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Prevalence and relationship between falls, frailty phenotype and physical activity in centenarians: a pilot study

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ABSTRACT. The objective of this study was to associate the occurrence of falls with the frailty phenotype and physical activity (PA) in centenarians. Population-based descriptive study carried out in the state of Santa Catarina, Brazil, which included 54 centenarians (101.8 ± 2.8 years), 34 women and 20 men. To assess PA, centenarians wore a pedometer for 7 days of a typical week. The occurrence of falls was confirmed by self-report and frailty phenotype using the criteria proposed by Fried et al. (2001). All assessments were carried out following the Multidimensional Assessment Protocol for the Centennial Elderly, applied through interviews. The chi-square test with adjusted standardized residuals was used to evaluate the association between the occurrence of falls and frailty and AF, adopting a significance level of 5%. The prevalence of frailty in the sample was 53.7%. The majority of centenarians did not do PA (66.7%) and did not suffer a fall in the last 12 months (68.5%). The average number of weekly steps was higher among fallers (1,796.1 steps/week) when compared to non-fallers (797.4 min/week) (p=0.019). There was a significant association between falls and frailty (p=0.03), with fallers tending to be frail. The occurrence of falls was also associated with AF (p=0.014), with fallers tending to be physically active. Concluding that centenarians with falls in the last 12 months showed a tendency to frailty and a higher level of PA. The results demonstrate the importance of monitoring frailty in this population and of PA interventions that aim to reduce the factors causing this condition.

Keywords: Centenarians; falls; frailty; physical activity.

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Introduction

Brazil is undergoing an epidemiological and demographic transition that has significantly contributed to the increase in life expectancy and, consequently, to the rapid aging of the population (International Longevity Center Brazil [I LC- Brazil], 2015). The global population aged 80 and over is also on the rise and is expected to triple between 2020 and 2050, reaching a total of 426 million (United Nations [UN], 2019). Considering this increase in life expectancy, it is important to address issues related to aging, and frailty is one of them.

With respect to the oldest old, the prevalence of frailty is 54% among nonagenarians and ranges from 54.7% to 64.7% among centenarians (Ribeiro, Duarte, Teixeira, & Paúl, 2018; Herr et al., 2018). In Brazil, the prevalence of pre-frailty among older adults ranges from 40.7% to 71.6% (Siriwardhana, Hardoon, Rait, Weerasinghe & Walters, 2018). However, the prevalence of frailty and the frailty phenotype are not well documented in centenarians. The latter is characterized by the presence of physical signs such as reduced body weight, muscle weakness (dynapenia), fatigue, slow gait, and a low level of physical activity (Fried et al., 2001).

A low level of physical activity is one of the indicators of frailty (Fried et al., 2001; Herr et al., 2018) in older adults (Da Silva et al., 2019). Mazo, Franco, Silva, Hoffmann, and Streit (2019) found a high prevalence of physical inactivity and passive leisure, restricted to the home environment, among centenarians in southern Brazil. Most elderly people with a low level of physical activity have functional disability and live in nursing homes (Franco et al., 2021, in press). In addition, a low level of physical activity is associated with a high risk of falls in older adults (Hansen et al., 2016; Moraes et al., 2017).

Regarding falls, a systematic review (Elias Filho, Borel, Diz, Barbosa, Britto, & Felício, 2019) estimated that 27% of elderly Brazilians suffered falls in the last 12 months, with a predominance of women aged ⩾ 80 years. The risk factors for falls include muscle weakness, visual impairment, environmental risks,

cardiovascular disease, medications (Ambrose, Paul, & Hausdorff, 2013), a history of falls, gait alteration, functional and cognitive impairment (Gama & Gómez-Conesa, 2008), depressive symptoms/depression, female gender, and fear of falling (Sousa et al., 2016). Although few studies have evaluated significant risk factors for falls in older populations, in Malaysia, Alex et al. (2020) identified the presence of urinary incontinence, hearing impairment, depression, arthritis, and cognitive impairment.

The above considerations indicate a lack of studies associating the occurrence of falls, frailty, and physical activity in centenarians. Such studies will help health professionals to propose exercise interventions for the oldest old, especially centenarians. Furthermore, there is strong scientific evidence that exercise reduces the rate of falls in older adults by approximately 25% (Sherrington et al., 2020; Bento, Rodacki, Homann, & Leite, 2010), demonstrating that this type of intervention prevents falls, in addition to minimizing frailty and increasing the level of physical activity of centenarians. Therefore, this study aims to evaluate the association of the occurrence of falls with the frailty phenotype and physical activity in centenarians.

Material and methods

Study design and ethical aspects

This analytical descriptive cross-sectional study is part of the Multidimensional Study of Centenarians of Santa Catarina (SC100 Project) conducted at the Gerontology Laboratory (LAGER) of the Center for Health and Sport Sciences (CEFID), University of the State of Santa Catarina (UDESC). The study was approved by the Ethics Committee on Research Involving Humans (CEPSH) of the institution (Approval number 1.468.034/2014), under Ethical Clearance Certificate 21417713.9.0000.0118. The study was conducted in accordance with the requirements of Resolution 512/2016 of the National Health Council. In addition, before participating in the study, the centenarians or their primary caregiver signed the free informed consent form.

Population and sample

The population of the present study consisted of 106 centenarians residing in the state of Santa Catarina. Since this study is part of the SC100 Project, data previously collected from older adults living in the mesoregion of Grande Florianópolis (58 centenarians, 41 women and 17 men), Joinville microregion (22 centenarians, 18 women and 4 men), and mesoregion of Vale do Itajaí (26 centenarians, 21 women and 5 men) were used.

Sampling was intentional and the following inclusion criteria were applied: age of 100 years or older; the centenarian answering, with or without the help of the main caregiver, the questions of the Multidimensional Assessment Protocol for the Centenarian Elderly (PAMIC) (Mazo, 2015) on identification, mental health, health conditions, functional assessment and physical activity/exercise, and use of a pedometer for 7 days of a normal week. Based on these criteria, 54 centenarians, 34 women and 20 men, participated in the study.

Instruments

Data were collected using the PAMIC (Mazo, 2017a), which was developed for the SC100 Project by LAGER/CEFID/UDESC. For the present study, the following questions and blocks of PAMIC were applied, according to the following objectives:

- to confirm the age of the centenarian: the date of birth was checked on the supporting document, such as a birth certificate, identity card or other (Questions 2, 3 and 6; Block 1 – Identification);
- to characterize the sample in terms of gender (Question 4; Block 1 – Identification), marital status (Question 47; Block 4 – Sociodemographic Information), and diseases (Questions 88 to 106; Block 7 – Health, Living Conditions and Habits);
- to identify the health conditions and life habits of the centenarian: the questions were answered with the help of the centenarian`s caregiver (Questions 115 to 120; Block 7 – Health Conditions and Life Habits of the Older Adult);
- to classify independence in activities of daily living: the questions of the Katz scale (Lino, Pereira, Camacho, Ribeiro Filho, & Buksman, 2008) were answered with the caregiver's help (Questions 129 to 134; Block 8 – Assessment of Functional Capacity);
- to determine difficulties, types of exercises, and frequency of physical activity of the older adult: the questions were answered with the caregiver's help (Questions 136 and 137; Block 9 – Physical Activity/Physical Exercise of the Older Adult).

Using the information obtained with the PAMIC, the frailty phenotype was identified based on the five criteria proposed by Fried et al. (2001) and adapted for centenarians by Herr et al. (2018): unintentional weight loss in the last year (> 4.5 kg); self-reported fatigue/exhaustion ("Does your health status make it difficult to perform physical activity and exercise?"); muscle weakness (handgrip strength); reduction in gait speed (gait speed assessment), and low level of physical activity (number of steps per week). Based on these criteria, the centenarians were classified according to Fried; Walston (2003) and Fried et al.(2001) as follows: robust (none of the criteria), pre-frail (one or two criteria), and frail (three or more criteria). For analysis, pre-frail and frail centenarians were classified as frail and robust centenarians were classified as non-frail.

The following information of centenarians was also obtained: body weight (G-TECH digital scale), height (Wood Portable Compact Economic Stadiometer - WCS; Cardiomed), handgrip strength (Saehan Dynamometer, model SH5001), stride length (measuring tape and Cescorf stopwatch), gait speed (measuring tape and Cescorf stopwatch), and the number of steps/day during a typical week, which was measured over 7 days using a Power Walker™ PW-610/611 pedometer. The data were recorded in PAMIC (Questions 208 to 220; Block 16 – Kinanthropometric and Physical Assessment of the Older Adult).

The average number of steps/week obtained with the pedometer was used to classify the physical activity level of centenarians. The participants were classified as "insufficiently active" when they walked < 1,000 steps/week and as "physically active" when they walked ⩾ 1,000 steps/week, based on the study by Tudor-Locke et al. (2011).

Data collection procedures

Data were collected between 2015 and 2019. First, the interviewers were trained according to the recommendations of the Interviewer's Manual: Application and Analysis of the Multidimensional Assessment Protocol for Centenarian Individuals (Mazo, 2017b). Telephone contact was then made with the centenarian and/or main caregiver who were invited to participate in the study. After they agreed to participate, a date was scheduled for data collection and signing the free informed consent form. Next, the PAMIC questions were applied by recorded interview with the older adults and their respective caregivers. The older adults were evaluated regarding their body weight, height, handgrip strength, stride length, and gait speed. The pedometer was given to the centenarian who was instructed on its use for 7 days. The participant also received a leaflet on the use of the pedometer. After the 7 days, the number of steps/day was recorded in the PAMIC (Figure 1-flowchart).

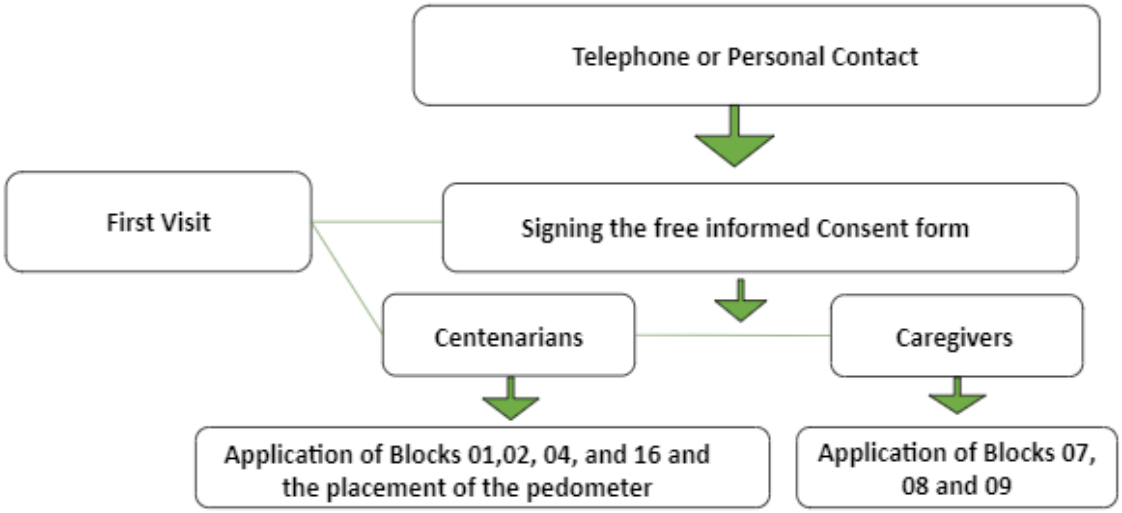

Figure 1. Flowchart of data collection process.
Source: Prepared by the author.

Data processing

Data were organized in Excel® and analyzed using the IBM SPSS Statistics 20.0 software. The variables were explored using descriptive statistics (mean, standard deviation, and frequency). Data normality was verified using the Kolmogorov-Smirnov test. The chi-square test with adjusted standardized residuals was applied to analyze the association of the occurrence of falls (fallers and non-fallers) with the frailty phenotype (frail and

non-frail), and the level of physical activity (active and insufficiently active). The independent t test was used to evaluate the association between the occurrence of falls (fallers and non-fallers) and the average number of steps/week (physical activity). A level of significance of 5% was adopted in all analyses.

Results and discussion

Fifty-four centenarians participated in the study. The mean age was 101.8 ± 2.8 years. Table 1 shows the characteristics of the sample. Regarding sociodemographic characteristics, most participants were female (63%), widowed (88.3%), had a caregiver (89%), and had never studied (44.4). Regarding health conditions, most centenarians had diseases (88.9%) and used medications (90.7%). The main self-reported diseases were hearing loss (70.4%), eye problems (55.6%), systemic arterial hypertension (46.3%), and urinary incontinence (31.5%). In addition, 53.7% of centenarians were classified as frail, 37% as pre-frail, and 9.3% as robust. Most centenarians did not perform physical activity (66.7%) and have not suffered a fall in the last 12 months (68.5%).

Table 1. Sociodemographic characteristics, health conditions, frailty phenotype, physical activity, and falls among centenarians participating in the study (n=54).

Variables	
Age (years), mean (SD)	101.8 (2.8)
Sociodemographic characteristics, n (%)	
Sex	
Male	20 (37)
Female	34 (63)
Marital status	
Not married	2 (3.7)
Married/With a partner	7 (13)
Widowed	45 (83.3)
Years of schooling	
Never studied	24 (44.4)
1 to 4	23 (42.6)
5 to 9	5 (9.3)
10 or more years	2 (3.7)
Has a caregiver	
Yes	48 (89)
No	6 (11)
Health Conditions, n (%)	
Diseases	
Yes	48 (88.9)
No	6 (11.1)
Type of disease	
Hearing loss	
Yes	38 (70.4)
No	16 (29.6)
Eye problems	
Yes	30 (55.6)
No	24 (44.4)
Hypertension	
Yes	25 (46.3)
No	29 (53.7)
Urinary incontinence	
Yes	17 (31.5)
No	37 (68.5)
Cardiovascular	
Yes	14 (25.9)
No	40 (74.1)
Back pain	
Yes	13 (24.1)
No	41 (75.9)
Osteoporosis	
Yes	11 (20.4)
No	43 (79.6)
Arthritis	
Yes	11 (20.4)
No	43 (79.6)

Osteoarthritis	
Yes	10 (18.5)
No	44 (81.5)
Stroke	
Yes	9 (16.7)
No	45 (83.3)
Dyslipidemia	
Yes	5 (9.3)
No	49 (90.7)
Diabetes	
Yes	4 (7.4)
No	50 (92.6)
Depression	
Yes	3 (5.6)
No	51(94.4)
Medication use, n (%)	
Yes	49 (90.7)
No	5 (9.3)
Frailty phenotype, n (%)	
Frail	29 (53.7)
Pre-frail	20 (37.0)
Robust	5 (9.3)
Physical activity, n (%)	
Yes	18 (33.3)
No	36 (66.7)
Falls, n (%)	
Yes	17 (31.5)
No	37 (68.5)

Note: n = absolute frequency; % = percentage; SD = standard deviation.

Source: Prepared by the author.

Table 2 shows the association between the occurrence of falls and frailty and physical activity among centenarians. A significant association was found between the occurrence of falls (fallers and non-fallers) and the frailty phenotype (with and without frailty) (p=0.03), with fallers tending to be frail. There was also an association between falls and the level of physical activity (active and insufficiently active) (p=0.014), with fallers tending to be physically active. In addition, fallers took a larger average number of steps/week (1,796.1 steps/week) than non-fallers (797.4 min/week) (p=0.019).

Table 2. Association between the occurrence of falls and frailty phenotype and physical activity among centenarians (n=54).

Variables	Total (n=54)	Fallers	Non-fallers	p value
Frailty phenotype, n (%)				
Frail	49 (90.7)	13 (76.5) [a]	36 (97.3)	0.03
Non-frail	5 (9.3)	4 (23.5)	1 (2.7) [a]	
Physical activity level, n (%)				
Active	19 (35.2)	10 (58.8) [a]	9 (24.3)	0.014
Insufficiently active	35 (64.8)	7 (41.2)	28 (75.7) [a]	
Average steps/week (SD)	1,111.8 (1,466.1)	1,796.1 (2,225.8)	797.4 (799.8)	0.019

Caption: n = absolute frequency; % = percentage; SD = standard deviation. *p<0.05; [a] adjusted residual > [2].

Source: Prepared by the author.

The present study aimed to evaluate the association of the occurrence of falls with the frailty phenotype and physical activity among centenarians. The results showed that centenarians with falls in the last 12 months tended to be frail and to have a higher level of physical activity. In addition, centenarians who fell took a larger average number of steps/week than older adults who did not fall.

Regarding frailty, most centenarians residing in Santa Catarina, who were part of the SC100 Project (Mazo et al., 2019), were found to be frail. Although no specific Brazilian studies involving centenarians are available, a population-based study – the Brazilian Longitudinal Study of Aging (ELSI-Brasil) – conducted between 2015 and 2016 that included 5,432 elderly people living in 70 municipalities in the five regions of the country, found that most older adults were pre-frail (54.5%) and frail (13.4%). Furthermore, the authors identified an increase in the prevalence of frailty in older age groups, with approximately 45% of frail older adults reporting some difficulty in performing basic activities of daily living and more than 67% reporting the

presence of at least two chronic diseases (Silva, Mambrini, Andrade, Andrade, & Lima-Costa, 2021). Another study involving people older than 80 years of age from a municipality in the southern region of Brazil found that 58% of the participants were frail and 42% were pre-frail, with the most frequent components being reduced gait speed, weight loss, and fatigue (Liberalesso, Dallazen, Bandeira, & Berlezi, 2017). The present findings agree with the two studies (Liberalesso et al., 2017; Silva et al., 2021), showing that centenarians are more frail.

The literature indicates a relationship between the risk of falling and frailty; frail older adults are at greater risk of falling than non-frail older adults and this risk increases proportionally with advancing age (Cheng &Chang, 2017). However, although the centenarians of the present study were frail, the prevalence of falls was low. In a survey of the results of studies related to the SC100 Project in Florianópolis/SC, Mazo et al.(2019) found that only 9 of the 30 centenarians evaluated had suffered falls in the last 12 months. These data agree with the present study, which showed a low prevalence of falls among centenarians from other municipalities in SC.

Despite the low prevalence of falls among the centenarians of the present study, the review by Leitão, Oliveira, Rolim, Carvalho, Filho, and Junior, (2018) showed a prevalence of falls among older adults ranging from 10.7 to 59.3%, with the home being the most frequent scenario, especially during the day. The most common causes of falls were tripping, slipping, dizziness, and the presence of uneven surfaces, causing falls from one's own height and resulting in fractures and the fear of falling again. The study also found that the factors most often associated with falls were female gender, age over 80 years, cognitive deficit, and depressive symptoms (Leitão et al., 2018).

Falls can be caused by the aging process itself linked to multiple factors that can lead to partial or total disability of the older adult, with the consequent loss of autonomy and independence (Fhon & Rodrigues, 2021). Duarte, Santos, Lebrão, and Duarte (2019) found a higher prevalence of falls among older adults with reduced handgrip strength and gait speed, weight loss, and fatigue. Fried et al. (2001) defined these criteria for the frailty phenotype. In addition, there is evidence that frailty reduces physical resistance and motor performance and causes changes in balance, with a consequent decline in the body's physiological reserve that makes it prone to falls (Fried et al., 2001). In a study conducted specifically on centenarians from five countries, Herr et al. (2018) evaluated frailty and concluded that the most common frailty criteria in centenarians are weakness, decreased strength, and low level of physical activity.

One finding of this study was the high percentage of centenarians with a low level of physical activity, which is an indicator of frailty. Within this context, Mazo et al. (2019) found a high prevalence of physical inactivity and passive leisure activities restricted to the home environment among centenarians. Thus, promoting physical activity and active home-based leisure activities in centenarians may minimize frailty and improve the level of physical activity of both fallers and non-fallers.

Another finding of the present study was that centenarians who walk more steps per week tend to suffer more falls. This result can be explained by the fact that falls are multifactorial and that, in addition to internal factors, the environment is also a major cause of falls (Nogueira, Ulbinski, Jaques, & Baldissera, 2021). Thus, when walking more, the centenarian will automatically be more exposed to different environments and to the risk of falling (Couto & Perracini, 2012). However, this does not mean that older adults should walk less to prevent falls; quite the opposite. Older adults must increase their level of physical activity since it enables them to know and perceive their own body, increasing social interaction and eliciting responses resulting from physiological and psychological adaptations which, in turn, will reduce fatigue and increase the willingness to perform daily tasks (Maciel, 2010). It is therefore essential to increase the level of physical activity of centenarians using interventions such as physical exercises and leisure activities, which will help minimize frailty and prevent falls (Bento et al., 2010) since exercise reduces by approximately 25% the occurrence of falls in older adults (Sherrington et al., 2020). Within this context, it is important that health professionals and caregivers encourage centenarians to perform physical activity and leisure activities in their daily lives.

This study has some limitations. The size and heterogeneity of the sample impaired the analysis and further discussion of the causal relationships between the occurrence of falls and the level of physical activity and frailty phenotype. In addition, falls can be caused by several factors. The causes of the fall can be intrinsic, like some of the criteria used in this analysis, or extrinsic, linked to the environment, which were not considered in the present study.

Nevertheless, the present results are extremely important in the context of very long-lived individuals, such as centenarians, since they highlight the need for preventing frailty and falls and for increasing the level of physical activity by maintaining a healthy and active lifestyle. Another strength of the study is the

population-based approach that involved centenarians from different cities and regions of SC, Brazil, and the use of a direct measure of physical activity (pedometer).

Conclusion

This study demonstrated a high prevalence of frailty among centenarians. In addition, older adults who fell in the last 12 months tended to be frail and to have a higher level of physical activity. We also found that fallers took a larger average number of steps/week than non-fallers. However, studies determining the frailty components that can cause falls in physically active centenarians are necessary. The results of this study will significantly contribute to the current scenario of population aging and can be used as a basis for future studies investigating very long-lived individuals.

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