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Research article

Frailty in the elderly population of Costa Rica

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Abstract

Objectives: To identify the health and sociodemographic characteristics associated with frailty within the elder Costa Rican population. Settings and Participants: A national sample of 8000 elderly individuals from CRELES the longitudinal study (Costa Rican Study of Longevity and Healthy Ageing). Methods: A subgroup of 3000 people from the national sample of 8000 elderly individuals from the CRELES longitudinal study was analyzed. A prevalence analysis was prepared for the year 2005. A frailty phenotype was constructed based on the phenotypic model that includes the following variables: weight loss, fatigue, grip strength, gait speed, and physical activity. Patients were classified into frail, pre-frail, and robust. Sociodemographic variables, comorbidities, and health status perception were collected and later analyzed using a logistic multinomial model. Results: From the final sample (2091 individuals), 22.6% were classified as robust, 65.5% as pre-frail and 11.6% as frail. There was a documented statistical association among people in frail condition between the age of 70 to 79 years (OR 2,25 CI 1,51-3,35) and those at 80 years or older (OR 20,77 CI 10,23-42,15) and arthritis (OR 3,19 CI 1,95-5,22), cerebrovascular events (OR 20,90 CI 5,31-82,33), osteoporosis (OR 1,88 CI 1,02-3,46), hypertension (OR 1,52 CI 1,05-2,2), diabetes (OR 2,47 CI 1,61-3,79), respiratory disease (OR 1,83 CI 1,14-2,92), and poor health perception (OR 5,60 CI 3,78-8,30). Conclusions: The prevalence of frailty in the Costa Rican elderly population is 11.6%. Variables of age, hypertension, diabetes, pulmonary disease, cerebrovascular events, arthropathies, osteoporosis, and a perception of poor health were associated to frailty with a statistical significance.

Key words: frailty, elderly, ageing, prevalence

Introduction

Between 2000 and 2050, the number of inhabitants on Earth aged 60 years or older will double. In absolute numbers, this age group will grow from 605 million to 2000 million in only half a century [1].

Frailty is considered as an increased state of vulnerability with regards to stress factors which are expressed as an increasing risk of unfavorable outcomes [2] and can occur because of a variety of diseases and medical conditions [3].

Multiple studies in populations have measured the prevalence of frailty and have shown the relationship between this condition and other sociodemographic and health variables [4]. However, few studies have been developed in Latin American populations and none have been performed in the Central American region [5].

Costa Rica is a country located in the Central American region, with a population, as of 2017, of 4,947,490, of which approximately 7.6% are elderly individuals with more than 65 years of age [6].

The goal of this study is to measure the prevalence of frailty, referencing the database Costa Rican Study of Longevity and Healthy Ageing (CRELES) database, which describes the characteristics of the frail population in Costa Rica and compares those characteristics with

other studies worldwide.

Methods and Materials

CRELES Study

The present analysis is based on the CRELES study aims at the creation of a baseline for health and living conditions of the elderly population for the country [7] and investigates a national sample comprising 8000 elderly individuals, with representation of nonagenarians and centenarians. Follow up for a panel of 3000 people from the sample included a in-depth questionnaire that included hour long interviews, anthropometric measurements, and biomarker readings in blood and urine samples [7].

The analysis of interest regarding frailty in the present study used the cohort of elderly people (within ages of 60 or older) that started in 2005. Of the 3000 individuals, 910 where excluded because they did not have all the data for each variable defining frailty (n: 809), and for defining the independent variable (n:100), resulting in a final sample of 2091 individuals. All further calculations were done considering available information contained in the database, which is a re-scaling factor.

Building the frailty variable

The frailty variable is built with a base structure of the 5 variables of the Fried phenotypic model [4] with certain modifications. These were considered as follows:

Gait speed

To acknowledge this variable the information obtained from the stand-up and walk test questions in the CRELES anthropometric chapter was taken into account. This test consists of asking the person to stand-up from a chair and walk to his or her usual rhythm to a distance of 3 meters. This distance is divided between the time obtained, resulting in the speed of the elderly individual. Afterwards, a regression model is adjusted, where the dependent variable is the previous calculated speed and the independent variables are height and sex, obtained from CRELES database. The predicted values are calculated and an average value obtained. The residual values are added to this average value, which results in a new speed variable for which the 20th percentile is calculated.

An altered gait speed variable was considered if one of the following conditions was present: the patient has a gait speed lower than the 20th percentile value and/or the person could not do the test at all and/or if the person answered affirmatively to question: "Do you have a problem that prevents you from doing any mobility or flexibility test?"

Grip strength

The grip strength test was done with a dynamometer. The elderly were asked to extend to full length his or her dominant arm alongside his or her body, when instructed by the interviewer, the person was to grip the handle with all their strength and immediately loosen the grip. Then, the individual rests for 3 minutes before repeating the test a second time. The result of the second grip strength test was used for this study.

A regression model is calculated, in which hand strength is the dependent variable and the independent variables are sex and body mass index. After, the residual values were added to the adjusted average value to create a standardized grip strength variable. The 20th percentile is calculated, resulting in the final value. The patient would have an altered grip strength test if his or her result was below the 20th percentile or could not perform the test at all.

Weight loss

For this variable the answer of the question, "In the last 6 months, have you lost more than 5 kilograms of weight without planning it?" was used. If the patient answered affirmatively, the variable was considered altered and could be interpreted as part of the Frailty Syndrome.

Physical activity

For this variable the answer of the question "In the past 12 months have you had regular exercise or rigorous physical activity such as sports, trotting, dancing or heavy workloads three times a week?" was used, considering it to be altered if no physical activity was done.

Fatigue self-perception

The question, "Were you full of energy?" was used for this variable. Was considered altered if the elderly responded that they felt they had no energy whatsoever.

Once the five variables were defined and codified as 1, if any one of them met the frail condition, and 0 if not, robust people were those who did not present any positive variables (meaning that the sum of all variables was 0) of the 5 for classification. Pre-frail people were those who presented 1 or 2 positive variables and, therefore, frail people would be those who presented 3 to 5 positive variables. If any values were missing, the individual was not included, as all data must have been strictly completed to be eligible for classification.

Statistical analysis

Once the frailty indicators were defined, using the criteria already described, descriptive statistics were prepared with the information of the 2005 cohort. For those descriptive analyses, two-dimension tables were created, where the percentage calculations of frail, pre-frail and robust were made for those individuals with underlying characteristics in the distinct sociodemographic variables, as well as others in the health field, as judged by experts. The variables considered were obtained from the "elderly" questionnaire, section C (health status) of CRELES, related to health conditions detected by the doctor and other socioeconomic variables, also obtained from the same questionnaire, Identification Section in

personal data and other sections, such as employment and income.

To reinforce the descriptive statistics, an analysis of the prevalence for the base year 2005 was prepared. A multinomial logistic model is used given to the fact that the main variable, frailty, presents 3 possible categories. Being a study with an explorative goal, a considerable number of variables within the health scope are used, as well as other socio-demographic variables (also using descriptive statistics). For the final model, the independent variables included were the following: hypertension, cholesterol, diabetes, cancer, pulmonary disease, myocardial infarction, cerebrovascular events, arthritis, osteoporosis, smoking, C-Reactive Protein, falls, age, education, sex, living alone, health perception, and income. Excluded variables were those who presented problems for the adjusted model, as well as other whose information was missing, thus, causing the odds ratio not to convert adequately. These excluded variables include the following: mini mental test and the physical activity model.

The final sample obtained for this model is 2091 valid cases, so that the estimation could be made. Once all these problems presented by the model were corrected and accurately reviewed, an odds ratio was obtained for the frail and pre-frail categories, as the other category (robust) was taken as reference, as it was considered as the healthiest of the other two. With the goal of opposing the relevance and possible odds ratio estimation error, a 95% confidence interval was estimated. All statistical analyses were prepared using the Stata program, version 13.0 for Windows.

Results

The final sample was composed of 2091 individuals with ages ranging from 60 to 109 (average of 70 years), of which 47.5% were women. Using a Fried´s based model with certain modifications, the Costa Rican prevalence of frailty in the CRELES Study for 2005 was 11.6 %, pre-frail at 65.5% and 22.9% for robust (Supplementary table 1).

The sociodemographic and health characteristics of the analyzed patients are summarized in Supplementary tables 1 and 2. A total of 53% of the patients were women. Regarding the frail patients, 40.8% were under the age range from 60 to 69 years, 33.7% between the ages of 70 to 79 years, and 25.5% were 80 years of age or older. A total of 82.7% presented an educational level of less than 6 years of schooling. At the economic level, 47.5% presented an income level below 100 United State Dollars (USD) and 18.7% had an income higher than 520 USD per month. Out of all frail patients, 13.5% lived alone and 71.1% presented a poor health perception (Supplementary table 1).

With regards to comorbidities observed in frail patients, 60.3% had hypertension, 30.8% diabetes, 21.4% pulmonary disease, 13.7% osteoporosis, 25.6% arthritis, 9.5% with cerebrovascular events, 7.3% cancer, 5.8% coronary disease, and 39.8% had dyslipidemia. 55.2% presented a history of falls at the moment of the interview (Supplementary table 2).

Discussion

Of the sociodemographic variables included in the study, a clear and significant statistical association was found only for the age variable, for the intervals from 70 to 79 years of age and for 80 years an older. It is thought that this phenomenon is caused because, as the elderly ages, there is a higher accumulation of deficits that increase the vulnerability factor as age also increases [2,11,12].

The increase in OR related to the age variable and the subsequent increase in the confidence interval results from a diminished final sample. For the robust category with individuals older than 80 years old, only 13 cases were present, in comparison with 65 frail patients in the same age range, which could overestimate the effect of this variable in the frailty condition. However, the association detected and the existing evidence from other studies warrants closer attention to this age group in particular and to expand the investigation for this age group.

Various comorbidities presented a significant statistical association with the frailty condition. These conditions were: cerebrovascular disease, hypertension, diabetes mellitus, arthritis, osteoporosis, and pulmonary disease. These are more frequent in the elderly with frailty than in the general Costa Rican elderly population [12].
The relationship between frailty and cerebrovascular disease has been extensively investigated. It is thought that the mechanisms that generates chronic inflammation that characterizes frailty are shared with atherosclerosis [13-15].

Among these, a high correlation between frailty and cerebrovascular disease (OR 20,90 CI 5,31-82,33) is reported in this study, which is higher than what was concluded in similar studies, such as Woods 1.71 (1.24–2.36) and Veronese 3.38 (2.37–4.81) [16,17].

As with the “age” variable, the high OR present in the link between cerebrovascular disease and the robust and frail condition is mainly due to the smaller sample analyzed. Only 3 cases presented a robust condition with cerebrovascular disease, in comparison to 24 cases in frail patients. Also, there is a significative increase in the standard estimation error of OR, at 0.7.

Regarding arterial hypertension, this association is also higher than has been reported in previous studies 1.18 (1.08–1.29) [25]. The subjacent mechanism that explains the relationship between hypertension and frailty is a decrease of the ability to use adenosine triphosphate (ATP) [18,19] and chronic inflammation that stimulates the renin-angiotensin system that increase in blood pressure [20,21].

This study documented a statistically significant association between diabetes and the frailty condition (OR 2,47 CI 1,61-3,79), doubling findings of other publica-

tions where prevalence of 1.4 (1.11–1.76) have been reported [22]. A link between these two conditions has been recognized, given that that diabetes can affect different components of frailty, particularly, sarcopenia and chronic inflammatory disease. [4].

This study determined that arthritis has a strong association with frailty. This finding has been reported in previous investigations [23-25] even in the Latin American population through cohort [26] and longitudinal studies [27].

The association of arthritis with frailty onset is due to diminished physical activity secondary to pain. Pain can lead to a decrease in physical activity, immobilization, fatigue, and sarcopenia [28,29].

Frailty is also related with osteoporosis, as has been documented in this study (OR 1,88 CI 1,02-3,457). Similar data has been reported in previous publications [30,31]. Frailty has been associated with a decrease of hormone levels, vitamin D levels, human growth hormone levels, and IGF-1 levels, all which play an important role in the physiopathology of osteoporosis [31].

Chronic Obstructive Pulmonary Disease has also been associated with frailty in this study (OR 1,82 CI 1,14-2,92). Similar findings have been previously documented [11]. The correlation between COPD and frailty has not been precisely understood, however, it is thought that there are previous inflammatory changes and innate immune alterations [32,33].

An increase in the prevalence of comorbidities that this study has reported would explain that the self-perception of health in the frail patient is poor. The poor health perception in frail patients is statistically significant (OR 5,60 CI 3,78-8,30), a finding already documented in previous Latin American studies [34,35].

Given that the main focus of this article centered on the predictions made with available data, it must be noted that construction of the frailty variable using a multinomial logistic model reduces the sample used. This generally does not drastically impact estimations, but the confidence intervals for said estimations, as a relatively small sample results in a higher confidence interval. The foregoing was observed in the age variables for 80 years or older, for cerebrovascular disease and for the frailty condition mentioned above. For this variables in this study, estimations were done with a smaller sample and larger confidence intervals. Therefore, caution should be exercised regarding the results obtained and a more in depth approached should be performed in subsequent analysis.

This study is the first to measure the prevalence of frailty, and also the characteristics of this population in the Central American region [8,9], allowing visualization of this condition in this area of the American continent. Also, it allows evidencing links between this pathology and other sociodemographic and health variables. A broad segment of the population is analyzed, surpassed only by two other studies performed at a Latin American level [9]. The sample analyzed was subjected to strict inclusion criteria and the definition of frailty closely matched the original phenotypic model criteria, which allows obtaining more robust results than other similar studies [8,9]. Additionally, as the sample includes the entire national territory, it allows drawing conclusions that are more representative for the country.

Conclusions

The prevalence of frailty in the Costa Rican population is 11.6%. The majority of the frail patients were women presented low income and education levels. They also presented with an increased number of comorbidities and a poor health perception.

Variables of age, hypertension, dyslipidemia, pulmonary disease, cerebrovascular events, arthritis, osteoporosis, and poor health perception were associated to frailty in a statistically significant way.

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Author Contributions

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Study concept and design: JP, IB, AS. Acquisition of data: JP, IB, AS. Analysis and interpretation of data: JP, AS. Drafting of the manuscript: JP, IB, AS, FM. Critical revision of the manuscript for important intellectual content: JP, IB, AS. Final approval of the version to be published; and agreement to be accountable for all aspects of the work: JP, IB,FM. Drafting the article or revising it critically for important intellectual content. JP, IB, FM.

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Human Subjects Involvement

The research protocol was approved by the relevant institutional review boards (IRBs) or ethics committees,

Conflicts of Interest

The authors do not report personal and financial conflicts of interests nor have they ever received financial aid from any institution.

Ethics

The authors declare that this study followed were in accordance with the ethical standards of the National

responsible committee on human experimentation and with the Helsinki Declaration of 1975, as revised in 2000.

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