SECTION – FUNDAMENTAL AND APPLIED KINESIOLOGY

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PHYSICAL FITNESS, BALANCE AND FALLS IN OLDER ADULTS

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Authors' contribution:

A. Study design/planning
B. Data collection/entry
C. Data analysis/statistics
D. Data interpretation
E. Preparation of manuscript
F. Literature analysis/search
G. Funds collection

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Abstract:

Aim. Falls are the second leading cause of accidental injury and deaths worldwide. Individuals aged 65 or above have the highest rates. Falls are preventable, but the consequences of falls can lead to injuries and may result in loss of independence. The present study aims to analyse the relationship between risk of falls, physical activity level (PA level) and physical fitness among elderly practitioners of physical exercise interventions.

Basic procedures. The data were collected through a demographic questionnaire; history of falls; PA level and physical fitness. Statistical analysis was performed using IBM® SPSS®, version 24.0 for Windows ($p \leq 0.05$).

Main findings. The study comprised 62 seniors taking part in physical exercise programmes from the community of Beja, Portugal (females n = 48; 77.4%), with the average age of 73.27 ± 5.45 years.

Results. It was found that elderly people with lower levels of strength, balance and cardiorespiratory fitness are at a higher risk of falls ($p < 0.05$). There were no correlations between the risk of falls and the PA level.

Conclusion. The results highlight the need for more specific research about strength and balance interventions in older adults reporting falls, in particular, the identification of intrinsic and extrinsic risk factors for their prevention.

Introduction

Nowadays, falls in the elderly are a determinant of scientific research, due to their multifactorial nature, impact on health as well as length and cost of treatment. Research in this area is also needed to identify preventive measures because falls represent a significant public health problem [1,2]. Ranked as the second leading cause of accidental deaths in the world [3], epidemiological data show that individuals aged 65 and above are those which have the highest number of fatal accidents [4], and the proportion of this population suffering, is estimated at 28-35% [5], increasing to 32-42% among people above the age of 70 [6,7]. These numbers are even more dramatic when adding to the evidence that after the first fall, the likelihood of falling again can increase two to three times in the same year [8]. The World Health Organization reveals that 20-30% of the demand for health care (hospitals and health centres) have their origin in injuries resulting from falls, which in more than half of these occurrences, lead to long-term hospitalization [2]. The average cost per episode of fall with injury involving an individual above the age of 65 is estimated to be around 2,900 Euros [9]. If the falls and the severity of associated injuries increase with age, it is expected that the number of falls and associated injuries will increase in coming years among elderly persons. Thus, fall prevention becomes a parallel challenge to promote healthy ageing, especially in countries that score a higher growth of the elderly population and where this problem may become endemic [2].

Currently, identification of fall risk factors has become a priority [10,11] due to the etiology of falls resulting from ageing and deteriorating health conditions, affecting everyday functionality [12]. Falls are of multifactorial etiology resulting from relationships with various risk factors [13,14]. Rubenstein and Josephson [15] define "a feature or situation found more often among individuals who subsequently experience an adverse event than in individuals who do not experience the same event" as a risk factor. These features involve extrinsic factors [16], which are related to environmental factors such as poor lighting, slippery, uneven and bumpy surfaces, carpets, high or narrow steps, obstacles, lack of handrails in hallways and bathtubs, chairs/beds. On the other hand, we may find intrinsic factors concerning the characteristics of each individual resulting from bio-psychological changes, related to age, strength and mobility changes, acute or chronic diseases, medication, etc. [17,18].

Developing skills that allow the elderly to maintain adequate fitness and efficacy are the key to maintaining their quality of life and independence [19-21]. Thus, functional ability, which includes the muscle force components, flexibility, aerobic capacity, motor speed/dynamic balance and body mass index, is defined as the physiological ability to perform normal daily activities safely and independently without excessive fatigue [22,23]. Maintaining balance is a decisive capacity for the development of activities of daily living and consequently, the quality of life of older people through the prevention of falls [24]. Balance plays as an essential role in tasks such as moving from sitting to standing position, standing, walking, performing many day-to-day activities, maintaining independence and reacting to external disturbances, [25]. Since some studies apply this differentiation, it should be noted that the ability to maintain balance is systematized in static and dynamic balance, and the same, decline with age and disease, but improve with exercise [26]. In several investigations, it has been shown that exercise can help older people to remain as independent as possible [20,27,28]. Balance being the coordinative capacity of sensory and motor mechanisms, showing a reduction in the number of falls, the risk of falls and fear of falling [29–32]. Maintaining the same tone, in several systematic reviews, it has been shown that exercise programmes reduce the rate of falls by 23%, as well as the number of falls per person [33,34] and the risk of falls, the proportion of people with one or more falls [33]. The present study aims to analyse the relationships between risk of falls, physical activity level (PA level) and physical fitness among elderly practitioners of physical exercise interventions.

Materials and methods

This was a cross-sectional study. A total of 62 participants of both genders (aged between 65 and 84) were enrolled in the Up Again Senior, an exercise programmee for the community of Beja, Baixo Alentejo (Portugal), aged 65 and above. The ages of the subjects ranged between 65 and 84 years (M = 73.27, SD = 5.45) and 22.6% comprised men (n = 14) while 77.4% totalled women (n = 48). Most of the participants were married (58.1%) and had academic qualifications corresponding to basic education (83.9%).

Instruments

Sociodemographic

The sociodemographic questionnaire describe the variables: "age", "sex", "marital status", "qualifications" and "history of falls." The latter was achieved by addressing the following questions: "Have you fallen within the last year?", "How many falls have you suffered in the last year?" and "Did the last fall result in injury?".

Risk of falls

To determine the risk of falls,the Fullerton Advanced Balance - FAB battery was used. Measurements were based on performance, the multiple dimensions of balance in static and dynamic balance activities developed for independent seniors [35,36]. The battery consists of 10 tests which use an ordinal five-point scale (0 to 4), the maximum possible score equalling 40 points. The same exam is composed of 10 individual tests: remain standing, eyes closed and feet together; reaching an object in the frontal plane; covering a circular path of 360° with support; stepping over a 15-cm step; performe 10 steps in a straight line; maintaining balance with support; keeping eyes closed and feet together on a foam surface; jumping on both feet; marching with simultaneous rotation of the head and control of postural reaction. A total score equal to or less than 25 predicts a fall risk, with a sensitivity and specificity of 74.6% and 52.6%, respectively [37].

PA level

PA level was assessed using the International Physical Activity Questionnaire (IPAQ-E), composed of 7 questions that evaluate the weekly frequency and duration in minutes per day of PA practice and determine the level of intensity (light, moderate, vigorous) as well as the time spent sitting [38].

The results of analysis and processing were obtained using the "Guidelines for data processing and analysis of the International Physical Activity Questionnaire". The score was based on continuous indicators for each type

Table 1. Social and demographic characteristic of the sample (n = 62)

		Female (N = 48)	Male (N = 14)	Total
Age, mean (SD)	years	73.35 ± 5.25	73.00 ± 6.30	73.27 ± 5:45
Age classes, n (%)		48 (77.4)	14 (22.6)	62 (100)
65-69 years		11 (22.9)	4 (28.6)	15 (24.2)
70-74 years		16 (33.3)	5 (35.7)	21 (33.9)
75-79 years		14 (29.2)	3 (21.4)	17 (27.4)
80-84 years		7 (14.6)	2 (14.3)	9 (14.5)
Marital status, n (%)				
Single		4 (8.3)	-	4 (6.5)
Married		26 (54.2)	10 (71.4)	36 (58.1)
Divorced		2 (4.2)	1 (7.1)	3 (4.8)
Widowed		16 (33.3)	3 (21.4)	19 (30.6)
Education, n (%)				
1st Cycle Basic Education		36 (75)	8 (57.1)	44 (71.0)
2nd Cycle Basic Education		2 (4.2)	-	2 (3.2)
3rd Cycle Basic Education		3 (6.3)	3 (21.4)	6 (9.7)
High school		2 (4.2)	3 (21.4)	5 (8)
University education		2 (4.2)	2 (14.3)	2 (3.2)
No education level		3 (6.3)	-	3 (4.8)
BMI, n (%)				
Normal		14 (29.2)	5 (35.7)	19 (30.6)
Overweight		19 (39.6)	6 (42.9)	25 (40.3)
Obese		15 (31.3)	3 (21.4)	18 (29)
Medication, n (%)	yes	45 (93.8)	13 (92.9)	58 (93.5)
History of falls, n (%)				
Fall occurrence	yes	17 (35.4)	3 (21.4)	20 (32.3)
Number of falls				
1 xs		13 (76.5)	1 (33.3)	14 (70)
2 to 3 xs		1 (5.9)	-	1 (5)
+ 3 xs		3 (17.6)	2 (66.7)	5 (25)
Injury associated with falling	yes	7 (41.2)	-	7 (35)

of activity by weighing average energy expenditure allocated to each activity, and the respective minutes performed weekly. PA level was expressed by the intensity levels via the estimation METS/min per week. The Portuguese short form of the test presents good reliability levels (0.69 and 0.99) and validity [39,40].

Data collection was carried out in January 2019, by previously trained sports coaches, responsible for coordination and the whole exercise programme.

Physical fitness

- To evaluate physical fitness, the authors used the Fullerton Functional Fitness Test battery. It aims to determine the functional fitness in day-to-day activities. It is safe and easy to perform and did not cause excessive exhaustion [35,41]. The battery consists of 8 tests, evaluating the physical condition of components related to the strength and endurance of upper and lower body, flexibility of the lower limbs and shoulder, agility/dynamic balance, aerobic fitness and body composition (body mass index - BMI).

Data analysis involved descriptive statistics (absolute frequencies, respective averages and standard deviations) and inferential statistics. To verify normality of the data, the Kolmogorov-Smirnoff test was performed, while homogeneity of variance was assessed using Levene's test. For parametric measures, the Student's *t*-test for independent samples was used (ratio between the risk of falls and physical fitness components), while for non-parametric measures, the Kruskal-Wallis test applied (examining the relationship between the risk of falls and PA level). As a reference to accept or reject the null hypothesis, the authors assumed the level of statistical significance level of $p<0.05$. Statistical analyses were performed with the IBM SPSS (Statistical Package for Social Sciences) version 24.0 for Windows.

Results

Risk of falls and PA Level
It was found that there are no significant differences between the risk of falls and PA level ($p>0.05$). Half of the sample was characterised by moderate PA level (see Table 2), but, 45.2% demonstrated lower levels of physical activity.

Risk of falls and physical fitness
There was a significant correlation between the risk of falls and physical fitness (Tab. 3). The results show that the risk of falls is related to the power capacity of the upper and lower limbs, dynamic balance and cardiorespiratory fitness ($p<0.05$).

Conclusions

The authors of this work aimed to analyse the relationship between risk of falls, physical activity level (PA level) and physical fitness among elderly practitioners of physical exercise interventions. It was possible to verify that those with no risk of falls are characterised by better physical fitness. Emphasizing the positive association between strength (upper and lower body), agility/dynamic balance and cardiorespiratory fitness with the risk of falls, these results are corroborated with previous studies [42-45]. Muscle strength appears to be a key component for maintaining autonomy and prevention of diseases, solving problems associated with loss of muscle mass, such as sarcopenia, frailty and chronic rates [42,46,47]. Balance is associated with increased morbidity and loss of autonomy activities of daily living [24,48], and aerobic endurance is assumed as one of the variables with greater importance in reducing the risk of mortality from all causes and particularly, from cardiovascular diseases [21].

The authors found no relationships between the risk of falls and PA level. These results are in agreement with literature reviews in which no significant differences be-

Table 2. The relationship between the risk of falls and PA level (n = 62)

Fall risk	PA light	PA moderate	PA vigorous	P
Risk of falls	7 (11.3%)	3 (4.8%)	-	.080
No risk of falls	21 (33.9%)	28 (45.2%)	3 (4.8%)	
Total	28 (45.2%)	31 (50%)	3 (4.8%)	

Table 3. Correlation between risk of falls and physical fitness components: strength, flexibility, dynamic balance and cardiorespiratory fitness (n = 62)

Variables	Fall risk	Average	Standard deviation	r
Strength (LB) a)	RF	15:50	3:50	0279 *
	nRF	20:37	6.62	
Strength (UP) b)	RF	20:50	4:38	0259 *
	nRF	23:33	3.86	
Flexibility (LB)	RF	1:20	3:46	0009
	nRF	1:41	9:33	
Flexibility (UB)	RFc	-8.40	8:46	0025
	nRF	-7.75	9.81	
Dynamic balance	RF	7.66	2:13	-0472 **
	nRF	5.81	1:08	
Cardiorespiratory fitness	RF	440.10	64.83	0013 *
	nRF	558.19	142.84	

Note. a) (lower body); b) (upper body) c) RF: with risk of fall d) nRF: no risk of fall.

* *P* <.05; ** *p* <.001.

tween the reduced risk of falls and fall rate by increasing the physical intensity levels were found [49]. However, approaches to the implementation of community programmes appear to be beneficial for increased functionality, level of health and quality of life [27,50].

Fall prevention should focus on screening, evaluating and monitoring risks and a personalised intervention, adjusted to the identified risk factors. In line with these findings, exercise programmes focused on strength, balance and cardiorespiratory fitness must be tailored to patients' needs. Evidence shows that the physical exercise interventions included in the Up Again Senior project promote positive results among physical fitness components and fall prevention, but it is crucial to undertake studies determining the minimum amount of PA level to prevent falls.

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