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Balance Training Through Immersive Virtual Reality to Optimize the Balance of the Elderly and its Influence on the Fear of Falls

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ABSTRACT

Introduction: Alteration of functional balance is one of the main factors that limit the life of the elderly, with falls being the most aggravating consequence. With the advent of technology, several resources have been implemented in different areas of health, with emphasis on immersive virtual reality (RVI).

Objective: To evaluate the effect of a swing training in immersive virtual reality on functional balance and its influence on the fear of falling in the elderly.

Methods: This is an experimental, uncontrolled study conducted with elderly people with changes in body balance. Balance assessment was performed using the Dynamic Gait Index and Timed Up and Go tests, which measure functional balance, mobility and speed, respectively. The fear of falls was assessed using the Scale Effectiveness of Falls - International. After the initial evaluation battery, we proceeded with the intervention stage, where balance training was implemented through Immersive Virtual Reality. In all, 16 sessions were held, each lasting 50 minutes. At the end, a reassessment was carried out using the same tests as the initial evaluation. In all analyzes, an alpha value equal to 5% and the software R v3.6.1 were adopted.

Results: Statically significant results were found only for balance ($p < 0.01$) and mobility and speed ($p < 0.01$). The fear of falls ($p = 0.33$) with an increase in the mean after the intervention, did not present a statistically significant result. Conclusion: The training was effective to optimize the functional balance, having no influence in reducing the fear of falling.

Introduction

Human aging is characterized by gradual loss of functional capacity, resulting in physical and cognitive changes, due to the progressive reduction in the ability to adapt to environmental stressors, which leads to the loss of the ability to maintain homeostatic balance [1]. Among the changes inherent to this process, those related to postural control stand out, where a compromise in the abilities of the central nervous system (SNC) is identified, in the processing of vestibular, visual and proprioceptive signals, which are responsible for maintaining the body balance. This variable, in turn, plays an important role in orienting the individual in space, allowing the maintenance of posture in different daily situations [2]. The alteration of the functional balance is one of the main factors that limits the life of the elderly, being the fall the most aggravating consequence of this impairment. Approximately 40% of Brazilian elderly people fall at least once a year, while 11% fall on a recurring basis, which may determine consequences not

only physical, but also psychic. After a fall event, the elderly begins to live with the feeling of fear of suffering a new episode of fall, and then start to restrict their daily activities [3,4]. Thus, the feeling of insecurity and constant fear, ends up conditioning the elderly to a reduction in mobility, in view of the imminent risk of falling. After his first fall, self-confidence in carrying out his activities goes downhill. Over time this becomes a vicious cycle, and soon there will be a progressive impairment of functional capacity, which in turn leads to a greater propensity for episodes of new falls [5].

With the advent of technology, several resources have been implemented in different areas of health, with special emphasis on immersive virtual reality (RVI), which, within the scope of Gerontology, has been gaining important notoriety, especially in the prevention and rehabilitation of elderly people at risk of falls [6]. Playfulness makes virtual reality therapy more attractive to the patient, improving not only physical health, but also self-esteem. It is, therefore, a new opportunity for intervention that increases adherence to treatment [7]. The RVI has the ability to stimulate multiple sensory modalities, creating an interface where the individual immerses itself in a virtual environment, similar to real events, allowing the use of games that offer different motor and cognitive demands, enabling feedback on performance and results, try to try, stimulating the search for better performance, therefore being an excellent motivational component [8]. Thus, because it is a tool that, although new, is already being used in treatments, especially with the elderly, and, understanding its potential positive effect in the perspective of rehabilitation of body balance and consequent reduction of fear of falls, seeking to generate scientific evidence, this study aimed to evaluate the effect of a balance training in immersive virtual reality on the functional balance and its influence on the fear of falling in the elderly.

Materials and Methods

This study was an experimental research, carried out at Physiotherapy School Clinic of University center CESMAC. The research protocol was approved by the Ethics Committee of the University center Cesmac. Research participants were recruited from the Holy House Active Aging Group (GEASC). GEASC is a health promotion and education project, where participants receive instructions from a multidisciplinary team in the form of lectures and dynamic activities aimed at active aging. The researchers went to the physical space where the GEASC meetings take place, and explained what the research objectives would be, and thus, the formal invitation was made. The inclusion criteria adopted were: individuals of both sexes, aged between 60 and 79 years old, who had balance disorders, previously diagnosed by a specialist doctor (otorhinolaryngologist, neurologist or geriatrician). The exclusion criteria were: elderly people with an inability to understand the simple verbal command; those who were unable to stand independently in the orthostatic position, who used auxiliary walking devices; who had serious or not compensated visual impairment with the use of corrective lenses; had orthopedic disorders that resulted in movement limitation, or use of prostheses in lower limbs; and who have undergone body balance rehabilitation in the past six months.

When analyzing the limitations of the physical space and the amount of equipment needed for data collection, a maximum number of ten participants was established, which were selected by drawing lots. After being selected, the individuals were invited to attend the Physiotherapy Clinic of the University center Cesmac, where they proceeded with the reading and signing of the Free and Informed Consent Form. At first, the elderly underwent an initial assessment, where socioeconomic and demographic data and questions regarding the history of falls and health were collected. Subsequently, we proceeded with the assessment of balance, carried out through the Dynamic Gait Index (DGI) test, which is a test that assesses the functional dynamic balance. and each task will receive a decreasing score from 3 to 0, where 3 represents a normal result for that particular task, 2 has a mild impairment, 1 has a moderate impairment, and 0 characterizes a severe impairment to perform that task. Overall score below 19 results in increased risk of falling [9]. Then, the Timed Up and Go (TUG) test was performed, which assesses mobility, speed, agility and dynamic balance, while the individual gets up from the chair and travels a distance of 3 meters. The test begins with the elderly person sitting in a chair with an upright spine, hands on thighs and feet flat on the floor. The evaluator gives the command, the participant gets up from the chair, goes to the marked point and returns until he / she sits down again, returning to the starting position. Doing this as quickly as possible, without running. Results below 10 seconds indicate that the elderly person has independence for basic transfers, results equal to or greater than 30 seconds indicate that the elderly person is dependent for carrying out their transfers [10].

To assess the fear of falling, the Falls Effectiveness Scale - International (FES-I), consisting of 16 items, was used, where each item represents a daily activity performed by the individual, with 4 possible answers (not at all concerned; one little worried; very worried; extremely worried). The individual will weigh each item according to his level of concern and the situation of the fall occurrence. Total scores between 16 and 19 indicate little concern about falls, between 20 and 27 indicate moderate concern about falls, and between 28 and 64 indicate great concern about falls [11]. After the initial evaluation, each elderly person's service days were scheduled, always interspersed, and the intervention stage was subsequently started. The resource used for the implementation of immersive virtual reality was the Rift Glasses. The games that were chosen for the therapeutic intervention were basketball with the head, dynamic boxing, In Cell and Roller Coaster. All games

chosen generate stimuli for postural control, cervical movement, postural reactions and exchanges, in addition to providing visual and cognitive stimulation during the entire execution of the game. This results in the provision of the minimum requirements for structuring a balance training. The consultations were carried out twice a week, with a duration of 50 minutes each session, with a total of 16 sessions. Monitoring of vital signs was performed before, during and at the end of each session.

Each participant started his session with a warm-up, performed through a walk, sequenced by active stretching of the upper and lower limbs. Soon after, the protocol of immersive virtual reality games began, ending with the cooling phase. During the entire process of applying the protocol, the elderly were closely monitored by the Physiotherapist along with the participating academics. At the end of the 16 sessions, the elderly underwent a reassessment, following the same battery of balance tests as the initial assessment. These tests were performed by the same initial evaluators. Continuous variables are presented as means and standard deviation, while categorical variables are presented as relative and absolute frequencies. To compare the variables in the 2 evaluation moments (baseline and post-intervention), a repeated measures ANOVA with Bonferroni's post-hoc test was used. In this analysis, the assumption of sphericity was assessed by the Mauchly test. All comparisons between groups of continuous variables were preceded by the Levene test to verify the homogeneity of the variances of the residuals and the "t" test was only conducted if the variable met this assumption of homoscedasticity. In cases where the assumption was not met, the Welch test was conducted. In all analyzes, an alpha value equal to 5% was adopted and the software R v3.6.1 (R Foundation for Statistical Analysis, Vienna, Austria) with the package "Rcmdr".

Results

The sample consisted of 20 elderly people, with a predominance of females. The average age was 69.25 years (± 5.67), with a minimum of 60 years and a maximum of 79 years. Most of the participants had a high level of education, with an average of 12.25 years (= ± 4.80). All the results referring to the sociodemographic data are distributed in the Table 1. About data related to falls, of the 20 survey participants, 12 (60%) reported episodes of falls in the last year. Having an average of 1.1 fall (± 1.2). The environment with the highest occurrence of falls was the street, with the biggest cause of stumbling / slipping. Of the 12 elderly people who suffered a fall, 2 progressed with functional repercussions. Information regarding the history of falls is distributed in Table 2. The evaluation of data related to the assessment of balance and fear of falls revealed statistically significant results only for balance. The information relevant to the comparisons of the tests performed are distributed in Table 3.

Table 1: Characterization of data on sociodemographic and demographic variables.

Variables	N	%
Sex		
Male	4	20
Female	16	80
Age Range		
60 – 69	11	55
70 – 79	9	45
Education		
0 to 1 year	2	10
Between 1 and 6 years	0	0
Between 6 and 10 years	2	10
Over 10 years	16	80
Marital Status		
Married	6	30
Single	5	25
Widower	9	45
Source: Author, 2020.		

Table 2: Characterization of data regarding the characteristics of the history of falls.

Variables	N	%
Fall Episode		
Yes	12	60
No	8	40
Number off Falls		
0	8	40
1 - 2	9	45
3 – 4	3	15
Repercunssion Func.		
Yes	2	10
No	10	50
Cause off the fall		
Trip / slip	10	50
Loss of consciousness	1	5
Absence of motive	1	5
Local		
Street	7	35

Table 3: Characterization of group results in tests performed before and after intervention.

Variables	Average	DP	P[1]
TUG Pré	10,29	2,85	<0,01
TUG Pós	8,58	1,75	
DGI Pré	18,15	3,91	<0,01
DGI Pós	21,15	2,58	

FES-I Pré	24,60	5,60	0,33
FES-I Pós	26,40	7,92	
Source: Author, 2020.			
[1]P- value for the "t" test for paired samples.			

Discussion

The analysis of data from the study presented here, allowed to reveal a positive and significant influence of balance training through immersive virtual reality on the outcomes of mobility and functional balance. However, the final evaluation did not show any improvement over the fear of falling. The predominant female population, participating in this study, confirms what is already widely discussed in the scientific literature, where culturally, especially in the northeastern region, elderly women were educated and instructed to take care of their health more frequently when compared to men [12]. Contrary to the reality of the majority of the elderly in the Northeast, the participants in this study had a high level of education. This fact can be explained by the recruitment site for the elderly, an active aging course. According to Esper et al. [13] there is a greater tendency for elderly people with higher education to attend these types of activities. As a result, this public is increasingly looking for continuing education, as it allows them to increase their capacities for understanding and actively coping with the repercussions currently occurring [13].

As for the place of fall, the result brings a number very close when comparing falling on the street with falling at home, however, there was a greater number of falls on the street. When epidemiology portrays the place where falls occur, it points to the home as the main place of accidents, together with the surroundings of the individual's home. In this case, the surroundings of the house are characterized as the external environment, that is, the street [14]. The biggest cause of falls was slipping and tripping. The data showed a higher rate of falls on the street and urban mobility has a great influence on this aspect. The discontinuation of the sidewalks, the unevenness, the presence of holes and inadequate lighting, characterize factors of high risk for the elderly. It is noteworthy that these people have a progression of loss of functional capacities, presence of less muscle mass, a greater number of associated morbidities, leading to a worse functional state to face these existing extrinsic factors [14,15]. The balance optimization found in this study is corroborated by other studies that also investigated the influence of VR on the components of postural control [16,17].

According to Phu et al. [17], in a study carried out to ascertain the effectiveness of VR training in reducing falls in the elderly, which also used the DGI test as a parameter for assessing balance, obtained positive results in the assessment that outcome. The authors report an increase in the support base of the participants, resulting in greater stability and greater safety in relation to falling, concluding that training with VR is a good ally for obtaining balance gain for patients, being an auxiliary resource to the treatment [17].

Duque et al. [18] in a study also carried out to evaluate the effect of balance training with VR in the elderly, showed a significant improvement in the parameters established for balance in the intervention group, after 6 weeks of training, also obtaining a reduction in the incidence of falls during this period. After nine months of training, the patients underwent a new evaluation, which resulted in a positive result for the maintenance and improvement of balance, however, there was no significant reduction in the episodes of falling in this reassessment [18]. Training using virtual reality involves tasks that stimulate cognition, as well as motor skills, generating an improvement in the user's balance, contributing to greater independence in activities of daily living, compared to training based only on motor exercises DE et al. [19].

In order to maintain balance, there is a need for integrity of the sensorimotor system, which includes muscle strength, proprioception and anticipatory and adaptive mechanisms, which are facilitated by immediate visual feedback due to interaction with the virtual reality system [20]. However, for the population participating in this study, the increase in functional balance and mobility was not enough to decrease the fear of falling, which goes against the results obtained by other studies of a similar character, such as the one by Camacho and Gomes (2017) [15]. It can be suggested that, because the training took place in a virtual indoor environment, and the episodes of falls pointed out by the research participants were the home environment and around it, it did not generate significant security to have a decrease in this fear of falling [15,17]. In addition, the major cause of falls recorded in the study was tripping and slipping, these are situations arising from walking. As a result, the individual tends to increase or decrease the fear of falling, when he is placed in a situation that he has already fallen. Therefore, the games used in therapy did not require the act of walking, and it may be something that did not lead the elderly to remember the fear of falling, and with that in the end, they did not improve in this regard [4].

Something that can also be taken into consideration is the period of therapy. Due to the fact that the research was carried out with only 16 sessions, it may have been a short period, so that the participants had the perception that the balance was improving their activities of daily living. And the failure to obtain this feeling that the balance has improved, together with the proposed environment in virtual reality is not the environment similar to the fall, may have raised the feeling of fear of falling [5,21]. Perhaps the best training for the elderly, which obtains greater effectiveness is not indoor, but a training that brings them to their common environment. And offering a greater number of sessions, thus increasing the training time, so that you can more effectively obtain the perception and raise the feeling of security from the fear of falling. As studies on the theme of virtual reality are still in small quantities and new, there is a need for more research with this type of approach, to add to the range of resources generating a more effective and attractive

therapy for the user. Fear of falling is characterized as one of the most disabling sequelae in the elderly, being presented in 88.5% of cases of post-fall, it brings with it a decrease in mobility and an increase in muscle disuse. That is, the inactivity caused by fear exacerbates the functional and balance loss, this fear can progress and become debilitating, directly impacting the daily activities of the elderly [22,23].

The fear that a new episode of falling may happen, may become a starting point for psychological manifestations in the elderly, such as anxiety symptoms, low self-esteem, and present feelings of fragility, insecurity and vulnerability of new episodes. Despite being a multifactorial event and causing physical disorders, it is important to keep an eye on the psychic and behavioral manifestations that the elderly may experience after the fall episode [24-26].

Conclusion

This study showed that the immersive virtual reality resource, for the studied population, was effective for optimizing the functional balance, showing no influence on the reduction of fear of falling.

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