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RESEARCH PAPER

Validation of Subjective and Objective Decisional Trees to prescribe exercise using the pace tool in outpatient older adults

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Key summary points

Aim This research addresses the existing gap in geriatric care, the lack of pragmatic, valid tools to support the prescription of adapted physical activity (APA) by healthcare professionals, by introducing two new valid tools within the PACE tool (Promote Autonomy through exerCisE) for estimating (Subjective Decisional Tree) or assessing (Objective Decisional Tree) the functional performance capacities of pre-frail and frail older individuals. These innovative tools are tailored to evaluate the decline of specific parameters associated with frailty in older adults.

Findings

- The PACE Subjective Decisional Tree (SDT), consisting of 13 questions, is a valid tool allowing geriatricians to quickly estimate the functional and physical performance of their pre-frail and frail outpatients.
- The PACE Objective Decisional Tree (ODT), comprising four validated geriatric physical and functional tests, is a valid tool enabling exercise professionals to conduct a thorough assessment of functional performance of a wide range of geriatric patient profiles.
- The scores and physical activity (PA) prescriptions obtained from the SDT and ODT are correlated but only weakly concordant.

Message The SDT and ODT, combined with a system for prescribing specific and APA programs offered by the PACE tool, facilitate the rapid and straightforward implementation of APA prescription in outpatient geriatric clinics. By offering versatility and pragmatism tailored to the unique demands of these care environments, these tools represent a significant advancement in geriatric care. They provide geriatricians and healthcare professionals with the means to efficiently prescribe APA programs that meet the individual needs and performance of pre-frail and frail older patients.

Abstract

Methods A tool called PACE, including two decisional trees (SDT for physicians and ODT for exercise professionals), was co-created to integrate PA prescriptions in outpatient geriatric care. The SDT comprised 13 questions from validated questionnaires (FRAIL, FIND, and SARC-F), and the ODT included four geriatric functional tests (30-s chair test, functional reach test, balance, and normal walking speed). SDT and ODT were administered to ninety-seven patients. Cronbach's alpha, confirmatory factor analysis, Pearson's correlation, Kappa, and Tau-B correlation were conducted.

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Results The SDT and ODT demonstrated good internal consistency ($\alpha = 0.74$–0.86 and $\alpha = 0.75$, respectively). Concurrent validity showed significant correlations between the SDT and indices of frailty and sarcopenia ($r = 0.62$–0.90, $p < 0.001$) and objective functional tests ($r = 0.66$–0.72, $p < 0.001$). The ODT showed significant correlations with functional tests ($r = 0.65$–0.88, $p < 0.001$). Despite some correlations between the decisional trees ($r = 0.48$–0.68, $p < 0.001$), their concordance was limited (kappa = 0.08–0.41). Sub-analyses revealed higher correlations and concordances when the caregiver living with the patient was involved in SDT responses.

Conclusions The SDT and ODT demonstrated good validity for assessing the functional performance profile of older adults and can be used to prescribe exercise programs using PACE. This study highlights the importance of involving caregivers in the SDT assessment to refine PACE prescriptions.

Keywords Screening · Validity · Functional capacities · Frailty · Aging

Background

Aging processes contribute to the deterioration of functional capacities [1–3], impacting quality of life and physical independence. An inactive and sedentary lifestyle further exacerbates these impairments [4–7]. While physical activity (PA) is widely recognized as an effective strategy to counter these effects [4, 8–10], the prescription of adapted and specific exercises remains poorly integrated into geriatric care [11, 12]. This lack of integration is attributed to several factors, including a lack of specific knowledge or training [13], time constraints [12], human bias [14], limited access to other rehabilitation professionals, such as exercise professionals [15, 16], and the absence of a pragmatic tool to bridge this gap [17].

To reduce these barriers, the PACE (Promote the Autonomy through exerCisE) tool was developed as a pragmatic, individualized approach, to prescribe specific and adapted PA. The PACE tool includes a decisional tree that can be either subjective (based on validated questionnaires) or objective (based on validated physical performance assessments) to prescribe the specific PA program, thereby overcoming implementing barriers. For instance, in settings where exercise professionals are scarce or objective assessment of physical performance is not feasible due to time constraints, sanitary concerns, or space limitations, a questionnaire-based assessment can provide a validated, rapid, and convenient alternative [18, 19]. However, decisions based on subjective assessments may be challenging due to influences, such as self-confidence and individual perception biases [20, 21], particularly with cognitively impaired geriatric patients. In contrast, objective assessments based on validated geriatric tests offer precise evaluation of physical performance [22, 23]. In addition, these assessments require adequate space, more time, and the presence of qualified professionals for administration.

To ensure the effectiveness and relevance of the PACE tool, this study aimed to validate the Subjective (SDT) and the Objective (ODT) Decisional Trees. Specifically, validation was conducted both to confirm that the tools reliably reflect the functional performance profile of older adults and to verify that they provide a sound basis for prescribing appropriate, adapted, and specific exercise interventions. This dual focus ensures that PACE can be used confidently in clinical settings to guide personalized PA prescriptions that address individual functional needs.

Methods

Study design

This cross-sectional study received ethical approval from the CRIUGM committee (#CER-VN-20-21-06), and all participants provided informed consent.

PACE tool

The PACE tool was co-designed for use in outpatient geriatric clinics by a team of 10 clinicians and researchers. This team included four geriatricians, one nurse working in outpatient geriatric clinics, and five research members with expertise in kinesiology and/or gerontology. The development process drew on similar tools previously co-created for other geriatric settings [24, 25]. The PACE tool aimed to prescribe individualized, adapted PA programs from 35 predefined modalities. These programs are unsupervised, home-based and without the need for specific equipment. The primary goals of these programs were to improve balance, mobility, and muscle function through exercises. Additionally, participants were encouraged to engage in daily walking for 10–30 min as part of their prescribed regimen. To mitigate age bias and subjective human judgment [14], two decisional trees were integrated into the tool to recommend the most appropriate PA program and facilitate its integration into routine care.

A) Subjective Decisional Tree (SDT):

The SDT was co-designed using validated subjective scales for measuring frailty or sarcopenia, selected by the expert team including FiND [26], the FRAIL Scale [27], and SARC-F [28]. Additional elements were also included to complement and refine the functional performance profile. Following recommendations in the literature [29], ambiguous items or those requiring a high level of comprehension were avoided. Through collaborative meetings, a set of 13 questions/items was devised to estimate the participant's functional performance profile [(lower limb muscle endurance (item #1–4; score A:x/6), balance (item #5–8; score B:x/6), and trunk flexibility (item #9–13; score C:x/6)] (Supplemental material Figure S2). The type of exercise program prescribed was determined by the scores obtained on the functional profile (score A, B, and C). These subscores determined the program's difficulty [5 levels (I to V) = I:0–4; II:5–8; III:9–12; IV:13–15; V:16–18] and focus [based on the lowest score obtained: A = Strength = Blue/B = Balance = Yellow/C = Flexibility = Red/A + B = Green/A + C = Purple/B + C = Orange/A + B + C = Brown]. The prescribed walking time during the consultation with the geriatricians was linked to the program level obtained (I = 10 min; II = 15 min; III = 20 min; IV and V = 30 min). For further details, refer to supplemental material Figure S1.

B) Objective Decisional Tree (ODT):

To address safety concerns and tailor prescriptions as needed, an ODT (see supplemental material Figure S2) was also co-created with the same expert team. The ODT incorporated four standard validated geriatric tests: 1) 30-s Sit-to-Stand (30-s STS) ([30, 31]; score A:x/6), 2) side-by-side, semi-tandem, tandem and unipedal balance ([32, 33]; score B:x/6), 3) the FRT ([34, 35]; score C:x/6), and 4) 4-m walking speed ([36]; score D:x/4). The interpretation of the scores to obtain the specific prescription aligns with that of the SDT.

Population

Inclusion criteria Included outpatient geriatric patients were required to have both decisional trees documented in their file.

Sample size The sample size for this study was determined based on broad recommendations for psychometric validation (item–response ratio ranging from 1:3 to 1:20; minimum: n = 50 [37–39]). Therefore, a sample size between 100 and 90 was deemed adequate to provide a sample corresponding to the ideal variables-to-factors ratios for the SDT [40].

Outcomes and data analysis

The normality of the data distribution was assessed to avoid potential multicollinearity. Confirmatory factor analysis (CFA) was employed to evaluate whether the structure of each single-factor SDT subscore aligned with the observed data. Cronbach's alpha was calculated for the total score of the ODT, SDT, and their subscores to assess internal consistency. Standardized Cronbach's alpha was used for consistency analysis, considering the items did not all have the same scales (0–1; 0–2) [41]. Internal consistency reliability was evaluated using Cronbach's alpha coefficient, where a value above 0.70 indicates high internal consistency [42]. Pearson's r coefficients were calculated to assess the concurrent validity of the tools, analyzing the relationships of the SDT with frailty indices (SARC-F, FiND, FRAIL) and validated geriatric functional tests (SPPB total score; STS 5-repetitions, 30-s STS, 3-m usual Timed Up-and-Go (TUG), walking speed), as well as the relationships of the ODT with the same functional tests. Pearson's coefficient was also used to measure the concordance between the ODT and SDT for all scores. Furthermore, the agreement between the ODT and SDT for their exercise prescriptions was analyzed using the Kappa coefficient for categorical variable concordance (color, difficulty level, daily walking goal) and the Tau-B for ordinal variable correlations (difficulty level, daily walking goal). A sub-analysis was conducted to assess the concordance between the SDT and ODT for each of the common improvement objectives and absolute difficulty levels of adapted physical activity programs. These modalities are referenced, respectively, by a color and a number from 1 to 5 according to the individual's functional status.

Results

Population characteristics

Among the 97 patients included (mean age: 79.4 ± 7.2 years), 53.6% were women, 81.4% were Caucasian, 86.6% lived at home, and 54.6% had a caregiver. Of these patients, 41.2% exhibited moderate cognitive impairment (based on MMSE scores [43]), and 73.2% perceived their health as "good" or "very good" (Likert scale 5 items; see supplemental material Table S1).

Subjective Decisional Tree (SDT)

Reliability

Internal consistency of the SDT was assessed using Cronbach's alpha (standardized) for the total score and each of its subscores. The coefficients for subscores A ($\alpha = 0.82$), B ($\alpha = 0.74$), C ($\alpha = 0.75$) and the total score (all items:

$\alpha = 0.86$) demonstrated acceptable internal consistency (Table 1).

Validity

Construct validity Factor analysis revealed a single-factor solution that accounted for between 53.0 and 65.3% of the variance on its own. Each subscore's items exhibited a strong correlation among themselves and their respective factor (factor loading > 0.5). Notably, only item #12 (subscore C) displayed a factor loading that could be considered substantial (factor loading = 0.44; Table 1). It is important to note that the factor analysis for subscore C revealed a positive, undefined correlation matrix, due to a perfect correlation between item #10 and item #11. A subsequent factor analysis was conducted for subscore C, omitting one of these two items. Ultimately, the common factor of this subscore accounted for 46.3% of the variance, and the correlation between each item and factor became strong (> 0.5).

Concurrent validity The results showed significant correlations ($p < 0.001$) between the SDT total score and the variables measuring frailty and sarcopenia. Specifically, the SDT total score displayed a strong negative correlation with FiND ($r = -0.62$) and FRAIL ($r = -0.64$), and a very strong negative correlation with SARC-F ($r = -0.90$). Additionally, strong to very strong correlations were evident between specific SDT subscores (A, B, C) and various FiND, FRAIL, and SARC-F scale scores. Correlation coefficients and specific p-values are shown in Table 4. Correlations were also observed between the SDT and physical performance assessments. In this case, strong correlations emerged with the SPPB total score ($r = 0.72$, $p < 0.001$), normal walking speed ($r = 0.67$, $p < 0.001$), and normal TUG ($r = 0.66$, $p < 0.001$). Significant correlations were also observed between the SDT subscores and these objective measures. Specifically, subscore A exhibited moderate correlations with the number of repetitions during the 30-s STS ($r = 0.50$, $p < 0.001$) and the SPPB STS-5-rep score ($r = 0.54$, $p < 0.01$). Subscore B demonstrated a moderate correlation with the SPPB balance score ($r = 0.54$, $p < 0.001$), and strong correlations with normal TUG time ($r = 0.63$, $p < 0.001$) and normal 4-m walking speed ($r = 0.64$, $p < 0.001$). Subscore C exhibited a weak correlation with the distance reached at the FRT ($r = 0.27$, $p < 0.001$). Additionally, the walking score was strongly correlated with the SPPB walking score ($r = 0.65$, $p < 0.001$) and the normal 4-m walking speed ($r = 0.63$, $p < 0.001$).

Sub-analyses, categorized by respondent type (patient, caregiver, physician), revealed that the majority of the strongest correlations occurred when the SDT was completed by the caregiver (living with the patient or not; Table 2).

Table 1 Factor loadings and structural consistency of the Subjective Decisional Tree (SDT)

Internal consistency analysis			Confirmatory factor analysis		
Cronbach's Alpha global		Cronbach's Alpha by subscore	Items	By subscore	Subscore C after correction
0.88	A	0.82	1	0.82	
			2	0.83	
			3	0.78	
			4	0.80	
	B	0.74	5	0.62	
			6	0.73	
			7	0.82	
			8	0.83	
	C	0.75	9	0.61	0.68
			10	0.94	0.82
			11	0.94	
			12	0.44	0.53
			13	0.58	0.67

Internal consistency is indicated by the standardized Cronbach's alpha coefficient for both the overall SDT structure and the structure of each subscore. The loading factor for each item is relative to the single parameter of each subscore shown in the confirmatory factor analysis. A secondary analysis was conducted for subscore C, where one of the two items (10 and 11) with perfect correlation and identical loading factor was omitted

Objective Decisional Tree (ODT)

Reliability

Cronbach's alpha was calculated for the entire test battery and indicates good measurement reliability for the ODT items ($\alpha = 0.75$). Additionally, the correlation between the items suggests consistency across measures ($0.45 \leq r \leq 0.58$; Table 2).

Validity

Concurrent validity An analysis of the relationships between the ODT and various physical and functional tests revealed significant correlations. Strong correlations were observed between the ODT total score and SPPB total score ($r = 0.88$, $p < 0.001$), TUG time at normal speed ($r = 0.66$, $p < 0.001$), and normal 4-m walking speed ($r = 0.65$, $p < 0.001$). The lower limb performance score (A) was strongly correlated with STS-5rep ($r = 0.60$, $p < 0.001$), walking speed ($r = 0.64$, $p < 0.001$), and very strongly correlated with the 30-s STS ($r = 0.85$, $p < 0.001$) and SPPB STS-5rep score ($r = 0.91$, $p < 0.001$). Balance score (B) demonstrated moderately correlations with the TUG score ($r = 0.54$, $p < 0.001$) and gait speed ($r = 0.59$, $p < 0.001$), and a very strong correlation with the SPPB balance score ($r = 0.85$, $p < 0.001$). Trunk performance (subscore C) exhibited moderate correlations with the TUG score ($r = 0.54$, $p < 0.001$) and walking speed ($r = 0.55$, $p < 0.001$), and a very strong correlation with the FRT score ($r = 0.68$, $p < 0.001$). Finally, gait performance (subscore D) was strongly correlated with the SPPB total score ($r = 0.88$, $p < 0.001$), 30-s STS ($r = 0.73$, $p < 0.001$), TUG ($r = 0.65$, $p < 0.001$), and walking speed ($r = 0.72$, $p < 0.001$). Other correlations were also found between the ODT total score, its subscores, and the physical performance tests (Table 2). However, these correlations should be considered moderate (Table 2).

SDT and ODT: score correlations

Comparison of means revealed that the SDT exhibited higher scores than with the ODT. Specifically, a mean difference of + 1.6 (± 1.1) was noted for subscore A, + 1.1 (± 1.0) for subscore B, + 1.4 (± 1.1) for subscore C, and + 3.4 (± 2.5) for the total score ($p < 0.001$).

However, calculations of Pearson's r coefficients revealed moderate correlations between the SDT and ODT for subscores A ($r = 0.57$) and C ($r = 0.48$), and strong correlations ($p < 0.001$) for subscore B ($r = 0.60$), walking scale ($r = 0.67$), and total scores ($r = 0.68$) ($p < 0.001$). When considering which respondents were involved in completing the SDT (patient, physician, caregiver living with the patient or not), the strongest correlation for subscores A, B, and total scores were observed when the caregiver living with the patient completed the SDT ($r = 0.64$, $r = 0.77$, and $r = 0.71$ respectively; see Table 3). Regarding subscore C, the strongest correlation was found when the SDT was completed by the caregiver not living with the patient ($r = 0.53$; see Table 3). The SDT exhibited the lowest r coefficients for each SDT score compared to those of the ODT (A: $r = 0.46$, B: $r = 0.49$, C: $r = 0.33$, total score: $r = 0.55$, walking scale: $r = 0.56$; $p < 0.01$) when completed by the physician only.

SDT and ODT: exercise prescription matching

The Kappa coefficient indicated a lack of agreement between the SDT and ODT regarding the prescribed program color, which represents the modalities of adapted physical activity recommended ($k = 0.08$; $p < 0.001$). Sub-analyses revealed weak agreement between the SDT and ODT for lower limb muscle performance ($k = 0.20$; $p < 0.001$) and no concordance for balance or trunk performance.

Regarding program difficulty levels, the analyses showed a mean difference of less than one difficulty level between the ODT and SDT ($\Delta = 0.74(\pm 0.96)$; $p < 0.001$). The agreement was low ($k = 0.19$; $p < 0.001$), while the correlation was moderate (Tau-b = 0.58; $p < 0.001$). Similarly, walking time prescriptions exhibited a moderate correlation (Tau-b = 0.58; $p < 0.001$) and low concordance ($k = 0.41$; $p < 0.001$), with the SDT prescribed walking time, which was 1.4 (± 5.4) min higher than the ODT (Table 4). Sub-analyses based on the SDT responder revealed that correlations related to difficulty level between the ODT and SDT became strong, with a higher concordance coefficient, when the caregiver was living with the patient (Tau-b = 0.69; $k = 0.17$; $p < 0.001$), or the patient themselves (Tau-b = 0.60; $k = 0.18$; $p < 0.001$) completed the SDT. Conversely, the correlation and concordance coefficients were lowest when only the physician was involved in the SDT responses (Tau-b = 0.49; $k = 0.09$; $p < 0.001$).

Regarding program focus, concordances between the ODT and SDT were stronger only when the caregiver not living with the patient ($k = 0.150$; $p < 0.001$) completed the SDT. Finally, strong correlations (Tau-b = 0.61; $p < 0.01$) and moderate agreement ($k = 0.54$; $p < 0.001$) related to walking goals between the ODT and SDT were observed when the caregiver living with the patient completed the SDT.

Table 2 Pearson's r correlation coefficient between decisional trees and functional capacity assessments

	SDT					ODT					SPPB			
	A score	B score	C score	Total score	Walking scale	A score	B score	C score	Total score	Walking scale	5rep score	Balance score	4MWS score	Total score
SDT														
A score	1	0.79[a]	0.60[a]	0.92[a]	0.85[a]	0.57[a]	0.47[a]	0.42[a]	0.59[a]	0.61[a]	0.54[a]	0.40[a]	0.62[a]	0.64[a]
B score		1	0.62[a]	0.91[a]	0.84[a]	0.50[a]	0.60[a]	0.43[a]	0.63[a]	0.69[a]	0.49[a]	0.54[a]	0.65[a]	0.68[a]
C score			1	0.83[a]	0.81[a]	0.38[a]	0.56[a]	0.48[a]	0.58[a]	0.59[a]	0.35[a]	0.54[a]	0.57[a]	0.58[a]
Total score				1	0.94[a]	0.55[a]	0.61[a]	0.50[a]	0.68[a]	0.71[a]	0.53[a]	0.55[a]	0.70[a]	0.72[a]
Walking scale					1	0.51[a]	0.60[a]	0.49[a]	0.65[a]	0.67[a]	0.47[a]	0.55[a]	0.65[a]	0.67[a]
ODT														
A score						1	0.50[a]	0.45[a]	0.78[a]	0.61[a]	0.91[a]	0.47[a]	0.61[a]	0.84[a]
B score							1	0.58[a]	0.87[a]	0.56[a]	0.47[a]	0.85[a]	0.53[a]	0.72[a]
C score								1	0.81[a]	0.49[a]	0.45[a]	0.52[a]	0.55[a]	0.61[a]
Total score									1	0.68[a]	0.74[a]	0.76[a]	0.68[a]	0.88[a]
Walking scale										1	0.58[a]	0.55[a]	0.95[a]	0.85[a]
SPPB SCORES														
5rep score											1	0.42[a]	0.57[a]	0.85[a]
Balance score												1	0.54[a]	0.75[a]
4MWS score													1	0.85[a]
Total score														1
STS														
5rep														
30 s														
MOBIL														
TUG														
Walking speed														
FRT														
FRAILTY INDEX														
SARC-F														
FiND														
FRAIL														

	STS		MOBIL			FRAILTY INDEX		
	5rep	30 s	TUG	Walking speed	FRT	SARC-F	FiND	FRAIL
SDT								
A score	− 0.45[a]	0.50[a]	− 0.57[a]	0.59[a]	0.28[b]	− 0.94[a]	− 0.70[a]	− 0.66[a]
B score	− 0.30[b]	0.46[a]	− 0.63[a]	0.64[a]	0.26[c]	− 0.81[a]	− 0.48[a]	− 0.48[a]
C score	− 0.21[c]	0.38[a]	− 0.56[a]	0.56[a]	0.27[b]	− 0.61[a]	− 0.40[a]	− 0.51[a]

Table 2 (continued)

	STS		MOBIL			FRAILTY INDEX		
	5rep	30 s	TUG	Walking speed	FRT	SARC-F	FiND	FRAIL
Total score	– 0.37[a]	0.51[a]	– 0.66[a]	0.67[a]	0.30[b]	– 0.90[a]	– 0.62[a]	– 0.64[a]
Walking scale	– 0.36[a]	0.46[a]	– 0.62[a]	0.63[a]	0.31[b]	– 0.82[a]	– 0.55[a]	– 0.64[a]
ODT								
A score	– 0.60[a]	0.85[a]	– 0.53[a]	0.64[a]	0.35[a]	– 0.62[a]	– 0.30[c]	– 0.33[b]
B score	– 0.27[b]	0.50[a]	– 0.54[a]	0.59[a]	0.45[a]	– 0.50[a]	– 0.29[c]	– 0.20
C score	– 0.30[b]	0.46[a]	– 0.54[a]	0.55[a]	0.68[a]	– 0.42[a]	– 0.29[c]	– 0.21
Total score	– 0.47[a]	0.73[a]	– 0.65[a]	0.72[a]	0.59[a]	– 0.62[a]	– 0.37[b]	– 0.31[c]
Walking scale	– 0.47[a]	0.59[a]	– 0.65[a]	0.85[a]	0.24[c]	– 0.67[a]	– 0.38[b]	– 0.35[b]
SPPB SCORES								
5rep score	– 0.61[a]	0.82[a]	– 0.49[a]	0.58[a]	0.35[a]	– 0.58[a]	– 0.31[c]	– 0.31[c]
Balance score	– 0.25[c]	0.48[a]	– 0.64[a]	0.52[a]	0.44[a]	– 0.47[a]	– 0.26[c]	– 0.18
4MWS score	– 0.55[a]	0.62[a]	– 0.66[a]	0.85[a]	0.26[b]	– 0.68[a]	– 0.42[a]	– 0.37[b]
Total score	– 0.60[a]	0.80[a]	– 0.71[a]	0.79[a]	0.42[a]	– 0.71[a]	– 0.41[a]	– 0.36[b]
STS								
5rep	1	– 0.70[a]	0.26[c]	– 0.46[a]	– 0.12	0.43[a]	0.34[b]	0.39[b]
30 s		1	– 0.58[a]	0.68[a]	0.28[b]	– 0.52[a]	– 0.33[b]	– 0.35[b]
MOBIL								
TUG			1	– 0.68[a]	– 0.32[b]	0.63[a]	0.39[b]	0.35[b]
Walking speed				1	0.34[a]	– 0.62[a]	– 0.36[b]	– 0.31[c]
FRT					1	– 0.27[b]	– 0.26[c]	– 0.12
FRAILTY INDEX								
SARC-F						1	0.56[a]	0.53[a]
FiND							1	0.67[a]
FRAIL								1

Correlations are expressed by Pearson's r coefficients. The significance levels of correlations are indicated as follows: $p<0.05^{c}$; $p<0.01^{b}$; $p<0.001^{a}$. The FiND and FRAIL frailty indices were only be calculated for part of our sample (n = 66). The other measures were complete (n = 97). SDT: Subjective Decision Tree (Total = X/18; Subscores = X/6; Walking scale = X/4); ODT: Objective Decision Tree (Total = X/18; Subscores = X/6; Walking scale = X/4); SPPB: Short Physical Performance Battery (Total = X/12; Subscores = X/4); 4MWS: 4 m normal walking speed; STS: Sit-to-Stand Test; 5rep: STS 5 repetitions (s); 30 s: STS in 30 s (number of repetitions); Walking speed: Usual walking speed ($m.s^{-1}$); TUG: Usual Timed Up-and-Go (s); FRT: Functional Reach Test (cm); SARC-F: Sarcopenia questionnaire (X/10); FiND: "Frail Non-Disabled" questionnaire (X/5); FRAIL: "Fatigue, Resistance, Ambulation, Illnesses, & Loss of Weight" questionnaire (X/5)

Table 3 Correlations between Subjective Decisional Tree and Objective Decisional Tree scores according to respondents

	All	Patient	Physician	Caregiver	
				Does not live with the patient	Live with the patient
A score	0.573[a]	0.565[a]	0.456[a]	0.456[b]	**0.640[b]**
B score	0.599[a]	0.594[a]	0.489**[a]**	0.641[b]	**0.766[a]**
C score	0.477[a]	0.509[a]	0.333[b]	**0.533[c]**	0.349
Total score	0.678[a]	0.695[a]	0.552**[a]**	0.658[b]	**0.705[b]**
Walking scale	0.666[a]	**0.694**[a]	0.561[a]	0.651[a]	0.677[a]

Correlations are expressed by Pearson's r coefficients. The significance levels of correlations are indicated as follows: $p < 0.05^c$; $p < 0.01^b$; $p < 0.001^a$. Coefficients in bold highlight the strongest correlations between the four respondents that may be involved in SDT responses

Table 4 Comparison of Subjective and Objective Decisional Trees prescriptions

Prescription SDT vs. ODT	Concordances	Correlations
Colors	0.08*	
Improvement goal		
Lower limb performance	0.20*	
Balance	0.17	
Trunk stability/mobility	– 0.09	
Global	– 0.07	
Level	0.19*	0.58*
Walking scale	0.41*	0.58*

Concordances are expressed by the Kappa coefficient for categorical variables, and correlations by the Tau-b coefficient for ordinal variables. The significance of correlations is indicated as follows: *p*-value < 0.001*

Discussion

The objective of this study was to validate the PACE SDT and ODT used for implementing PA prescriptions in an outpatient geriatric clinic. Both trees exhibited good construct and concurrent validity, with strong correlations between them. However, there is a need to improve the concordance between the prescriptions provided.

First, the internal consistency of the SDT was satisfactory (criteria: Cronbach alpha > 0.7) for the total score and each subscore. Additionally, the concurrent validation analysis of the SDT showed significant and strong correlations with subjective measures of frailty and sarcopenia (SARC-F, FiND, FRAIL) as well as with physical performance measures (SPPB, TUG, walking speed). These findings may be attributed to the innovative approach of the questionnaire, which involves a specific assessment of physical performance (strength–endurance, balance, trunk stability/mobility) through the subjective perspectives of those involved in the patient's care (i.e., physician, caregiver, and patient themselves). To our knowledge, no questionnaire allowing for component-by-component estimation of physical performance has yet been validated. The SDT could prove be a relevant tool for accurately assessing a patient's physical condition in the context of outpatient geriatric consultations, by identifying the level of frailty and key incapacities. Sub-analyses indicated that involving a caregiver enhanced these correlations. Our results, to the best of our knowledge, are the first to demonstrate that including a caregiver in a questionnaire-based assessment of functional performance profile enhances the representativeness of this evaluation. Given that the literature has already shown the importance of including the caregiver in the treatment of older patients in order to increase adherence [44], it might be beneficial to systematically include them during the administration of the SDT. This approach could improve the reliability of the assessment while promoting adherence [16] and benefits [45] of the PA treatment. Additionally, this strategy could help alleviate the burden on physicians during consultations [46]. However, these recommendations should be applied cautiously and on a case-by-case basis, considering the potential burden already experienced by the caregivers [47].

The ODT also demonstrated satisfactory internal consistency. Additionally, a previous study indicated that the SPPB, a widely used and validated battery considered a "gold standard" in geriatric settings, had a lower Cronbach's alpha compared to the ODT. This suggests better internal consistency on the part of our test battery [48]. The design of the ODT, with a broader range of scales and subscores (X/6 for each test; X/18 in total), potentially allowed for greater sensitivity in assessing the various functional performance profiles. This scoring system distinguishes older adults who are unable to rise from a chair (0/18) and those who are physically independent (18/18). Several studies have noted a significant ceiling effect [49–51] with the SPPB, where up to 17% of geriatric outpatients achieved a maximum score [52, 53]. In our study, some patients reached the maximum score on the SPPB, but none reached the maximum score on the ODT. Therefore, the ODT might offer an interesting alternative to address the ceiling effect of the SPPB, allowing for a relevant assessment of fitter patient profiles. Moreover, the choice to assess specific performances (lower limbs, balance, trunk) independently of walking, which is influenced by these different parameters, potentially enabled a more representative assessment [54] of the patient's abilities. Our concurrent validation results confirmed the validity of the ODT, showing a strong correlation with the SPPB (the gold standard tool for assessing functional performance), normal walking speed, and the 30-s STS. Additionally, the SPPB has been linked to various causes of mortality [55]. The ODT is a battery of tests aimed at assessing physical and functional parameters [56–60]. Moreover, the ODT and the SPPB exhibited a similar level of correlation with frailty indices (SARC-F, FiND, FRAIL) and other objective physical performance tests (TUG, walking speed). However, while the ODT and SPPB measure very similar constructs (as reflected by a high correlation of $r = 0.88$), the ODT was designed to provide a more nuanced scoring system to reduce ceiling effects and potentially enhance clinical sensitivity in certain subpopulations**.** However, future studies could further investigate if the ODT could serve as an alternative for assessing fall risk or identifying at-risk profiles, for example.

Furthermore, Pearson's correlation coefficients revealed moderate to strong relationships between SDT and ODT scores, supporting a relative fit between the different decisional tree scores. However, some discrepancies were noted. First, the SDT tended to overestimate physical performance compared to the ODT. Additionally, a comparison of prescriptions between the SDT and the ODT revealed poor agreement between the programs obtained at all levels (focus or difficulty level), despite moderate correlations for the walking time prescription. Several factors may contribute to these discrepancies. The algorithm relies on identifying the lowest score (A, B, or C) to determine the improvement objective and program color. However, this principle requires nearly perfect correlation between subjective and objective scores, as well as identical variances in terms of subscores. Consequently, this statistical requirement reduces the likelihood of concordance. On the other hand, difficulty levels have been empirically defined along the total point continuum. To address this lack of concordance, a confirmatory study should be conducted to redefine the difficulty levels using specific quintiles for each decisional tree. Finally, the findings may be impacted by the high variability of subjective health measurements reported in scientific literature [20]. Thus, given this variability in subjective health judgment, it appears challenging to ensure the specificity of a recommendation based solely on a subjective scale, particularly in the context of prescribing PA. This raises the question of the complementary roles of subjective (SDT) and objective (ODT) assessments: while objective functional assessments remain the gold standard, subjective tools like the SDT may provide a rapid, accessible, and useful alternative in settings where objective testing is not feasible, albeit with some limitations regarding precision and concordance.

Despite the promising results regarding the validity of the trees included in the PACE tool, certain methodological limitations constrain the conclusions. One of the main limitations is the absence of assessment repeatability (test–retest). This shortcoming compromises the demonstration of measurement stability and consistency over time. To address these limitations, a longitudinal study should be performed to assess the repeatability on a representative cohort of outpatient geriatric clinics. Such studies should also more precisely examine the influence of the physician and caregiver as responders during administration of the SDT. Moreover, the sensitivity to change of the SDT and ODT has not been assessed, limiting our ability to draw conclusions about their usefulness for measuring changes in a patient's physical and functional condition as part of follow-up care. Therefore, a longitudinal study is also needed to assess standard error of measurement and minimal detectable change according to validated frailty and functional indices. Finally, another limitation pertains to the lack of exploration of the tool's ability to accurately measure the level of physical performance in very frail older adults. Indeed, examining floor and ceiling effects by including participants with a variety of frailty profiles would be important to ensure the tool's validity across the full range of physical abilities. Additionally, cross-validation with different populations or in other settings should be conducted to demonstrate their robustness and applicability in various contexts.

Conclusion

In summary, this study offers evidence supporting the validity of PACE's decisional trees for assessing the functional performance profile of older adults and integrating the prescription of pragmatic and adapted physical activity programs into outpatient geriatric care. The validity of both the SDT and ODT, along with the robustness of the links between them, emphasizes their importance in the care pathway for implementing PA prescriptions. However, future studies validating the test–retest repeatability and responsiveness of these two decisional trees are needed before confirming their relevance to the PA prescription process and functional performance profile assessment.

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Declarations

Conflict of interest The authors declare that the research was conducted without any financial or commercial relationships that could be considered as potential conflicts of interest.

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