

## Multidimensional analysis of frailty in older people of a Brazilian community: a cross-sectional study

Análise multidimensional da fragilidade em idosos de uma comunidade brasileira: um estudo transversal

Análisis multidimensional de la fragilidad en ancianos de una comunidad brasileña: un estudio transversal

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### Abstract

In Brazil, the aging process takes place under unfavorable economic, social and health conditions. Therefore, a better understanding of the functionality patterns of different elderly populations becomes essential, especially in times of Covid-19. The objective of study is to assess the functionality of institutionalized and community older people. Cross-sectional study with 51 older people, divided into two groups: Institutionalized Older People Group (GII) and Community Older People Group (GIC), assessed by the Mini Mental State Examination, Clinical Functional Vulnerability Index-20 (IVCF-20), Barthel Scale, Lawton Scale and Tinetti Scale, descriptive analysis, multivariate multiple correspondence technique, multinomial and binomial logistic regression, with the R software were performed. The results showed: the quartiles: robust GIC (IVCF-20=6.75), independent (Lawton=21/Barthel=100). The fragile GII (IVCF-20=18), partially dependent (Lawton=13/Barthel=100). In GII association of frail older people and high risk of falls. In the GIC there is no association. The GIC showed more chances compared to the GII: 198.34 cognitively normal; 5.48 robust; more than 100,000 independents; and 14 low risk of falls. In this way, it is concluded that older people in the community have better functional performance than older people living in the two Long Term Care Institutions.

**Keywords:** Activities of daily living; Aging; Geriatric assessment; Frailty; Independent living.

### Resumo

No Brasil, o processo de envelhecimento ocorre em condições econômicas, sociais e de saúde desfavoráveis. Por isso, uma melhor compreensão dos padrões de funcionalidade das diferentes populações idosas torna-se essencial, principalmente em tempos de Covid-19. O objetivo deste estudo foi avaliar a funcionalidade de idosos institucionalizados e da comunidade. Estudo transversal com 51 idosos, divididos em dois grupos: Grupo de Idosos Institucionalizados (GII) e Grupo de Idosos da Comunidade (GIC), avaliados pelo Mini Exame do Estado Mental, Índice de Vulnerabilidade Clínico Funcional-20 (IVCF-20), Escala de Barthel, Escala de Lawton e Escala de Tinetti, foram realizadas análise descritiva, análise de correspondência múltipla multivariada, regressão logística multinomial e binomial, com o software R. Os resultados mostraram: os quartis: GIC robusto (IVCF-20=6,75), independente

(Lawton=21/Barthel=100). GII frágil (IVCF-20=18), parcialmente dependente (Lawton=13/Barthel=100). No GII associação de idosos frágeis e alto risco de quedas. No GIC não há associação. O GIC apresentou mais chances em relação ao GII: 198,34 cognitivamente normais; 5,48 robusto; mais de 100.000 independentes; e 14 vezes baixo risco de quedas. Desta forma, conclui-se que os idosos da comunidade apresentam melhor desempenho funcional do que os idosos residentes nas duas Instituições de Longa Permanência.

**Palavras-chave:** Atividades cotidianas; Envelhecimento; Avaliação geriátrica; Fragilidade; Vida independente.

### Resumen

En Brasil, el proceso de envejecimiento ocurre en condiciones sociales y de salud favorables. Por lo tanto, una mejor comprensión de los patrones de funcionalidad de diferentes poblaciones se vuelve esencial, especialmente en tiempos de Covid-19. El objetivo de este estudio es evaluar la funcionalidad de los ancianos institucionalizados y la comunidad. Estudio transversal con 51 ancianos, divididos en dos grupos: Grupo de Ancianos Institucionalizados (GII) y Grupo de Ancianos Comunitarios (GIC), evaluados por el Mini Examen del Estado Mental, Índice de Vulnerabilidad Clínica Funcional-20 (IVCF-20), Escala de Barthel, Escala de Lawton y Escala de Tinetti, análisis descriptivo, análisis multivariado de correspondencias múltiples, regresión logística multinomial y binomial se realizaron mediante el software R. Los resultados mostraron: Cuartiles: GIC robusto (IVCF-20=6,75), independiente (Lawton=21/Barthel=100). GII frágil (IVCF-20=18), parcialmente dependente (Lawton=13/Barthel=100). En GII asociación de ancianos frágiles y alto riesgo de caídas. En el GIC no hay asociación. El GIC presentó más chances en relación al GII: 198,34 cognitivamente normal; 5,48 robusto; más de 100.000 independientes; y 14 veces bajo riesgo de caídas. De esta forma, se concluye que los ancianos de la comunidad presentan mejor desempeño funcional que los ancianos residentes en las dos Instituciones de Larga Estancia.

**Palabras clave:** Actividades cotidianas; Envejecimiento; Evaluación geriátrica; Fragilidad; Vida independiente.

## 1. Introduction

Ageing is defined as a sequential process of deterioration of a mature organism, proper to all members of a species, closely associated with the weakening process, and, consequently, directed to the death process (Moreira et al., 2020).

In Brazil, the ageing process occurs in unfavorable economic, social and health conditions (Belasco & Okuno, 2019). In 2010, the number of older people aged 60 or over in the country was approximately 20.5 million, and it is estimated that this number will reach 32 million in 2020, reaching 13.8% of the total Brazilian population, rising to 33.7 % in 2060 (IBGE, 2018). There is also an increase in life expectancy, with projections that it will reach 80 years in 2041, according to the Brazilian Institute of Geography and Statistics (IBGE, 2018).

With the advancement of age, there is a decrease in organic functions, including the immune system, which in addition to frailty promotes homeostatic and metabolic imbalance (Zeng et al., 2020), which may justify the prevalence of infectious and parasitic diseases such as morbidities. However, age, in itself, is an inadequate predictor of frailty (Moreira et al., 2020).

Among the risk factors related to frailty in the older people, the use of medication stands out (Pagno et al., 2018), chronic non-communicable diseases (Kaushal et al., 2019), low education (Belasco & Okuno, 2019), low socioeconomic conditions (Freer e Wallington, 2019), and female (Lee et al., 2020). Such factors have disabling sequelae, associated with great functional impairment and physical dependence (Crooms & Gelfman, 2020).

The frailty syndrome is a medical syndrome with multiple causes, which is characterized by decreased strength, resistance and reduction of physiological function that increases an individual's vulnerability to develop greater dependence and/or death (Lourenço et al., 2019). The outcome is a decline in the physiological system, related to sarcopenia, immune dysfunction and neuroendocrine dysregulation (Carraro et al., 2021).

When frailty is considered a syndrome, its prevalence rises to 74.1% in Long-Term Care Facilities (LTCF) and 50.6% in the hospital environment, checking the interaction of frailty with biological, psychological, cognitive, social and environmental factors experienced over time (Zeng et al., 2020; Freer & Wallington, 2019). Researches indicate that the

average prevalence of the syndrome is 13.6% and 33.5% for pre-fractures in older people in the community (Stubbs et al., 2020).

Older people care and attention must be considering the positive response to weight loss, exhaustion, low level of physical activity, reduced muscle strength and slow gait, it is possible to classify it as frail, pre-frail and non-frail older people (Guedes et al., 2020). These manifestations of the embrittlement cycle constitute the fragility phenotype proposed by Fried et al., 2001; once the risk is identified, the priority is early rehabilitation, in order to reduce the impact of chronic conditions on functionality, seeking to intervene before the injury occurs (Said et al., 2020).

In this context, the decline of the physiological system is accelerated and the homeostatic mechanisms begin to fail, with a consequent erosion of the homeostatic reserve, resulting in continuous loss of strength and aerobic resistance, which causes the older people to have a greater tendency to postural instability, changes in gait and risks of falls (Mkrtchyan et al., 2020).

Falls represent one of the main reasons for hospitalization of the older people in Brazil. In 2016, among the people hospitalized by the Unified Health System, 24.9% were over 60 years old and 14.2% over 70 years old (Carvalho et al., 2018), representing a rising public health problem (James et al., 2020). Each year, 28% to 35% of people over 65 years of age suffer some episode of fall, and this proportion rises to values ranging from 32% to 42% for the older people over 70 years of age (Almeida et al., 2019). Calf circumference less than 31 centimeters is currently considered the best clinical indicator of sarcopenia and is directly related to functional disability and the risk of falls (Bertschi et al., 2021).

In view of the above, as there is a need to constantly evaluate the health conditions of the older people, as this group is on the rise in the population in the country, the objective of this to assess the functionality of older people in the community and older people who live in two long-term institutions.

## **2. Methodology**

### **2.1 Study Design and Ethical Considerations**

This is a primary, analytical, observational, cross-sectional study, approved by the Research Ethics Committee of the University of Sapucaí Valley (UNIVAS), is located in Pouso Alegre, Minas Gerais, Brazil, under Consubstantiated Opinion number 3.505.573, Certificate of Ethical Approval number 16590719.8.0000.5102, which complies with the Declaration of Helsinki and registered at the Brazilian Registry of Clinical Trials, under number RBR-677rt3.

The researcher and the institutions followed the terms of Resolution 466/2012 of the Brazilian National Health Council. The materials and data obtained were utilized solely and exclusively for the aim of this study. The subjects only participated in the study after clarification, orientation and signing the Informed Consent Form (ICF). Informed consent was obtained from all participants.

### **2.2 Participants**

The community-dwelling older people were selected in Dores de Campos, in the state of Minas Gerais, Brazil, by oral invitation. They performed the study procedures at the local Social Assistance Reference Center (CRAS). The institutionalized older people were recruited in two Long-Term Care Facilities (LTCF) in Barroso and Prados, both also in the state of Minas Gerais. The recruitment took place between September and November 2019.

In order to select the participants, a pilot study was conducted, which tested the suitability of the geriatric assessment tools (Mini-Mental State Examination, Clinical and Functional Vulnerability Index, Barthel scale, Lawton scale and Tinetti scale) for 20 institutionalized older people.

First, the Shapiro-Wilk test was used to assess the normality of data and the *t*-test was applied to two samples. The significance level was 0.05 and the standard deviation was 5. The software Minitab version 18.1 was used for sample size determination, resulting in 21 subjects for each group.

The sample for this study consisted of 51 older people, 21 of them in the Institutionalized Older People Group (GII) and 30 in the Community-Dwelling Older People Group (GIC). The selected subjects were above the age of 60, of both sexes, ambulant even if with the aid of orthoses or prostheses, who accepted to participate in the study and signed the ICF. Subjects who either scored 17 points or fewer on the Mini-Mental State Examination, had immobility syndrome, or showed any conditions that made it impossible for them to carry out the proposed procedures, were not included in the study.

### 2.3 Assessment items

The first step of the comprehensive assessment was to fill in the Older People Data Record Survey with the personal information of the subjects. The other tools were split into two application stages: The first stage consisted of the Mini-Mental State Examination (MMSE) (Scarabelot et al., 2019), the second stage consisted of the Clinical and Functional Vulnerability Index (IVCF-20) (Faller et al., 2019), Barthel scale (Yi et al., 2020), Lawton scale (Dufournet et al., 2021) and Tinetti scale (Strini et al., 2021). After the situational diagnosis of the subjects, the data from each assessment tool were gathered in a spreadsheet and in the Older People Data Record Survey for control, analysis, and comparison.

### 2.4 Statistical Analysis

Firstly, measures of central tendency and variability were obtained for the quantitative variables (age, height, weight, BMI). Absolute and relative frequencies were obtained for the following variables: sex, physical activity and calf circumference. In order to assess the distribution of the data, boxplots were used to represent the individual observations for the IVCF-20, Lawton, Barthel and Tinetti scales. Multiple correspondence analysis was used to identify possible associations among the categories of the scales.

Given the categorical nature of the response variables in this study, generalized linear models were the chosen strategy for predictions and hypotheses testing. Thus, multinomial, ordered logistic regression and proportional odds models were used for the response variables MMSE, IVCF-20, Lawton and Barthel scales, which have more than two ranked categories. In addition, binomial logistic regression models were fitted to the Tinetti variable, which presents exactly two categories. Likelihood ratio tests and AIC-based stepwise were carried out to decide whether to include covariates in the final model. Based on the final models selected for each response variable, 95% confidence intervals were obtained for the odds ratio of interest by likelihood profiling.

All statistical analyses were conducted in R (R Core Team, 2018), using the packages ‘CA’, ‘MASS’ and ‘VGAM’.

## 3. Results

Table 1 shows the descriptive measurements obtained from the subjects for the quantitative variables. Absolute and relative frequencies for the variables sex, physical activity and calf circumference are shown in Table 2.

**Table 1.** Position and dispersion measures for the quantitative variables under study.

Group	Variable	Minimum	Maximum	Average	Standard deviation	Coefficient of Variation (%)	Median
GII	Age (years)	60	93	74.29	7.82	10.53	76
	Height (cm)	140	188	161	0.12	7.45	160
	BMI (kg/m <sup>2</sup> )	17.6	42.9	26.38	6.15	23.31	26.2
GIC	Age (years)	60	86	69,7	7.09	10.17	67
	Height (cm)	140	182	161	0.11	6.83	160
	BMI (kg/m <sup>2</sup> )	16.6	58.3	29.45	7.54	25.60	28.2

Source: Authors.

**Table 2.** Frequencies of the variables gender, physical activity and calf circumference.

Group	Sex	Activity Physics		Circumference calf					
		n <sub>i</sub>	100f <sub>i</sub> (%)	n <sub>i</sub>	100f <sub>i</sub> (%)				
GII	Male	13	62	Yes	9	43	< 31	9	43
	Female	8	38	No	12	57	> 31	12	57
GIC	Male	9	30	Yes	21	70	< 31	6	20
	Female	21	70	No	9	30	> 31	24	80

Abbreviations: n<sub>i</sub>: absolute frequencies; f<sub>i</sub>: relative frequencies. Source: Authors.

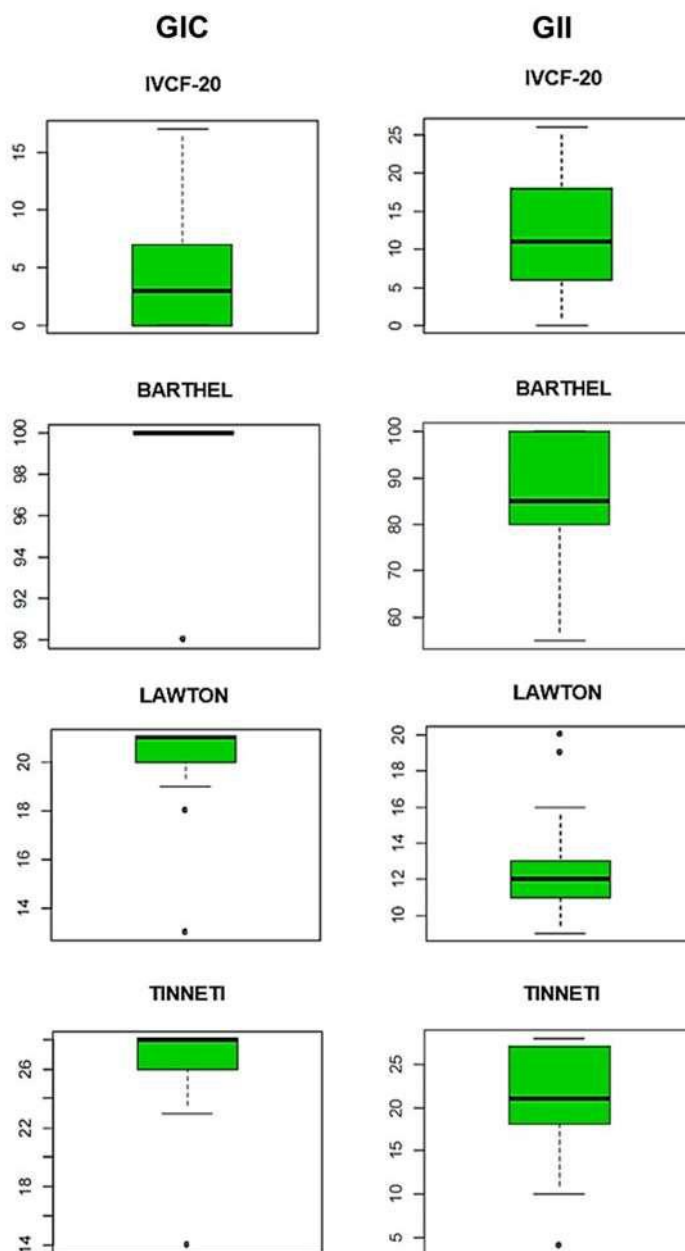
Table 3 and the boxplot in Figure 1 show that, in GII, the scores of all scales have skewness. On the Lawton scale, there are two discrepant measures, causing a positive skew. The Tinetti scale also has a discrepant observation.

**Table 3.** Position measures (minimum, maximum e quartiles) for the scores of the scales IVCF-20, Lawton, Barthel e Tinetti.

Group	Measure	IVCF-20	LAWTON	BARTHEL	TINNETI
GII	Minimum	0	9	55	4
	q <sub>1</sub>	6	11	80	18
	q <sub>2</sub>	11	12	85	21
	q <sub>3</sub>	18	13	100	27
	Maximum	26	20	100	28
GIC	Minimum	0	13	90	14
	q <sub>1</sub>	0	20	100	26
	q <sub>2</sub>	3	21	100	28
	q <sub>3</sub>	6,75	21	100	28
	Maximum	17	21	100	28

Abbreviations: q<sub>1</sub>=q(0,25): first quartile; q<sub>2</sub>=q(0,50): second quartile; q<sub>3</sub>=q(0,75): third quartile. Source: Authors.

**Figure 1.** Boxplot of the IVCF-20, Barthel, Lawton and Tinetti scores.



Source: Authors.

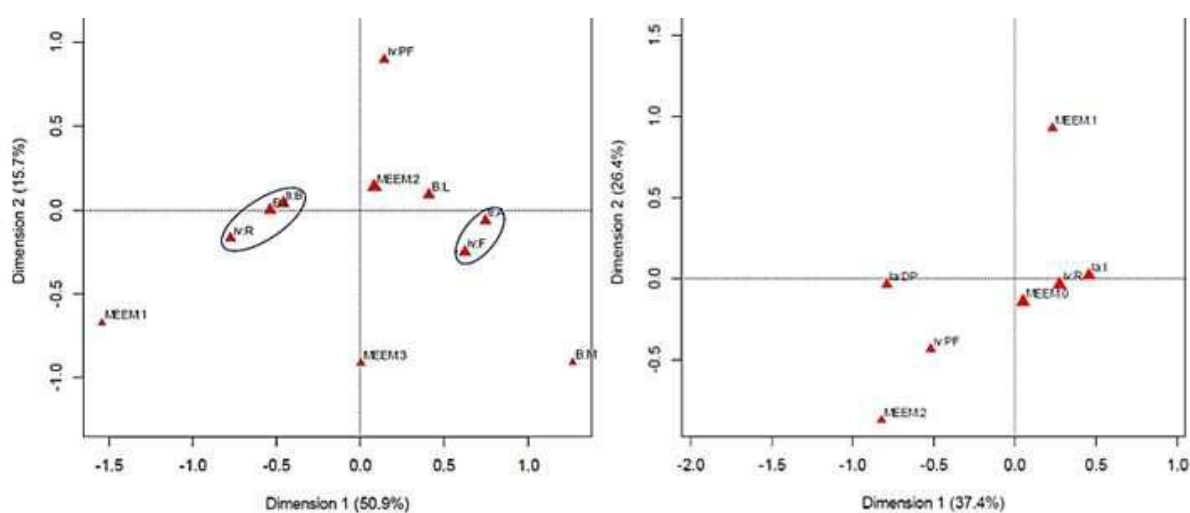
On the Lawton scale, GIC shows a higher concentration of scores of 20 and 21 points (75%). There is a discrepancy for scores of 13 and 18 points. There is a higher concentration (75%) of scores above 26 points and a divergent score of 14 points on the Tinetti scale. Out of the 30 subjects in the group, only two had a score of 90 on the Barthel scale. The others had a score of 100. For that reason, the scores of 90 are shown as highlighted, separated points (frequently and erroneously classified as “outliers”) in the boxplot.

When comparing the results of Table 3 and Figure 1, it is noted that, in general, the subjects of GIC have lower scores on the IVCF-20 scale, that is, lower frailty, and higher scores on the other scales, that is, higher independence in activities of daily living and lower risk of falling.

Multiple correspondence analysis was performed for GII to determine the association among the scales. It shows that

the first two dimensions in the perceptual map in Figure 2 explain 66.6% of the variance in the cloud of categories. An association was observed between the categories frail older people on the IVCF-20 scale (iv:F) and older people with high risk of falling on the Tinetti scale (ti:A), since both categories are to the right of axis 1. They contribute to 32.89% of variance along the axis. To the left of axis 1, the categories robust older people on the IVCF-20 scale (iv:R), independent older people on the Barthel scale (B:I) and with low risk of falling on the Tinetti scale (t:B) were related, contributing to 31.56% of variance along this axis. Regarding axis 2, no associations were observed. This analysis was not performed on the Lawton scale, since there was no difference in the classification of the subjects (they were all partly dependent in IADL). No association was observed among the scales for GIC.

**Figure 2.** Perceptual map of association of scales in GII and GIC.



Source: Authors.

The final model for the MMSE only included the effect of the group variable. Sex, age and BMI were not significant at 5% significance level. Estimates of the parameters of the model indicate that GIC is 198 (27.9 to 4313.9 at CI95%) times more likely to have normal older people than older people with cognitive function impairment or with mental decline when compared with GII.

The final model for the IVCF-20 scale included the covariates group, age and BMI, that is, there was no significant influence of sex on the categories of frailty. Estimates of the parameters indicate that GIC is 5.48 (1.45 to 23.4) times more likely to have robust older people in contrast to GII. In view of the negative estimates of parameters associated with age and BMI, it is noted that the increase in these variables decreases the chances of a subject being classified as robust. In fact, with the increase by one year of age, the chance of a subject being classified as frail increases by approximately 1.3 ( $=1/0.78$ ) times, whereas with one unit increase in BMI that chance increases by approximately 1.1 ( $=1/0.88$ ) times.

A scenario similar to that of the IVCF-20 scale occurred with the results obtained from fitting the model to the categories observed on the Lawton scale, that is, the patterns are the same, but more exaggerated. For instance, a subject of GIC is over 100 thousand times more likely to be independent than one of GII, so the 95% confidence limit could not be obtained with accuracy. In addition, the degree of dependence on the Lawton scale is also negatively affected by age and BMI: the increase by one year of age and one BMI unit increase the chance of an older people being wholly or partly dependent by 1.2 (1.04 to 1.45) and 1.14 (1.28 to 1.00) times, respectively.

Although similar to the results obtained from the Lawton scale, the ones obtained from fitting the model to the data observed on the Barthel scale indicate differences for group and sex, in addition to the effect of age. According to these results, women tend to show a degree of independence nearly eight times higher than men. The group and age patterns were remarkably close to those observed for the other scales.

The binomial model for the risk of falling fit to the data from the Tinetti scale included covariates group and age. A subject of GIC is 14 times more likely to show low risk of falling when compared to one of GII and, for every year of age, the chance of showing high risk of falling increases by approximately 1.15 times.

#### 4. Discussion

Our findings show the characteristics of both institutionalized and community-dwelling older people in terms of cognition, frailty, functional independence and balance and gait performance with risk of falling.

The average age of the subjects in this study was of 74.2 ( $\pm 7.82$ ) years with a minimum of 60 and a maximum of 93 years in GII, and of 69.7 ( $\pm 7.09$ ) years with a minimum of 60 and a maximum of 86 years in GIC. Previous studies have observed similar values, such as Pagno et al. (2018) where the average age of the subjects was of 71.1 ( $\pm 8.28$ ) years with a minimum of 60 and a maximum of 102 years. Bagueixa et al. (2017) discuss the frailty of older people who are admitted to an orthopedics unit, with ages ranging from 65 to 98 years and an average of 79.7 ( $\pm 7.50$ ) years.

In the present study, community-dwelling older people had a lower average age (69.7 years) and a higher average weight (75.3 kg), with a higher proportion of overweight subjects when compared with the older people living in institutions (average age of 74.2 years and average weight of 68.7 kg). The prevalence of overweight community-dwelling older people can be explained by the fact that they have free access to food. Most older people living in institutions are men who do not exercise, as opposed to community-dwelling older people, who are mostly women who exercise.

Our findings are consistent with a study on the quality of life among elderly people living in a Brazilian community and elderly people living in long-term care facilities by Dias and Pais-Ribeiro (2018) that shows a prevalence of women among the community-dwelling older people. Results obtained by Simeão et al. (2018) in a study on the quality of life of both nursing home residents and the older people who go to *Centro Dia* (a community center that provides the older people with acceptance, protection and social interactions), with a prevalence of men in nursing homes, are also consistent with our findings. This might be explained by the fact that adult women are afraid of depending on other people, hence more independent.

The present study shows a lower score on the IVCF-20 scale and higher scores on the other scales for GIC when compared with GII. From these data we can infer that community-dwelling older people are less frail and more independent, with a lower risk of falling. Bagueixa et al. (2017) when assessing the frailty of the older people admitted to an orthopedics unit, observed that the higher the score on the Barthel scale, the higher the score on the Lawton scale. That means that older people who are more independent in Activities of Daily Living are also more independent in Instrumental Activities of Daily Living and have a lower cognitive risk. These results are consistent with our findings.

Maia et al. (2020) in their study on the prevalence of robustness among older people, found that 48% of the 1,750 subjects were considered robust, which was associated with independence in performing Activities of Daily Living on the IVCF-20 scale. Regarding GII in the present study, low risk of falling is associated with independence on the Barthel scale and with robustness on the IVCF-20 scale. On the other hand, there is a correlation between high risk of falling and frailty on the IVCF-20 scale, which was expected.

Regarding the odds ratio, in this study, subjects of GIC were more likely to be cognitively normal, robust, independent and with a low risk of falling when compared with GII. Vieira et al. (2018) in their study on the prevalence of falls and its



factors among the older people, found a higher prevalence ratio for falls among women, older people at an advanced age, and older people with functional disabilities in instrumental activities of daily living.

## 5. Conclusion

Older people in the community have better functional performance than older people living in Long Term Care Institutions.

This study has some limitations, such as the small number of participants in the sample due to the exclusion of the MMSE. For more robust results, further well-designed studies with larger populations should be conducted in the future.

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