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Original Report

# Inequalities in Life Expectancy With Frailty Among Brazilian Older Adults: A Multistate Approach

**Luciana Correia Alves, PhD,[1,*] Flávia Cristina Drumond Andrade, PhD,[2] Ligiana Pires Corona, PhD,[3] Jair Licio Ferreira Santos, PhD,[4] and Yeda Aparecida de Oliveira Duarte PhD,[5]**

[1]Department of Demography, Institute of Philosophy and Human Sciences (IFCH), University of Campinas (UNICAMP), Brazil. [2]School of Social Work, University of Illinois at Urbana-Champaign. [3]Faculty of Applied Sciences, University of Campinas, Brazil. [4]Faculty of Medicine of Ribeirão Preto, University of São Paulo, Brazil. [5]Medical-Surgical Nursing Department, School of Nursing, University of São Paulo, Brazil.

*Address correspondence to: Luciana Correia Alves, PhD, Department of Demography at the Institute of Philosophy and Human Sciences, Population Studies Center Elza Berquó—NEPO, University of Campinas—Unicamp, Cidade Universitária Zeferino Vaz, Av. Albert Einstein, 1300—Sala 24, 13081–970, Campinas—SP, Brazil. E-mail: luciana@nepo.unicamp.br

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## Abstract

**Background and Objectives:** Frailty is considered one of the major conditions faced by aging societies. Little has been reported about the effect of becoming frail on life expectancy among older adults in developing countries. The aim was to estimate total life expectancy and life expectancy with or without frailty by age, sex, and education among older adults in Brazil. **Data and Methods:** The study was developed based on information provided by the Health, Well-being, and Aging (SABE) Study. The sample included 1,399 older adults (≥60 years old) followed up from 2006 to 2010. Frailty status was classified according to the Fried criteria. Additional variables include age (in years), gender, and years of education. Estimates of total life expectancy, frailty-free life expectancy, and frailty life expectancy were obtained using the multistate life table method. **Results:** At the baseline, the proportion of individuals with frailty was 13.7% and participants had, on average, 4.0 years of education. Men had more years of education than women (4.6 vs. 3.7, $p < .001$). Older adults with higher education live fewer years with frailty. Compared with older adults with no education, those with 6 years of education have higher frailty-free life expectancy. At age 70, men with no education expect to live 9.1 years (95% confidence interval [CI] = 7.8, 10.4) without frailty compared with 10.6 years (95% CI = 9.4, 11.8) among those with 6 years of education. Among women age 70, frailty-free life expectancy reaches 11.7 years (95% CI = 10.6, 12.8) among those with no education, but 13.9 years (95% CI = 12.5, 15.3) among those with 6 years. **Implications:** Given the recent changes in educational achievement in Brazil, we believe that educational policies are powerful ways in addressing inequalities in healthy life expectancy. Public health policies aimed at avoiding the development of frailty among elderly at risk should be encouraged.

**Translational Significance:** This article examines how education may influence the number of years that older adults expect to live with frailty. These socioeconomic differences are important because frailty is a geriatric syndrome that causes early disability and mortality in older adults. Among older adults in Latin America and the Caribbean, no or low education is associated with shorter life expectancy without frailty.

**Keywords:** Aging, Brazil, Education, Frailty, SABE study

Brazil has experienced a pronounced aging of its population, with a large increase in the number of older adults in recent decades. In 1980, 7.1 million individuals were 60 and older in Brazil (5.8%) and this number reached 19.8 million (10.0%) in 2010 (Economic Commission for Latin America and the Caribbean (ECLAC), 2016). This process is expected to continue in coming decades and the number of older adults should reach 43.3 million (18.9%) in 2030 (ECLAC, 2016). At the same time, the country is experiencing marked gains in life expectancy among older adults. Life expectancy at age 60 among men increased from 14.6 years in 1980 to 19.1 in 2010 (ECLAC, 2017). Among women, gains were also marked—from 17.6 in 1980 to 22.5 in 2010 (ECLAC, 2017). The probability of a 60-year old man to survive to age 80 increased 80% between 1980 and 2010 (ECLAC, 2017). Among women, this increase was of 50%, but a higher proportion of women reach older ages than men (ECLAC, 2017). This fast aging process creates additional challenges for Brazil, which is marked by a number of social inequalities, limitations in health care access, and inadequacies in the social security system.

Along with this aging process, Brazil has been experiencing major epidemiological changes. In particular, there is increasing awareness regarding the impact of frailty among older adults. Frailty is a geriatric syndrome that results from a multisystemic reduction in a reserve capacity, leading to a high risk for a set of adverse conditions (Fried, Ferrucci, Darer, Williamson, & Anderson, 2004). The main mechanisms of frailty are changes related to the aging process and the occurrence of comorbidities (Fried et al., 2001). However, a number of sociodemographic factors, such age, gender, education, income, and race are involved in the development of frailty (Mello, Engstrom, & Alves, 2014).

There is no consensus on the frailty diagnostic criteria, so the estimated prevalence of frailty may vary depending on the definition used. Studies using the phenotype of frailty proposed by Fried and colleagues (measuring five criteria: unintentional weight loss, fatigue reported, reduced grip strength, reduced walking speed, and low physical activity) appear to converge to a frailty syndrome prevalence between 4% (Avila-Funes et al., 2008; Collard, Boter, Schoevers, & Voshaar, 2012; Fried et al., 2001) and 17% of the older adult population (Santos-Eggimann, Cuénoud, Spagnoli, & Junod, 2009). Rockwood, Fox, Stolee, Robertson, and Beattie (1994) report that frailty is a complex condition that affects older adults in several domains (i.e., social, cognitive, psychological, and physical) and suggest that indexes should include all of them. However, the frailty measures that follow the multidomain approach report higher prevalence rates, ranging from 22% (Song, Mitnitski, & Rockwood, 2010) to 46% (Gobbens, van Assen, Luijkx, Wijnen-Sponselee, & Schols, 2010). A recent meta-analysis using modified versions of the Frailty Phenotype (i.e., that adopted different metrics or criterion) reported that prevalence of frailty in Latin America and the Caribbean was 20%, but varied from 8% to 23% (Da Mata et al., 2016). In Brazil, recent national estimates indicate that prevalence of frailty was 13.5% among the older adults aged 60 or older and 16.2% among those 65 aged years or older (J. M. Andrade et al., 2018). Higher prevalence of frailty was reported among older Brazilian adults with low education, multiple chronic conditions and disability (J. M. Andrade et al., 2018).

To date, few studies have estimated total life expectancy with and without frailty. The exceptions are the studies by Romero-Ortuno, Fouweather, and Jagger (2014) and Herr, Arvieu, Ankri, and Robine, 2018) who used European data. However, these studies estimated life expectancy using available cross-sectional data and Sullivan methods (Sullivan, 1971).

Because data, particularly longitudinal data pertaining to frailty in Latin America and the Caribbean, have become available only relatively recently, most of the existing studies estimating healthy life expectancy by socioeconomic conditions used available cross-sectional data. One of the few exceptions is the work by Beltran-Sanchez and Andrade (2013). They used data from the Survey on Health, Well-Being, and Aging in Latin America and the Caribbean (SABE) collected in São Paulo to estimate life expectancy with and without disability by educational levels (Beltran-Sanchez & Andrade, 2013).

There is a general agreement that lower socioeconomic conditions are associated with lower life expectancy and lower healthy life expectancy (for a review, see Elo, 2009; Hummer & Lariscy, 2011; Pongiglione, De Stavola, & Ploubidis, 2015). In Brazil, there is wide evidence that individuals of lower socioeconomic conditions exhibit worse health outcomes than those with better socioeconomic conditions (Leite et al., 2013; Messias, 2003; Szwarcwald, Souza Júnior, Marques, Almeida, & Montilla, 2016). This study expands this literature and estimates the total life expectancy, frailty-free life expectancy, and frailty life expectancy among older adults in São Paulo, Brazil. Understanding how long older adults spend, on average, in need of medical and care support, allows for better planning. We hypothesize that disparities in total life expectancy, frailty-free life expectancy, and frailty life expectancy are related to differences in education. Given the differences between men and women in terms of life expectancy and frailty, we also disaggregate the comparisons by sex.

## Research Design and Methods

Data are from two waves of a longitudinal study called Saúde, Bem-estar e Envelhecimento (SABE [Health,

Wellbeing and Ageing]) study. SABE study began in the year 2000 under the coordination of the Pan American Health Organization. The original SABE study was a household population-based, cross-sectional study, with the aim of investigating different aspects related to the health of the population of elderly living in urban areas in seven countries of Latin America and the Caribbean: Argentina, Barbados, Brazil, Chile, Cuba, Mexico, and Uruguay. In Brazil, the SABE study was limited to the city of São Paulo. A total of 2,143 male and female community-dwelling individuals aged 60 years or older were interviewed between January 2000 and March 2001 (Lebrão & Duarte, 2003). A two-stage sampling process was conducted.

In 2006, the SABE study in Brazil became a longitudinal survey. The cohort from 2000 was located and 1,115 individuals were interviewed a second time. Losses in the period corresponded to deaths (22.9%), refusals to participate (9.6%), changes of address to another city (2.5%), cases of institutionalization (0.4%), and individuals who were not located (12.6%). This cohort was denominated $A_{06}$. Further probabilistic, randomized sampling was performed for the inclusion of a cohort of 298 additional individuals between 60 and 64 years of age (cohort $B_{06}$). In 2010, the next wave of the SABE study was conducted. Cohorts $A_{06}$ and $B_{06}$ were located and interviewed again ($n$ = 990). Losses in the period were due to deaths (11.9%), refusals to participate, changes of address to another city, cases of institutionalization, and individuals who were not located (18.0%). In 2011, probabilistic, randomized sampling was performed for the inclusion of a cohort of 355 additional individuals between 60 and 64 years of age (cohort $C_{10}$). Figure 1 illustrates the evolution of the cohorts over time.

This current analysis uses the 2006 wave as the baseline because data on frailty were not collected in 2000. A total of 1,413 respondents from $A_{06}$ and $B_{06}$ were included in the sample, but 14 individuals didn't have complete information on frailty and education were excluded. Thus, the present observational cohort study involved 1,399 older adults followed up from 2006 to 2010, representing 1,019,243 elderly in the city of São Paulo.

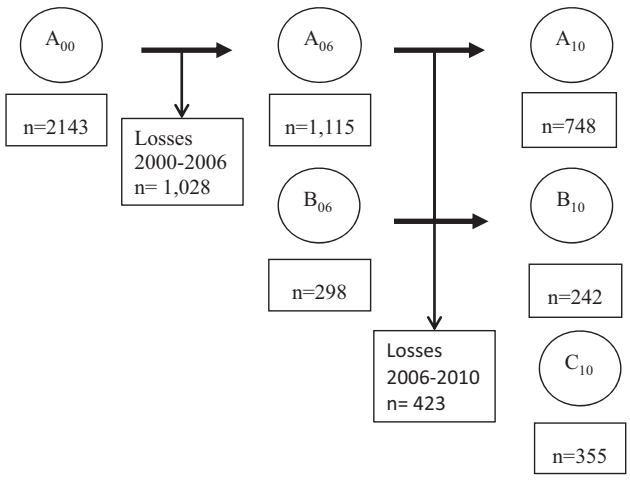


**Figure 1.** Flowchart of cohorts of SABE study.

Frailty was defined based on the criteria proposed by Fried and colleagues (2001): unintentional weight loss, diminished muscle strength, complaints of fatigue or exhaustion, a reduction in gait velocity, and a low level of physical activity. The components were adapted according to SABE protocol, for example, the level of weekly physical activity was assessed using the Brazilian version of the International Physical Activity Questionnaire, and cut-offs for the lower quintile of gait speed, slowness, and low physical activity were calculated for the SABE sample. Details on the methodology and cutoff points are found in a previous study (Alexandre et al., 2018).

A frailty score was constructed based on the presence/absence of each of the five frailty components. Individuals with none of these characteristics are classified as nonfrail, those with one or two are classified as pre-frail and those with three or more are classified as frail. In this study, we compare those who are frail with those who are not frail (nonfrail and prefrail). Studies previous have also used dichotomous categories of frail versus nonfrail (combined nonfrail and prefrail) and assessed the change from not being frail to being frail (Vries et al., 2011).

Additional variables include age (in years), obtained using date of birth and date of the interview, gender (male and female) and years of education. About 23% of the sample has no education (0 years), 31.3% have 4 years, and 6.2% have completed 11 years of formal education. Over two-thirds of older adults have 4 or fewer years of education, whereas 93.4% have 11 or fewer. In the Brazilian educational system, 4 years of education represents the completion of the fundamental education I and 11 years represent the completion of secondary education. In this article, we present results for these selected years: 0, 4, and 11. Results for other specific number of years of education are available upon request.

Estimates of total life expectancy, frailty-free life expectancy, and frailty life expectancy were obtained using the multistate life table method.

We used the 0.99r17 version of the IMaCh (Interpolative Markov Chain) software (Brouard & Lievre, 2006) and longitudinal data from SABE 2006 to 2010 to compute these estimates. IMaCh generates estimates of total and state-specific life expectancies (i.e., FFLE and FLE) and their standard errors (Lievre, Brouard, & Heathcote, 2003). The embedded Markov chain introduced by Laditka and Wolf (1998) and incorporated in the IMaCh software applies the multistate life table model to shorter transition periods, which are embedded within the longer interval between surveys. For the current analysis, annual transitions were computed. We report the "population based" estimates that are

average population expectancies. Sample weights from 2006 were used in the analysis.

The present study received approval from the Human Research Ethics Committee at the School of Public Health, University of São Paulo, and the National Committee for Research Ethics. Participation was voluntary, and all participants signed a statement of informed consent.

## Results

At the baseline, age ranged from 60 to 104 years (mean: 70 ± 7.5 years; median: 69 years). On average, participants had 4.0 years of education. Men had, on average, almost one more year of education than women (4.6 vs. 3.7, $p < .001$). Table 1 displays the characteristics of the sample. The population was predominantly female (59.4%); 55.7% had 60 and 69 years; 53.8% had between 1 and 4 years of schooling. The results showed that 8.5% of the interviewees were frail and 41.5% were prefrail in 2006. There was a higher prevalence of frailty among women than men (15.5% vs. 10.9%).

### Population-Based Results

Tables 2 and 3 present the total life expectancy (TLE), frailty-free life expectancy (FFLE), frailty life expectancy (FLE), and the proportion of years expected to be lived without frailty (%FFLE/TLE) for selected ages for men and women, respectively. At age 60, total life expectancy for men reaches 19.3 years (95% confidence interval [CI] = 18.0, 20.6), but it varies from 17.8 (95% CI = 16.1, 19.5) among those who have no education to 21.4 years (95% CI = 19.3, 23.5) among those with 11 years of education. Total life expectancy is higher among females—23.0 (95% CI = 21.7, 24.3), but varies from 21.7 years (95% CI = 20.34, 23.10) among those with no years of education to 26.2 (95% CI = 23.0, 29.4) among those who have completed 11 years of education. At age 60, frailty life expectancy is 1.3 (95% CI = 0.8, 1.8) among men and 1.8 (95% CI = 1.1, 2.5) among women. Even though there is a tendency for those with higher education to live fewer years with frailty, the educational differences in frailty life expectancy are not statistically significant. However, there are important differences in frailty-free life expectancy. Compared to older adults with no education, those with 11 years of education have higher frailty-free life expectancy. For example, at age 70, men with no education expect to live 9.1 years (95% CI = 7.9, 10.3) without frailty compared with 12.5 years (95% CI = 10.7, 14.3) among those with 11 years of education. Among women age 70, frailty-free life expectancy reaches 11.7 years (95% CI = 10.6, 12.8) among those with no education, but 16.2 years (95% CI = 13.9, 18.5) among those with 11 years. In sum, higher education is associated with higher total life expectancy and frailty-free life expectancy (Figure 2). As a result, the proportion of years expected to be lived without frailty is higher among those with higher education.

**Table 1.** Relative Distribution (%) of Demographic Characteristics and Frailty Status of Elderly in the City of São Paulo, Brazil, 2006 (Baseline)

| Variables | *n* (1,019,243) | Relative distribution (%) |
|---|---|---|
| Age (years) | | |
| 60–64 | 291,575 | 28.6 |
| 65–69 | 276,147 | 27.1 |
| 70–74 | 202,625 | 19.9 |
| 75–79 | 128,466 | 12.6 |
| 80 or older | 120,430 | 11.8 |
| Sex | | |
| Male | 413,971 | 40.6 |
| Female | 605,272 | 59.4 |
| Schooling (years) | | |
| None | 199,396 | 19,6 |
| 1–4 | 548,739 | 53,8 |
| 5 or more | 270,385 | 26,5 |
| Frailty | | |
| Nonfrail | 509,268 | 50.0 |
| Prefrail | 423,489 | 41.5 |
| Frail | 86,486 | 8.5 |

*Source:* SABE study, 2006.

## Discussion

This study estimated the total life expectancy, frailty free life expectancy, and frailty life expectancy among the Brazilian older adults between 2006 and 2010, by sex and education level using the multistate life table method.

To date, few studies based on European samples have estimated total life expectancy with and without frailty. We found that frailty life expectancy was 1.4 years (95% CI = 0.9, 1.9) among men at age 70 and 1.8 years (95% CI = 1.1–2.5) among Brazilian women counterparts. Methodological differences across studies affect comparability of the results, but Romero-Otuno and colleagues (2014) estimated that frailty life expectancy was 0.1–1.8 years among men at age 70 using data from 14 countries in the Survey of Health, Ageing and Retirement in Europe (SHARE). Among women, the average number of years with frailty were higher—0.4–5.5, but women lived fewer years without frailty or disability (Romero-Ortuno et al., 2014). More recently, Herr and colleagues used data from France and estimated that life expectancy with frailty at age 70 was 3.4 years among women and 1.2 years among men (Herr et al., 2018). However, the number of years expected to be lived prefrail was higher—6.0 (men) and 7.4 (women; Herr et al., 2018). In further analyses (not shown, but available upon request) confirm this finding—at age 70, men expect to live prefrail for 5.6 years on average, whereas women expect to live 7.0 years. Gender differences are possibly the result of differentials in socioeconomic conditions and biological factors (Romero-Ortuno et al., 2014). It is important to note that these previous studies estimated

**Table 2.** Population-Based Estimates of Total Life Expectancy, Frailty-Free Life Expectancy (FFLE), Frailty Life Expectancy (FLE) and 95% Confidence Intervals for Men by Age and Years of Education Based on Frailty Results From SABE-Brazil

| | Years of education | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Total | | 0 | | 4 | | 11 | |
| Age 60 | | | | | | | | |
| Total life expectancy | 19.3 | (18.0, 20.6) | 17.8 | (16.1, 19.5) | 18.8 | (17.5, 20.1) | 21.4 | (19.3, 23.5) |
| FFLE | 18.0 | (16.7, 19.3) | 16.1 | (14.5, 17.7) | 17.5 | (16.2, 18.8) | 20.5 | (18.4, 22.6) |
| FLE | 1.3 | (0.8, 1.8) | 1.7 | (1.0, 2.4) | 1.3 | (0.8, 1.8) | 0.9 | (0.2, 1.6) |
| % with no frailty | 93.1 | | 90.6 | | 92.9 | | 95.6 | |
| Age 65 | | | | | | | | |
| Total life expectancy | 15.4 | (14.2, 16.6) | 14.1 | (12.6, 15.6) | 14.9 | (13.7, 16.1) | 17.2 | (15.2, 19.2) |
| FFLE | 14.1 | (13, 15.2) | 12.4 | (11, 13.8) | 13.5 | (12.3, 14.7) | 16.3 | (14.3, 18.3) |
| FLE | 1.3 | (0.8, 1.8) | 1.7 | (1.0, 2.4) | 1.4 | (0.9, 1.9) | 1.0 | (0.3, 1.7) |
| % with no frailty | 91.3 | | 87.9 | | 90.9 | | 94.5 | |
| Age 70 | | | | | | | | |
| Total life expectancy | 12.0 | (11, 13) | 10.8 | (9.5, 12.1) | 11.4 | (10.3, 12.5) | 13.4 | (11.6, 15.2) |
| FFLE | 10.6 | (9.6, 11.6) | 9.1 | (7.9, 10.3) | 10.0 | (8.9, 11.1) | 12.5 | (10.7, 14.3) |
| FLE | 1.4 | (0.9, 1.9) | 1.7 | (1.0, 2.4) | 1.4 | (0.9, 1.9) | 1.0 | (0.3, 1.7) |
| % with no frailty | 88.6 | | 83.9 | | 87.9 | | 92.8 | |
| Age 75 | | | | | | | | |
| Total life expectancy | 9.0 | (8.1, 9.9) | 8.2 | (7, 9.4) | 8.5 | (7.5, 9.5) | 10.1 | (8.4, 11.8) |
| FFLE | 7.6 | (6.6, 8.6) | 6.4 | (5.3, 7.5) | 7.1 | (6.1, 8.1) | 9.1 | (7.4, 10.8) |
| FLE | 1.4 | (0.9, 1.9) | 1.8 | (1.0, 2.6) | 1.4 | (0.9, 1.9) | 1.0 | (0.3, 1.7) |
| % with no frailty | 84.5 | | 78.2 | | 83.3 | | 90.2 | |

*Source:* SABE study, 2006–2010.

**Table 3.** Population-Based Estimates of Total Life Expectancy, Frailty-Free Life Expectancy (FFLE), Frailty Life Expectancy (FLE), and 95% Confidence Intervals for Women by Age and Years of Education Based on Frailty Results From SABE-Brazil

| | Years of education | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Total | | 0 | | 4 | | 11 | |
| Age 60 | | | | | | | | |
| Total life expectancy | 23.0 | (21.7, 24.3) | 21.7 | (20.4, 23) | 23.1 | (21.8, 24.4) | 26.2 | (23, 29.4) |
| FFLE | 21.2 | (19.6, 22.8) | 19.6 | (18.3, 20.9) | 21.3 | (20, 22.6) | 24.9 | (22.2, 27.6) |
| FLE | 1.8 | (1.1, 2.5) | 2.1 | (1.6, 2.6) | 1.8 | (1.2, 2.4) | 1.3 | (0.0, 2.7) |
| % with no frailty | 92.1 | | 90.3 | | 92.2 | | 94.9 | |
| Age 65 | | | | | | | | |
| Total life expectancy | 18.9 | (17.7, 20.1) | 17.6 | (16.4, 18.8) | 18.8 | (17.6, 20) | 21.7 | (19.1, 24.3) |
| FFLE | 17.0 | (15.6, 18.4) | 15.5 | (14.3, 16.7) | 17.0 | (15.8, 18.2) | 20.4 | (17.9, 22.9) |
| FLE | 1.8 | (1.1, 2.5) | 2.1 | (1.5, 2.7) | 1.8 | (1.2, 2.4) | 1.3 | (0.2, 2.4) |
| % with no frailty | 90.3 | | 87.9 | | 90.3 | | 93.9 | |
| Age 70 | | | | | | | | |
| Total life expectancy | 15.0 | (13.9, 16.1) | 13.8 | (12.7, 14.9) | 14.9 | (13.7, 16.1) | 17.5 | (15.2, 19.8) |
| FFLE | 13.2 | (12, 14.4) | 11.7 | (10.6, 12.8) | 13.1 | (11.9, 14.3) | 16.2 | (13.9, 18.5) |
| FLE | 1.8 | (1.1, 2.5) | 2.2 | (1.6, 2.8) | 1.8 | (1.2, 2.4) | 1.3 | (0.2, 2.4) |
| % with no frailty | 87.7 | | 84.5 | | 87.7 | | 92.4 | |
| Age 75 | | | | | | | | |
| Total life expectancy | 11.6 | (10.6, 12.6) | 10.6 | (9.6, 11.6) | 11.4 | (10.3, 12.5) | 13.7 | (11.6, 15.8) |
| FFLE | 9.8 | (8.7, 10.9) | 8.4 | (7.3, 9.5) | 9.6 | (8.4, 10.8) | 12.3 | (10.1, 14.5) |
| FLE | 1.9 | (1.1, 2.7) | 2.2 | (1.6, 2.8) | 1.9 | (1.3, 2.5) | 1.4 | (0.3, 2.5) |
| % with no frailty | 83.9 | | 79.4 | | 83.7 | | 90.1 | |

*Source:* SABE study, 2006–2010.

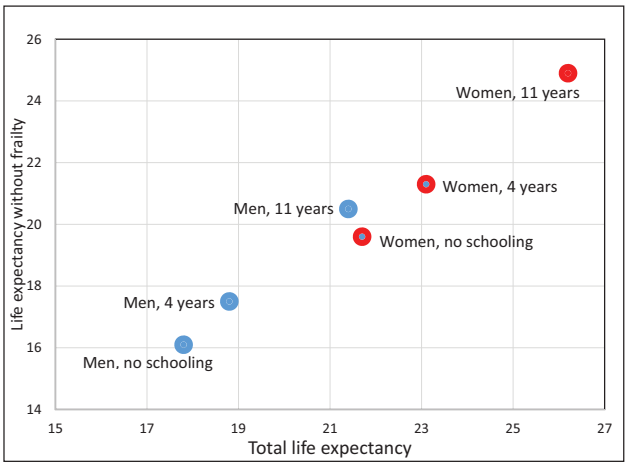


**Figure 2.** Total life expectancy and frailty-free life expectancy at age 60 by sex and educational levels. *Source:* SABE study, 2006–2010.

frailty life expectancy using available cross-sectional data and Sullivan methods (Sullivan, 1971).

We further contribute to the literature by examining educational differences. We find that higher education is associated with higher total life expectancy and frailty-free life expectancy. For both sexes, there was a gradient in which higher total life expectancy was accompanied with higher frailty-free life expectancy, as a result the expected years of survival among older adults without frailty is higher among those with higher education. These findings are similar to Beltran-Sanchez and Andrade (2013) who found that higher educational levels in Brazil are associated with higher life expectancy and life expectancy without disability. Even though education may not directly be involved in the pathophysiology of frailty, it affects directly cognition (Sattler, Toro, Schönknecht, & Schröder, 2012), which has been used an element in the identification of frailty (Azzopardi et al., 2018). Although Fried's phenotype do not include cognition as one of the criteria, they show that cognition is highly associated to the phenotype (Fried et al., 2001), and several other more recent frailty definitions included cognition (Azzopardi et al., 2018). So, as education is one of the most robust measures for cognitive reserve (Jefferson et al., 2011), it can directly influence frailty.

Education may also indirectly affect by influencing individuals' lifestyle, quality of life, and access to health care (Hirsch et al., 2006). In fact, results from the last Brazilian National Health Survey in 2013 showed that individuals with more education have better lifestyle markers, such as the fruits and vegetables consumption and recommended levels of physical activity (Malta et al., 2015). According to data from the 2013 Brazilian National Health Survey, people with higher levels of education showed greater access to health services compared with those with lower levels of education (Stopa et al., 2017). A study carried out in São Paulo reported that older adults with lower income and educational levels sought health services less frequently (Louvison et al., 2008). Differences in the use of services and reduced access to medical appointments by education level have also been described in a study by Barros comparing the 2003 and 2008 editions of the Pesquisa Nacional por Amostra de Domicílios (PNAD-Brazilian National Household Survey; Barros, Francisco, Zanchetta, & César, 2011). According to Andrade and Mehta (2018), the prevalence of poor self-rated health was higher among those with lower educational levels.

Education is an important social determinant in Brazil. In the past decades, Brazil has been experiencing major changes in social determinants of health, particularly in educational levels. Since 1990s, basic education expanded in Brazil. At the same time, the number of students in higher education has doubled (Schwartzman, 2004), but large educational inequalities remain in health outcomes (F. C. D. Andrade & Mehta, 2018).

The present findings are in agreement with data reported in previous studies, which demonstrate an association between the advance in age and the development of frailty (Vieira et al., 2013). The physiological process of aging causes changes in different systems of the body, resulting in the loss of capacity. Thus, individuals become increasingly vulnerable with age (Mühlberg & Sieber, 2004). As we presented, the percentage of older adults with no frailty reduces with increasing age. This is the first study to use longitudinal data to estimate life expectancy with and without frailty. Our study examines a large population-based cohort of older adults who were followed over 4 years. One limitation is that we focused on those with frailty and included those with prefrailty along with those who did not have frailty. Another limitation of our study relates to our estimates of frailty may be biased because institutionalized respondents were not included. However, the institutionalized population in Brazil is small, therefore, this bias is likely to be minor (Camarano & Kanso, 2010). Given that longitudinal nationally representative data are not yet available, we examine the experiences of older adults in the largest city in Brazil, which may differ from the general Brazilian population. São Paulo, despite its economic prominence, is marked by large social inequalities (Chiavegatto Filho, Lebrão, & Kawachi, 2012) that influence health conditions across educational groups. Nonetheless, older adults in urban areas often have better education and access to health care, which may also influence the results.

## Implications

Despite the social changes in Brazil in recent decades which include reduced inequality and poverty, the effect of socioeconomic inequality on the health status of the elderly in the country nevertheless continues to be relevant. The findings of the present study are innovative and make an important contribution to the study of frailty among older adults in Brazil, focusing on the city of São Paulo. These findings allow a better understanding of the epidemiology of frailty in developing countries. Given the recent changes

in educational achievement in Brazil, we believe that educational policies are powerful ways in addressing inequalities in healthy life expectancy. Finally, specific strategies and actions directed at slowing, minimizing or recovering from frailty are of extreme importance. Public health policies aimed at avoiding the development of frailty among elderly at risk should be encouraged. Likewise, policies that suggest adequate interventions are important to restoring physical and biological capacity as well as reducing the degree of vulnerability among those who are frail. In the prefrailty period, an appropriate approach could either reverse the condition or at least slow its progress. Therefore, addressing the factors associated with the transition among older is essential to improving the quality of care for individuals who are frail or at risk of becoming frail.

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## Conflict of Interest

None reported.

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