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Promoting elderly mobility and fall prevention through virtual reality: a sustainable approach to gait balance training

Promoção da mobilidade de idosos e prevenção de quedas por meio da realidade virtual: uma abordagem sustentável para o treinamento de equilíbrio da marcha

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ABSTRACT

Background: Deterioration of physical coordinative capacity, balance and falls cause significant physical repercussions in the older adult population. **Objective**: to design a program for gait balance training in older adults at risk of falls using Virtual Reality. **Methods**: descriptive study, with quantitative approach, longitudinal cut, fifteen older adults with an age range from 65 to 84 years belonging to the care unit "Dulce Hogar" of one of the MIES projects participated, all of them executed the program through virtual reality for 16 weeks with a frequency of 1 session per week. Participants were evaluated before and after the intervention using the Tinetti scale and the unipodal (timed) station. **Results**: for the statistical analysis the SPSS version 29.0 computer system was used, the Student's t-test was used with a statistical significance $p<0.05$, yielding results of $p<0.001$ in all parameters tested: balance, gait and risk of falls. The results were expressed in statistical tables with their respective analyses. **Conclusions**: Virtual Reality applied in a gait balance training program for the elderly is beneficial because it showed a better balance, better gait performance and decreased the risk of falls in the elderly.

Keywords: balance; accidental falls; virtual reality; elderly; social inclusion; sustainability.

RESUMO

Antecedentes: A deterioração da capacidade de coordenação física, o equilíbrio e as quedas causam repercussões físicas significativas na população idosa. Objetivo: elaborar um programa de treinamento de equilíbrio de marcha em idosos com risco de quedas usando Realidade Virtual. **Métodos**: estudo descritivo, com abordagem quantitativa, corte longitudinal, participaram 15 idosos com faixa etária de 65 a 84 anos pertencentes à unidade de atendimento "Dulce Hogar" de um dos projetos do MIES, todos eles executaram o programa por meio de realidade virtual durante 16 semanas com frequência de 1 sessão por semana. Os participantes foram avaliados antes e depois da intervenção usando a escala de Tinetti e a estação unipodal (cronometrada). **Resultados**: para a análise estatística foi utilizado o sistema de computador SPSS versão 29.0, o teste t de Student foi utilizado com significância estatística $p<0,05$, produzindo resultados de $p<0,001$ em todos os parâmetros testados: equilíbrio, marcha e risco de quedas. Os resultados foram expressos em tabelas estatísticas com suas respectivas análises. **Conclusões**: A Realidade Virtual aplicada em um programa de treinamento de equilíbrio de marcha para idosos é benéfica, pois apresentou melhor equilíbrio, melhor desempenho de marcha e diminuiu o risco de quedas em idosos.

Palavras-chave: equilíbrio; quedas acidentais; realidade virtual; idosos; inclusão social; sustentabilidade.

INTRODUCTION

Aging is the sum of morphological and physiological changes that gradually accumulate in the individual and modify all systems of the human body (Rico-Rosillo et al., 2018). It affects the static and dynamic balance that are only achieved through the interaction of the central nervous system, musculoskeletal reflex arcs, proprioceptive vestibular reflexes and

visual systems (Freire et al., 2022). These alterations in physical, coordination and balance capacity trigger the risk of falling, which represents one of the main causes of morbidity, mortality, or causes social, psychological, and physical repercussions such as fractures, polytrauma, generating loss of autonomy.(Martinez-Gonzalez et al., 2020). In other words, musculoskeletal deficiencies are debilitating conditions that interfere with normal activities of daily living and harm the quality of life of this age group (Rose et al., 2018).

Population aging is one of the main demographic phenomena in the world. In Latin America and the Caribbean 13.4% of the population are people over 60 years of age according to the Economic Commission for Latin America and the Caribbean (ECLAC) United Nations (2022). One third of older adults (AM) have a high probability of suffering a fall each year, 20% of those who suffer falls need medical attention for serious injuries and 10% have fractures.(Martinez-Gonzalez et al., 2020).

In Ecuador, according to population projections from the National Institute of Statistics and Census (INEC) (2010), older adults represent 7% of the population, as indicated by the Ministry of Economic and Social Inclusion (MIES) (2020). The health, well-being and aging survey concluded that 37% of the elderly suffered falls in the last year according to Freire (2014). This is why the national government, through the MIES, complies with public policies to intervene in this problem.

In the Province of Bolívar, 10% of the population are seniors according to the National Institute of Statistics and Census (INEC), (2010). No official data was found regarding the rate of falls in them, however, in the study group that belongs to one of the MIES projects, through the application of the Tinetti scale in June 2022, a risk of falls was recorded in 65% of users. This is why it is essential to constantly update health care protocols and specific syndromes of this age group, to preserve their functionality and quality of life using all the tools and technological advances available. For example, Virtual Reality (VR) provides a modern and interactive approach to physical activity.

In recent years, virtual reality has been used in the field of medicine and rehabilitation. It is important to highlight a study carried out by Campo-Prieto et al., (2021), in which they analyzed the safety and experiences of Immersive Virtual Reality (IVR). The sessions were personalized, lasting 10 to 15 minutes for interaction with the game. Coordinated movements of all body segments were necessary. According to the results obtained in this study, the authors point out that IVR guarantees safety, feasibility and does not present adverse effects.

Similarly, Kamińska et al., (2018) conducted a study on the effectiveness of virtual reality training to reduce the risk of falls in older people, using the "Xbox 360 Kinect" to execute the VR training program. 23 individuals participated and it lasted 30 days. The intervention time was of 30 minutes 3 times a week. Several highly reliable tests were used with which they were able to show that VR-based training facilitates motor training, improves static and dynamic balance, and reduces the rate of falls.

Mascret et al., (2020) carried out research on the acceptance of a virtual reality headset designed for the prevention of falls in older adults, whose purpose was to evaluate the attitudes of older adults towards Immersive Virtual Reality (IVR). The results of the study demonstrated that the attitudes of the elderly became more positive after a first exposure to IVR. This proved that the contribution of IVR applications to the health of older adults will not be hindered by negative attitudes or cybersickness.

Ku et al., (2019) in their study evaluated the clinical efficiency of a three-dimensional interactive augmented reality system (3D-ARS) for balance and mobility rehabilitation. It aimed at training participants with a realistic 3D interactive balance exercise, with 36 participants and aged 56-76 years. The training was carried out three times a week for 1 month, and the sessions lasted 30 minutes. The authors concluded that significant changes occurred in the 3D-ARS group, thus demonstrating that this system can improve balance in older people more effectively.

Similarly, Seaaz-Moctezuma et al., (2019), in their research, analyzed the changes in the functional capacity and balance of the elderly. They applied the IREX (Immersive Rehabilitation Exercise) system, which facilitates the creation of educational and interactive environments to carry out physical activity. This can be done in segments or for the whole body. In this study, the exercises were performed in segments and involving balance. By obtaining significant changes in the quality of life of the participants, the authors conclude that this system improves functional capacity in this age group.

In this context Labra & Mahecha, (2020) conducted a study in older adults aged 65-85 years, to verify the effectiveness of an "exergames" program using "KineLabs 3D" on balance and functional mobility. It was carried out during 24 sessions with a frequency of 3 times a week. The authors determined that the program was beneficial for the balance and functionality of the older adult, since by constantly having visual feedback and dynamic interaction it allowed the older adult to remain interested and motivated when performing the exercises. Thus, it is a viable alternative for balance training.

In addition, Vries et al., (2018) searched virtual reality balance training for seniors, with the aim of evaluating the extent to which two similar ski games challenge balance. 30 young adults aged 18 to 35 were selected and 30 healthy older adults over 65 years old. The participants performed two ski games, one on the Wii Balance board (Wiiski), which uses a force

plate, and another with the Kinect sensor (Kinski), which tracks movement. The authors established that the Kinski game obtained larger changes in the evaluated parameters than the Wiiski game.

Similarly, Castillo-Daza et al., (2022) in their study evaluated the effects of virtual reality on body balance in the adult population. 30 subjects participated using the PlayStation VR headset in the underwater world scenario of the VR Word video game for 15 min. The authors concluded that the use of virtual reality goggles in a controlled environment generated significant changes at the level of balance and body balance due to the sensory and vestibular stimulation applied through the virtual reality goggles and the simulated environment. This showed greater stability.

Montealegre et al., (2021) developed a research project using semi-immersive virtual reality to determine appropriate exercises for the elderly, VR being an interactive alternative to exercise at home. The authors concluded that the proposed exercises can be performed during sessions of 30 to 50 minutes, 3 to 5 series of 8 to 20 repetitions. The maximum heart rate of each participant is considered, which will start at 30% and advance up to 75%.

Furthermore, in the research by Hernández et al., (2018), they analyzed the effects of training with Xbox Kinect on functional mobility in older adults. They found favorable changes in muscle strength, balance, functional mobility, cognitive function and knee proprioception in older adults. Therefore, this intervention has a direct influence on functional independence and quality of life.

Variations in body systems typical of aging are highly related to the increase of falls in older adults. And it is essential to intervene in the balance of this age group to preserve their functionality and independence when carrying out activities of daily living (Morejón et al., 2018). In this context, it is important to continue researching therapeutic alternatives that can influence the loss of balance in older adults. Therefore, this study aimed to design a program, using virtual reality, to train balance when walking in older adults who are at risk of falls.

METHODS

Descriptive study, with a quantitative, longitudinal approach to numerically measure the initial and final evaluations of the participants. The study was carried out in the "Dulce Hogar" Care Unit that provides home care through extramural service to older adults with quintiles of poverty and extreme poverty. It included the "Aging Together" project through an agreement signed by the Ministry of Economic Inclusion and Social and the Social and Economic Assistance Foundation "Semillas de Vida" of the Bolívar province, Ecuador. The census sample was of 15 older adults.

Inclusion criteria: individuals of both sexes with an age range of 65 to 84 years, who agreed to participate in the research, mestizo and indigenous individuals, subjects with a history of risk of falling due to the deterioration of physical functions due to aging. Exclusion criteria: individuals who do not understand the Spanish language 100%, subjects who present proven vestibular syndromes, individuals who use assistive devices, subjects with severe cognitive impairment, individuals with visual or auditory alterations, subjects with neurological pathologies.

As a diagnostic method, the Tinetti scale was used, a single-leg station (timed) to carry out the initial and final evaluation of the participants. 20 minutes were used for the application of the two scales. The Tinetti scale evaluates the mobility of the elderly. It is composed of 9 balance items and 7 gait items, which are rated 0: abnormal, 1: adaptive and 2: normal. The total score is 28, with the balance section being 16 and the gait section being 12. It is considered a high risk of falls: less than 19 points; risk of falls: from 19 to 23 points, and low risk of falls: from 24 to 28 points (Carballo-Rodríguez et al., 2018). The scale has proven to be a valid and reliable tool for the assessment of mobility (r 0.74-0.93), and it also has a high inter-observer reliability of 0.95.(Guevara & Lugo, 2012).

The Single-leg Station scale (timed) assesses the individual's center of gravity and its movements in a static position. The elderly are instructed to cross the arms over the chest, rest the hands on the shoulders and perform triple-flexion of a leg at 90° and maintaining as much time as possible on one foot, with a maximum of 30 seconds (sec). The procedure will be repeated three times, considering the best time obtained. It is assumed that an old adult presents a high risk of falls by not maintaining the position ≥5 sec.(Mancilla et al., 2015). In relation to inter- and intraobserver reliability, there are internal consistency values of 0.98-0.99.(Concha, 2016).

For the design of the virtual reality program, the Nintendo Wii home console model RVL-001 was used, which has a series of games based on the improvement of physical abilities and through the Wii Balance Board peripheral device, which has inside pressure sensors. It is possible to measure the weight and position of the center of gravity of the participant. The balance platform works with the Wii Fit software which saves the information captured by the participant (Clark et al., 2010). The virtual character provides immediate visual or auditory feedback allowing participants to adjust their own movements according to the feedback in real time (Liao et al., 2015). Using the Wii Fit system, various programs have been carried out to

improve balance in older adults (Molhemi et al., 2021), (Sultana et al., 2020),(Aijse et al., 2018).

The present study was carried out over a period of 16 weeks. In week 1, the clinical history of the Ministry of Public Health (MSP) of Ecuador (2009), the Tinetti scale and single-leg station (timed) were applied. The program consisting of 3 phases, which was applied once a week. The following Wii Fit games were chosen to perform the exercises: 1. "Soccer Heading", the participant was given instructions to head the soccer balls while they were kicked, avoiding other flying objects. They had to tilt his body to the left and right to direct the soccer balls that were flying towards them. 2. "Table Tilt", the subject had to tilt his body to the left, to the right, forward and backward to take the balls towards the holes, during the established time. **3**. "**Pengui Slide",** the individual moves his o her body quickly to the left and right to tilt the iceberg and feed the penguin. **4. "Snowboard Slalom"**, the participant had to lean to the left, to the right, to the back and forth to pass between the flags while snowboarding. **5. "Ski Slalom"** the individual had to lean left and right to go through the gates and ski on a slalom course. **6. "Balance Bubble**", to advance the participant had to move forward and lean left and right to direct. **7. "Tightrope Walk",** the subject walked in place to cross the tightrope, bending and straightening the knees to jump and pass over the obstacles. **8. "Lotus Focus",** the participant had to sit on the balance board, with their back straight, with legs crossed or if that was difficult with their legs straight. They had to keep the body still so that the fire did not go out.

The time and number of repetitions increased progressively: phase 1 was from week 2 to 7. A series of each proposed exercise was performed and it lasted 11 minutes. Phase 2 was from week 8 to 11, in which two series of each proposed exercise were executed, except for exercise number 8, which will remain in one series, thus progressively increasing the program time, reaching 20 minutes. Phase 3 was from week 12 to 15 in which three series of each proposed exercise were performed, except in exercises 4 and 5 which were performed in four series and exercise 8 in which one series was performed, thus ending the execution phase of the program with a time of 30 minutes. Finally, the final evaluation was carried out with the Tinetti scale and Unipodal Station (timed) in week 16.

Statistical analysis

To analyze the results, the SPSS computer system, Spanish version 29.0 for Windows was used. Statistical decisions were made at a significance level of $p<0.05$. The statistics used were univariate descriptive for the sociodemographic variables (age, sex). The confirmation of the hypothesis was carried out through the normality test, taking into account that there are 15 participants. The Shapiro-Wilk test was used to analyze the normal distribution of the initial and final evaluations, resulting in $p>0.05$. Therefore, it was confirmed that the distribution of the analyzed data meets the assumption of normality. So, the parametric Student's T test was applied for related samples, and the results of which were expressed in statistical tables with their respective analyses.

Ethical considerations

The current research was approved by the Ethics Committee for Research on Human Beings of the Faculty of Health Sciences, Technical University of Ambato with code 046-CEISH-UTA-2023 where it is concluded that the research complies with all the ethical, methodological and legal requirements established by the Committee's regulations.

RESULTS

SOCIODEMOGRAPHIC CHARACTERISTICS

In the sociodemographic characteristics, the participants who belong to the "Dulce Hogar" Care Unit are distributed by age ranges: from 65 to 74 years, in which there are 9 older adults who represent 60% and from 75 to 84 years, in which includes 6 older adults who represent 40%. The 65- to 74-year-old group was predominat. A larger female population was identified with 10 participants corresponding to 66.7%, in contrast to 5 male participants corresponding to 33.3% of the total population (Table 1).

Table 1. Sociodemographic characteristics of the "Dulce Hogar" Care Unit

Age	Frequency	Percentage (%)
65-74	9	60.0
75-84	6	40.0
Total	**15**	**100.0**
Sex		
Female	10	66.7
Male	5	33.3
Total	**15**	**100.0**

Source: Medical records from the "Dulce Hogar" Care Unit

TINETTI SCALE

The Tinetti scale was used, which evaluates the mobility of the elderly and presents quantitative scoring criteria. The balance, gait and risk of falls sections were evaluated separately.

Balance

In the balance section, 2 older adults with a score of 7 are initially shown, representing 13.3%, a figure that is no longer evident in the final evaluation. 2 older adults with a score of 8, which corresponds to 13.3% initially, a figure that is not reflected in the final evaluation. Initially, 3 older adults with a score of 9 are shown, represented by 20.0%, a figure that finally decreased to 1 older adult, which corresponds to 6.7%. Initially, 1 older adult was obtained with a score of 10, which represents 6.7%, a figure that is finally no longer evident. In the initial evaluation, 1 older adult was obtained with a score of 11, representing 6.7%, however this figure is no longer taken into account in the final evaluation. Initially, 3 older adults obtained a score of 12, which corresponds to 20.0%, a figure that increases to 4 older adults, representing 26.7% in the final evaluation. In the initial evaluation the score of 13 is not taken into account, however, in the final evaluation 1 older adult achieved this score, which corresponds to 6.7%. In the initial evaluation, 1 older adult achieved a score of 14, representing 6.7%, a figure that increased to 2 older adults, representing 13.3%. Initially, 2 older adults achieved the score of 15 represented with 13.3%, a figure that was finally maintained. In the initial evaluation, no older adult obtained the maximum score, which is 16, however, in the final evaluation, 3 older adults achieved a score of 16, which corresponds to 20.0% (Table 2).

Table 2. Initial Balance vs Final Balance with the Tinetti Scale

Punctuation	Initial balance		Final balance	
	Frequency	Percentage (%)	Frequency	Percentage (%)
7	2	13.3	-	-
8	2	13.3	-	-
9	3	20.0	1	6.7
10	1	6.7	-	-
11	1	6.7	2	13.3
12	3	13.3	4	26.7
13	-	-	1	6.7
14	1	6.7	2	13.3
15	2	13.3	2	13.3
16	-	-	3	20.0
Total	15	100.0	15	100.0

Source: Tinetti scale

Hypothesis testing test for equilibrium

In the balance section, the student's T test was used at a confidence level of 95%, yielding a result of $p<0.001$, with which the null hypothesis is rejected. That is, the program was effective for the balance of the elderly. (Table 3).

Table 3. Paired samples test

	Paired differences						
		Standard	95% confidence interval of the difference				
	Half	deviation	lower	Superior	T	l	Sig. (bilateral)
FINAL BALANCE - INITIAL BALANCE	3,667	1,447	2,865	4,468	.811	4	,000

Source: IBM SPSS program

Gait

In the walking section, 5 older adults with a score of 8 are initially shown, representing 33.3%, a figure that decreased to 1 older adult, corresponding to 6.7% in the final evaluation. Initially, 6 older adults obtained a score of 9, which corresponds to 40%, a figure that finally decreased to 4 older adults represented with 26.6%. In the initial evaluation, there were 2 older adults with a score of 10, representing 13.3%, a figure that increased to 6 older adults represented with 40% in the final evaluation. Initially, 2 older adults achieved a score of 11, which represents 13.3%, a figure that finally decreased to 1 older adult, which corresponds to 6.7%. In the initial evaluation, no older adult obtained the maximum score, which is 12, however, in the final evaluation, 3 older adults reached the score of 12, which represents 20.0%. (Table 4)

Table 4. Initial gait vs Final gait

Punctuation	Initial gait		Final gait	
	Frequency	Percentage (%)	Frequency	Percentage (%)
8	5	33.3	1	6.7
9	6	40.0	4	26.6
10	2	13.3	6	40.0
11	2	13.3	1	6.7
12	-	-	3	20.0
Total	**15**	**100.0**	**15**	**100.0**

Source: Tinetti scale

Hypothesis testing test for gait

In the walking section, the student's T test was used at a confidence level of 95%, yielding a result of p<0.001, with which the null hypothesis is rejected. That is, the program was effective for gait in the elderly (Table 5).

Table 5. Paired Samples Test

	Paired differences						
			95% confidence interval of the difference				
	Half	Standard deviation	lower	Superior	T	l	Sig. (bilateral)
FINAL GEAR - INITIAL GEAR	1,400	.986	.854	1,946	,501	4	,000

Source: IBM SPSS program

Risk of falls

The risk of falls initially shows 7 older adults within the high risk of falls range, representing 46.7%, however, this figure decreased completely, so for the final evaluation this range disappeared. In the initial evaluation, 6 older adults were within the fall risk range, which corresponds to 40%, a figure that increased to 8, which corresponds to 53.3% in the final evaluation. Initially, 2 older adults obtained the low risk of falls range represented with 13.3%, a figure that finally increased to 7 older adults corresponding to 46.7% (Table 6).

Table 6. Initial fall risk vs. final fall risk

	Initial risk of falls		Final risk of falls	
	Frequency	Percentage (%)	Frequency	Percentage (%)
High Risk of Falls	7	46.7	-	-
Risk of falls	6	40.0	8	53.3
Low Risk of Falls	2	13.3	7	46.7
Total	**15**	**100.0**	**15**	**100.0**

Source: Tinetti scale

Hypothesis testing test for risk of falls

The risk of falls was worked with the student's T test at a confidence level of 95%, yielding a result p<0.001, with which the null hypothesis is rejected. That is, the program was effective for the risk of falls in the elderly (Table 7).

Table 7. Paired Samples Test

	Paired differences						
		Standard	95% confidence interval of the difference				
	Half	deviation	lower	Superior	T	I	Sig. (bilateral)
FINAL RISK OF FALLS – INITIAL RISK OF FALLS	1.00000	.53452	.70399	1.29601	.246	4	,000

Source: IBM SPSS program

UNIPODAL STATION (TIMED)

In the single-leg (timed) station that assesses the individual's center of gravity and its movements in a static position, initially shown: 1 older adult with a score of 2 (sec) which represents 6.7%, a figure that is no longer taken into account for the final evaluation. In the initial evaluation, 5 older adults obtained a score of 3 (sec), which corresponds to 33.3%, a figure that decreased to 2 older adults, which represents 13.3% in the final evaluation. Initially, 4 older adults achieved a score of 4 (sec), which represents 26.7%, a figure that finally decreased to 1 older adult, which corresponds to 6.7%. Initially, 5 older adults achieved the score of 5 (sec), which represents 33.3%, a figure that is finally no longer taken into account. In the initial evaluation no older adult achieved more than 5 (sec), however, in the final evaluation 3 older adults achieved the score of 6 (sec) which represents 20.0%, 2 older adults achieved the score of 7 (sec). sec) which corresponds to 13.3%, 4 older adults achieved the score of 8 (sec) which represents 26.7% and 10 older adults achieved the score of 10 (sec) which represents 20.0% (Table 8).

Table 8. Initial evaluation and final evaluation with the Unipodal Station (timed)

Punctuation	initial evaluation		Final evaluation	
	Frequency	Percentage (%)	Frequency	Percentage (%)
2 (sec)	1	6.7	-	-
3 (sec)	5	33.3	2	13.3
4 (sec)	4	26.7	1	6.7
5 (sec)	5	33.3	-	-
6 (sec)	-	-	3	20.0
7(sec)	-	-	2	13.3
8 (sec)	-	-	4	26.7
10 (sec)	-	-	3	20.0
Total	**15**	**100.0**	**15**	**100.0**

Source: Single leg station (timed)

Hypothesis testing test for risk of falls

The risk of falls was worked with the student's T test at a confidence level of 95%, yielding a result $p<0.001$, with which the null hypothesis is rejected. That is, the program was effective for the risk of falls in old adults. (Table 9).

Table 9. Paired Samples Test

	Paired differences						
		Standard	95% confidence interval of the difference				
	Half	deviation	lower	Superior	T	I	Sig. (bilateral)
FINAL EVALUATION - INITIAL EVALUATION	.067	1,944	1,990	4,143	.108	4	,000

Source: IBM SPSS program

DISCUSSION

The present research was developed with 15 older adults who belong to the "Dulce Hogar" Care Unit. As for sociodemographic characteristics, the group of 65 to 74 years old predominates with 60.0%, and the female sex with 66.7%. It is similar to the study carried out by Mascret et al., (2020) who found a prevalence of 60.5% in the same age group and unlike the study by Kamińska et al., (2018) who worked with a female population of 82.6% of older adults.

In the research, the Tinetti scale was used that evaluates the mobility of the elderly and through the sections of balance, gait and risk of falls. The initial and final evaluations were contrasted to evaluate the effectiveness of the program through virtual reality based on Wii games. Fit. The student's T test was used at a confidence level of 95%, obtaining a result of $p<0.001$ in the three sections, with which the null hypothesis was rejected due to the significance of $p<0.05$. This proved that the program was effective for the balance in gait of older adults at risk of falls. These results are consistent with those obtained in the research of Kim & Cho, (2022)in which they analyzed the benefits of a virtual reality program on balance and falls in older adults. The program was carried out using a Wii Fit game program and as a measurement instrument they used the Tinetti scale in which a significant decrease of fear of falling was evident in all periods $p<0.05$. Thereby, it is confirmed that the virtual reality program was effective for all static balance skills and fall efficiency.

To execute the virtual reality program, some Wii Fit games were chosen to perform the exercises. It consists of 3 phases, the time and number of repetitions increased progressively until reaching a time of 30 minutes. It was applied once a week, for 16 weeks. This program is a viable alternative for balance training in older adults at risk of falls due to its ease of use and application, in addition to being interactive, with visual and auditory stimuli, which allows attention and constant motivation of this age group. In relation to it Saeed Yousefi Babadi, (2021)also conducted a study on the effects of virtual reality on balance. It was developed with 60-minute interventions, 3 times a week and for 9 weeks. It was concluded that a virtual reality training program can be a safe, pleasant and accessible alternative that can be used as a new training method to improve balance in elderly populations. In this research, it is agreed that a virtual reality program is effective and very useful for improving balance in older adults.

Likewise, this research contributed to the literature on the viable benefits of balance training based on Virtual Reality for older adults. Sultana et al., (2020) conducted a systematic review and meta-analysis to evaluate the effects of Wii Fit physical training on the balance of older adults in which they concluded that training with Wii Fit has a positive effect on balance in older adults. However, more research is needed with sufficient power to evaluate its effectiveness.

CONCLUSIONS

The application of the program for training balance in the gait of the elderly at risk of falls through virtual reality had favorable results. Based on the comparisons made between the initial and final evaluation, there were significant differences with greater balance and better gait execution. Regarding the risk of falls, the high risk of falls category was no longer evident and the majority of older adults achieved the risk-of-falls category, while the others remain in the low-risk category.

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