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Kihon Checklist to assess frailty in older adults: Some evidence on the internal consistency and validity of the Spanish version

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Aim: The aim of this study was to assess the internal consistency, hypothesis testing and criterion-related validity of the Spanish versions of the Kihon Checklist (KCL) – the original 25-item and reduced 15-item versions – for screening frailty in community-dwelling older adults.

Methods: A cross-sectional study was carried out between March and September 2018 in Valencia province (Spain). A sample of 251 participants was recruited. Construct validity was assessed using four different frailty instruments, and alternative measures corresponding to the KCL domains (handgrip strength, gait speed, the Short Physical Performance Battery, skeletal muscle mass index, physical activity level, functional status, cognitive function, depressive mood, health-related quality of life and nutritional status). Fried's Frailty Phenotype was used to evaluate criterion validity.

Results: Internal consistency assessed with Kuder–Richardson Formula had a value of 0.69 for the 25-item version, slightly lower than the usual 0.7 for considering good reliability, and 0.71 for the 15-item version. There were significant correlations between KCL versions and Fried's Frailty Phenotype, Edmonton Scale, Tilburg Indicator and FRAIL Scale. Consistent significant correlations were also obtained with all frailty measurements and instrumental activities of daily living, physical strength, eating, socialization, and mood domains of the KCL. The KCL closely correlated with other standardized measurements of physical function, cognitive function, depressive mood, and health-related quality of life. The KCL also showed satisfactory diagnostic accuracy for frailty (area under the curve 0.891 for KCL-25; area under the curve 0.857 for KCL-15). The optimal cut-off points were 5/6 and 3/4, respectively.

Conclusions: The findings suggest that both versions of the KCL, especially KCL-15, showed adequate evidence of validity and internal consistency as a preliminary screening of frailty among community-dwelling older adults in Spain. **Geriatr Gerontol Int 2021; 21: 262–267**.

Keywords: frailty, older adults, Spanish, validation study.

Introduction

Frailty as a key concept of clinical care of older adults has become a topic of debate among researchers in recent years. Although a clear consensus on its definition does not yet exist,[1] frailty is considered to be a geriatric syndrome characterized by an increased vulnerability to minor stressors.[2,3] This syndrome leads to greater risk of adverse health outcomes, such as functional decline, hospitalization and death.[4]

With an increasingly aging global population, frailty might become a serious worldwide health issue.[3] Effective frailty screening is important for optimizing healthcare. There is a wide variety of assessment tools to identify individuals at risk of frailty, although a "gold standard" has not yet been put in place.[1] Assessment tools that are simple, reliable and valid are therefore crucial for both research and clinical purposes.[4,5]

Currently, frailty is recognized as a multidimensional concept with dynamic interrelated factors in the physical, psychological, social and environmental domains affecting the physiological equilibrium of the older adults. Such a holistic approach to frailty could be addressed using a multicomponent assessment tool.[1] Various multidomain instruments exist; however, some of these assessment methods have not yet been transculturally validated for the Spanish population, whereas others require long application times or specific technical equipment, making their application difficult in a clinical setting, and finally, others include disability as an indicator of frailty, which is questionable.

The Kihon Checklist (KCL) is a multidimensional tool widely used in Japan. This frailty index was developed by the Japanese Ministry of Health, Labor and Welfare as a screening tool to identify community-dwelling older adults vulnerable to frailty potentially at risk of becoming dependent.[6] Psychometric properties of KCL have been established in the literature,[7,8] making KCL a good screening tool in clinical practice. The KCL questionnaire has been translated into English,[9] and validated for Japanese, Brazilian Portuguese and Turkish cultures.[10–12] Recently, it has also

been translated into Spanish,[13] and its dimensional structure has been tested, showing that the best fitting model was a one-factor solution that retained 15 items.[14] The items removed to obtain the reduced version were the following: visiting friends (4), advice from friends or family members (5), climbing stairs without using handrail or wall for support (6), standing up for a chair without aids (7), weight loss (11), body mass index (12), difficulties eating tough foods (13), dry mouth (15), family or friends pointing out memory loss (18) and call by looking up phone numbers (19). This 15-item version had good estimates of reliability, with a value of 0.91 for the Composite Reliability Index.

However, more evidence on the validity and internal consistency for use with the Spanish population is required. The KCL would make a useful instrument to enable Spanish-speaking professionals to detect frailty and respond accordingly. Hence, the purpose of the present study was to study the internal consistency, hypothesis testing and criterion-related validity of the Spanish version of the KCL (original 25-item and 15-item edition) in community-dwelling older adults.

Methods

Population and study design

A cross-sectional study was carried out between March and September 2018. A convenience sample was recruited from three community settings and three rehabilitation units from five different towns in the province of Valencia, Spain. Inclusion criteria were aged ≥65 years and community-dwelling. Exclusion criteria included: Barthel Index[15] <85 points considered as a person with a disability, Mini-Mental State Examination[16] <18 points, acute disease or unstable chronic disease. Participation was voluntary, and informed consent was given by participants. The study was approved by the Ethics Committee for Human Research at the University of Valencia, Spain (H1507116319683), and was registered in the ClinicalTrials.gov (ID: NCT04152070). It followed the Declaration of Helsinki guidelines.

Measurements

KCL

The KCL is a self-report survey for screening frail older adults.[6] The original instrument consists of 25 yes/no questions divided into seven domains: instrumental activities of daily living (questions 1–5); physical strength (questions 6–10); nutrition (questions 11, 12); eating (questions 13–15); socialization (questions 16, 17); memory (questions 18–20); and mood (questions 21–25). Higher scores indicate higher risk of requiring support or care. The Spanish version used was translated by Maseda *et al.*[13] The unidimensionality of the scale was previously checked. Different models were tested by means of confirmatory factor analysis, following the original factor structure and a final reduced unidimensional scale with 15 items was proposed.[14]

Other frailty assessment tools

Besides the KCL, four other frailty instruments were used. The Fried's Frailty Phenotype[2] which consists of five criteria (unintentional weight loss, self-reported exhaustion, low physical activity, reduced grip strength and reduced gait speed) using the modified Baecke Questionnaire[17] to assess low physical activity as an alternative to the Minnesota Leisure Time Activity Questionnaire proposed in the original Fried's criteria[10]; the Edmonton Frailty Scale,[18] which evaluates nine domains of frailty: cognition, general health status, functional independence, social support, medication usage, nutrition, mood, continence and functional performance; the FRAIL Scale,[19] a five-item screening tool including fatigue, resistance, ambulation, illness and loss of weight components; and, finally, the Tilburg Frailty Indicator[20] as a self-report of 15 items addressing physical, psychological and social domains.

Physical assessment

Each participant's weight was calculated using a Tanita BC 601 model weighing device (TANITA, Amsterdam, the Netherlands). Height was measured with a stadiometer SECA 213 (Seca, Hamburg, Germany). The body mass index was calculated as weight (kg) divided by height squared (m^2). Body composition was measured with bioimpedance analysis using a Bodystat 1500MDD analyser (Bodystat, Douglas, UK). Fat-free mass was measured by bioimpedance analysis, and skeletal muscle mass (SMM) was calculated using the following equation: SMM (kg) $=0.566 \times$ FFM (Fat Free Mass).[21] SMM index (SMMI) adjusted for height was calculated as SMM (kg) / height squared (m^2). Handgrip strength (kg) was assessed with a Jamar Plus+ digital hand dynamometer (Patterson Medical, Sammons Preston, Bolingbrook, IL, USA). Gait speed (m/s) was recorded using a 4-m walking test. Physical performance was measured by the Short Physical Performance Battery,[22] and daily physical activity was assessed using the modified Baecke Questionnaire.[17]

Other questionnaires

Functional status was measured by the Barthel Index,[15] cognitive function by the Spanish version of the Mini-Mental State Examination[16] (scores not adjusted for age and educational level), depressive mood by the Center for Epidemiology Studies Depression Scale Short Form,[23] health-related quality of life by the eight-item Short Form Health Survey[24] and nutritional status by the Mini Nutritional Assessment-Short Form.[25]

Procedure

For participant recruitment, we contacted the different centers. Participants underwent questionnaire interviews and physical performance tests by three well-trained researchers, and the full assessment was made in one session. The data were collected in the community centers or health units the participants regularly attended. Participants were recruited following the protocol determined by each center, and they were evaluated in order of registration in the list of individuals interested in participating in the study, provided by the head of each center. To avoid inter-individual errors in the physical performance test, intraclass correlation coefficients (ICCs) were calculated. All ICCs in this study ranged from 0.802 to 0.985, a very good reliability.

Statistical analysis

Statistical analyses were carried out in SPSS 25 (IBM Corporation, Armonk, NY, USA), and included descriptive statistics, internal consistencies correlations and receiver operating characteristic (ROC) curve. Internal consistency was calculated with the Kuder–Richardson Formula 20, an application of alpha coefficient for binary items, with values >0.70 representing good internal consistency.[26] To assess the validity of KCL, several analyses were carried out. First, zero-order correlations were used to study the convergent validity of KCL with other measures of frailty, as well as relationships with other measures related to frailty (nomological net). Interpretation for the magnitude of the correlations is based on Cohen's criteria[27]: small, $0.10 \leq 0.30$; medium, $0.30 \leq 0.50$; large, ≥0.50. Second, a ROC curve was used. The ROC curve is a plot that shows the trade-off between sensitivity (true positive rate) and specificity (false positive rate) on a series of cut-off points.

Table 1 Main descriptive characteristics of the sample

Characteristic	Mean ± SD or n (%)	Range	Men/women Mean ± SD
Age (years)	72.79 ± 5.63	65–87	
Sex (women)	170 (67.7)		
Marital status (married)	150 (59.8)		
Level of education			
None/primary	76 (30.4)		
Secondary	11 (4.4)		
Post-secondary	163 (65.2)		
No. prescribed medications	3.53 ± 2.65	0–15	
No. falls in the last year	0.4 ± 0.85	0–5	
No. hospital admissions in past year	0.11 ± 0.36	0–2	
Comorbidity			
Musculoskeletal	209 (83.3)		
Respiratory	28 (11.2)		
Cardiovascular	116 (46.2)		
Endocrine-metabolic	113 (45.0)		
Neurological	34 (13.5)		
Gastrointestinal	77 (30.7)		
Renal	37 (14.7)		
Others	102 (40.6)		
No. total comorbidities	2.85 ± 1.26	0–7	
Economic status			
Live well	197 (78.5)		
Can deal with basic needs	52 (20.7)		
Has difficulty dealing with basic needs	2 (0.8)		
Cannot deal with basic needs	0 (0)		
Kihon Checklist (0–25 score)	4.34 ± 3.23	0–18	
Kihon Checklist (0–15 score)	2.12 ± 2.48	0–14	
Fried's Frailty Phenotype (0–5 score)	1.02 ± 0.89	0–4	
Robust	76 (30.4)		
Prefrail	157 (62.8)		
Frail	17 (6.8)		
Edmonton Frailty Scale (0–17 score)	2.68 ± 2.28	0–15	
FRAIL Scale (0–5 score)	0.52 ± 0.77	0–4	
Tilburg Frailty Indicator (0–15 score)	3.99 ± 2.43	0–11	
Mini-Mental State Examination (0–35 score)	29.36 ± 3.03	18–33	
Barthel Index (0–100 score)	97.98 ± 3.44	85–100	
SMM Index adjusted for height^2 (kg/m^2)	9.83 ± 1.88	6.9–26.1	11.5 ± 1.2/9.1 ± 1.5
Gait speed (m/s)	1.09 ± 0.25	0.4–1.7	
Body mass index (kg/m^2)	28.38 ± 4.47	16.4–43.8	28.9 ± 4.1/28.1 ± 4.6
Maximum handgrip strength (kg$_f$)	27.31 ± 8.38	10.8–51.4	36.1 ± 7.6/23.1 ± 4.5
Mean handgrip strength (kg$_f$)	25.86 ± 8.22	9.8–49.9	34.5 ± 7.5/21.7 ± 4.5
Modified Baecke Questionnaire (0–47.56)	8.60 ± 4.17	1.9–20.7	
SPPB (0–12 score)	10.46 ± 2.04	3–11	
Short Form Health Survey SF-8 (8–40 score)	33.59 ± 4.56	8–32	
Mini Nutritional Assessment-Short Form	13.13 ± 1.31	7–14	

Total n = 251. SMM, skeletal muscle mass; SPPB, short physical performance battery.

The area under the ROC curve (AUC) is considered an effective measure of the inherent diagnostic validity of a test. Additionally, ICCs were calculated to know the interraters reliabilities of the physical evaluation. Values of ICCs between 0.75 and 0.9 show good reliability, and values >0.90 indicate excellent reliability.[28]

Results

Characteristics of the participants

A total of 251 participants were included in the present study. The mean age of the sample was 72.79 years (SD 5.63 years), and 67.7% were women. Descriptive statistics for all the variables are presented as means and standard deviations or percentages in Table 1.

Feasibility

Given the nature of the study with voluntary participation and interviewers present, there was a low percentage of missing data across items and indicators. Of the 251 participants, there were three (1.2%) missing values for the item "fear of falling" and one (0.4%) missing value for each of the items "weight loss", "memory loss" and "phone calls". The remaining 245 (97.6%) participants

Table 2 Correlation coefficients of the Kihon Checklist and its domains with external measures of frailty

Kihon Checklist score	Fried's Frailty Phenotype		Edmonton scale		Tilburg indicator		Frail scale	
	r	Partial *r*	*r*	Partial *r*	*r*	Partial *r*	*r*	Partial *r*
KCL-25 total score	0.433**	0.382**	0.541**	0.493**	0.539**	0.496**	0.387**	0.362**
KCL-15 total score	0.420**	0.346**	0.513**	0.442**	0.535**	0.452**	0.358**	0.294**
KCL IADL domain	0.311**	0.260**	0.417**	0.365**	0.278**	0.232**	0.333**	0.275**
KCL physical domain	0.320**	0.247**	0.483**	0.303**	0.477**	0.290**	0.360**	0.216**
KCL nutrition domain	0.019	0.042	0.048	0.089	−0.100	−0.085	0.217**	0.246**
KCL eating domain	0.167**	0.132*	0.237**	0.210**	0.251**	0.256**	0.129*	0.127*
KCL socialization domain	0.210**	0.143*	0.194**	0.135*	0.309**	0.235**	0.177**	0.107
KCL memory domain	0.053	0.025	0.146*	0.125*	0.246**	0.253**	−0.007	−0.007
KCL mood domain	0.370**	0.323**	0.404**	0.359**	0.483**	0.409**	0.287**	0.273**

*$P < 0.05$; **$P < 0.01$. IADL, instrumental activities daily living; KCL, Kihon Checklist; Partial *r*, partial correlations controlling for age and sex.

Table 3 Correlations among the Kihon Checklist

Variables	KCL-25		KCL-15	
	r	Partial *r*	*r*	Partial *r*
Maximum handgrip strength	−0.256**	0.147	−0.343**	−0.160
Mean handgrip strength	−0.262**	−0.104	−0.356**	−0.174
Gait speed	−0.435**	−0.354**	−0.430**	−0.315**
Mini Nutritional Assessment	−0.151*	−0.163**	−0.120	−0.090
Mini-Mental State Examination	−0.423**	−0.376**	−0.384**	−0.284**
Modified Baecke questionnaire	−0.210**	−0.197**	−0.183**	−0.142*
Depressive symptoms CES-D	−0.423**	−0.438**	−0.471**	−0.443**
Skeletal muscle mass index	−0.096	0.028	−0.144*	0.000
Short form health survey SF-8	−0.498**	−0.411**	−0.515**	−0.389**

*$P < 0.05$; **$P < 0.01$. CES-D, Center for Epidemiology Studies Depression Scale; KCL, Kihon Checklist; Partial *r*, partial correlations controlling for age and sex.

completed all items on the KCL, and 248 (98.8%) completed the reduced version of 15 items.

Reliability

Internal consistency was calculated with the Kuder–Richardson Formula 20, and had a value of 0.69 for the 25-item version and 0.71 for the 15-item version of KCL.

Validity

To test hypotheses for construct validity of the Spanish versions of KCL, zero-order correlations were calculated among the KCL-25 (original version), KCL-15 (reduced version), and its seven dimensions and other scales of frailty. These correlations are presented in Table 2. Regarding the total score of KCL with the other measures of frailty, there were strong positive correlations with all of them. When associations with the dimensions of KCL were examined in detail, consistent significant correlations were also obtained with all the external measures for the dimensions of instrumental activities of daily living, physical strength, eating, socialization and mood domains. However, the dimension of nutritional status only correlated significantly with the FRAIL Scale, and the memory domain only correlated significantly with the Edmonton Scale and the Tilburg Indicator.

Correlations of the KCL-25 and KCL-15 total score, and several measures traditionally associated with frailty measurement (nomological net of variables) were also calculated. These data are presented in Table 3. KCL systematically correlated negatively and significantly with all external measures, with the exception of the muscle mass index for KCL-25 and the Mini Nutritional Assessment-Short Form for KCL-15. The strongest correlations were those with gait speed, depression symptoms (Center for Epidemiology Studies Depression Scale short form), cognitive function (Mini-Mental State Examination) and health-related quality of life (the 8-item Short Form Health Survey).

Regarding criterion validity, a ROC curve was generated with the KCL total score as the continuous variable and the diagnostic status (frail vs. not frail) using the Fried's Frailty Phenotype, typically selected for the diagnostic test accuracy of frailty screening instruments. Figure 1 shows the AUC with the corresponding sensitivity and specificity (1-specificity) estimates. A cut-off point from 5.5 on the KCL-25 gave the best trade-off for sensitivity (0.94) and specificity (0.78), and the AUC was 0.891 (SE 0.031, $P < 0.001$, CI 95% 0.831–0.952). A cut-off point from 3.5 on the KCL-15 represented the best trade-off for sensitivity (0.69) and specificity (0.85), and the AUC was 0.857 (SE 0.042, $P < 0.001$, CI 95% 0.775–0.939). AUC values between 0.70 and 0.80 are considered fair, values from 0.80 to 0.90 are considered good and values >0.90 are considered excellent.

Discussion

Previous studies have validated the KCL in other languages, such as Japanese, Brazilian Portuguese and Turkish. We present a validation study both for the original 25-item and the reduced 15-item Spanish versions. The KCL was found to be a valid

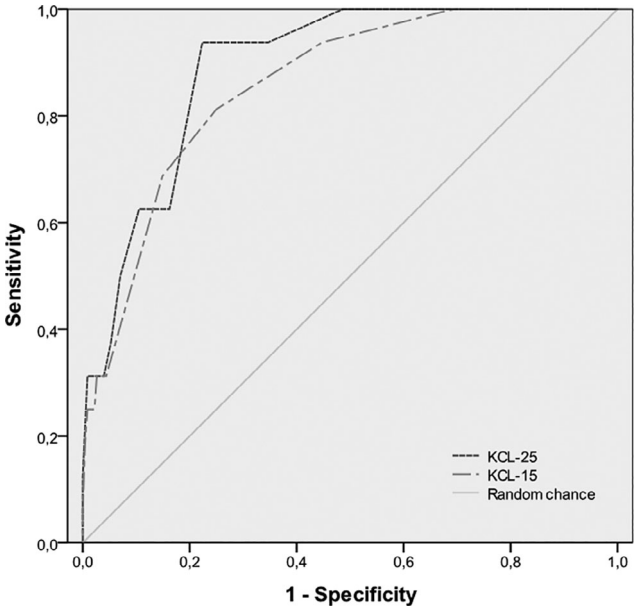

Figure 1 Receiver operating characteristic curve (ROC) analysis of the Kihon Checklist.

instrument for assessing frailty status in community-dwelling older adults in Spain. The present findings showed acceptable internal consistency, good hypothesis testing evidence and satisfactory diagnostic accuracy compared with the standard reference.

Regarding reliability, the Kuder–Richardson Formula 20 coefficient was 0.69 for the KCL-25 and 0.71 for the KCL-15 version. Internal consistency in the 25-item Spanish version might be somehow compromised. This could be due to a lack of covariance among different dimensions of the KCL leading to a lower reliability in the overall scale.[14] Previous studies showed values of 0.78[11] and 0.87.[12] Cultural reasons might lead to this lower covariance (for example, in Spain socialization might be less problematic, even in frail adults, because social networks in Spain are very tight-knit) or even participants with low levels of frailty, including less variability in the sample. More evidence is required on the older population in Spain before making further assumptions.

On testing the construct validity with well-established alternative frailty measures, the KCL strongly correlated with the Edmonton Scale and Tilburg Indicator, and moderately correlated with Fried's Frailty Phenotype and FRAIL Scale total scores. Although other validation studies only compare the KCL with a single frailty measurement, the present results are in line with those obtained by Sewo Sampaio *et al.*,[11] who showed a strong correlation between the KCL and Edmonton Scale, and Satake *et al.*,[10] who obtained strong associations between the KCL and Fried's Frailty Phenotype.

In the present study, all KCL domain scores were correlated with the total score of the other four frailty scales, except the nutritional status and memory domains. The memory domain was only correlated with those frailty instruments in which cognitive function was evaluated, such as the Edmonton Scale and Tilburg Indicator. Similarly, the nutritional status domain was only associated with the FRAIL Scale. Esenkaya *et al.* stated that questions about weight loss were not strong indicators for determining frailty.[12] This could be because frailty is also common in obese people or because these questions thus described could have low discriminative power in detecting frail older adults. Another reason might be the relatively low variability. Again, this is purely a tentative explanation that should be corroborated with further research. Sampaio *et al.* showed similar results when comparing KCL domains with the Edmonton Scale, with the exception of the nutrition domain in Brazilian Portuguese population.[11] These authors found that all KCL domains correlated with the Edmonton Scale total score and, in accordance with the present results, the highest correlated domains were instrumental activities of daily living, physical strength and mood.

Physical indicator seems to be the most relevant domain in the KCL, being the domain with the strongest correlations with all other frailty scales, with the exception of the Tilburg Indicator and Fried's Frailty Phenotype. However, when these associations were adjusted for age and sex, the mood domain acquired more relevance. Fukutomi *et al.* stated that "physical" was the only domain that could possibly predict, under the long-term care insurance scheme, the incidence of newly certified cases of frailty among Japanese older men.[29] The present results regarding the convergent validity of the KCL with other related measures are similar to those of other authors. Esenkaya *et al.* found significant associations in physical functions and cognitive function.[12] These findings generally agree with Satake *et al.* with respect to physical functions, cognitive function and depressive mood.[10] Regarding mass muscle index, the present findings only showed a significant association for the 15-item version that disappeared after controlling for age and sex. Authors who studied this variable showed no significant relationships with KCL.[10]

KCL-25 showed good discrimination ability in the identification of frailty (AUC 0.891). This value is close to that in previous studies among older adults (0.92 and 0.85).[10,12] Although there is not an established gold standard to identify frailty, Fried's Frailty Phenotype is the most accepted one, and is used by various authors as a reference standard. The present study identified the optimal cut off of 5/6 (frail /non-frail) for the KCL-25, which was lower than those found in other studies with a Japanese population (7/8 points)[10] and Turkish population (9 points).[12] The only study that coincided with our 5/6 cut-off point was that by Ogawa *et al.*, when the KCL total score excluded the five mood domain questions.[7] These differences might be explained by cultural reasons that particularly affect self-report measurements or the characteristics and variability of the sample. It is worth mentioning that Satake *et al.* did not finally recommend the optimal cut-off point (the point that maximizes the value of sensitivity and specificity), but rather the chosen point was the one with the highest specificity.[10] In this regard, taking into account our results of the ROC curve, higher cut-off point values would have presented less sensitivity, but also greater specificity.

The KCL was originally developed to identify older adults at risk of becoming dependent in the near future. Furthermore, the inclusion of disability in the concept of frailty is questionable, as there is a consensus that frailty is a state of pre-disability, which acknowledges a frail person as someone who is able to manage his/her daily activities, but is at risk of adverse effects.[30] With this definition in mind, we used the exclusion criterion of Barthel Index <85 points, similar to that of Satake *et al.*, although other studies did not use this exclusion criterion.[10] This lack of criteria delimitation is seen in other frailty studies. Therefore, a standardization of inclusion/exclusion criteria would help better define frailty and make results easier to compare.

Some limitations of this research should be discussed. First, we did not assess the stability of the measure over time (test–retest reliability) and the predictive validity of the KCL instrument for adverse outcomes. Second, the results should be treated with caution, as our sample was made up of participants from just one region of Spain. Third, although all participants were evaluated

with light and similar clothing, such as sport pants and T-shirt or underwear, no clothing adjustment was applied for the collection of body composition and, thus, this could have affected the results, especially in those participants with borderline weights. Fourth, the educational level was high in comparison with data from the Spanish population, possibly due to the centers where the sample was recruited. This characteristic might also have influenced the results obtained. Finally, the studied sample was relatively robust; however, a sample with greater variability would better test the validity and reliability of the KCL.

The present findings suggest that both versions of the KCL in Spanish, and especially KCL-15, have shown adequate evidence of validity and internal consistency as a preliminary screening of frailty among community-dwelling older adults in Spain. This tool can help the clinical and research field to identify the initial stages of frailty, so that specific measures can be taken to decelerate further decline. We suggest future studies include different regions of Spain and settings, a more heterogeneous sample, and longitudinal cohorts to consider causal implications. This would test other measurement properties and confirm its applicability in the Spanish framework.

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Disclosure statement

The authors declare no conflict of interest.

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