Original Article

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Can spirometric parameters predict the incidence of frailty in the elderly people?

Parâmetros espirométricos podem predizer a incidência de fragilidade em pessoas idosas?

Ariana Oliveira Santos[1], Marcos Henrique Fernandes[1], Patrícia Honório Silva Santos[2], Thaís Alves Brito[1], Raildo da Silva Coqueiro[1], José Ailton Oliveira Carneiro[1]

ABSTRACT

Objective: To verify the association between spirometric indicators and the incidence of frailty syndrome in elderly people. **Methods:** This is a study with a longitudinal design carried out in 2014-2019, with a study sample of 104 elderly people. The dependent variable was the frailty syndrome, assessed using the phenotype of Fried et al. and the independent variables were the spirometric indicators, namely Forced Vital Capacity (FVC), Peak Expiratory Flow (PEF), Forced Expiratory Volume in one second (FEV1), FEV1/FVC ratio and Forced Expiratory Flow 25%-75 % (FEF25-75%). **Results:** The incidence of frail elderly people was 16.3% in both genders, with males presenting better lung function indicators than females. Despite this, we observed that there was no association between the frailty syndrome and the spirometric indicators (p>0.05). **Conclusion:** Spirometric indicators are not predictors of frailty in community-dwelling elderly people after five years of follow-up.

Keywords: Aged, Frailty, Spirometry, Longitudinal Studies

RESUMO

Objetivo: Verificar a associação entre indicadores espirométricos e a incidência da síndrome de fragilidade em pessoas idosas. **Métodos:** Trata-se de um estudo com delineamento longitudinal realizado em 2014-2019, com uma amostra de estudo de 104 pessoas idosas. A variável dependente foi a síndrome de fragilidade, avaliada por meio do fenótipo de Fried et al. e as variáveis independentes foram os indicadores espirométricos, sendo eles a Capacidade Vital Forçada (CVF), Pico de Fluxo Expiratório (PFE), Volume Expiratório Forçado no primeiro segundo (VEF1), relação VEF1/CVF e o Fluxo Expiratório Forçado 25%-75% (FEF25-75%). **Resultados:** A incidência de pessoas idosas frágeis foi de 16,3% em ambos os sexos, sendo que o sexo masculino apresentou melhores indicadores de função pulmonar que as mulheres. Apesar disso, observamos que não houve associação entre a síndrome de fragilidade e os indicadores espirométricos (p>0,05). **Conclusão:** Os indicadores espirométricos não são preditores de fragilidade em pessoas idosas residentes na comunidade, após cinco anos de seguimento.

Palavras-chaves: Idoso, Fragilidade, Espirometria, Estudos Longitudinais

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INTRODUCTION

Frailty syndrome is characterized by increased vulnerability to stressors due to a reduction in homeostatic capacity, which leads to an increased risk of falls, disability, hospitalizations and a greater risk of morbidity and mortality, including mortality from respiratory diseases.[1,2]

The aging process causes physical and physiological repercussions, which trigger changes in the respiratory capacities of the elderly, such as a reduction in peak expiratory flow.[3] Parameters capable of measuring respiratory function include Forced Vital Capacity (FVC), Peak Expiratory Flow (PEF), First Second Expiratory Volume (FEV1), FEV1/FVC ratio and Forced Expiratory Flow 25%-75% (FEF25-75%), with spirometry being the most widely used method for assessing respiratory disorders.[4]

In a cross-sectional study carried out by Magave et al.[5] the authors observed an inverse relationship between PEF and frailty syndrome, since frail elderly people had lower PEF when compared to non-frail people.[5] Queiroz et al.[6] also in a cross-sectional study, pointed out that the spirometric variable of the FEV1/FVC ratio and the percentage of predicted values were not able to predict frailty syndrome in the elderly.[6]

The studies found on the subject generally have a cross-sectional design, with the exception of Charles et al.[7] and Fragoso et al.[8], a longitudinal study with a 1-year follow-up and a mixed study, respectively. The one-year follow-up study was unable to analyze the association between spirometry and frailty. Most cross-sectional studies make it impossible to establish causal relationships because they do not prove the existence of a temporal sequence between exposure and the outcome.

This study analyzed the relationship between spirometry variables and the incidence of FS and is the first longitudinal study to analyze five spirometry variables associated with frailty syndrome. The importance of this knowledge implies the possibility of screening for FS during spirometry tests, which enables appropriate intervention and care for the health of the elderly.

OBJECTIVE

To determine whether there is an association between the incidence of frailty syndrome and spirometric indicators.

METHOD

This is a longitudinal study, which used data from the population-based epidemiological research entitled "Nutritional status, risk behaviors and health conditions of the elderly in Lafaiete Coutinho-BA", approved by the Research Ethics Committee of the State University of Southwest Bahia (CEP/UESB), under protocols No. 491.661/2013 (2014 data collection) and No. 3.092.535/2018 (2019 data collection). The research followed all the guidelines and standards for research involving human beings (Resolution 466/2012) and the Declaration of Helsinki (2000).

The study follows the recommendations of the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines, which presents a 22-item checklist to ensure high quality in observational studies, including cohort studies such as this one.[9]

In 2014, 331 elderly people of both sexes, registered with the Family Health Strategy (ESF) and living in the urban area of the municipality, were identified. With 3 refusals and 10 individuals not located (after three attempts made on different days, times and shifts), the population that took part in the family surveys was 318 elderly people. In the second collection, carried out in January 2019, 9 elderly people refused to take part, 39 were not located and 64 died, making a total of 206 elderly people who took part in the second collection.

Subsequently, 19 elderly people who did not meet the minimum criteria for constructing the frailty phenotype in 2014; 30 elderly people who did not meet the minimum criteria for constructing the frailty phenotype in 2019; 24 elderly people who did not undergo spirometry tests in 2014; and 29 frail elderly people in 2014 were excluded, leaving a final population of 104 elderly people for this study (Figure 1).

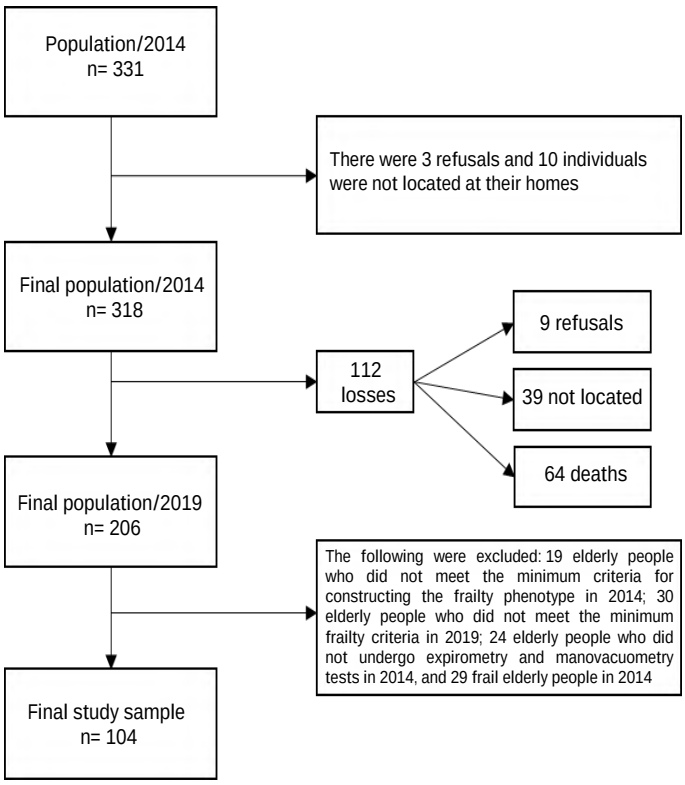

Figure 1. Stages for composing the study sample

Data collection was carried out in two stages, the first being a home interview followed by functional performance tests. The second stage, scheduled between one and three days after the interview, included anthropometric measurements, the Handgrip Strength (HGS) test, spirometry and respiratory muscle strength measurements, at the municipality's two Health Units. Prior to data collection, training was given to the group of interviewers (undergraduate students, master's and doctoral students and professionals, both from the health sector).

For the home interview, a specific form was used, based on the questionnaire used in the Health, Well-being and Ageing Survey (SABE),[10] with questions relating to socio-demographic, behavioral and health conditions, cognitive assessment, anthropometry and functional performance tests.

All the elderly were assessed for cognitive status using the adapted version of the Mini-Mental State Examination (MMSE).[11] Elderly people with a score ≤ 12 were considered to have cognitive impairment, while those with a score ≥ 13 were considered not to have cognitive impairment.[11] For elderly people classified as having cognitive impairment (MMSE ≤ 12), the presence of an informant who lived in the same house and knew information

about the elderly person was requested, in order to apply the Functional Activities Questionnaire (FAQ).[12]

For scores ≥ 6 on the FAQ, the interview was continued with the informant. The combination of the MMSE and FAQ aimed to enhance the screening of elderly people with severe cognitive impairment, in order to minimize possible biases caused by the low level of education of the elderly.[12,13]

The level of physical activity was assessed using the International Physical Activity Questionnaire (IPAQ), a long form validated for the elderly in Brazil.[14,15] To assess low physical endurance (fatigue), two specific questions from the Geriatric Depression Scale (GDS) reduced version were used, consisting of 15 questions, validated for use in Brazil.[16]

Frailty syndrome (dependent variable)

Frailty Syndrome (FS) was diagnosed according to the five criteria proposed by Fried et al.[1]: muscle weakness, unintentional weight loss, reduced walking speed, low endurance and insufficient level of physical activity. Elderly people with three or more criteria were classified as frail, those with one or two criteria as pre-frail and none of the criteria as non-frail.[1] After classifying the frailty profile, it was recategorized into frail (≥ 3 criteria) and non-frail (pre-frail + non-frail).

Muscle weakness: Muscle strength was assessed using the handgrip test with a hydraulic dynamometer (Saehan Corporation SH5001, Korea), using the arm that the elderly person considered to have the most strength. During the test, the elderly person sat with their elbow on a table, forearm supinated and wrist in a neutral position. Each elderly person made two attempts, developing maximum strength with an interval of 1 minute, and the highest value obtained (kg/f)[17] was considered for the study. Muscle weakness was defined according to gender and body mass index [BMI = body mass (kg) / height2 (m)], using the criteria adapted from Fried et al.[1]

Initially, BMI was classified into three categories: underweight (< 22 kg/m^2); adequate weight (22.0 ≤ BMI ≤ 27 kg/m^2); and overweight (> 27 kg/m^2).[18] Next, for each category, the cut-off point for HGS was set at the 25th percentile, adjusted for gender and BMI. Thus, the following were established for men: underweight (< 22 Kgf); adequate weight (≤ 26 Kgf); and overweight (≤ 23 Kgf). And the following cut-off points for women: underweight (≤14.75Kgf); adequate weight (≤17.00Kgf); overweight (≤18.00Kgf).

Elderly people with muscle strength below their respective cut-off point and those who were unable to perform the test due to physical limitations were considered to have muscle weakness.

Weight loss: defined by self-reported unintentional body weight loss ≥ 3.0 kg in the last 12 months.[19]

Reduction in gait speed: To assess gait speed, the 2.44m walk test (WT) was carried out, with guidance to walk at the usual speed. The elderly could use support devices if necessary. The route was completed twice, with the time recorded in seconds by a digital stopwatch, the shortest time being considered for analysis. The test was considered valid when the time taken was equal to or less than 60s.[20]

According to the criteria adapted from Guralnik et al.[20] to define the elderly with insufficient physical performance, classification was first made into two categories, adjusted for gender and height, based on the median (50th percentile): women with height ≤1.49m below or equal to the median and women with height >1.49m above the median; men with height ≤1.61m below or equal to the median and those with height >1.61m above the median. Subsequently, the 75th percentile was used to identify the time spent on CT in each height category: women below or equal to the median height had a cut-off point of 5.0s; women above the median height had a cut-off point of 4.40s; men below or equal to the median height had a cut-off point of 4.40s; and men above the median height had a cut-off point of 3.92s. Elderly people with values above the cut-off point for time spent on the CT, and those who did not perform the test due to physical limitations, were considered to have slow gait.

Low resistance: This was characterized by self-report using two questions from the GDS[16]: "Have you given up many of your activities and interests?" and "Do you feel full of energy?". A positive answer to the first question and/or a negative answer to the second were considered low stamina/lack of energy.

Insufficient level of physical activity: the level of physical activity was assessed using the International Physical Activity Questionnaire IPAQ, long version, validated for the elderly in Brazil.[14,15]

The questionnaire consists of 5 domains and 15 questions. Elderly people who performed less than 150 minutes a week of moderate or vigorous physical activity were considered insufficiently active.[21]

Spirometric parameters (independent variables)

The test used to assess the pulmonary function of the elderly was spirometry, using a calibrated Microlab^{TM} Spirometer (Care Fusion - USA), in accordance with the Guidelines of the Brazilian Society of Pulmonology and Phthisiology.[22] The elderly were positioned in a sedentary position, with head and neck balance, without arm support, and rested for up to ten minutes before the test.

All the elderly were instructed on the use of the nose clip by the examiner, who explained the test. In all the maneuvers, the command included a maximum inhalation, followed by a rapid and prolonged exhalation, until the examiner interrupted it (usually longer than 6 seconds or until the plateau was formed). The test was repeated until three acceptable and reproducible curves emerged, from three to eight attempts, with no perioral leak, cough, vasalva maneuver, glottal noises or obstruction of the mouthpiece.

Forced Vital Capacity (FVC), Peak Expiratory Flow (PEF), Forced Expiratory Volume in the first second (FEV1), FEV1/FVC ratio and Forced Expiratory Flow 25%-75% (FEF25-75%) curves were obtained.[22] The curves that showed evidence of zero-point error and resistance were excluded, possibly for reasons of displaced calibration (which results in a false positive increase in FVC) and the presence of fluids that impact on the resistance of the test, respectively.[23]

Study covariates

In addition to the use of the outcome variable (frailty) and the independent variables (spirometry indicators), sociodemographic information, lifestyle habits and health conditions of community-dwelling elderly people were considered covariates for characterizing the study population.

Sociodemographic data included gender (female and male) and age group (60-69 years, 70-79 years and ≥ 80 years). The lifestyle habits analyzed are smoking (never smoked, ex-smoker and smoker) and level of physical activity (active and insufficiently active), using the same instrument and classification mentioned

above.

Health conditions include number of chronic diseases (none, one, two or more), diagnosed by a health professional, such as hypertension, diabetes, cancer (except skin tumors), chronic lung disease, heart disease, circulatory disease, rheumatic diseases and osteoporosis; hospitalization in the last 12 months (yes and no); depressive symptoms (yes and no) assessed using the reduced version of the Geriatric Depression Scale (GDS),[16] with the absence of depressive symptoms considered to be 5 points or less, and the presence of depressive symptoms considered to be the elderly who scored more than 5 points; falls in the last 12 months (yes and no); and functional capacity, with Basic Activities of Daily Living (BADL) assessed using the Katz scale[24] and Instrumental Activities of Daily Living (IADL) using the Lawton and Brody scale.[25] Initially, the elderly were classified as independent when they performed the activities without help, and dependent when they needed help with at least one of the activities. Subsequently, functional capacity was classified hierarchically[26] into three categories: independent, dependent in IADLs, dependent in BADLs and IADLs.

Statistical procedures

A descriptive analysis was carried out, calculating absolute and relative frequencies for categorical variables and measures of central tendency and dispersion for quantitative variables. The normal distribution of the spirometric variables was also observed using the Kolmogorov-Smirnov test.

The student's t-test or the Mann-Whitney test were used to compare the mean or median values of the spirometry variables between the sexes, depending on the normal distribution of the variables.

The association between frailty syndrome and spirometric parameters was analyzed using Poisson regression, obtaining relative risk (RR) values and their respective confidence intervals (95% CI), adjusted by age group (based on a previous study) and stratified by gender. The data was analyzed using the Statistical Package for Social Sciences for Windows (SPSS. 21.0, 2012, Armonk, NY: IBM Corp.) and in all analyses the significance level adopted was 5% (α = 0.05).

RESULTS

Of the 104 elderly people who took part in the study, 56.7% were female, 48.1% were aged between 60-69, 46.6% were former smokers, 44.6% had at least two chronic diseases, 12.5% had been hospitalized one or more times, 13.5% had depressive symptoms, 14.6% reported having fallen and 20.2% were dependent on IADLs (Table 1).

Figure 2 shows the total incidence of frailty syndrome in the elderly and stratified by gender after 5 years of follow-up.

Table 2 shows a descriptive and comparative analysis of the spirometry indicators of the elderly, stratified by gender. It was observed that elderly men had better pulmonary function indicators than women (p≤0.05), except for the FEV1/FVC ratio, which was higher in elderly women.

Table 3 shows the analysis of the association between the incidence of frailty syndrome and spirometric indicators stratified by sex, adjusted for age group. We found that there was no association between frailty syndrome and spirometric indicators (p>0.05).

Table 1. Characterization of the study population, Lafaiete Coutinho/Bahia

Variables	% of Response	n	%
Gender	100		
Female		59	56.7
Male		45	43.3
Age group	100		
60-69 years		50	48.1
70-79 years		42	40.4
≥ 80 years		12	11.5
Smoking	99		
Never smoked		48	46.6
Former smoker		48	46.6
Smoker		7	6.8
Level of physical activity	100		
Active		95	91.3
Insufficiently active		9	8.7
Chronic diseases	97.1		
None		16	15.8
One		40	39.6
Two or more		45	44.6
Hospitalization	100		
None		91	87.5
One or more		13	12.5
Depressive symptoms	100		
No		90	86.5
Yes		14	13.5
Fall	99		
No		88	85.4
Yes		15	14.6
Functional capacity	100		
Independent		70	67.3
Dependent for IADL		21	20.2
Dependent for IADL and BADL		13	12.5

IADL: Instrumental activities of daily living; BADL: Basic activities of daily living

Figure 2. Total incidence and stratified by sex of frailty syndrome in the elderly after 5 years of follow-up, Lafaiete Coutinho/Bahia

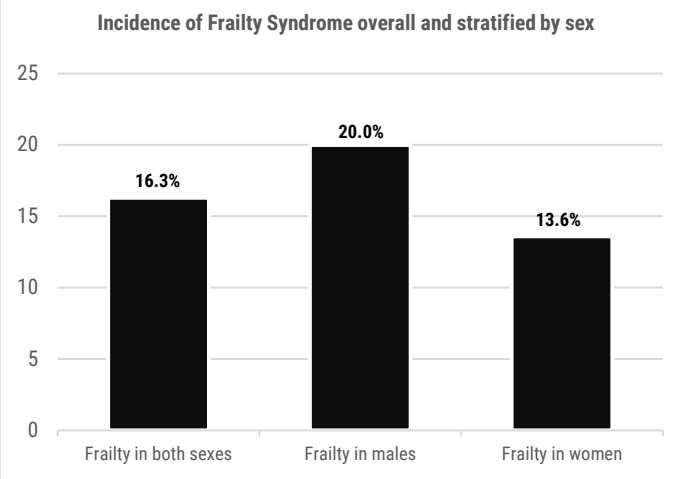

Table 2. Analysis by gender of spirometric indicators of community-dwelling elderly, Lafaiete Coutinho/Bahia

Variables	Female (n= 59) Median (Q1 - Q3)* Average (SD)	Male (n= 45) Median (Q1 - Q3)* Average (SD)	P-value
VEF1 (L)	1.3 (0.36)	2.0 (0.55)	p<0.001
CVF (L)	1.7 (0.45)	2.6 (0.60)	p<0.001
VEF1/CVF (%)*	82.0 (72.0 - 89.0)*	79.5 (71.2 – 86.7)*	p<0.001
PFE (L/s)	2.9 (1.1)	4.5 (1.6)	p<0.001
$FEF_{25-75\%}$ (L/s)	1.4 (0.70)	2.0 (0.86)	p<0.001

**Median and Q1-Q3: Interquartile Range; SD: Standard Deviation; FEV1: Forced Expiratory Volume in the First Second; FVC: Forced Vital Capacity; FEV1/FVC; Ratio of Forced Expiratory Volume in the First Second and Forced Vital Capacity; PEF; Peak Expiratory Flow; $FEF_{25-75\%}$: Forced Expiratory Flow obtained between 25 and 75% of FVC*

Table 3. Association between the incidence of frailty syndrome and spirometric indicators in the elderly, Lafaiete Coutinho/Bahia

Variables	Female			Male		
	$RR_{adjusted}$	IC95%	P-value	$RR_{adjusted}$	IC95%	P-value
CVF (L)	1.93	0.72 - 5.21	0.193	0.39	0.06 - 2.67	0.337
VEF1 (L)	2.77	0.31 - 24.42	0.36	0.59	0.13 - 2.70	0.497
VEF1/CVF (%)	0.99	0.96 - 1.03	0.694	1	0.98 - 1.03	0.655
PFE (L/s)	0.75	0.43 - 1.33	0.331	0.81	0.49 - 1.35	0.424
$FEF_{25-75\%}$ (L/s)	0.49	0.15 - 1.64	0.248	0.55	0.21 - 1.46	0.229

FVC: forced vital capacity; FEV1: forced expiratory volume in the first second; PEF: peak expiratory flow; $FEF_{25\%-75\%}$: forced expiratory flow obtained between 25% and 75% of FVC

DISCUSSION

This is the first longitudinal study to investigate the incidence of frailty syndrome associated with more than one spirometric variable in community-dwelling elderly people over a 5-year follow-up period. The findings indicate that there was no association between frailty syndrome and spirometric parameters. It should be noted that the follow-up period was five years, which in this case was not enough to identify significant changes in lung function.

In a longitudinal study, with a 1-year follow-up, carried out by Charles et al.[7], the authors also found no association between the spirometric variable PEF and frailty syndrome, corroborating our findings, although the follow-up time was different.

In the current study, elderly males performed better in the pulmonary function test in terms of FEV1, FVC, PEF and $FEF_{25-75\%}$ when compared to females. This data can be analyzed from an anatomophysiological point of view, which indicates that men have greater lung function than women, since they have larger airway diameters and a greater number of alveoli, which results in larger diffusion surfaces and higher lung volumes.[27]

It is known that with ageing there are changes in body composition which alter the physiology and functioning of the body, such as the respiratory system, leading to reduced thoracic compliance and altered lung volumes.[28] Frailty syndrome is also associated with respiratory impairment, as it leads to musculoskeletal dysfunctions, mainly related to older age.[29]

In a cross-sectional study published by Magave et al.[5] with 409 community-dwelling elderly people, the authors showed an association between PEF and frailty syndrome, and the cut-off point found was higher for males (PEF≤350L/min) compared to females (PEF≤220L/min).

A cross-sectional study associating frailty with respiratory impairment assessed by spirometry found that the pre-frail and frail elderly were 62% and 88% more likely to have airflow limitation, respectively, and 80% and 205% more likely to have a restrictive pattern. From a longitudinal perspective, it analyzed a 42% increase in those with frailty criteria developing respiratory deficits, while those with poor breathing had a 58% increase in the chance of presenting frailty syndrome.[8]

According to Barbosa, Mansur and Colugnati,[30] the higher the frailty index, the greater the health compromises, since frail elderly people have a potentially higher risk of falls and hospitalizations, 64% and 84% respectively, which increases the chances of death. In addition to physical damage, frailty syndrome can compromise cognitive functions, and support aimed at preventing the psychological, physical, and social impacts of the syndrome on the elderly population is of fundamental importance.[31]

Although evidence shows that in cross-sectional studies there is an association between frailty syndrome and isolated spirometric variables,[5,32] in the longitudinal aspect and analyzing more than one spirometric variable, their influence on the incidence of frail elderly was not observed, only aspects related to the aging process.

Limitations include the number of elderly people who were excluded from the study population. Despite these limitations, this is an unprecedented study in terms of its longitudinal design, showing that there is no causal relationship between spirometric indicators and frailty syndrome over five years of follow-up.

CONCLUSION

No association was found between the incidence of frailty syndrome and spirometric indicators over five years of follow-up. Therefore, these indicators cannot be used as predictors of frail elderly people. Therefore, further longitudinal studies with longer follow-up times are needed to better understand the relationship between these variables.

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