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Risk of community-acquired pneumonia in older adults with sarcopenia of a hospital from Callao, Peru 2010–2015

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Abstract

Introduction: Sarcopenia is a geriatric syndrome characterized by loss of muscle mass and strength. The prevalence in people between 60–70 years is about 5–13% and in adults over 80 years, between 11–50% in the USA. Sarcopenia increases the risk of mortality and nosocomial infections.

Community-acquired pneumonia is the first infectious-related cause of death in elderly people. However, there is lack of evidence about the association between sarcopenia and pneumonia. The aim of our study was to determine the incidence and risk factors of community-acquired pneumonia in older adults with sarcopenia in a Peruvian hospital.

Methods: A retrospective cohort study was conducted in the geriatrics service of Centro Medico Naval “Cirujano Mayor Santiago Tavara”. Sarcopenia was defined by “European Consensus of Sarcopenia” criteria. Multivariate *Poisson* regression model was conducted to estimate the effect of the independent association between sarcopenia and pneumonia.

Results: A total of 1598 subjects were enrolled, 59.0% were male; with a mean age of 78.3 ± 8.6 years. The prevalence of sarcopenia was 15.1% (95% CI: 13.3–16.8) and the incidence of community-acquired pneumonia was 15.14% (95%CI 13.4–16.9). In the multivariate model, we found a higher incidence of pneumonia in sarcopenic compared to non-sarcopenic, RR(a) 3.88 (95% CI: 2.82–5.33).

Discussion: Our study showed a higher incidence of community-acquired pneumonia in sarcopenic subject. Results provide information on the importance of detecting this syndrome because it gives us scientific evidence of the interest of a correct comprehensive geriatric assessment in older patients with a high risk of pneumonia.

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Conflict of interest

The authors declare that they have no conflicts of interest concerning this article.

Keywords

Community-acquired pneumonia; Hospitals; Sarcopenia; Elderly

1. Introduction

There are aging-related changes that increase the risk of some health conditions or problems, such as sarcopenia, which is defined as the gradual and generalized loss of muscle mass and strength with the risk of generating frailty (Cruz-Jentoft et al., 2010). Sarcopenia is associated with an increased risk of mortality regardless of age, medical comorbidities such as chronic obstructive pulmonary disease, cardiovascular disease and/or cerebrovascular disease, disability, cognitive impairment and education (Arango-Lopera, Arroyo, Gutiérrez-Robledo, Pérez-Zepeda, & Cesari, 2013; Landi et al., 2013). It is considered that sarcopenia is a conditioning factor to acquire nosocomial infections (Cosquéric et al., 2006).

In the United States, between 5–13% of people between 60 and 70 years have sarcopenia and in adults over 80 years, the prevalence ranges between 11–50% (Morley, 2008). In Latin American cities such as Bogotá, the percentage of sarcopenia was 11.5% (Samper-Ternent, Reyes-Ortiz, Ottenbacher, & Cano, 2016) and with respect to Peru, a study by Tramontano A et al. showed a prevalence of 17.6% (Tramontano et al., 2017).

Sheean et al. showed a high prevalence of sarcopenia (60%) in patients with respiratory insufficiency who entered the ICU due to the need for mechanical ventilation (Sheean et al., 2014). Criteria for sarcopenia, as a decreased grip strength, has been linked to the risk of pneumonia, because it is an indicator of generalized muscle strength loss, including respiratory and oropharyngeal muscles (Yardimci et al., 2016). In addition, this syndrome is a risk factor for dysphagia(Maeda & Akagi, 2016), which has been associated with hospital readmission for aspiration and non-aspiration pneumonia (Cabré et al., 2014). Also, some studies have found a positive association between sarcopenia and having a respiratory complication in postoperative esophagectomy and liver transplant patients (Krell et al., 2013; Nishigori et al., 2016). However, there is lack of scientific evidence to establish the relationship between sarcopenia and community-acquired pneumonia, considered as the first cause of mortality of infectious origin in the geriatric population.

The objective of our study was to evaluate the relationship between sarcopenia and community-acquired pneumonia and other risk factors. In Latin America and Peru there is an increase in the geriatric population, so we need to focus the resources of public health in the main diseases. For example, our National Institute of Statistics (INEI) reported in 2015 the main cause of mortality in elderly population was the lower respiratory infection (INEI, 2017). Additionally, health services burden and health-related costs are increasing, on behalf of the elderly population become higher (Valdez et al., 2017). Sarcopenia, a very important (but poorly explored) geriatric syndrome, as we describe in our introduction section, is highly associated with frailty and abnormal responses to infections, therefore, we aimed our research to explore its association.

2. Methodology

2.1. Sample

A retrospective cohort study which analyzes a database where participants from Geriatric Service of Centro Medico Naval “Cirujano Mayor Santiago Tavara” which is one of the most well-equipped centers in Peru with excellent healthcare and research facilities. They have a research team, that they do geriatric evaluations on patients to improve quality of life or quality of care of older adults with sarcopenia and others geriatric diseases. The primary study conducted by the research team, entitled “*Prevalence and factors associated with frailty among Peruvian older adults”* has allowed the publication of different sub-studies in the topic (Díaz Villegas & Runzer Colmenares, 2015; Parodi et al., 2018; Runzer-Colmenares et al., 2014, 2017; Sandival Ampuero et al., 2017).

The participants were followed-up annual time since 2010, entering a new group every year until 2015; chosen by non-probabilistic sampling. All participants were 60 years older or more and resided in Lima or Callao. A total of 1891 subjects were recruited, 293 were excluded from this study: 89 have a Mini-Mental State Examination (MMSE) less than 17, because it reflects severe cognitive impairment (Nguyen, Black, Ray, Espino, & Markides, 2002), and 211 doesn’t have complete data of hand grip, Short Physical Performance Battery (SPPB), calf circumference, weight and/or height. Finally, 1598 subjects were included, calculating a power of 100% for an RR > 2.5 based on Nishigori et al results (Nishigori et al., 2016).

2.2. Definition of variables

2.2.1. Outcome variable—Community-acquired pneumonia was defined by the clinical-radiological diagnosis criteria of internist, pneumologist and/or geriatrician at Centro Medico Naval ‘Cirujano Mayor Santiago Tavara” in the patient’s medical history for one year after admission to the cohort. It is considered a patient with pneumonia if at least one episode of pneumonia occurred during the follow-up year We include the following ICD 10: J13-J16.

2.2.2. Exposure variable—Sarcopenia was defined based on the European Working Group on Sarcopenia in Older People criteria, who defined this syndrome characterized by low muscle mass and low strength and/or poor physical performance (Cruz-Jentoft et al., 2010),

Low muscle mass was considered when calf circumference is less than 31 cm based on the review of Rolland et al. (Rolland et al., 2003). Muscle strength by the methodology of Fried et al., which determined patients were unable to perform handgrip test and the 20% of people who obtained the lowest results, adjusted for BMI and stratified by sex were considered as decreased muscle strength (Fried et al., 2001). At least, SPPB less than 6 is considered poor physical performance by the results of Guralnik et al. (2000),

2.2.3. Co-variables—We included socio-demographic variables such: sex, age, marital status, education, military rank, years of retirement, live alone, drink alcohol consumption and smoking habit. We dichotomized our education variable as complete (> 11 years) or (10

years or less). The variable military rank has been used as a proxy of socioeconomic status as has been used in various studies (Blattner et al., 2018; Mullie et al., 2013).

The variable alcohol consumption was defined by the question: Do you usually drink alcoholic beverages?

Three questions were used to define the variable smoke: Have you ever smoked? Have you ever smoked daily for six months or more sometime in your life? Do you smoke now? Smoking habit was considered positive if they affirmed the first two and/or the last question.

Subjects were asked about these medical conditions: diabetes mellitus 2, high blood pressure, chronic kidney disease, heart failure and history of depression. The number of hospitalizations was obtained by asking the subjects how many times they had been hospitalized last year.

Additionally, four indexes and tests were considered in this study as covariates. Barthel index was used to identify the functional status of basic activities of daily living and was divided according to the recommendation of Shah, Vanclay, and Cooper (1989) in: total dependence (0–20), severe (21–60), moderate (61–90), low (91–99) and independence (100); Lawton-Brody index evaluates instrumental activities of daily living and was considered as a numerical variable; Yesavage questionnaire (5-items) evaluates depression with a cut point higher or equal than 3. Finally, MMSE, a numerical variable detects cognitive impairment.

Incomplete data is when a variable does not have the total data of the participants.

2.3. Statistical analysis

Chi-square test was used to analyze our outcome variable with categorical variables. T-student or U of Mann Whitney was used for the numerical variables with pneumonia, depending on variance homogeneity and normality. Finally, a crude and adjusted Poisson regression analysis was performed to calculate the risk ratio (RR) between sarcopenia and pneumonia and other associated confounders. We used Stata version 14.0 (Stata Corporation, College Station, TX, USA) to conduct all the analyses and a p-value < 0.05 was considered statistically significant.

2.4. Ethics

Our study was approved by two Institutional Review Board, the Centro Medico Naval “Cirujano Mayor Tavara” (Memorandum N°. 054) and the Universidad Peruana de Ciencias Aplicadas, (PI053–16).

3. Results

A total of 1598 subjects were included in the study, 59.0% were males (n = 943) and the mean age was 78.3 years (SD 8.6). 74.2% (n = 1175) were married, 73.6% (n = 1166) finished their studies and 50.9% (n = 807) had the rank of subaltern. High blood pressure, history of depression and diabetes mellitus 2 as the most frequent comorbidities: 62.6% (n

= 996), 21.6%(n = 341) and 17.0%(n = 269) respectively. The mean of IBM was 25.9(SD 5.5) with a prevalence of overweight of 27.0% (n = 242). The frequency of sarcopenia was, 15.1% (n = 241). Table 1, shows sociodemographic characteristics by sarcopenia status.

Table 2, shows the percentage of subjects for each component of sarcopenia in our population. Of all patients with sarcopenia, 100% (n = 241) decreased muscle mass, 57.3% (n = 138) decreased muscle strength and 73.9% (n = 178) decreased physical performance.

The accumulated incidence of community-acquired pneumonia in our study was 15.14% (95%CI 13.4–16.9). and the risk of presenting pneumonia in sarcopenic patients was 3.88 (95%CI 2.82–5.33) more than in non-sarcopenic patients.

Risk factors of pneumonia in our population are shown in Table 3. Bivariate analysis showed a significant relationship between smoking, Lawton and Brody scale, Yesavage test, Mini-mental state examination and sarcopenia with pneumonia (Table 4). Multivariate Poisson regression model found a significant relationship between smoking and sarcopenia (Table 5).

4. Discussion

Prevalence of sarcopenia in our population was 15.1% (95% CI: 13.3–16.8) which is similar to the prevalence reported in another study in Peru (17.6%) (Tramontano et al., 2017). Similar prevalence is reported in a geriatric population of Brazil: 16.1% in women and 14.4% in men (da S. Alexandre, Duarte, Santos, Wong, & Lebrão, 2014); while in Bogota the prevalence is lower (11.5%) (Samper-Ternent et al., 2016). In contrast, the prevalence in Mexico was 33.8% which differs from the countries already described and may be due to different characteristics such overweight with a prevalence of 48.1%, higher than our country (Arango-Lopera, Arroyo, Gutiérrez-Robledo, & Pérez-Zepeda, 2012). Likewise, these studies described different methods, criteria, and cutoff points to define sarcopenia.

Respect to community-acquired pneumonia worldwide, we found incidence rates of 13.95 per 1000 older adults per year approximately in Spain (Ochoa-Gondar et al., 2008) and 18.3 cases per 1000 per year in the United States (Simonetti, Viasus, Garcia-Vidal, & Carratalà, 2014). However, there is lack of information about the cumulative incidence of pneumonia in geriatric population participating in a cohort with clinical and hospitalization care like our study.

Risk factors identified in the subjects of our study were smoking and sarcopenia. The presence of sarcopenia increased 3.88 times the risk of this infection; this can be explained probably because it alters the immune system by decreasing muscle IL-15 production, which is important in natural killer cells functioning (Lutz & Quinn, 2012) and there is a dysregulation of the fosfatidilinositol 3 kinase pathway (PI3k / Akt) whose dysfunction alters neutrophils migration and phagocytosis (Wilson, Jackson, Sapey, & Lord, 2017). Besides, in the sarcopenia exist a generalized muscle strength loss, including respiratory muscles (Yardimci et al., 2016). For these reasons, the patient is in a state of immunosuppression and is prone to pneumonia. In our study, smoking that showed an increased risk of pneumonia in 41%. This is a risk factor very studied in relation to

pneumonia and it has been demonstrated that there are anatomical factors, such as the alteration of the bronchial mucosa, and immunological factors, such as the alteration of the opsonization capacity, phagocytosis and the maturation of dendritic cells; that makes it prone to the growth of the germs in the Broncho-alveolar tree (Almirall, Blanquer, & Bello, 2014).

Recently dysphagia due to sarcopenia (i.e. “sarcopenic dysphagia”) has been reported as a new concept. Sarcopenic dysphagia results from low swallowing and general skeletal muscle mass and strength. The characteristic changes in swallowing muscles occur primarily in oral and pharyngeal muscles along with other associated factors (van der Maarel-Wierink, Vanobbergen, Bronkhorst, Schols, & de Baat, 2011). A meta-analysis on aspiration pneumonia in frail older people revealed that dysphagia is a significant risk factor for aspiration pneumonia (Sakai & Sakuma, 2017).

Other studies have demonstrated the association between pneumonia with high blood pressure, diabetes mellitus 2, chronic kidney disease, alcoholism, and gender (Bahat et al., 2010; Calle et al., 2014; Koivula, Sten, & Mäkelä, 1994; Loeb, McGeer, McArthur, Walter, & Simor, 1999; Riquelme et al., 1996). But, our study has not appreciated those associations possibly because some variables were self-reported such alcohol intake, smoking, high blood pressure, diabetes mellitus 2, chronic kidney disease, heart failure, history of depression. Similarly, subjects were selected because they belonged to an ambulatory geriatric program at Centro Medico Naval, which is not the case in other cohorts.

A previous study has shown that cognitive ability has a relation to physical fragility in older adults (Gale, Ritchie, Cooper, Starr, & Deary, 2017). However, in our study was not associated because patients with severe dementia were excluded, so the variable lost significance.

Sarcopenia is a broad geriatric syndrome that includes functional aspects and possibly early onset. These involve functional factors that can be evaluated through geriatric tests such as Lawton-Brody and Barthel indexes. In addition, as depression has been shown to be related to the risk of pneumonia (Riquelme et al., 1996), we have the Yesavage test tool to allow us to screen for depression. For these reasons, it is important a complete geriatric evaluation in our elderly patients.

Sarcopenia and frailty factors are associated with pneumonia and the risk of disability in the older adults, models of evidence-based programs for the prevention and management of these problems should be considered in order to fit health services to the real needs of the Older Adults, including patient-centered clinical decisions based on the comprehensive geriatric assessment.

Our investigation had some limitations. First, the sample was chosen by convenience and only retired veterans and their relatives attended in the hospital were selected; for this reason, a selection bias was generated because they do not represent elderly people in Peru. In addition, it was a secondary analysis of database, we can only use comorbidities described in the original study and could exist information bias due to possible improper registration. On the other hand, the diagnostic test for measurement of muscle mass in our

study was calf circumference; although we know other accessible tests have more sensitivity as bioimpedance or dual energy X-absorptiometry (DEXA) but were not available for this study. Diagnosis of community-acquired pneumonia was based on the medical history of subjects with possible information bias.

Additionally, some variables with missing information were associated with our outcome variable, which means that some bias may be present and affect our conclusions. However, missing data were not associated with sarcopenia or community-acquired pneumonia.

This study shows an elevated risk of pneumonia in patients with sarcopenia, which could be explained by the presence of immunological alterations, loss of respiratory muscle strength and difficulty of swallowing, particularly in adults with higher rates of malnutrition like our community. Finally, these findings allow us to evaluate future measures for the prevention of sarcopenia and in the future to evaluate the impact of the treatment of this syndrome in the reduction of community-acquired pneumonia or other infections, which is a field not yet studied.

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Table 1

Sociodemographic characteristics of patients participating in the study, Centro Médico Naval Cirujano Mayor Santiago Távara, 2010–2015 (N = 1598).

Characteristics	With Sarcopenia		Without Sarcopenia	
	n	%	n	%
Total	241	15.1	1357	84.9
Sex				
Man	811	40.2	109	45.2
Woman	546	59.8	132	54.8
Age (Mean, SD)	82.9	8.9	77.5	8.3
Marital status[a]				
Single	5	2.1	41	3.1
Married	176	73.6	999	74.3
Widower/divorced	49	20.5	251	18.6
Cohabitant	9	3.7	54	4.0
Education				
< 11 years	73	30.5	345	25.6
≥ 11 years	166	69.5	1000	74.4
Military rank[a]				
Officer	16	6.7	152	11.2
Subaltern	103	43.1	704	52.3
Civilian	120	50.2	491	36.5
Years of retirement (Mean, SD)	20.4	10.3	20.5	9.9
Live alone[a]				
Yes	43	17.8	186	13.8
No	198	82.2	1164	86.2
Alcohol consumption				
Yes	116	48.1	605	44.6
No	125	51.9	752	55.4
Smoking habit				
Yes	179	74.3	952	70.1
No	62	25.7	405	29.9

[a]Incomplete data.

Table 2

Percentage of individuals for each component of Sarcopenia (N=1598).

Characteristics[a]	Definition	n (%)
Low muscle mass	Calf circumference less than 31 cm	941(58.9)
Low muscle strength	The 20% of patients who obtained the lowest results in the grip test (adjusted for BMI and stratified by sex) *Men* *Strength ≤ 19.1 for BMI ≤ 22.4* *Strength ≤ 19.6 for BMI 22.5–24.8* *Strength ≤ 19.6 for BMI 24.9–28.2* *Strength ≤ 17.2 for BMI ≥ 28.3* *Women* *Strength ≤ 16.9 for BMI ≤ 22* *Strength ≤ 15.2 for BMI 22.1–24.2* *Strength ≤ 15.1 for BMI 24.3–27.8* *Strength ≤ 19.8 for BMI ≥ 27.9*	228(14.3)
Poor physical performance	SPPB < 6	333(20.8)

[a]Sarcopenia is defined as low muscle mass and at least one of the following:Low muscle strength and/or poor physical performance.

Table 3

Clinical characteristics of patients participating in the study, Centro Medico Naval Cirujano Mayor Santiago Tavara, 2010–2015 (N = 1598).

		With Sarcopenia		Without Sarcopenia	
Characteristics		**n**	**%**	**n**	**%**
Diabetes[a]					
	Yes	44	18.3	225	16.8
	No	197	81.7	1114	83.2
High blood pressure[a]					
	Yes	143	59.3	853	63.2
	No	98	40.7	497	36.8
Chronic kidney disease					
	Yes	57	23.6	243	18.1
	No	184	76.4	1096	81.9
Heart failure					
	Yes	8	3.3	83	6.1
	No	233	96.7	1274	93.9
History of depression					
	Yes	44	18.5	297	22.2
	No	194	81.5	1041	77.8
Body mass index (Mean, SD)		26.2	5.9	25.8	5.4
Lawton-Brody index (Mean, SD)[a]		3.4	2.2	4.9	1.9
Barthel index*					
	Total dependent	5	2.1	21.0	1.6
	Severe dependent	14	5.8	39.0	2.9
	Moderate dependent	83	34.4	616.0	45.6
	Mild dependent	30	12.5	199.0	14.7
	Independent	109	45.2	476.0	35.2
Yesavage questionnaire (5-items)					
	With depression	145	60.2	262	19.3
	Without depression	96	39.8	1095	80.7
Mini-Mental state examination (Mean, SD)		23.0	5.1	25.8	3.7
Hospitalizations in the last year[a]					
	Never	99	41.1	670	49.8
	1	119	49.4	554	41.2
	2	23	9.5	121	9.0

[a]Incomplete data.

Table 4

Characteristics according to pneumonia of patients participating in the study, Centro Medico Naval Cirujano Mayor Santiago Tavara, 2010–2015 (N=1598).

Characteristics		With Pneumonia		Without Pneumonia		
		n	%	n	%	p value
Total		242	15.1	1356	84.9	
Sex						
	Man	137	14.5	806	85.5	0.410
	Woman	105	16.0	550	84.0	
Age (Mean, SD)		79.3	9.1	78.1	85.5	0.203
Marital status[a]						
	Single	5	10.9	41	89.1	0.557
	Married	186	15.8	989	84.2	
	Widower/divorced	40	13.3	260	86.7	
	Cohabitant	11	17.5	52	82.5	
Education						
	Less than 11 years	57	13.6	361	86.4	0.314
	Greater or equal to 11 years	183	15.7	983	84.3	
Military rank[a]						
	Officer	19	11.3	149	88.7	0.108
	Subaltern	117	14.5	690	85.5	
	Civilian	106	17.4	505	82.7	
Years of retirement (Mean, SD)		20.8	10.3	20.4	9.9	0.820
Live alone[a]						
	Yes	43	18.8	186	81.2	0.104
	No	199	14.6	1163	85.4	
Alcohol consumption						
	Yes	114	15.8	607	84.2	0.500
	No	128	14.6	749	85.4	
Smoking habit						

Characteristics		With Pneumonia		Without Pneumonia		
		n	%	n	%	p value
Yes		186	16.5	945	83.5	0.024*
No		56	12.0	411	88.0	
High blood pressure[a,b]						
	Yes	153	15.4	843	84.6	0.758
	No	88	14.8	507	85.2	
Diabetes[a,b]						
	Yes	43	16.0	226	84.0	0.738
	No	199	15.2	1112	84.8	
Chronic kidney disease[a,b]						
	Yes	53	17.7	247	82.3	0.209
	No	189	14.8	1091	85.2	
Heart failure[b]						
	Yes	12	13.2	79	86.8	0.592
	No	230	15.3	1277	84.7	
History of depression[a,b]						
	Yes	56	16.4	285	83.6	0.488
	No	184	14.9	1051	85.1	
Lawton-Brody index (Mean, SD)[a,c]		3.9	3.9	4.8	2.0	0.001*
Barthel index[a,b]						
	Total dependent	6	23.1	20	76.9	0.051
	Severe dependent	14	26.4	39	73.6	
	Moderate dependent	102	14.6	597	85.4	
	Mild dependent	26	11.4	203	88.6	
	Independent	92	15.7	493	84.3	
Yesavage questionnaire[a,b] (5-items)						
	With depression	96	23.6	331	76.4	0.001*
	Without depression	146	12.3	1045	87.7	

Characteristics		With Pneumonia		Without Pneumonia		
		n	%	n	%	p value
Mini-Mental state examination (Mean, SD)[c]		24.0	4.5	25.7	3.9	0.001*
Hospitalizations in the last year[a,b]						
	Never	119	15.5	650	84.5	0.97
	1	101	15.0	572	84.0	
	2	22.0	15.3	122	84.7	
Sarcopenia[b]						
	Yes	106	44.0	135	56.0	0.001*
	No	136	10.0	1221	90.0	

p values in bold shows statistically significant association.

[a] Incomplete data.

[b] Chi-square test.

[c] U-Mann Whitney test.

Table 5

Poisson regression model crude and adjusted for the risk of pneumonia in elderly patients, Centro Medico Naval Cirujano Mayor Santiago Tavara, 2010–2015 (N=1598).

Variable	RR crude (IC95%)	p value	RR adjusted (IC95%)	p value
Sarcopenia	4.38(3.40–5.66)	0.001	3.88(2.82–5.33)	**0.001***
Age	1.01(0.99–1.03)	0.068	0.99(0.98–1.00)	0.313
Sex	0.91(0.70–1.16)	0.448	0.96(0.74–1.26)	0.778
Smoking habit	1.37(1.01–1.85)	0.038	1.41(1.03–1.95)	**0.035***
Lawton-Brody index	0.86(0.81–0.90)	0.001	0.93(0.85–1.02)	0.136
Yesavage questionnaire (5-items)	1.92(1.49–2.49)	0.001	0.70(0.45–1.10)	0.121
Mini-Mental state examination	0.92(0.89–0.95)	0.001	0.96(0.92–1.00)	0.081

p values in bold shows statistically significant association.