Accuracy of the life-space mobility measure for discriminating frailty and sarcopenia in older people

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Abstract

Objective: To identify the profile of a sample of older people recruited at home based on a measure of life-space mobility and to establish the accuracy of the cut-off points of this instrument for discriminating between levels of frailty, frailty in walking speed and risk of sarcopenia. *Method:* An observational methodological study of 391 participants aged ≥72 (80.4±4.6) years, who answered the Life-Space Assessment (LSA) and underwent frailty and risk of sarcopenia screening using the frailty phenotype and SARC-F measures, respectively, was performed. The cut-off points for frailty and risk of sarcopenia were determined using ROC (Receiver Operating Characteristic) curves and their respective 95% confidence intervals. *Results:* Mean total LSA score was 53.6±21.8. The cut-off points with the best diagnostic accuracy for total LSA were ≤54 points for frailty in walking speed (AUC=0.645 95%; $p<0.001$) and ≤60 points for risk of sarcopenia (AUC=0.651 95%; $p<0.001$). *Conclusion:* The ability of older people to move around life-space levels, as assessed by the LSA, proved a promising tool to screen for frailty in walking speed and risk of sarcopenia, thus contributing to the prevention of adverse outcomes.

Keywords: Aging. Older people. Frailty. Sarcopenia. Mobility Limitation.

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INTRODUCTION

Mobility can be defined as intentional activity of a person moving oneself from one place to another. This movement is undertaken within the internal and external environments and for specific purposes, such as walking around the house, visiting friends and family, taking part in religious or cultural events and visiting health services[1,2]. Independence for mobility is recognized as a key marker of functioning and healthy aging[1,3]. Studies have found mobility to be associated with physical and psychological wellbeing in older people[1-3]. Moreover, social engagement of older adults is strongly associated with mobility outside the home, into the neighborhood or journeys to places within and beyond the city[2].

For research purposes, mobility within and beyond one's home has been measured in terms of life-space[4-6]. To this end, Webber et al.[6] devised a life-space framework which includes concentric areas of expanding locations from home with increasing requirements for independent mobility. These mobility zones include the room where one sleeps, the home, the outdoor area surrounding the home, the neighborhood, the service community (e.g., shops, banks, health care facilities), the town, the surrounding area (e.g., within the state and country) and the world[6]. Under this model, life-space is measured by an instrument called the Life Space Assessment (LSA)[5] which estimates the magnitude or extent of travel within environments that expand from one´s home into the wider environment beyond, regardless of how one gets there, albeit independently or by using assistive devices or transportation[5].

The LSA was validated in a random sample of 306 older adults aged 65 years and older. The test-retest reliability at 2-week follow-up was 0.96 (95% CI=0.95–0.97)[1]. The LSA has been translated into several languages (German, Chinese, Danish, Spanish, Finnish, French-Canadian, Japanese and Portuguese)[1]. The Brazilian version of the LSA has met content validity criteria in community-dwelling older adults. The instrument had a Cronbach alpha of 0.92 and intraclass correlation coefficient of 0.97 (95% CI=0.95-0.98)[7].

The life-space is a good construct and valid criterion for assessing mobility limitations[1,4,5,6]. In older adults, mobility restriction in life spaces is associated with adverse health events, such as falling, fractures, sarcopenia, cognitive decline, frailty and institutionalization and even death[1,7-12]. Conversely, the maintenance of mobility in life spaces is associated with good functional capacity and sense of autonomy, resulting in the desire to participate in social activities and in good levels of perceived quality of life[1,5,8,9,13-16]. Impaired mobility stems not only from the cumulative effect of comorbidities on physiological systems, but also from the interaction of biological, behavioral, social, economic and environmental factors[1,2,15,16].

Life-space mobility is a multidimensional concept able to identify negative health and functioning outcomes in older adults, including sarcopenia and frailty[1,12-17]. Assessing life-space mobility is straightforward and low-cost and has great potential for monitoring older individuals treated under the primary care system[1], but is a tool little used in Brazil for this purpose. Although distinct concepts, the coexistence of sarcopenia, frailty and mobility restriction is common with aging.

The objective of the present study was to identify the profile of life-space mobility in community-dwelling adults and to determine the accuracy of the cut-off points of the instrument for discriminating frailty levels, frailty in walking speed and risk of sarcopenia.

METHODS

A cross-sectional, descriptive, observational, methodological study was carried out based on data from the Fibra (Frailty in Brazilian Older Adults) study. The Fibra is a multicenter, population-based study with measurements collected during 2 waves (2008-2009 and 2016-17) at cities selected according to convenience in the 5 geographic macro regions of Brazil. In the first wave of measurements, a simple randomization of a predefined number of census sectors was performed, with sectors grouped by geographic criteria for the purposes of recruitment and data collection. At baseline, quotas of men and

women aged 65-69, 70-74, 75-79 and ≥80 years were recruited, with quotas estimated according to size of the respective segments of the general population, with the addition of a further 25% to replace possible losses.

This stage also entailed the application of eligibility and exclusion criteria at the time of recruitment, performed at households and points of flow of older adults. The eligibility criteria were: age, being a permanent resident of the city and within the census sector, comprehension of instructions, and acceptance of the invitation to take part in a study on demographic, socioeconomic, health and psychosocial factors associated with frailty in older adults. The exclusion criteria comprised: severe sensory deficits, stroke complications such as aphasia, immobility and local loss of strength, dementia, advanced-stage Parkinson´s Disease, being bedridden or constrained to a wheelchair, impaired comprehension and expression, cancer, undergoing chemotherapy treatment, and terminal illness. Data collection took place through a single session lasting 40-90 mins held at public venues on dates and times previously scheduled with the participant (see Neri et al.[18] for further details on methodology).

In 2015, the second wave of measurement collection was conducted involving the samples of Campinas city and Ermelino Matarazzo (subdistrict of São Paulo city). In the second wave, 549 (42.8%) out of the baseline sample of 1,284 participants from the first wave were recruited and reinterviewed at households. Between the two waves, a total of 192 respondents (14.9%) had died and 543 (42.3%) were considered sample losses (due to refusal, not found, exclusion, drop-out or safety risk to interviewers). Of the 549 participants reinterviewed, 130 were subsequently excluded for scoring below the education-adjusted cut-off points on the Mini-Mental State Exam (MMSE)[19-21], namely: 17 for illiterate individuals and those with no formal schooling; 22 for individuals with 1-4 years; 24 for 5-8 years, and 26 for ≥9 years of education[19,20]. Out of the 419 who scored above the MMSE cut-off, a further 28 individuals were excluded, giving a final sample for the present study of 391 older adults aged ≥72 years in 2016-2017.

The variables investigated were sociodemographics, sex (derived from yes/no responses to male/female options), age (derived by subtracting date of birth from data of follow-up interview), marital status [married or living with partner, single, divorced, widowed] and full years of education (0,1-4, 5-8 or ≥9).

Life-space mobility was measured using the LSA questionnaire[6], translated and transculturally adapted to Brazilian Portuguese[22] and submitted to psychometric studies for validity, reliability and interpretability[7]. As an indicator of internal consistency, the scale had a Cronbach alpha of 0.92, intraclass correlation coefficient of 0.97 (95% CI 0.95-0.98), and standard error of measurement of 4.12[7]. The LSA consists of questions on the 5 life-space levels frequented by the respondent, with or without assistance, in the 4 weeks leading up to the assessment: 1) other rooms of the home besides the room where they sleep; 2) an area immediately outside the home; 3) places in neighborhood; 4) places outside neighborhood; and 5) places outside town. The frequency per week is recorded (<1 time, 1-3 times, 4-6 times or daily), along with degree of independence (without assistive devices or personal assistance, and with assistive devices or personal assistance), with which each older adult frequents and uses these spaces.

Overall score on the scale ranges from 0-120 points and is calculated by tallying the scores for each life-space level. Higher overall score indicates greater life-space mobility[6]. Simões et al.[7] analyzed the validity, reliability and interpretability of the LSA for Brazilian community-dwelling adults. The LSA met the criteria for content validity.

Frailty was assessed based on the phenotype model, operationalized by Fried[23], involving 5 components: 1) Unintentional weight loss in the 12 months prior to interview of 4.5kg or 5% of body weight[23]; 2) Fatigue/exhaustion as indicated by always and almost always responses to either of 2 items on strength and vitality for carrying out activities of daily living (ADLs), in the past 7 days[23,24]; 3) Low hand-grip strength measured by hand-held dynamometer[23], as defined as a force value below the 1st quintile of the distribution of

means of the sample for 3 consecutive attempts, adjusted by sex and body mass index - BMI (men: BMI ≤23kg/m^2, cut-off: ≤24.67kgf; BMI>23kg and <28kg/m^2, cut-off: ≤23.33kgf; BMI≥28 and <30kg/m^2, cut-off: ≤45.90kgf; BMI≥30kg/m^2, cut-off: ≤21,33kgf. Women: BMI≤23kg/m^2, cut-off: ≤10.67kgf; BMI>23kg and <28kg/m^2, cut-off: ≤13.33kgf; BMI≥28 and <30kg/m^2, cut-off: ≤13.67kgf; and BMI≥30kg/m^2, cut-off: ≤13.33kgf); 4) Slow walking speed as indicated by mean time in seconds, for 3 attempts, taken to walk 4.6m in a straight line with usual gait, yielding values above the 80th percentile of the distribution, adjusted for height and weight (men: height ≤166cm, cut-off: ≥7.60; height >166cm, cut-off:≥7.10. Women: height ≤152cm, cut-off:≥8.54; height>152cm, cut-off:≥8.62)[25]; and 5) Low physical activity level indicated by weekly energy expenditure in METs (Metabolic Equivalent of Task) adjusted for gender, spent on moderate or vigorous intensity physical exercise in leisure or active sports situations, as per responses on selected items from the Minnesota Leisure Time Activities Questionnaire[25]. Individuals scoring within the lowest 20% of values for the distribution were classified as frail.

Risk of sarcopenia was screened using the 5-item SARC-F[26,] questionnaire validated for the Brazilian population[26]. In 4 of the items, participants were probed whether they experienced difficulty performing the following activities: 1) lifting and carrying 5kg; 2) walking across a room; 3) rising from a chair or bed; and 4) climbing a flight of 10 stairs. Each item response was scored on a 3-level scale: 0= none; 1= some; and 2= a lot or unable without assistance. The fifth item asks how many times the respondent has fallen in the past year[25]. Total score on the SARC-F ranges from 0 to 10 points, with 0-4 points indicating absence of signs suggesting risk of sarcopenia, while 5-10 points suggests presence of risk of sarcopenia[27].

This study is part of the follow-up study of the Campinas and Ermelino Matarazzo cohorts of the Fibra Study: predictors and outcomes of frailty in older adults in Brazil. The present investigation complied with Resolution nos. 466/2012 and 510/2016 and was approved by CEP UNICAMP permit nos. 1.332.651 of 23/1/2015 and by CEP Unicamp permit no 2.847.829, of 27/08/2018. All participants were informed about the study goals and procedures and regarding their rights and obligations, and signed the Free and Informed Consent Form.

The sample profile was described by building frequency tables containing the categorical variables, expressed as absolute frequency (n) and percentage (%), and descriptive statistics for numeric variables. Cronbach's alpha coefficient was employed to analyze internal consistency. Alpha values ≥0.70 were taken to indicate high consistency. The Mann-Whitney test was used to compare numeric variables between the two groups, whereas the Kruskal-Wallis test was used for comparison of three or more groups, given the absence of normal distribution of variables. Spearman´s correlation coefficient was employed to determine correlation of the variables frailty, frailty in walking and risk of sarcopenia with LSA score. The level of significance adopted for the statistical tests was 5% ($p<0.05$).

Receiver Operating Characteristic (ROC) curves were plotted to identify the optimal cut-off point for the LSA as best predictors of frailty and risk of sarcopenia, maximizing the sensitivity and specificity of these measures. The area under the curve, and respective 95% CI, were also determined for this measure.

RESULTS

Of the total sample (n=391), 273 (69.8%) participants were female and mean age was 84.3 (±4.6) years. Regarding marital status of participants, 181 (46.6%) were widowed and 117 (45.6%) married or living with a partner. For education, 231 respondents (59.0%) had 1-4 years of education. In terms of frailty status, 248 participants (63.4%) were classified as pre-frail and 64 (16.3%) as frail. Of the sample, 76 (20.0%) scored for frailty in walking. Regarding sarcopenia, 296 (76.6%) had no signs suggesting risk of sarcopenia (Table 1).

Table 1. Characteristics of sample (N=391) for sociodemographic data, frailty, and sarcopenia risk. FIBRA study, participants from Campinas and Ermelino Matarazzo, São Paulo state, Brazil, 2016-2017.

Variables	n (%)
Sex	
Female	273 (69.8)
Male	118 (30.1)
Age (years)	
72-79	161 (41.1)
≥ 80	230 (58.8)
Marital status	
Married or living with partner	117 (45.6)
Single	18 (4.6)
Divorced	12 (3.0)
Widow(er)	181 (46.6)
Educational level (years)	
0	55 (14.0)
1-4	231 (59.0)
5-8	61 (15.6)
≥ 9	44 (11.2)
Frailty level	
Non-frail	79 (20.2)
Pre-frail	248 (63.4)
Frail	64 (16.3)
Sarcopenia risk*	
Absence of signs suggesting sarcopenia risk	296 (76.6)
Presence of signs suggesting sarcopenia risk	90 (23.3)

*Frequency missing = 05.

The LSA showed moderate internal consistency, with a Cronbach alpha coefficient of 0.613. Mean total score was 53.6±21.8 points and median 52.5 points. With regard to mobility of participants at each LSA level, 385 (98.7%) reported frequenting level 1 daily. As the life-space extended, there was a reduction in mobility reported within the environments each participant used and in the frequency of access. At level 4 for instance, 142 (44.7%) reported accessing this space less than once a week, while 201 (53.3%) did not access level 5 at all. In terms of independence in life spaces, 352 (90.5%) were independent for level 1 and 138 (75.8%) for level 5. However, an increased need of personal assistance for life-space mobility was evident from level 4 and above (Table 2).

Regarding the relationship between total LSA scores and sociodemographic variables, frailty, frailty in walking speed and risk of sarcopenia, participants who scored for frailty, frailty in walking or attained >4 points on the SARC-F had lower total scores on the LSA (Table 3).

There was no significant correlation between the variable age and total LSA score. Conversely, the variables frailty, frailty in walking speed and risk of sarcopenia correlated significantly with total LSA score (Table 4).

Using ROC curves, the optimal cut-off scores on the LSA for predicting frailty levels (non-frail, pre-frail and frail), frailty in walking speed and risk of sarcopenia were determined. Areas under the curve (AUC) were significant for frailty in walking speed and for risk of sarcopenia at total LSA scores of ≤54 and ≤60 points, respectively (Figure 1).

Table 2. Description of LSA (Life Space Assessment) according to the 5 life-space levels accessed by participants, with or without assistance, in the 4 weeks leading up to assessment. FIBRA study, participants from Campinas and Ermelino Matarazzo, São Paulo state, Brazil, 2016-2017.

Life-space level	n	Weekly frequency	n (%)	Independence	n (%)
Level 1	390	< 1 time	2 (0.5)	personal assistance	7(1.8)
		4-6 times	3 (0.7)	devices	30 (7.7)
		daily	385 (98.7)	none	352 (90.4)
Level 2	389	< 1 time	3 (0.7)	personal assistance	11 (2.8)
		1-3 times	14 (3.6)	devices	34 (8.7)
		4-6 times	11 (2.8)	none	343 (88.4)
		daily	359 (92.7)		
Level 3	341	< 1 time	53 (15.5)	personal assistance	22 (6.3)
		1-3 times	96 (28.0)	devices	31 (8.9)
		4-6 times	33 (9.6)	none	292 (84.6)
		daily	160 (46.7)		
Level 4	317	< 1 time	142 (44.7)	personal assistance	45 (14.0)
		1-3 times	104 (32.8)	devices	19 (5.9)
		4-6 times	17 (5.3)	none	256 (80.0)
		daily	54 (17.0)		
Level 5	176	< 1 time	164 (91.6)	personal assistance	36 (19.7)
		1-3 times	8 (4.4)	devices	8 (4.4)
		daily	7 (3.9)	none	138 (75.8)

Level 1- other rooms of the home besides the room where participant sleeps; Level 2- an area immediately outside the home area, e.g. porch, patio, garage, or hallway of an apartment; Level 3- places in neighborhood, beyond own property or building; Level 4- places outside neighborhood, but within the town; and Level 5- places outside town.

Table 3. Comparative analysis of total scores on LSA, according to sociodemographic variables, frailty, frailty in walking speed, and risk of sarcopenia. FIBRA study, participants from Campinas and Ermelino Matarazzo, São Paulo state, Brazil, 2016-2017.

Variables	Total score on LSA	*p-valor*
Sex		p=0.139*
Female (n=273)	56	
Male (n=118)	52	
Age		p= 0.749*
72-79 years (n=161)	52	
≥ 80 years (n=230)	54	
Education		p=0.228**
0 years (n=55)	45	
1-4 years (n=231)	54	
5-8 years (n= 61)	52	
≥ 9 years (n=44)	55	
Frailty		**p= 0.001****
Non-frail (n=79)	62	
Pre-frail (n=248)	52	
Frail (n=64)	38.5	

to be continued

Continuation of Table 3

Variables	Total score on LSA	*p-valor*
Frailty in walking speed		***p*<0.001***
Yes (n=76)	35.2	
No (n=306)	56	
Risk of sarcopenia		***p*<0.001***
Presence of signs suggesting risk of sarcopenia (n=90)	39	
Absence of signs suggesting risk of sarcopenia (n=296)	56	

Total score on LSA ranges from 0 to 120 points. Higher overall score indicates greater life-space mobility. *p*-value of Mann-Whitney test for comparison of variables between 2 groups; **p-value of Kruskal-Wallis test for comparison of variables among 3 or more groups.

Table 4. Correlation of LSA with age, frailty criteria score, walking speed and risk of sarcopenia assessments. FIBRA study, participants from Campinas and Ermelino Matarazzo, São Paulo state, Brazil, 2016-2017.

LSA scores	Age	Frailty	Frailty in walking speed	Sarcopenia risk
Total	*r*= -0.0628	*r*= -0.3389	*r*= -0.4440	*r*= -0.4205
	p= 0.2234	***p*=<0.0001**	***p*<0.0001**	***p*<0.0001**

r= Spearman's correlation coefficient.

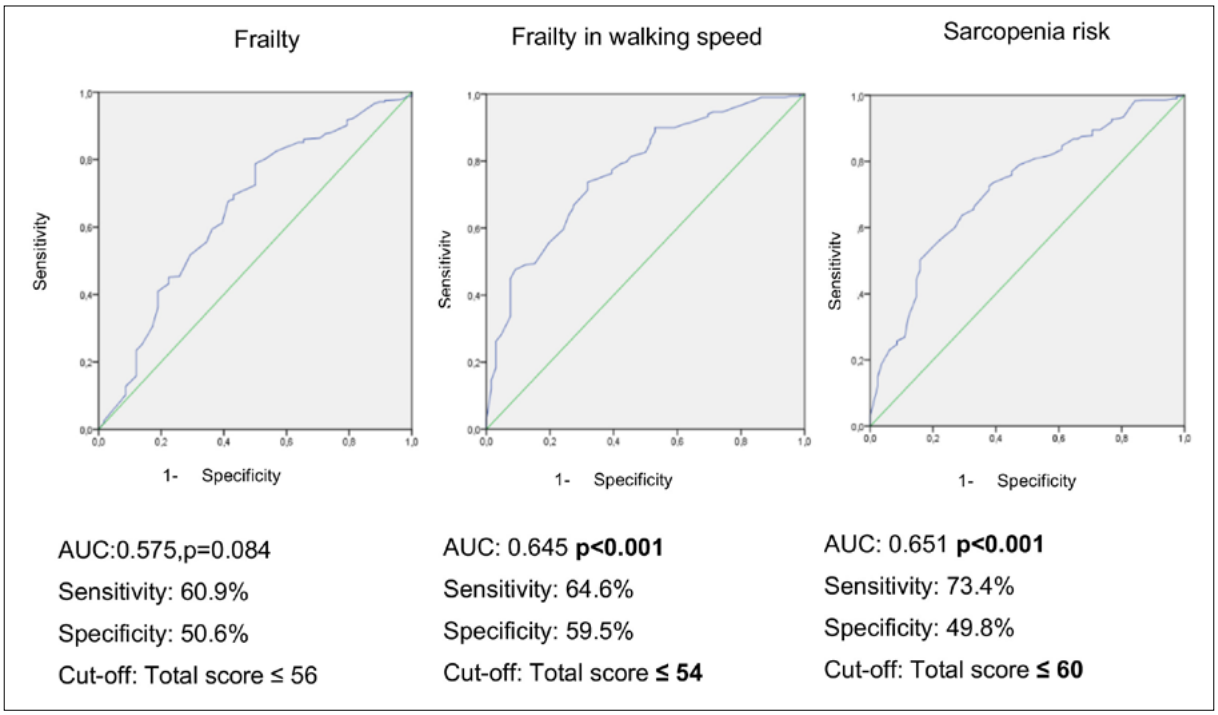

Figure 1. ROC curve demonstrating sensitivity and specificity of optimal cut-off points for total LSA score as predictors of frailty in walking and risk of sarcopenia. FIBRA study, participants from Campinas and Ermelino Matarazzo, São Paulo state, Brazil, 2016-2017.

DISCUSSION

This study found that LSA scores were correlated with scores for frailty in walking speed and risk of sarcopenia. The optimal cut-offs of total LSA score for best diagnostic accuracy were ≤54 for frailty in walking speed and ≤60 points for risk of sarcopenia.

The maintenance of mobility is believed to be fundamental to healthy active aging[1,3]. Conversely, loss of mobility can adversely affect physical and mental health, limiting social participation in the community and negatively impacting quality of life[1,3,8,9,11-16]. The study of Rantakokko et al.[9] investigating changes in life-space mobility and quality of life among community-dwelling older people found a mean LSA score of 63.9 in their sample with a mean age of 80,6 years.

By comparison, overall score on the LSA averaged 53.6 for the present study sample with a mean age of 84.3 years. No national studies of individuals aged 80 or older are currently available. However, a study of older adults from the Brazilian city of Natal city (n=150)[22] reported a mean LSA score of 59.6 in a sample with a mean age of 69.6 years. In the study by Simões et al.[7] exploring the properties of the LSA measure in Brazilian community-dwelling Brazilian adults with a mean age of 70 years, found a mean LSA score of 52.8 points[7].

According to Tsai et al.[28], scores above 60 have been considered to indicate impaired space-life mobility, suggesting the individual is no longer able to travel beyond their surrounding area, where this restriction correlates with low levels of social participation and increased risk for mortality.

Cross-sectional studies analyzing sociodemographic variables and LSA scores have shown advanced age[5,29,30], female gender[5,29-31], lower socioeconomic level[29,30,32] to be associated with reduced LSA scores. According to Webber et al.[6] and Choi et al.[8], impaired mobility has been shown to be an early predictor of physical disability and restriction in functional performance. In the present study, as life-space expanded, a growing proportion of participants required more personal help to travel in spaces associated with greater physical and cognitive demand (6.3% at level 3, 14.0% level 4 and 19.5% for level 5). Commensurately, the number of times a week that each life-space level was accessed fell with increasing distance and demands. From level 3 and above, there was a steady decline in the weekly frequency of movement.

According to studies by Rantakokko et al.[9,31], the most common restrictions in participation of older people involve environmental barriers. Increased social and emotional support and sense of security to go outside the home and travel to places outside the immediate neighborhood, as well as inside and outside town, can contribute to functioning and activities of older adults[9,31].

In clinical practice, particularly primary health, measures that are straight-forward, rapid, low-cost and offering good predictive power are needed to screen for mobility restriction[33].

LSA scores were negatively correlated with frailty, frailty in walking speed and risk of sarcopenia, where higher scores on the scale were associated with fewer frailty criteria, faster walking time and lower sarcopenia screening score. The optimal cut-offs of total LSA score for best diagnostic accuracy were ≤54 for frailty in walking speed and ≤60 points for risk of sarcopenia. Portegijs et al.[12] identified older adults with risk of reduced mobility in activities of daily living using the LSA. The study found a cut-off of 52.3 for a mean age of 80.4 years, 86% sensitivity and 74% specificity. In the present study, the results of analysis of the ROC curve analysis and of diagnostic accuracy measurements revealed ideal cut-offs for total LSA score of ≤54 as a predictor of frailty in walking speed (64.6% sensitivity and 59.5% specificity) and of ≤60 as a predictor of risk of sarcopenia (73.4% sensitivity and 49.8% specificity).

Ullrich et al[34]. estimated the cut-off for the LSA in 118 older persons with cognitive impairment and comorbidities. The authors found the ideal cut-off on the LSA to differentiate between individuals with reduced life-space (confined to home) and extended life-space (out of home and active) was <26.75 (range 0-90 points), with sensitivity of 78% and specificity 84%, and moderately accurate diagnostic validity of 0.8.

The present study sample had singular characteristics, calling for caution in generalization of results[16]. The participants were older survivors of a previous study investigating the frailty profile in older Brazilian adults. It is possible that the more robust participants with better health status survived, a factor which may have affected the results. In general, older participants in the FIBRA study have demonstrated better health status compared to those of other studies[16,18]. Approximately 63% of participants were classified as pre-frail and 76% exhibited no signs of risk of sarcopenia. The study participants were survivors of a baseline sample assessed in 2008-2009 which originally had a robust, pro-active profile[18].

Because collection for this study was carried out at households, it was not possible to fully follow the Find cases-Assess-Confirm-Severity (F - A - C - S) path as recommended by the European Working Group on Sarcopenia in Older People (EWGSOP) consensus[35]. Risk of sarcopenia was screened using the SARC-F alone, corresponding to the Find cases step. The subsequent steps, comprising the assessment and confirmation of sarcopenia using the handgrip strength measure, and detection of low muscle mass and quality using imaging techniques, such as Dual-energy X-ray absorptiometry (DEXA), could not be performed[35].

Strengths of the study include its novel contribution in Brazil regarding screening frailty and risk of sarcopenia using the life-space mobility assessment (LSA) scale. Given its low-cost and ease-of-use, the tool holds promise for use in clinical and primary health settings. Further studies investigating the utility and impact of life-space mobility in monitoring older adults treated in primary care are warranted.

CONCLUSION

The ability of older adults to move through different levels of life space, as measured by the Life Space Assessment (LSA) scale, proved a useful tool to help screen for frailty in walking speed and risk of sarcopenia in the older population. The use of the LSA in different lines of gerontological health care, together with accurate cut-offs, can help health professionals employ preventive approaches to slow functional decline and maintain social participation.

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