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pour le

DIPLÔME D'ÉTAT DE DOCTEUR EN MÉDECINE

Qualification en D.E.S de gériatrie

ELDER-RISE

Characteristics of patients with pathological Five Times Sit to Stand (FTSS)

Caractéristiques des patients ayant un Five Times Sit to Stand (FTSS) pathologique

FAURE Marion

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Liste des abréviations

ADL	Activity of daily living
BMI	Body Mass Index
CHAID	Chi-square Automatic Interaction Detector
CHR	Centre Hospitalier Régional
CHRU	Centre Hospitalier Régional Universitaire
CHU	Centre Hospitalier Universitaire
CI	Confidence Interval
FITNESS	Fall Interest To Target Newly Sarcopenic Society
FTSS	Five Times Sit-to-Stand
GDS	Geriatric Depression Scale
IADL	Instrumental Activities of Daily Living
ICOPE	Integrated Care for Older People
IQR	Interquartile Range
MMSE	Mini-Mental State Examination
MNA	Mini Nutritional Assessment
OR	Odds Ratio
RR	Relative Risk
SAS	Statistical Analysis System
SD	Standard Deviation

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Characteristics of patients with pathological Five Times Sit to Stand (FTSS)

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INTRODUCTION

Functional mobility is crucial for carrying out daily activities and maintaining a good quality of life in older adults (1). During the ageing process, there is a decrease in muscle mass, strength, and often performance, a condition known as sarcopenia (2). In older adults, the strength of the lower limbs is one of the main indicators of the ability to mobilize (1). Studies have shown that factors such as lower limb muscle strength, general health and confidence in balance can explain up to 72% of the variance in walking speed (3). These results have highlighted a multitude of factors involved in mobility, shifting the research focus from sarcopenia to understanding the relationship between muscle strength and mobility (2,4).

In addition to walking, sit-to-stand movement is one of the most frequently performed functional tasks. Sitting and standing is considered a fundamental requirement for mobility (1). It is an essential movement for keeping up an active lifestyle. In the geriatric population, the inability to perform this skill can lead to institutionalization, through impaired mobility in the acts of daily living (5). Studies have also shown that inability to perform this task is associated with an increase in all-cause mortality rates (6-8).

Given these findings, the assessment of mobility performance in older adults using physical tests has become an essential clinical practice. Among these tests, the Five Times Sit-to-Stand Test (FTSS), introduced by Csuka and McCarthy in 1985 (9), simulates daily activities and requires complex muscle coordination (10,11). The FTSS measures the time taken to stand up and sit down 5 times from a seated position, as quickly as possible without pushing with the arms (10). The FTSS is a simple, inexpensive test that can be easily performed in primary care settings and requires little space and time (less than 2 minutes, including explanation and execution) (12). Its practicality and lack of need for specific equipment make it suitable for everyday clinical use. According to Roebroeck et al (13), this movement was defined as moving

the center of body mass upwards from a sitting to a standing position without losing balance. In geriatrics, an FTSS performance of more than 14 seconds is defined as pathological (14).

The FTSS specifically assesses functional mobility through a targeted transfer and is a validated method for assessing dynamic balance (1,15). More than simple performance measures, the determinants of FTSS encompass characteristics related to sitting posture, as well as individual parameters such as age and muscular capacity, in association with execution modalities, including motor strategies (16). The robustness of the FTSS as a reliable assessment tool has been rigorously established for both healthy subjects and those with chronic pathologies (1,17), particularly for predicting the recurrence of falls (18). Whether used in primary or secondary prevention, the FTSS is essential for a comprehensive geriatric assessment, providing an overview of muscle strength, balance, mobility and factors associated with functional decline.

This study aimed to examine the characteristics of patients with pathological FTSS (≥ 14 seconds) and identify the clinical factors associated with this condition in older adults. In this context, FTSS plays an important role in public health initiatives such as ICOPE (Integrated Care for Older People), developed by the World Health Organization (WHO) (19). ICOPE aims to improve the care of older adults through an integrated, person-centered approach, with the objective of preventing frailty and functional decline through regular assessments, of which the FTSS is one. By performing this test annually, ICOPE enables early detection of locomotion disorders and other signs of frailty, which is crucial to maintaining independence and quality of life in aging individuals. Thus, understanding the determinants of FTSS is essential to optimize its use in this comprehensive screening framework.

The aim of this study was to explore the characteristics of patients with pathological performance on the FTSS (≥ 14 seconds) and to identify the clinical factors associated with this condition in older adults. Given the lack of predefined hypotheses at the outset of the

study, an exploratory approach was adopted to identify the clinical determinants influencing FTSS performance in older adults. Based on a review of the literature, we examined the main factors recognized as having a potential impact on FTSS.

METHODS

1. Design and settings

The ELDER-RISE study is an observational, retrospective study based on the FITNESS (Fall Interest To Target Newly Sarcopenic Society) database. Data were collected in the context of a multidisciplinary consultation for older adults patients with history of falls, at several centers (CHU d'Angers, CHRU de Lille and CHR d'Orléans). Patients were included over the period from March 2017 to November 2018. Over this period, 365 patients were received in day hospital or convention hospitalization.

Inclusion criteria were an age of 75 years or older, and a reason for admission "fall" or "gait disorder" or "fall risk". Exclusion criteria were age strictly less than 75 years, MMSE (Mini-Mental State Examination) (20) less than 15, severe loss of functional independence defined by ADL (Activity of daily living) less strictly than 4, unstable medical condition and lack of consent to participate in the study.

Of the 365 patients in the FITNESS database, 170 completed the FTSS. After excluding 5 patients due to missing data (1 missing GDS score, 2 missing Charlson scores and 2 with fear accompanied by activity restriction), 165 patients were analyzed (Figure 1).

2. Data collection

Data for each patient who consulted for falls or gait disorders were collected during a day hospitalization, using a standardized data collection notebook. A descriptive analysis of body composition, muscular condition, physical activity and a standardized geriatric assessment were carried out.

This assessment included the following items:

- assessment of autonomy: ADL, IADL (Instrumental ADL) (21),

- cognitive assessment: Dubois test (22), Clock test (23), MMSE (20),

- thymic assessment: GDS (Geriatric Depression Scale) (24),

- assessment of comorbidities: Charlson score (25), number of medications, number of geriatric syndromes (26),

- nutritional assessment: albumin and 25-OH vitamin D3 levels, 30-point MNA (Mini Nutritional Assessment) (27), BMI (Body Mass Index = weight/height^2, kg/m^2). If the biological samples were not taken in the day hospital, a prescription was given to the patient to take the sample on an outpatient basis within 72 hours of inclusion,

- assessment of risk of falls and fractures: search for a history of falls, and search for a history of fractures, measurement of grip strength (Grip Test) (28), monopodal support, Timed Up and Go Test (29), walking talking test and fear of falling.

3. Statistical analyses

Descriptive participants' characteristics were summarized using means and standard deviations (SD) or medians [interquartile range (IQR)] for quantitative variables, and counts and percentages for qualitative variables, as appropriate.

First, participants were divided into two groups according to the FTSS test performance. Comparative analyses were then conducted to ascertain differences between participants who completed the FTSS in less than 14 seconds and those who took 14 seconds or more. Chi-square or Fisher's exact tests were utilized for categorical variables, whereas Student's t-tests or Mann-Whitney U tests were applied for continuous variables, based on data normality.

Secondly, univariate logistic regressions were used to examine the associations between participants' clinical characteristics (independent variables) and FTSS performance (dependent variable). Separate models were performed for each characteristic.

Thirdly, the metrological properties of the FTSS test were evaluated to assess its effectiveness in identifying participants' functional status in this cohort.

To further explore the factors associated with FTSS performance, we conducted a classification tree analysis using the Chi-square Automatic Interaction Detector (CHAID) algorithm. This method uncovers relationships between a categorical outcome variable (FTSS performance) and a set of predictor variables (all clinical variables collected in the study). The CHAID algorithm splits the dataset into subgroups that are as homogeneous as possible regarding the response variable, allowing for the identification of distinct patterns within the data.

The analysis was adjusted for potential confounding variables to ensure accurate results. The probability of having a pathological FTSS (≥ 14 seconds) was calculated for each terminal node, using the node with the lowest prevalence of pathological FTSS as a reference.

The classification tree provided a comprehensive visualization of how different clinical characteristics interact to influence FTSS performance. For each node, we calculated the relative risk (RR) and the 95% confidence interval (CI) for having a pathological FTSS, with the node having the lowest prevalence serving as the reference. This approach allowed us to identify significant predictors and their interactions, making the CHAID analysis a valuable tool for summarizing and interpreting the complex relationships within the dataset.

Two-sided P-values were considered as significant if < 0.05. All statistical analyses were performed using SAS, version 9.4 (SAS Institute Inc.).

RESULTS

1. Participants characteristics

The study included 165 participants with a mean age of 83.1 years (SD ± 4.8), of whom 122 (73.9%) were women. Participants were divided into two groups according to their performance on the FTSS test: those who completed the test in less than 14 seconds (n = 37) and those who took 14 seconds or more (n = 128) (Table 1).

2. Demographic and clinical characteristics

The demographic and clinical characteristics of the participants are presented in Table 1. No significant differences were observed between groups with respect to gender, age or BMI. In the group that completed the FTSS test in less than 14 seconds, 73.0% were women versus 74.2% in the group that took 14 seconds or more (p = 0.879). The mean age of participants was 82.3 years (SD ± 5.1) in the <14 sec group and 83.4 years (SD ± 4.6) in the ≥14 sec group (p = 0.245). Median BMI was 26.9 (IQR ± 5.2) in the <14 sec group and 27.1 (IQR ± 4.8) in the ≥14 sec group (p = 0.778). The presence of family and caregivers did not differ significantly between groups.

Significant differences between groups mainly concerned the use of technical walking aids, Charlson comorbidity index, neurocognitive disorders, depression, fear with activity restriction, and inability to get up from the ground. The use of technical walking aids was significantly higher in the ≥14 sec group, with 65.6% of participants using a cane or walker, compared with only 18.9% in the <14 sec group (p < 0.001). In addition, the Charlson

comorbidity index was higher in the ≥14 sec group, with a median of 2 (IQR 1-3.5), compared with a median of 1 (IQR 1-2) in the <14 sec group (p = 0.020).

Participants in the ≥14 sec group also had a higher prevalence of neurocognitive disorders and depression. Neurocognitive disorders were present in 45.3% of participants in the ≥14 sec group, versus 27.0% in the <14 sec group (p = 0.047). Depression was more common in the ≥14 sec group, with 39.1% of participants affected, compared with 21.6% in the <14 sec group (p = 0.0503). Fear with activity restriction was more common in the ≥14 sec group, with 61.7% of participants affected, compared with 43.2% in the <14 sec group (p = 0.045). Finally, inability to get up from the ground was significantly more common in the ≥14 sec group, with 52.3% of participants affected, compared with 18.9% in the <14 sec group (p < 0.001).

In summary, significant differences between groups were related to the use of walking aids, Charlson comorbidity index, prevalence of neurocognitive disorders and depression, fear with activity restriction, and inability to get up from the ground.

3. Association between clinical characteristics and pathological FTSS

As shown in Table 2, several clinical characteristics were significantly associated with pathological FTSS (≥ 14 seconds) in the multivariate models. In the fully adjusted multivariate model, walking aids and inability to rise from the ground remained as significant predictors. Participants using a cane had an adjusted odds ratio (OR) of 4.14 (95% CI [1.43; 12.00]), and those using a walker/frame had an adjusted OR of 11.60 (95% CI [1.34; 100.19]). Inability to rise from the ground remained a significant predictor with an adjusted OR of 2.64 (95% CI [0.94; 7.44]).

The top-down stepwise method confirmed the importance of walking aids and inability to rise from the ground as key predictors. In this model, participants using a cane had an OR of 5.25 (95% CI [1.97; 13.94]), and those using a walker/frame had an OR of 13.19 (95% CI [1.61; 108.11]). The inability to rise from the ground also remained significant, with an OR of 2.71 (95% CI [1.03; 7.13]).

Notably, the comparison of these results with those of participants with non-pathological FTSS showed multiple significant differences, in particular greater reliance on assistive devices for walking and higher Charlson Comorbidity Index scores in the pathological FTSS group.

4. Classification tree Analysis of factors associated with pathological FTSS

As shown in Figure 2, classification tree analysis was used to identify the profile of patients with a high probability of having a pathological FTSS (≥ 14 seconds). This analysis helps predict the risk factors associated with pathological FTSS and provides a clear visualization of how different clinical characteristics interact to influence FTSS performance.

The initial division of the tree was based on the use of walking aids (cane, walker, or frame). Of the 165 patients, 128 (77.6%) had pathological FTSS. Patients were divided into two groups: those who used assistive devices (node 2) and those who did not (node 1). Patients using assistive devices had a significantly higher probability of having pathological FTSS (92.3%) than those not using assistive devices (59.5%).

The next significant division for node 1 was based on the inability to rise from the ground. Patients who were able to get up from the ground (node 3) had a 51.9% probability of having pathological FTSS, while those who were unable to get up from the ground (node 4) had an 80.0% probability.

For node 2, the significant split was determined by the presence of fear accompanied by activity restriction. Patients without fear with activity restriction (node 5) had a 79.3% probability of having pathological FTSS, while those with fear and activity restriction (node 6) had a 98.4% probability.

DISCUSSION AND CONCLUSION

In this study, we examined the characteristics of patients with pathological FTSS (≥ 14 seconds) and identified several clinical factors associated with this condition. Our multivariate analyses and classification tree highlighted that the use of assistive devices for walking, inability to get up from the ground and fear with activity restriction were the main predictors of pathological FTSS. These results underscore the importance of these factors in assessing functional mobility in older adults.

The use of technical walking aids (30,31) and the inability to rise from the ground (32) have been identified as key indicators of reduced mobility in older adults in various studies. In addition, the high prevalence of neurocognitive disorders and depression in patients with pathological FTSS is consistent with previous research (6,10), which has shown the impact of psychological conditions on mobility. These results highlight the interdependence between physical and psychological factors in determining mobility performance.

Although fear of falling is common and debilitating, its management remains poorly understood. Approximately half of community-dwelling older adults, whether they have fallen or not, experience this fear (33), which often leads to activity restriction and increases the risk of functional decline and further falls. A recent systematic review and meta-analysis demonstrate that there are no definitive studies to guide clinical practice in this area (34). Our findings highlight the need for clinicians to be aware of the anxiety and depression frequently associated with fear of falling, and for research to be directed towards exercise interventions in this context.

One of the major strengths of this study is the use of the FITNESS database, enabling detailed information to be collected on a diverse cohort of older adults patients. In addition, the application of robust statistical analyses, including multivariate models and a classification tree, strengthened the validity of the results. However, the retrospective nature of the study

may introduce selection and recall biases. Some variables, such as fear of falling, were based on self-reports, which may lead to measurement errors. Finally, the hospital setting of the study limits the generalization of the results to the general older adults population.

The results of this study have significant clinical implications. Recognition of the factors associated with pathological FTSS may help clinicians to rapidly identify patients at risk of functional decline, thereby facilitating more effective and targeted assessment. Using the classification tree, it was possible to determine that patients using walking aids and those with an inability to get up from the ground or an activity-restricted fear have a particularly high risk of having a pathological FTSS. This approach has the potential to simplify and speed up the assessment process by allowing clinicians to predict FTSS performance based on observed clinical features, thereby avoiding the need to systematically perform the test in patients identified as being at high risk. This would allow a more efficient allocation of resources and clinical time.

Future research should explore specific interventions to improve FTSS performance in patients identified as at risk. Longitudinal studies are needed to confirm the causal relationships between the identified variables and FTSS performance. In addition, the impact of multidimensional interventions on improving mobility and reducing the risk of falls deserves particular attention. It would also be relevant to examine the impact of these interventions on the quality of life of older adults patients.

In conclusion, this study identified several clinical factors associated with pathological FTSS in older adults patients. The use of technical walking aids, inability to get up from the ground and fear accompanied by activity restriction are key indicators of reduced mobility. These results underline the importance of a multidimensional assessment of mobility in the older adults to prevent functional decline and improve quality of life. Interventions targeting

these factors can play a crucial role in the management of older adults patients and the prevention of falls, thereby contributing to greater independence and quality of life.

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ANNEXES

Table 1 : description of participants' characteristics and comparisons based on FTSS test performance (n=165).

	Total (n=165)	FTSS		p-value*
		< 14 sec (n =37)	≥ 14 sec (n=128)	
Demographics				
Female	122(73.9)	27(73.0)	95(74.2)	0.879
Age (mean. ± SD) (years)	83.1±4.8	82.3±5.1	83.4±4.6	0.245
Family and caregivers	120(72.7)	24(67.6)	95(74.2)	0.423
BMI, median [IQR] (Kg/m²)	27.1±4.9	26.9±5.2	27.1±4.8	0.778
Treatments, walking aids				
Polypharmacy[†|]	131(80.4)	30(81.1)	101(80.2)	0.901
Psychotropic drugs[|]	77(47.2)	18(48.7)	59(46.8)	0.845
Cardiotropics drugs[|]	88(54.0)	19(51.4)	69(54.8)	0.714
Vitamin D[|]	109(66.9)	27(73.0)	82(65.1)	0.370
Technical walking aids				**<0.001**
None	74(44.9)	30(81.1)	44(34.4)	
Can	57(34.5)	6(16.2)	51(39.8)	
Walker	34(20.6)	1(2.7)	33(25.8)	
Medical history, comorbidities				
Charlson comorbidity index, median [IQR]	2 [1-3]	1 [1-2]	2 [1-3.5]	**0.020**
Dementia[‡]	68(41.2)	10(27.0)	58(45.3)	**0.047**
Depression [$]	58(35.2)	8(21.6)	50(39.1)	0.0503
Malnutrition[¶]	12(7.3)	3(8.1)	9(7.0)	0.732
Orthostatic hypotension	37(22.4)	8(21.6)	29(22.7)	0894
Fear with activity restriction	95(57.6)	16(43.2)	79(61.7)	**0.045**
History of falls	103(62.4)	21(56.8)	82(64.1)	0.419
Inability to rise from ground	74(44.9)	7(18.9)	67(52.3)	**<0.001**
ADL, median [IQR]	5.5 [5.0-6.0]	6.0 [5.5-6.0]	5.5 [5.0-6.0]	**0.008**
Biology				
25(OHD) < 30 ng/ml, (mean, ± SD)[||]	94(57.3)	19(51.4)	75(59.1)	0.404

SD, standard deviation ; IQR, interquartile range ; BMI, Body Mass Index ; ADL : Activities of Daily Living ; * Chi^2 or Fisher exact test for qualitative variables and Student or Mann-Withney Wilcoxon test for quantitative variables ; [†] ≥ 5 drugs/day ; [|] Missing data n=2 ; [‡] MMSE score (Mini Mental State Examination) < 27/30 ; [$] GDS score (Geriatric Depression Scale) > 5/15 ; [¶] Score au MNA (Mini Nutritional Assesssment) < 17/30 ; [||] Missing data n=1.

Table 2 : multivariate logistic regression showing the association between pathological FTSS (≥ 14 sec) (dependent variable) and clinical characteristics (independent variables) (n=165).

	Univariate models		**Fully adjusted multivariate model**		**Multivariate model With top-down stepwise method**	
	RC [IC à 95 %]	P-value	RC [IC à 95 %]	P-value	RC [IC à 95 %]	P-value
Female	1.07 [0.47 ; 2.44]	0.879	0.87 [0.33 ; 2.26]	0.774	-	-
Age	1.05 [0.97 ; 1.13]	0.245	1.00 [0.91 ; 1.10]	0.958	-	-
Technical walking aid	-	**<0.001**	-	**0.006**	-	**<0.001**
None	ref.	-	ref.	-	ref.	-
Can	5.80 [2.21 ; 15.21]	-	4.14 [1.43 ; 12.00]	-	5.25 [1.97 ; 13.94]	-
Walker	22.50 [2.92 ; 173.53]	-	11.60 [1.34 ; 100.19]	-	13.19 [1.61 ; 108.11]	-
Charlson	1.32 [1.02 ; 1.72]	**0.036**	1.25 [0.94 ; 1.67]	0.128	-	-
Neurocognitive disorders*	2.24 [1.001 ; 5.00]	**0.0499**	1.19 [0.47 ; 3.03]	0.709	-	-
Depression†	2.32 [0.98 ; 5.49]	0.055	2.54 [0.93 ; 6.94]	0.070	-	-
Fear with activity restriction	2.12 [1.01 ; 4.44]	**0.048**	0.97 [0.40 ; 2.36]	0.951	-	-
Inability to rise from the ground	4.71 [1.93 ; 11.49]	**<0.001**	2.64 [0.94 ; 7.44]	0.068	2.71 [1.03 ; 7.13]	**0.044**
ADL	0.31 [0.13 ; 0.73]	**0.008**	0.61 [0.22 ; 1.68]	0.343	-	-

ADL: Activities of Daily Living; BMI: Body Mass Index; *MMSE score (Mini Mental State Examination) < 27/30 ; † GDS score (Geriatric Depression Scale) > 5/15

Figure 1 : flow chart.

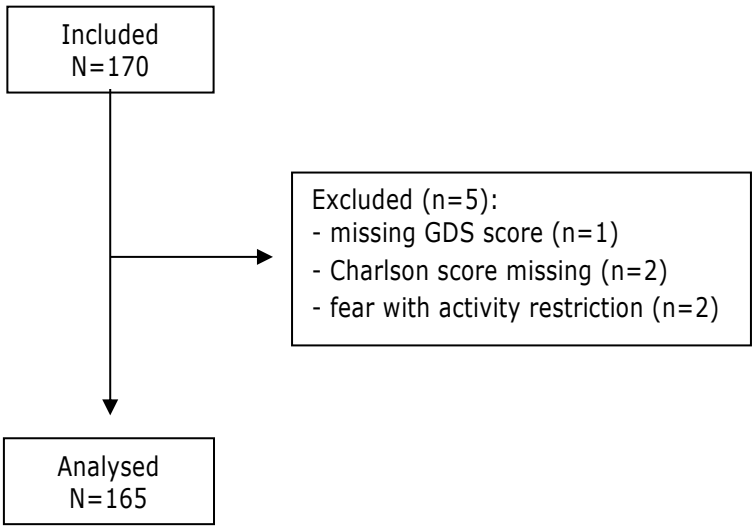
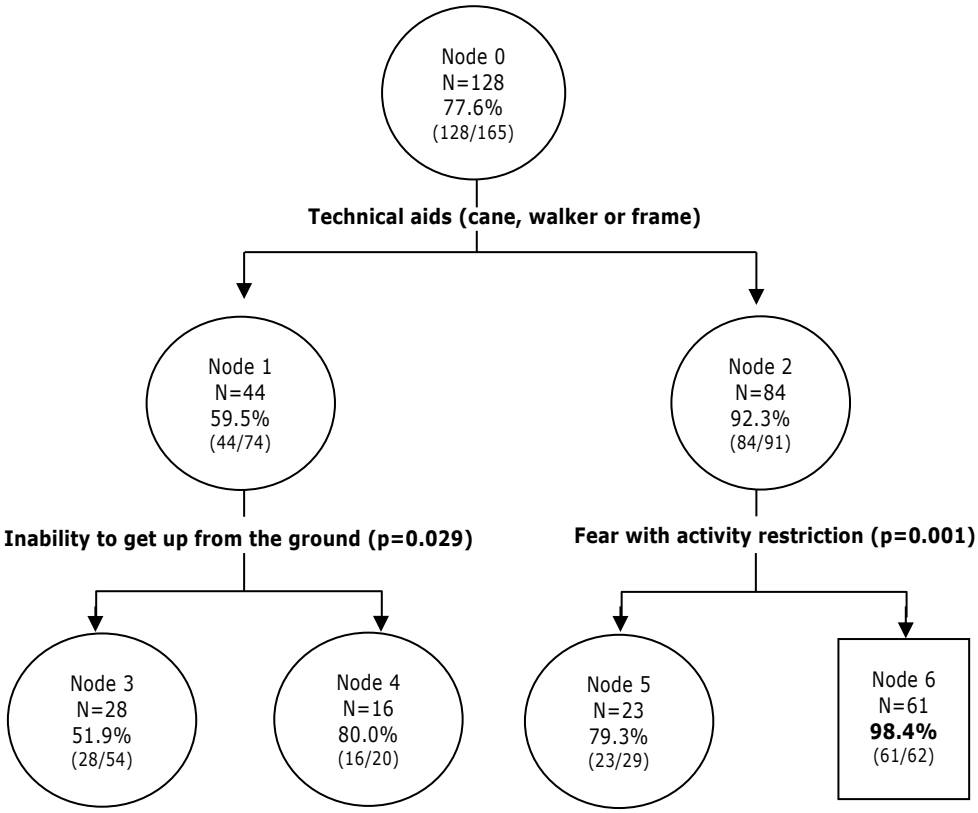


Figure 2 : classification tree for the prediction of pathological FTSS (i.e., FTSS ≥ 14 sec) among patients (N = 165).



Probability of Pathological FTSS (≥ 14 sec) (RR[95%CI])	**1** (reference)	**1.54** [1.10-2.16]	**1.53** [1.11-2.10]	**1.90** [1.47-2.46]

For each node: node number; N of patients with pathological FTSS within node; proportion of patients with pathological FTSS within node (N with pathological FTSS / N node). RR: relative risk; 95CI: 95 % confidence interval.

FAURE Marion

Caractéristiques des patients ayant un Five Times Sit to Stand (FTSS) pathologique

RÉSUMÉ

Introduction : la mobilité fonctionnelle est essentielle pour maintenir l'indépendance et la qualité de vie des personnes âgées. Le test "Five Times Sit to Stand" (FTSS) évalue cette mobilité, où un temps supérieur à 14 secondes est pathologique. L'objectif de cette étude était d'identifier les facteurs cliniques associés à un FTSS pathologique.

Méthodes : l'étude ELDER-RISE est une étude observationnelle rétrospective utilisant la base de données FITNESS. Elle inclut 165 patients de 75 ans et plus, admis pour des chutes ou des troubles de la marche. Les caractéristiques démographiques, cliniques et les résultats du FTSS ont été analysés. Des modèles de régression logistique et un arbre de classification (CHAID) ont été utilisés.

Résultats : 77,6 % des patients avaient un FTSS pathologique. L'utilisation d'aides à la marche (OR=4,14) et l'incapacité à se relever du sol (OR=2,64) étaient des prédicteurs significatifs. L'arbre de classification a montré que les patients utilisant des aides à la marche et ayant peur avec restriction d'activité avaient un risque élevé de FTSS pathologique.

Conclusion : l'utilisation d'aides techniques, l'incapacité à se relever du sol et la peur avec restriction d'activité sont des indicateurs clés de FTSS pathologique chez les personnes âgées. Cette approche peut simplifier et accélérer l'évaluation clinique en prédiction des performances au FTSS.

Mots-clés : **mobilité fonctionnelle, personnes âgées, test FTSS, facteurs de risque, évaluation clinique.**

Characteristics of patients with pathological Five Times Sit to Stand (FTSS)

ABSTRACT

Introduction: functional mobility is essential for maintaining independence and quality of life in older adults. The Five Times Sit to Stand (FTSS) test assesses this mobility, where a time greater than 14 seconds is pathological. The aim of this study was to identify the clinical factors associated with pathological FTSS.

Methods: the ELDER-RISE study was a retrospective observational study using the FITNESS database. It included 165 patients aged 75 and over admitted for falls or gait disorders. Demographic and clinical characteristics and FITNESS results were analysed. Logistic regression models and a classification tree (CHAID) were used.

Results: 77.6% of patients had a pathological FTSS. The use of walking aids (OR=4.14) and inability to rise from the ground (OR=2.64) were significant predictors. The classification tree showed that patients using walking aids and fear with activity restriction had a high risk of pathological FTSS.

Conclusion: the use of technical aids, inability to get up from the ground and fear with activity restriction are key indicators of pathological TSSF in older adult patients. This approach can simplify and accelerate clinical assessment by predicting FTSS performance.

Keywords: functional mobility, older people, FTSS test, risk factors, clinical assessment.

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