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ACUTE EFFECTS OF NINTENDO WII FIT ON BALANCE IN YOUNGADULTS: A RANDOMIZED TRIAL

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Abstract

To investigate the effects of Nintendo Wii Fit balance board on young adults' balance. This experimental randomized trial included 98 participants. The participants were randomly divided into two groups, the control (54) and experimental group (44). The control group received no intervention, and was used to give reliable data to be compared with the data from the experimental group. The experimental group on the other hand played the "Table Tilt" game on the Nintendo Wii balance board. The two tests used to observe the effect of the balance board on balance were unipedal and bipedal stance tests by using Biodex stability system (BBS). These tests were performed before and after the program to study the difference. In both groups, there was a significant reduction ($p < 0.05$) in Double Leg Stance Stability (DLSS), Dominant Single Leg Stance Stability (DSLS), and Non- Dominant Single Leg Stance Stability (NDSLS) in the post treatment condition compared with the pretreatment. Moreover, there was a significant improvement ($p < 0.05$) in balance in favor of the study group for the Double Leg Stance Stability. However, there wasn't a significant difference ($p < 0.05$) between the two groups in the Dominant Single Leg Stance Stability (DSLS), and the Non-Dominant Single Leg Stance Stability(NDSLS)

Keywords

Balance, Nintendo Wii, Video game, Young adults

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ABSTRACT: *To investigate the effects of Nintendo Wii Fit balance board on young adults' balance. This experimental randomized trial included 98 participants. The participants were randomly divided into two groups, the control (54) and experimental group (44). The control group received no intervention, and was used to give reliable data to be compared with the data from the experimental group. The experimental group on the other hand played the "Table Tilt" game on the Nintendo Wii balance board. The two tests used to observe the effect of the balance board on balance were unipedal and bipedal stance tests by using Biodex stability system (BBS). These tests were performed before and after the program to study the difference. In both groups, there was a significant reduction ($p < 0.05$) in Double Leg Stance Stability (DLSS), Dominant Single Leg Stance Stability (DSLS), and Non-Dominant Single Leg Stance Stability (NDSLS) in the post treatment condition compared with the pretreatment. Moreover, there was a significant improvement ($p < 0.05$) in balance in favor of the study group for the Double Leg Stance Stability. However, there wasn't a significant difference ($p < 0.05$) between the two groups in the Dominant Single Leg Stance Stability (DSLS), and the Non-Dominant Single Leg Stance Stability(NDSLS)*

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1. INTRODUCTION

Balance is the ability to return the center of mass (COM) within the base of support (BOS) in order to maintain body equilibrium against disturbances (Alexandrov et al., 2005). A proper and functional balance system is of crucial importance. This is true for several reason, as balance allows humans to function properly during motion, maintain accurate orientation with respect to gravity, detect direction and speed of movement, and make automatic postural adjustments to maintain stability in different conditions (Shumway-Cook and Woollacott, 2001). Moreover, postural balance is important in allowing humans to perform tasks in their daily lives.

Balance during erect standing is achieved by the following process: an external force caused by the floor reaction force and the body weight is applied to the joint; this external moment must be offset by an equal internal force. This internal force is produced by surrounding muscles and non-contractile connective tissue, which keep the center of mass relative to the joint axis (Oatis, 2008).

As a normal process of biological aging, body sway increases due to the decline of the sensory systems, diminished muscle strength, decreased muscle volume and mass, loss of muscle fibers, alterations in the motor units, and changes in posture. The ability to maintain stance is optimal between the ages of 25 and 60 years (Fujita et al., 2005). To maintain normal stance and to safely perform the majority of activities of daily living, individuals rely primarily on proprioceptive and cutaneous input. The muscle spindles play an important role in proprioception. The mechanoreceptors provide the nervous system with information about the muscle's length and velocity of contraction, thus contributing to the individual's ability to discern joint movement and position sense. The muscle spindles also provide afferent feedback that translates stimuli to appropriate reflexive and voluntary movements (Shaffer and Harrison, 2007).

Owing to its low cost, ease of use, and portability, the Nintendo Wii is being used in physical therapy clinics and skilled nursing facilities as a popular substitute for the expensive and complicated force plates to improve dynamic strength and balance, and postural equilibrium changes throughout life span (Bainbridge et al., 2011).

The Nintendo Wii Fit is an interesting example of a new exercise choice that could be used to improve strength, flexibility, fitness, postural stability, and general well-being. Using this device, players receive visual and auditory feedback that provides useful information that helps them to adapt their postural stability (Siriphorn and Chamonchant, 2015, Franco et al., 2012).

2. MATERIALS AND METHODS

2.1 Subjects:

This parallel, randomized trial, involved a total of 98 participants recruited from Beirut Arab University. They were enrolled and assessed for their eligibility to participate in the study. The participants were randomly divided into two groups: 44 participants (23 females, 21 males) in the experimental group, and 54 (27 females, 27 males) in the control group. The participants held a sedentary lifestyle, and their age ranged from 18 to 25. The study was done in Al Sahel General Hospital Lebanon.

The study protocol was approved by the institutional review board at Beirut Arab University with the following number: 2014H-001-HS-R-0039. Each subject was given a full explanation of the experimental procedures, and submitted a written informed consent before participating.

Pre participation Questionnaire was utilized to determine each subject's general health status (Physical Activity

Readiness Questionnaire (Thomas et al., 1992).

The following people were excluded: subjects with visual defect, impairment of vestibular function, marked postural abnormalities, severe neurological and musculoskeletal defects, or other medical conditions that would interfere with the training program were excluded. In addition, individuals with self-reported lower extremity injuries within the previous six months were excluded (Cone et al., 2015 and Hayes and Rooks, 1998). Subjects should follow simple commands, and instructions of the exercises accurately.

2.2 Instrumentation

2.2.1 Assessment instrumentation:

Biodex stability system (BBS): (Shirley, NY, USA). BBS is used to measure dynamic balance and utilizes dynamic multiaxial platform. This platform allows approximately 20 degrees deflection in any direction and is linked with a computer software. It measures the patient's ability to control the platform's angle of tilt.

Stability levels range from one to eight, with the first level being the most stable and the eighth level the least. The eighth stability level is the most stable since it tilts the platform the least, and the same applies to the first level. The apparatus was calibrated by the manufacturing company agent to insure accurate results.

2.2.2 Therapeutic instrumentation:

A 42 inch LG television was connected to a Wii. The balance board was placed 1.5 meters away from the television with Bluetooth technology. It has the ability to support one person at a time weighing up to 150 Kg.

Cotton socks were used to unify the surface, and prevent the influence of shoes. The timer was set from a stopwatch to monitor the duration of playing.

2.3 Procedures

2.3.1 Assessment procedure:

After warming up with low intensity exercises to prepare the subjects, the subjects' balance was assessed using the Biodex Balance Stability System before and after training, and data was collected. Their balance was also tested using the unipedal (ULS) and bipedal (BLS) stance tests, while keeping their eyes open. For the ULS and BLS, they were instructed to maintain a level platform for a period of 20 seconds and rest by sitting for one minute (Pincivero,1995).

The subjects were tested without foot wear and were asked to perform three test trials before commencing the procedure for the purpose of instrument familiarity prior to data collection to ensure that the learning effects are negated.

Support rails were adjusted according to the subjects' comfort and safety. Display height and tilt were adjusted, so that the subject could look straight at it. All users should have a verbal

understanding of the balance system. The balance platform must be locked in position before each trial, and the patient must be standing in the center of the platform.

Subjects should progress from hands on to hands off the support handle, this will help and protect the patient against sudden or unexpected movement of the platform.

The test protocol for ULS and BLS are very similar, with the standing posture being the only difference. In ULS, subjects were instructed to stand with the dominant leg, which is defined as the preferred used limb in voluntary motor acts, such as kicking a ball. Their middle toe and heel were aligned with the midline of the platform. The knee of the contra-lateral limb was held in a slightly flexed position to 90˚. However, the non-supported limb was neither allowed to come into contact with the supporting limb nor to touch the platform throughout the test.

If the subject fell down, the test was aborted and repeated. The same steps were followed for the non-dominant side.

2.3.2 Training procedures:

Promptly after pre-measuring, volunteers were instructed to play "Table Tilt" on the Nintendo Wii for 15 minutes on the Wii Fit using the same socks (Gioftsidou et al., 2013).

This game was chosen for its elements, as it has clear goals, immediate feedback, and requires concentration from the player.

For safety reasons, participants were instructed not to jump on the board. The purpose of the game is to set the ball in the target by swaying the body mass on the Wii Fit board.

Balance was measured using the same procedure that was utilized for the pre-balance test for both BLS and ULS.

2.4 Data analyses

All statistical measures were performed using the Statistical Package for Social science (SPSS) program version 20 for windows. Prior to final analysis, the data was screened for normality assumption, and presence of extreme scores. This exploration was done as a pre-requisite for parametric calculation of the analysis of difference and analysis of relationship measures. Descriptive analysis using histograms with the normal distribution curve showed that the data were normally distributed and not violates the parametric assumption for the Double Leg Stance Stability (DLSS), Dominant Single Leg Stance Stability (DSLS), and Non-Dominant Single Leg Stance Stability (NDSLS). Additionally, testing for the homogeneity of covariance using Box's test revealed that there was no significa nt 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, that reflect the data was normally distributed for Double Leg Stance Stability (DLSS), Dominant Single Leg Stance Stability (DSLS), and Non-Dominant Single Leg Stance Stability (NDSLS). All these findings allowed the researchers to conduct parametric analysis. Therefore, 2×2 mixed design MANOVA was used to compare the tested variables of interest for different test groups and at different measuring periods. The alpha level was set at 0.05.

3. RESULTS

100 participants were checked and 98 were included in the final data analysis. They were divided into two groups; the study group, which played "Table Tilt" on the Nintendo Wii for 15 minutes, and the control group, which received no intervention. The independent t-test revealed that there was no significant difference (P>0.05) between subjects in both groups concerning their weight, height, and BMI. Additionally, the chi square test revealed that there was not a significant difference between both groups in sex and dominant side distribution (p>0.05) (Table 1). Lastly, there was not a statistically significant difference between the two groups regarding any outcome variables at baseline (pre-intervention).

Table 1: Demographic characteristics of patients in both groups:

Characteristics	Study group (n =50)	Control group (n =48)	*P*-value
Weight (Kg)	67.64±12.99	70.47±10.36	0.236
Height (m)	1.66±0.057	1.67±0.049	0.345

BMI (kg/m^2)		24.31±4.26	25±3.08	0.359
Sex	Female	23	27	0.823
	Male	21	27	
Dominant	Right	45	44	0.7
	Left	5	4	

*Significant level is set at alpha level <0.05.

Statistical analysis using mixed design MANOVA analyzed 98 participants assigned into two groups. It revealed that there was a significant difference within subject effect (F = 40.391, p = 0.0001) and treatment*time effect (F = 10.51, p = 0.0001*). However there was not a significant difference between subject effect (F= 1.626, p = 0.189).

Table 2: Descriptive statistics for the all dependent variables for both groups at different training periods.

	Study group		Control group	
Variables	Pre	Post	Pre	Post
Double Leg Stance Stability (DLSS)	2.79±1.18	2.25±1.09	3.05±1.25	2.86±1.2
Dominant Single Leg Stance Stability (DSLS)	3.4±1.17	2.75±1.15	3.39±1.11	3.18±1.13
Non-Dominant Single Leg Stance Stability	3.69±1.19	2.97±1.27	3.55±1.03	3.32±1.03

Table (2 and 3) present descriptive statistic and multiple pairwise comparison tests (Post hoc tests) for the all dependent variables. In the same context regarding subject effect, the multiple pairwise comparison tests revealed that there was a significant reduction (p <0.05) in Double Leg Stance Stability (DLSS), Dominant Single Leg Stance Stability (DSLS), and Non-Dominant Single Leg Stance Stability (NDSLS) in the post treatment condition compared with the pretreatment in both groups.

Between subject effects, multiple pairwise comparisons revealed that there was a significant difference of Double Leg Stance Stability between both groups (p <0.05) and this significant reduction was in favor of the study group. However there was not a significant difference in Dominant Single Leg Stance Stability (DSLS), and Non-Dominant Single Leg Stance Stability (NDSLS) between both groups (p >0.05).

Table 3: Multiple pairwise comparison tests (Post hoc tests) for the all dependent variables at both groups. Within groups (Pre Vs. Post)

p-value	DLSS	DSLS	NDSLS
Study group	0.0001*	0.0001*	0.0001*
Control group	0.015*	0.003*	0.001*
Between groups (study Vs. control)			
p-value	DLSS	DSLS	NDSLS
Pre treatment	0.294	0.965	0.55
Post treatment	0.01*	0.068	0.139

*Significant at the alpha level (p < 0.05), .DLSS: Double Leg Stance Stability, DSLS: Dominant Single Leg Stance
Stability, NDSLS: Non-Dominant Single Leg Stance Stability

4. DISCUSSION

The main aim of the current study was to examine the immediate effects of Nintendo Wii Fit on dynamic balance in young healthy adults. Findings revealed that there were significant reduction in DLSS, DSLS, and NDSLS after training compared with the pretreatment in both groups.

Findings of the current study revealed a significant difference of Double Leg Stance Stability between both groups and this significant reduction was in favor of the study group. However there wasn't a significant difference in Dominant Single Leg Stance Stability (DSLS), and Non-Dominant Single Leg Stance Stability (NDSLS) between both groups.

A study conducted on healthy young individuals stated that Nintendo Wii fit empowered the balance activities in young adults, and results showed declination of stability index (Vernadakis et al., 2012), which support the findings of the current study. This indicates that subjects were capable to deal faster with prompts after training. In addition, Wii fit training program showed a favorable immediate effect on balance in a study done on healthy women (Nitz et al., 2010), these findings were in accordance with the current study.

Another study proved that balance training can reduce center of pressure displacements during single leg stance thus it can be considered as an effective training to improve proactive balance in young adults (Lesinski et al.,2015).

A research conducted on the effectiveness of Nintendo Wii Fit on postural control in healthy students divided into two groups, the first group performed traditional balance training and the second group was submitted to Nintendo Wii Fit gaming system for eight weeks program. Findings showed great effectiveness of using Wii gaming as a balance-training tool (Gioftsidou et al., 2013). Improvement in the postural balance after Wii training might be explained by immediate, frequent and visual feedback of performance.

A study examined the effects of balance exercise program on a Wii balance board, subjects showed significant improvement of stability limit. The reaction time of the examined subjects was significantly faster in the forward right and backward left directions (Siriphorn A and Chamonchant, 2015).

It is important to mention that positive adaptations after balance training, improvement in balance performance, inhibition of spinal reflex excitability and structural changes in white and gray matter volume in healthy young adults were found after using Wii fit training (Taube et al., 2007).

By comparing the effects of balance training on 40 healthy male and female adults in the upright standing position, it was found that females presented better stability indices than males (Greve et al., 2013).

Underweight individuals demonstrated a better balance performance, and postural activity was negatively affected by increased weight in bipedal leg stance. Researchers revealed that obese individuals are not able to generate sufficient muscle force to control the displacement of the center of mass. Thus, increasing the risk of falls (Colne et al., 2008). On the other hand, the height pointed a negative correlation with balance that may be assigned to the ankle displacements and the response of the gastrocnemius that increases with increasing height (Greve et al., 2013)

5. CONCLUSION

Studies demonstrated that Wii Fit is a safe, entertaining, and interesting exercise training for adults. Using the Wii Fit for assessment and training of dynamic balance is likely to grow and continue in the upcoming years. Future researches needed to study effects of anthropometrics measurements on dynamic balance and to determine and describe training intensity and frequency of balance training for adults in sports and clinical related situations.

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