

ORIGINAL ARTICLE

FallSkip device is a useful tool for fall risk assessment in sarcopenic older community people

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Funding information

No funding was received for this study. The Government authorities and the Catholic University of Valencia, University of Valencia and Instituto de biomecánica de Valencia played no role in the conduction of this study. None of the authors received financial support for this study.

Abstract

Purpose: Fall prevention is a major health concern for the ageing population. Sarcopenia is considered a risk factor for falls. Some instruments, such as Time Up and Go (TUG), are used for screening risk. The use of sensors has also been shown to be a viable tool that can provide accurate, cost-effective, and easy to manage assessment of fall risk. One novel sensor for assessing fall risk in older people is the FallSkip device. The present study evaluates the performance of the FallSkip device against the TUG method in fall risk screening and assesses its measurement properties in sarcopenic older people.

Methods: A cross-sectional study was made in a sample of community-dwelling sarcopenic and non-sarcopenic older people aged 70 years or over.

Results: The study sample consisted of 34 older people with a mean age of 77.03 (6.58) years, of which 79.4% ($n = 27$) were females, and 41.2% ($n = 14$) were sarcopenic. The Pearson correlation coefficient between TUG time and FallSkip time was 0.70 ($p < 0.001$). The sarcopenic individuals took longer in performing both TUG and FallSkip. They also presented poorer reaction time, gait and sit-to-stand – though no statistically significant differences were observed. The results in terms of feasibility, acceptability, reliability and validity in sarcopenic older people with FallSkip were acceptable.

Conclusions: The FallSkip device has suitable metric properties for the assessment of fall risk in sarcopenic community-dwelling older people. FallSkip analyses more parameters than TUG in assessing fall risk and has greater discriminatory power in evaluating the risk of falls.

KEYWORDS

aged, equipment and supplies, independent living, risk assessment, sarcopenia

1 | INTRODUCTION

Fall prevention is a major health concern for the ageing population. The number of falls is increasing with the rise in number of older people in many countries. According to the World Health Organization (WHO), approximately 28–35% of all people aged 65 years and over suffer a fall each year – a rate that increases to 32–42% among those over 70 years of age. Falls often produce a post-fall syndrome that includes dependence, loss of autonomy, confusion, immobilisation and depression. All this produces a greater limitation of daily activities and decreases quality of life (Bjerk et al., 2018; World Health Organization, 2008). Falls are the second leading cause of unintentional injury deaths worldwide, with over 80% being concentrated in low- and middle-income countries. Prevention strategies should emphasise education, training and the creation of safer environments, prioritising fall-related research and establishing effective policies to reduce risk (World Health Organization, 2021).

There are numerous risk factors related to falls, including age, the female sex, frailty, fear of falling, drug treatments, comorbidity, gait and balance disorders, and sarcopenia (Yeung et al., 2019). Sarcopenia is defined by the European Working Group on Sarcopenia in Older People (EWGSOP) as a condition characterised by progressive loss of skeletal muscle mass and strength, with a consequent increased risk of adverse events such as physical disability, loss of quality of life and death (Cruz-Jentoft et al., 2010). Its growing importance in recent years led sarcopenia to be considered as a separate disease condition in 2016, with inclusion in the tenth revision of the International Classification of Diseases (ICD-10) (Anker et al., 2016). Diagnostic criteria for sarcopenia include low muscle mass, low muscle strength and low physical performance. The Time Up and Go (TUG) is an instrument used to assess both low physical performance and the risk of falls (Cruz-Jentoft et al., 2010). Sarcopenia and falls are directly related in older people, and the presence of either should be systematically assessed in order to implement useful prevention strategies (Benjumea et al., 2018; Matsumoto et al., 2020).

Gerontological nurses may exert the greatest impact in reducing patient falls and have the most consistent contact with patients, continually monitoring changes in condition in hospitals, long term care and community settings (King et al., 2018). Nurses are in an important position to screen, educate and intervene for better outcomes. With the implementation of evidence-based work placements and ongoing research related to falls, we can anticipate new approaches to reduce falls (Enderlin et al., 2015).

The main primary prevention strategy for falls starts with an accurate falls risk assessment. A comprehensive assessment consists of the detection of risk factors for falls, with the aim of determining risk in order to establish early preventive measures such as the implementation of exercise to improve gait and balance, and increase muscle strength (Callis, 2016; Gillespie et al., 2012).

Falls risk assessment should be performed in older people at least once a year, but the reality of daily clinical practice is far from achieving this objective due to several reasons ranging from overreliance

What does this research add to existing knowledge in gerontology?

Sarcopenic older people have higher fall risk and FallSkip has suitable properties for assessing fall risk in sarcopenic older people.

What are the implications of this new knowledge for nursing care with older people?

Time up and Go (TUG) is the most used instrument to assess fall risk. The TUG classifies most of the sarcopenic subjects as being at moderate risk, and FallSkip distinguishes more sarcopenic subjects at between moderate and high risk of falls.

How could the findings be used to influence policy or practice or research or education?

FallSkip analyses more parameters than TUG in assessing fall risk and has greater discriminatory power in evaluating the risk of falls. The use of this device could help to screen risk more accurately in this population.

on unreliable subjective measures, lack of cost-effective assessment technology, and clinical time constraints (Sun & Sosnoff, 2018). First of all, we have to choose the suitable instrument according to the setting involved (community, acute care hospitals, nursing homes, long term care) as the risk factors for falls may differ from each other (Falcão et al., 2019; Matarese et al., 2015; Nunan et al., 2018; Park, 2018). In addition, we have to consider the presence of comorbidities such as cancer, Parkinson, stroke or dementia, as each pathology can potentially affect gait and balance as well as other factors related to drugs or functional impairment. (Brognara et al., 2020; Mohile et al., 2018; Wong & Pang, 2019; Wynaden et al., 2016).

The literature shows that there are useful methods for assessing the risk of falls in community-dwelling older people. Some tools recommended by the literature are the Downton Fall Risk Index, the Hendrich II Fall Risk Model, STRATIFY, the Physiological Profile Assessment (PPA), Time Up and Go (TUG), the Berg Balance Scale, Tinetti scale, and the Short Physical Performance Battery (SPPB) (Guralnik et al., 1994; Kloos et al., 2010; Lord et al., 2003; Park, 2018). These validated tools have some weaknesses, lacking sufficiently high predictive validity for differentiating between high and low fall risk, in addition to having a wide specificity range (Park, 2018). Moreover, most of these tools require healthcare personnel to dedicate time which they do not have in normal practice, demand special training, and are predominantly used by occupational and physical therapists.

The exception may be TUG, because it is a simple and objective assessment tool that can be used in almost any clinical setting with minimal equipment. It also does not require extensive professional experience or training (Podsiadlo & Richardson, 1991; Wall, 2000).

For this reason, TUG is the most widely used tool in clinical practice (Barry et al., 2014). On the other hand, TUG has a number of limitations. Some authors associate it with low accuracy, and report TUG to have limited ability to predict falls in community-dwelling older people – it thus being necessary to accompany the assessments with another instrument in order to identify people with a high risk of falls in this setting (Barry et al., 2014). Besides, the authors conclude that since risk of falling is a multifactorial problem, a single assessment tool is not enough to provide a reliable measurement, and the combination of TUG with other tests such as the Berg Balance Scale could increase the sensitivity and specificity of both instruments (Park, 2018). Moreover, to overcome the limitations of TUG, different authors recommend changes; Barry et al. (2014) propose a time score of ≥ 13.5 s to identify individuals at higher risk of falling instead of 20 s. Likewise, Kojima et al. (2015) propose 12.6 s. Other authors suggest that the time score should be adapted to age: 9.0 s for subjects between 60–69 years of age, 10.2 s for those between 70–79 years of age, and 12.7 s for individuals between 80–99 years of age. Finally, the cut-off time might not be the only functional measurement to be used in TUG, and the use of sensors has been proposed with a view to obtaining more information on the functional status of the patient while performing the test (Greene et al., 2012).

The use of sensors for fall risk assessment has been shown to be a viable tool that is accurate, cost-effective and easy to manage (Sun & Sosnoff, 2018). Current technologies offer cheap wearable sensors for measuring human movements, and the current smartphones have embedded accelerometers, which opens the possibility of developing applications that use the data provided by them for fall risk assessment (Immonen et al., 2019). However, it is advisable for these applications to be used by clinicians and not by people at risk, because the results must be interpreted by an expert (Roeing et al., 2017).

One novel sensor for assessing fall risk of older people is the FallSkip device (FallSkip - Technology to Evaluate Fall Risk in Older Adults, 2021). This instrument applies a clinical protocol based on a modification of the TUG test. It includes an initial assessment of the 30-s Romberg test and subsequently uses inertial sensors to measure different variables (time, movement of the centre of mass) in the different phases of the TUG. In this way, it improves upon TUG by evaluating variables similar to those of the Physiological Profile Assessment (PPA). The PPA assesses falls risk in older people by measuring impairments most associated with multiple falls. It was developed to assess falls risk by measuring key physiological impairments with a view to predicting falls in older people, and consists of 5 short tests: (1) edge contrast sensitivity; (2) position sense; (3) muscle strength; (4) reaction time; and (5) postural sway (Lord et al., 2003). The FallSkip developers used the biomechanical records of a group of 65 people over the age of 65 to define a fall risk classification model based on the pattern of gait, balance, muscle power, and temporal variables. The model has been contrasted with the PPA, and presents a reliability $>80\%$ (intraclass correlation coefficient

[ICC] = [0.884–0.951]), with a correlation to PPA of -0.65 ($p < 0.01$, two-tailed) (Medina-Ripoll et al., 2017).

In the assessment of falls in older people, the detection of the moment of the fall, the classification of faller or non-faller, the detection of the risk of falls and the categorisation of the risk of falls are important. The use of devices helps the previous assessments and provides greater objectivity than functional tests. The combination of functional testing and/or a device based on the assessment of daily activities brings even greater precision to the analysis of the results for getting closer to daily reality. A systematic review reveals that most studies with devices are aimed at fall risk screening, but due to the heterogeneity of the studies, there is a need for further research in specific populations, with a representative sample size calculation and the use of functional tests and devices (Bet et al., 2019).

Community-dwelling older people with sarcopenia are at risk of falls. The FallSkip device includes an initial assessment that would be equivalent to a part of the Berg Balance Scale (BBS) and a subsequent assessment like the TUG. Both instruments (BBS and TUG) currently have the highest diagnostic capacity for fall risk. The present study evaluates the performance of the FallSkip device against the TUG method in screening for fall risk and assesses its measurement properties in sarcopenic older people.

2 | MATERIAL AND METHODS

The present cross-sectional study is nested to a clinical trial NCT03834558 in sarcopenic older people and was approved by the Clinical Research Ethics Committee of the University of Valencia (Valencia, Spain).

2.1 | Participants

The inclusion criteria were individuals aged 70 years or older; independence for walking (being allowed walking aids, that is canes, crutches, walkers, and rollators); and community-dwelling people in Valencia, Spain.

The exclusion criteria were a life expectancy of <6 months; institutionalised people; severe auditory or visual impairment; contraindication to performing physical exercise (cardiovascular risk factors); severe psychiatric illness or moderate or severe cognitive impairment diagnosed by a physician; refusal to sign the informed consent form prior to participation.

The sample size was calculated knowing that the population census estimates that there are 688 people over 70 years of age in the study district (Distritos-València, 2021). The prevalence of sarcopenia in the community is about 8% (Petermann-Rocha et al., 2020), of which 22.6% are functionally independent (dos Santos et al., 2017). Assuming a sampling error of $\pm 3\%$, $\alpha = 5$ and an expected attrition rate of 5%, the minimum sample required for this study is 33 older people.

2.2 | Procedure

The study was carried out in the Physical Performance Laboratory of the Faculty of Physical Therapy (Universitat de València), in two periods: the first from January to March 2019, and the second from October to December 2019. During one of the first assessment sessions of the larger study, the participants were asked to voluntarily participate in a test to compare TUG versus FallSkip; 34 individuals agreed to participate in the test.

All participants were assessed according to the sarcopenia 2010 criteria (Cruz-Jentoft et al., 2010). Subjects were considered to be sarcopenic if they had low muscle mass as assessed by bioimpedance analysis (BIA) (men $<8.87 \text{ kg/m}^2$ and women $<6.42 \text{ kg/m}^2$) and also met one of the following criteria: low muscle strength assessed by handgrip ($<20 \text{ kg}$ in women and $<30 \text{ kg}$ in men) or low physical performance assessed by gait speed ($<0.8 \text{ m/s}$).

The 34 participants performed the TUG protocol (Podsiadlo & Richardson, 1991) and the FallSkip protocol described below. The TUG and FallSkip tests were supervised by a nurse. The order of the protocols for each participant was randomised using the randomisation sequence provided by the MS Excel[®] spreadsheet.

In the TUG test, the patient sits in a chair with arms, stands up (start of the timing test), walks three metres, turns around and sits back down in the same chair (end of the timing test). The variables were recorded in seconds and also in categories according to fall risk (Podsiadlo & Richardson, 1991), defined as low ($\leq 10 \text{ s}$), moderate ($>10 \text{ s}$ and $\leq 20 \text{ s}$) or high ($>20 \text{ s}$).

FallSkip provides the following results: (a) total time taken to perform the test in seconds; (b) four fall risk levels: low, mild, moderate or high; and (c) normality ratios (0–1) referred to balance, reaction time, gait and sit-to-stand movements. According to the FallSkip documentation, values near to 1 indicate a healthy gait pattern.

Before starting the FallSkip protocol, the following data of the participants were entered in the FallSkip device: weight in kg, height in cm, gender, and the presence of previous falls in the last year as a dichotomic variable (yes/no).

A support band was placed and the FallSkip device was attached to the lower back (Figure 1).



The FallSkip protocol consisted of the following phases (Figure 2):

Phase 1. Standing: At the beginning of the measurement, the patient remains standing, with the arms at the sides facing the front, for 30 s (Romberg open eyes).

Phase 2. Gait: The device emits a sound, and at that moment the patient must start a walk through a three-metre corridor in a straight line, in the direction of a chair.

Phase 3. Seating and rising: On reaching the end of the walking corridor, the patient must sit down and get up from a chair.

Phase 4. Gait: The patient walks in the opposite direction until reaching the starting position of the test.

FallSkip provides grouped scorings based on the different phases of the test (balance, walking, sitting down and waking up). The way these scorings are provided is not specified in the App. However, the inner variables used for the assessment of each phase can be seen in Serra-Añó et al. (2019).

At the end of both tests (TUG and FallSkip), the participants were asked the following question to assess test preferences: "Of the two tests carried out, which one would you choose or is it indifferent to you?". We collected this information using a card showing a picture of the TUG test and a picture of the device (FallSkip), with three response options: Fallskip, TUG or "indifferent".

2.3 | Statistical analysis

Quantitative variables were reported as the mean and standard deviation (SD), and qualitative variables as frequencies and percentages for the descriptive analysis. The analysis of differences in the risk of falls between sarcopenic and non-sarcopenic individuals was based on the use of contingency tables. The analysis of differences in the time (seconds) and normality ratios between sex and sarcopenic and non-sarcopenic individuals was performed using Welch's t-test. The relationship of the levels of risk of falls between TUG and FallSkip was explored by Spearman's rank correlation coefficient analysis. The measurement properties of FallSkip were also analysed. Feasibility included the percentage of missing data and the percentage of computable data. Acceptability included the mean,

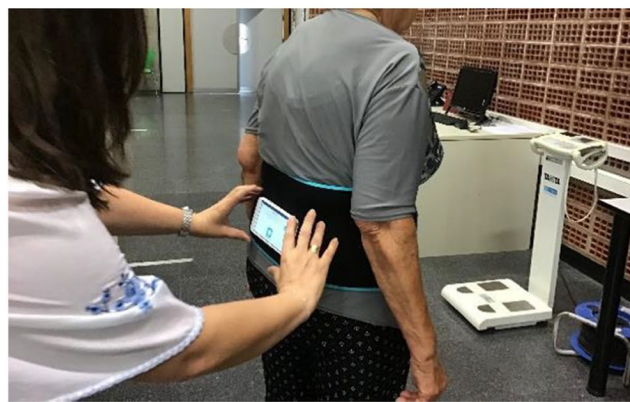


FIGURE 1 Setup of measuring equipment

median and standard deviation similar across items, asymmetry, kurtosis and floor and ceiling effect. Reliability in turn was analysed by the intraclass correlation coefficient (ICC), which has been widely used in conservative care medicine to establish confidence in the measurements (Koo & Li, 2016). We analysed inter-rater reliability, reflecting the variation between two or more raters who measure the same group of subjects. In our sample, measurement was between FallSkip and TUG, using a one-way, random-effects

model. Internal validity included the correlation of FallSkip Balance, Reaction time, Sit stand and Gait (Table 1).

3 | RESULTS

A total of 34 people participated in the study. Of these, 79.4% ($n = 27$) were women and 20.6% ($n = 7$) were men; 23.53% ($n = 8$)

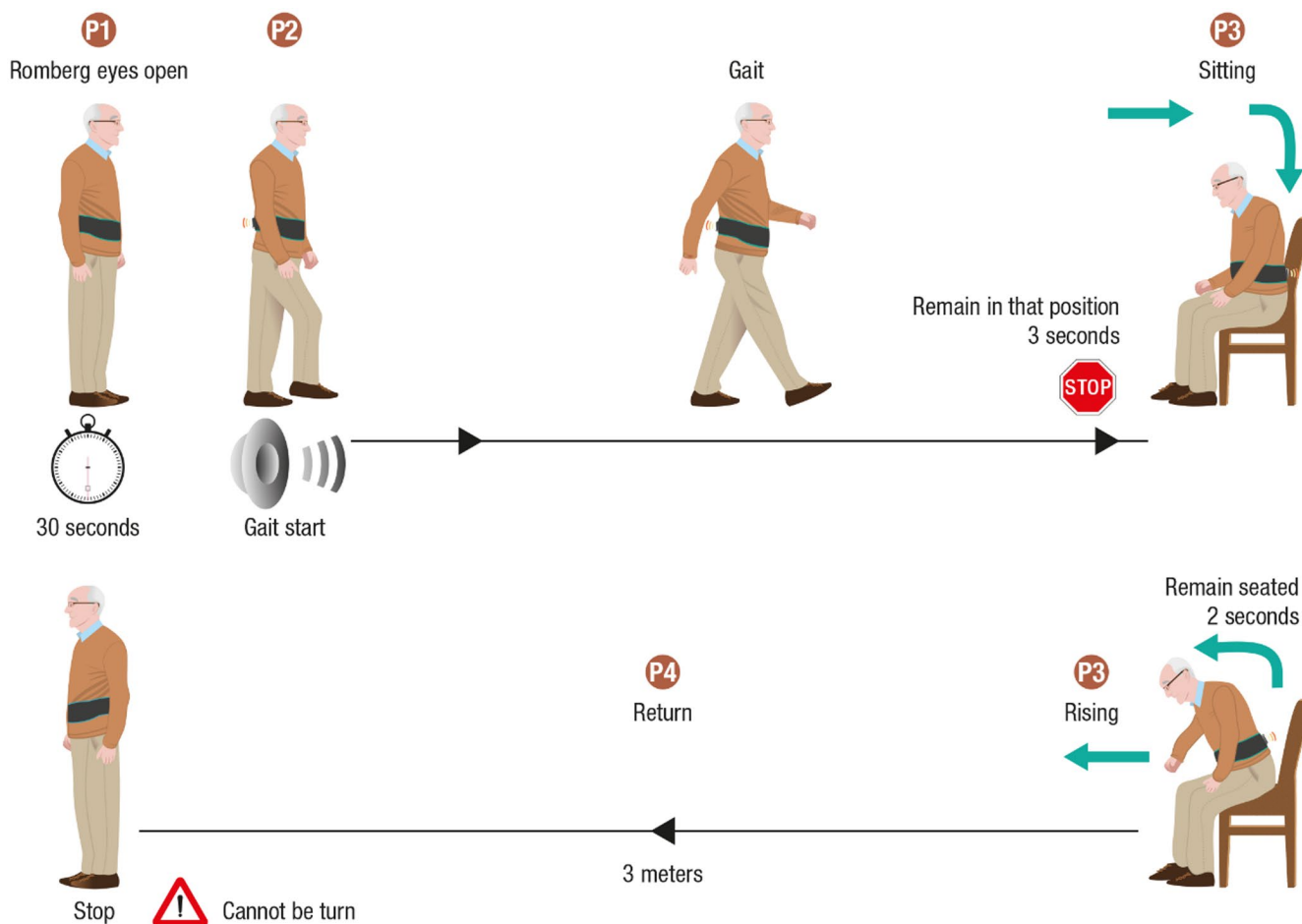


FIGURE 2 FallSkip protocol

TABLE 1 Measurement properties of the FallSkip device

Property	Criteria
Feasibility	Percentage of missing data (should be <10%) Percentage of computable data (should be >95%)
Acceptability	Mean, median and standard deviation similar across items (15% maximum divergence) Asymmetry and kurtosis should range between -1 and 1 Floor and ceiling effect (percentage of scores in the lower and upper extremes should be <15%)
Reliability	ICC (FallSkip and TUG, one-way, random-effects model; acceptable values were ≥ 0.7)
Validity	Internal: correlation between FallSkip Balance, Reaction time, Sit stand and Gait ($r = 0.30-0.70$)

Note: Abbreviations: ICC, intraclass correlation coefficient; TUG, Time Up and Go.

TABLE 2 Variables analysed by sex

	Total (n = 34)		Women (n = 27)		Men (n = 7)		p-value*
	Mean (SD)	Min-Max	Mean (SD)	Min-Max	Mean (SD)	Min -Max	
Age (years)	77.03 (6.58)	70–91	76.5 (6.2)	70–91	81 (5.7)	71–87	0.023
Weight (kg)	67.1 (11.7)	43–93	65.4 (11.6)	43–93	74.9 (7.9)	66.9–88.2	0.04
Height (cm)	156.1 (0.07)	146–177	153.9 (5.7)	146–166	165.7 (5.6)	161–177	<0.001
BMI (kg/m ²)	27.47 (4.00)	20.4–36.7	27.5 (4.1)	20.4–36.7	27.3 (3.3)	24.2–33.2	0.98
TUG time (seconds)	14.06 (4.68)	8.28–33.4	14.08 (4.97)	8.28–33.24	13.93 (3.38)	10.34–17.92	0.93
FallSkip time (seconds)	15.09 (4.79)	9.41–26.80	15.03 (3.59)	10.4–23.2	15.33 (6.18)	9.41–26.8	0.91
FallSkip Balance	0.82 (0.20)	0.05–1.00	0.80 (0.21)	0.05–1.00	0.92 (0.05)	0.83–0.97	0.01
FallSkip Reaction time	0.83 (0.09)	0.59–0.96	0.82 (0.09)	0.59–0.99	0.84 (0.10)	0.67–0.96	0.74
FallSkip Gait	0.73 (0.15)	0.50–1.00	0.73 (0.15)	0.50–1.00	0.72 (0.12)	0.51–0.87	0.98
FallSkip Sit-to-stand	0.79 (0.17)	0.31–1.00	0.76 (0.18)	0.31–1.00	0.90 (0.07)	0.79–0.97	0.001

Note: Abbreviations: BMI, body mass index; p-value, Welch's test; SD, standard deviation.

TABLE 3 Subject TUG score ranges versus FallSkip score ranges

	FallSkip				
	Low	Mild	Moderate	High	Total
TUG					
Low	1	1	1	0	3
Moderate	2	2	14	12	30
High	0	0	0	1	1
Total	3	3	15	13	34

Note: Abbreviation: TUG, Time Up and Go.

had suffered at least one fall over the last 12 months. Sex differences were observed in relation to age, body mass index (BMI). No sex differences were found in the number of seconds taken to perform the TUG and the FallSkip. On the other hand, differences were found in FallSkip balance and sit-to-stand, where men yielded better scores than women (Table 2).

Categorisation according to risk ranges was analysed with TUG and FallSkip, with a greater number of subjects being found to be at moderate risk ($n = 15$) and high risk ($n = 13$), while in TUG assessment most subjects were at moderate risk ($n = 30$) (Table 3). Spearman's rank correlation coefficient between the TUG scores and FallSkip scores was 0.40 ($p = 0.02$), and the Pearson correlation coefficient between TUG time and FallSkip time was 0.70 ($p < 0.001$) (Figure 3).

Of the total of 34 people that participated in the study, 41.18% ($n = 14$) were sarcopenic at the time of the study (13 women and one man). The relationship between TUG time and FallSkip variables with sarcopenia was analysed with Welch's t-test (Table 4).

The sarcopenic individuals took longer in performing both TUG and FallSkip. They also presented poorer reaction time, gait and sit-to-stand – though no statistically significant differences were observed, except for reaction time (Table 4).

In addition, the relationship between risk of fall in TUG and FallSkip with sarcopenia was analysed based on contingency tables

and Pearson's chi-squared test. There was a higher percentage of sarcopenic subjects screened as being at moderate and high risk with both FallSkip and TUG (Figure 4). The differences were not statistically significant, however (Pearson's chi-squared test, $p = 0.16$).

A total of 82.4% ($n = 28$) of the subjects reported indifference between the two methods, 11.8% ($n = 4$) reported a preference for FallSkip, and 5.9% ($n = 2$) reported a preference for TUG.

3.1 | Measurement properties: feasibility, acceptability, reliability and validity in sarcopenic older people

In order to establish the validity of the aforementioned data, we analysed the measurement properties of FallSkip in the sarcopenic older participant sample. There were no missing data, and all data were computable. After analysing the items for acceptability, similar values were observed in terms of the mean and median, while asymmetry in FallSkip was close to 1 and higher in TUG. Kurtosis in FallSkip was within the recommended limits, in contrast to the case of TUG. There were no floor and ceiling effects (Table 5).

On analysing reliability, we obtained ICC = 0.77 (95% confidence interval [CI] 0.37 to 0.91; $p = 0.003$), evidencing a strong correlation for FallSkip time and TUG time. Lastly, there was a strong correlation between FallSkip gait and reaction time (Table 6).

FallSkip exhibited suitable metric properties (feasibility, acceptability, reliability and validity in sarcopenic older people) for the assessment of fall risk in the sarcopenic population.

4 | DISCUSSION

Nurses spend a lot of time in assessing older people after falls, in the context of injury care, psychological help and prevention of

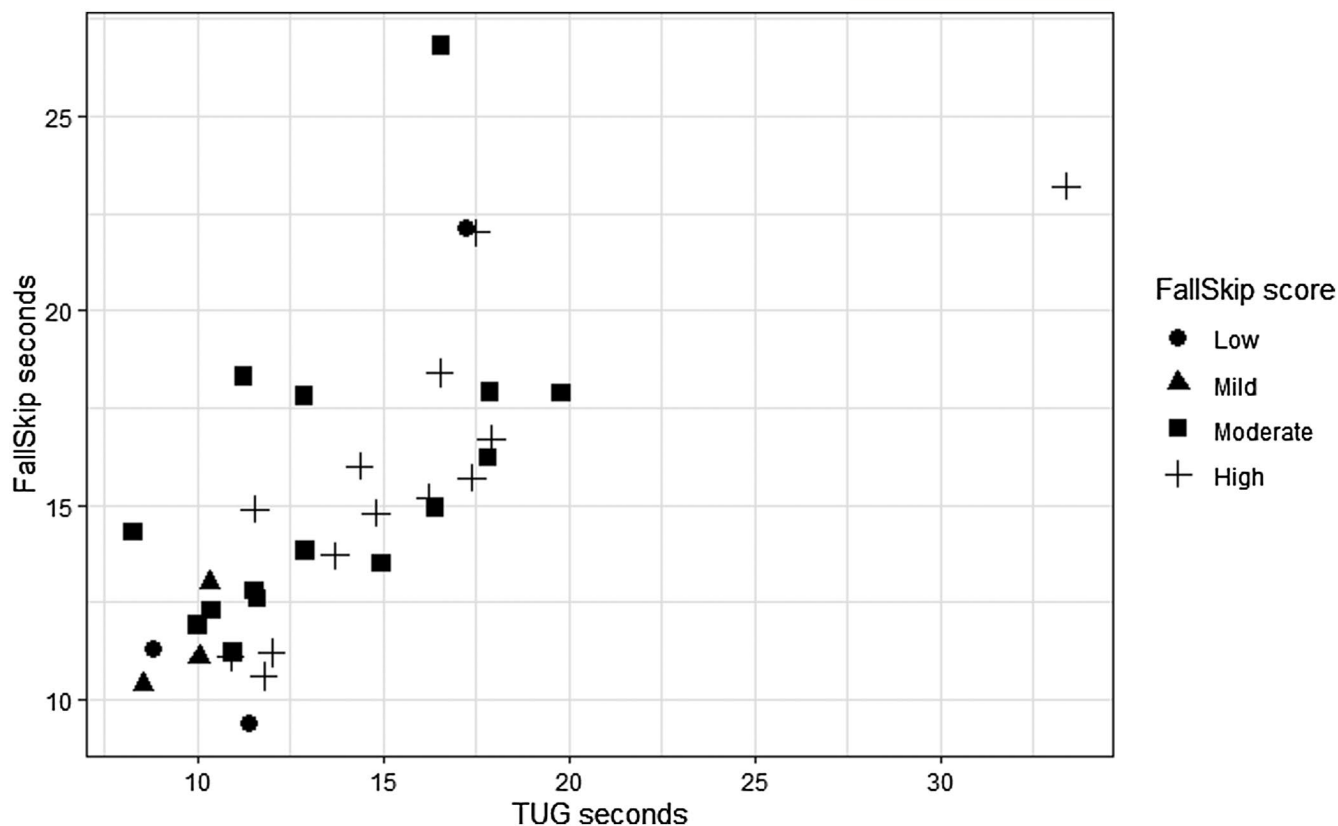


FIGURE 3 TUG time versus FallSkip time

TABLE 4 Time Up and Go and FallSkip assessment according to sarcopenia

	Non-sarcopenic (n = 20) Mean (SD)	Sarcopenic (n = 14) Mean (SD)	p-value*
TUG time, seconds	12.31 (3.20)	16.55 (5.42)	$p = 0.01$
FallSkip time, seconds	14.34 (4.35)	16.15 (3.42)	$p = 0.18$
FallSkip Balance	0.86 (0.14)	0.79 (0.23)	$p = 0.28$
FallSkip Reaction time	0.86 (0.09)	0.79 (0.09)	$p = 0.04$
FallSkip Gait	0.75 (0.13)	0.69 (0.16)	$p = 0.23$
FallSkip Sit-to-stand	0.82 (0.14)	0.73 (0.20)	$p = 0.21$

*Welch's t-test

fear of falling. Prevention of falls is fundamental in the older population, and investing time in prevention can avoid spending more time in addressing their consequences (Hopewell et al., 2018). Falls are multifactorial and older people have a greater number of risk factors for falls, exploring the causes of any fall is key to prevention. Sarcopenia, which is characterised by a loss of muscle mass and strength, is a modifiable risk factor for falls, and the prevention of both sarcopenia and falls could help to avoid disability and dependence (Wang et al., 2020). The present study was carried out to evaluate the performance of the FallSkip device versus the TUG method, and to establish the measurement properties of the device in sarcopenic older people. Our results show that FallSkip has suitable metric properties (feasibility, acceptability, reliability and validity) for the assessment of falls risk in sarcopenic community-dwelling older people. On the other hand, we found no significant

differences in the risk of falls as assessed with TUG and FallSkip between people with and without sarcopenia. Although sarcopenia is a risk factor for falls in older people (Gadelha et al., 2018; Landi et al., 2012; Tanimoto et al., 2014), some studies have confirmed no such association (Benjumea et al., 2018; Bischoff-Ferrari et al., 2015; Dietzel et al., 2015). The causes of falls are complex (Barry et al., 2014; Greene et al., 2012; Kojima et al., 2015), and the characteristics of the analysed community-dwelling population must be taken into account. Although sarcopenia is associated with loss of function, not all older people are highly dependent, and the subjects in the present study were functionally independent for walking and presumably also for basic and instrumental activities of daily living.

The literature indicates that the most advisable approach to the assessment of the risk of falls is to choose the most appropriate

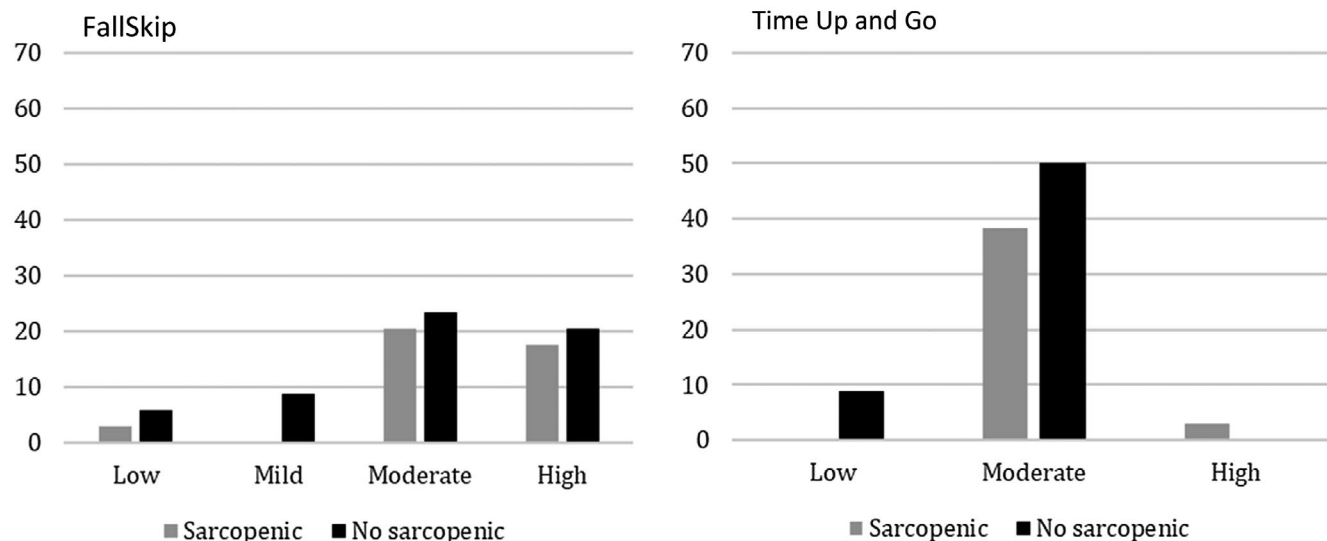


FIGURE 4 FallSkip and Time up and go categories of fall risk in the presence of sarcopenia

TABLE 5 Feasibility and acceptability properties in sarcopenic subjects of FallSkip and Time Up and Go ($n = 17$)

	FallSkip	Time Up and Go
Mean	16.24	15.90
Standard deviation	4.39	5.23
Median	15.20	14.96
Asymmetry	1.05 ^a	2.45 ^a
Kurtosis	0.81	8.03 ^a
Ceiling	5.90	5.90
Floor	5.90	5.90

^aOut of range from -1 to 1 .

instrument according to the setting where the assessments are going to be carried out. Furthermore, and depending on the instrument used, the sensitivity may vary, and it may be necessary to use two instruments together in order to increase the detection of older people at high risk. The TUG assesses the risk of falls by establishing categories according to the time spent in performing the test (Podsiadlo & Richardson, 1991), and is generally used in community settings, with a pooled sensitivity of 70% (Park, 2018).

FallSkip is based on a modification of the TUG test. The results obtained reveal a correlation between TUG and the FallSkip, both in terms of the time used by the subjects and as regards the fall risk scores. FallSkip analyses more parameters than TUG in assessing fall risk and has greater discriminatory power in evaluating the risk of falls. The TUG classifies most of the subjects as being at moderate risk, while FallSkip distinguishes more subjects at between moderate and high risk of falls. Thus, FallSkip could be a good device for assessing risk by increasing the detection of subjects at risk (Park, 2018). Studies involving older populations without comorbidities or in different settings are needed to better understand the sensitivity and specificity.

Also, TUG is one of the instruments used for assessment of the low physical performance criterion of sarcopenia, using time as a continuous variable for gait speed measurement (Cawthon, 2015). Thus, subjects with sarcopenia should present a greater proportion of slower gait speed due to their sarcopenic condition. In our sample, although the differences were not statistically significant except for FallSkip reaction time, the results showed sarcopenic older individuals to take longer in performing TUG and FallSkip, and to have lower normality ratios (FallSkip Reaction time, FallSkip Gait and FallSkip Sit-to-stand).

The use of devices for the assessment of the risk of falls is an established practice in the literature, as they afford objective data and greater precision (Montesinos et al., 2018; Sun & Sosnoff, 2018). To our knowledge, the FallSkip is the first device with adequate metric properties to analyse risk in the older sarcopenic community-dwelling population, and could help to screen risk more accurately in this population (Pang et al., 2019) so the use of more parameters is recommended in the literature; better discrimination in screening thus improves fall risk assessment (Barry et al., 2014; Greene et al., 2012).

Lastly, the FallSkip test is just as easy to perform as the TUG test. It does not imply a greater workload for the examiner (Folch Marin, 2019), and is comfortable for both the healthcare professional and the patient. In this study, the majority of the participants did not show preferences between TUG and FallSkip, though among those who did express a preference, FallSkip was seen to predominate over TUG.

The present study has the limitation of its cross-sectional design as well as the modest sample size. It is also true that TUG is a very useful, simple and cost-free tool, while FallSkip is more expensive but provides higher quality data. Longitudinal studies with the larger samples of older community people with sarcopenia are needed to calculate FallSkip sensitivity and specificity. They help us to better understand the risk of falls community-dwelling older people, to implement prevention and health promotion measures (Yeung et al., 2019).

TABLE 6 Correlation between FallSkip items

	FallSkip balance	FallSkip reaction time	FallSkip sit stand	FallSkip gait
FallSkip Balance	1	-	-	-
FallSkip Reaction time	$r = 0.359$	1	-	-
FallSkip Sit stand	$r = -0.098$	$r = 0.464$	1	-
FallSkip Gait	$r = -0.224$	$r = -0.507^a$	$r = -0.052$	1

* $p < 0.05$.

5 | CONCLUSIONS

The FallSkip device has suitable metric properties for the assessment of falls risk in sarcopenic community-dwelling older people. Although the sarcopenic subjects in our sample did not have an increased risk of falls, FallSkip analysed more parameters than TUG in assessing fall risk and exhibited greater discriminatory power in assessing the risk of falls compared with TUG.

ACKNOWLEDGMENTS

We would like to thank all the participants of the SARCOIMAGE project, Dr. Joaquín Barrachina and Cristina Flor.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest in relation to the present study.

AUTHOR CONTRIBUTIONS

J.V-D. and M.A.S-A involved in methodology and conceptualisation. P.P-R., F.M., M-A and J.V-D involved in formal analysis. M.A.S-A., F.M. and M-A. involved in investigation. M.A.S-A involved in data curation. J.V-D., M.A.S-A., P.P-R., F.M. and M-A. involved in writing – original draft preparation. J.V-D., M.A.S-A., P.P-R., F.M. M-A., and J.M-B-L involved in writing – review and editing. All authors have read and agreed to the published version of the manuscript.

DATA AVAILABILITY STATEMENT

Data available on request from the authors.

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How to cite this article: Pérez-Ros, P., Sanchis-Aguado, M. A., Durá-Gil, J. V., Martínez-Arnau, F. M., & Belda-Lois, J. M. (2021). FallSkip device is a useful tool for fall risk assessment in sarcopenic older community people. *International Journal of Older People Nursing*, 00, e12431. <https://doi.org/10.1111/opn.12431>