ISSN 0103-5150
Fisioter. Mov., Curitiba, v. 27, n. 1, p. 21-28, jan./mar. 2014

DOI: http://dx.doi.org.10.1590/0103-5150.027.001.AO02

Evaluation and physiotherapeutic intervention in older with deficit balance through the Scale of Berg and Wii Balance Board platform

Avaliação e intervenção fisioterapêutica em idosas com deficit *de equilíbrio por meio da Escala de Berg e da plataforma Wii Balance Board*

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Abstract

Introduction: The aging process causes structural and functional changes in the organism. Among these changes, the systems responsible for controlling the balance are also affected, especially in women. This study aims to perform an assessment and physiotherapy intervention in elderly with balance deficits through Berg scale and platform Wii Balance Board. **Materials and methods**: The study was longitudinal quasi-experimental intervention. Held in the city of Passo Fundo, RS - Brazil. Participants were 38 elderly women who had a deficit balance. The instruments used to collect data was a questionnaire to identify, assess balance across the Berg Balance Scale and an intervention program with six games via the Wii Balance Board™ platform. To statistically analyze the effects before and after the intervention were used Wilcoxon and Pearson correlation, with a significance level of p = 0.05. **Results**: In the present study, we observed a statistically significant improvement in the balance of elderly compared before and after intervention,

moreover, the six games played also showed statistical significance when comparing the first and twentieth session, highlighting the games Tightrope Walk Table Tilt, Deep Breathing and Soccer Heading. **Conclusion**: The evaluation and balance training with the platform Wii Balance Board were able to provide significant results for the elderly, besides, the game has the potential to treat the health, well-being and functional capacity of older people through the visual representation the game in real time.

Keywords: Aging. Physiotherapy. Postural balance. Videogames.

Resumo

Introdução*: O processo de envelhecimento gera modificações funcionais e estruturais no organismo. Dentre essas alterações, os sistemas responsáveis pelo controle do equilíbrio também são afetados, principalmente em mulheres. Este estudo teve como objetivo realizar uma avaliação e uma intervenção fisioterapêutica em idosas com* deficit *de equilíbrio por meio da escala de Berg e da plataforma Wii Balance Board.* ***Materiais e métodos****: O estudo foi longitudinal intervencionista quase experimental. Realizado na cidade de Passo Fundo (RS). Participaram da pesquisa 38 mulheres idosas que apresentavam* deficit *de equilíbrio. Os instrumentos utilizados para a coleta dos dados foram um questionário de identificação, avaliação do equilíbrio através da Escala de Berg e um programa de intervenção com seis jogos através da plataforma Wii Balance Board. Para analisar estatisticamente os efeitos antes e após intervenção foram utilizados testes de Wilcoxon e correlação de Pearson, com um nível de significância de p = 0,05.* ***Resultados****: No presente estudo, observou-se melhora estatisticamente significativa no equilíbrio das idosas quando comparadas antes e após intervenção, além disso, os seis jogos realizados também apresentaram significância estatística quando comparadas a primeira e a vigésima sessão, destacando-se os jogos Tightrope Walk, Table Tilt, Deep Breathing e Soccer Heading.* ***Conclusão****: A avaliação e o treino de equilíbrio com a plataforma Wii Balance Board foram capazes de proporcionar resultados significativos para as idosas, além disto, o videogame tem o potencial para tratar a saúde, o bem- estar e a capacidade funcional dos idosos através da representação visual do jogo em tempo real.*

Palavras-chave*: Envelhecimento. Fisioterapia. Equilíbrio postural.* Videogames.

Introduction

Brazil is an ageing country, ranking in the sixth place in the absolute number of individuals aged over 60 years. One of the consequences of this finding is the difficulty in planning actions to improve the services delivered by the Unified Health System (1). The healthcare of women is problematic as they account for most of the users who seek medical care; as they currently have a life expectancy at birth of 72.9 years; and also because they live one third of their lives in their fifties and beyond. For these reasons, the female population needs specific and integral healthcare, and efforts should be put in so that they have a better quality of life as well (2).

Ageing is a natural process that puts the body through several physical and functional changes. These changes are progressive and cause effective reduction in functional capacity. Although there are changes which are specifically related to ageing, not all organs suffer its effects in a similar way; they occur at different rates and have different implications (3).

It is commonly known that imbalance is a limiting factor in the life of elderly women. Ageing affects the ability of the central nervous system to process vestibular, visual and proprioceptive signs necessary to maintain body balance, and also reduces the capacity of adaptive reflexes to change. These degenerative processes cause vertigo and/or dizziness and imbalance in this population. The manifestations of impaired body balance have a large impact on elderly women and can diminish their social autonomy as they end up restricting their activities of daily living due to their proneness to falls and fractures, which inflict suffering, immobility, fear of falling down again and high costs associated with the health treatment (4).

The application of technologies in the field of computing science for the treatment of the elderly used

to be underinvestigated. Now, virtual reality (VR) has increasingly developed in the health sector, consisting of an advanced man-machine interface that emulates a real-world environment and provides an experience of immersion and interaction based on 3D computer-generated graphical images (5).

Balance training with Nintendo® Wii Fit and Nintendo® Wii Balance Board is a virtual reality-based technology that simulates real-life learning of an activity and allows increasing training intensity, giving a 3D feedback by means of visual, sensory and auditory stimulation. This technology allows users to interact with a computer-generated scenario in a virtual world, making corrections while an activity is underway (6).

The aim of this paper was to carry out an analysis and physiotherapy intervention in elderly women with impaired balance using the Berg Balance Scale (BBS) and the Nintendo® Wii Balance Board.

Methods

Study participants included women aged 60 years or older. A sample proportion estimate was made using a 5% significance level and establishing that the incidence rate of functional disorders related to imbalance in elderly women would not exceed 5% of the population. Table 1 shows the proportion of elderly participating in the study. The definition of the sample was a convenience, but stratified by age group, according to Census Data, 2000 (7).

For the statistical analysis, we assessed the effects before and after the intervention by applying Wilcoxon's test and Pearson's correlation coefficient with a $p \leq 0.05$. The inclusion criteria were as follows: female patient; age over 60 years; and diagnosis of impaired balance. Those women with any neurological or cognitive disorder or visual impairment, or who had been taking drugs that affected balance or who needed any mobility aid were excluded from the study. We used BBS to assess balance.

We designed a program with six exercises performed in 30-minute sessions. To maximize the intervention, two patients shared the same piece of equipment. The physiotherapy dynamics of each videogame session consisted of the following activities: a) in the deep breathing exercise, the patient placed her hands on the lower part of the abdomen and inspired and expired deeply for 2 minutes; b) in the penguin slide, ski slalom, soccer heading and tightrope walk exercises, the patient performed weight shifting, moving from right to left and vice versa; c) finally, in the table tilt exercise, the patient performed weight shifting multidirectionally. Each exercise was done three times by each patient, in each of the 20 sessions. Before and after each session, the patients performed global stretching. At the beginning, the intensity of all exercises was low, but it was increased according to the evolution of each patient.

The study protocol (427/2010) was approved by the Ethics Research Committee of Universidade de Passo Fundo. All participants signed a free informed consent form.

Results

A total of 38 women with a mean age of 68.1 and standard deviation of 6.2 years were assessed. Aged varied between 60 and 83 years.

Table 2 shows the analyses, expressed as mean and standard deviation, of BBS before and after the intervention.

The result was statistically significant for after the intervention, when the mean values increased from 46.7 to 50.9 and the minimum values rose from 41 to 46.

Table 3 demonstrates the results for the mean and standard deviation for the six exercises done on the Nintendo® Wii Balance Board in the 1st and 20th sessions.

The results were statistically significant for all exercises, but the results for the median, especially in tightrope walk (16.3 before and 56.3 after the intervention) and table tilt (16.7 before and 56.7 after the intervention) were better than in the other exercises. Moreover, the deep breathing exercise yielded a more homogenous mean, reducing the standard deviation values (19.7 before and 6.4 after the intervention). Soccer heading yielded a mean of 16.5 in the 1st session, with a standard deviation of 6.2, and a mean of 22.3 in the 20th session, with a standard deviation of 7.1.

Table 4 shows the correlation between the mean values of the six exercises in the 20th session and BBS after the intervention, when no statistically significant result was obtained.

Table 5 shows the analyses of the center of gravity in the 1st and 20th sessions.

Table 1 - Determination of sample

Age	Women		
	N	N	%
60 to 64 years	98	13	33%
65 to 69 years	70	9	23%
70 to 74 years	68	9	23%
75 to 79 years	43	6	14%
80 years or more	21	3	7%
Total	**300**	**40**	**100%**

Source: IBGE (7).

Table 2 - Berg balance scale before and after the intervention

Berg balance scale	Mean	Standard deviation	p
Before the intervention	46.7	2.6	< 0.000*
After the intervention	50.9	1.4	

Note: *: Wilcoxon's test, significant value for $p \leq 0.05$.
Source: Research data.

Table 3 - Analysis of exercises done in the 1st and 20th sessions

Exercises	Mean	Standard deviation	p
Deep Breathing[1]	67.8	19.7	< 0.000*
Deep Breathing[2]	87.6	6.4	
Penguin Slide[1]	43.5	13.2	< 0.000*
Penguin Slide[2]	71.5	12.4	
Ski Slalom[1]	104.4	17.1	< 0.000*
Ski Slalom[2]	80.8	19.4	
Soccer Heading[1]	16.5	6.2	0.001*
Soccer Heading[2]	22.3	7.1	
Tightrope Walk[1]	22.9	20.1	< 0.000*
Tightrope Walk[2]	53.8	26.3	
Table Tilt[1]	19.3	13.0	< 0.000*
Table Tilt[2]	53.3	12.3	

Note: *: Wilcoxon's test, significant value for $p \leq 0.05$; [1]: 1st session; [2]: 20th session.
Source: Research data.

Table 4 - Correlation between the mean values of the six exercises in the 20th session and BBS

Exercises	Berg balance scale	
	R	p
Deep Breathing	0.105	0.531
Penguin Slide	0.238	0.150
Ski Slalom	0.010	0.954
Soccer Heading	0.016	0.923
Tightrope Walk	-0.124	0.458
Table Tilt	0.180	0.279

Note: *: Pearson's correlation coeficiente.
Source: Research data.

Table 5 - Analysis of the center of gravity in the 1st and 20th sessions

Center of gravity	Mean	Standard deviation	p
Right[1]	0.50	0.044	0.172
Right[2]	0.50	0.022	
Left[1]	0.49	0.044	0.172
Left[2]	0.49	0.022	

Note: *: Wilcoxon's test, significant value for $p \leq 0.05$; [1]: 1st session; [2]: 20th session.
Source: Research data.

There was no statistically significant difference in the center of gravity of the patients. However, a decrease in standard deviation values occurred on the right and left sides in the 20th session (0.022), in addition to very similar maximum and minimum values in the 20th session on both sides, on which the difference dropped by half.

Discussion

The effects of virtual reality on balance were initially described by Sveistrup (8) who found virtual reality to help the balance and posture of healthy adult individuals. Rehabilitation has evolved beyond conventional therapy, and practical studies are important to confirm the efficiency of this new sort of rehabilitation (9).

In line with the findings of this study, an intervention program conducted in a population that was prone to falls, consisting of 15 elderly individuals with mean age of 76.0 and a standard deviation of 5.2 years, used rehabilitation exercises, supervised by a physical therapist, on a Nintendo® Wii Balance Board. The following games were played individually by the patients, twice weekly for 12 weeks: Table Tilt, Soccer Heading, Ski Slalom, Jogging, Hula Hoop, and Ski Jump. In four weeks, BBS improved significantly ($p = 0.020$) (10).

A case study of an 89-year-old female patient who suffered from multiple falls included six 1-hour treatment sessions with Nintendo® Wii Bowling performed during 2 weeks, played against the researcher. The authors concluded that the risk of falls decreased significantly, as shown by the increase in BBS, which rose from 48 to 53 (11). Another study that used the Nintendo® Wii Balance Board demonstrated that, at the end of the treatment, the minimum and maximum scores were 0 and 60 in table tilt and 32 and 53 in penguin slide, respectively (12), in line with the results of our study, but these values were higher at the end of 20 sessions in both exercises.

Based on the findings of this study, it is suggested that Nintendo® Wii Fit, by means of the Nintendo® Wii Balance Board, can provide proprioceptive stimulation through plantar receptors, which are essential for maintaining the balance in barefoot exercises.

Proprioception and sensory information are important for maintenance of balance under normal circumstances; thus, proprioceptive training increases these stimuli, allowing for better postural balance in elderly individuals (13). A systematic review, conducted in the Cochrane database, which analyzed exercises that could improve the balance of elderly people included 34 studies and 2,883 participants. The conclusion was that exercises involving gait, proprioception (balance), coordination, function, and strength apparently have a considerable impact on balance assessments; however, among these exercises, those that involve proprioception prove to be more effective than usual exercises (14).

A study investigated whether a specific exercise program involving proprioception could contribute to improving balance in 40 elderly women aged 60 to 80 years over a two-month period. The protocol was based on exercises that included head, neck and eye movements, postural control in different positions, on one-foot stance, gait, and use of unstable platforms; the exercises lasted 45 minutes and were performed twice a week. The results showed that BBS improved, on average, by 3 points (15). This is in line with the findings of this study, where the elderly patients performed exercises on the WBB platform that included head, neck and eye movements on a two-foot stance, which are essential for the activities of daily living of this population.

In order for elderly individuals to perform body movements in their activities of daily living, they must have good dynamic balance, especially when changes in direction and in the center of gravity occur, as the base of support increases and the center of gravity tends to be forward, in search of greater balance (16, 17). Nevertheless, the determination of the center of gravity of the human body is not an easy task, as its density is not uniform, it is neither rigid nor symmetrical, and is unrelated to the center of mass, which may be altered by posture, body weight and increase in the base of support. This is mainly important in elderly individuals in whom the bone structure that makes up and supports the body is put through considerable physiological changes in bone mineral density and in microarchitecture, in addition to musculoskeletal and biomechanical changes (18).

In general, the similar minimum and maximum values obtained for the center of gravity, through automatic and anticipatory postural responses on the Nintendo® Wii Balance Board (19) are justifiable since, among these reactions, there is a visual feedback, which provides information based on the movements carried out by the patients and sends it to them, thus urging them to maintain the center of gravity.

The Nintendo® Wii Balance Board can give a visual feedback to the patient during the exercise session. In the clinical setting, the use of games with visual feedback may help with short-term rehabilitation and also be efficient in improving the functional state. In addition, when performed in group, the exercises can increase treatment compliance and improve patients' motivation (20, 21).

A study that used Nintendo® Wii Fit and the Nintendo® Wii Balance Board showed that the selected games produced latero-lateral and antero-posterior imbalance through weight shift and, consequently, stimulated the recruitment of such motor strategies, which might have been facilitated by immediate visual feedback by interaction with the system, as BBS (22) improved after the intervention, corroborating the findings of this study.

The use of the Nintendo® Wii Balance Board allows the patient to see on the screen which lower limb shifts more weight during the alternate hip movements with consequent displacement of the center of gravity. Therefore, we suggest that the results found here are also closely related to body weight shifting from the latero-lateral to antero-posterior position.

Previous studies indicated that a force platform is a useful resource to provide instructions about partial body weight shifting. Nonetheless, digital scales are sufficient to provide this information, as the force platform is not available in all physiotherapy departments (23, 24). The efficiency of the Nintendo® Wii Balance Board was assessed in a study that compared it with a pressure platform for the acquisition of orthostatic balance of patients with eyes open and closed and on two-foot and one-foot stances. Thirty healthy individuals without involvement of lower limbs, with a mean age of 23.7 and standard deviation of 5.6 years, submitted to 14 days of training, more or less one and a half hour per day, totaling 24 hours, were assessed. The study shows the efficacy and validity of Nintendo® Wii Balance Board in providing balance control, even when the exercises are

performed in the orthostatic two-foot stance with eyes open (25).

Conclusion

In conclusion, the features and functions of Nintendo® Wii Fit and of the Nintendo® Wii Balance Board are potentially useful for the treatment of the health and welfare of elderly people; first because the game interface provides a real-time visual representation of the players and second because a substantial amount of functional capacity is necessary to play Nintendo® Wii Fit. These two features tell it apart from other videogames, being significantly beneficial in health interventions to treat elderly individuals, especially with respect to impaired balance.

Acknowledgments

We thank CAPES (Coordination for the Improvement of Higher Level Personnel) for financial support and the University of Passo Fundo for support this international publication through the "Special Incentive Program for International Publications in English Language".

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Received: 04/11/2013
Recebido: 11/04/2013

Approved: 12/18/2013
Aprovado: 18/12/2013