Accuracy of functional tests to identify frail community elderly

Acurácia de testes funcionais para identificar idosos comunitários frágeis

Precisión de pruebas funcionales para identificar ancianos de la comunidad frágiles

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Abstract
Objective: To verify the accuracy of functional tests in identifying frail older adults in two different regions. Methods: Observational, descriptive and cross-sectional study with the participation of 120 community older adults. Fried Phenotype and Edmonton Frail Scale were used to classify the frailty and the Timed Up and Go (TUG) and gait speed tests to identify the frail older adults. Results: In Ribeirão Preto and Lagarto, frail older adults performed TUG test in a longer time than pre-frail (p = 0.001) and non-frail (p < 0.001). As for gait speed, frail older adults had lower speed than non-frail (p = 0.01). The TUG test had moderate accuracy for the identification of frail older adults in Ribeirão Preto (AUC = 0.86, 95% CI 0.78 to 0.95, p < 0.001) and in Lagarto (AUC = 0.76, 95% CI 0.64 to 0.88, p = 0.001). Gait speed, on the other hand, is not accurate to discriminate frail older adults. The cut-off points for TUG with the highest sensitivity and specificity were 11.5 seconds for both older adults living in Ribeirão Preto and Lagarto. Conclusion: The TUG was capable of identifying frail older adults of two different regions, even when two different diagnostic methods of frailty were applied, standing out as a simple screening to be used in clinical practice.
Keywords: Frailty; Aged; Primary health care.

Resumo
Objetivo: Verificar a acurácia de testes funcionais na identificação de idosos frágeis em duas regiões diferentes. Métodos: Estudo observacional, descritivo e transversal com a participação de 120 idosos da comunidade. Fenótipo Fried e Edmonton Frail Scale foram utilizados para classificar a fragilidade e os testes Timed Up and Go (TUG) e velocidade de marcha para identificar os idosos frágeis. Resultados: Em Ribeirão Preto e Lagarto, idosos frágeis realizaram o teste TUG em um tempo maior que pré-frágeis (p = 0,001) e não frágeis (p < 0,001). Quanto à velocidade da marcha, os idosos frágeis apresentaram menor velocidade do que os não frágeis (p = 0,01). O teste TUG apresentou acurácia moderada para a identificação de idosos frágeis em Ribeirão Preto (AUC = 0,86, IC 95% 0,78 a 0,95, p < 0,001) e em Lagarto (AUC = 0,76, IC 95% 0,64 a 0,88, p = 0,001). A velocidade da marcha, por outro lado, não foi precisa para discriminar idosos frágeis. Os pontos de corte do TUG com maior sensibilidade e especificidade foram 11,5 segundos tanto para idosos residentes em Ribeirão Preto quanto para Lagarto. Conclusão: O TUG foi capaz de identificar idosos frágeis de duas regiões diferentes, mesmo quando foram aplicados dois métodos diagnósticos diferentes de fragilidade, destacando-se como uma triagem simples para ser utilizada na prática clínica.
Palavras-chave: Fragilidade; Idoso; Atenção primária à saúde.

Resumen
Objetivo: Verificar la precisión de las pruebas funcionales en la identificación de ancianos frágiles en dos regiones diferentes. Métodos: Estudio observacional, descriptivo y transversal con la participación de 120 ancianos de la comunidad. Se utilizaron el fenotipo Fried y la Edmonton Frail Scale para clasificar la fragilidad y las pruebas Timed Up and Go (TUG) y de velocidad de la marcha para identificar a los adultos mayores frágiles. Resultados: En Ribeirão Preto y Lagarto, los ancianos frágiles realizaron la prueba TUG en mayor tiempo que los pre frágiles (p = 0,001) y los no frágiles (p < 0,001). En cuanto a la velocidad de la marcha, los ancianos frágiles presentaron menor velocidad que los no frágiles (p = 0,01). La prueba TUG tuvo precisión moderada para la identificación de ancianos frágiles en Ribeirão Preto (AUC = 0,86, IC 95% 0,78 a 0,95, p < 0,001) y en Lagarto (AUC = 0,76, IC 95% 0,64 a 0,88, p = 0,001). La velocidad de la marcha, por otro lado, no fue precisa para discriminar ancianos frágiles. Los

puntos de corte del TUG con mayor sensibilidad y especificidad fueron 11,5 segundos para los ancianos residentes de Ribeirão Preto y Lagarto. Conclusión: TUG pudo identificar ancianos frágiles de dos regiones diferentes, incluso cuando se aplicaron dos métodos de diagnóstico de fragilidad diferentes, destacándose como una simple clasificación para usar en la práctica clínica.
Palabras clave: Fragilidad; Anciano; Atención primaria de salud.

1. Introduction

The accelerated growth of the aging population in Brazil is notorious, but the same does not happen with public health policies aimed at the older adults (Brasil, 2015). In developed countries, on the contrary, there is concern with the cost-effectiveness. In this perspective, frail older adults are cited as a population group that needs greater attention from health care, due to the various negative outcomes associated with frailty (Boch et al., 2016, Sirven et al., 2017, Comans et al., 2016, Tello-Rodríguez et al., 2016).

In Brazil, there is a great variation in data regarding the prevalence of frailty, with values between 6.7 and 74.1%. These variations were attributed to different instruments used for classification and research scenarios (Lourenço et al., 2018). The prevalence of frailty in Latin America ranged from 7.7 to 42.6% (Da Mata et al., 2016).

Frailty does not yet have a consensual definition due to the heterogeneity of the data regarding assessment tools and classification (Tribess et al., 2011). However, it is quite acceptable that there is a greater organic vulnerability associated with aging in the frailty, which negatively affects homeostasis and functional reserves of the individual (Aguayo et al., 2017, Fried et al., 2001). The multidimensional approach is also addressed, especially with cognitive, physical and social losses (Fabrício-Wehbe et al., 2009, Fabrício-Wehbe et al., 2013).

As in the concept, there are a number of instruments used to identify frail older adults. The frailty phenotype is one of the most used in research and involves five items: unintentional weight loss, low muscle strength, slow gait, fatigue and low level of physical activity (Aguayo et al., 2017). On the other hand, the Edmonton Frail Scale (EFS) has a multidimensional evaluation and addresses nine domains such as cognition, health status, functionality, social support, medication, nutrition, mood, incontinence and mobility (Fried et al., 2001, Verloo et al., 2016).

Functional mobility of the older adults is commonly assessed using the Timed Up and Go (TUG) test (Shumway-Cook et al., 2000), which has been used to identify frailty (Savva et al., 2013, Silveira et al., 2017, Filippin et al., 2017). However, which is the best cut-off point to identify frail older adults is still uncertain. Most studies have cut-off points above 10 seconds for the identification of frail older adults (Savva et al., 2013, Walston, Buta et al., 2018, Sukkriang et al., 2020).

Due to the diversity of instruments, one can show the difficulty to identify frail older adults and compare the results of studies in different regions (Da Mata et al., 2016). Thus, in an attempt to identify simple instruments that can be used in clinical practice in the fields of primary care, the study aims to verify the accuracy of functional tests, named Timed Up and Go and gait speed, in identifying frail older adults in two regions with different sociodemographic characteristics and using different diagnoses of frailty.

2. Methodology

This is an observational, descriptive and cross-sectional study that took place in cities in two regions of Brazil: one in the Northeast and another in the Southeast.

Participants

The sample occurred for convenience in the regions where the study was conducted, with the participation of 60 older adults in Lagarto (Northeastern Brazil) and 60 in Ribeirão Preto (Southeastern Brazil). In both places, older adults from the

community supported by the primary health care participated.

Inclusion and exclusion criteria

Individuals aged 60 years or over, of both sexes, who accepted to participate in the research were included. The ineligibility criteria were unable to answer the questionnaires, mobility restriction, those diagnosed with dementia or behavioral disorders and those who presented cognitive decline by the 10-Point Cognitive Screener (10-CS), according to the education level (< 8 points) (Apolinário et al., 2016).

Procedures and Instruments

The collections were carried out from August to December 2019, at the Simulations and Practices Center of the Federal University of Sergipe and the Laboratory of Assessment and Rehabilitation of Equilibrium, of the Department of Health Sciences, Ribeirão Preto Medical School, University of São Paulo (FMRP - USP). Before collections were started, the evaluators were previously trained by experienced physiotherapists to apply the assessment instruments.

Demographic (age, sex) and socioeconomic (education level, income) variables were used to characterize the participants.

The frailty assessment in the older adults of Lagarto was carried out through the Edmonton Frail Scale (EFS), culturally adapted to the Portuguese language in Brazil, reliable, valid and easy to apply. The scale has nine domains and eleven items, whose maximum score is 17 points. The scores to analyze the frailty were: 0-4, no frailty; 5-6, apparently vulnerable; 7-8, mild frailty; 9-10, moderate frailty; 11 or more, severe frailty (Fabrício-Wehbe et al., 2009, Fabrício-Wehbe et al., 2013).

In the older adults of Ribeirão Preto, the Phenotype Frailty criteria (Fried et al., 2001) were used: unintentional weight loss, in the last year, greater than 5%; slow walk speed; weak grip strength; low level of physical activity and self-reported exhaustion. A stopwatch was used to assess gait speed, a manual dynamometer (Jamar, Sammons Preston, Illinois, USA) to measure strength, the International Physical Activity Questionnaire (IPAQ) adapted for older adults in order to assess the level of physical activity (Mazo et al., 2010) fatigue was identified by means of two questions of the Center for Epidemiological Studies Depression Scale (CES-D) (1- "I felt that everything I did was an effort ", 2-" I could not get going ") (Batistoni et al., 2007) whose responses were "occasionally" or "most of the time" to 1 of the 2. Three or more criteria were classified as frail, one or two criteria as pre-frail and no criteria, as non-frail.

Ethical aspects

The study was approved by the Human Research Ethics Committee of Sergipe (number 3.493.364) and São Paulo (number 932043). All the participants signed the free and informed consent forms prior to the assessments.

Statistical Analysis

All statistical analyses were undertaken using SPSS for Windows Version 16.0 (SPSS Inc., Armonk, NY, USA), and the level of significance was set at $p < 0.05$. Means and standard deviations were used to characterize the sample. Descriptive analysis consisted of age (years), BMI (kg/m^2) and clinical tests (TUG test, gait speed). Intergroup differences regarding frailty classification (frail, pre-frail and non-frail) in older adults who live in Lagarto and Ribeirão Preto were analysed using two-way ANOVA and Tukey's post-hoc test. Also, intragroup differences among frailty classification in each group were also analysed using two-way ANOVA and Tukey's post-hoc test. For categorical variables (incomes and years of education), the Chi-square test was used to evaluate differences between frail, pre-frail and non-frail older adults for each city (Lagarto and Ribeirão

Preto). Following this methodology, the sample power calculation was performed with 86% of power, α error of 5% and effect size r = 0.35. The calculation was carried out using the G*Power software (v 3.1.9.2) (Universität Kiel, Kiel, Germany).

Associations between evaluations with the TUG test and gait speed (independent variables) and Frail category according to Fried phenotype for the city of Ribeirão Preto city and to the Edmonton frail scale (dependent variable) for the city of Lagarto were tested separately with multinomial logistic regression and with the determination of the odds ratio and the respective 95% confidence interval [CI].

After multinomial logistic regression, the participants were divided into two groups, frail and non-frail (pre-frail and non-frail). As the frail older adults of Lagarto and Ribeirão Preto had higher TUG than the NF and PF, the non-frail group was composed by non-frail and pre-frail older adults. Next, the accuracy of the TUG and gait speed for the discrimination of frail older adults was assessed by means of the Receiver Operating Characteristics (ROC) curve, which provided the parameters area under the ROC curve (AUC), sensitivity and specificity. The accuracy of the TUG and gait speed test to identify frail older adults can be determined by considering the AUC of the ROC curve. AUC > 0.9 indicates high accuracy, 0.7–0.9 indicates moderate accuracy, 0.5–0.7 indicates low accuracy and <0.5 indicates a random result (Akobeng, 2007). The cut-off points of each test were determined using the Youden Index (sensitivity + specificity -1), which ranges from 0 to 1. The cut-off points were then considered to be those with the highest Youden Index (closest to one), i.e., the point on the ROC curve farthest from chance.

From the data obtained with the ROC curve, PoTP was calculated using the method of Lusardi et al. (2017) to identify the degree of change in the certainty of the diagnosis.

3. Results

One hundred and twenty older adults were included in this study, being the majority female in Ribeirão Preto (78,3%) and Lagarto (80,0%). Mean age, BMI, income, years of education, time to perform TUG test and gait speed for both cities are listed in Table 1.

Table 1. Characterization of the sample with mean±SD and frequency (%).

	Ribeirão Preto (n=60)			Lagarto (n=60)		
	NF (n=20)	PF (n=23)	F (n=17)	NF (n=18)	PF (n=19)	F (n=23)
Age (years)	71±7.0	76±6.6‡	77±7.2*†	67±6.7	69±6.7	68±7.1
BMI (m/Kg²)	27±2.7	29±5.6	26±5.3	25±4.6	27±2.9	27±5.4
Income n (%)						
< 1 minimum wage	5(26.3)	8(34.7)	13(72.2)	11(68.8)	14(82.4)	19(82.6)
1-2 minimum wages	12(63.2)	13(56.5)	4(22.2)	5(31.2)	3(17.6)	4(17.4)
>3 minimum wages	2(10.5)	2(8.7)	1(5.6)	0	0	0
Years of education n (%)						
Illiterate	0	0	2(10.5)	6(33.3)	8(42.1)	7(30.4)
1-4 years	7(36.8)	14(60.9)	8(42.1)	11(61.1)	11(57.9)	15(62.2)
5-8 years	9(47.4)	4(17.4)	5(26.3)	0	0	0
>9 years	3(15.8)	5(21.7)	4(21.1)	1(5.6)	0	1(4.3)
TUG (seconds)	10±2.4	11±3.6	15±3.0*#	10±1.9	11±3.0	14±3.2*#
Gait speed (m/seconds)	0.89±0.2	0.80±0.2	0.69±0.1*	0.77±0.1	0.76±0.1	0.61±0.1*

NF, non-frail; PF, pre-frail; F, frail; BMI, body mass index; TUG test, Timed up and Go test; SD, standard deviation. *p < 0.05, F vs NF; †p < 0.05, F vs F;‡p < 0.05, PF vs PF; #p < 0.05, F vs PF according to two-way ANOVA test. Income and years of education were analyzed with the Chi-square test. Source: Authors.

In the intragroup analysis, according to the older adults from Ribeirão Preto, the frail adults were significantly older than non-frails (p = 0.024), frails performed TUG test in a longer time than pre-frail (p = 0.001) and non-frail (p < 0.001). As

for gait speed, frail adults had lower speed than non-frail (p = 0.01). In Lagarto, frails performed TUG test in more time than pre-frail (p = 0.002) and non-frail (p = 0.01), and frail older adults had lower gait speed than the non-frail (p = 0.04).

In the intergroup analysis, when older adults from Ribeirão Preto were compared with those from Lagarto, frail adults from Ribeirão Preto were older than frails from Lagarto (p < 0.001), pre-frails from Ribeirão Preto were significantly older than pre-frails from Lagarto (p = 0.004), and non-frails from Lagarto fell more than non-frails from Ribeirão Preto (p = 0.007).

For income, according to the Chi-square test, the most reported was <1 minimum wage (68.8 %) for Lagarto and 1-2 minimum wage (63.2 %) for Ribeirão Preto, in non-frail groups (p = 0.03). In pre-frail groups, 82.4% reported earning <1 minimum wage in Lagarto, and 56.5% earning 1-2 minimum wage in Ribeirão Preto (p = 0.01). In frail groups, 82.6% older adults reported earning <1 minimum wage in Lagarto and 72.2% reported earning the same amount in Ribeirão Preto (p = 0.04).

For years of education, in non-frail groups, 61.1% older adults declared having studied during 1-4 years in Lagarto and 47.4% during 5-8 years in Ribeirão Preto (p = 0.001). In the pre-frail, Lagarto and Ribeirão Preto had 57.9% and 60.9%, respectively, of older adults who reported 1-4 years of education (p = 0.001). Likewise, in frail groups, Lagarto and Ribeirão Preto had 62.2% and 42.1%, respectively, of older adults who reported 1-4 years of education (p = 0.01).

The logistic regression model showed that gait speed was not associated with Frail category, and the TUG test was positively associated with Frail category according to Fried phenotype for Ribeirão Preto and to the Edmonton frail scale for Lagarto. The results show that an increase in the time needed to perform the TUG test by 0.53 seconds led to a 1.7-fold increase in the risk of older adults to be frail in Ribeirão Preto; also, an increase in the time needed to perform the TUG test by 0.41 seconds led to a 1.5-fold increase in the risk of older adults to be frail in Lagarto (Table 2).

Table 2. Association between the scores of the Fried phenotype for Ribeirao Preto city and of the Edmonton frail scale for Lagarto city, and TUG test.

Test	β	Odds ration	95% CI	P- value
Ribeirao Preto				
TUG test	0.53	1.7	1.26-2.27	<0.001*
Gait speed	-1.74	0.17	0.01-2.81	0.21
Lagarto				
TUG test	0.41	1.5	1.13-1.99	0.004*
Gait speed	-0.31	0.7	0.01-51.4	0.88

TUG test, Timed up and Go test; CI, confidence interval; *P < 0.05 according to Multinomial Logistic Regression.
Source: Authors.

The ROC curves showed that the TUG test (AUC = 0.86, 95% CI, 0.78-0.95, p < 0.001) has moderate accuracy for the identification of frail older adults in Ribeirão Preto. The ROC curves showed that the TUG test (AUC = 0.76, 95% CI, 0.64t-0.88, p = 0.001) has moderate accuracy for the identification of frail older adults in Lagarto (Table 3). The cut-off points for TUG test for both cities (i.e., scores with the best sensitivity and specificity) are presented in Table 3. The scores with the highest sensitivity and specificity identified by the ROC curves for TUG were 11.5 seconds for Ribeirão Preto and Lagarto.

Table 3. A receiver operating characteristics (ROC) curve to determine the accuracy of the TUG test for the identification of frail older adults in Ribeirão Preto and Lagarto.

	AUC	95% CI	p- value	Cut-off point	Sensitivity	Specificity	LR(+)	LR(-)
TUG test- **Ribeirão Preto**	0.86	0.78 - 0.95	0.00*	11.5 s	0.94	0.67	2.85	0.09
TUG test- **Lagarto**	0.76	0.64 - 0.88	0.00*	11.5 s	0.87	0.38	1.40	0.34

AUC: area under the ROC curve; 95% CI: 95% confidence interval; LR: likelihood ratio; * p <0.05 according to ROC curve.
Source: Authors.

TUG test from Ribeirão Preto demonstrated the PoTP for a positive test of 40% and negative test of 2%. The TUG test from Lagarto demonstrated the PoTP for a positive test of 22% and negative test of 4% (Table 4). The results demonstrate that the older adults who perform the TUG test in less than 11.5 seconds have just 2% of probability to be frail in Ribeirão Preto and 4% of probability to be frail in Lagarto.

Table 4. Post-test probability (PoTP) for the clinical tests to identify frail older adults.

Variable	PoTP	
	PoTP (+)	PoTP (-)
Ribeirao Preto		
TUG test	40%	2%
Lagarto		
TUG test	22%	4%

TUG test, Timed up and Go test; PoTP, Post-test probability. Source: Authors.

4. Discussion

The present study demonstrated that considering the gait speed and TUG test, only the TUG test was able to discriminate frail older adults (moderate accuracy) and the same cut-off score was established for the older adults who live in different regions of Brazil. There are several instruments that are used to identify frail older adults, but there are some difficulties for their applicability in clinical practice, such as the need for more time for the execution or for expensive instruments, which are not always accessible in the clinical practice. Therefore, the possibility of using the TUG test for screening older adults with frail in primary care allows the use of simple and fast tools possible to be applied in any clinical setting, thus expanding the possibility of early identification of such individuals who need some health care approach.

Our results demonstrated that the cut-off score of 11.5 seconds for the identification of frailty may be appropriate for different profiles of older adults since our sample was composed of older adults from Northeastern Brazil (Lagarto) and Southeastern Brazil (Ribeirão Preto). Additionally, our results demonstrated that the TUG had moderate accuracy to identify frail older adults, even when different instruments for the classification of frailty were used.

Considering our results, in Ribeirão Preto, an increase of 0.53 seconds in the TUG test reflects a 1.7-fold greater risk of the older adult to become frail. On the other hand, in Lagarto, an increase of 0.41 seconds to perform the TUG test corresponds to a 1.5-fold greater risk. In other words, approximately half a second is already enough to almost double the risk of frailty, which reinforces the importance of periodic assessments in order to detect and intervene early.

Previous studies have shown that the TUG test is a good predictor of frailty identification. A cut-off point of 10 seconds for the TUG test was observed in some studies (Savva et al., 2013, Sukkriang et al., 2020, Ambagtsheer et al., 2020) with sensitivity of 72.0% and specificity of 82.54% obtained by Sukkriang et al., (2020). Ambagtsheer et al. (2020) obtained an AUC of 0.79, sensitivity of 82.5% and specificity of 50.50%. Savva et al. (2013) obtained an AUC of 0.87, sensitivity of

93.00% and specificity of 62.00%. However, Fillipin et al. (2017) suggested a cut-off point of eight seconds, with AUC of 0.775, sensitivity of 85.0%, specificity of 59.5%. Methodological differences, such as sample size and study design, may justify the divergence of the findings.

Using the post-test probability, the interpretation of our results is easier and more accessible for any health care professional, which may facilitate the research and clinical practice to get closer and reinforce the translational researches. Our results demonstrated that older adults both from Ribeirão Preto (2%) and Lagarto (4%) showed a low probability of having frailty when performing the TUG test below 11.5 seconds. On the other hand, when the time to spend the TUG test is 11.5 seconds or longer, those individuals should be directed to a multidisciplinary health care team in order to establish the appropriate therapeutic intervention to improve the physical and functional capacity and, consequently, minimize frailty.

Our results demonstrated that gait speed has no association with frailty, considering older adults of Ribeirão Preto and Lagarto (p < 0.05). Our results did not corroborate with Santos et al. (2016), who indicated the cut-off point of 5 seconds to walk a distance of 2.44 meters for the discrimination of frailty in the older adults, with a sensitivity of 88.9% and specificity of 74.5%.

This study has both strengths and limitations. It is the first study that evaluated older adults from two regions, who were diagnosed as frail using different instruments. Even so, it presented the same cut-off point. However, caution is necessary due to the small sample and lack of detail regarding the physical activity level of the Lagarto population.

5. Conclusion

The study showed that only the TUG test identified frail older adults in clinical practice. In addition, the same cut-off point was observed in older adults from two different regions. Future studies should include a larger sample and consider the level of physical activity when using the Edmonton Frail Scale.

References

Aguayo, G. A., Donneau, A. F., Vaillant, M. T., Schritz, A., Franco, O. H., Stranges, S., Malisoux, L., Guillaume, M., & Witte, D. R. (2017). Agreement Between 35 Published Frailty Scores in the General Population. *American journal of epidemiology*, *186*(4), 420–434. https://doi.org/10.1093/aje/kwx061.

Akobeng A. K. (2007). Understanding diagnostic tests 2: likelihood ratios, pre- and post-test probabilities and their use in clinical practice. *Acta paediatrica (Oslo, Norway:1992)*, *96*(4), 487–491. https://doi.org/10.1111/j.1651-2227.2006.00179.x.

Ambagtsheer, R. C., Visvanathan, R., Dent, E., Yu, S., Schultz, T. J., & Beilby, J. (2020). Commonly Used Screening Instruments to Identify Frailty Among Community-Dwelling Older People in a General Practice (Primary Care) Setting: A Study of Diagnostic Test Accuracy. *The journals of gerontology. Series A, Biological sciences and medical sciences*, *75*(6), 1134–1142. https://doi.org/10.1093/gerona/glz260.

Apolinario, D., Lichtenthaler, D. G., Magaldi, R. M., Soares, A. T., Busse, A. L., Amaral, J. R., Jacob-Filho, W., & Brucki, S. M. (2016). Using temporal orientation, category fluency, and word recall for detecting cognitive impairment: the 10-point cognitive screener (10-CS). *International journal of geriatric psychiatry*, *31*(1), 4–12. https://doi.org/10.1002/gps.4282.

Batistoni, S. S., Neri, A. L., & Cupertino, A. P. (2007). Validade da escala de depressão do Center for Epidemiological Studies entre idosos brasileiros [Validity of the Center for Epidemiological Studies Depression Scale among Brazilian elderly]. *Revista de saude publica*, *41*(4), 598–605. https://doi.org/10.1590/s0034-89102007000400014.

Bock, J. O., König, H. H., Brenner, H., Haefeli, W. E., Quinzler, R., Matschinger, H., Saum, K. U., Schöttker, B., & Heider, D. (2016). Associations of frailty with health care costs--results of the ESTHER cohort study. *BMC health services research*, *16*, 128. https://doi.org/10.1186/s12913-016-1360-3.

Brasil. Instituto Brasileiro de Geografia e Estatística (2015). *Síntese de indicadores sociais: uma análise das condições de vida da população brasileira*. http://biblioteca.ibge.gov.br/visualizacao/livros/liv95011.pdf.

Da Mata, F. A., Pereira, P. P., Andrade, K. R., Figueiredo, A. C., Silva, M. T., & Pereira, M. G. (2016). Prevalence of Frailty in Latin America and the Caribbean: A Systematic Review and Meta-Analysis. *PloS one*, *11*(8), e0160019. https://doi.org/10.1371/journal.pone.0160019.

Comans, T. A., Peel, N. M., Hubbard, R. E., Mulligan, A. D., Gray, L. C., & Scuffham, P. A. (2016). The increase in healthcare costs associated with frailty in older people discharged to a post-acute transition care program. *Age and ageing*, *45*(2), 317–320. https://doi.org/10.1093/ageing/afv196.

Fabrício-Wehbe, S. C., Schiaveto, F. V., Vendrusculo, T. R., Haas, V. J., Dantas, R. A., & Rodrigues, R. A. (2009). Cross-cultural adaptation and validity of the 'Edmonton Frail Scale - EFS' in a Brazilian elderly sample. *Revista latino-americana de enfermagem*, *17*(6), 1043–1049. https://doi.org/10.1590/s0104-11692009000600018.

Fabrício-Wehbe, S. C., Cruz, I. R., Haas, V. J., Diniz, M. A., Dantas, R. A., & Rodrigues, R. A. (2013). Reproducibility of the Brazilian version of the Edmonton Frail Scale for elderly living in the community. *Revista latino-americana de enfermagem*, *21*(6), 1330–1336. https://doi.org/10.1590/0104-1169.2933.2371.

Filippin, L.I., Miraglia, F., Leite, J.C.C., Chakr, R., Oliveira, N.C., & Berwanger, D.D (2017). Identifying frailty syndrome with TUG test in home-dwelling elderly. *Geriatr Gerontol Aging*., 11(2):80-7.

Fried, L. P., Tangen, C. M., Walston, J., Newman, A. B., Hirsch, C., Gottdiener, J., Seeman, T., Tracy, R., Kop, W. J., Burke, G., McBurnie, M. A., & Cardiovascular Health Study Collaborative Research Group (2001). Frailty in older adults: evidence for a phenotype. *The journals of gerontology. Series A, Biological sciences and medical sciences*, *56*(3), M146–M156. https://doi.org/10.1093/gerona/56.3.m146.

Lourenço, R. A., Moreira, V. G., de Mello, R. G. B., Santos, I. S., Lin, S. M, Pinto, A. L. F., Lustosa, L. P., Duarte, Y. A. O., Ribeiro, J. A., Correia, C. C., Mansur, H. N., Ribeiro, E., Dalla Corte, R. R., Ferrioli, E., Uehara, C. A., Maeda, A., Petroni, T. Lima, T. S., Durão, S. F., Aprahamian, I., Avesani, C. M, & Filho, W. J. (2018). Brazilian consensus on frailty in older people: concepts, epidemiology and evaluation instruments. *Geriatr Gerontol Aging*, 12(2):121-35.

Lusardi, M. M., Fritz, S., Middleton, A., Allison, L., Wingood, M., Phillips, E., Criss, M., Verma, S., Osborne, J., & Chui, K. K. (2017). Determining Risk of Falls in Community Dwelling Older Adults: A Systematic Review and Meta-analysis Using Posttest Probability. *Journal of geriatric physical therapy (2001)*, *40*(1), 1–36. https://doi.org/10.1519/JPT.0000000000000099.

Mazo, G. Z., & Benedetti. T. B. (2010). Adaptação do questionário internacional de atividade física para idosos. *Ver Bras Cineantropom Desempenho Hum.*,12(6):480-484.

Santos, P. L. S., Fernandes, M. H., Santos, P. H. S, Santana, T. D. B, Cassoti, C. A., Coqueiro, R. S., Carneiro, J. A. O. (2016). Indicadores de desempenho motor como preditores de fragilidade em idosos cadastrados em uma Unidade de Saúde da Família. *Motricidade*, 12(2): 88-96.

Savva, G. M., Donoghue, O. A., Horgan, F., O'Regan, C., Cronin, H., & Kenny, R. A. (2013). Using timed up-and-go to identify frail members of the older population. *The journals of gerontology. Series A, Biological sciences and medical sciences*, *68*(4), 441–446. https://doi.org/10.1093/gerona/gls190.

Shumway-Cook, A., Brauer, S., & Woollacott, M. (2000). Predicting the probability for falls in community-dwelling older adults using the Timed Up & Go Test. *Physical therapy*, *80*(9), 896–903.

Silveira, M.B., & Filippin, L.I. (2017). Timed Up and Go como ferramenta de screening para fragilidade em idosos fisicamente ativos. *Cad Saúde Colet.*, 25 (4): 389-393.

Sirven, N., & Rapp, T. (2017). The cost of frailty in France. *The European journal of health economics: HEPAC: health economics in prevention and care*, *18*(2), 243–253. https://doi.org/10.1007/s10198-016-0772-7.

Sukkriang, N., & Punsawad, C. (2020). Comparison of geriatric assessment tools for frailty among community elderly. *Heliyon*, *6*(9), e04797. https://doi.org/10.1016/j.heliyon.2020.e04797.

Tello-Rodríguez, T., & Varela-Pinedo, L. (2016). Fragilidad en el adulto mayor: detección, intervención en la comunidad y toma de decisiones en el manejo de enfermedades crónicas [Frailty in older adults: detection, community-based intervention, and decision-making in the management of chronic illnesses]. *Revista peruana de medicina experimental y salud publica*, *33*(2), 328–334.

Tribess, S., & de Oliveira, R. J. (2011). Síndrome da fragilidade biológica em idosos: revisão sistemática [Biological fragility syndrome in the elderly: systematic review]. *Revista de salud publica (Bogota, Colombia)*, *13*(5), 853–864. https://doi.org/10.1590/s0124-00642011000500014.

Verloo, H., Goulet, C., Morin, D., & von Gunten, A. (2016). Association between frailty and delirium in older adult patients discharged from hospital. *Clinical interventions in aging*, *11*, 55–63. https://doi.org/10.2147/CIA.S100576.

Walston, J., Buta, B., & Xue, Q. L. (2018). Frailty Screening and Interventions: Considerations for Clinical Practice. *Clinics in geriatric medicine*, *34*(1), 25–38. https://doi.org/10.1016/j.cger.2017.09.004.