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Knee extension strength on gait speed in the elderly

La fuerza de extensión de la rodilla en la velocidad de la marcha en ancianos

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ABSTRACT

Background: Aging is a universal process, associated with biological modifications that cause alterations in the gait pattern, decreased walking speed, and loss of muscle strength, which decreases 1 and 2% annually in the elderly. Thus, as years go by, the elderly are associated with the loss of functionality. Gait speed is considered an indicator of mobility and functionality. In addition, it is used in the evaluation of the physical performance of the elderly. **Objective**: To determine the relationship of knee extension strength in the gait speed of the elderly. **Methods**: This research was of an observational, quantitative and cross-sectional type, with the inclusion of 25 older adults, between the ages of 65 and 90 years. The participants were evaluated for isometric knee extension strength through manual dynamometry and gait speed with the 10 Meters walk test. **Results**: It is verified that the right (r=0.559) and left (r=0.449) knee extension force is correlated with gait speed, obtaining a value $p<0.05$. It is also observed that muscle strength and gait speed decrease at advanced ages. **Conclusions**: Knee extension muscle strength is related to gait speed in the elderly.

Keywords: walking speed; muscle strength; aged; quadriceps muscle, lower extremity.

RESUMEN

Antecedentes: El envejecimiento es un proceso universal, asociado a modificaciones biológicas que provocan alteraciones en el patrón de marcha, disminución de la velocidad de la marcha y pérdida de la fuerza muscular, que disminuye 1 y 2% anualmente en los ancianos. Así, con el paso de los años, los ancianos se asocian a la pérdida de funcionalidad. La velocidad de la marcha se considera un indicador de movilidad y funcionalidad. Además, se utiliza en la evaluación del rendimiento físico de los ancianos. **Objetivo**: Determinar la relación de la fuerza de extensión de la rodilla en la velocidad de marcha de los ancianos. **Metodología**: Esta investigación fue de tipo observacional, cuantitativa y transversal, con la inclusión de 25 adultos mayores, con edades comprendidas entre 65 y 90 años. Los participantes fueron evaluados para la fuerza isométrica de extensión de rodilla a través de dinamometría manual y la velocidad de marcha con la prueba de caminata de 10 metros. **Resultados**: Se comprueba que la fuerza de extensión de rodilla derecha (r=0,559) e izquierda (r=0,449) se correlaciona con la velocidad de la marcha, obteniendo un valor $p<0,05$. También se observa que la fuerza muscular y la velocidad de la marcha disminuyen a edades avanzadas. **Conclusiones**: La fuerza muscular de extensión de rodilla está relacionada con la velocidad de la marcha en ancianos.

Palabras clave: velocidad de la marcha; fuerza muscular; ancianos; músculo cuádriceps, extremidad inferior

INTRODUCTION

Aging is a universal and inevitable process that causes biological modifications, which generates disability (Herrera et al., 2020). Advanced age in individuals modifies gait parameters. Thus, there is a decrease in step length, reduced cadence (fewer steps in a given interval), increased double support time and increased step width. These changes are due to the gradual loss of muscle strength, which is characteristic of older adults (Stotz et al. al., 2023).

Gait speed is considered an indicator of functionality and an evaluator of dismobility. Therefore, a gait speed value of less than 1m/s is considered an indicator of mobility disorders. A decrease in walking speed is associated with greater disability, hospitalization and an increase in the morbidity and mortality rate. (Oyarzún et al., 2020). In the research of Jung et al. (2018) it is established that a walking speed value of less than 0.8 m/s is an indicator of sarcopenia. Advanced age generates balance and mobility deficits, causing a decrease in walking speed. (Pradeep et al., 2020). Adequate walking capacity is related to maintaining autonomy and independence (Subirana & Martínez, 2020).

Another factor associated with aging is the decrease in strength. This is defined as the tension exerted by a muscle group to cause a contraction. (Al et al., 2022). In aging, muscle strength decreases between 1 and 2% annually, and it is considered that after the age of 75, it decreases 3.4% annually, causing dependence. (Quintero et al., 2021). Some of the biological modifications in the elderly are associated with the reduction in the number and size of type b fibers, and the loss of alpha motor neurons, generating a decrease in muscle strength (Beijersbergen et al., 2013). The objective of the present study was to determine the relationship between knee extension muscle strength and gait speed in older adults.

Limitation of movement causes changes in the walking pattern. The World Health Organization (WHO) indicates that 50% of individuals over 80 years of age and 20% of adults over 70 years of age have movement limitations. 5% of the population over 65 years old, have difficulty ambulating at home, and 12% have difficulty climbing stairs. For this reason, dismobility is considered a geriatric syndrome (Oyarzún et al., 2020).

In Latin America, it is considered that 1% of the population is dependent (Echeverría et al., 2022). In Ecuador there are no studies regarding the physical fitness of the elderly. However, it is considered that this population corresponds to 15% of the total population. (Falcones, et al., 2019).

The authors Dommershuijsen et al. (2022) consider gait speed as an evaluation of physical performance in older adults. In a descriptive, cross-sectional study, it indicates that the average gait speed in older adults was 1.20 m/s. It also indicates that gait speed decreased with age in women (1.26 to 0.76) m/s, and men (1.31 to 0.91) m/s at the age of 90. Thus, it also shows that the height of individuals differs in gait speed in men and women. However, in older adults it is not evident whether height or sex affects gait speed.

In a cross-sectional, observational and descriptive study carried out by the authors Sgaravatti et al. (2018), it refers to the average walking speed according to age: from 65 to 74 years old 1.23 m/s, from 75 to 80 years old 1.12m/s, and over 80 years old 1.06m/s. It is considered that the normal value in the gait speed of the elderly is 1.20 m/s. The gait greater than 1.0 m/s is related to independence for Activities for Daily Living (ADL), and the gait less than 0.80 m/s is considered as functional impairment. In the research of Fukuchi et al. (2019), in a bibliographic review indicates that the comfortable condition of gait speed in older adults is 0.94 to 1.34 m/s. Walking lower or higher than the indicated value is considered slow and fast respectively. Furthermore, it is indicated that in older adults the cadence and step length decrease as the gait speed becomes slower.

Regarding muscle strength, the authors Concha et al. (2020) indicate that muscle strength in individuals can increase until the third decade. Thus, from the fourth decade onwards, the decrease in strength is observed in men and women, in such a way that every 5 years, the decrease of 1.4 kg in men and 1.2 kg in women. Furthermore, it is considered that the decrease in muscle strength is most frequently evident in the antigravity muscles. That is, ankle plantar flexors and knee extensors.

METHODOLOGY

The research was observational, quantitative and transversal (Manterola et al., 2019), with the inclusion of older adults, aged between 65 and 90 years, who attend the "Picaihua Centro" Senior Adult Club, in the province of Tungurahua, Ecuador. The population was 48 older adults. Those who decided to participate freely and voluntarily, and carried out ambulation without the help of external devices were considered. On the other hand, the older adults who presented chronic pain in the limb, lower back pain, severe osteoarticular diseases and a personal surgical history of less than 1 year ago were not taken into account. Therefore, a non-probabilistic sampling was carried out, obtaining a sample of 25 participants in the study.

The evaluation of strength in knee extension was carried out by manual dynamometry, with the Baseline 12-0221 HD hand-held hydraulic dynamometer, an instrument that has an ICC confidence interval (0.97 to 0.98). (Grootswagers et al., 2022) As for the evaluation of gait speed, the 10 Meter Walk Test (10MWTS) was used. It presents an ICC confidence interval (between 0.96 and 0.98). (Peters et al., 2013). The test consists of tracking the time used by the testee to walk a distance of 10 meters.

Regarding the evaluation of knee extension strength, socialization and prior execution were carried out. The participant performed an isometric contraction for 5 seconds, performing the test in 2 attempts with a rest interval of 30 seconds. Finally, the highest value obtained in the two attempts was selected. The execution of the test was carried out with the participant in a supine position, the dynamometer was placed under the popliteal foramen, and an isometric contraction of the quadriceps was requested. That is, the participant pressed with his knee in the direction of the stretcher.

In the evaluation of the test (10MWTS), the space used for its execution had a distance of 20 meters. The initial 5m are considered as the acceleration zone, followed by 10m, where two cones called the first marker were located. This was the place where the timing began when the tested person's front leg crossed the first marker. The second marker was located at the end of the 10 meters. In that place, two cones were placed, indicating the place where the timing stopped when the evaluated person crossed his front leg. The test culminated with the final 5 meters called the deceleration phase where a final cone was located, which, like the acceleration phase, was timed.

The execution of the test was carried out during 3 attempts. The first attempt considered familiarization was not timed. Followed by this attempt, the second and third attempts were carried out and were timed. At the distance mentioned above, between each attempt, a rest time of 30 seconds was considered. The verbal commands given to the participant were "walk as fast as you can, until you reach the final cone." The calculation of walking speed was carried out with the equation m/s, distance / time in seconds. Thus, the distance always had a value of 10 m and the time calculated for each participant.

The data obtained from the evaluations carried out were processed using the SPSS version 29.0 system and represented in tables, and the mean scores of each of the variables with their respective standard deviation were used. The correlation of the data was applied using the Pearson correlation coefficient statistical test. The significance of the data was represented by the value $p<0.05$.

The research was approved through the Ethics Committee for research on human beings of the Technical University of Ambato, with resolution No. 035-CEISH-UTA-2023. The older adults were informed in a clear and concise manner about the procedures to be carried out in the execution of the study. After that, they proceeded to sign the informed consent, which was carried out under the rules of the bioethics committee. Data collection from the participants was done in the medical history, in which all affiliation data was recorded.

RESULTS AND DISCUSSION

The study was carried out with 25 older adults from the Picaihua Parish, who attend the "Picaihua Centro" Senior Adult Club, of which the following results were considered:

Table 1. Sociodemographic characteristics of the Elderly at the Picaihua Centro Club.

		Frequency	Percentage
Sex	Male	4	16.0
	Female	21	84.0
	Total	25	100.0
Age	65-69	8	32.0
	70-74	6	24.0
	75-79	4	16.0
	80-84	5	20.0
	85-88	2	8.0
Total		25	100.0

Source: Clinical History.

Regarding the age of the participants, the study was carried out on older adults with an average age of 74 ± 7 years. It is indicated that 8 older adults, representing 32%, have an age range between 65 and 69 years. Thus, it is observed that the highest percentage of participants are between 65 and 74 years old, and they are considered young elderly. Regarding the gender of the participants in the study, 16% of the participants belong to the male gender, while 84% were made up of the female gender. Therefore, it can be indicated that the female gender prevails in the Senior Adult Club of the aforementioned parish.

Table 2. Evaluation of muscle strength of the Elderly at the Picaihua Centro Club.

		Right Knee (Kg)	Left Knee (Kg)
	n	**Mean Standard deviation**	**Mean Standard deviation**
65 - 70 Years	8	15.8 ±1.98	15.0 ±1.85
71 - 75 Years	6	15.0 ±4.15	12.7 ±3.50
78 - 80 Years	5	12.8 ±3.90	13.2 ±4.60
> 81 Years	6	12.7 ±3.27	13.3 ±3.27
Total	25	14.1 1.56	13.6 1.0

Source: Dynamometry Evaluation.

Table 2 shows the results of the muscle strength evaluation. It is evident that the older adult population with the greatest muscle strength is in an age range between 65 and 70 years, presenting a muscle strength of 15.8 ± 1.98 kg in the right limb and 15.0 ± 1.85 kg in the left limb. Furthermore, it is observed that, as older adults age, muscle strength in knee extension tends to decrease.

Table 3. Evaluation of the Gait Speed of the Elderly at the "Picaihua Centro" Club.

	n	**Gait speed (m/s) Standard deviation**
65 - 70 Years	8	1.32 m/s ±0.14
71 - 75 Years	6	1.24 m/s ±0.20
78 - 80 Years	5	1.08 m/s ±0.16
> 81 Years	6	1.07 m/s ±0.25
Total	25	1.17m/s ±0.23

Source: 10 meter walk test.

Regarding gait speed, it is evident that older adults between 65 and 70 years old have a higher walking speed, with a speed of 1.32±0.14m/s. Likewise, it is observed that as individuals age, walking speed decreases.

Table 4. Correlation Matrix

		Right knee extension	**Left knee extension**
Walking speed	Pearson's R	0.559	0.449
	p value	0.004	0.024

Table 4 shows that, with 95% confidence, the right (r=0.559) and left (r=0.449) knee extension strength correlates with gait speed. Right knee extension correlates positively with speed at moderate intensity. While, left knee extension is correlated with a mild intensity.

Discussion

The present study was carried out in the Picaihua parish, with the participation of 25 older adults, with the female gender predominating in such population. This finding is similar to what was cited by the authors Álvarez et al. (2020), who indicate that there is a predominance of the older adult population of women in Ecuador.

The analysis of the results confirms the association that exists between age and muscle strength of the elderly. That is, the older the age, the less muscle strength. Thus, the authors Pisciottano et al. (2014), also indicate this significant association. In addition, it relates to physical performance tests, where gait speed is one of them. All muscle strength score averages obtained in the research are lower than the results obtained by the authors Abdul et al. (2021).

Among the important findings in the research, regarding gait speed in the older adult population, there was an average gait speed of 1.17±0.23m/s. This way, the authors Sgaravatti et al. (2018) consider this as a normal value, as well as the authors Takayanagi et al. (2019) who, in their research, obtained a similar average score of 117.0±19.9cm/s. However, there are studies with a mean score higher than that found previously. Thus, the authors Wuet al. (2021) and the authors Kawai et al. (2020) present an average of 1.71 ± 0.25 m/s and 2.24 ± 0.38 m/s respectively.

Furthermore, in the research, it is evident that gait speed progressively decreases at advanced ages. This is correlated with the authors Jiang et al. (2022) who indicate that the gait speed in adults over 65 years of age 1.64 ± 0.31 m/s decreased at 80 years of age to 1.16 ± 0.33 m/s. Also, the authors Umegaki et al., (2022), identified a speed of 1.81 ± 0.22 m/s in adults over 74 years of age and a speed of 1.07 ± 0.14 m/s in adults over 80 years of age.

Regarding the relationship between the muscular strength of the lower limb and the gait speed, it was evident that the force in knee extension presents a correlation with the speed of walking. And also, different studies identified a positive correlation, the authors Abdul et al. (2021) and the authors Inoue et al. (2017), presented a value ($p<0.001$). The research carried out indicates a correlation of moderate intensity of knee extension force. However, the authors Harris et al. (2018) report a slight intensity relationship in said structure with the values ($r =0.46$) ($p=0.010$) in the fast gait speed. Similar results were obtained by the authors Stotz et al. (2023), in which they found a significant correlation of knee extension force in gait speed, with a value ($p=0.016$). However, the Muehlbauer authors et al. (2018), indicate in their study that there was no evidence of a relationship between muscle strength and walking speed in older adults.

CONCLUSION

The evaluations carried out on muscle strength and walking speed allow us to determine the correlation of muscle strength with walking speed. In this way, with the analysis of the statistical data, it is concluded that there is a correlation of moderate intensity of muscle strength in knee extension in gait speed.

Furthermore, muscle strength and gait speed decrease in advanced age individuals. Therefore, it is observed that those considered young elderly are those who have greater muscle strength and gait speed in the older adult population. It is also concluded that there is a greater percentage of the female elderly population and that they participate in different programs for older adults.

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