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ARTICLE

Absence of association between frailty index and survival in elderly Brazilians: the FIBRA Study

Ausência de associação entre o índice de fragilidade e a sobrevivência de idosos no Brasil: Estudo FIBRA

La falta de asociación entre el índice de fragilidad y supervivencia en los ancianos en Brasil: Estudio FIBRA

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Abstract

In Brazil, the frailty index has not been evaluated previously for its capacity to predict mortality in community-dwelling elderly. The objective of the current study was to evaluate the association between frailty index and mortality in the elderly. This was a prospective study consisting of data from the FIBRA Network-2008-2009 in Campinas, São Paulo State, with information on community-dwelling older adults from the urban area and through the Mortality Information System. Comparisons and statistical associations were performed with the following tests: Mann-Whitney, Kruskal-Wallis, chi-square, and Cox regression with 95% confidence intervals. A total of 689 older adults participated (72.1 ± 5.3 years), of whom 68.8% were women. The prevalence rate for frailty was 38.8%, compared to 51.6% for pre-frailty and 9.6% for fit elders; overall mean frailty index was higher in women. There was no association between frailty index and chronological age. Cox regression showed that the variables age (HR: 1.10; 95%CI: 1.05-1.15) and gender (HR: 0.57; 95%CI: 0.33-0.99) were significantly associated with mortality. No association was found between frailty index and mortality (HR: 3.02; 95%CI: 0.24-37.64). Frailty index was not capable of predicting mortality in community-dwelling elderly Brazilians.

Aged; Frail Elderly; Health of the Elderly; Mortality

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Introduction

Frailty is defined as a clinical syndrome with increased vulnerability to various types of internal and external stressors. The syndrome reflects a decline in energy reserves, inherent to physiological aging, which can be aggravated by current and life-course biological and environmental variables [1,2,3,4]. It involves a set of characteristics and genetic and environmental determinants that distinguish individuals in a cohort [4,5,6]. There is a consensus among researchers concerning the notion of increased vulnerability, heterogeneity, and multidimensionality associated with frailty [4,7,8,9,10]. In clinical terms, it includes risks of adverse events such as falls, reduced mobility, loss of independence, hospitalization, disability, and death. Among these outcomes, mortality, functional disability, and institutionalization are the most common findings in the literature [6,11].

There are different ways of operationalizing the frailty phenomenon [3,4,5,6,9]. According to a literature review by Boiullon et al. [11], the most widely adopted model is the frailty phenotype proposed by Fried et al. [3], followed by the frailty index (FI) described by Mitnitski et al. [1] and Rockwood & Mitnitski [7].

FI is a mathematical model derived from data from the longitudinal *Canadian Study of Health and Aging* (CSHA) [1,12]. It does not provide for a specific set of clinical markers present in old age, as in the model by Fried et al. [3], but rather a sum of observed deficits in different systems at the time of measurement (signs, symptoms, functional disability, diseases, laboratory results) [1,2,7], based on the notion that age-related changes have a cumulative effect on health. It is based on the quantification of observed changes in a variety of physiological, psychological, and functional conditions and the search for relations between them and adverse outcomes in the elderly [12,13]. According to the Rockwood & Mitnitski [7], frailty results from an accumulation of deficits and expresses a continuous scale ranging from 0 to 1, which reflects the relationship between the number of deficits the individual presents and the total number of possible deficits from a model corresponding to the study sample (for example, an individual with 4 deficits in 38 study variables has a frailty index of 0.10) [7,12].

The FI does not require the inclusion of a specific number of deficits. Previous studies have used 30 to 70 variables [1,2,7,14,15]. However, to be part of the index, the variable must meet the following criteria: associated with age and negative health outcomes; present in at least 1% of the population; includes various organ systems; does not contain more than 5% missing data; and is not saturated, i.e., present in at least 80% of individuals below 90 years of age [12,16,17]. In community-dwelling elderly, the prevalence of frailty measured by the FI model is around 24% [14,18,19]. It is higher in women than in men and increases with age [13,14,15,19,20].

In Song et al. [14], FI consisted of 36 deficits that included health conditions, signs and symptoms, and functional disability. Frail individuals were defined as those that scored > 0.25. The results showed that mean FI was higher in elderly individuals that died during follow-up compared to those that survived. Having more deficits was associated with greater risk of adverse events. Frail elderly showed 15% greater risk of death than non-frail elders, independently of gender [19]. FI is a more robust predictor of mortality than chronological age [2,7,14].

In Kulminski et al. [20], FI showed greater accuracy than frailty phenotype in discriminating elderly with moderate to severe frailty [3], since it assesses frailty as the product of the cumulative effect of deficits in multiple physiological systems on a continuous scale rather than by specific indicators present in old age [11,14,19,20,21]. Based on the concept of biological heterogeneity, a higher FI score is associated with greater risk of death, independently of chronological age [1]. In this context, the current study's hypothesis was that the frailty index is capable of predicting mortality, independently of chronological age. There are no Brazilian studies on frailty and mortality in the elderly using the cumulative deficits model. The study aimed to investigate the prevalence of frailty based on the frailty index and the association between this measure of frailty and death in community-dwelling elderly.

Material and methods

This study was based on two databases. One was the electronic database from the FIBRA Study (the Portuguese acronym for *Frailty in Elderly Brazilians*), conducted in Campinas, São Paulo State, Brazil, in the context of a multicenter, population-based cross-sectional study aimed at investigating frailty and its relations with socio-demographic, psychosocial, clinical, cognitive, anthropometric, functional capacity, and physical and mental health variables in community-dwelling elderly. The second database was from the Mortality Information System (SIM) of the city of Campinas for the years 2009, 2010, 2011, 2012, and 2013, accessed every six months.

The FIBRA Study project was submitted to the Ethics Committee for Research in Human Subjects, School of Medicine, State University in Campinas, and approved under case review n. 208/2007. The current study was submitted as an addendum to the main project and was approved under case review n. 736.943/2010. The ethical principles of the *Declaration of Helsinki* were followed, and all the participants signed a free and informed consent form.

Participants

Participants in the FIBRA Study were recruited in family or individual households located in 90 randomly selected urban census tracts in Campinas, in which previously specified quotas of men and women were recruited, 65 to 69, 70 to 74, 75 to 79, and 80 years and older. The quotas were proportional to their presence in the elderly population in each census tract. The following eligibility criteria were adopted: age 65 years or older, permanent resident in the household and in the census tract, and absence of severe cognitive, communicative, or sensory impairment or severely impaired mobility. The exclusion criteria were: problems with memory, attention, orientation in time and space, and communication, suggestive of dementia; bedridden elderly; elderly with severe stroke sequelas, with loss of strength and/or aphasia; advanced or unstable Parkinson's disease, with serious impairment of mobility, speech, or affect; seriously impaired hearing or vision, hindering communication; and terminal illness [22]. Of all the elderly recruited, 1,055 appeared at the data collection sites and 900 comprised the sample. The 155 exclusions were due to the following: age under 65 years, and non-resident in the census tract, and withdrawal.

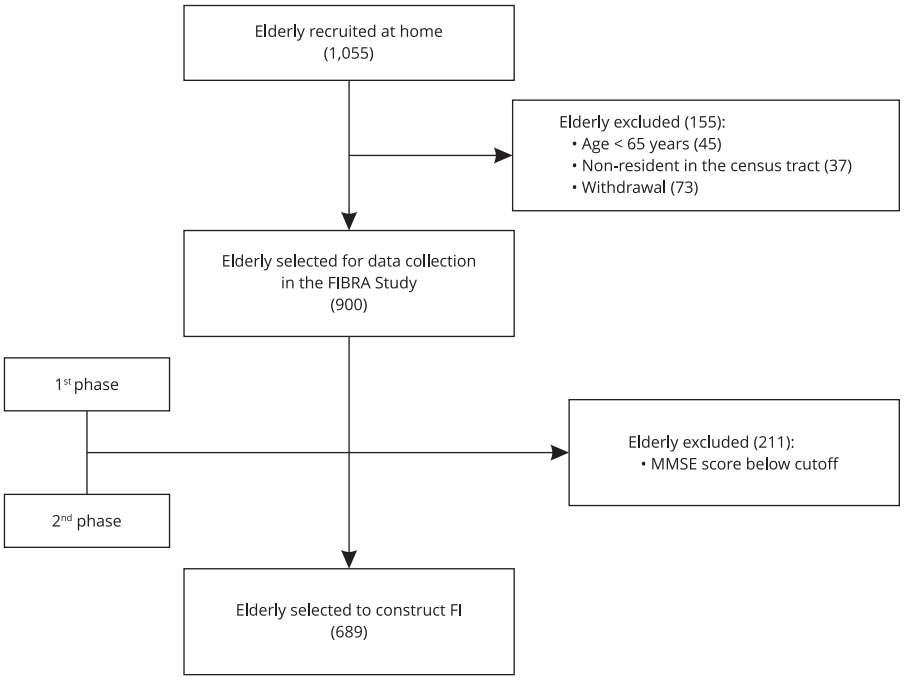
The 900 selected elderly participated in the first phase of the data collection, consisting of a section on socio-demographic, anthropometric, clinical, and frailty measures [3]. In this phase, the score obtained on the *Mini Mental State Examination* (MMSE) was used as the criterion for participation in the second data collection phase, on self-rated physical and mental health, functional performance, and subjective well-being. The following cutoff scores were used for exclusion: 17 for illiterate individuals; 22 for elderly with 1 to 4 years of schooling; 24 for those with 5 to 8 years of schooling; and 26 for those with at least 9 years of schooling [23,24,25]. Six hundred and eighty-nine elderly without cognitive deficit suggestive of dementia selected according to this criterion constituted the current study's sample. Mean age was 72.1 ± 5.3 years; 68.8% were women [26] (Figure 1).

Variables and measures

The target variables were investigated according to the following conditions:
(a) FI: composition of the index used 40 variables from different domains assessed by the FIBRA Study, according to the eligibility criteria in Searle et al. [12] and Song et al. [14]. Among the available anthropometric measures, the following were selected: body mass index (BMI) and waist to hip ratio (WHR) [27]. In self-rated health, the following were chosen: chronic diseases, signs and symptoms, difficulties in performing activities of daily living, falls, number of medication, smoking, alcohol consumption, self-perceived health, and leisure-time physical exercise and sports [3,12,28,29]. Physical performance measures included: gait speed and grip strength [3]. The selected psychosocial variables were: depressive symptoms and life satisfaction [30,31].
Frailty indices were calculated for all the participants, based on the selected variables. When the variables were dichotomous (e.g. hypertension – yes vs. no), the attribute's presence was scored as 1 and its absence as 0. For continuous variables, intermediate points were created (e.g., self-rated health as

Figure 1

Composition of sample of elderly selected in the FIBRA Study to construct the frailty index (FI). Campinas, São Paulo State, Brazil.



MMSE: *Mini Mental State Examination*.

very good = 0; good = 0.25; fair = 0.5; bad = 0.75; and very bad = 1.0). For cognitive status, the points corresponded to the quintiles obtained by the sample in the cognitive screening test (1st quintile = 1; 2nd quintile = 0.75; 3rd quintile = 0.5; 4th quintile = 0.25; and 5th quintile = 0). The study followed the rules recommended in the literature for assessing parameters, such as waist to hip ratio (men > 1 = 1.0; women > 0.85 = 1,0; men < 0.99 = 0; and women < 0.84 = 0) [27], low grip strength (the lowest 20% of values in the distribution of the means on three attempts, adjusted by gender and BMI = 1.0) [3], low gait speed (values above the 80th percentile in the distribution of the mean times in seconds that the individual took to walk 4.6 meters three times) [3] and low level of physical activity (the lowest 20% of values in the distribution of the sum of kcal spent in physical exercise, adjusted by gender = 1.0) [3]. For each elderly individual, FI was calculated, based on the sum of the scores for frailty divided by 40, which was the total number of selected items in the protocol. Unanswered items were excluded from the participant's score. The lowest denominator considered was 29 deficits. Based on Rockwood et al. [32], on a scale from 0 to 1, individuals were classified as fit when they scored ≤ 0.11, as pre-frail when they scored from 0.12 to 0.24, and as frail when they scored ≥ 0.25 (Table 1) [14].

(b) Gender and age: two self-report items, (male vs. female; years of age; date of birth).

(c) Mortality: in the database of the SIM for Campinas, we identified and counted the surviving and non-surviving elderly from 2009 to 2013 at each moment when the database was consulted. The database was obtained by probabilistic record linkage using the blocking strategy in multiple linked steps: first name, last name, year of birth, and home address. It was measured as the proportion of deaths in elderly in Campinas, and the variable was categorized as "yes" or "no".

Table 1

Distribution of variables included in the frailty index, frailty categories according to frailty index (FI) score, and percentage of deaths. FIBRA Study, Campinas, São Paulo State, Brazil, 2008-2009.

Variables	n	Cutoff points	Deaths (%)
Cognitive status	677	1st quintile = 1	116 (17.13)
		2nd quintile = 0.75	127 (18.76)
		3rd quintile = 0.5	146 (21.57)
		4th quintile = 0.25	177 (26.14)
		5th quintile = 0	111 (16.40)
BMI	677	≥ 18.5 < 25 = 0	202 (29.84)
		≥ 25 < 30 = 0.5	281 (41.51)
		< 18.5 = 1/≥ 30 = 1	194 (28.66)
WHR	677	Men: ≥ 1 = 1/Women: ≥ 0.85 = 1	383 (56.57)
		Men: ≤ 0.99 = 0/Women: ≤ 0.84 = 0	294 (43.43)
Weight loss	664	Yes = 1	99 (14.91)
		No = 0	565 (85.09)
Low physical activity	676	Yes = 1	108 (15.98)
		No = 0	568 (84.02)
Fatigue	670	Always = 1	58 (8.66)
		Most of the time = 0.5	58 (8.66)
		Rarely or never = 0	554 (82.69)
Low grip strength	673	Yes = 1	112 (16.64)
		No = 0	561 (83.36)
Slow gait	676	Yes = 1	107 (15.83)
		No = 0	569 (84.17)
Heart disease	676	Yes = 1	179 (26.48)
		No = 0	497 (73.52)
High blood pressure/hypertension	677	Yes = 1	437 (64.55)
		No = 0	240 (35.45)
Stroke	677	Yes = 1	51 (7.53)
		No = 0	626 (92.47)
Diabetes mellitus	677	Yes = 1	148 (21.86)
		No = 0	529 (78.14)
Cancer	676	Yes = 1	64 (9.47)
		No = 0	612 (90.53)
Arthritis	677	Yes = 1	293 (43.28)
		No = 0	384 (56.72)
Lung diseases	676	Yes = 1	68 (10.06)
		No = 0	608 (89.94)
Osteoporosis	675	Yes = 1	178 (26.37)
		No = 0	497 (73.63)
Urinary incontinence	676	Yes = 1	233 (34.47)
		No = 0	443 (65.53)
Fecal incontinence	677	Yes = 1	42 (6.20)
		No = 0	635 (93.80)
Loss of appetite	674	Yes = 1	120 (17.80)
		No = 0	554 (82.20)
Falls	673	Yes = 1	206 (30.61)
		No = 0	467 (69.39)
Memory impairment	674	Yes = 1	385 (57.12)
		No = 0	467 (69.39)
Sleep problems	676	Yes = 1	295 (43.64)
		No = 0	381 (56.36)

(continues)

Table 1 (continued)

Variables	n	Cutoff points	Deaths (%)
Number of medications	665	None = 0	118 (17.74)
		1-4 = 0.5	411 (61.80)
		≥ 5 = 1	136 (20.45)
Hearing impairment	669	Yes = 1	181 (27.06)
		No = 0	488 (72.94)
Visual impairment	670	Yes = 1	289 (43.13)
		No = 0	381 (56.87)
Current smoker	677	Yes = 1	74 (10.93)
		No = 0	603 (89.07)
Two or more doses of alcohol four or more times per week	677	Yes = 1	18 (2.66)
		No = 0	659 (97.34)
Self-rated health	675	Very bad = 1	8 (1.19)
		Bad = 0.75	31 (4.59)
		Regular = 0.5	238 (35.26)
		Good = 0.25	303 (44.89)
		Very good = 0	95 (14.07)
Level of activities in previous year	667	Worse = 1	185 (27.74)
		Same or better = 0	482 (72.26)
Four or more days of hospitalization in previous year	665	Yes = 1	27 (4.06)
		No = 0	638 (95.94)
Difficulty chewing and swallowing food	670	Yes = 1	106 (15.82)
		No = 0	564 (84.18)
Needs help using transportation	674	Yes = 1	48 (7.12)
		No = 0	626 (92.88)
Needs help shopping	673	Yes = 1	75 (11.14)
		No = 0	598 (88.86)
Needs help preparing meals	671	Yes = 1	37 (5.51)
		No = 0	634 (94.49)
Needs help with household chores	672	Yes = 1	90 (13.39)
		No = 0	582 (86.61)
Needs help managing money	674	Yes = 1	54 (8.01)
		No = 0	620 (91.99)
Needs help bathing	674	Yes = 1	2 (0.30)
		No = 0	672 (99.70)
Needs help getting dressed	674	Yes = 1	5 (0.74)
		No = 0	669 (99.26)
Depressive symptoms	673	≥ 6 = 1	132 (19.61)
		< 6 = 0	541 (80.39)
Life satisfaction	673	Low = 1	32 (4.75)
		Moderate = 0.5	217 (32.24)
		High = 0	424 (63)
FI	677	≤ 0.11	65 (9.60)
		0.12-0.24	349 (51.55)
		≥ 0.25	263 (38.85)
Mortality	677	Yes	56 (8.27)
		No	621 (91.73)

BMI: body mass index; WHR: waist to rip ratio.

Statistical analysis

The FIBRA Study forms were consecutively checked by two supervisors before keying-in. The electronic database was checked by two trained evaluators, with 100% agreement required. Frequency measures were performed for the scores obtained by the elderly in each of the health and psychosocial variables comprising the FI and in the score ranges corresponding to the three levels of frailty. Statistical comparisons between the frailty indices for the groups formed by men and women were performed using the Mann-Whitney test and between the age groups according to the Kruskal-Wallis test. The Dunn test was used for post hoc comparison of the results from the Kruskal-Wallis test. The rates of surviving and non-surviving elderly by gender, age, and frailty levels were compared with the chi-square test. Associations between the independent variables gender, age, and frailty and mortality were studied by Cox regression. The analyses used SAS, version 9.2 (SAS Inst., Cary, USA). Statistical significance was set at 5%, or $p < 0.05$.

Results

Of the 689 elderly whose data were analyzed according to the FI protocol, 86.6% (588) answered 40 items; 9.75% answered 39; 2.81% answered 38; 0.15% answered 37; 0.30% answered 31; and 0.15% answered 29. Twelve elderly were excluded who failed to respond to more than 30% of the study items. Table 1 showed the absolute frequencies and percentages of the variables that comprised the FI according to the score adopted. The observed frailty indices were generally low or intermediate: the lowest observed index was 0.03 and the highest 0.62, with low dispersion around the mean (0.23 ± 0.10) and a median of 0.22. Prevalence of frail elderly was 38.8%, pre-frail elderly 51.6%, and fit elderly 9.6%.

Women showed significantly higher mean values for subcomponents of the frailty index compared to men in BMI, WHR, fatigue, hypertension, arthritis, osteoporosis, urinary incontinence, falls, sleep problems, and need for help using transportation and shopping. The mean indices in men exceeded those in women for the variables cancer, smoking, alcohol consumption, and need for help preparing meals. Overall mean FI was higher in women (0.25 ± 0.10) than in men (0.20 ± 0.10) (Table 2).

As for mean values for each FI component and age bracket, the variables with significant differences were: cognitive status, WHR, level of physical activity, fatigue, grip strength, slow gait, falls, sleep problems, and need for help using transportation, shopping, and doing household chores. Differences between age brackets were verified with the multiple comparisons test and are represented by letters in Table 3. Overall mean FI did not differ statistically by age bracket ($p = 0.063$).

In the five years of follow-up, 8.2% of the elderly died. There was no significant difference between mortality and the variables gender and FI (Table 4). There was a significantly higher percentage of mortality in elderly 75 years and older (Table 4).

Cox multiple regression analysis adjusted by age, gender, and frailty index showed that the variables age and gender were significantly associated with mortality. Increased risk of death in the elderly was associated with older age (each additional year of age was associated with an increase of 10.2% in mortality) and male gender (73% greater risk of death than in women). No association was observed between FI and mortality in the overall sample (Table 5).

Discussion

Prevalence of frail elderly was 38.8%, higher than the mean prevalence in a review of 24 population-based studies in elderly 65 years and older, showing FI prevalence of 24% (range: 18-44%) [19]. A survey by Collard et al. [18], involving 21 studies of community-dwelling elderly (61,500 participants), found prevalence rates ranging from 4 to 59%. The total FIBRA Campinas sample (n = 900), which used the model by Fried et al. [3], showed 7.7% frail, 52.3% pre-frail, and 40% fit or non-frail elderly. Elderly women and elders 80 years or older scored on more frailty criteria, when compared to elderly men and elders under 80 years of age [26,33].

Table 2

Comparison of men and women on scores for variables included in frailty index (FI) and according to FI score. FIBRA Study, Campinas, São Paulo State, Brazil, 2008-2009 (n = 677).

Variables	Gender		p-value
	Male (n = 212) [mean ± SD]	Female (n = 465) [mean ± SD]	
Cognitive status	0.46 ± 0.32	0.50 ± 0.34	0.137
BMI	0.42 ± 0.36	0.53 ± 0.39	< 0.001
WHR	0.36 ± 0.48	0.66 ± 0.47	< 0.001
Weight loss	0.12 ± 0.33	0.16 ± 0.37	0.214
Low physical activity	0.18 ± 0.38	0.15 ± 0.36	0.350
Fatigue	0.09 ± 0.26	0.15 ± 0.32	0.018
Low grip strength	0.16 ± 0.36	0.17 ± 0.38	0.612
Slow gait	0.18 ± 0.38	0.15 ± 0.36	0.313
Heart disease	0.29 ± 0.46	0.25 ± 0.43	0.271
High blood pressure/hypertension	0.58 ± 0.49	0.67 ± 0.47	0.026
Stroke	0.09 ± 0.29	0.07 ± 0.25	0.342
Diabetes mellitus	0.23 ± 0.42	0.21 ± 0.41	0.595
Cancer	0.13 ± 0.33	0.08 ± 0.27	0.049
Arthritis	0.26 ± 0.49	0.51 ± 0.50	< 0.001
Lung diseases	0.10 ± 0.30	0.10 ± 0.30	0.929
Osteoporosis	0.06 ± 0.24	0.36 ± 0.48	< 0.001
Urinary incontinence	0.26 ± 0.44	0.38 ± 0.49	0.003
Fecal incontinence	0.04 ± 0.19	0.07 ± 0.26	0.077
Loss of appetite	0.16 ± 0.36	0.19 ± 0.39	0.304
Falls	0.19 ± 0.39	0.36 ± 0.48	< 0.001
Memory impairment	0.53 ± 0.50	0.59 ± 0.49	0.175
Sleep problems	0.29 ± 0.46	0.50 ± 0.50	< 0.001
Number of medications	0.49 ± 0.32	0.53 ± 0.30	0.154
Hearing impairment	0.32 ± 0.47	0.25 ± 0.43	0.068
Visual impairment	0.43 ± 0.50	0.43 ± 0.50	0.962
Current smoker	0.15 ± 0.36	0.09 ± 0.29	0.019
≥ 2 doses alcohol ≥ 4 times/week	0.07 ± 0.25	0.01 ± 0.09	< 0.001
Self-rated health	0.31 ± 0.19	0.34 ± 0.21	0.124
Level of activities in previous year	0.25 ± 0.44	0.29 ± 0.45	0.373
≥ 4 days hospitalization in previous year	0.06 ± 0.23	0.03 ± 0.18	0.132
Difficulty chewing and swallowing food	0.13 ± 0.34	0.17 ± 0.38	0.177
Help using transportation	0.02 ± 0.15	0.09 ± 0.29	0.001
Help shopping	0.07 ± 0.26	0.13 ± 0.34	0.026
Help preparing meals	0.15 ± 0.36	0.01 ± 0.10	< 0.001
Help doing household chores	0.11 ± 0.31	0.15 ± 0.35	0.143
Help managing money	0.07 ± 0.25	0.09 ± 0.28	0.374
Help bathing	0.00 ± 0.07	0.00 ± 0.05	0.568
Help getting dressed	0.01 ± 0.10	0.01 ± 0.08	0.674
Depressive symptoms	0.16 ± 0.37	0.21 ± 0.41	0.132
Life satisfaction	0.20 ± 0.29	0.21 ± 0.29	0.784
FI	0.20 ± 0.10	0.25 ± 0.10	< 0.001

BMI: body mass index; WHR: waist to rip ratio.

Table 3

Comparison of age groups on scores for variables included in the frailty index (FI) and according to FI score. FIBRA Study, Campinas, São Paulo State, Brazil, 2008-2009 (n = 677).

Variables	Age groups				p-value
	65-69 (n = 247) [mean ± SD]	70-74 (n = 226) [mean ± SD]	75-79 (n = 133) [mean ± SD]	≥ 80 (n = 71) [mean ± SD]	
Cognitive status	0.43 ± 0.33	0.49 ± 0.34	0.53 ± 0.32	0.57 ± 0.33	0.003 (a)
BMI	0.53 ± 0.37	0.51 ± 0.39	0.46 ± 0.39	0.40 ± 0.34	0.061
WHR	0.60 ± 0.49	0.54 ± 0.50	0.61 ± 0.49	0.44 ± 0.50	0.049 (b)
Weight loss	0.12 ± 0.33	0.17 ± 0.38	0.15 ± 0.36	0.19 ± 0.39	0.366
Low physical activity	0.10 ± 0.30	0.18 ± 0.38	0.17 ± 0.37	0.30 ± 0.46	< 0.001 (c)
Fatigue	0.18 ± 0.35	0.13 ± 0.30	0.08 ± 0.25	0.07 ± 0.21	0.007 (d)
Low grip strength	0.09 ± 0.29	0.14 ± 0.34	0.28 ± 0.45	0.30 ± 0.46	< 0.001 (e)
Slow gait	0.09 ± 0.29	0.17 ± 0.38	0.23 ± 0.42	0.24 ± 0.43	< 0.001 (d)
Heart disease	0.23 ± 0.42	0.31 ± 0.46	0.29 ± 0.46	0.20 ± 0.40	0.098
High blood pressure/hypertension	0.66 ± 0.47	0.65 ± 0.48	0.65 ± 0.48	0.56 ± 0.50	0.479
Stroke	0.05 ± 0.22	0.09 ± 0.29	0.08 ± 0.26	0.10 ± 0.30	0.337
Diabetes mellitus	0.24 ± 0.43	0.21 ± 0.41	0.22 ± 0.41	0.17 ± 0.38	0.645
Cancer	0.09 ± 0.29	0.08 ± 0.28	0.14 ± 0.34	0.06 ± 0.23	0.255
Arthritis	0.47 ± 0.50	0.43 ± 0.50	0.42 ± 0.50	0.34 ± 0.48	0.257
Lung diseases	0.08 ± 0.27	0.11 ± 0.31	0.12 ± 0.33	0.11 ± 0.32	0.609
Osteoporosis	0.24 ± 0.43	0.25 ± 0.43	0.32 ± 0.47	0.28 ± 0.45	0.402
Urinary incontinence	0.30 ± 0.46	0.35 ± 0.48	0.42 ± 0.50	0.35 ± 0.48	0.129
Fecal incontinence	0.06 ± 0.23	0.08 ± 0.27	0.06 ± 0.24	0.03 ± 0.17	0.435
Loss of appetite	0.14 ± 0.35	0.21 ± 0.41	0.19 ± 0.39	0.17 ± 0.38	0.233
Falls	0.29 ± 0.45	0.26 ± 0.44	0.33 ± 0.47	0.46 ± 0.50	0.016 (f)
Memory impairment	0.58 ± 0.49	0.58 ± 0.49	0.58 ± 0.50	0.51 ± 0.50	0.720
Sleep problems	0.39 ± 0.49	0.50 ± 0.50	0.46 ± 0.50	0.34 ± 0.48	0.024 (g)
Number of medications	0.50 ± 0.32	0.54 ± 0.30	0.53 ± 0.31	0.45 ± 0.30	0.156
Hearing impairment	0.25 ± 0.43	0.28 ± 0.45	0.29 ± 0.45	0.30 ± 0.46	0.744
Visual impairment	0.43 ± 0.50	0.42 ± 0.50	0.42 ± 0.50	0.47 ± 0.50	0.912
Current smoker	0.15 ± 0.35	0.09 ± 0.29	0.08 ± 0.28	0.08 ± 0.28	0.145
≥ 2 doses alcohol ≥ 4 times/week	0.04 ± 0.19	0.02 ± 0.13	0.04 ± 0.19	0.00 ± 0.00	0.244
Self-rated health	0.33 ± 0.22	0.34 ± 0.20	0.34 ± 0.21	0.32 ± 0.15	0.720
Level of activities in previous year	0.27 ± 0.45	0.28 ± 0.45	0.28 ± 0.45	0.28 ± 0.45	0.991
≥ 4 days hospitalization in previous year	0.03 ± 0.18	0.04 ± 0.20	0.06 ± 0.24	0.03 ± 0.17	0.554
Difficulty chewing and swallowing food	0.16 ± 0.36	0.17 ± 0.38	0.15 ± 0.36	0.14 ± 0.35	0.927
Help using transportation	0.03 ± 0.18	0.07 ± 0.26	0.11 ± 0.31	0.14 ± 0.35	0.005 (a)
Help shopping	0.06 ± 0.24	0.11 ± 0.31	0.16 ± 0.37	0.21 ± 0.41	< 0.001 (f)
Help preparing meals	0.04 ± 0.19	0.04 ± 0.21	0.08 ± 0.28	0.10 ± 0.30	0.080
Help doing household chores	0.08 ± 0.27	0.15 ± 0.35	0.17 ± 0.38	0.21 ± 0.41	0.006 (a)
Help managing money	0.05 ± 0.22	0.08 ± 0.28	0.11 ± 0.32	0.11 ± 0.32	0.102
Help bathing	0.00 ± 0.06	0.00 ± 0.07	0.00 ± 0.00	0.00 ± 0.00	0.832
Help getting dressed	0.01 ± 0.09	0.01 ± 0.11	0.00 ± 0.00	0.00 ± 0.00	0.456
Depressive symptoms	0.18 ± 0.38	0.20 ± 0.40	0.23 ± 0.42	0.17 ± 0.38	0.543
Life satisfaction	0.21 ± 0.29	0.22 ± 0.30	0.21 ± 0.30	0.18 ± 0.28	0.849
FI	0.22 ± 0.10	0.24 ± 0.11	0.25 ± 0.10	0.23 ± 0.10	0.063

BMI: body mass index; WHR: waist to rip ratio.

Note: differences between age brackets are represented by letters: (a) 65-69 ≠ ≥ 80; (b) 65-69 and 75-79 ≠ ≥ 80; (c) 65-69 and 70-74 e 75-79 ≠ ≥ 80; (d) 65-69 ≠ 75-79 and ≥ 80; (e) 65-69 ≠ 75-79 and ≥ 80, 70-74 ≠ 75-79 and ≥ 80; (f) 65-69 and 70-74 ≠ ≥ 80; (g) 70-74 ≠ ≥ 80

Table 4

Survivors and non-survivors according to gender, age, and frailty index (FI). FIBRA Study, Campinas, São Paulo State, Brazil, 2008-2009 (n = 677).

Variables	Mortality		p-value
	Yes n (%)	No n (%)	
Gender			
Male	23 (10.85)	189 (89.15)	0.100
Female	33 (7.10)	432 (92.90)	
Age (years)			
65-69	12 (4.86)	235 (95.14)	< 0.001
70-74	14 (6.19)	212 (93.81)	
75-79	15 (11.28)	118 (88.72)	
≥ 80	15 (21.13)	56 (78.87)	
FI			
≤ 0.11	4 (6.15)	61 (93.85)	0.794
0.12-0.24	29 (8.31)	320 (91.69)	
≥ 0.25	23 (8.75)	240 (91.25)	

Table 5

Results of Cox regression for the variables gender, age, and frailty index (FI), according to survival in participants. FIBRA Study, Campinas, São Paulo State, Brazil, 2008-2009 (n = 676 *).

Variables	HR	95%CI	p-value
Age (years)	1.10	1.05-1.15	**< 0.001**
Gender (female)	0.57	0.33-0.99	**0.048**
FI (≤ 0.11)	3.02	0.24-37.64	0.390

* 621 survivors and 55 deaths.

95%CI: 95% confidence interval; HR: mortality risk ratio (hazard ratio).

This wide variation may be explained by the difference in the instrument for assessing the syndrome and differences in the sample's composition, especially relating to ethnicity and nationality. Despite the universal decline in the mechanisms for adaptation and biological regulation associated with aging, different trajectories can distinguish individuals from different cohorts and different contexts [8,20,34,35,36,37].

Women showed higher frailty indices than men, corroborating findings in the literature, for example the *National Population and Health Survey* (NPHS) [14], *Survey of Health, Ageing, and Retirement in Europe* (SHARE) [38], and *Beijing Longitudinal Study of Aging* [15]. Unlike these studies, which also found higher frailty indices and higher frailty prevalence rates in the older elderly, the current study did not show differences between these variables (frailty index and age bracket). Individuals in the same age bracket may present different health profiles. However, the current sample did not show differences in relation to age groups as the frailty index proposes.

In this study, risk of death in men was 1.73 times higher than in women. In a study of elderly Chinese, women showed higher mean FI than men, while the incidence of death was higher for men than for women [39]. In a sample of elderly Brazilians, males were 2.7 times more likely to die than females [40].

According to the literature, men generally die more from acute illnesses, while women live longer and with more disabilities and more comorbidities [41,42]. Kulminski et al. [20] assessed the prevalence of morbidity in men and women in relation to mortality, using the cumulative deficits model. They found that morbidity and risk of mortality according to gender may vary as a result of the set of deficits used, the cohort, and environmental factors. These results show the paradox of morbidity and mortality: despite worse health conditions, women present higher survival rates than men.

The association between chronological age and mortality has been widely reported in the literature [40,41,42]. Physiological changes associated with aging and lower functional reserve are important factors influencing the relationship between age and mortality, especially in advanced old age [36,41,42].

According to the theoretical formulation of the frailty index model, the index represents a measure of the individual's biological age, and FI should thus be a more robust predictor of mortality than chronological age itself [1,7]. Unlike findings from international studies, the current study found no association between FI and mortality [14,36,38]. As far as we know, this is the first study in which FI does not predict mortality in community-dwelling elderly. The main objective of the frailty index as a measure is to assess biological heterogeneity in order to identify the individuals most vulnerable to adverse health events [1,7]. However, this result was not observed in this sample. This may be related to the limitation of the index in terms of the variability in health in old age and its different influences on the occurrence of negative events [37,43]. That is, some deficits have a greater effect than others on mortality rates [40]. For example, elderly individuals with heart disease, diabetes, and hypertension score lower on the index when compared to elderly with osteoporosis and arthritis, which require help using transportation and performing household chores. Still, the former conditions are more lethal than the latter. Besides, there is no consensus at present on the cutoff point as the classificatory criterion for FI or for characterizing frail elderly in different contexts [34,35,36,37,42,43]. Despite this lack of consensus in the literature, the cutoff points used in the current study followed the recommendations made by the developers of the FI [12,14,32]. According to Martin et al. [44] and Walston & Bandeen-Roche [45], although the developers of the frailty index suggest that the items comprising the measure are correlated, there is still no evidence on the internal validity of the set of items in the FI, since the number and nature of the variables differ in the studies that used the operational model. The original FI study used 70 variables to compose the measure, including diseases, signs and symptoms, functional disabilities in basic and instrumental activities of daily living, cognitive decline, and psychological disorders [32]. The FIBRA study used 40 variables to comprise the FI. According to the authors [7,12], a composite index with at least 30 variables is capable of predicting adverse health outcomes. It is also necessary to understand the underlying mechanisms in the interaction of deficits in the pathophysiology of frailty [45].

For convenience purposes, the data in the FIBRA Study were collected in a social setting in the community that is well-known and easy for participants to access. This decision may have partly selected elderly individuals in better physical condition. Likewise, when selecting the elderly for the second phase of data collection using the MMSE, FIBRA clearly opted for elderly with more intact cognition. Song et al. [14] did not use a cognitive screening test in their sample selection. In the *Beijing Longitudinal Study of Aging*, the MMSE score was not used as an exclusion criterion for participants [15,39]. Ours is the first Brazilian study on the prevalence of FI and its association with socio-demographic variables and mortality as the outcome. The data showed that women presented higher FI than men. For the study population, the frailty index did not serve as a good measure of frailty, since it was not associated with either mortality or chronological age. Future studies may assess and compare different measures of frailty with unfavorable outcomes, besides identifying factors that protect against negative events related to the frailty syndrome.

Contributors

A. A. Pereira conducted the study proposal, literature review, data analysis and interpretation, and writing of the manuscript. F. S. A. Borim and A. L. Neri collaborated in the data analysis and interpretation, writing of the manuscript, and critical revision of the intellectual content.

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References

1. Mitnitski AB, Mogilner AJ, Rockwood K. Accumulation of deficits as a proxy measure of aging. ScientificWorldJournal 2001; 1:323-36.
2. Kulminski A, Yashin A, Ukraintseva S, Akushevich I, Arbeev K, Land K, et al. Accumulation of health disorders as a systemic measure of aging: findings from the NLTCS data. Mech Ageing Dev 2006; 127:840-8.
3. Fried LP, Tangen C, Walston J, Newman AB, Hirsch C, Gottdiener J, et al. Frailty in older adults: evidence for a phenotype. J Gerontol A Biol Sci Med Sci 2001; 56:M146-56.
4. Walston J, Hadley EV, Ferrucci L, Guralnik JM, Newman AB, Studenski SA, et al. Research agenda for frailty in older adults: toward a better understanding of physiology and etiology: summary from the American Geriatrics Society/National Institute on Aging Research Conference on Frailty in older adults. J Am Geriatr Soc 2006; 54:991-1001.
5. Karunananthan S, Wolfson C, Bergman H, Béland F, Hogan DB. A multidisciplinary systematic literature review on frailty: overview of the methodology used by the Canadian Initiative on Frailty and Aging. BMC Med Res Methodol 2009; 9:68.
6. Sternberg SA, Schwartz AW, Karunananthan S, Bergman H, Clarfield AM. The identification of frailty: a systematic literature review. J Am Geriatr Soc 2011; 59:2129-38.
7. Rockwood K, Mitnitski A. Frailty in relation to the accumulation of deficits. J Gerontol A Biol Sci Med Sci 2007; 62:722-7.
8. Yang Y, Lee LC. Dynamics and heterogeneity in the process of human frailty and aging: evidence from the U.S. older adult population. J Gerontol B Psychol Sci Soc Sci 2010; 65: 246-55.
9. Rodríguez-Mañas L, Féart C, Mann G, Viña J, Chatterji S, Chdozko-Zajko W, et al. Searching for a operational definition of frailty: a Delphi method based consensus statement. The Frailty Operative Definition-Consensus Conference Project. J Gerontol A Biol Sci Med Sci 2013; 68:62-7.
10. Morley JE, Vellas B, van Kan GA, Anker SD, Bauer JM, Bernabei R, et al. Frailty consensus: a call for action. J Am Med Dir Assoc 2013; 14:392-7.
11. Bouillon K, Kivimaki M, Hamer M, Sabia S, Fransson EI, Singh-Manoux A, et al. Measures of frailty in population based studies: an overview. BMC Geriatr 2013; 13:64.
12. Searle SD, Mitnitski AB, Gahbauer EA, Gill TM, Rockwood K. A standard procedure for creating a frailty index. BMC Geriatr 2008; 8:24.
13. Drubbel I, Numans ME, Kranenburg G, Bleijenberg N, de Wit NJ, Schuurmans MJ. Screening for frailty in primary care: a systematic review of the psychometric properties of the frailty index in community-dwelling older people. BMC Geriatr 2014; 14:27.
14. Song X, Mitnitski A, Rockwood K. Prevalence and 10-year outcomes of frailty in older adults in relation to deficit accumulation. J Am Geriatr Soc 2010; 58:681-7.
15. Fang X, Shi J, Song X, Mitnitski A, Tang Z, Wang C, et al. Frailty in relation to the risk of falls, fractures, and mortality in older Chinese adults: results from the Beijing Longitudinal Study of Aging. J Nutr Health Aging 2012; 16:903-7.
16. Rockwood K, Mitnitski A. Frailty defined by deficit accumulation and geriatric medicine defined by frailty. Clin Geriatr Med 2011; 27:17-26.
17. Howlett SE, Rocwood K. New horizons in frailty: ageing and the deficits-scaling problems. Age Ageing 2013; 42:416-23.
18. Collard RM, Boter H, Schoevers RA, Voshaar RCO. Prevalence of frailty in community-dwelling older persons: a systematic review. J Am Geriatr Soc 2012; 60:1487-92.
19. Shamlyian T, Talley KMC, Ramakrishnan R, Kane R. Association of frailty with survival: a systematic literature review. Ageing Res Rev 2013; 12:719-36.

20. Kulminski AM, Ukraintseva SV, Kulminskaya IV, Arbeev KG, Land K, Yashin AI. Cumulative deficits better characterize susceptibility to death in elderly people than phenotypic frailty: lessons from the Cardiovascular Health Study. J Am Geriatr Soc 2008; 56:898-903.
21. Blodgett J, Theou O, Kirkland S, Andreou P, Rockwood K. Frailty in NHANES: comparing the frailty index and phenotype. Arch Gerontol Geriatr 2015; 60:464-70.
22. Ferrucci L, Guralnik JM, Studenski S, Fried LP, Cutler Jr. GB, Walston JD, et al. Designing randomized, controlled trials aimed at preventing or delaying functional decline and disability in frail, older persons: a consensus report. J Am Geriatr Soc 2004; 52:625-34.
23. Folstein MF, Folstein SE, McHugh PR. "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res 1975; 12:189-98.
24. Bertolucci PHF, Brucki SMD, Campacci S, Juliano Y. O Mini-Exame do Estado Mental em uma população geral: impacto da escolaridade. Arq Neuropsiquiatr 1994; 52:1-7.
25. Brucki SMD, Nitrini R, Caramelli P, Bertolucci PHF, Okamoto IH. Sugestões para o uso do Mini-Exame do Estado Mental no Brasil. Arq Neuropsiquiatr 2003; 61:777-81.
26. Neri AL, Yassuda MS, Araújo LF, Eulálio MC, Cabral BE, Siqueira MEC, et al. Metodologia e perfil sociodemográfico, cognitivo e de fragilidade de idosos comunitários de sete cidades brasileiras: Estudo FIBRA. Cad Saúde Pública 2013; 29:778-92.
27. Santos DM, Siquieri R. Índice de massa corporal e indicadores antropométricos de adiposidade em idosos. Rev Saúde Pública 2005; 39:163-8.
28. Lawton M, Brody E. Assessment of older people: self-maintaining and instrumental activities of daily living. Gerontologist 1969; 9:179-86.
29. Strawbridge WJ, Wallhagen MI, Cohen RD. Successful aging and well-being: self-rated compared with Rowe and Kahn. Gerontologist 2002; 42:727-33.
30. Yesavage JA, Brink TL, Rose TL, Lum O, Huang V, Adey M, et al. Development and validation of a geriatric depression screening scale: a preliminary report. J Psychiatr Res 1983; 17:37-49.
31. Almeida OP, Almeida SA. Short versions of the Geriatric Depression Scale: a study of their validity for the diagnosis of major depressive episode according to ICD-10 and DSM-IV. Int J Geriatr Psychiatry 1999; 14:858-65.
32. Rockwood K, Andrew M, Mitnitski A. Comparison of two approaches to measuring frailty in elderly people. J Gerontol A Biol Sci Med Sci 2007; 62:738-43.
33. Borim FSA, Costa TB, Moraes, ZV, Pinto JM, Guariento ME, Neri AL. Indicadores de fragilidade. In: Neri AL, Guariento ME, organizadoras. Fragilidade, saúde e bem-estar em idosos. Dados do Estudo FIBRA Campinas. Campinas: Alínea Editora; 2011. p. 205-24.
34. Arbeev KG, Ukraintseva SV, Akushevich I, Kulminski AM, Arbeeva LS, Akushevich L, et al. Age trajectories of physiological indices in relation to healthy life course. Mech Ageing Dev 2011; 132:93-102.
35. Mitnitski A, Song X, Rockwood K. Trajectories of changes of twelve years in the health status of Canadians from late middle age. Exp Gerontol 2012; 47:893-9.
36. Wang C, Song X, Mitnitski A, Fang X, Tang Z, Yu P, et al. Effect of health deficit accumulation and mortality risk in older adults in the Beijing Longitudinal Study of Aging. J Am Geriatr Soc 2014; 62:821-8.
37. Harttgen K, Kowal P, Strulik H, Chatterji S, Vollmer S. Patterns of frailty in older adults: comparing results from higher and lower income countries using the Survey of Health, Ageing and Retirement in Europe (SHARE) and the Study on global AGEing and adult health (SAGE). PLoS One 2013; 8:e75847.
38. Romero-Ortuno R, Kenny RA. The frailty index in Europeans: association with age and mortality. Age Ageing 2012; 41:684-9.
39. Shi J, Yang Z, Song X, Yu P, Fang X, Tang Z, et al. Sex differences in the limit to deficit accumulation in late middle-aged and older Chinese people: results from the Beijing Longitudinal Study of Aging. J Gerontol A Biol Sci Med Sci 2014; 69:702-9.
40. Maia FOM, Duarte YAO, Lebrão ML, Santos JLF. Fatores de risco para mortalidade em idosos. Rev Saúde Pública 2006; 40:1049-56.
41. Theou O, Rockwood MRH, Mitnitski A, Rockwood K. Disability and comorbidity in relation to frailty: how much do they overlap? Arch Gerontol Geriatr 2012; 55:e1-e8.
42. Banks J, Muriel A, Smith JP. Disease prevalence, disease incidence, and mortality in the United States and in England. Demography 2010; 47:S211-31.
43. Mitnitski A, Song X, Skoog I, Broe GA, Cox JL, Grunfeld E, et al. Relative fitness and frailty of elderly men and women in developed countries and their relationship with mortality. J Am Geriatr Soc 2005; 53:2184-9.
44. Martin FC, Brighton P. Frailty: diferente tools for diferente purposes? Age Ageing 2008; 37:129-31.
45. Walston JD, Bandeen-Roche K. Frailty: a tale of two concepts. BMC Med 2015; 13:185.

Resumo

No contexto brasileiro, o índice de fragilidade ainda não foi avaliado em relação à sua capacidade de predizer mortalidade em idosos comunitários. O objetivo do presente trabalho foi avaliar a associação entre o índice de fragilidade e mortalidade em idosos. Trata-se de um estudo prospectivo, composto por dados provenientes da Rede FIBRA-2008-2009 em Campinas, Estado de São Paulo, com informações de pessoas não institucionalizadas da área urbana e pelo Sistema de Informações sobre Mortalidade. Comparações e associações estatísticas foram feitas mediante os testes: Mann-Whitney, Kruskal-Wallis, qui-quadrado e regressão de Cox com intervalos de 95% de confiança. Participaram 689 idosos (72,1 ± 5,3 anos); 68,8% deles eram mulheres. A prevalência de idosos frágeis foi de 38,8%, de pré-frágeis 51,6% e robustos 9,6%; a média geral do índice de fragilidade foi maior nas mulheres. Não houve associação entre o índice de fragilidade e a idade cronológica. A regressão de Cox indicou que as variáveis idade (HR: 1,10; IC95%: 1,05-1,15) e sexo (HR: 0,57; IC95%: 0,33-0,99) foram significativamente associadas à mortalidade. Não foi observada associação entre o índice de fragilidade e mortalidade (HR: 3,02; IC95%: 0,24-37,64). O índice de fragilidade não foi capaz de predizer mortalidade em idosos brasileiros residentes na comunidade.

Idoso; Idoso Fragilizado; Saúde do Idoso; Mortalidade

Resumen

En el contexto brasileño, el índice de fragilidad todavía no fue evaluado en relación a su capacidad de predecir mortalidad en ancianos residentes en comunidades de escasos recursos. El objetivo del presente trabajo fue evaluar la asociación entre el índice de fragilidad y mortalidad en ancianos. Se trata de un estudio prospectivo, compuesto por datos provenientes de la Red FIBRA-2008-2009 en Campinas, Estado de São Paulo, con información de personas no institucionalizadas del área urbana y por el Sistema de Información de Mortalidad. Comparaciones y asociaciones estadísticas se realizaron mediante los tests: Mann-Whitney, Kruskal-Wallis, chi-cuadrado y regresión de Cox con intervalos de confianza de 95%. Participaron 689 ancianos (72,1 ± 5,3 años); un 68,8% de ellos eran mujeres. La prevalencia de ancianos frágiles fue de un 38,8%, de pre-frágiles 51,6% y fuertes 9,6%; la media general del índice de fragilidad fue mayor en las mujeres. No hubo asociación entre el índice de fragilidad y la edad cronológica. La regresión de Cox indicó que las variables edad (HR: 1,10; IC95%: 1,05-1,15) y sexo (HR: 0,57; IC95%: 0,33-0,99) fueron significativamente asociadas a la mortalidad. No se observó asociación entre el índice de fragilidad y mortalidad (HR: 3,02; IC95%: 0,24-37,64). El índice de fragilidad no fue capaz de predecir mortalidad en ancianos brasileños residentes en comunidades sin recursos.

Anciano; Anciano Frágil; Salud del Anciano; Mortalidad

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