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Research Article

Range of Lower Limb Joint Mobility and Risk of falls in the Elderly

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Background

Ageing can be defined as a process of cumulative, irreversible, universal, and non-pathological wear and tear that causes the mature organism to deteriorate, progressively becoming unable to fulfil basic physiological functions and leading to death. Among the biological changes caused by the ageing process are increased susceptibility to diseases, especially chronic degenerative diseases, which cause limitations, dependence and disabilities [1].

The unequivocal increase in average life expectancy and consequent increase in the number of elderly individuals highlights the need to place increasing emphasis on this specific population, with the lower limbs being one of the main targets of age-related changes due to their enormous and inevitable demands throughout life [2].

Foot problems are very common in the elderly and can result in considerable pain and disability. Epidemiological studies show that 80% of the elderly have at least one foot problem, and many of them report that a foot impairment limits their mobility and ability to perform activities of daily living [3,4]. states that although more research is needed to support the causal link between restricted joint mobility, instability and falls, some studies suggest that age associated with the loss of joint range of motion in the foot can affect postural instability by decreasing the foot's ability to adapt to changes in the terrain.

Mobility is a requirement of physical function that is indispensable for walking and for preserving independence and functional capacity. In principle, the concept of mobility seems simple, but there is evidence of the complexity of mobility in the elderly [4].

The prognosis of loss of mobility is a serious concern for anyone, particularly the elderly: a progressive decrease in the range of joint movement and an increase in joint stiffness characterize advancing age. The specific causes and importance of these changes in old age are not sufficiently clear [5].

Decreased range of motion can involve the deterioration of cartilage, ligaments, tendons, synovial fluid, and muscles. It is not known which of these factors play the most significant role in relation to old age: however, as old age sets in, calcification of the cartilage and surrounding tissues increases; there is a tendency for muscles to shorten, arthritis to develop and other negative orthopedic conditions, which intensify the restriction of joint movement and reduce the elasticity and compression tolerance of the spine [5].

Ageing leads to a reduction in range of movement in general, however, there is a restriction of mobility in the spine, hips, knees and ankles which favors a restriction in performing routine activities such as using public transport and walking at different levels [6].

The range of movement during walking in the lower extremity joints becomes progressively limited. Elderly people take shorter strides than young people, with limited hip flexion and extension and reduced ankle flexibility. Everyday tasks such as squatting and tying shoelaces require a large range of movement, which is restricted in old age [7].

In the senescent, joint amplitudes, particularly in the lower extremities, can decrease from minimal values to 57 per cent when compared to normal values in the young population. By the age of 65, 80 per cent of the population has joint alterations [8].

Although the decrease in joint mobility in the large joints is the most emphasized in the literature, several authors, such as Avidos [9], state that the decrease in mobility in joints such as the ankle and metatarsophalangeal joints of the halllux is a condition of loss of postural instability.

With regard to joint range of motion of small joints, several authors have found that 40 per cent of elderly individuals have a limitation in foot eversion, 15 per cent have a limitation in dorsiflexion of the first metatarsophalangeal joint and 70 per cent have a limited range of dorsiflexion of the ankle joint [10].

Several authors suggest that inversion and eversion movements of the foot and ankle are important for controlling posture in the frontal plane [11]. Falling can be defined as the lack of ability to correct the displacement of the body during its movement in space, becoming an unexpected act that takes the individual to the ground, or to a lower level [12].

Falls and their consequences are present at all stages of life but are explicitly seen as a problem of old age. Older people fall more and are more at risk of injury, and the psychological impact of falls is devastating for older people. An episode of falling can cause direct trauma, post-fall immobility, psychological and social damage, as well as being a cause of mortality [13].

Falls are a geriatric syndrome, as they are a multifactorial and heterogeneous event that can be caused by intrinsic and/or extrinsic factors [14].

The incidence of falls with advancing age is well known, with an increase of 35 to 40 per cent in individuals over 60 years of age, and a peak incidence between 80 and 90 years of age, with women falling more frequently [15]. Young people (60-75 years old) fall due to trips and slips, while people over 75 fall due to illnesses such as musculoskeletal, cardiac, neurological, sensory and medication use. The causes of this problem among older people can be single and clearly identified, or multiple and difficult to individualize [13].

According to the WHO (2010), falls are considered the second biggest cause of accidental death in the world. Every year the percentage of people over 65 who fall at least once is 30 per cent and the percentage who fall at least twice is 15 per cent [16]. In Portugal, various studies indicate that 40 to 60 per cent of people over the age of 65 have experienced at least one fall, and that this is more common among nursing home users and women [17].

Around 75 per cent of falls in the elderly happen in their own homes, including collective accommodation (retirement homes, nursing homes and other places of care), in the surrounding environment (stairs, garden or patio) or by slipping on the street [18]. Around 30 per cent of elderly people living in the community fall at least once a year and half of them fall repeatedly, but elderly people living in long-term care institutions tend to suffer more falls (50 per cent) (Perracini, Gazzola, & Okuma, 2007). This can be explained by the greater frailty of institutionalized elderly people, which puts them at greater risk of falls [19].

Daley and Spinks [8] adds that 32% of institutionalized people aged 75 and over fall at least once and more than 5% suffer fractures. According to this author, falls account for 87% of all fractures in the elderly, with fractures of the neck of the femur being the most prolonged.

Methods

Participants

This study was based on informed consent, protecting the rights and freedoms of the people taking part in this research. This study was carried out in 5 institutions in the municipalities of Maia, Póvoa de Varzim and Vila do Conde, which had a "home" service in operation, and which freely and spontaneously agreed to take part in this study.

The sample for this study consisted of 80 elderly individuals aged 65 or over, autonomous, selected using the Katz index, selected non-probabilistically and who were permanently institutionalized in the institutions. Exclusion criteria included the use of walking aids, a history of foot fractures and trauma other than sporadic pain, lower limb surgery, the use of lower limb prostheses, neuromotor pathologies and individuals with diabetic neuropathy or diabetes mellitus with more than 25 years of evolution.

Procedures

In order to obtain the relevant data for the study, a questionnaire was divided into two parts: the first part consists of socio-demographic questions, medical history and the Katz Index, which quantifies the degree of autonomy in activities of daily living; the second part records the values obtained by goniometry for the hip joint (flexion movement), knee (flexion movement) and sub-astragalus (dorsal and plantar flexion and inversion and eversion movements). This part also includes the Hendrich II scale to assess the risk of falls and direct questions about the history of falls.

The assessments were carried out in a natural environment in the doctors' offices of the respective institutions.

Statistical Analysis

All the data collected was entered into a database in the SPSS® (Statistical Programme for the Social Science) software, version 21.0.

Initially, in order to characterize the sample and the variables under study, we used a descriptive analysis of the sample and the

variables under study, more specifically the analysis of absolute and relative frequencies (percentages) as well as the calculation of measures of central tendency, namely the mean and the modal value, a measure of dispersion summarized only by calculating the standard deviation, and the distribution of both absolute and relative frequencies.

Double entry tables were made to analyze the descriptive variables. The Student's t-test was used to assess the differences in means for the variables of interest, which, according to the sequence entered into the database, positive values indicate that the first value (Low risk and No) is higher than the second (remaining variables), and negative values indicate that the second is higher than the first value. The Chi-Square test was used for the qualitative variables (assessment scales and joint range) to study the dependence and degree of association between them. The confidence interval was set at 95% with a significance level of 5%. $P < 0.05$ was considered significant. The Anova (F) test was also used to analyze variation, which shows a positive, directly proportional relationship between the variables under study.

Results

Descriptive analysis

With regard to the participants in this study, the majority were female, with an average age of around 81 and a Body Mass Index within the normal range. When we analyzed their visual and hearing acuity, we found that the majority thought they could see and hear well, although a large percentage wore glasses.

With regard to a history of falls, it was observed that most of the elderly had already had at least one fall, the most frequent cause being tripping/slipping, resulting in fear and haematoma, followed by fractures. In general, there was a reduction in the range of joint movement, with the subtalar joint showing the greatest limitation, particularly for inversion and eversion movements (Table 1).

		Right limb		Left limb	
Joint	**Movement**	**Mean (degrees)**	**SD**	**Mean (degrees)**	**SD**
	Flexion	± 106º	13,07	± 105º	15,32
Hip	**Internal rotation**	± 26º	6,73	± 26º	6,05
	External rotation	± 22º	6,06	± 23º	6,07
Knee	**Flexion**	± 113º	14,73	± 113º	20
Ankle	**Dorsiflexion**	± 12º	5,04	± 12º	5,14
	Plantar flexion	± 21º	8,78	± 22º	8,84
Subtalar	**Inversion**	± 4º	3,17	± 4º	3
	Eversion	± 1º	1,29	± 1º	1,23

Table 1: Range of motion in body segments (hip, knee, ankle and subtalar)

Correlational Analysis

When we evaluate the risk of falls and joint amplitude, we can see that elderly people with a low risk of falls have better average joint amplitude in all joints, and for most movements this relationship is statistically significant. This result may suggest that elderly people with higher joint amplitude values have a lower risk of falls (Table 2).

		Hendrich II		N	Mean	P	t
Hip	**Flexion**	Right	Low risk	**47**	**110º**	**0,00**	**2,76**
			High risk	**33**	**102º**		
		Left	Low risk	**47**	**108º**	**0,02**	**2,10**
			High risk	**33**	**101º**		
	Internal rotation	Right	Low risk	**47**	**27º**	**0,17**	**1,37**
			High risk	**33**	**25º**		
		Left	Low risk	**47**	**24º**	**0,00**	**3,34**
			High risk	**33**	**20º**		
	External rotation	Right	Low risk	**47**	**24º**	**0,00**	**3,34**
			High risk	**33**	**22º**		
		Left	Low risk	**47**	**23º**	**0,05**	**1,89**
			High risk	**33**	**21º**		

Knee	**Flexin**	Right	Low risk	**47**	**114º**	**0,82**	**-0,22**
			High risk	**33**	**114º**		
		Left	Low risk	**47**	**113º**	**0,90**	**-0,12**
			High risk	**33**	**113º**		
Ankle	**Dorsalflexion**	Right	Low risk	**47**	**12º**	**0,11**	**1,58**
			High risk	**33**	**11º**		
		Left	Low risk	**47**	**12º**	**0,48**	**0,71**
			High risk	**33**	**11º**		
		Right	Low risk	**47**	**22º**	**0,21**	**1,24**
	Plantarflexion		High risk	**33**	**20º**		
		Left	Low risk	**47**	**22º**	**0,53**	**0,63**
			High risk	**33**	**21º**		
Subtalar	**Inversion**	Right	Low risk	**47**	**5º**	**0,00**	**3,43**
			High risk	**33**	**3º**		
		Left	Low risk	**47**	**5º**	**0,00**	**3,04**
			High risk	**33**	**3º**		
	Eversion	Right	Low risk	**47**	**1º**	**0,03**	**2,30**
			High risk	**33**	**0,6º**		
		Left	Low risk	**47**	**1º**	**0,11**	**1,64**
			High risk	**33**	**0,5º**		

Table 2: Relationship between the joint range and risk of falls

With regard to history of falls and joint range of motion, we found that for hip flexion, individuals who had no history of falls had better average joint range of motion than those who had. However, for the other movements of the hip and joints, this trend tends to reverse, with individuals with a history of falls having better mean joint ranges. Some of them were statistically significant with values of $p<0.05$ (Table 3).

		Previous Falls		**N**	**Mean**	**t**	**P**
Hip	**Flexion**	Right	No	**28**	**108º**	**0,65**	**0,52**
			yes	**52**	**106º**		
		Left	No	**28**	**109º**	**1,95**	**0,05**
			yes	**52**	**102º**		
	Internal rotation	Right	No	**28**	**23º**	**-2,76**	**0,01**
			yes	**52**	**28º**		
		Left	No	**28**	**24º**	**-2,72**	**0,01**
			yes	**52**	**27º**		
	External rotation	Right	No	**28**	**23º**	**0,54**	**0,59**
			yes	**52**	**22º**		
		Left	No	**28**	**22º**	**-1,21**	**0,23**
			yes	**52**	**24º**		

Knee	**Flexion**	Right	No	**28**	**113º**	**-0,50**	**0,62**
			yes	**52**	**114º**		
		Left	No	**28**	**115º**	**0,72**	**0,48**
			yes	**52**	**112º**		
Ankle	**Dorsalflexion**	Right	No	**28**	**11º**	**-0,21**	**-0,84**
			yes	**52**	**12º**		
		Left	No	**28**	**11º**	**-0,32**	**0,75**
			yes	**52**	**12º**		
	Plantarflexion	Right	No	**28**	**21º**	**-0,25**	**0,80**
			yes	**52**	**22º**		
		Left	No	**28**	**21º**	**-1,05**	**0,29**
			yes	**52**	**23º**		
Subtalar	**Inversion**	Right	No	**28**	**5º**	**1,01**	**0,31**
			yes	**52**	**4º**		
		Left	No	**28**	**5º**	**1,14**	**0,16**
			yes	**52**	**4º**		
	Eversion	Right	No	**28**	**1º**	**1,27**	**0,21**
			yes	**52**	**1º**		
		Left	No	**28**	**1º**	**1,96**	**0,05**
			yes	**52**	**1º**		

Table 3: History of falls and joint range

Discussion

With regard to the general characterization of the sample, it was observed that the majority of individuals were female with an average age of approximately 81 years. These figures are in line with the results of the 2011 Census, which emphasized the predominance of women over men. The preponderance of the female population increases with age, and the over-mortality of the male population and the lower life expectancy at birth for men compared to women help to explain these results [20].

When we analyzed the history of falls, we found that the majority of elderly people had fallen at least once, with the most prevalent cause being tripping/slipping and the consequences being fear and bruising. The following studies corroborate our data. According to the World Health Organization [22], falls are considered the second biggest cause of accidental death in the world. Every year the percentage of people over 65 who fall at least once is 30 per cent and the percentage who fall at least twice is 15 per cent [21]. In Portugal, various studies indicate that 40 to 60 per cent of people over the age of 65 have experienced at least one fall, which is more frequent among nursing home users and women [17]. Young people (60-75 years old) fall due to trips and slips, while people over the age of 75 fall due to illness [13]. The importance of the foot in falls has been much studied in terms of its influence on falls, including the decrease in sensitivity in the feet of the elderly, in which the elderly person steps or stumbles over an obstacle without realizing it immediately, thus leading to a fall [22]. On the other hand, in the gait of the elderly, there is a lower elevation of the heel in relation to the ground, which can be an ultimate challenge for the elderly person, especially when they need to overcome obstacles [17].

In general, there was a reduction in the range of joint movement, with the subtalar joint showing the greatest limitation, particularly for inversion and eversion movements. This is in line with [8]. who state that in the senescent, joint ranges, particularly in the lower extremities, can decrease from minimal values to 57% when compared to normal values in the young population. With regard to the eversion movement, several authors have found that 40 per cent of elderly people have limitations in eversion of the foot [3,9] also found significant differences in the range of motion of the foot and ankle between the young and the elderly in their study which attempted to relate joint range of motion to age, showing a highly significant reduction in eversion movement in women.

As one of the main objectives was to compare joint range of motion and the risk of falls in the elderly, we found that elderly people with a low risk of falls had better joint range averages in all joints, and for most movements this relationship was statistically significant. These data are in line with the authors [23] who state that limitations in joint range of motion and functional ability associated with ageing can affect an individual's ability to maintain a stable posture when walking and standing, consequently increasing the risk of falls in the elderly, so if our sample has better functionality and independence, it has a lower risk of falls.

With regard to history of falls and joint range of motion, we found that for hip flexion, individuals who had no history of falls had better average joint range of motion than those who had. However,

for the other movements of the hip and joints, this trend tends to reverse, with individuals with a history of falls having better mean joint ranges. According to [6]. The elderly have a global restriction of range of movement, especially in the hip, knee and ankle joints. Elderly people with a history of falls show a significant reduction in dorsiflexion and plantar flexion, while in the hip joint there is a significantly smaller range of movement in the sagittal plane when compared to elderly people with no history of falls. These data suggest that there is less change in the movement pattern in the sagittal plane with age when compared to movements made in the frontal plane. This idea is in line with [24], who states that there is a relationship between falls and body sway in the frontal plane. The literature also describes dorsiflexion and plantar flexion as the main movements performed during walking [25]as well as inversion and eversion movements of the foot and ankle as important for controlling posture in the frontal plane [9,26]. Goes further when he states that ankle mobility influences balance, i.e. the greater the ankle movement, the greater the individual's ability to maintain balance.

Conclusions

In relation to the main objective of this study, it was found that elderly people at low risk of falls have better mean joint ranges in all joints, and for most movements this relationship is statistically significant.

With regard to history of falls and joint range of motion, we found that for hip flexion, individuals who had no history of falls had better average joint range of motion than those who had. However, for the other movements of the hip and joints, this trend tends to reverse, with individuals with a history of falls having better mean joint ranges. Some of them were statistically significant with values of $p<0.05$. The obtained data clarify the need for training in relation to studies of Podiatric when you want to apply to the geriatric community. Therefore they deserve a particular theoretical-scientific approach.

References

1. Ferraz IN, dos Reis LA, Assis WC, Rabelo LAN, Guimarães FE de O, et al. (2021) Impactos dos fatores extrínsecos no envelhecimento precoce: Uma reflexão teórica. Research, Society and Development, 10: e21210615761.
2. Mogiana F, Mogiana F, Estadual U, Mogiana F, As R (2024) Relationship Between Falls And Functional Capacity In The Elderly Population. 9: 71–82.
3. Awale A, Hagedorn TJ, Dufour AB, Menz HB, Casey VA, et al. (2017) Foot Function, Foot Pain, and Falls in Older Adults: the Framingham Foot Study. Gerontology, 63: 318-324.
4. Menz HB (2015). Biomechanics of the Ageing Foot and Ankle: A Mini-Review. Gerontology, 61: 381–388.
5. Gomes de Souza Vale R, Boscher Torres J, Oliveira Martinho K, Bauerfeldt Lopes R, da Silva Novaes J, et al. (2004) Efeitos do treinamento de força na flexibilidade de mulheres idosas. Fitness & Performance Journal, 3: 266–271.
6. Guimarães JMN, Farinatti P de TV (2005) Análise descritiva de variáveis teoricamente associadas ao risco de quedas em mulheres idosas. Revista Brasileira de Medicina Do Esporte, 11: 299–305.
7. Fidelis LT, Patrizzi LJ, de Walsh IAP (2013) Influência da prática de exercícios físicos sobre a flexibilidade, força muscular manual e mobilidade funcional em idosos / Influence of physical exercise on the flexibility, hand muscle strength and functional mobility in the elderly. Rev. Bras. Geriatr. Gerontol.16: 109–116.
8. Daley MJ, Spinks WL (2000) Exercise, mobility and aging. Sports Medicine (Auckland, N.Z.), 29:1–12.
9. Avidos, L., Diz, J. C., Ribeiro, F., Padin-Iruegas, M. E., & Neves, J. (2022). The influence of subtalar axis orientation on the foot posture of older adults in a closed kinetic chain. Geriatr., Gerontol. Aging (Online), 16, 1–9. https://doi.org/10.53886/GGA.E0220014
10. Menz HB (2008) Foot problems in older people: Assessment and management. Foot Problems in Older People: Assessment and Management, 1–261.
11. Hamlyn C, Docherty CL, Klossner J (2012). Orthotic Intervention and Postural Stability in Participants With Functional Ankle Instability After an Accommodation Period. Journal of Athletic Training, 47: 130–135.
12. Guimarães T, Galdino A, Martins M, Vitorino M, Pereira L, et al. (2019) Comparação da propensão de quedas entre idosos que praticam atividade física e idosos sedentários. Revista Neurociências, 12: 68–72.
13. Freitas MAV, Scheicher ME (2008) Preocupação de idosos em relação a quedas. Revista Brasileira de Geriatria e Gerontologia, 11:57–64.
14. Morsch P, Myskiw M, De Carvalho Myskiw J (2016) Falls' problematization and risk factors identification through older adults' narrative. Ciências & Saude Coletiva, 3565–3574.
15. Lee S (2021) Falls associated with indoor and outdoor environmental hazards among community-dwelling older adults between men and women. BMC Geriatrics, 21:547.
16. Giovannini S, Brau F, Galluzzo V, Santagada DA, Loreti C, et al. (2022) Falls among Older Adults: Screening, Identification, Rehabilitation, and Management. Applied Sciences (Switzerland), 12: 7934.
17. Carvalho J, Pinto J, Mota J (2004) Actividade física, equilíbrio e medo de cair. Um estudo em idosos institucionalizados. 7:225-231.
18. Dellinger AM, Boyd RM, Haileyesus T (2008) Fall injuries in older adults from an unusual source: Entering and exiting a vehicle. Journal of the American Geriatrics Society, 56: 609–614.
19. Kallin K, Gustafson Y, Sandman PO, Karlsson S (2004. Drugs and falls in older people in geriatric care settings. Aging Clinical and Experimental Research, 16: 270–276.
20. INE (2019). Estimativas de População Residente em Portugal - 2018. Destaque Informação à Comunicação Social, 1–14.
21. OMS (2015) Relatório Mundial de Envelhecimento e Saúde.
22. Schillings AM, Mulder T, Duysens J (2005) Stumbling over obstacles in older adults compared to young adults. Journal of Neurophysiology, 94: 1158–1168.
23. Sakano Y, Murata S, Goda A, Nakano H (2023). Factors Influencing the Use of Walking Aids by Frail Elderly People in Senior Day Care Centers. Healthcare, 11-858.

24. Johansson J, Jarocka E, Westling G, Nordström A, Nordström P (2019) Predicting incident falls: Relationship between postural sway and limits of stability in older adults. Human Movement Science, 66: 117–123.

25. Mueller MJ, Minor SD, Schaaf JA, Strube MJ, Sahrmann SA. (1995). Relationship of plantar-flexor peak torque and dorsiflexion range of motion to kinetic variables during walking. Physical Therapy, 75:684–693.

26. Bok SK, Lee TH, Lee SS (2013) The Effects of Changes of Ankle Strength and Range of Motion According to Aging on Balance. Annals of Rehabilitation Medicine, 37:10-16.