Prevalence of Frailty in Latin America and the Caribbean: A Systematic Review and Meta-Analysis

Fabiana Araújo Figueiredo Da Mata1*, Priscilla Perez da Silva Pereira2‡, Keitty Regina Cordeiro de Andrade1‡, Ana Claudia Morais Godoy Figueiredo2‡, Marcus Tolentino Silva3‡, Maurício Gomes Pereira1‡

1 Department of Medical Sciences, University of Brasilia, Brasilia, Federal District, Brazil, 2 Department of Health Sciences, University of Brasilia, Brasilia, Federal District, Brazil, 3 Department of Health Sciences, Federal University of Amazonas, Manaus, Amazonas, Brazil

* These authors contributed equally to this work.
‡ These authors also contributed equally to this work.

Abstract

Background
Countries in Latin America and the Caribbean (LAC) have experienced a rapid increase in their proportion of older people. This region is marked by a high prevalence of chronic diseases and disabilities among aging adults. Frailty appears in the context of LAC negatively affecting quality of life among many older people.

Aim
To investigate the prevalence of frailty among community-dwelling older people in LAC through a systematic review and meta-analysis.

Methods
A literature search was performed in indexed databases and in the grey literature. Studies investigating the prevalence of frailty with representative samples of community-dwelling older people in Latin America and the Caribbean were retrieved. Independent investigators carried out the study selection process and the data extraction. A meta-analysis and meta-regression were performed using STATA 11 software. The systematic review was registered at the International Prospective Register of Systematic Reviews under the number CRD42014015203.

Results
A total of 29 studies and 43,083 individuals were included in the systematic review. The prevalence of frailty was 19.6% (95% CI: 15.4–24.3%) in the investigated region, with a range of 7.7% to 42.6% in the studies reviewed. The year of data collection influenced the heterogeneity between the studies.
Conclusion

Frailty is very common among older people in LAC. As a result, countries in the region need to adapt their health and social care systems to demands of an older population.

Introduction

Frailty is characterized by an accelerated decrease in several inter-related physiological systems resulting in the malfunction of homeostatic mechanisms [1]. This condition is more prevalent among older people, negatively affects people’s quality of life, and predicts disability, falls, hospitalization, and mortality [2, 3]. As a result, frail older people require extra care, which impacts individual and governmental financial planning [4].

Frailty has been studied extensively in recent years, and its prevalence has been investigated more thoroughly in North America, Europe, and developed countries, where it has appeared to increase with age and be higher among women [4, 5]. However, there is no consensus regarding the prevalence of frailty worldwide [4].

The lack of agreement regarding the best frailty measurements and diagnostic criteria has also been stated in the literature [6, 7]. Some well accepted conceptual models define frailty as a purely physical syndrome, while others include psychological and social aspects in its definition [3, 6, 8]. Based on these conceptual models, a variety of instruments have been developed to assess frailty. The Frailty Phenotype, for instance, classified frailty based on five physical criteria, while the Tilburg Frailty Indicator and the Frailty Index added social and psychological domains to their definition of frailty [3, 8–9].

The Frailty Phenotype is the most commonly used way of measuring frailty. It was developed and operationalized by Fried et al. (2001) and used data from the Cardiovascular Health Study (CHS) Cohort [3]. However, modified versions of the proposed Phenotype have often been used because it is not always feasible to assess all the physical criteria in the same way measured in the CHS Cohort [10]. As different conceptual models influence the selected characteristics for defining frailty [7], it has been observed that the prevalence of frailty varies according to each adopted definition and way of measurement [4, 10–12].

Few studies investigating the prevalence of frailty in less-developed countries are found in the literature. Countries in Latin American and the Caribbean (LAC) are experiencing a rapid increase in the proportion of aging citizens and this process is likely to continue for the next three decades [13–14]. Rising longevity in countries with poor standards of living increases the likelihood of having a larger population of frail older adults [13–14]. Moreover, compared to developed nations, Latin American adults are facing a higher number of chronic diseases and disabilities as they age [12, 15–16]. A study conducted in low- and middle-income countries reported similar or higher incidence of dementia compared with countries of high-income [17]. As a result, Latin American countries will need to adapt their institutions and public policies to the new challenges that arise from a less healthy older population [5, 12, 15].

Stating the prevalence of frailty is challenging due to the variety of frailty measurements. However, in an under researched region where an aging population is combined with marked social disadvantages having an estimated prevalence may contribute to planning health and social care policies. Some studies have investigated frailty in LAC cities, but, as far we are aware, no systematic review on the topic has been carried out thus far. Therefore, this study aims to investigate the pooled prevalence of frailty among community-dwelling older people in LAC through a systematic review and meta-analysis.
Materials and Methods

Register and protocol

This study was registered at Prospero (International Prospective Register of Systematic Reviews) under the number CRD42014015203.

Eligibility criteria

We selected cross-sectional surveys and baseline assessments of longitudinal studies with representative samples of community-dwelling older men and women aged 60 years and above living in the Latin American and Caribbean region. Eligible studies had to report their working definition of frailty, to state the prevalence of frailty or to supply data that allowed us to calculate frailty prevalence measures. We excluded studies stating mean frailty scores without cutoff points for frailty categories and studies that examined a disease-specific population. The definition of frailty and sample size were not part of the criteria for excluding studies in this review. There was no limit for language, publication date or status. The minimum age of 60 years in reference to the older population was assumed according to the cutoff agreed to by the United Nations [18].

Information sources and search strategy

The literature search for potential eligible studies was performed between 5th and 7th May 2016 using the following electronic databases: MEDLINE (via PubMed), Embase, Lilacs, SciELO, Google Scholar, Web of Science, Scopus, ProQuest, CINAHL, and academic works (theses database). Moreover, studies were also selected through manual search of reference citations. The search strategy was developed using Mesh terms for PubMed, EMTREE terms for Embase, and a combination of keywords. For example, the full electronic search strategy used at PubMed was: (“Frail Elderly” [Mesh] OR "Frail Elderly" [TIAB] OR "Frailty" OR "Frail Older People") AND ("Prevalence" OR "Frequency"). The search strategy was slightly modified based on each database (S1 Table).

Study selection process

The study selection process was carried out in two stages by four independent investigators (FAFM, PPSP, KRCA, and ACGF), each record was independently read by two authors. Records (articles) were selected based on their titles and abstracts; duplicate records were excluded. The remaining records were read in their entireties, and those suitable for the review were selected. In cases where a consensus could not be reached by the two authors, a third author helped make a decision regarding the paper selection. Sometimes, a record could describe more than one study; thus, the total number of individual studies was considered at the end of the review. When different studies shared the same population, the study that provided the largest sample size or the one with more detailed information about the participants and frailty definition was chosen--these criteria have been used by other authors [4]. Studies using modified versions of the Frailty Phenotype (i.e., that adopted different metrics or criterion) were also selected.

Data extraction and quality assessment of studies

Three authors (FAFM, PPSP, and KRCA) independently extracted data onto a standardized datasheet. In cases of disagreement, decisions were made by consensus. The data extracted included studies’ features, sample sizes, and prevalence of frailty. In cases that a record compared two prevalence measures from different definitions of frailty, the lower prevalence was
the chosen one in order to be more conservative. We tried to contact all the correspondent authors to gather data to complete the data extraction form for each study.

The quality assessments of the studies were carried out based on a tool described by Munn et al., 2015 [19–20]. This tool includes nine items for critical appraisals of the methodological quality of studies reporting prevalence data. For each criterion met, the study received a “yes”. The total number of “yes” answers was counted per study. The larger the number of “yes”, the lesser the risk of bias in the study. As one of the items presented in the tool inquired about the validity of the methods used to identify the condition, we considered modified versions of the Frailty Phenotype as a valid method in this item.

Data analysis

The main outcome in this review was the prevalence of frailty in older people in LAC with a 95% confidence interval (95% CI).

A meta-analysis of a random-effects model was chosen a priori. We used the metaprop fit command in STATA (version 11.0) to perform the analysis as it incorporates the Freeman-Tukey double arcsine method to stabilize the variance [21–22]. The chi-squared test was applied to measure heterogeneity between studies at the p < 0.10 significance level. We adopted this p-value over the standard p < 0.05 to be more conservative as low power is attributed to the chi-squared test in meta-analyses when a small number of studies or studies of small sample size are considered [23]. The magnitude of inconsistency was measured using I-squared (I²) statistics. High heterogeneity was considered when I² was over 75%, moderate when it was between 25% and 75%, and low when I² was less than 25% [23–26].

To explore potential sources of heterogeneity, sensitivity and subgroup analyses of the prevalence were carried out. Subgroups were divided by sex (men versus women), region (North America versus Central America versus South America), frailty definition (Frailty Phenotype versus Modified Frailty Phenotype versus Edmonton Frailty Scale versus Five physical criteria), and country (Brazil versus other countries). A meta-regression was performed considering p < 0.05 to determine whether possible covariates such as the sample size, mean age, proportion of women, data collection year (represented by the last year of the data collection), and study quality could explain the heterogeneity between studies. Meta-regressions were carried out in each subgroup analysis as well [26]. Potential publication bias (or the small-studies effect) was analyzed using Funnel plots and the Egger’s test [26–28]. We used STATA software (version 11.0) for all the statistical analysis.

Results

Selection process and characteristics of studies

The literature search yielded 6,678 records. After removing duplicates and assessing titles, abstracts, and inclusion criteria, 84 manuscripts were submitted for a complete reading. From these, 21 were included in the review. Two records [29–30] contained information on prevalence from four studies each. Therefore, a total of 29 studies were included in the systematic review. Fig 1 displays details about the selection process and the reasons for the exclusion of records [29–112].

Table 1 displays the characteristics of the studies [29–30, 94–112]. A total of 43,083 participants were included in the review; the majority of the studies were composed of women, and the feminine proportions in the samples ranged from 52.2% [97] to 67.7% [101]. Twenty two studies in this review used modified versions of the Frailty Phenotype to define frailty [29–30, 94–97, 99, 102–104, 108–109, 100–111], four studies used the Frailty Phenotype according to the operationalization used in the CHS [101, 106, 110, 112], two studies used the Edmonton...
Frailty Scale [98, 105], and one used five physical tests to define frailty [107]. Data were stratified by sex in 19 studies [29, 94–95, 97, 99, 101–104, 106–111]. Regarding geographic regions, 20 studies were performed in South America [29–30, 97, 101, 95–96, 98, 100, 102–106, 109–112]; four were performed in Central America [29–30, 107], and five were performed in North America [29–30, 94, 99, 108]. The quality assessment for each study is presented in the S2 Table. All studies seemed to be of good quality, with the number of “yes” answers varying between 7 and 9 with a mean of 8.3. A meta-analysis was performed for all of the 29 included studies. The data extraction form is presented in the S3 Table.

Frailty Prevalence

The prevalence of frailty in Latin America and the Caribbean was 19.6% (95% CI: 15.4–24.3; 29 studies; 43,083 individuals; $I^2 = 99.3\%$, 95% CI: 99.18–99.35) with a range of 7.7% to 42.6% in the studies reviewed (Fig 2). Visual inspection of the funnel plot revealed asymmetry, and the
| Author, publication year | Place | Year of data collection | Study group | Study design | Frailty definition | Sample size (n) | Mean age | Women (%) | Frailty Prevalence (%) | Confidence Interval (CI) |
|--------------------------|-------|-------------------------|-------------|--------------|------------------|----------------|---------|------------|------------------------|--------------------------|
| Aguilar-Navarro et al., 2015 [94] | Mexico | 2001 | Mexican Health and Ageing Study (MHAS) | Baseline of a longitudinal study | Modified version of Frailty Phenotype | 5,644 | 68.7 | 53.6 | 37.2 | NA |
| Alvarado et al., 2008 [29] | Bridgetown, Barbados | 1999–2000 | SABE | Population-based | Modified version of Frailty Phenotype | 1,446 | NA | 61.0 | 26.7 | NA |
| Alvarado et al., 2008 [29] | São Paulo, Brazil | 1999–2000 | SABE | Population-based | Modified version of Frailty Phenotype | 1,879 | NA | 59.0 | 40.6 | NA |
| Alvarado et al., 2008 [29] | Santiago, Chile | 1999–2000 | SABE | Population-based | Modified version of Frailty Phenotype | 1,220 | NA | 65.7 | 42.6 | NA |
| Alvarado et al., 2008 [29] | Havana, Cuba | 1999–2000 | SABE | Population-based | Modified version of Frailty Phenotype | 1,726 | NA | 62.8 | 39.0 | NA |
| Alvarado et al., 2008 [29] | Mexico City, Mexico | 1999–2000 | SABE | Population-based | Modified version of Frailty Phenotype | 1,063 | NA | 56.4 | 39.5 | NA |
| Andrade et al., 2013 [95] | São Paulo, Brazil | 2006 | SABE—São Paulo | Cross-sectional | Modified version of Fried Phenotype | 1,374 | NA | 59.7 | 8.5 | NA |
| Corona et al., 2015 [96] | São Paulo, Brazil | 2010 | SABE—São Paulo | Cross-sectional | Modified version of Fried Phenotype | 1,256 | 70.0 | 60.9 | 8.0 | 6.3–10.2 |
| Curcio et al., 2014 [97] | Four cities in Colombia | 2005 | NA | Survey | Modified version of Frailty Phenotype | 1,878 | 70.9 | 52.2 | 12.2 | 6.8–17.0 |
| Fohn et al., 2013 [98] | Ribeirão Preto, Brazil | 2010–2011 | NA | Cross-sectional | Edmonton Frail Scale | 240 | 73.5 | 62.9 | 39.2 | NA |
| García-Peña et al., 2016 [99] | Mexico | 2012 | Mexican Health and Ageing Study (MHAS) | Cross-sectional | Modified version of Fried Phenotype | 1,108 | 69.8 | 54.6 | 24.9 | NA |
| Jotheeswaran et al., 2015 [30] | Cuba | 2003–2007 | 10/66 Dementia Research Group’s | Population-based | Modified version of Fried Phenotype | 2,813 | 75.2 | 65.0 | 21.0 | NA |
| Jotheeswaran et al., 2015 [30] | Dominican Republic | 2003–2007 | 10/66 Dementia Research Group’s | Population-based | Modified version of Fried Phenotype | 2,011 | 75.4 | 66.3 | 34.6 | NA |
| Jotheeswaran et al., 2015 [30] | Venezuela | 2003–2007 | 10/66 Dementia Research Group’s | Population-based | Modified version of Fried Phenotype | 1,997 | 72.3 | 63.2 | 11.0 | NA |
| Jotheeswaran et al., 2015 [30] | Mexico | 2003–2007 | 10/66 Dementia Research Group’s | Population-based | Modified version of Fried Phenotype | 2,003 | 74.2 | Urban population: 66.5 Rural population: 60.9 | Urban population: 10.1 Rural population: 8.5 | NA | (Continued)
Table 1. (Continued)

| Author, publication year | Place | Year of data collection | Study group | Study design | Frailty definition | Sample size (n) | Mean age | Women (%) | Frailty Prevalence (%) | Confidence Interval (CI) |
|--------------------------|-------|-------------------------|-------------|--------------|-------------------|----------------|---------|-----------|-----------------------|------------------------|
| Jotheeswaran et al., 2015 [30] | Peru | 2003–2007 | 10/66 Dementia Research Group’s | Population-based | Modified version of Frailty Phenotype | 1,933 | 74.5 | Urban population: 64.7 Rural population: 53.2 | Urban population: 25.9 Rural population: 17.2 | NA |
| Junior et al., 2011 [100] | Lafaiete Coutinho, Brazil | 2011 | Nutritional status, risk behaviors and health conditions of the elderly people of Lafaiete Coutinho-BA. | Cross-sectional | Modified version of Frailty Phenotype | 286 | NA | NA | 23.8 | NA |
| Neri et al., 2013 [101] | Belém, Brazil, Parnaíba, Brazil, Campina Grande, Brazil, Poços de Caldas, Brazil, Emelino Matarazzo, Brazil, Campinas, Brazil, Ivoti, Brazil | 2008–2009 | FIBRA NETWORK | Cross-sectional | Fried Phenotype (CHS) | 3,478 | 72.9 | 67.7 | 9.0 | NA |
| Ocampo-Chaparro et al., 2013 [102] | Cali, Colombia | 2009 | NA | Population-based | Modified version of Frailty Phenotype | 314 | NA | NA | 12.7 | NA |
| Pegarori et al., 2014 [103] | Uberaba, Brazil | 2012 | FIBRA NETWORK | Cross-sectional | Modified version of Frailty Phenotype | 958 | 73.8 | 64.4 | 12.8 | 10.87–15.11 |
| Pinedo et al., 2010 [104] | Lima, Peru | NA | NA | Cross-sectional | Modified version of Frailty Phenotype | 246 | 69.9 | 59.8 | 7.7 | NA |
| Ramos et al., 2015 [105] | Montes Claros, Brazil | 2013 | NA | Population-based | Edmonton Frail Scale | 639 | 70.6 | 64.0 | 33.6 | NA |
| Ricci et al., 2014 [106] | Barueri, Brazil, Cuiabá, Brazil | 2009–2010 | FIBRA NETWORK | Population-based | Fried Phenotype (CHS) | 761 | 71.9 | 64.3 | 9.7 | NA |
| Rosero-Bixby et al., 2009 [107] | Costa Rica | 2004–2006 | CRELES | Baseline of a longitudinal study | Five physical tests: grip strength, pulmonary peak flow, standing up from a chair, picking an object up from the floor, and standing and walking 3m | 2,827 | NA | 52.4 | 23.6 | 21.1–26.3 |

(Continued)
Egger’s test findings suggested that publication bias might have been present (p = 0.040). We used the “trim and fill” approach to try to account for non-published results and the prevalence of frailty was 13.1% (95% CI = 8.2–17.9) [113]. Between-study heterogeneity was identified (Chi-square = 3848.02, df = 28, p < 0.001). A meta-regression indicated that the year of data collection partly explained the heterogeneity observed in the prevalence of frailty (p = 0.003; R² = 28.7%). S1, S2, and S3 Figs display the funnel plot, the trim and fill, and meta-regression graphs respectively.

Sensitivity and subgroup analyses

We identified four studies with sample size larger than 2,500 which we considered outliers compared to the sample size of other studies included in this review [30, 94, 101, 107]. We performed a meta-analysis without these studies and the results were similar (Prevalence = 19.4%, CI = 14.8–24.5; I² = 99.1, p < 0.001).

A subgroup analysis revealed high heterogeneity in all analyzed categories, except for the one defining frailty according to the Edmonton Frailty Scale that presented moderate heterogeneity (Table 2). By considering the overlap among the confidence intervals in each subgroup, no differences in prevalence were observed for the population sex and for the country subgroup. However, frailty prevalence was higher in Central than South America, when the Edmonton Scale was used, and when modified versions of Frailty Phenotype were used compared to the traditional version.

Meta-regressions performed in subgroups indicated that not all of the analyzed covariates were significantly possible causes of the high heterogeneity between the studies (p > 0.05). However, the year of data collection partly explained the heterogeneity observed in the subgroups of women (p < 0.001; R² = 62.4%), men (p < 0.05; R² = 43.2%), in the modified version of Frailty Phenotype (p < 0.001; R² = 51.5%), and in the other countries subgroup (p = 0.001; R² = 53.1%). Sample size, mean age, study quality, and the proportion of women were not found to explain the between-sample heterogeneity in any subgroup.

### Table 1. (Continued)

| Author, publication year | Place | Year of data collection | Study group | Study design | Frailty definition | Sample size (n) | Mean age | Women (%) | Frailty Prevalence (%) | Confidence Interval (CI) |
|--------------------------|-------|-------------------------|-------------|-------------|------------------|----------------|---------|-----------|-----------------------|------------------------|
| Ruiz-Arregui et al., 2013 [108] | Coyoacan, Mexico | 2008–2009 | Coyoacán Cohort Study | Baseline of a longitudinal study | Modified version of Frailty Phenotype | 927 | 79.5 | 54.9 | 14.1 | 11.9–16.5 |
| Samper-Tement et al., 2016 [109] | Bogotá, Colombia | 2012 | SABE (Bogotá Study) | Cross-sectional | Modified version of Frailty Phenotype | 1,442 | 70.7 | 61.0 | 9.4 | NA |
| Sousa et al., 2012 [110] | Santa Cruz, Brazil | NA | FIBRA Network | Cross-sectional | Fried Phenotype (CHS) | 391 | 74.0 | 61.4 | 17.1 | NA |
| Tribess et al., 2012 [111] | Uberaba, Brazil | 2010 | Population Study of Physical Activity and Aging (Estudo Populacional de Atividade Física e Envelhecimento) | Cross-sectional | Modified version of Frailty Phenotype | 622 | 71.0 | 65.0 | 19.9 | NA |
| Vieira et al., 2013 [112] | Belo Horizonte, Brazil | 2008–2009 | FIBRA NETWORK | Population-based | Fried Phenotype (CHS) | 601 | 74.3 | 66.2 | 8.7 | NA |

doi:10.1371/journal.pone.0160019.t001
Discussion

In LAC, on average, 19.6% of community-dwelling older people are frail. This prevalence ranges from 7.7% [104] to 42.6% [29] according to the studies selected for this review.

Previous studies

The estimated prevalence of frailty in LAC is different to those observed in studies conducted in more developed regions. In 2012, a systematic review carried out with people aged 65 years
and over in countries in Europe, North America, and Oceania investigated the average prevalence of frailty when using physical and broader definitions of the syndrome. The prevalence of physical frailty was 9.9%, and when broader definitions including psychological and social aspects were considered, the prevalence rose to 13.6% [4]. A cross-sectional analysis performed in 10 European countries revealed that 17% of the individuals aged at least 65 years were frail [5]. In a cohort study of community-dwelling older Japanese aged 65 years and above, the estimated prevalence of frailty was 12.5% [114].

A systematic review conducted with 21 studies from developing countries showed that measures of prevalence varied between 5.4% and 44.0% in community-dwelling older people aged 55 years and over. A summary measure of the prevalence was not estimated by the authors [115]. Another study carried out with people aged 50 years and over showed that lower income countries such as China, Ghana, India, Mexico, Russia Federation, and South Africa had lower levels of frailty compared to higher income countries from Europe [116].

We note that studies assessing frailty use different age cutoffs to classify older people. According to the World Health Organization, a minimum age of 65 years characterizes an older person in developed countries, while in developing countries this cutoff is 60 years and over [18]. Therefore, it is not possible to establish a direct comparison between the above referred prevalence measures and the one estimated in this review. However, in general, one may note a trend of lower prevalence of frailty in developed countries related to the estimated prevalence for LAC in this study.

Differences among frailty prevalence estimates between LAC and developed countries may be due to a number of factors. For instance, lifestyles, health statuses, and demographic and socioeconomic characteristics vary greatly between countries at different stages of development. In LAC, approximately 1 out of 5 older persons is frail. This large proportion of frail older people is likely to increase the demand for health and social services.

Our results showed no differences in prevalence between men and women. However, the literature shows that women are commonly more frail than men [5, 29, 117–120]. Because women live longer and generally have a larger number of comorbidities [121], a greater
prevalence of frailty is expected in the female population. A study conducted in Europe showed that while women have a shorter disability-free life expectancy, men have a shorter life expectancy with frailty [122]. We could not assess the prevalence of frailty by age group in this review because the studies report different age categories and distributions. However, it is well established in the literature that frailty increases with age [29, 119–120] because as people age, they accumulate deficits and become more vulnerable to adverse health outcomes [7].

The prevalence of frailty in Central America was higher than in South America. However, this result should be interpreted with caution given the greater number of studies conducted in South America compared with the smaller number of studies conducted in Central America. The variability of sample size in the studies might have also contributed to an unbalanced comparison between the regions. The 19.6% estimated prevalence of frailty in LAC ranges from 7.7% to 42.6% among the individual studies selected in the review. These prevalence measures are from an array of studies conducted in different cities in LAC and show how varied the prevalence of frailty can be among individual studies in the region.

High levels of heterogeneity were observed between almost all of the prevalence measures in this review. The exception was the subgroup that defined frailty using the Edmonton Frailty Scale that presented non-significant heterogeneity. However, this result should not be automatically interpreted as between-study homogeneity because of the small number of studies in the subgroup—only two [23]. Our results showed that a possible methodological source of the observed heterogeneity was the year of data collection. Between-study heterogeneity may be influenced by the data collection year because more recent investigations provide information about younger cohorts of older persons who might have benefited from better access to healthcare, while people from older cohorts may not have had such access [13].

Limitations and strengths of the study

This review included a number of studies conducted in different cities and different countries; thus, caution is required when interpreting the results. The high level of heterogeneity among the studies may be related to the research designs of the primary studies selected by this review, different sample sizes, health statuses, and cultural, demographic, and socioeconomic differences among the countries investigated [24]. Although these countries are in the same region, they are quite disparate in economic and cultural terms. Consequently, these discrepancies might influence the heterogeneity observed between studies. The unbalanced distribution of studies among the three American regions is another consideration factor when interpreting the results. We could not assess frailty distributions by age due to study differences when reporting the age categories. Publication bias might have been present in this review, although we have tried to understand it using the “trim and fill” approach.

One of the strengths of this review is that an extensive search of studies was carried out in databases and in the grey literature with the aim of diminishing the risk of losing studies (selection bias). Moreover, possible causes of heterogeneity were investigated through meta-regression and sensitivity and subgroup analyses to allow for a better understanding of the high variability between studies. In addition, authors from the selected original studies were contacted for gathering additional data for this review.

Frailty is a topic that requires further investigation. Although the population of older people in LAC is growing fast and need attention, there are not enough investigations regarding the subject in the region. Future studies should detail the prevalence of frailty in each Latin American and Caribbean country as well as in the region as a whole to obtain more precise estimates. Moreover, consensus regarding the use of a unified tool for measuring frailty is needed, as it would allow more comprehensive comparisons to be made between primary studies.
This systematic review analyzed the available literature regarding the prevalence of frailty in people living in an under-researched region. It revealed that roughly one in five community-dwelling older persons is frail in LAC. This is a massive estimate in a region of fragile institutions where the population has been aging rapidly, and it is predicted to continue growing. Results from this study may assist policy makers and the healthcare community in further investigating frailty and its aspects, as frailty was demonstrated to be very common among older people in LAC.

Supporting Information

S1 Fig. Funnel Plot of the prevalence of frailty in LAC. (TIF)

S2 Fig. Trim and fill graph. (TIF)

S3 Fig. Meta-regression of the prevalence of frailty in LAC. (TIF)

S1 Table. Search strategies. (DOCX)

S2 Table. Quality Assessment. (DOCX)

S3 Table. Data extraction form. (DOCX)

Author Contributions

Conceived and designed the experiments: FAFM PPSP KRCA ACMGF MGP MTS.

Performed the experiments: FAFM PPSP KRCA ACMGF.

Analyzed the data: FAFM ACMGF MTS MGP.

Wrote the paper: FAFM.

Critical review for intellectual content: FAFM PPSP KRCA ACMGF MTS MGP.

References

1. Clegg A, Young J, Iliffe S, Rikkert MO, Rockwood K. Frailty in elderly people. Lancet. 2013; 381 (9868):752–62. doi:10.1016/S0140-6736(12)62167-9 PMID: 23395245

2. Fried LP, Ferrucci L, Darer J, Williamson JD, Anderson G. Untangling the concepts of disability, frailty, and comorbidity: implications for improved targeting and care. J Gerontol A Biol Sci Med Sci. 2004; 59(3):255–63. PMID:15031310

3. Fried LP, Tangen CM, 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(3):M146–56. PMID: 11253156

4. Collard RM, Boter H, Schoevers RA, Oude Voshaar RC. Prevalence of frailty in community-dwelling older persons: a systematic review. J Am Geriatr Soc. 2012; 60(8):1487–92. doi:10.1111/j.1532-5415.2012.04054.x PMID: 22881367

5. Santos-Eggimann B, Cuénoud P, Spagnoli J, Junod J. Prevalence of frailty in middle-aged and older community-dwelling Europeans living in 10 countries. J Gerontol A Biol Sci Med Sci. 2009; 64(6):675–81. doi:10.1093/gerona/glq012 PMID: 19276189

6. Lally F, Crome P. Understanding frailty. Postgrad Med J. 2007; 83(975):16–20. PMID: 17267673
7. Bergman H, Ferrucci L, Guralnik J, Hogan DB, Hummel S, Karunanathan S, et al. Frailty: an emerging research and clinical paradigm—issues and controversies. J Gerontol A Biol Sci Med Sci. 2007; 62(7):731–7. PMID: 17634320

8. Gobbens RJ, van Assen MA, Luijjkx KG, Wijnen-Sponselee MT, Schols JM. The Tilburg Frailty Indicator: psychometric properties. J Am Med Dir Assoc. 2010; 11(5):344–55. doi: 10.1016/j.jamda.2009.11.003 PMID: 20511102

9. Mitnitski AB, Mogilner AJ, Rockwood K. Accumulation of deficits as a proxy measure of aging. ScientificWorldJournal. 2001; 1:323–36. PMID:12806071

10. Theou O, Cann L, Blodgett J, Wallace LM, Brothers TD, Rockwood K. Modifications to the frailty phenotype criteria: Systematic review of the current literature and investigation of 262 frailty phenotypes in the Survey of Health, Ageing, and Retirement in Europe. Ageing Res Rev. 2015; 21:78–94. doi: 10.1016/j.arr.2015.04.001 PMID: 25846451

11. Roppolo M, Mulasso A, Gobbens RJ, Mosso CO, Rabaglietti E. A comparison between uni- and multi-dimensional frailty measures: prevalence, functional status, and relationships with disability. Clin Interv Aging. 2015; 10:1669–78. doi:10.2147/CIA.S92328 PMID: 26543356

12. Cesari M, Prince M, Thiyagarajan JA, De Carvalho IA, Bernabei R, Chan P, et al. Frailty: An Emerging Public Health Priority. J Am Med Dir Assoc. 2016; 17(3):188–92. doi: 10.1016/j.jamda.2015.12.016 PMID: 26805753

13. Palloni A, Mceniry M, Wong R, Pelaez M. The Elderly in Latin America and the Caribbean. Revista Galega de Economía. 2005; 14:1–33.

14. Palloni A, Pinto-Aguiarre G, Peláez M. Demographic and health conditions of ageing in Latin America and the Caribbean. International Journal of Epidemiology. 2002; 31(4):762–71. PMID: 12177016

15. Runzer-Colmenares FM, Samper-Ternet R, Al Shih S, Ottenbacher KJ, Parodi JF, Wong R. Prevalence and factors associated with frailty among Peruvian older adults. Arch Gerontol Geriatr. 2014; 58(1):69–73. doi: 10.1016/j.archger.2013.07.005 PMID: 23978328

16. Guerra M, Prina AM, Ferri CP, Acosta D, Gallardo S, Huang Y, et al. A comparative cross-cultural study of the prevalence of late life depression in low and middle income countries. J Affect Disord. 2016; 190:362–8. doi: 10.1016/j.jad.2015.09.004 PMID: 26546420

17. Prina AM, Acosta D, Acostas I, Guerra M, Huang Y, Jotheeswaran AT, et al. Cohort Profile: The 10/66 study. Int J Epidemiol. 2016.

18. World Health Organization. Age-friendly primary health care centres toolkit.: WHO; 2008. Available: http://www.who.int/ageing/publications/Age-Friendly-PHC-Centre-toolkitDec08.pdf.

19. Munn Z, Moola S, Lisy K, Riitano D, Tufanaru C. Methodological guidance for systematic reviews of observational epidemiological studies reporting prevalence and cumulative incidence data. Int J Evid Based Healthc. 2015; 13(3):123–8. doi:10.15171/ijhpm.2014.71 PMID: 25197676

20. Nyaga VN, Arbyn M, Aerts M. Metaprop: a Stata command to perform meta-analysis of binomial data. Arch Public Health. 2014; 72(1):39. doi: 10.1186/2049-3258-72-39 PMID: 25810908

21. Barendregt SAD, Lee YY, Norman RE, Vos T. Meta-analysis of prevalence. J Epidemiol Community Health 2013.

22. Higgins JP, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. BMJ. 2003; 327(7414):557–60. PMID: 12959120

23. Brasil. Diretrizes Metodológicas: Elaboração de revisão sistemática e metanálise de estudos observacionais comparativos sobre fatores de risco e prognóstico. Brasília: Ministério da Saúde; 2014.

24. Rodrigues CL, Ziegelmann PK. Metanálise: Um Guia Prático. Rev HCPA. 2010; 33(3):123–8. doi: 10.15171/ijhpm.2014.71 PMID: 25197676

25. Sterne JA, Egger M, Davey Smith G, Schneider M. Bias in meta-analysis detected by a simple, graphical test. BMJ. 1997; 315(7109):629–34. PMID: 9310563

26. Sterne JA, Egger M, Davey Smith G, Schneider M. Bias in meta-analysis detected by a simple, graphical test. BMJ. 1997; 315(7109):629–34. PMID: 9310563

27. Egger M, Davey Smith G, Schneider M, Minder C. Bias in meta-analysis detected by a simple, graphical test. BMJ. 1997; 315(7109):629–34. PMID: 9310563

28. Sterne JA, Egger M, Davey Smith G, Schneider M. Bias in meta-analysis detected by a simple, graphical test. BMJ. 1997; 315(7109):629–34. PMID: 9310563

29. Alvarado BE, Zunzunegui MV, Béland F, Barnvita JM. Life course social and health conditions linked to frailty in Latin American older men and women. J Gerontol A Biol Sci Med Sci. 2008; 63(12):1399–406. PMID: 19126855
30. At J, Bryce R, Prina M, Acosta D, Ferri CP, Guerra M, et al. Frailty and the prediction of dependence and mortality in low- and middle-income countries: a 10/66 population-based cohort study. BMC Med. 2015; 13:138. doi: 10.1186/s12916-015-0378-4 PMID: 26063168

31. Bollwein J, Diekmann R, Kaiser MJ. Mon does the mere risk of malnutrition increase the risk of frailty and an impaired physical performance in community-dwelling older adults? Clinical Nutrition 2011; 6 (1):128–9.

32. Calado LB, Melo MP, Ferriolli E, Moriguti JC, Nereida KC. Blood pressure and the frailty syndrome. The Journal of Clinical Hypertension. 2013; 15.

33. Duarte MCS, Fernandes MGM, Rodrigues PRA, Nóbrega MML. Prevalence and sociodemographic factors associated with frailty in elderly women. Rev bras enferm. 2013; 66(6).

34. Ferrer A, Badia T, Formiga F, Sanz H, Megido MJ, Pujol R, et al. Frailty in the oldest old: prevalence and associated factors. J Am Geriatr Soc. 2013; 61(2):294–6. doi: 10.1111/jgs.12154 PMID: 23405926

35. Galbán PA, Soberats FJS, Navarro AMD, García MC. Diagnosis of frailty in urban community-dwelling older adults. Rev Cubana Salud Pública. 2009; 35(2).

36. Díaz de León González E, Gutiérrez Hermosillo H, Martinez Beltran JA, Chavez JH, Palacios Corona R, Salinas Garza DP, et al. Validation of the FRAIL scale in Mexican elderly: results from the Mexican Health and Aging Study. Aging Clin Exp Res. 2015.

37. Ilhan B, Bahat Ozturk G, Kilic C, Tufan A, Aykin S, Muratli S, et al. Frequency of frailty syndrome in elders older than 75 years of age according to the frail criteria. European Geriatric Medicine. 2014; 5 (1):126–7.

38. Moreira VG, Lourenço RA. Prevalence and factors associated with frailty in an older population from the city of Rio de Janeiro, Brazil: the FIBRA-RJ Study. Clinics (Sao Paulo). 2013; 68(7):979–85.

39. Roppolo M, Mulasso A, Gobbens RJ, Mosso CO, Rabaglietti E. A comparison between uni- and multi-dimensional frailty measures: prevalence, functional status, and relationships with disability. Clin Interv Aging. 2015; 10:1669–78. doi: 10.2147/CIA.S92328 PMID: 26543356

40. Rosero-Bixby L. The exceptionally high life expectancy of Costa Rican nonagenarians. Demography. 2008; 45(3):673–91. PMID: 18939667

41. Sánchez-García S, Sánchez-Arenas R, García-Peña C, Rosas-Carrasco O, Avila-Funes JA, Ruiz-Aregui L, et al. Frailty among community-dwelling elderly Mexican people: prevalence and association with sociodemographic characteristics, health state and the use of health services. Geriatr Gerontol Int. 2014; 14(2):395–402. doi: 10.1111/ggi.12114 PMID: 23809887

42. Sansó ea. polypharmacy: The most prevalent frailty criteria in the elderly. VaccıMonitor. 2010; 19.

43. Sternberg EA. Osteoporosis and frailty. Osteoporos Int. 2011;

44. Valdiglesias V, Bonassi S, Dell’Armi V, Settanni S, Celi M, Mastropaolo S, et al. Micronucleus frequency in peripheral blood lymphocytes and frailty status in elderly. A lack of association with clinical features. Mutat Res. 2015; 780:47–54. doi: 10.1016/j.mrfmmm.2015.07.010 PMID: 26292172

45. Valcárcel EA. Association between elderly frailty and consumption of a varied diet. Correo Científico Médico De Holguín. 2014.

46. St John PD, Tyas SL, Montgomery PR. Life satisfaction and frailty in community-based older adults: cross-sectional and prospective analyses. Int Psychogeriatr. 2013; 25(10):1709–16. doi: 10.1017/S1041610213000902 PMID: 23830492

47. Simone PM, Haas AL. Frailty, Leisure Activity and Functional Status in Older Adults: Relationship With Subjective Well Being. Clinical Gerontologist 2013; 36(4).

48. Amaral FLJS, Guerra RO, Nascimento AFF, Maciel ACC. Social support and the frailty syndrome among elderly residents in the community.

49. Theou O, Mititski AB, Rockwood K. Prevalence of frailty across countries: is it related to national economic status?. The Gerontological Society of America. 2012.

50. Erusalimsky JD, Grilli J, Grune T, Jansen-Duerr P, Lippi G, Sinclair AJ, et al. In Search of ‘Omics’-Based Biomarkers to Predict Risk of Frailty and Its Consequences in Older Individuals: The FRAILOMIC Initiative. Gerontology. 2016; 62(2):182–90. doi: 10.1159/000435853 PMID: 26227153

51. Kulmala J, Nykänen I, Hartikainen S. Frailty as a predictor of all-cause mortality in older men and women. Geriatr Gerontol Int. 2014; 14(4):899–905. doi: 10.1111/ggi.12190 PMID: 24666801

52. Jürschik P, Botigüe T, Nuin C, Lavedán A. Association between Mini Nutritional Assessment and the Fried frailty index in older people living in the community. Med Clin (Barc). 2014; 143(5):191–5.

53. Ramos CGEL. Frailty and risk associations in older adults from an urban community. Revista Cubana de Medicina Militar. 2013; 42(3).
54. Garre-Olmo J, Calvó-Perxas L, López-Pousa S, de Gracia Blanco M, Vilalta-Franch J. Prevalence of frailty phenotypes and risk of mortality in a community-dwelling elderly cohort. Age Ageing. 2013; 42 (1):46–51. doi: 10.1093/ageing/afs047 PMID: 22454134

55. Barbosa EA. Avaliação dos fatores de risco cardiovasculares com ênfase na pressão arterial, na síndrome da fragilidade em idosos. 2013.

56. Salmito M. Associação entre equilíbrio, marcha e síndrome da fragilidade em idosos residentes em área urbana. 2012.

57. Maia FdOM. Vulnerabilidade e envelhecimento: panorama dos idosos residentes no município de São Paulo—Estudo SABE. 2015.

58. Carvalho EMS. Associação entre postura corporal e fragilidade em idosos residentes em área urbana. 2012.

59. Pegorari MS, Ruas G, Patrizzi LJ. Relationship between frailty and respiratory function in the community-dwelling elderly. Braz J Phys Ther. 2013; 17(1):9–16. PMID:23538454

60. Quevedo-Tejero EDC, Zavala-González MA, Alonso-Benites JR. Síndrome de fragilidad en adultos mayores no institucionalizados de Emiliano Zapata, Tabasco, México. Univ Méd Bogotá (Colombia). 2011; 52(3):255–68.

61. Santiago LM. Fragilidade em idosos no Brasil: identificação e análise de um instrumento de avaliação para ser utilizado na população do país 2013.

62. Wong YY, Almeida OP, McCaul KA, Yeap BB, Hankey GJ, Flicker L. Homocysteine, frailty, and all-cause mortality in older men: the health in men study. J Gerontol A Biol Sci Med Sci. 2013; 68(5):590–8. doi: 10.1093/gerona/gls211 PMID: 23070880

63. Alexandre TaS, Corona LP, Nunes DP, Santos JL, Duarte YA, Lebrão ML. Similarities among factors associated with components of frailty in elderly: SABE Study. J Aging Health. 2014; 26(3):441–57. doi: 10.1177/0898264313519818 PMID: 24509067

64. Llibre JeJ, López AM, Valhuerdi A, Guerra M, Llibre-Guerra JJ, Sánchez YY, et al. Frailty, dependency and mortality predictors in a cohort of Cuban older adults, 2003–2011. MEDICC Rev. 2014; 16 (1):24–30. PMID: 24487672

65. Manrique-Espinoza bS-R, Snyder A, Moreno-Tamayo NS, Gutiérrez-Robledo LM, Avila-Funes J.A. Frailty and Social Vulnerability in Mexican Deprived and Rural Settings. Journal of aging and Health. 2015.

66. Aguilar-Navarro S, Gutiérrez-Robledo LM, García-Lara JM, Payette H, Amieva H, Ávila-Funes JA, et al. The phenotype of frailty predicts disability and mortality among Mexican community-dwelling elderly. J Frailty Aging. 2012; 1.

67. DA Silva Coqueiro R, DE Queiroz BM, Oliveira DS, Das Mercês MC, Carneiro JA, Pereira R, et al. Cross-sectional relationships between sedentary behavior and frailty in older adults. J Sports Med Phys Fitness. 2016.

68. Papiol M, Serra-Prat M, Vico J, Jerez N, Salvador N, García M, et al. Poor Muscle Strength and Low Physical Activity are the Most Prevalent Frailty Components in Community-Dwelling Older Adults. J Aging Phys Act. 2015.

69. Lanzotti Azevedo da Silva S, Campos Cavalcanti Maciel Á, de Sousa Máximo Pereira L, Domínguez Dias JM, Guimarães de Assis M, Corrêa Dias R. Transition Patterns of Frailty Syndrome in Community-Dwelling Elderly Individuals: A Longitudinal Study. J Frailty Aging. 2015; 4(2):50–5. doi: 10.14283/jfa.2015.43 PMID: 27032045

70. Avila-Funes JA, Medina-Campos RH, Tamez-Rivera O, Navarrete-Reyes AP, Amieva H, Aguilar-Navarro S. Frailty Is Associated with Disability and Recent Hospitalization in Community-Dwelling Elderly: The Coyoacan Cohort. J Frailty Aging. 2014; 3(4):206–10. doi: 10.14283/jfa.2014.25 PMID: 27048658

71. Avila-Funes JA, Paniagua-Santos DL, Escobar-Rivera V, Navarrete-Reyes AP, Aguilar-Navarro S, Amieva H. Association between employee benefits and frailty in community-dwelling older adults. Geriatr Gerontol Int. 2016; 16(5):606–11. doi: 10.1111/jgi.12523 PMID: 26017498

72. Fattori A, Santimaria MR, Alves RM, Guariento ME, Neri AL. Influence of blood pressure profile on frailty phenotype in community-dwelling elders in Brazil—FIBRA study. Arch Gerontol Geriatr. 2013; 56(2):343–9. doi: 10.1016/j.archger.2012.08.004 PMID: 22939428

73. González-Pichardo AM, Navarrete-Reyes AP, Adame-Encarnación H, Aguilar-Navarro S, García-Lara JM, Amieva H, et al. Association between Self-Reported Health Status and Frailty in Community-Dwelling Elderly. J Frailty Aging. 2014; 3(2):104–8. doi: 10.14283/jfa.2014.9 PMID: 27049902

74. Macuco CR, Batistoni SS, Lopes A, Cachioni M, da Silva Falcão DV, Neri AL, et al. Mini-Mental State Examination performance in frail, pre-frail, and non-frail community dwelling older adults in Ermelino
75. Pérez-Suárez TG, Gutiérrez-Robledo LM, Alberto J, Acosta JL, Escamilla-Tich M, Ramón J, et al. VNTR polymorphisms of the IL-4 abd IL-1RN genes and their relationship with frailty syndrome in Mexican community-dwelling elderly. Aging Clin Exp Res. 2015.

76. Sánchez-García EA. Frailty in Mexican community-dwelling elderly. 2011.

77. Silva JC, Moraes ZY, Silva C, Mazon SeB, Guariento ME, Neri AL, et al. Understanding red blood cell parameters in the context of the frailty phenotype: interpretations of the FIBRA (Frailty in Brazilian Seniors) study. Arch Gerontol Geriatr. 2014; 59(3):636–41. doi: 10.1016/j.archger.2014.07.014 PMID: 25236441

78. Silva DD, Held RB, Torres SV, Sousa MaL, Neri AL, Antunes JL. Self-perceived oral health and associated factors among the elderly in Campinas, Southeastern Brazil, 2008–2009. Rev Saude Publica. 2011; 45(6):1145–53. PMID:21953025

79. Fohn EA. Frailty syndrome related to disability in the elderly. Acta paulista de enfermagem. 2012; 25.

80. Santos AA, Ceolim MF, Pavarini SCI, Neri AL, Rampazo MK. Associação entre transtornos do sono e níveis de fragilidade entre idosos. Acta paula enferm. 2014; 27(2).

81. Nunes D. Validação da avaliação subjetiva de fragilidade em idosos no município de São Paulo: Estudo Sabe (Saúde, bem estar e envelhecimento). 2011.

82. Arroyo N. Fatores associados a desempenho funcional autorrelatado: dados do projeto FIBRA—POLÔ UNICAMP. 2012.

83. Amparo M. Estado nutricional, adiposidade abdominal e síndrome da fragilidade em idosos da comunidade: Dados do estudo FIBRA—PÔLO UNICAMP. 2012.

84. Ebert N. Doenças crônicas, fragilidade e características emocionais de idosos comunitários: Estudo FIBRA IVOTI/RS. 2012.

85. Montes JFG, Borrero CLC, Henao GM. Frailty among Mexican community-dwelling elderly: a story told 11 years later. The Mexican Health and Aging Study. Salud Publica Mex. 2015; 57 Suppl 1:S62–9. PMID: 26172236

86. Corona LP, Andrade FCD, Duarte YAO, Lebrao ML. The relationship between oral health and frailty in community-dwelling elderly individuals in Brazil. J Am Geriatr Soc. 2013; 61(5):809–14. doi: 10.1111/jgs.12221 PMID: 23647172

87. Curcio CL, Henao GM, Gomez F. Frailty among rural elderly adults. BMC Geriatr. 2014; 14:2. doi: 10.1186/1471-2318-14-2 PMID: 24405584

88. Fohn EA. Frailty syndrome related to disability in the elderly. Acta paulista de enfermagem. 2012; 25.
99. García-Peña C, Ávila-Funes JA, Dent E, Gutiérrez-Robledo L, Pérez-Zepeda M. Frailty prevalence and associated factors in the Mexican health and aging study: A comparison of the frailty index and the phenotype. Exp Gerontol. 2016; 79:55–60. doi: 10.1016/j.exger.2016.03.016 PMID: 27032304

100. Reis Júnior WMR, Carneiro JAO, Coqueiro RS, Santos KT, Fernandes MH. Pre-frailty and frailty of elderly residents in a municipality with a low Human Development Index. Rev Latino-Am Enfermagem 2014; 22(4).

101. Neri AL, Yassuda MS, Araújo LF, Eulálio MoC, Cabral BE, Siqueira ME, et al. [Methodology and social and demographic, cognitive, and frailty profiles of community-dwelling elderly from seven Brazilian cities: the FIBRA Study], Cad Saude Publica. 2013; 29(4):778–92. PMID: 23568307

102. Ocampo-Chaparro JM, Zapata-Ossa HeJ, Cubides-Munévar AM, Curcio CL, Villegas JeD, Reyes-Ortiz CA. Prevalence of poor self-rated health and associated risk factors among older adults in Cali, Colombia. Colomb Med (Cal). 2013; 44(4):224–31.

103. Pegorari MS, Tavares DMS. Factors associated with the frailty syndrome in elderly individuals living in the urban area. Rev Latino-Am Enfermagem 2014; 22(5).

104. Pinedo LV, Saavedra PJO, Jimeno HC. Velocidad de la marcha como indicador de fragilidad en adultos mayores de la comunidad en Lima, Perú. Revista Española de Geriatría y Gerontología. 2010; 45(1):22–5.

105. Ramos GCF, Carneiro JA, Barbosa ATF, Mendonça JMG, Caldeira AP. Prevalence of depressive symptoms and associated factors among elderly in northern Minas Gerais: a population-based study. Jornal Brasileiro de Psiquiatria. 2015; 64(2).

106. Ricci NA, Pessoa GS, Ferriolli E, Dias RC, Perracini MR. Frailty and cardiovascular risk in community-dwelling elderly: a population-based study. Clin Interv Aging. 2014; 9:1677–85. doi: 10.2147/CIA.S68642 PMID: 25336932

107. Rosero-Bixby L, Dow WH. Surprising SES Gradients in mortality, health, and biomarkers in a Latin American population of adults. J Gerontol B Psychol Sci Soc Sci. 2009; 64(1):105–17. doi: 10.1093/geronb/gbn004 PMID: 19196695

108. Ruiz-Arregui L, Ávila-Funes JA, Amieva H, Borges-Yañez SA, Villa-Romero A, Aguilar-Navarro S, et al. The Coyoacán cohort study: design, methodology and participant characteristics of a Mexican study on nutritional and psychosocial markers of frailty. 2013:1–29.

109. Samper-Terent R, Reyes-Ortiz C, Ottenhancher KJ, Cano AC. Frailty and sarcopenia in Bogotá: results from the SABE Bogotá Study. Aging Clin Exp Res. 2015.

110. Sousa AC, Dias RC, Maciel Á, Guerra RO. Frailty syndrome and associated factors in community-dwelling elderly in Northeast Brazil. Arch Gerontol Geriatr. 2012; 54(2):e95–e101. doi: 10.1016/j.archger.2011.08.010 PMID: 21930311

111. Tríbeas S, Júnior JSV, Oliveira RJ. Atividade física como preditor da ausência de fragilidade em idosos. Rev Assoc Med Bras. 2012; 58(3):341–7. PMID: 22735227

112. Vieira RA, Guerra RO, Giacomini KC, Vasconcelos KSS, Andrade ACS, Pereira LCM, et al. Prevalence of frailty and associated factors in community-dwelling elderly in Belo Horizonte, Minas Gerais State, Brazil: data from the FIBRA study Cad Saude Pública. 2013; 48(1):22426304

113. Yamada M, Arai H. Predictive Value of Frailty Scores for Healthy Life Expectancy in Community-Dwelling Older Japanese Adults. J Am Med Dir Assoc. 2015; 16(11):1002.e7–11.

114. Puts MT, Lips P, Deeg DJ. Sex differences in the risk of frailty for mortality independent of disability and chronic diseases. J Am Geriatr Soc. 2005; 53(1):40–7. PMID: 15667374

115. Mihatsch 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(10): e75847. doi: 10.1371/journal.pone.0075847 PMID: 24204581

116. Rockwood K, Song X, MacKnight C, Bergman H, Hogan DB, McDowell I, et al. A global clinical measure of fitness and frailty in elderly people. CMAJ. 2005; 173(5):489–95. PMID: 16129869

117. Shamliyan T, Talley KM, Ramakrishnan R, Kane RL. Association of frailty with survival: a systematic literature review. Ageing Res Rev. 2013; 12(2):719–36. doi: 10.1016/j.arr.2012.03.001 PMID: 22426304
121. Hubbard RE, Rockwood K. Frailty in older women. Maturitas. 2011; 69(3):203–7. doi: 10.1016/j.maturitas.2011.04.006 PMID: 21570783

122. Romero-Ortuno R, Fouweather T, Jagger C. Cross-national disparities in sex differences in life expectancy with and without frailty. Age Ageing. 2014; 43(2):222–8. doi: 10.1093/ageing/aft115 PMID: 23917483