

## **EFFECTIVENESS OF VIRTUAL REALITY FOR BALANCE AND COORDINATION TRAINING OF ELDERLY PATIENTS**

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### **Abstract**

The aim of the research is to analyse the use of virtual reality for balance and coordination training on elderly patients. Objectives: to evaluate and compare functional mobility and balance, confidence of the balance and fear to fall and coordination before and after physiotherapy procedures using different physiotherapy programmes; to determine satisfaction with different physiotherapy procedures in elderly patients. The object of the research: the use of virtual reality for balance and coordination training on elderly patients. Methods of research are tests and questionnaire. Hypothesis of the research: The use of virtual reality training will improve balance and coordination in elderly patients. Conclusions of the research show that both group programmes had a positive influence on functional mobility and balance. Both programmes had a statistically significant influence on the Tinetti test, however, only group I programme had improvement of Berg Balance scale results ( $p < 0.05$ ). When evaluating patients balance confidence and fear to fall, there was no statistically significant ( $p > 0.05$ ) difference in groups after procedures. Both programmes had a positive influence on improving coordination, but statistically significant ( $p < 0.05$ ) improvement was only in group I. Subjects of group I were statistically significantly ( $p < 0.05$ ) more satisfied with their programme, than subjects in group II.

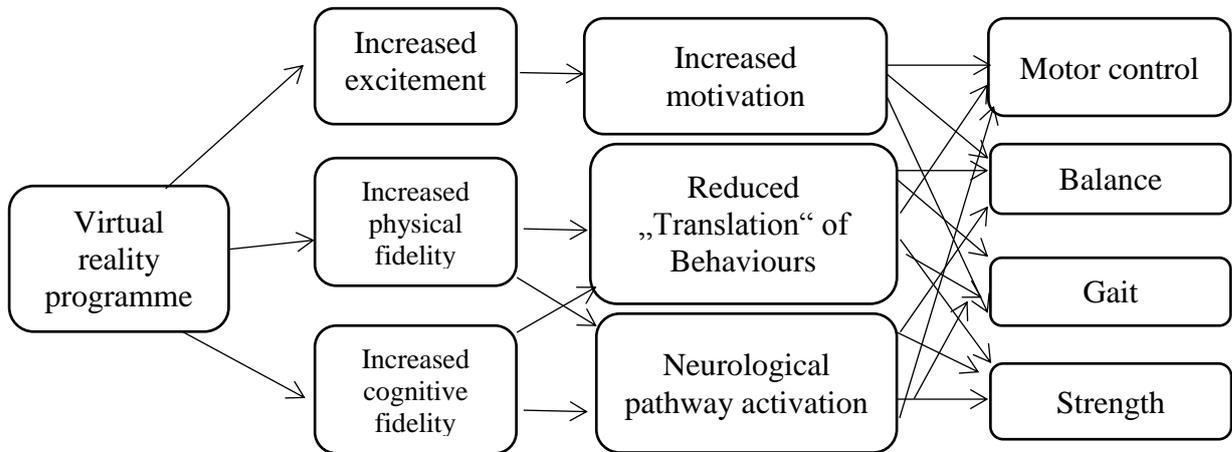
Keywords: Virtual reality, elderly patients, physiotherapy, balance, coordination.

### **Introduction**

According to the data of the Lithuanian Department of Statistics at the beginning of 2017, almost 275 thousand people who lived in Lithuania are those of 75 years old and older, and account for 9.65% of all inhabitants of Lithuania. G. Šurkienė and others (2012) predict that the aging process will accelerate even more and will attract more and more countries. According to Sodeman W. A., Sodeman T.C. (2008), falls are one of the most important causes of elderly people disability and death. A. A. Guccione et al (2012) have investigated that 30% of people over 65 years old and 40% of people over 75 years old fall annually. Therefore, for elderly people it was recommended to incorporate balance and coordination movements in their physiotherapy programmes.

In Lithuania, virtual reality is not commonly used in physiotherapy procedures, especially for the elderly (75 years and older) people. The physiotherapy programme consists of balancing and coordination exercises. Virtual reality is a computer-simulated environment that can simulate a physically real or imagined world. Usually, users control their virtual characters in order to perform their respective tasks in a virtual environment (Howard, 2017). Virtual reality activities include a combination of exercises and games. These activities, performed in total body movements, can be controlled by duration, intensity, complexity, speed, and number of repetitions. Virtual reality is becoming increasingly popular in physiotherapy and applies to patients with various motor disorders. It improves static balance, posture and dynamic balance in the elderly. S.D. Choi et al. (2016) conducted a systematic review of the literature on the prevention of the use of virtual games and interactive interventions for the eradication of elderly people. The authors point out that various tests used different gaming systems (SensBalance Fitness Board, Dance Video Game with a pad), but most researchers use Nintendo Wii; Xbox Kinect. Virtual reality technology is virtual reality games that have a therapeutic effect on balancing correctness. The ability to repeat the exact tasks in the virtual reality encourages the learning of motions and the interest and motivation of the participants (Shih et al., 2016; Donath et al., 2016; M.G. Prata and M.E. Scheicher, 2015). M. C. The Howard (2017) meta-analysis showed that virtual reality physiotherapy programmes are statistically significantly more effective than traditional physiotherapy programmes. The greatest positive effect in the application of virtual reality physiotherapy programmes is seen in the

development of the gait, later on the strength, motor control and balance. The author presents possible mechanisms for making virtual reality applications effective (see picture 1).



**Picture 1.** Proposed mechanisms of virtual reality programme success (Howard, 2017).

The purpose of this research is to demonstrate practical significance: by analysing the application of virtual reality games for elderly patient balance and coordination, it could be used as an additional element of the physiotherapy procedure, or even replaced instead of balance and coordination exercises. The **problem** of the research: what is the effect of physiotherapy using virtual reality on elderly patients? **The aim of the research** is to analyse the use of virtual reality for balance and coordination training on elderly patients. To reach the aim of the research, the following **objectives** were set: to evaluate and compare functional mobility and balance, confidence of the balance and fear to fall and coordination before and after physiotherapy procedures using different physiotherapy programmes; to determine satisfaction with different physiotherapy procedures in elderly patients. **The object of the research:** the use of virtual reality for balance and coordination training on elderly patients. **Hypothesis of the research:** The use of virtual reality training will improve balance and coordination in elderly patients.

## **Methods**

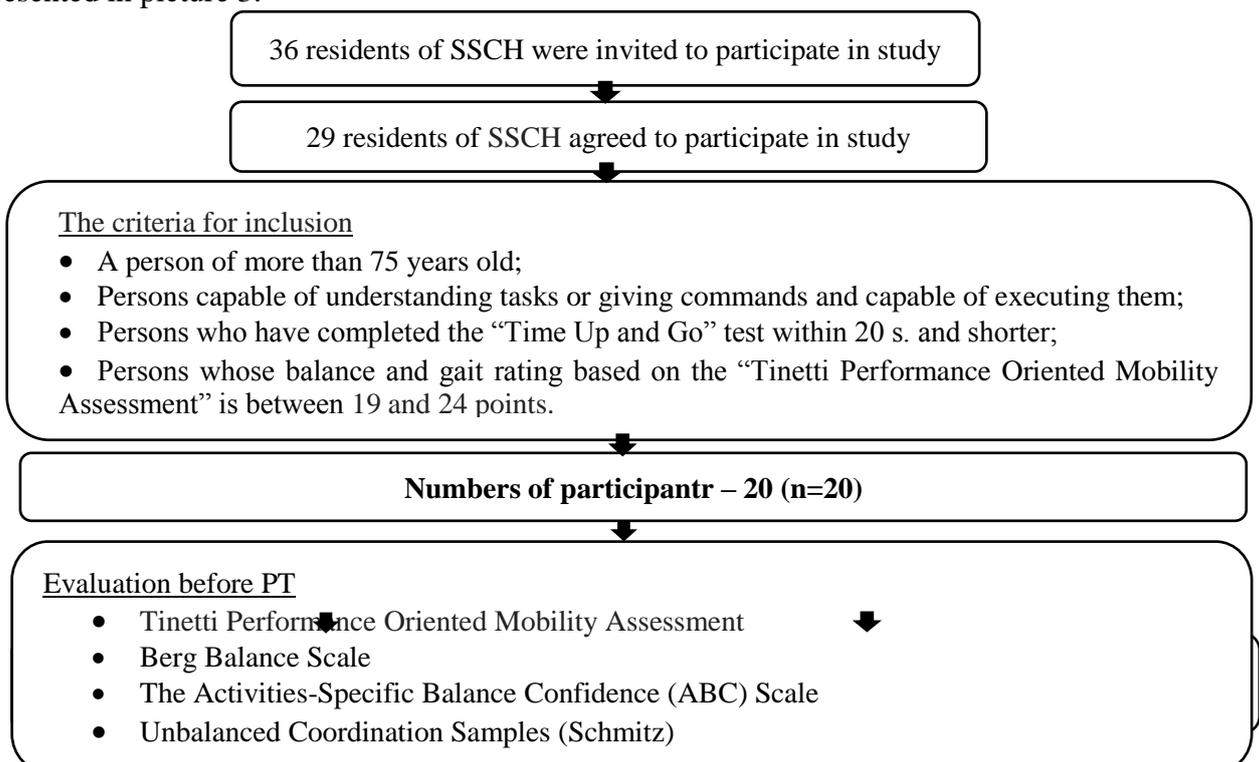
Persons involved in the survey - residents of Seniors Social Care Home (SSCH) (Senjorų socialinės globos namai). The study was conducted March – May months of 2017. Seniors need constant care and support for physical and/or social inequality. The study excluded those with significant visual and hearing impairment. The participants of the study signed a written form for the person's consent to participate in the study.



*Picture 2. Virtual reality session.*

Participants matching the criteria for inclusion (see picture 3) were divided into two (I and II) groups of 10 subjects randomly selected ( $n = 10$ ). Group I consisted of 5 men and 5 women with an average age of 82.8 years old). Group II consisted of 6 men and 4 women with an average age of 80.4 years old. For both groups, physiotherapy procedures were 30 to 45 minutes, for each patient individually. Each patient was subjected 2 evaluations before and after physiotherapy (before and after PT (see picture 3)) and to 10 procedures. Group I consisted of patients undergoing balance and coordination exercises using games in the virtual reality (Microsoft Xbox 360 gaming device and Kinect appendix were used). Patients stood in the centre of the front of the TV ~ 3 meters away. Patients stepped forward, backward, left, right, changed the centre of gravity, used hand and others movements, depending on what game was played and shown on the TV screen. For the patient safety, during virtual reality session, the physiotherapist stood behind the back of the patient (see picture 2).

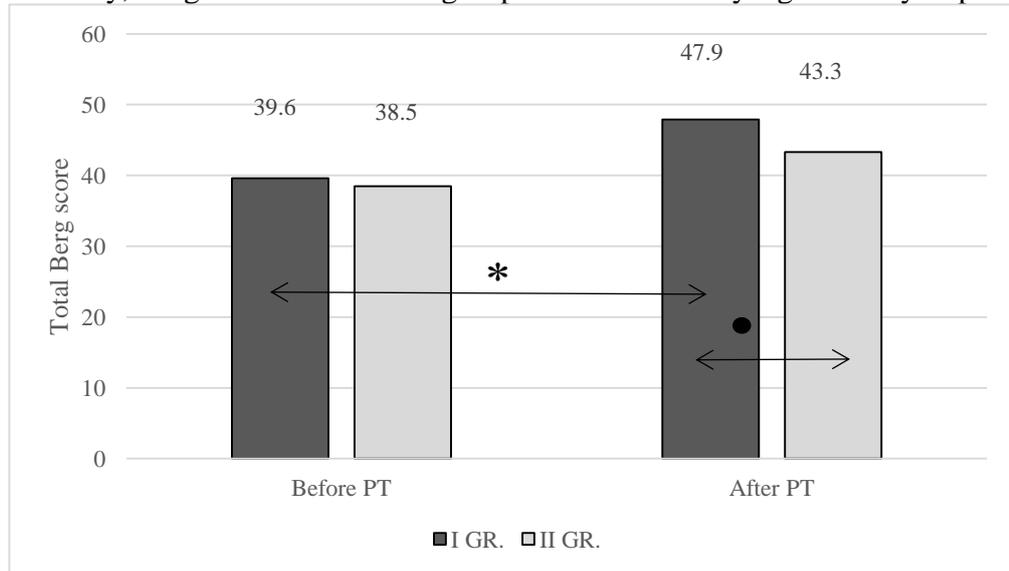
In group II, a balance and coordination was trained using exercise programme. Exercises have been selected matching virtual reality games of group I. The research organization chart is presented in picture 3.





score in both groups varied from 19 to 24 points before the procedure. 19 – 24 points show an average risk of falling. In the evaluation of the individual Tinetti test results after PT it was observed that the lowest point obtained in group I is 23, the highest – 27 (respectively in group II – 20 and 27).

The Berg balance scale was evaluated for static and dynamic balance. The averages of Berg's balance scale are presented in picture 5. Comparing Berg's balance scores averages before PT, the difference between the two groups was statistically insignificant 1.1 point ( $p > 0.05$ ). In the evaluation of the results after PT, it is seen that the average score for the group I increased by 30.9% (8.3 points), group II – 12.5% (4.8 points). Comparing the mean score of the balance scale of group I and group II after PT, it was found to be statistically significant ( $p < 0.05$ ). When evaluating the change in the score for group I, it can be argued that the mean scores of the test points increased statistically significantly ( $p < 0.05$ ). In group II, although there is a marked improvement after PT, but this improvement was not statistically significant ( $p > 0.05$ ). In conclusion, it can be stated that at the end of the study, Berg's balance score in group I was statistically significantly improved.



**Picture 5.** Average Berg balance score in groups before and after PT.

Note: \* -  $p < 0,05$ , when results were compared before and after PT in I group; ● -  $p < 0,05$ , when results were compared between groups after PT.

By comparing the effects of two different PT programmes on the Berg balance scale, it can be argued that virtual space games are a more efficient procedure. The individual score before PT of the Berg-scale in the group I ranged from 28 to 46 points, in the group II from 28 to 44. After analysing the individual results of the Berg scale after PT, they ranged from 39 to 52 in the group I, from 33 to 50 in the group II.

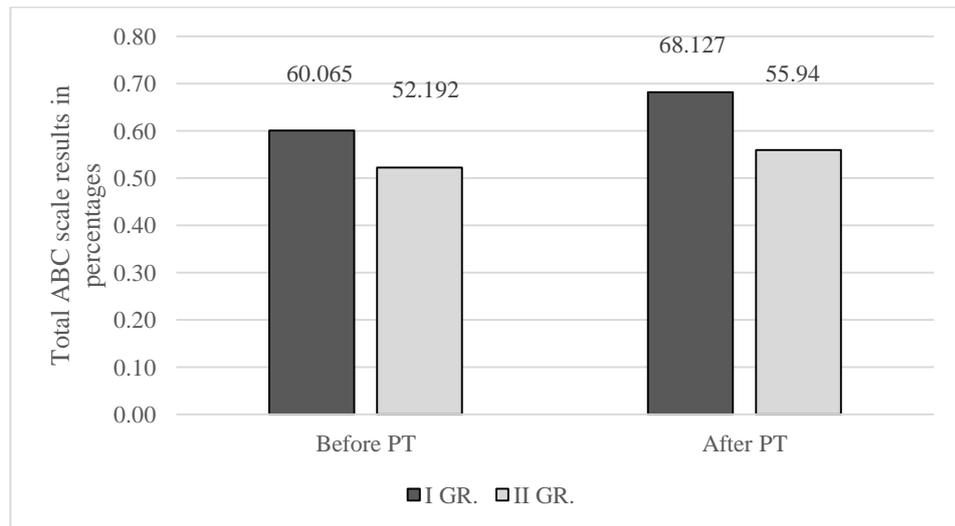
Summing up the results of the Tinetti test and the Berg balance scales, it is concluded that both groups of exercises have a positive effect on the balance training. The results of the Tinetti test indicate that the results in both groups were statistically significant ( $p < 0.05$ ). Analysis of Berg test results was statistically significantly ( $p < 0.05$ ) better in group I.

### **Trust of the Balance and Fear of Fall Assessment**

To find out the patients' confidence in their balance and stability in daily activities The Activities-Specific Balance Confidence (ABC) Scale was used. By analysing the balance data, self-awareness of the individuals is important for balance and stability, as this subjective feeling can lead to a change in mobility. The average score of confidence are presented in picture 6.

Before the study, subjects of group I assessed their balance better than subjects of group II. This tendency is also observed after PT. It can be argued that the percentage of confidence in group I increased more (8.06%) than in group II (3.75%). However, there was no statistically significant

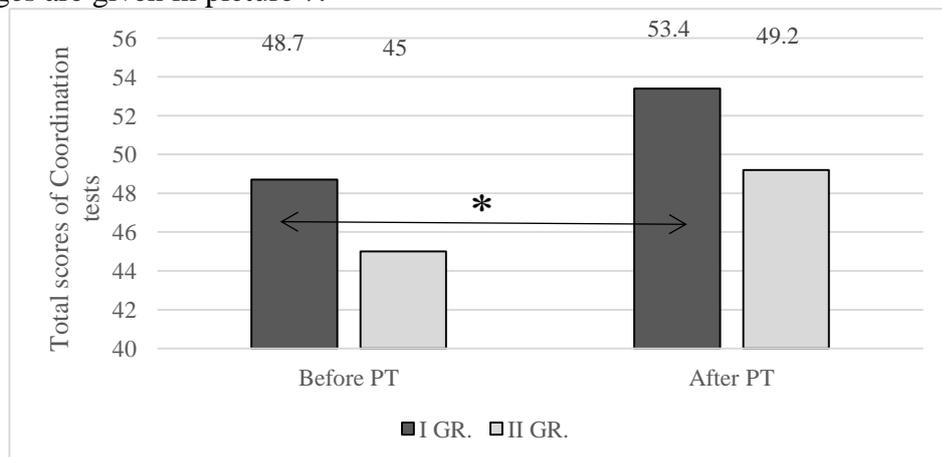
difference in confidence-based post-test balance among the groups ( $p > 0.05$ ). Analysing the changes in the groups before and after PT programmes, there was no statistical significance ( $p > 0.05$ ). In the analysis of the individual confidence balance questionnaire (ABC), it was found that before PT in group I, the lowest confidence balance was 42.5%, the highest – 79.38%. In group II, the confidence balance before PT varied from 28.13 % to 73.13 %. After PT in group I, the percentage of individual trust varied from 53.13% to 85%, in group II from 35.6 3% up to 80%. It can be argued that the application of both programmes does not have a statistically significant effect on patients' confidence in their balance and stability assessment.



**Picture 6.** Average percentages of Activities-specific Balance Confidence (ABC) Scale before and after PT.

### Coordination assessment

Coordination was assessed using Unbalanced Coordination Samples (Schmitz). Coordination scores averages are given in picture 7.



**Picture 7.** Average scores of Nonequilibrium coordination tests (by Schmitz) in groups before and after PT.

Note: \* -  $p < 0,05$ , when results were compared before and after physiotherapy procedures in I group;

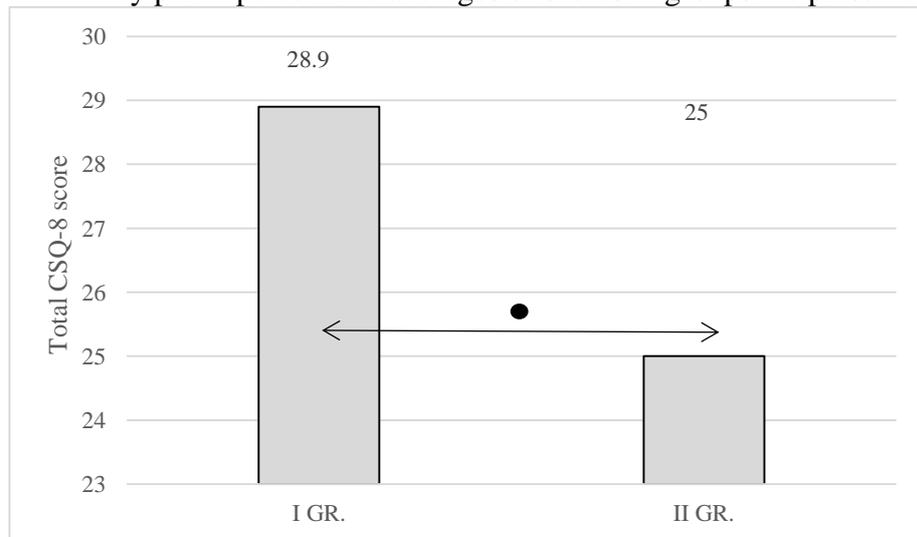
Before PT the coordination points did not differ statistically between the groups ( $p > 0.05$ ). In the assessment of the mean score for coordination points, it increased by 9.7% after PT in group I. (4.7 points), in group II – 9.3% (4.2 points). When comparing the mean score of the coordination in the groups after PT, this difference was not statistically significant ( $p > 0.05$ ). Comparing the changes in the mean of coordination points in the group before and after PT, it is seen that improvement in group I was statistically significant ( $p < 0.05$ ). In group II, although there was an improvement, but it was not statistically significant ( $p > 0.05$ ).

The individual coordination samples before PT in group I ranged from 42 to 54, and in group II it ranged from 33 to 52. The individual scores after PT in group I ranged from 50 to 57 points. In group II, the individual coordination scores ranged from 42 to 55 points.

Summing up, both groups showed an improvement in the mean of coordination after PT, but only in group I this improvement was statistically significant ( $p < 0.05$ ). Comparing the results after PT between the groups, they differ statistically insignificantly ( $p > 0.05$ ).

### **Patients' Opinion about Procedures Assessment**

At the end of the study, participants completed Client satisfaction questionnaire (CSQ-8). This questionnaire was designed (to assess the attitude of the procedures) to assess their attitude to the procedures in which they participated. The averages of scores in groups are presented in picture 8.



**Picture 8.** Average Client Satisfaction Questionnaire (CSQ-8) score in groups  
Note: ● -  $p < 0.05$ , when results were compared between groups

The average score for participations Client satisfaction questionnaire (CSQ-8) in group I was 15.6% (3,9 points) higher than in group II. The average scores of Client satisfaction questionnaire (CSQ-8) for participants in group I was 15.6% (3.9 points) higher than in group II. This difference was statistically significant ( $p < 0.05$ ). Subjects of group I were more satisfied with the PT programme than those of group II. When discussing the patients' satisfaction questionnaire (CSQ-8), it is expedient to analyse the average of the results of individual questions in more detail.

Having analysed the Client Satisfaction Questionnaire (CSQ-8), it is evident that the respondents in group I rated it better than those of another group. Question 3, which asked how much the programme met the needs of the participant, 24.14% were better in group I. 22.2% of answers in group I were better in answering question 2 ("Did you get what you hoped for? "), 18.18% better responding to question 4 ("If your friend needs a similar help, would you recommend him this programme?") and 8 ("If you need to ask for help again will you return to our programme?"), question 5 ("Are you satisfied with the amount of aid you received") was better in 15.63%, question 7 ("Are you generally satisfied with the procedures you received?") - 11.76%, question 6 ("Have the procedures you received helped you solve your problems more efficiently?") - 10%, question 1 ("How would you rate the quality of procedures you received?") - 6.25%. Summing up, the study participants assessed the virtual space physiotherapy better than participants of the balance and coordination exercise group.

## **Conclusions**

Programmes from both groups have a positive effect on functional mobility and balance. Both programmes had a statistically significant effect ( $p < 0.05$ ) on the improvement of Tinetti test results (In group I the average increased by 3.7 points, in group II - by 2.2 points). In the assessment of the Berg Balance scales (the mean of group I increased by 8.3 points, in group II- by 4.8 points), the statistically significant difference ( $p < 0.05$ ) was obtained in group I, in the group before and after physiotherapy programmes and among the groups after the physiotherapy programmes. After assessing and comparing patient confidence and fear of collapse before and after physiotherapy, it was found that in group I the confidence balance and the percentage of fear of falling (were) increased by 8,06, in group II - by 3.75. However, no statistically significant differences were found ( $p > 0.05$ ). Both programmes had a positive impact on the improvement of coordination indicators (in group I the average increased by 4.7 points, in group II - by 4.2 points). Improvement in the coordination of group I in the study was statistically significant ( $p < 0.05$ ). It was found that subjects of group I were more satisfied with the programme they applied for than those of group II. This difference (3.9 points) among the groups was statistically significant ( $p < 0.05$ ). **The hypothesis** that the use of virtual reality for the development of balance and coordination of elderly patients is positive has proved to be true.

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