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CORE Strengthening Exercise Program for the management of falls in older adults

Programa de ejercicios de fortalecimiento del tronco para el tratamiento de las caídas en personas mayores

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ABSTRACT

Background: The risk of falls is a common problem in older adults that can have serious consequences. They can cause fractures, brain injuries, hospitalization and disability, which can affect the quality of life and autonomy of older people. The strengthening of the CORE (Word in English that means Center and refers to the central region of the human body) is an effective strategy to reduce the risk of falls and improve well-being in the geriatric population. **Objective**: To compare the results before and after the intervention where a Core strengthening exercise program was used. **Methods**: The methodology considered was quantitative, longitudinal and descriptive, to assess the risk of falls in the population studied, the Berg and TUG (Timed Up and go) tests were used. They were applied at the beginning and at the end of the treatment through an intervention program of exercises of strengthening of the core muscles. **Results**: The data obtained show that there was a reduction in the risk of falls in the studied population. The two tests used obtained results of p=0.000, demonstrating that the intervention achieved the expected results. **Conclusions**: It is concluded that Core strengthening exercises reduce the risk of falls in older adults.

Keywords: resistance training; abdominal CORE; accidental falls; aged.

RESUMEN

Antecedentes: El riesgo de caídas es un problema común en los adultos mayores que puede tener graves consecuencias. Pueden causar fracturas, lesiones cerebrales, hospitalización y discapacidad, lo que puede afectar a la calidad de vida y la autonomía de las personas mayores. El fortalecimiento del CORE (palabra en inglés que significa Centro y se refiere a la región central del cuerpo humano) es una estrategia eficaz para reducir el riesgo de caídas y mejorar el bienestar en la población geriátrica. **Objetivo**: Comparar los resultados antes y después de la intervención en la que se utilizó un programa de ejercicios de fortalecimiento del tronco. **Métodos**: La metodología considerada fue cuantitativa, longitudinal y descriptiva, para valorar el riesgo de caídas en la población estudiada se utilizaron los test de Berg y TUG (Timed Up and go). Se aplicaron al inicio y al final del tratamiento mediante un programa de intervención de ejercicios de fortalecimiento de la musculatura del tronco. **Resultados**: Los datos obtenidos muestran que hubo una reducción del riesgo de caídas en la población estudiada. Las dos pruebas utilizadas obtuvieron resultados de p=0,000, demostrando que la intervención alcanzó los resultados esperados. **Conclusiones**: Se concluye que los ejercicios de fortalecimiento del tronco reducen el riesgo de caídas en adultos mayores.

Palabras clave: entrenamiento de resistencia; CORE abdominal; caídas accidentales; edad.

INTRODUCTION

Aging is defined as a constant and irreversible natural process experienced by humans (Thomas et al., 2019; Fernández et al., 2021). This process gives rise to a series of functional changes that contribute to the increased incidence of falls (Liepa et al., 2019). Aging is a significant risk factor due to changes in mobility and balance (Smith et al., 2019). Numerous research studies have demonstrated a relationship between age and the possibility of falling (Martínez et al., 2020)

Falls are defined, according to the World Health Organization (WHO, 2021), as involuntary movements that affect and reduce balance, representing one of the most common causes of geriatric injuries with a high risk of morbidity and mortality (Pérez de Alejo et al., 2020). Statistics show that there are approximately 37.3 million falls in older adults (OA), with 424,000 fatal cases, which places them as the sixth cause of death worldwide. According to the Ministry of Economic and Social Inclusion in Ecuador, there are 1,049,824 people over 65 years of age, which corresponds to 6.5% of the population. In 2017, people over 75 years of age represented 40.6% of the falls recorded in the country (Astudillo et al., 2017).

Several studies have highlighted the importance of understanding the increase of the risk of falls in OA with chronic medical conditions, such as cardiovascular diseases, osteoporosis and diabetes (Johnson et al., 2020). Additionally, the physical environment plays a crucial role, as obstacles in the home and lack of adequate lighting can contribute to falls in this population (Brown et al., 2021; Lee et al., 2022).

Prevention and management of falls is an important factor in geriatric patients. It has been shown that individualized evaluation and intervention, accompanied by timely follow-up, can reduce the incidence of falls by up to 24% (López et al., 2021). Programs that include resistance, strength, balance, coordination, and flexibility exercises are an excellent option to improve functionality. They reduce the risk of falls and improve gait and balance parameters. (Cigarroa et al., 2021). It is necessary to perform exercise interventions by working in muscle strength and power training in OA. This directly affects the reduction in the incidence of falls (Riaño et al., 2018; Solís et al., 2022). However, for older adults, the adoption of exercise strategies should be performed with caution and thorough planning to minimize the risk of injury (Vieira Costa & Silva Dias, 2024).

CORE, which is an English word that means center, refers to a group of muscles found in the central region of the body, specifically in the area of the abdomen and lower back (Hsu et al., 2018). The muscles that make up the CORE are the abdominal and paraspinal muscles, glutes, diaphragm and pelvic floor muscles. They work together to stabilize the spine and pelvis during movement (Chung et al., 2013). Strengthening these muscles plays a crucial role in preventing falls. The activation of these is essential to create a stable and safe base for the movement of the upper and lower limbs (Silhi-Vargas et al., 2022). Training the muscles of the CORE can significantly improve the static balance ability in AMs (Xu, 2022).

In relation to specific studies, CORE training has been shown to have positive effects on the balance and gait of the OA, which contributes to reducing the risk of falls. It has been found that CORE training significantly improves balance and gait in the geriatric population (Hall et al., 2017).

Furthermore, it has been observed that education and the implementation of different interventions can modify the risk factors associated with falls in the elderly. This includes addressing balance and strength issues, which are modifiable, thereby achieving notable improvement in fall risk reduction and quality of life for this population (Burns & Kakara, 2018).

METHODOLOGY

This research was carried out at "Mi Lindo Pilahuín" Senior Adult Club located in the province of Tungurahua-Ecuador, directed by the Decentralized Autonomous Government (GAD) of the Pilahuín parish. It has a population of 45 older adults, of which 21 participated in the research and met all the inclusion and exclusion criteria.

This research was longitudinal since an intervention was carried out in the OA. The risk of falls was evaluated at the beginning and at the end of the treatment. Both qualitative and quantitative data were collected from the assessed individuals, following up the participants for a determined time period which in this case was 16 weeks and the research design is based on non-experimental models.

Inclusion criteria

People 65 years old or older

Men and women

Mestizos and indigenous

Exclusion criteria

People who do not understand the Spanish language

People with surgeries less than 6 months

People with uncontrolled hypertension

Data collection plan:

The study was carried out with 21 older adults of both sexes, 13 women and 8 men, who met all the inclusion and exclusion criteria from whom their sociodemographic data was taken at the beginning of the intervention. This included sex, weight, height, and body mass (BMI). To measure weight and height, the technique of Frankfurt map was applied and a Healthweigh scale-stadiometer, Rice Lake model was used. To calculate the BMI, the following formula was utilized: weight in kilograms divided by height in meters squared (BMI = weight in kg / (height in meters) ^{2} (Weir & Jan 2022). Within the BMI ranges are:

- Underweight: BMI less than 18.5
- Normal weight: BMI between 18.5 and 24.9
- Overweight: BMI between 25 and 29.9
- Obesity class I: BMI between 30 and 34.9
- Obesity class II: BMI between 35 and 39.9
- Class III obesity: BMI equal to or greater than 40

The project lasted 16 weeks, for which the risk of falling was assessed at the beginning and at the end of the intervention. The Berg tests were used to assess static balance and the Timed Up and Go (TUG) test to assess dynamic balance.

The Berg test is a tool to assess a quantitative measure of the functional state of balance in the elderly.

It has a reliability that is above 0.90 (Bouça-Machado et al., 2022). It consists of 14 items where each item consists of 5 values from 0 to 4 where a value is given depending on the ability of the older adult to sit, stand, extend arms, stand on one leg, and turn.

At the end, the values obtained in each item were added. The score obtained in this test revealed the risk of falls that older adults have, being:

0-20 High risk of falls

21-40 Moderate risk of falls

41-56 Slight risk of falls

To assess dynamic balance, the TUG test was applied, which is a test indicated to evaluate the risk of falls. It demonstrates very good test-retest reliability (ICC 0.80-0.99) (Ugarte & Vargas, 2021). The older adult must sit in a chair and is asked to get up and walk forward 3 meters after turning and sit back in the same chair. This is assessed using a stopwatch, and depending on the time the older adult delays performing the test, the following results will be obtained:

Less than 10 seconds: low risk of falling.

Between 10 and 20 seconds: indicates fragility (risk of falling).

More than 20 seconds: High risk of falling

The remaining 14 weeks were used to apply the CORE muscle strengthening exercise program. It was carried out in sessions, with a total of 28 divided into three phases, starting with simple, low-intensity exercises and increasing as they progressed. They mastered the exercises, always respecting the rule of no pain and correct posture.

Phase I.- It was applied from session 1 to 9 and consisted of 7 exercises.

Phase II.- It was applied from session 10 to 19 and consisted of 6 exercises.

Phase III.- It was applied from session 20 to 28 and consisted of 6 exercises.

Participants attended twice a week for an approximate time of 40 minutes per session.

Statistical analysis

The tabulation was carried out in the Microsoft Excel program, which was processed in the SPSS Computer System, version 25.0 for Windows in Spanish. The mean and standard deviation were analyzed, then a database was created to tabulate and analyze them, the results were presented in tables and to check the significance the T-test was used. A value of p=0.000 was obtained.

Bioethical Considerations

To carry out this research, the informed consent was used, which contained all the information about this project, and was signed by all participants.

Through resolution **021-CEISH-UTA-2023** this research project was approved by the bioethics committee of the Technical University of Ambato. It states that this research complies with all the ethical, methodological and legal requirements established by the regulations of the Committee.

RESULTS AND DISCUSSION

For the analysis of sociodemographic data of the "Mi lindo Pilahuín" older adults' club who participated in the research, tabulation of sex, weight, height, and BMI was applied.

We worked with a female population of 13 people, which corresponds to 69.9%, and a male population of 8, which corresponds to 38.1%. Regarding the weight of older adults, 23.8% have a range between 40 to 50 kg, 42.9% maintain a weight between 51 to 60 kg, 19% weigh between 61 to 70 kg and 14.3 % has a weight of between 71 to 80 kg.

In relation to height, 47.6% measure between 1.40-1.50 cm and 52.4% maintain a height between 1.51-1.60 cm. Regarding the body mass index, 47.6% have a normal composition, 42.9% are overweight and 9.9% are obese:

Table 1. Sociodemographic variables of the older adults of the Mi Lindo Pilahuín Club who participated in the research.

		Frequency	Percentage
Sex	Female	13	61.9
	Male	8	38.1
Weight	40-50kg	5	23.8
	51-60kg	9	42.9
	61-70kg	4	19.0
	71-80kg	3	14.3
Size	1.40-1.50m	10	47.6
	1.51-1.60m	11	52.4
BMI	Normal	10	47.6
	Overweight	9	42.9
	Obesity	2	9.9

Regarding the assessment of static balance where the Berg Test was used, it can be seen that in the initial assessment 57.1% had a slight risk of falls, while 42.9% had a moderate risk of falls. There were no participants with a high risk of falls while in the final assessment 100% of the participants reached a slight risk of falls.

Table 2. Assessment of static balance before and after the intervention.

		Initial		Final	
Assessment of static balance (Berg Test)	**Falling risk**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
	Slight risk of falls	12	57.1%	21	100%
	Moderate risk of falls	9	42.9%	0	000%
	High risk of falls	0	00.0%	0	0.00%

Meanwhile, in the assessment of dynamic balance where the TUG Test was used, it is seen that in the initial assessment there are 90.5% of people at risk of falls and 9.5% at high risk, with no data for low risk of falling. As for the final assessment there are 42.9% with a low risk of falls and 57.1% with a risk of falls, leaving no older adults with a high risk of falls.

Table 3. Assessment of dynamic balance before and after the intervention

		Initial		Final	
	Falling risk	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Assessment of dynamic balance (TUG Test)	**Low risk of falling**	0	0.00%	9	42.9%
	Falling risk	19	90.5%	12	57.1%
	High risk of falling	2	9.5%	0	0.00%

TUG (Timed up and go)

In Table 4 it can be seen that the level of significance is lower at p=≤0.005 in both static balance and dynamic balance, which shows that the exercise of the CORE muscles reduces the risk of falls in older adults who participated in the intervention.

Table 4.- Descriptive statistics of dynamic and static balance before and after the intervention

Assessment	**Female**		**Male**		**Total**		**p value**
	n= 13 (61.9%)		**n=8 (38.1%)**		**n= 21 (100%)**		
	Initial	**Final**	**Initial**	**Final**	**Initial**	**Final**	
	Mean ± SD	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**	
Dynamic balance (TUG)	12.31±1.25	9.62±1.33	15.38±3.74	12.38±3.78	13.48±2.86	10.67±2.82	0.000
Statistical Equilibrium (Berg Test)	44.69±6.17	51.3 ±3.18	40.75±7.36	48.13 ±5.41	43.19±6.76	50.14 ±4.35	0.000

In the TUG test, the mean of 13.48 seconds in the initial assessment indicates that the patients took approximately 13.5 seconds to perform the test, with a variability of approximately 2.9 seconds. In the final assessment, the mean of 10.67 seconds suggests that patients improved their time by approximately 2.8 seconds, indicating a significant improvement in mobility.

In the Berg test, the initial assessment of 43.19 points suggests a moderate level of balance and mobility in the patients, with a variability of approximately 6.8 points. In the final assessment, the mean of 50.14 points indicates a significant improvement in the patients' balance and mobility, with a reduction of approximately 2.4 points in the standard deviation.

Discussion

The risk of falls in older adults is an important concern due to its high prevalence and its negative consequences on people's quality of life. Risk factors for falls are multifactorial, and the relationship between sex, height, weight and BMI with the risk of falls in older adults has been investigated.

Sex: There is evidence that sex may be a risk factor for falls in older adults. In a study of 10,143 older adults in the United States, men had a higher risk of falls compared to women (Li et al., 2021). However, in another study of 1,036 older adults in Spain, no significant association was found between sex and the risk of falls (Canales et al., 2020). This suggests that the relationship between sex and fall risk may be complex and may vary depending on the population studied.

Weight and Body Mass Index: Weight and BMI have also been studied as risk factors for falls in older adults. In a study of 926 older adults in South Korea, BMI was found to be inversely associated with the risk of falls after adjusting for age, sex, physical activity level, and other variables (Kim et al., 2018). This suggests that older adults with a higher BMI may have a lower risk of falls compared to older adults with a lower BMI.

Height: Height has also been studied as a risk factor for falls in older adults. In a study of 1,294 older adults in China, height was found to be inversely associated with fall risk after adjusting for age, sex, body mass index, and other variables (Wang et al., 2018). This suggests that taller older adults may have a lower risk of falls compared to shorter older adults.

Overall, the results of the studies reviewed suggest that sex, height, weight, and body mass index may be associated with the risk of falls in older adults. However, it is important to keep in mind that the relationship between these factors and the risk of falls can be complex and may vary depending on the population studied.

The present research yields encouraging results on the effectiveness of strengthening the core muscles on reducing the risk of falls in older adults through the results obtained with The Berg test and the TUG test (p =0.000). In this way, working on the core muscles reduces the risk of falls in this population, coinciding with studies carried out by other authors.

A study published by (Ponde et.al 2021) where they analyzed "The Effect of CORE stabilization exercises on balance performance in Older Adults", had an experimental group and a control group. The risk of falling was evaluated using the scale de Berg, Balance test and functional reach test before and after intervention. After six weeks of intervention in the

experimental group, a significant improvement was observed in the scores of the Berg Balance scale ($p \leq 0.05$), balance test ($p \leq 0.05$) and functional reach test ($p \leq 0.05$). Compared to the control group, no significant improvement was observed ($p \geq 0.05$).

Likewise, in the study by (Sadeghi et al., 2020) where a randomized controlled experimental design was used, participants were randomly assigned to an intervention group that received central stabilization exercises or to a control group that did not receive intervention.

At the end of the research, the authors obtained the following results: core stability training had a significant effect on static balance with open and closed eyes, TUG and 10-meter walk ($p = 0.001$). The control group did not show a significant effect on the static balance factors of eyes closed, TUG, and 10-meter walk. After the training period, the experimental group showed a significantly better status in all variables compared to the control group ($0.91 \leq \eta 2 \leq 0.94$, $p = 0.001$).

CONCLUSION

Regarding gender, it is observed that the majority of the sample is made up of women (69.9%) in relation to the male population (38.1%). About weight, the majority of participants have a weight in the range of 51 to 60 kg (42.9%), followed by those who have a weight between 40 and 50 kg (23.8%). Regarding height, the majority of participants measure between 1.51-1.60 cm (52.4%).

Concerning body mass index, most participants have a normal body composition (47.6%), followed by those who are overweight (42.9%). Only a small percentage is obese (9.9%). After analyzing the data obtained in the evaluation with the Berg Test, the following conclusions can be drawn:

At the initial assessment, more than half of the participants had a slight risk of falls (57.1%). Additionally, (42.9%) of the participants had a moderate risk of falls, which indicates a higher level of risk in their ability to perform physical activities. Importantly, there were no participants at high risk of falls.

At the final assessment, all participants (100%) managed to achieve a mild fall risk, indicating a significant improvement in their ability to perform activities requiring balance and coordination. This suggests that evaluation with the Berg Test may be a useful tool to identify the risk of falls in older adults and to develop specific intervention programs to improve their physical capacity and reduce the risk of falls. After analyzing the data obtained in the evaluation with the TUG Test, the following conclusions can be drawn:

At initial assessment, none of the participants were at low risk for falls, suggesting that most of them had difficulty performing activities requiring balance and coordination. Furthermore, 90.5% of participants were at risk of falls, indicating a moderate level of risk, while 9.5% were at high risk of falls.

In the final assessment, a significant improvement was observed in the participants' ability to perform activities that require balance and coordination. 42.9% of participants managed to achieve a low risk of falls, indicating that they significantly improved their ability to perform these activities, while 57.1% still had a risk of falls at a more moderate level. It is important to note that there were no participants with a high risk of falls at the final assessment.

Overall, these results suggest that evaluation with the TUG Test may be a useful tool to identify the risk of falls in older adults and to develop specific intervention programs to improve their physical capacity and reduce the risk of falls. It is important to continue to regularly evaluate physical capacity and risk of falls in older adults to prevent injuries and improve their quality of life. It can be seen that by applying an exercise program to manage the core muscles, the risk of falls is reduced in the population studied.

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