A comparison between physical and biopsychosocial measures of frailty : prevalence and associated factors in Brazilian older adults

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1. Introduction

Frailty is an important issue in the discussions about aging due to its impact on the health of older adults, since it is recognized as a predictor of health adverse outcomes such as falls, hospitalization, increased use of health services, functional dependency and death (Fried et al., 2001; Gobbens & Van Assen, 2012; Gobbens et al., 2012; Santiago et al., 2018). In recent years, experts have been striving to reach consensus on the best operational definition of this condition and thus identify the appropriate way to diagnose it.

In 2013, the "Frailty Operative Definition- Consensus Conference Project" was held, with the participation of selected experts in different fields of knowledge (geriatricians, non-geriatrician physicians, other health professionals, basic scientists, social and non-governmental workers) and localities (Europe, Canada, USA and Mexico). Although the conference failed to define an operationalization of frailty that was satisfactory for all participating experts, there was consensus on the need to consider the clinical contexts and to establish a clear conceptual framework. In addition, there was still great agreement on some aspects related to the condition: considered a clinical syndrome; different from disability; raises vulnerability to stressors; can be reversed or attenuated when performing interventions; early diagnosisis essential and; useful in primary health care (Rodríguez-Mañas et al., 2013).

Currently, two distinct conceptual approaches are considered for the evaluation of frailty: the unidimensional or physical frailty; and the multidimensional or biopsychosocial, which also aggregates psychological and social, besides physical characteristics. From these approaches, numerous assessment instruments have emerged. According to Morley and colleagues (2013), some instruments are well validated, having been tested in cohorts of different locations, as to their validity of content, construct and criterion. Among the instruments that meet the validation criteria, we have the Cardiovascular Health Study index (CHS index), created by Fried et al. (2001) with a physical approach, and the Tilburg Frailty Indicator (TFI), created by Gobbens et al. (2010a) which evaluates the physical, psychological and social domains (Morley et al., 2013).

It is recognized that the prevalence of frailty is distinct when considering the two types of conceptualization. There are studies that compare physical and

biopsychosocial concepts and their differences, as well as the applicability of the instruments based on the two approaches, on populations of older people around the world (Rockwood, Andrew & Mitnitski, 2007; Hoogendijk et al., 2013; Theou et al., 2013; Jung et al., 2014; Blodgett et al., 2015; Li et al., 2015; Roppolo et al., 2015; Coelho et al., 2015; Harmand et al., 2017). Few of these publications specifically compared the CHS index and the TFI, none of them in the context of a country with characteristics like those of Brazil.

Using secondary data from the Survey of Health, Aging, and Retirement in Europe (SHARE), which includes individuals aged 50 years and over (mean age= 65.3 years SD=10.5), from eleven European countries, a study was conducted to compare eight scales of frailty and their content validity, feasibility, prevalence, and ability to predict all-cause mortality. In this study, versions of the CHS index (CHS score ≥ 3 points) and the TFI (TFI score ≥ 5 points) were included to assess frailty, observing prevalence equal to 11.3% and 29.2% of frail people, respectively. Agreement between these scales, examined using the Cohen kappa statistic, was 0.37 (Theou et al., 2013). In the study of Roppolo et al. (2015), which compared the frequency of frailty and analyzed the differences in the functional status of 267 community-dwelling older Italian (mean age 73.4 years, SD = 6.0 years), the researchers identified a prevalence of frail people of 12.7% by CHS index (score ≥ 3 points), and 44.6% by TFI (score ≥ 5 points) (Roppolo et al., 2015). In the study performed to validate the Portuguese version of the TFI, the authors compared their version of the TFI with the CHS index and the Groningen Frailty Indicator (GFI) to examine the criterion validity of the instrument, in a sample of 252 Portuguese community-dwelling 65 years and over. The prevalence of frailty evaluated with the CHS index was 36.5%, equal to 48.4% for the GFI (score ≥ 5 points) and 54.8% for the TFI (score ≥ 6 points) (Coelho et al., 2015). In the French study with 1278 participants of the Three-City study, a prospective population-based study, to compare the predictive value of three different frailty instruments (CHS index, Rockwood's Frailty Index and TFI) for adverse outcomes, the researchers observed a prevalence of frailty of 46.5% (N= 594) by CHS index (including scores ≥ 3 points= frail and ≥ 2 points= pre-frail), and 23.7% (N= 303) by TFI (score ≥ 5 points) (Hardman et al., 2017).

To the best of our knowledge, there is no study using community-dwelling Brazilian older adults for comparing two different frailty instruments, based on two

quite different approaches of frailty (biopsychosocial, physical). This study aims to estimate the prevalence of frailty, according to the instruments TFI and CHS index, to investigate the correlation between both instruments, and to identify the factors associated with this condition in older Brazilians users of primary health care.

2. Methods

2.1. Study population and data collection

This cross-sectional study is a subproject of the study "Diagnosis of frailty in the elderly in primary health care: comparison between two proposals". The Research Ethics Committee of the National School of Public Health/Oswaldo Cruz Foundation approved the study (authorization number 46244815.5.0000.5240/2015).

Individuals aged 60 years or more, enrolled in the Family Health Program of two Family Clinics of Rio de Janeiro/ Brazil were eligible for the study (about 3129 old people registered). Research assistants, duly trained to standardize the procedures, carried out 302 interviews in the households of participants. Considering the logistical difficulties (such as outdated addresses, locations that are unsafe to visit) to access the elderly and the short time and low funding resource, a convenience sample was made. All the participants signed the informed consent form.

2.2. Measures

The background characteristics of the participants included sociodemographic variables, self-reported health, lifestyle, housing environment, and life events.

Sociodemographic variables of interest were: age, sex, education, marital status, household situation, and family income (see Table 1 for the answering categories). Self-reported health was assessed with the question “How do you evaluate your health?” Self-reported lifestyle was assessed by asking “Overall, how healthy would you say your lifestyle is?”. In addition, we examined the following self-reported lifestyle factors; smoking, by asking “Do you have a habit of smoking?”; alcohol consumption, by asking “Do you drink alcohol regularly?”; and physical activity, by asking “In the last 12 months, have you been doing physical activity regularly?”. Housing environment was examined with the question “Are you satisfied with your home living environment?”.

Chronic diseases of interest were arterial hypertension, diabetes mellitus, high cholesterol or triglycerides, osteoarticular diseases (arthritis, rheumatism or arthrosis), heart disease (angina or infarction), stroke or ischemia, respiratory diseases (asthma, bronchitis or emphysema), and cancer (except skin). Data on chronic diseases was self-reported.

Two instruments evaluated functional dependence. For measuring functional dependence in Activities of Daily Living (ADL) and in Instrumental Activities of Daily Living (IADL) we used the Katz scale (Katz et al., 1970) and the Lawton scale (Lawton et al., 1982), respectively. Both scales are validated for the Brazilian population (Lino et al., 2008; Santos & Virtuoso Júnior, 2008). For each scale, we considered the individuals who reported inability or need for help to perform one or more of these activities as functional dependents.

2.2.1. Frailty

Frailty was assessed with the Brazilian version of the Tilburg Frailty Indicator (TFI) (Santiago et al., 2012; 2013) and the Cardiovascular Health Study index (CHS index) (Fried et al., 2001).

The TFI consists of fifteen self-referred questions, distributed in the physical (eight), psychological (four) and social (three) domains. Eleven of the questions that make up the TFI are answered with yes or no and the other questions are answered with yes, sometimes or no; its result is a score ranging from zero to 15 points. Higher scores mean a higher level of frailty or, alternatively, scores ≥ 5 points indicate the presence of the condition (Gobbens et al., 2010a). Previous research suggests that the TFI is a valid and reliable instrument for measuring of frailty (Gobbens et al., 2010b; 2012; Santiago et al., 2013; 2018; Sutton et al., 2016). In the present study the reliability (Cronbach's alpha) of the TFI was 0.74.

The CHS index consists of five measures of physical frailty. In the present study, the variables Shrinking (self-reported unintentional loss of 4.5 kg in the last year), Weakness (evaluated by grip strength test, adjusted for gender, with cut-off points determined by the percentile 20 of the distribution, using the electronic hand dynamometer E-Clear, model EH101) and Poor endurance and energy (self-reported exhaustion, identified by two questions from the Center for Epidemiologic Studies Depression Scale (CES-D scale), "moderate time" or "most of the time" response to "I felt that everything I did was effortless" or "I could not continue") were measured as proposed by Fried et al. (2001). Due to operational issues, the adaptations of the

Salud, Bienestar y Envejecimiento (SABE) group, which included Brazilian elderly in their study, were chosen for the evaluation of the variables Slowness (considered self-reported difficulties in walking 100 meters and/or climbing a set of stairs) and Low physical activity level (negative answer to the question "Have you exercised regularly or participated in vigorous physical activities such as sports, dance or heavy housework three or more times a week in the past 12 months?") (Alvarado et al., 2008). Older adults with a score of 3 or more points were considered frail. The CHS index is considered a valid instrument in its ability to predict adverse health outcomes, being widely tested (Fried et al., 2001; Ensrud et al., 2009; Theou et al., 2013; Chang & Lin, 2015). In this study, the internal consistence (Cronbach's alpha) was used to test the reliability. The coefficient for the CHS index was 0.45.

2.3. Data analysis

First, descriptive analysis of the distribution of the variables was conducted using measures of central tendency and dispersion for continuous variables, and frequency distributions for categorical variables.

Correlations between the CHS index and the TFI total and its domains (physical, psychological and social) were investigated with Pearson's correlation coefficient, considering a significance level ≤ 0.05.

For each instrument, using the categorical criterion of classification of frailty, prevalence ratios (PR) were calculated to assess associations between frailty and the independent variables (background characteristics, adverse health outcomes). Multivariate analysis was performed using Poisson regression, to a ≤ 0.05 level of statistical significance. All variables that presented statistical significance in the bivariate analysis were tested in the multivariate model, and those that remained with significance were maintained.

Statistical analyses were performed using the statistical software STATA, version 10.0 (StataCorp LP).

3. Results

The mean age of the participants was 70.4 years (median 68.0, SD = 7.6), most females (65.9%), with low schooling (72.8%), and approximately 50.0% were married or living with a partner.

The mean score of the study population by the CHS index was 1.7 points (median 1.0, SD= 1.1) and by the TFI was 3.9 points (median 3.0, SD= 2.0). Considering the domains of the TFI, the mean score of the TFI physical was 1.8 points (median 1.0, SD= 2.0), of the TFI psychological was 0.9 points (median 1.0, SD= 0.7) and of the TFI social was 1.2 points (median 1.0, SD= 1.0). Most individuals (N= 181) were not classified as frail by either instrument, when we considered the scores ≥ 5 points for the TFI and ≥ 3 points for the CHS index. Using this criterion, the prevalence of frailty estimated by the TFI was 35.8% (N= 108) and by the CHS was equal to 23.5% (N= 71), while 19.2% (N= 58) were considered frail by both instruments (Diagram 1).

In Table 1, we can observe the significant correlations between the two frailty instruments (r= 0.675, p <0.001) and between the CHS index and the physical (r= 0.744, p <0.001) and psychological domains (r= 0.322, p <0.001) of the TFI. There was no significant correlation between the CHS index and social frailty.

Table 2 shows the distribution of the variables by frailty condition, according to the TFI classification. In the bivariate analysis (column 4), it is possible to observe numerous factors associated to frailty. These factors were sex, age group, marital status, healthy lifestyle, satisfaction of housing environment, self-rated health, and all self-reported chronic diseases(except cancer), medication use, and functional dependence in ADL and IADL. However, in the multivariate model (column 5), only the variables sex (PR= 1.45 CI 95% 1.02-2.04), age group (PR= 1.19 CI 95% 1.02-1.40), healthy lifestyle (PR= 2.01 CI 95% 1.55-2.61), osteoarticular diseases (arthritis, rheumatism or arthrosis) (PR= 1.84 CI 95% 1.35-2.51), stroke or ischemia (PR=1.72 CI 95% 1.15-2.59) and functional dependence in IADL (PR= 2.00 CI 95% 1.39-2.91) maintained the statistical significance in the model.

Table 3 presents the distribution of the variables by frailty condition, according to the CHS index. Only the variables smoking, consumption of alcoholic beverage, high cholesterol or triglycerides, stroke or ischemia and cancer were not associated with frailty in bivariate analysis (column 4). In the multivariate analysis (column 5), only the variables marital status (PR= 1.76 CI 95% 1.23-2.52), satisfaction with housing environment (PR= 2.29 CI 95% 1.60-3.27), osteoarticular diseases (arthritis, rheumatism or arthrosis) (PR= 1.86 CI 95% 1.30-2.67), medication use (PR= 3.01 CI 95% 1.04-8.71), functional dependence in ADL (PR= 2.24 CI 95% 1.66-3.02) and

IADL (PR= 4.79 CI 95% 2.44-9.55) maintained a significant statistical association with frailty.

4. Discussion

The importance of frailty in older adults has turned this syndrome into one of the main topics on health in aging. While efforts are being made to reach a consensus on the most appropriate way to operationalize frailty and, consequently, to assess this condition, a format has not yet been identified that would serve all the experts consulted (Rodríguez-Mañas et al., 2013; Morley et al., 2013). In this study we aimed to compare the prevalence of frailty among Brazilian older adults with two frequently used and validated instruments, the TFI and the CHS index, measuring biopsychosocial and physical frailty, respectively. In addition, we evaluated the association between the two measures, and determined the associations of background characteristics and frailty considering each measure of frailty.

To attend the first aim, we started presenting information on the prevalence of frailty. In this study, different frequencies of frailty were identified when comparing the estimates by the physical and biopsychosocial instruments. Convergent with previous studies, the prevalence of frailty measured by the biopsychosocial instrument, the TFI, was higher than that measured by the CHS index (35.8% versus 23.5%). In addition, 19.2% of the total frail individuals were classified by both instruments. Compared with other studies, the prevalence of frailty estimated in this study was higher than that found in the cohort of individuals from eleven European countries Survey of Health, Aging, and Retirement in Europe (SHARE) (TFI= 29.2% e CHS index= 11.3%) (Theou et al., 2013). Differences were also observed compared with the results of the population of community-dwelling older Italians, whose frequency of frailty was higher using the TFI (44.6%) and practically half when considering the evaluation made by CHS index (12.7%) (Roppolo et al., 2015). In the Portuguese community-dwelling older population the prevalence was higher for both measures CHS index (36.5%) and TFI (54.8%), even though the cut-off point used by the authors to consider an individual like frail was 6 points or more (Coelho et al., 2015). Although the prevalence of frailty measured by the TFI is very similar between the present study and the French study from the Three-City study cohort (23.7%), it was not possible to compare the prevalence estimated by the CHS index because the

authors presented data from frail (score ≥ 3 points) and pre-frail (score 1-2 points) older adults together (44.6%), overestimating the frequency of frailty in the population (Harmand et al., 2017).

Beyond the questions related to sociodemographic and cultural variables among populations included in the studies, a possible explanation for the differences in the prevalence of frailty between the studies cited and the present study is due to the different ways of the operationalization of the items that make up the instruments in each study. In the SHARE study, data were collected for other primary objectives, therefore, several adjustments were necessary in the composition of the items of the CHS index and the TFI. In the CHS index only the item weakness was verified in the original form and for the TFI all components were modified (Theou et al., 2013). In the Italian study, just the items weakness, poor energy or endurance were measured in the same way as in the present study, and the TFI was evaluated in its original format (Roppolo et al., 2015). In the French study, to construct the CHS index, the same operationalization of poor energy or endurance was used, as in the present study. However, the components shrinking, weakness, slowness, and physical activity were different. To evaluate the individuals by the TFI, proxies of almost all components were built using available data from Three-City study (Harmand et al., 2017).

When the prevalence of frailty is investigated in countries such as Brazil, a large variation is observed, especially related to the measure used to evaluate this condition. In a recent meta-analysis performed to investigate the prevalence of frailty among community-dwelling older people in countries of Latin American and the Caribbean, a total of 29 studies and 43,083 individuals were included. The prevalence of frailty estimated was 19.6% (95% CI: 15.4–24.3%), with a range of 7.7% to 42.6% in the studies reviewed. It is important to clarify that this review included studies using different instruments (CHS index, modified CHS index, Edmonton Frail scale, five physical tests), referring to different definitions of frailty. The highest prevalence was observed when two studies using the Edmonton Frail Scale (EFS) were evaluated together (35.8%, CI: 30.6-41.2). This is not surprisingly, because the ESF was the only instrument using a multidimensional approach of frailty (Da Mata et al., 2016).

In this study, a convenience sample was used, due to the difficulties of access to the older adults of the target population, which were pointed out in the methods.

This strategy especially limits the extrapolation of data on the prevalence of frailty, so it is important to carry out population-based studies to a best comparation.

Regarding the second aim of the study, the CHS index and TFI were positively correlated with each other (r= 0.675, p <0.001). As expected, the CHS index presented a high correlation with the physical domain of the TFI (r= 0.744, p <0.001). However, the CHS index showed a weak correlation with the psychological domain of the TFI (r= 0.322, p <0.001) and did not present a correlation with the social domain of this instrument (r= 0.059, p> 0.005). Similar results can be observed in the study by Roppolo and colleagues (2015), although the correlation between the two instruments was lower (r= 0.483, p <0.001), as well as the correlation between the CHS index and the physical domain of the TFI (r= 0.419, p <0.001). Furthermore, the correlation between the CHS index and the psychological domain of the TFI was slightly stronger (r= 0.369, p <0.001) and a weak correlation with the social domain was identified (r= 0.211, p <0.001) (Roppolo et al., 2015).

Finally, we investigated the associations between several factors and frailty. In the crude analysis, many similarities were observed in the associations between frailty and covariates. For both instruments (TFI and CHS index), positive associations were identified between frailty and most of the sociodemographic variables (sex, age group, marital status), except for the educational level for frailty measured by the TFI. The variables smoking, and consumption of alcoholic beverage were not associated with frailty assessed with the TFI as well as the CHS index. Regarding variables related to health, self-reported health, use of regular medication, history of chronic diseases (except cancer for TFI and high cholesterol/triglycerides, stroke/ischemia and cancer for CHS index), as well as functional dependence on ADL and IADL, represented a greater risk of frailty for both assessments. However, only history of osteoarticular diseases and functional dependence in IADL remained in both multivariate models, and the other frailty determinants were distinct for the TFI and the CHS index models.

In the evaluation performed by the TFI, the variables that remained associated with frailty in the multivariate model were female, age, unhealthy lifestyle (self-reported), history of osteoarticular disease and stroke or ischemia, and functional dependence on ADL. In other studies, the female is commonly referred to as a risk factor for frailty (Alvarado et al., 2008; Santos-Eggimann et al., 2009, Alcalá et al., 2010, Abizanda et al., 2011; Shamliyan et al., 2013, Gala et al., 2015), which is

attributed to the greater longevity of women, associated with a greater number of comorbidities (Hubbard & Rockwood, 2011; Collard et al., 2012). Greater age is also indicated as an important factor associated with frailty (Fried et al., 2001; Alvarado et al., 2008, Alcalá et al., 2010, Abizanda et al., 2011; Gala et al., 2015), because it is related to the reduction of functional reserves and to changes in the social functions of individuals, which increases the risk of adverse health outcomes (Tabue-Teguo et al., 2017). Although there were no associations, individually, between lifestyle habits (smoking, alcohol intake, physical activity) and frailty, having an unhealthy lifestyle (self-reported) was identified as a risk factor (Gobbens et al., 2010c). This finding may indicate that the concept of lifestyle, that traditionally refers us to the habits mentioned, may not be enough to translate the construct, which also considers emotional and social aspects. In relation to the health problems, osteoarticular diseases can cause important motor problems, which have a direct impact on walking, balance, strength and fatigue in the older people (Hübscher et al., 2010; Winter et al., 2010; Santos et al., 2016), some of the items that make up the physical part of the TFI and the CHS index, justifying its association with frailty. Problems such as hemiplegia, hemiparesis and aphasia are recognized as sequelae of stroke, directly impacting the performance of physical functions and the social participation of individuals (Weimar et al., 2002; Aidar et al., 2011). Therefore, it is understandable that it is related to frailty, in a biopsychosocial approach. Finally, the performance of IADL depends on preserved cognitive and motor functions (Mattos et al., 2014), and many studies describe the relationship between functional dependence and frailty (Abizanda et al., 2011, Sousa et al., 2012, Gala et al., 2015).

Regarding the evaluation by the CHS index, individuals with no partner (single/divorced/widowed), no satisfaction with housing environment, with a history of osteoarticular disease and functional dependence in ADL and IADL presented a higher risk of being frail, in a model adjusted by all variables cited above. Studies also indicate that the absence of partners (unmarried, widowed, divorced) may be a risk factor for frailty (Alvarado et al., 2008; Chen et al., 2010). Marital status can be considered one of the structural aspects of the social relationships of the individuals (Holt-Lunstad et al., 2010). The association between dissatisfaction with housing environment and the CHS index can be explained by the physical limitations of frail individuals and its interaction with environmental barriers to performing activities of daily living. Dissatisfaction with housing environment may also represent social

difficulties, which favor the emergence of frailty. Tabue-Teguo and colleagues (2017) argue that, with the advancement of age, environmental determinants will play an important role in maintaining social connections and dealing with stress situations. However, in our study no association existed between dissatisfaction with housing environment and the TFI, including social frailty. We recommend more studies focusing on this topic. Dependence in ADL is considered the most "advanced" stage of functional disability, occurring later to dependence in IADL and being even more limiting in individuals' lives (Mattos et al., 2014). The osteoarticular diseases and functional dependence in IADL have already been discussed above.

In relation to the quantitative and qualitative differences between older adults considered frail by each instrument, we need to discuss the best method to evaluate frailty in the context of primary health care in Brazil. To implement an evaluation method, it is important to consider its feasibility and acceptability, as well as the instrument's ability to predict the adverse health outcomes related to frailty in this level of health care.

Ambagtsheer and colleagues (2017) determined the feasibility, acceptability and diagnostic test accuracy of several frailty screening instruments (Reported EFS; Kihon Checklist; Frail Scale, Groningen Frailty Indicator, PRISMA-7, EFS and Gait Speed Test) among community-dwelling older Australians who made an appointment to see their general practitioner. This research group evaluated the tests in three perspectives: feasibility of implementation within the context of a busy general practice environment; acceptability to health service providers; and acceptability to consumers.

Regarding the perspective of feasibility (applicability), both tests require training and standardization of techniques for research assistants. However, the CHS index involves the measurement of grip strength and that requires specific equipment (dynamometer), involving a longer training time for the correct handling and reading of the device. To apply the instruments, we believe that the evaluators must have at least a level of education equivalent to high school. However, a person that has not completed high school but had specific and exhaustive training regarding the instrument use could be able to do so.

The two assessments do not require special physical space and are quick to apply, but the need to provide a dynamometer may make the use of CHS index in primary health care financially impossible, which differs from TFI, which consists only

of self-rated questions. The perspective of acceptability to consumers refers to low refusal and minimum non-response for the items of the two instruments. In our study the TFI showed no missing and the CHS index showed only three missing in the measurement of grip strength; these findings may indicate a good acceptance of both instruments concerning the evaluation of frailty by older adults themselves. We used both instruments in the same interview, and since the investigation of acceptability was not one of our initial objectives, questions about the preference of the individuals were not included. In our study, research assistants collected the data, and then it is still necessary to evaluate the acceptability of the health service providers. However, we believe that a fully self-rated evaluation is more practical to be applied in their routine.

We recommend conducting a longitudinal study to compare the performance of the CHS index and the TFI in the prediction of adverse health outcomes related to frailty, such as falls, hospitalizations, loss of functional independence and premature death among older adults' users of primary health care services, to determine the instrument that best identifies individuals at greater risk.

5. Conclusion

In this study we used both physical and biopsychosocial measures of frailty, represented by the CHS index and the TFI, respectively. The prevalence of frailty was considerably higher in assessing frailty with the TFI than in assessing frailty with the CHS index; the difference was 12,3%. Based on this finding, we conclude that the measurement instruments identify two different groups of frail older adults. Our study also demonstrated a strong correlation between the CHS index and the TFI (0.675), explained by the significant correlations between the CHS index and the physical and psychological domains of the TFI. Finally, the present study showed that the instrument used (CHS index, TFI) determines which factors are associated with frailty. Both the CHS index and the TFI were associated with six of the 21 factors included in our study; only two of these factors were the same (osteoarticular diseases, functional dependence in IADL). Concerning feasibility and acceptability the CHS index as well as the TFI seem suitable to be used by primary healthcare professionals in Brazil for detecting frail older adults with the aim to reduce their

frailty, prevent adverse health outcomes and enhance their quality of life. However, considering the necessity of a special equipment (dynamometer) for the evaluation of one of the items of the CHS index, which would increase the costs and would involve a longer training time for the correct handling and reading of the device, we believe that the TFI would be the a more viable alternative for implementation in the primary health care in Brazil.

Conflict of interest

The authors declare that they have no conflict of interest.

Ethical approval

All procedures performed in our study were in accordance with ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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References

Abizanda, P., Sánchez-Jurado, P. M., Romero, L., Paterna, G., Martínez-Sánchez, E., Atienzar-Núñez, P. (2011). Prevalence of frailty in a Spanish elderly population: the frailty and dependence in Abacete study. *J American Geriatrics Society*, *59*(7), 1356-1359.

Aidar, F. J., Oliveira, R. J., Silva, A. J., Matos, D. G., Carneiro, A. L., Garrido, N., et al. (2011). The influence of the level of physical activity and human development in the quality of life in survivors of stroke. *Health Qual Life Outcomes, 9*, 89.

Alcalá, M. V. C., Puime, A. O., Santos, M. T. S., Barral, A. G., Montalvo, J. I. G., Zunzunegui, M. V. (2010). Prevalence of frailty in an elderly Spanish urban population. Relationship with comorbidity and disability. *Aten Primaria, 42*(10), 520-527.

Alvarado, B. E., Zunzunegui, M. V., Béland, F., Bamvita, J. M. (2008). Life course social and health conditions linked to frailty in Latin American older men and women. *J Gerontol A Biol Sci Med Sci,63*(12),1399-1406.

Ambagtsheer, R., Visvanathan, R., Cesari, M., Yu, S., Archibald, M., Schultz, T., et al. (2017). Feasibility, acceptability and diagnostic test accuracy of frailty screening

instruments in community-dwelling older people within the Australian general practice setting: a study protocol for a crosssectional study. *BMJ Open, 7*, e016663.

Blodgett, J., Theou, O., Kirkland, S., Andreou, P., Rockwood, K. (2015). Frailty in NHANES: Comparing the frailty index and phenotype. *Arch Gerontol Geriatr, 60*(3), 464-470.

Chang, S. F., Lin, P. L. (2015). Frail phenotype and mortality prediction: A systematic review and meta-analysis of prospective cohort studies. *IJNS, 52*(8), 1362-1374.

Chen, C. Y., Wu, S. C., Chen, L. J., Lue, B. H. (2010). The prevalence of subjective frailty and factors associated with frailty in Taiwan. *Arch GerontolGeriatr, 50*(Suppl 1), S43-S47.

Coelho, T., Santos, R., Paúl, C., Gobbens, R. J. J., Fernandes, L. (2015). Portuguese version of the Tilburg Frailty Indicator: Transcultural adaptation and psychometric validation. *Geriatr Gerontol Int*, *15(8)*, 951-960.

Collard, R. M., Boter, H., Shoevers, R. A., Voshaar, R. C. O. (2012). Prevalence of Frailty in Community-Dwelling Older Persons: A Systematic Review. *J Am Geriatr Soc, 60*, 1487-1492.

Da Mata, F. A. F., Pereira, P. P. S., Andrade, K. R. C., Figueiredo, A. C. M. G., Silva, M. T., Pereira, M. G. (2016). Prevalence of Frailty in Latin America and the Caribbean: A Systematic Review and Meta-Analysis. *PLoS One,16;11*(8), e0160019.

Ensrud, K. E., Ewing, S. K., Cawthon, P. M., Fink, H. A., Taylor, B. C., Cauley, J. A. (2009). A comparison of frailty indexes for the prediction of falls, disability, fractures, and mortality in older men. *J Am Geriatr Soc, 57*, 492-498.

Fried, L. P., Tangen, C. M., Walston, J., Newman, A. B., Hirsch, C., Gottdiener, J. et al. (2001). Frailty in older adults: evidence for a phenotype. *J Gerontol A Biol Sci Med Sci, 56*, 146-156.

Gala, C. R., Cooper, C., Sayer, A. A. (2015). Prevalence of frailty and disability: findings from the English Longitudinal Study of Ageing. *Age Ageing, 44*, 162-165.

Gobbens, R. J. J., Luijkx, K. G., Wijnen-Sponselee, M. T., Schols, J. M. G. A. (2010a). In search of an integral conceptual definition of frailty: opinions of experts. *J Am Med Dir Assoc, 11*, 338-343.

Gobbens, R. J. J., van Assen, M. A. L. M., Luijkx, K. G., Wijnen-Sponselee, M. T., Schols, J. M. G. A. (2010b). The Tilburg Frailty Indicator: Psychometrics Properties. *J Am Med Dir Assoc, 11*, 344-55.

Gobbens, R. J. J., van Assen, M. A. L. M., Luijkx, K. G., Wijnen-Sponselee, M. T., Schols, J. M. G. A. (2010c). Determinants of Frailty. *J Am Med Dir Assoc, 11*, 356-364.

Gobbens, R. J. J., van Assen, M. A. L. M. (2012). Frailty and its prediction of disability and health care utilization: The added value of interviews and physical measures following a self-report questionnaire. *Arch Gerontol Geriatr, 55*, 369-379.

Gobbens, R. J. J., van Assen, M. A. L. M., Luijkx, K. G., Schols, J. M. G. (2012). The Predictive Validity of the Tilburg Frailty Indicator: Disability, Health Care Utilization, and Quality of Life in a Population at Risk. *The Gerontologist, 0*(0), 1-13.

Harmand, M. G. C., Meillon, C., Bergua, V., TabueTeguo, M., Dartigues, J. F., Avila-Funes, J. A., et al. (2017). Comparing the predictive value of three definitions of frailty: Results from the Three-City study. *Arch GerontolGeriatr, 72*, 153-163.

Holt-Lunstad, J., Smith, T. B., Layton, J. B. (2010). Social relationships and mortality risk: a meta-analytic review. *PLoS Med, 7*, e1000316.

Hoogendijk, E. O., van der Horst, H. E., Deeg, D. J. H., Frijters, D. H., Prins, B. A., Jansen, A. P., et al. (2013). The identification of frail older adults in primary care: comparing the accuracy of five simple instruments. *Age Ageing, 42*(2), 262-265.

Hubbard, R. E., Rockwood, K. (2011). Frailty in older women. *Maturitas, 69*(3), 203-207.

Hübscher, M., Vogt, L., Schmidt, K., Fink, M., Banzer, W. (2010). Perceived pain, fear of falling and physical function in women with osteoporosis. *Gait Posture, 32*(3), 383-385.

Jung, H. W., Kim, S. W., Ahn, S., Lim, J. Y., Han, J. W., Kim, T. H., et al. (2014). Prevalence and outcomes of frailty in Korean elderly population: comparisons of a multidimensional frailty index with two phenotype models. *PLoS One, 9*(2), e87958.

Katz, S., Downs, T. D., Cash, H. R., Grotz, R. C. (1970). Progress in development of index of ADL. *The Gerontologist, 10*, 20-30.

Lawton, M. P., Moss, M., Fulcomer, M., Kleban, M. H. (1982). A Research and Service Oriented Multilevel Assessment Instrument. *J Gerontol, 37*, 91-99.

Li, G., Thabane, L., Ioannidis, G., Kennedy, C., Papaioannou, A., Adachi, J. D. (2015). Comparison between frailty index of deficit accumulation and phenotypic model to predict risk of falls: data from the global longitudinal study of osteoporosis in women (GLOW) Hamilton cohort. *PLoS One, 10*(3), e0120144.

Lino, V. T. S., Pereira, S. R. M., Camacho, L. A. B., Ribeiro Filho, S. T., Buksman, S. (2008). Adaptação transcultural da Escala de Independência em Atividades da Vida Diária (Escala de Katz). *Cad SaúdePública, 24*(1), 103-112.

Mattos, I. E., Carmo, C. N., Santiago, L. M., Luz, L. L. (2014). Factors associated with functional incapacityin elders living in long stay institutions in Brazil:a cross-sectional study. *BMC Geriatrics,14*, 47.

Morley, J. E., Vellas, B., van Kan, G. A., Anker, S. D., Bauer, J. M., Bernabei, R. (2013). Frailty Consensus: A Call to Action. *JAMDA, 14*, 392-397.

Rockwood, K., Andrew, M., Mitnitski, A. (2007). A comparison of two approaches to measuring frailty in elderly people. *J GerontolA Biol Sci Med Sci, 62*(7), 738-743.

Rodríguez-Mañas, L., Féart, C., Mann, G., Viña, J., Chatterji, S., Chodzko-Zajko, W. (2013). Searching for an operational definition of frailty: a Delphi method based consensus statement: the frailty operative definition-consensus conference project. *J GerontolA Biol Sci Med Sci, 68*, 62-67.

Roppolo, M., Mulasso, A., Gobbens, R. J., Mosso, C. O., Rabaglietti, E. (2015). A comparison between uni- and multidimensional frailty measures:prevalence, functional status, and relationships with disability. *Clin Interv Aging, 10*, 1669-1678.

Santiago, L. M., Luz, L. L., Mattos, I. E., Gobbens, R. J. J. (2012). Adaptação transcultural do instrumento Tilburg Frailty Indicator (TFI) para a população brasileira. *Cad Saúde Púb, 28*(9), 1795-1801.

Santiago, L. M., Luz, L. L., Mattos, I. E., Gobbens, R. J. J., van Assen, M. A. L. M. (2013). Psychometric properties of the Brazilian version of the Tilburg Frailty Indicator. *Arch Gerontol Geriatr, 57*(1), 39-45.

Santiago, L. M., Gobbens, R. J. J., van Assen, M. A. L. M., Carmo, C. N., Ferreira, D. B., Mattos, I. E. (2018).Predictive validity of the Brazilian version of the Tilburg Frailty Indicator for adverse health outcomes in older adults. *Arch Gerontol Geriatr, 76*, 114-119.

Santos, R. L., Virtuoso Júnior, J. S. (2008). Confiabilidade da versão brasileira da escala de atividades instrumentais de vida diária. *Rev Bras Promoção Saúde, 21*(4), 290-296.

Santos, V. R., Gobbo, L. A., Christofaro, D. G. D., Gomes, I. C., Mota, J., Gobbi, S., et al. (2016). Osteoarticular diseases and physical performance of Brazilians over 80 years old. *Ciênc Saúde Col, 21*(2), 423-430.

Santos-Eggimann, B., Cuénoud, P., Spagnoli, J., Junod, J. (2009). Prevalence of frailty in middle-aged and older community-dwelling Europeans living in 10 countries. *J GerontolA Biol Sci Med Sci, 64*(6), 675-681.

Shamliyan, T., Talley, K. M., Ramakrishnan, R., Kane, R. L. (2013). Association of frailty with survival: a systematic literature review. *Ageing Res Rev, 12*(2), 719-736.

Sousa, A. C. P. A., Dias, R. C., Maciel, A. C. C., Guerra, R. O. (2012). Frailty syndrome and associated factors in community-dwelling elderly in Northeast Brazil. *Arch Gerontol Geriatrics, 54*(2), e95-e101.

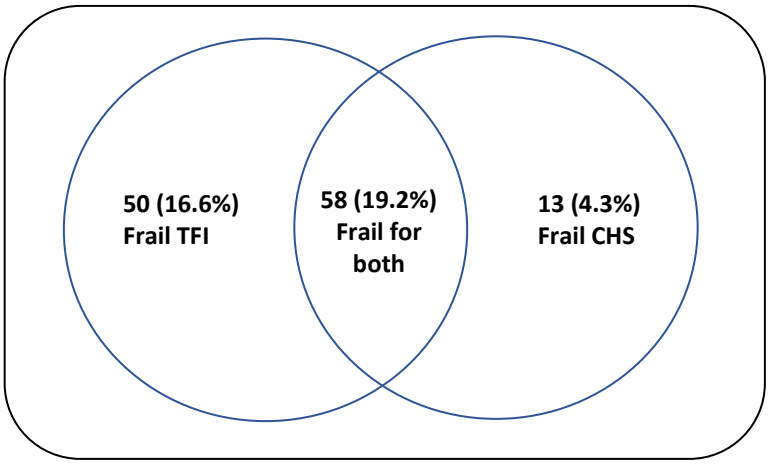
Sutton, J. L., Gould, R. L., Daley, S., Coulson, M. C., Ward, E. V., Butler, A. M., et al. (2016). Psychometric properties of multicomponent tools designed to assess frailty in older adults: A systematic review. *BMC Geriatr,16*, 55.

Tabue-Teguo, M., Simo, N., Harmand, M. G. C., Cesari, M., Avila-Funes, J. A., Féart, C., et al. (2017). Fragilité de lapersonne âgée: miseau point. *Geriatr Psychol Neuropsychiatr Vieil, 15*(2), 127-137.

Theou, O., Brothers, T. D., Mitnitski, A., Rockwood, K. (2013). Operationalization of frailty using eight commonly used scales and comparison of their ability to predict all-cause mortality. *J Am Geriatr Soc, 61*(9), 1537-1551.
Weimar, C., Ziegler, A., König, I. R., Diener, H. C. (2002). Predicting functional outcome and survival after acute ischemic stroke. *J Neurol, 249*, 888-895.

Winter, C. C., Brandes, M., Muller, C., Schubert, T., Ringling, M., Hillmann, A., et al. (2010). Walking ability during daily life in patients with osteoarthritis of the knee or the hip and lumbar spinal stenosis: a cross sectional study. *BMC Musculoskeletal Disorders*, 11, 233.

Diagram 1: Diagnosis of frailty*, according to the TFI and the CHS index.



* Older people with a TFI score ≥ 5 and CHS score ≥ 3 were considered frail.

Table 1. Correlations between unidimensional (CHS index) and multidimensional (TFI) frailty measures.

	TFI Physical	TFI Psychological	TFI Social	TFI
CHS index	**0.744*** **	**0.322*** **	**0.059**	**0.675*** **
TFI Physical		**0.345*** **	**0.149** **	**0.888*** **
TFI Psychological			**0.232*** **	**0.677*** **
TFI Social				**0.428*** **

** p <0.01; *** p < 0.001.

CHS index = Cardiovascular Health Study index; TFI = Tilburg Frailty Indicator

Table 2: Sociodemographic, lifestyle and health characterization of the study population, due to the frailty condition assessed by the TFI (N = 302).

Variables	Not frail N (%)	Frail N (%)	PR crude (CI 95%)	PR adjusted** (CI 95%)
Sex				
Male	78 (40.2)	25 (23.1)	1	1
Female	116 (59.8)	83 (76.9)	1.72 (1.17-2.51)	1.45 (1.02-2.04)
Age group				
60-69 years	120 (61.9)	42 (38.9)	1	1
70-79 years	54 (27.8)	39 (36.1)	1.62 (1.14-2.30)	1.19 (1.02-1.40)
80 years or more	20 (10.3)	27 (25.0)	2.21 (1.55-3.17)	
Education				
>five years at school	60 (30.9)	22 (20.6)	1	
≤ five years at school	134 (69.1)	85 (79.4)	1.44 (0.97-2.15)	
Marital status				
Married/cohabiting	106 (54.3)	46 (42.6)	1	
Single/divorced/widowed	88 (45.4)	62 (57.4)	1.36 (1.00-1.86)	
Smoking				
Never smoked	106 (54.9)	55 (50.9)	1	
Smoker in the past/current smoker	87 (45.1)	53 (49.1)	1.11 (0.82-1.50)	
Consumption of alcoholic beverage				
Never had the habit	97 (50.0)	50 (46.3)	1	
Habit in the past/ current habit	97 (50.0)	58 (53.7)	1.10 (0.81-1.49)	
Regular physical activity				
Yes	42 (21.6)	19 (17.6)	1	
No	152 (78.4)	89 (82.4)	1.18 (0.79-1.78)	
Healthy lifestyle				
Yes	187 (96.4)	66 (61.1)	1	1
No	7 (3.6)	42 (38.9)	3.28 (2.59-4.16)	2.01 (1.55-2.61)
Satisfaction of housing environment				
Yes	179 (92.3)	79 (73.1)	1	
No	15 (7.7)	29 (26.9)	2.15 (1.62-2.85)	
Self-rated health				
Very good/good/regular	193 (99.5)	88 (82.2)	1	
Poor/very poor	1 (0.5)	19 (17.8)	3.03 (2.48-3.71)	
Arterial hypertension				
No	71 (36.6)	26 (24.1)	1	
Yes	123 (63.4)	82 (75.9)	1.49 (1.03-2.16)	
Diabetes Mellitus				
No	147 (75.8)	69 (63.9)	1	
Yes	47 (24.2)	39 (36.1)	1.42 (1.05-1.92)	
High Cholesterol or Triglycerides				
No	170 (87.6)	78 (72.2)	1	
Yes	24 (12.4)	30 (27.8)	1.77 (1.30-2.39)	
Arthritis, rheumatism or arthrosis				
No	152 (78.4)	45 (41.7)	1	1
Yes	42 (21.6)	63 (58.3)	2.62 (1.94-3.55)	1.84 (1.35-2.51)
Heart disease (Angina or Infarction)				
No	181 (93.3)	80 (74.1)	1	
Yes	13 (6.7)	28 (25.9)	2.23 (1.69-2.94)	
Stroke or ischemia				
No	185(95.4)	95 (88.0)	1	1
Yes	9 (4.6)	13 (12.0)	1.74 (1.18-2.56)	1.72 (1.15-2.59)
Asthma, bronchitis or emphysema				
No	187 (96.4)	96 (88.9)	1	

Yes	7 (3.6)	12 (11.1)	1.86 (1.27-2.72)	
Cancer (except skin)				
No	188 (96.9)	107 (99.1)	1	
Yes	6 (3.1)	1 (0.9)	0.39 (0.06-2.44)	
Use of medication				
No	54 (27.8)	9 (8.3)	1	
Yes	140 (72.2)	99 (91.7)	2.90 (1.55-5.41)	
Functional dependence in ADL				
No	193 (99.5)	89 (82.4)	1	
Yes	1 (0.5)	19 (17.6)	3.01 (2.46-3.67)	
Functional dependence in IADL				
No	123 (63.4)	27 (25.0)	1	1
Yes	71 (36.6)	81 (75.0)	2.96 (2.04-4.30)	2.00 (1.39-2.91)

* Differences between absolute numbers are due to missing values.

** ** Only the significant associations are presented

Table 3: Sociodemographic, lifestyle and health characterization of the study population, due to the frailty condition assessed by the CHS index (N=302).

Variables	Not frail N (%)	Frail N (%)	PR crude (CI 95%)	PR adjusted** (CI 95%)
Sex				
Male	87 (37.7)	16 (22.5)	1	
Female	144 (62.3)	55 (77.5)	1.78 (1.07-2.94)	
Age group				
60-69 years	138 (59.7)	24 (33.8)	1	
70-79 years	67 (29.0)	26 (36.6)	1.89 (1.15-3.09)	
80 years or more	26 (11.3)	21 (29.6)	3.01 (1.85-4.91)	
Education				
>five years at school	71 (30.9)	11 (15.5)	1	
≤ five years at school	159 (69.1)	60 (84.5)	2.04 (1.13-3.69)	
Marital status				
Married/cohabiting	127 (55.0)	25 (35.2)	1	1
Single/divorced/widowed	104 (45.0)	46 (64.8)	1.86 (1.21-2.87)	1.76 (1.23-2.52)
Smoking				
Never smoked	126 (54.8)	35 (49.3)	1	
Smoker in the past/current smoker	104 (45.2)	36 (50.7)	1.18 (0.79-1.78)	
Consumption of alcoholic beverage				
Never had the habit	115(49.8)	32 (45.1)	1	
Habit in the past/ current habit	116 (50.2)	39 (54.9)	1.15 (0.77-1.74)	
Regular physical activity				
Yes	54 (23.4)	7 (9.9)	1	
No	177 (76.6)	64 (90.1)	2.31 (1.11-4.80)	
Healthy lifestyle				
Yes	209 (90.5)	44 (62.0)	1	
No	22 (9.5)	27 (38.0)	3.17 (2.19-4.50)	
Satisfaction of housing environment				
Yes	211 (91.3)	47 (66.2)	1	1
No	20 (8.7)	24 (33.8)	2.99 (2.06-4.35)	2.29 (1.60-3.27)
Self-rated health				
Very good/good/regular	224 (97.4)	57 (80.3)	1	
Poor/very poor	6 (2.6)	14 (19.7)	3.45 (2.38-4.99)	
Arterial hypertension				
No	82 (35.5)	15 (21.1)	1	
Yes	149 (64.5)	56 (78.9)	1.76 (1.05-2.96)	
Diabetes Mellitus				
No	174 (75.3)	42 (59.2)	1	
Yes	57 (24.7)	29 (40.8)	1.73 (1.16-2.59)	
High Cholesterol or Triglycerides				
No	194 (84.0)	54 (76.1)	1	
Yes	37 (16.0)	17 (23.9)	1.44 (0.91-2.29)	
Arthritis, rheumatism or arthrosis				
No	170 (73.6)	27 (38.0)	1	1
Yes	61 (26.4)	44 (62.0)	3.06 (2.01-4.64)	1.86 (1.30-2.67)
Heart disease (Angina or Infarction)				
No	211 (91.3)	50 (70.4)	1	
Yes	20 (8.7)	21 (29.6)	2.67 (1.81-3.95)	
Stroke or ischemia				
No	217 (93.9)	62 (87.3)	1	
Yes	14 (6.1)	9 (12.7)	1.61 (0.89-2.53)	
Asthma, bronchitis or emphysema				
No	221 (95.7)	62 (87.3)	1	

Yes	10 (4.3)	9 (12.7)	2.16 (1.28-3.65)	
Cancer (except skin)				
No	226 (97.8)	69 (97.2)	1	
Yes	5 (2.2)	2 (2.8)	1.22 (0.37-4.02)	
Use of medication				
No	60 (26.0)	3 (4.2)	1	1
Yes	171 (74.0)	68 (95.8)	5.97 (1.94-18.39)	3.01 (1.04-8.71)
Functional dependence in ADL				
No	230 (99.6)	52 (73.2)	1	1
Yes	1 (0.4)	19 (26.8)	5.15 (3.95-6.72)	2.24 (1.66-3.02)
Functional dependence in IADL				
No	142 (61.5)	8 (11.3)	1	1
Yes	89 (38.5)	63 (88.7)	7.77 (3.85-15.67)	4.79 (2.44-9.55)

* Differences between absolute numbers are due to missing values.
** Only the significant associations are presented