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Factors associated with the prevalence of sarcopenia and frailty syndrome in elderly university workers

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ABSTRACT

Background: Frailty and sarcopenia are highly prevalent, as a part of geriatric syndrome, among elderly individuals. However, little is known about how these syndromes can affect elderly individuals who continue to work.

Objective: To estimate the prevalence of sarcopenia and frailty, and their individual and occupational factors among elderly individuals.

Methods: This cross-sectional study included elderly individuals working in a public university in Brazil, who were classified according to their sarcopenia and frailty profiles. They answered a structured questionnaire comprising potential explanatory variables: individual sociodemographic factors, work related factors, and health behaviors. Additionally, they performed a physical performance test. Multinomial logistic regression was used to estimate *odds ratios* and respective 95% confidence intervals (95% CIs). All analyses were conducted using the Stata 13.0 software, considering a significance of 5%.

Results: Respectively, 55.8% and 6.3% of the elderly participants were classified in the Sarcopenia and Severe Sarcopenia groups. Frailty prevalence was 9.4%, with 62.5% classified as Pre-frail. Sarcopenia prevalence was significantly higher among men, and among those living with a partner, with a university degree, exhibiting poor lower limb function, and with multiple work demands. Frailty prevalence was significantly higher among women, and among those living without a partner, having a low educational level, with less work experience, working in an unhealthy/dangerous environment, and whose job was predominantly physical.

Conclusion: This study identified different potential trigger factors for the development of sarcopenia and frailty. These findings confirm that individual and work factors could explain the incidence of sarcopenia and frailty syndrome.

1. Introduction

Population aging in Brazil is causing economic, social, labor related, and public health challenges (Geib, 2012; Jackson, Strauss, & How, 2009; Veras, 2009). It can be a problem for a sustainable economic growth since it reduces the relative size of job offers because of the retirement process (Jacinto & Ribeiro, 2012). However, there is growing scientific and political interest in understanding the portion of the elderly population that is still engaging in occupational activities (Camarano, Kanso, & Fernandes, 2013) and the relationship between aging and work. Additionally, there is growing interest in silent events that trigger disabilities, such as frailty syndrome and sarcopenia.

Predictive factors for work activity maintenance stem from a dynamic process between individual resources in relation to the job, healthy status, lifestyle, social and behavioral aspects, and aging itself. These factors can be classified as Individual, Work, and Life Outside of Work factors, according to the multidimensional model (Gould, Ilmarinen, Jarvisalo, & Koshinen, 2008). Individual resources comprise sociodemographic conditions, health, knowledge and abilities, values, and attitudes. Work factors include the work environment, content, and demands, and the work community (Sampaio & Augusto, 2012). Elderly workers' individual characteristics are associated to frailty syndrome

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and sarcopenia because they determine physical ability, one of the functionality components, including muscle strength and performance on functional tasks (Savinainen, Nygard, & Ilmarinen, 2004). Simultaneously, workload as well as work time and intensity of physical exposure can reduce the muscle capacity to generate power, which in turn facilitates the development of these age-related syndromes (Jung, Gruenewald, Seeman, & Sarkisian, 2009; Savinainen et al., 2004). The estimated prevalence rates of sarcopenia and frailty among community-dwelling elderly individuals are 15.4% and 11.2%, respectively (Silva, Duarte, Santos, Wong, & Lebrão, 2014; Silva, Neri, Ferrioli, Lourenço, & Dias, 2016). However, in elderly workers these conditions have not yet been observed, and this topic requires scientific investigations.

Studies have shown that the reduction in the functional capacity of elderly workers aged 65 years or more (Amorim, Salla, & Trelha, 2014; Luis & Diaz, 2011) and their muscle performance deterioration can explain accidents at work. Muscle strength, physical performance, exhaustion at work and energy expenditure are determinants of work capacities, and they are related to the physiological reserve that can guarantee higher chances of continuing to work. Functionality and work domains are parts of the constructs for the diagnosis of frailty and sarcopenia, suggesting that their adverse effects can affect elderly workers. However, the same is not well established in the literature. Therefore, the present study aimed to estimate the prevalence of sarcopenia and frailty, and to examine their individual and occupational factors among public university elderly workers.

2. Materials and methods

This cross sectional study was conducted with elderly workers from a public university in North Paraná, Brazil. After receiving permission from the human resources pro rectory, all workers aged 60 years or more, located in the different centers and sectors of the institution, were included in the study, independent of occupational activity, gender, race or social class.

Sample size was determined using the finite formula based on population proportion, considering the reference population of economically active and working elderly in the city, adopting a 95% confidence interval, a significance of 0.05, power of 80%, a Z value of 1.96 and an error estimation of 3%. After sample size calculation, n = 319 was estimated with maximum additional losses of 20% (N = 53). The parsimony principle was adopted considering that 1) the university workers' population would be representative of the city and that 2) there was a discrepancy in the number of elderly participants between public and private higher education institutions.

The following exclusion criteria were employed: cognitive impairment detected by the Mini Mental Exam Examination (Bertolucci, Brucki, Campacci, & Juliano, 1994); elderly individuals who had withdrawn from work for at least 15 days because of holidays or license during the research period, refusal to participate, death, and those who were retired at the time of contact for this study.

Participants were though phone calls or in person, at their workplace, and were previously informed of the study objectives. Those who demonstrated interest in voluntarily participating in the study were scheduled for data collection. The study was approved by the Ethics and Research Committee involving Human Beings of the University (#107/2013) and all participants signed an Informed Consent form.

Before the commencement of the study, a pilot study was conducted with 30 elderly workers not belonging to the final sample, to adjust data collection instruments. During the pilot study, all researchers involved were trained, and subsequently, the main investigation occurred between August 2013 and August 2014. A structured questionnaire including sociodemographic data, health status, and lifestyle was used to describe the sample. Physical tests to assess participants' clinical functional condition were also performed.

2.1. Sarcopenia and frailty syndrome diagnosis (dependent variables)

Considering sarcopenia and frailty as outcome variables, the recommendations of the European Working Group on Sarcopenia in Older People were used to characterize sarcopenia according to the following items: low appendicular muscle mass index, reduced muscle strength, and poor physical performance (Cruz-Jentoft et al., 2014).

Low muscle mass was estimated by Lee et al.'s equation (2000) considering age, sex, height, gender, weight, and race. Following the sarcopenia algorithm recommended, the Muscle Mass Index adjusted by height was calculated, and the participants were classified into the Sarcopenia group when they presented values equal or lower than 8.90 kg/m^2 and 6.37 kg/m^2 for men and women, respectively. Handgrip strength (HGS) was assessed by a Saehan dynamometer (*Saehan Corporation, 973, Yangdeok-Dong, Masan 630–728, Korea*), to evaluate low muscle strength. This instrument has been validated for use in research (Reis & Arantes, 2011). Measurement was made with the participant being seated on an armless chair, feet supported on the floor, hips and knees flexed at 90°, arms parallel to the body, elbows flexed at 90°, and forearms and wrists in a neutral position. Three measurements were made on the dominant side, with one-minute intervals between them, always using verbal stimulation. Results are presented in Kilogram/force (Kgf) using the mean of the three measures, as suggested by Figueiredo, Sampaio, Mancini, Silva, and Souza, (2007). According the algorithm, low muscle mass was diagnosed if the score was lower than 30 kgf for men and 20 kgf for women.

Physical performance was assessed using a gait speed test on a 4-meter course, with 0.8 m/s as the cutoff point. Participants were classified into the pre-sarcopenia (if they had only low muscle mass), sarcopenia (low muscle mass + low muscle strength or low physical performance) and severe sarcopenia groups (all three criteria positive).

Frailty syndrome was identified according to the following five items proposed by Fried et al. (2001): 1) unintentional weight loss; 2) exhaustion assessed by self related fatigue; 3) low handgrip strength; 4) low physical performance; and 5) low gait speed. Weight loss was defined as self-related unintentional weight loss ≥ 4.5 kg or ≥ 5% of last year's body weight, being positive those participants who related weight loss. Fatigue was defined based on self-related exhaustion assessed by the following two questions: "How many days during the last week have you felt that anything you did was a big effort?" and "How many times during the last week have you felt that you could not keep on doing things?" Answers were scored between 0 and 4 depending on symptom frequency; if any question received a score of 2 or higher, this criterion was considered positive. Low muscle mass was defined by the handgrip strength test according the abovementioned sarcopenia algorithm.

The short version of the *International Physical Activity Questionnaire* (IPAQ) for Brazilian elderly (Mazo & Benedetti, 2010) was used to evaluate physical activity level. Information on type, frequency, and duration of physical activity in the last 90 days were collected. Then the physical activity level was calculated based on oxygen consumption, quantified by energy expenditure in the Metabolic Equivalents of Task (MET), and only moderate to vigorous activities lasting for more than 10 min were considered. Those presenting energy expenditure < 450 MET min/week were classified as sedentary and those who performed moderate/vigorous activities for less than 150 min/week were characterized as insufficiently active and were scored as positive for this frailty item. "Non-frail" participants were those who did not score positively on any of the five items, while "pre-frail" were those who scored positively on one or two items. "Frail" individuals were those who scored positively on three or more criteria (Fried et al., 2001).

2.2. Explanatory variables

Potential explanatory variables were selected based on previous studies about aging, work, sarcopenia, and frailty (Amorim et al., 2014;

Fried et al., 2001; Gould et al., 2008; Silva et al., 2014, 2016), including i) individual sociodemographic factors (age, gender, marital status, and educational level), health behaviors (smoking and drinking), physical and functional performance (five times sit to stand test; 5 × SST) and ii) work related factors (requirements, work schedule, dangerous or unhealthy environment, and weekly workload).

Health behaviors included alcohol consumption, smoking, and physical activity level. Problems with alcohol were considered if more than seven doses were consumed per week in the 12 months preceding the interview, according to the *Alcohol Use Disorder Identification Test* (AUDIT) (Moretti-Pires & Corradi-Webster, 2011). Cards with standard liquid amounts (corresponding a dose of beer, wine, or brandy) were showed to the participants. "Current smokers" were those who had smoked at least 100 cigarettes in their life and were still smoking; participants who had definitely stopped smoking were classified as "stopped smoking," while "non-smokers" were those who had never smoked in their life (Peixoto, Firmo, & Lima-Costa, 2005). The 5 × SST was used to assess physical performance as fast as possible, using a standard 45 cm high armless chair. Participants sat with arms crossed on the trunk, and their time on the task was counted in seconds.

In relation to work characteristics, participants were asked about formal work time during their life (years), weekly workload, and predominant work shift (morning/afternoon/evening). Participants who reported having received a hazard pay in addition to their salary were considered as working in a dangerous or unhealthy environment. Information on mental and/or physical work demands were also collected.

2.3. Statistical analysis

The collected data were tabulated by two independent researchers and information was compared to minimize inconsistencies. Archives were compared through Epi Info® program version 3.5.1 and discrepant data were corrected after consulting questionnaires. Sample characteristics, considering confusing variables, were presented in proportions and means (with respective standard deviations). Besides, these characteristics were compared between the following groups: Pre-sarcopenia, Sarcopenia and Severe Sarcopenia, as well as Non-frail, Pre-frail, and Frail, using the Pearson's chi-square or Fisher's Exact test to compare proportions, and the Analysis of Variance (ANOVA) to compare means.

Multinomial logistic regression was used to estimate *odds ratios* and respective 95% confidence intervals (95% CIs). Multivariate analyses were conducted to include multiple factors considering p value < 0.20, and significant statistical associations were considered if $p < 0.05$ after the adjusted analysis. The Hosmer-Lemeshow test was applied to verify if the final model was adequate. All analyses were conducted using the Stata 13.0 software, considering a significance of 5%.

3. Results

Among the 258 elderly in the sample, 55.8% (95% CI: 0.49–0.62) and 6.3% (95% CI: 0.04–0.10) were classified as Sarcopenic and Severe Sarcopenic, respectively. Frailty prevalence was 9.4% (95% CI: 0.06–0.14) and 62.5% (95% CI: 0.57–0.70) of the elderly were classified as pre-frail. Elderly workers' characteristics have been presented in Table 1. Sarcopenia prevalence was significantly higher among men (77.9%), and among those living with a partner (67.6%), who had a university degree (52.1%), had the worst lower-limb performance (13.1 s on the 5 × SST) and had multiple work demands (58.6%). Frailty prevalence was significantly higher among women (87.5%), and among those living without a partner (58.3%), having a low educational level (70.8%), having less work time (22.2 years), working in an unhealthy/dangerous environment (70.8%), and being engaging in predominantly physically demanding work (50%). More details on the sociodemographic characteristics, lifestyle, physical performance, and work indicators of the sample participants, and their distributions according to frailty and sarcopenia syndromes have been presented in Tables 2 and 3.

Table 1
Sociodemographic conditions, health behaviors, and work conditions of public university elderly workers.

Characteristics	Total (n = 258) Mean ± SD	N (%)
Individual factors		
Age (years)	62.9 ± 2.47	
Gender		
Male		149 (57.8%)
Female		109 (42.2%)
Marital situation		
Without partner		100 (38.9%)
With partner		157 (61.1%)
Schooling		
High school		107 (41.5%)
Higher education and post-graduation		151 (58.5%)
Smoking		
Non-smoker		127 (49.2%)
Stopped smoking		100 (38.8%)
Current smoker		31 (12.0%)
Drinking		
Risk-free use		231 (89.5%)
Risk use		27 (10.5%)
SST	9.8 ± 2.9	
Factors related to work		
Working time	26.7 ± 8.9	
Hours worked per week		
Until 36 h/week		31 (12.0%)
36 to 60 h/week		227 (88.0%)
Hazard pay (yes)		140 (54.3%)
Night work (yes)		90 (34.9%)
Requirements for work		
Mental		24 (9.3%)
Physical		72 (27.9%)
Mixed		162 (62.8%)
Sarcopenia		140 (55.8%)
Severe Sarcopenia		16 (6.4%)
Pre-frail		160 (62.5%)
Frail		24 (9.4%)

SD: standard deviation; SST: five times sit to stand test.

Table 4 shows results from the multivariate analysis in relation to the associations between individual and work characteristics, according to Sarcopenia and Severe Sarcopenia prevalence. After adjustments for previously selected factors ($p < 0.20$), women showed an association with Sarcopenia (OR: 10.96; 95% CI: 5.29–22.67) and Severe Sarcopenia (OR: 93.12; 95% CI: 9.33–29.26), and the worst performance on lower-limb tasks was associated with Severe Sarcopenia in elderly workers (OR: 1.37; 95%: 1.12–1.68).

Factors associated with frailty have been presented in Table 5. After adjustment for covariates, the following factors were identified: being female (OR: 17.85; 95% CI: 3.55–89.64), having a low educational level (OR: 5.79; 95% CI: 1.41–23.84), and poor lower-limb performance (OR: 1.58; 95% CI: 1.27–1.98). Being pre-frail was associated with poor lower-limb performance (OR: 1.16; 95% CI: 1.02–1.33) and working time in the institution (OR: 3.08; 95% CI: 1.13–8.34), but the association was smaller when unhealthy/dangerous behavior was reported (OR: 0.48; 95% CI: 0.25–0.92).

4. Discussion

This study investigated the prevalence of sarcopenia and frailty in an exclusive sample of elderly works in a public university. A

Table 2
Public university elderly workers' characteristics according to their frailty syndrome diagnosis.

Characteristics	Frailty syndrome			p-value
	Non-frail (n = 72; 28.1%)	Pre-frail (n = 160; 62.5%)	Frail (n = 24; 9.4%)	
Age (years)	63.0 ± 2.6	62.9 ± 2.5	62.5 ± 2.3	0.667[a]
Gender				0.000[b]
Male	54 (75%)	91 (56.9%)	3 (12.5%)	
Female	18 (25%)	69 (43.1%)	21 (87.5%)	
Marital situation				0,033[b]
Without partner	21 (29.2%)	64 (40.2%)	14 (58.3%)	
With partner	51 (70.8%)	95 (59.8%)	10 (41.7%)	
Schooling				0.009[b]
High school	28 (38.9%)	61 (38.1%)	17 (70.8%)	
Higher education and post-graduation	44 (61.1%)	99 (61.9%)	7 (29.2%)	
Smoking				0.166
Non-smoker	35 (48.6%)	75 (46.9%)	16 (66.7%)	
Stopped smoking	30 (41.7%)	61 (38.1%)	8 (33.3%)	
Current smoker	7 (9.7%)	24 (15.0%)	0 (0.0%)	
Drinking				0.489[c]
Risk-free use	16 (100.0%)	27 (87.1%)	4 (100.0%)	
Risk use	0 (0.0%)	4 (12.9%)	0 (0.0%)	
SST	8.9 ± 2.0	9.7 ± 2.6	13.1 ± 4.4	0.000
Working time	24.8 ± 8.9	28.2 ± 8.7	22.2 ± 7.5	0.000
Hours worked per week	39.0 ± 4.9	39.7 ± 3.8	39.1 ± 2.6	0.373[a]
Hazard pay (yes)	46 (63.9%)	76 (47.5%)	17 (70.8%)	0.016[b]
Night work (yes)	24 (33.3%)	59 (36.9%)	7 (29.2%)	0.708[b]
Requirements for work				0.060[c]
Mental	10 (13.9%)	12 (7.5%)	2 (8.3%)	
Physical	16 (22.2%)	43 (26.9%)	12 (50.0%)	
Mixed	46 (63.9%)	105 (65.6%)	10 (41.7%)	

SST: five times sit to stand test.
[a] ANOVA.
[b] Chi-square.
[c] Fisher exact.

Table 3
Public university elderly workers' characteristics according to sarcopenia diagnosis.

Characteristics	Pre-sarcoepnia (n = 98; %37.9)	Sarcopenia (n = 144; 55.8%)	Severe Sarcopenia (n = 16; 6.3%)	p-value
Age (years)	62.9 ± 2.7	62.8 ± 2.3	63.6 ± 2.1	0.487[a]
Gender				0.000[c]
Male	25 (26.3%)	109 (77.9%)	14 (87.5%)	
Female	70 (73.7%)	31 (22.1%)	2 (12.5%)	
Marital situation				0.044[b]
Without partner	46 (48.4%)	45 (32.4%)	7 (43.8%)	
With partner	49 (51.6%)	94 (67.6%)	9 (56.2%)	
Schooling				0.003[b]
High school	27 (28.4%)	67 (47.9%)	10 (62.5%)	
Higher education and post-graduation	68 (71.6%)	73 (52.1%)	6 (37.5%)	
Smoking				0.541[c]
Non-smoker	45 (47.4%)	72 (51.4%)	6 (37.5%)	
Stopped smoking	38 (40.0%)	53 (37.9%)	6 (37.5%)	
Current smoker	12 (12.6%)	15 (10.7%)	4 (25.0%)	
Drinking				0.237[c]
Risk-free use	19 (100.0%)	23 (85.2%)	3 (100.0%)	
Risk use	0 (0.0%)	4 (14.8%)	0 (0.0%)	
SST	10.1 ± 2.9	9.3 ± 2.8	12.0 ± 3.6	0.000[a]
Working time	26.4 ± 8.8	27.0 ± 9.1	26.8 ± 7.6	0.863[a]
Hours worked per week	39.1 ± 5.1	39.8 ± 2.9	38.8 ± 5.6	0.351[a]
Hazard pay (yes)	45 (47.4%)	81 (57.9%)	9 (56.3%)	0.280[b]
Night work (yes)	32 (33.7%)	50 (35.7%)	7 (43.8%)	0.735[b]
Requirements for work				0.005[c]
Mental	2 (2.1%)	14 (10.0%)	4 (25.0%)	
Physical	22 (23.2%)	44 (31.4%)	4 (25.0%)	
Mixed	71 (74.7%)	82 (58.6%)	8 (50.0%)	

SST: five times sit to stand test.
[a] ANOVA.
[b] Chi-square.
[c] Fisher exact.

prevalence rate of 55.8% and 6.3% was observed for Sarcopenia and Severe Sarcopenia, respectively. Values identified in a literature review (Cruz-Jentoft et al., 2014) ranged from 1 to 29%, depending on the criteria used to assess muscle mass as in our study, but all studies were conducted in community-dwelling elderly. Using the same criteria of muscle mass, muscle strength, and physical performance used in our study, Marty, Liu, Samuel, Or, and Lane, (2017) found prevalence rates between 29% and 33%, values that were substantially lower than those observed in the present study. In a population based Brazilian study that also used the EWGSOP, the prevalence of sarcopenia was 16.1% for women and 14.4% for men (Silva et al., 2014). Another national study (Pereira, Leite, & Paula, 2015) conducted with a male sample identified 12.6% Pre-sarcopenic elderly and 10.1% Sarcopenic elderly. All these values are lower than those reported in our study, but none of the samples comprised elderly workers. Most of these studies included retired individuals or they did not mention their occupational position (Pereira et al., 2015; Silva et al., 2014). Possibly, elderly individuals who are exposed to high work demands have poorer muscle strength (Savinainen et al., 2004) and they exhibit worsening in physical function, which can explain the high prevalence of sarcopenia in this population (Kenny, Yardley, Martineau, & Jay, 2008). According to Cote, Kenny, Dussetschleger, and Farr, (2014), normative data can underestimate physical performance in "healthy" elderly workers, thus supporting the high prevalence of sarcopenia found on the present study. Indeed, the effect on healthy workers can be lower when the deficits are intrinsically related to strength and muscle mass. This finding suggests the need to review sarcopenia diagnosis parameters for the working population, because the participation of elderly individuals in the job market is growing. In 1977, elderly individuals comprised 4.9% of the economically active population (EAP), which increased to 9% in 1998 and is expected to reach 13% by 2020 (Camarano et al., 2013).

Factors associated with severe sarcopenia were gender (women) and lower-limb physical performance, while those associated with frailty were gender (women), education (high school) and lower-limb physical performance. Women presented higher chances of developing sarcopenia; while work time (years), unhealthy work environment, and worse lower-limb physical performance were associated with higher chances of being pre-frail.

In relation to the association between sarcopenia and lower performance on the SST, previous studies only found associations between sarcopenia and physical function in younger elderly individuals (Bijlsma et al. (2014), similar to the present sample, despite using different methods to assess physical performance. The importance of frequent physical performance measurements is even more relevant when investigating elderly individuals (Dale, Addison, Lester, Kaskutas, & Evanoff, 2014). However, in newly-hired young individuals, handgrip strength is not useful to identify workers at risk of developing musculoskeletal diseases or work inabilities.

Pre sarcopenia and severe sarcopenia were also associated with gender. Data from the SABE project (Health, well-being and aging) database (Health, well-being and aging) showed higher prevalence of sarcopenia in women by using Lee's equation to determine muscle mass (Silva et al., 2014), thus corroborating our findings. However, results from a different study (Pereira et al., 2015) have evidenced higher prevalences among men, but that sample was older. These findings indicate that the relation between gender and sarcopenia can vary with

Table 4
Factors associated with sarcopenia diagnosis in public university elderly workers.

Characteristics	Sarcopenia diagnosis			
	Crude model		Adjusted model	
	Sarcopenia OR (95% CI)	Severe Sarcopenia OR (95% CI)	Sarcopenia OR (95% CI)	Severe Sarcopenia OR (95% CI)
Age (years)	0.99 (0.89–1.10)	1.11 (0.91–1.36)	0.98 (0.86–1.12)	1.04 (0.80–1.34)
Gender				
Male	1.00	1.00	1.00	1.00
Female	9.8 (5.37–18.05) [b]	19.6 (4.16–92.38) [b]	10.96 (5.29–22.67)	93.12 (9.33–29.26)
Marital situation				
Without partner	1.00	1.00	1.00	1.00
With partner	0.51 (0.30–0.87) [b]	0.83 (1.36–2.71)	1.39 (0.69–2.81)	3.24 (0.86–12.31)
Schooling				
High school	2.31 (1.33–4.03) [b]	4.20 (1.39–12.69) [b]	1.68 (0.79–3.55)	2.56 (0.58–11.25)
Higher education and post-graduation	1.00	1.00	1.00	1.00
Smoking				
Non-smoker	1.00	1.00	–	–
Stopped smoking	0.87 (0.50–1.52)	1.18 (0.35–3.98)	–	–
Current smoker	0.78 (0.34–1.82)	2.50 (0.61–10.31)	–	–
Drinking				
Risk-free use	1.00	1.00	–	–
Risk use	0.59 (0.25–1.40)	1.60 (0.40–6.43)	–	–
SST	0.90 (0.82–0.99)[b]	1.15 (1.01–1.32) [b]	0.99 (0.88–1.11)	1.37 (1.12–1.68)
Working time	1.50 (0.69–3.25)	0.51 (0.06–4.24)	–	–
Hours worked per week	1.04 (0.98–1.12)	0.98 (0.88–1.10)	–	–
Hazard pay (yes)	1.53 (0.90–2.58)[a]	1.43 (0.49–4.15) [a]	–	–
Night work (yes)	1.09 (0.63–1.89)	1.53 (0.52–4.49)	–	–
Requirements for work				
Mental	1.00	1.00	1.00	1.00
Physical	0.29 (0.06–1.37)[a]	0.09 (0.01–0.67)[b]	0.76 (0.14–4.24)	0.25 (0.03–2.52)
Mixed	0.16 (0.04–0.75)[b]	0.06 (0.01–0.36)[b]	0.43 (0.08–2.23)	0.21 (0.02–1.79)

SST: five times sit to stand test.
[a] $p < 0.20$.
[b] $p < 0.05$.

reference to age. On the other hand, the sample did not comprise elderly workers. Gender and poor performance on the SST, one of the tasks on the *Short Physical Performance Battery* (SPPB) (Fragala et al., 2015), has been used items, were related in intervention studies in which elderly women presenting worse strength and muscle mass index scores at baseline had better SPPB performance when they participated in an exercise program. This finding confirms the association between gender, physical performance, and sarcopenia (Fragala et al., 2015).

Frailty prevalence was also higher in the present study when compared to others. An investigation with a random sample from Belo Horizonte (Brazil), using the same frailty criteria, found 13.5% frail elderly and 55.5% non-frail elderly (Vieira et al., 2013). Another study in the same city, with a bigger sample, found 46.3% pre-frail elderly and 8.7% frail participants (Lustosa, Marra, Pessanha, Freiras, & Guedes, 2013). However, in both studies, the sample mostly comprised retired elderly individuals and not those participating in labor activities.

Frailty was associated with SST performance, with elderly individuals presenting worse performance exhibiting higher chances of being pre-frail and frail. Though using a different physical performance test, a study with a Brazilian sample (Lustosa et al., 2013) also found a significant correlation between physical performance and frailty. According to Luis and Diaz (2011), performance measurements that demand speed are strongly affected by these abilities, and these data reveal the divergence of strength and mobility as parameters to classify elderly at risk of losing functional capacity.

Frailty was also associated with time of occupation, and unhealthy and dangerous working environment. Considering that the frailty assessment instrument includes strength, physical performance, weight loss, and physical activity, it is evident that these measures are directly influenced when elderly are exposed to those environments (Charles et al., 2006). Studies (Charles et al., 2006; Kenny et al., 2008; Luis & Diaz, 2011) have revealed that the place of work of the elderly may trigger neuropathic events that limit handgrip strength, generating, in some cases, hospitalizations, disabilities, weight loss, and a sedentary lifestyle.

It is important to consider the context of the institution where the investigation was conducted. During the present data collection, a huge heterogeneity of occupational activities was observed in the sample, because the university offers community teaching, research, extension, and technical service jobs. Similarly, it is relevant to notice that the employees' tasks were mostly characterized by intellectual work with constant use of mental skills. These activities were characterized by the perception and processing of various information, high responsibility for abstract values, time pressure, high work volume, and high need of professional qualifications. These workers' characteristics can justify the results on poor physical performance and possibly the increase in sarcopenia and frailty prevalence, given the low demand for muscle strength, low gait speed, and physical activity, but also on the perception of fatigue/exhaustion.

One of the limitations of the present study is its cross sectional nature, which prevents the determination of causal relations and the possible overestimation of the effects of the variables studied. There was no selection or sampling bias since loss analyses according to sociodemographic and occupational characteristics evidenced no differences between those who participated in the study and those who did not do so. With regard to external validity, the study presents the possibility to generalize the results to the elderly university population (Camarano et al., 2013; Godinho et al., 2016; Padula, Comper, Moraes, Sabbagh, & Pagliato Junior, 2013; Sampaio & Augusto, 2012).

Table 5
Factors associated with frailty syndrome diagnosis in public university elderly workers.

Characteristics	Frailty Syndrome			
	Crude model		Adjusted model	
	Pre frail OR (95% CI)	Frail OR (95% CI)	Pre Frail OR (95% CI)	Frail OR (95% CI)
Age (years)	0.99 (0.89–1.11)	0.92 (0.75–1.12)	0.94 (0.83–1.06)	0.76 (0.58–1.00)
Gender				
Male	1.00	1.00	1.00	1.00
Female	2.27 (1.23–4.22) [b]	21.0 (5.60–78.78) [b]	1.84 (0.91–3.69)	17.85 (3.55–89.64)
Marital situation				
Without partner	1.00	1.00	1.00	1.00
With partner	1.64 (0.90–2.98)[a]	3.40 (1.31–8.86) [b]	1.37 (0.70–2.70)	1.42 (0.41–89.64)
Schooling				
High school	0.97 (0.55–1.71)	3.82 (1.40–10.37) [b]	1.34 (0.66–2.72)	5.79 (1.41–23.84)
Higher education and post-graduation	1.00	1.00	1.00	1.00
Smoking				
Non-smoker	1.00	1.00	–	–
Stopped smoking	0.95 (0.52–1.72)	0.58 (0.22–1.55)	–	–
Current smoker	1.60 (0.63–4.07)	3.63 (NA)	–	–
Drinking				
Risk-free use	1.00	1.00	–	–
Risk use	0.78 (0.33–1.85)	0.64 (0.13–3.17)	–	–
SST	1.16 (1.03–1.32) [b]	1.58 (1.32–1.89) [b]	1.16 (1.02–1.33)	1.58 (1.27–1.98)
Working time	2.44 (096–616)[a]	0.48 (005–419)	3.08 (1.13–8.34)	2.22 (0.20–24.54)
Hours worked per week	1.05 (098–112)[a]	1.01 (091–112)	1.04 (0.96–1.12)	0.96 (0.84–1.10)
Hazard pay (yes)	0.51 (0.29–0.91) [b]	1.37 (0.50–3.74)	0.48 (0.25–0.92)	0.76 (0.20–2.82)
Night work (yes)	1.17 (0.65–2.10)	0.82 (0.30–2.26)	–	–
Requirements for work				
Mental	1.00	1.00	1.00	1.00
Physical	2.24 (0.81–6.19)[a]	3.75 (0.69–20.38)[a]	1.99 (0.67–5.90)	1.06 (0.13–8.89)
Mixed	1.90 (0.77–4.72)[a]	1.09 (0.21–5.75)	1.28 (0.47–3.47)	0.54 (0.06–4.74)

SST: five times sit to stand test.
[a] $p < 0.20$.
[b] $p < 0.05$.

Considering the results and study limitations, and within a conception of capacity to work based on the relationship among workers' resources and work demands, we present the following suggestions. The implementation of actions to investigate functional capacity in occupational health programs is recommended, besides the traditional clinical measurements that are important indicators for worker health, especially the elderly. Functional capacity and work status should be monitored aiming to quickly identify alterations and implement timely corrective measures, both at the individual and collective level. We also suggest projects to promote physical activities, fall prevention at work, and adjustments of mental work intensity to the study participants.

Literature shows investigations of these geriatric syndromes in community dwelling elderly, or living in long-term institutions, where prevalence is associated to the decline of health conditions and functionality. Considering the context in which our study was delineated, and the existing studies about sarcopenia and frailty in working elderly individuals, we suggest that future studies included a design allowing to establish causal directions and/or to assess the results of preventive measures of these outcomes. Data from this research will reinforce the urgency and need to include these outcomes in occupational medicine professionals' evaluation.

4.1. Conclusion

This study proposed an investigation and scientific discussion of complex interpretation about aging, work, frailty and sarcopenia. The findings of the exploratory analysis of the elderly university population reinforced that alterations in individual factors and in those related to work could explain biological and functional alterations that lead to sarcopenia and frailty development. A meticulous statistical analysis, supported by a previous theoretical model, was conducted to clarify the distribution of elderly workers' characteristics. As a result, we have identified that the prevalence of the outcomes was high. Additionally we revealed new factors related to these syndromes, which were different from the classic ones presented in the existing literature.

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Declarations of interest

None

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