighting applied the weights in a symmetrical fashion to the anterior and posterior aspects of the trunk, whereas, this study focused on strategic weighting of the torso. A study by Rodolfo Parreria studied the effects of trunk extensor fatigue on balance and found that trunk extensor fatigue significantly impacted postural control. As the role of trunk extensor musculature is well established, the weights were strategically placed in a 2:1 Extensors to flexor ratio for the trunk. This also helped prevent excessive flexion torque, which is a main contributor to imbalance and falls [28].

Another study by Janet Shaw applying weighted vest found that the women in the weighted vest group were able to move more quickly and accurately in the medial-lateral direction after the exercise intervention and concluded that this may reduce fall severity when the hip is impacted by a lateral fall [13]. She proposed an increased feedback as one of the mechanisms by which WTBT helps improve balance.

An even more concrete evidence of the beneficial effects of weighted torso training on reactive balance was put forth by K. Fouad in his article where he tested reflex adaptations on treadmill walking with increasing body load. He studied compensatory reflex responses of the leg extensor muscles (Gastrocnemius Medial and lateral, Soleus) using EMG and studied their reflex adaptations during treadmill walking and concluded that axial loading reduced compensatory reaction time and increased stance phase duration during the gait cycle [29].

To the best of our knowledge, no other study has compared the effects of weighted torso balance training on sensory orientation in elderly, however, Study by Kristin K. Horn et. al compared the immediate effects of Torso weighting on Sensory organization test and concluded that torso weighting in a single session, showed significant improvements in postural stability and fall reduction in patients with Multiple Sclerosis [12].

Lack of positive effects of WTBT on dynamic gait can be explained with a study by Hyuk Jae Choi, wherein they administered WTBT for improving static and dynamic balance in paraplegics, while static balance improved, dynamic balance, which was assessed using Timed Up and Go (TUG) Test showed declining performance i.e. increased TUG duration, hinting towards a probable slowing of horizontal trajectory and gait [23].

Clinically, a vast number of participants from the experimental group in the study self-reported increased stability with increased weights each week. They claimed that it was easier to perform exercises like tandem standing, unilateral standing etc. with added weights to the weighted vest. They also reported feelings of instant improved posture upon donning of the weighted vest.

Conclusion

This study concluded that weighted torso balance training as an adjunct to conventional balance training has a better effect than conventional balance training alone in improving anticipatory and reactive balance in elderly individuals.

Clinical Implications: Weighted vest training is cost-effective, portable, easily available tool which has a wide variety of application in patients with neurological impairments like stroke, Multiple Sclerosis, paraplegics, etc. It can be used to improve anticipatory balance, reactive balance and sensory orientation in the elderly population. It can form the basis of prophylactic treatment protocols to prevent falls with increasing age in day to day clinics.

Future Scope of The Study: Similar studies can be carried out for elderly aging more than 75 years of age. EMG analysis to more accurately objectify the APAs and CPAs improvement can be undertaken.

Conflict Of Interest: None.

References

1. Mahajan A, Ray A. The Indian elder: Factors affecting geriatric care in India. Glob J Med Public Health. 2013;2:1-5.
2. Chauhan YS. Imbalance and falls in elderly: Review of Literature. Int. J. Otorhinolaryngol Clin. 2013;5(3):139-41.
3. Halvarsson A, Dohrn IM, Ståhle A. Taking balance training for older adults one step further: the rationale for and a description of a proven balance training programme. Clinical rehabilitation 2015;29(5):417-25.
4. Kisner C, Colby LA, Borstad J. Therapeutic exercise: foundations and techniques. Fa Davis 2017.
5. Pasma JH, Engelhart D, Maier AB, Schouten AC, van der Kooij H, Meskers CG. Changes in sensory reweighting of proprioceptive information during standing balance with age and disease. Journal of neurophysiology 2015;114(6):3220-33.
6. Al-Aama T. Falls in the elderly: spectrum and prevention. Canadian Family Physician. 2011;57(7):771-6.
7. Dagnelie G. Age-related psychophysical changes and low vision. Investigative Ophthalmology & Visual Science 2013;54(14):ORSF88-93.
8. Ribeiro F, Oliveira J. Aging effects on joint proprioception: the role of physical activity in proprioception preservation. European Review of Aging and Physical Activity 2007;4(2):71-6.
9. King GW, Abreu EL, Cheng AL, Chertoff KK, Brotto L, Kelly PJ *et al*. A multimodal assessment of balance in elderly and young adults. Oncotarget. 2016;7(12):13297
10. Welch TD, Ting LH. Mechanisms of motor adaptation in reactive balance control. PloS one. 2014;9(5):e96440.
11. Tajali S, Rouhani M, Mehravar M, Negahban H, Sadati E, Oskouei AE. Effects of external perturbations on anticipatory and compensatory postural adjustments in patients with multiple sclerosis and a fall history. International journal of MS care 2018;20(4):164-72.
12. Horn KK, Allen DD, Gibson-Horn C, Widener GL. Effects of torso-weighting on standing balance and falls during the sensory organization test in people with multiple sclerosis. International Journal of MS Care. 2018;20(2):68-75.
13. Shaw JM, Snow CM. Weighted Vest Exercise Improves Indices of Fall Risk.
14. Roghani T, Torkaman G, Movasseghe S, Hedayati M, Goosheh B, Bayat N. Effects of short- term aerobic exercise with and without external loading on bone metabolism and balance in postmenopausal women with osteoporosis. Rheumatology international 2013;33(2):291- 8.
15. Gardner MM, Buchner DM, Robertson MC, Campbell AJ. Practical implementation of an exercise-based falls prevention programme. Age and ageing 2001;30(1):77-83.
16. Abarghuei AF, Fadavi-Ghaffar M, Tousi S, Amini M, Salehi AR. Effect of cawthorne and cooksey exercises on balance and quality of life of 60 to 80 year-old individuals in Shiraz: A randomized clinical trial. Medical Journal of the Islamic Republic of Iran 2018;32:74.
17. Ribeiro AD, Pereira JS. Balance improvement and reduction of likelihood of falls in older women after Cawthorne and Cooksey exercises. Brazilian journal of otorhinolaryngology 2005;71(1):38-46.
18. Melzer I, Kurz I, Shahar D, Oddsson LI. Do voluntary step reactions in dual task conditions have an added value over single task for fall prediction? A prospective

study. Aging clinical and experimental research 2010;22(5-6):360-6.
19. Potter K, Brandfass K. The Mini-Balance Evaluation Systems Test (Mini-BESTest). Journal of physiotherapy 2015;61(4):225.
20. Widener GL, Conley N, Whiteford S, Gee J, Harrell A, Gibson-Horn C *et al*. Changes in standing stability with balance-based torso-weighting with cerebellar ataxia: A pilot study. Physiotherapy Research International 2020;25(1):e1814.
21. Johannsen L, Wing AM, Hatzitaki V. Effects of maintaining touch contact on predictive and reactive balance. Journal of neurophysiology 2007;97(4):2686-95.
22. Winter DA, Prince FR, Frank JS, Powell CO, Zabjek KF. Unified theory regarding A/P and M/L balance in quiet stance. Journal of neurophysiology. 1996;75(6):2334-43.
23. Choi HJ, Kang HJ. Study of gait using weighted vests on balance with paraplegic patients. Journal of exercise rehabilitation 2017;13(3):348.
24. Goldberg A, Hernandez ME, Alexander NB. Trunk repositioning errors are increased in balance-impaired older adults. The Journals of Gerontology Series A: Biological Sciences and Medical Sciences 2005;60(10):1310-4.
25. Song CH, Petrofsky JS, Lee SW, Lee KJ, Yim JE. Effects of an exercise program on balance and trunk proprioception in older adults with diabetic neuropathies. Diabetes technology & therapeutics 2011;13(8):803-11.
26. Crittendon A, O'Neill D, Widener GL, Allen DD. Standing data disproves biomechanical mechanism for balance-based torso-weighting. Archives of physical medicine and rehabilitation 2014;95(1):43-9.
27. Widener GL, Allen DD, Gibson-Horn C. Randomized clinical trial of balance-based torso weighting for improving upright mobility in people with multiple sclerosis. Neurorehabilitation and neural repair 2009;23(8):784-91.
28. Vincenzo JL. The Effect of Balance-Based Torso-Weighting on Mobility, Gait, Balance, Postural Control, and Falls Efficacy in Mobility Limited Older Adults.
29. Fouad K, Bastiaanse CM, Dietz V. Reflex adaptations during treadmill walking with increased body load. Experimental brain research 2001;137(2):133-40.