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Original Article

Validity of functional assessment for control of trunk in patients with subacute stroke: a multicenter, cross-sectional study

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Abstract. [Purpose] The purpose of this study was to clarify the criterion validity, construct validity, and feasibility of the Functional Assessment for Control of Trunk (FACT). [Participants and Methods] This study was a multicenter, cross-sectional study of patients with subacute stroke at three Japanese rehabilitation hospitals. To clarify feasibility, we examined the differences in the measurement time between FACT and the Trunk Impairment Scale (TIS). For the criterion validity of FACT, correlations between FACT, TIS, and the trunk items of the Stroke Impairment Assessment Set (SIAS) were examined using Spearman's rank correlation coefficient. For the construct validity of FACT, we examined the correlations with the other assessments. [Results] Seventy-three patients participated in this study. The measurement time was significantly shorter for FACT (212.6 ± 79.2 s) than TIS (372.4 ± 199.6 s). For criterion validity, FACT correlated significantly with TIS (r=0.896) and two SIAS trunk items (r=0.453, 0.594). For construct validity, significant correlations were found for FACT and other tests (r=0.249–0.797). Areas under the curve for FACT and TIS were 0.809 and 0.812, respectively, and the cutoff values for walking independence were 9 and 13 points, respectively. [Conclusion] For inpatients with stroke, FACT offered feasibility, criterion validity, and construct validity.

Key words: Functional Assessment for Control of Trunk (FACT), Validity, Trunk function

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INTRODUCTION

Most studies prior to 2000 focused on lower extremity function in physical therapy for patients with stroke[1, 2)]. The Trunk Control Test (TCT)[3)] has been used to measure trunk movements, consisting of basic movements such as turning over and getting up. Although the TCT was able to objectively evaluate trunk function, it is an assessment of activity rather than physical function. Given this situation, Verheyden et al. developed the Trunk Impairment Scale (TIS) in 2004[4)] and we developed the Functional Assessment for Control of Trunk (FACT) around the same time, in 2006[5)]. The TIS consists of major components of static sitting balance and dynamic sitting balance, and observes compensatory movements to assess quality of movement.

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FACT consists of 10 performance tests, with a minimum score of 0 and a maximum score of 20. These tests provide a comprehensive evaluation of trunk support, mobility, muscle strength, and ability to move the center of gravity (Table 1). FACT can be considered a clinical examination, since special tools are not required and the assessment can be performed in about 5 min for a skilled examiner. FACT offers high inter-rater reliability (intraclass correlation coefficient: ICC(2,1)=0.96), item-by-item agreement of 87–100%, kappa coefficient of 0.62–1, and Cronbach's alpha of 0.81 for internal consistency[5].

Table 1. Functional Assessment for Control of Trunk (FACT)

Item	Task description	Score description	Score
Static trunk control			
1	Keep sitting for 10 s with arm support	Falls	0
		Maintains sitting for 10 s with arm support	1
2	Keep sitting for 10 s without arm support	Falls or needs arm support	0
		Maintains sitting for 10 s without arm support	1
Dynamic trunk control			
3	Anterior tilt and rotation of trunk to touch the opposite ankle with either hand and returns to the starting position	Falls or can not touch or compensation used (heel lift from floor, arm support)	0
		Touches the opposite ankle with either hand and return to the starting position	1
4	Anterior tilt of trunk to lift bottom from seat and move 10 cm to the left and right sides	Falls or cannot move 10 cm to the both sides	0
		Moves 10 cm to the left and right sides while lifting bottom	2
5	Keep lifting one buttock from seat for 3 s	Falls or cannot lift for 3 s	0
		Maintains lifting one buttock for 3 s with the examiner's fingers passing between ischial tuberosity and seat: unilateral	1
		Maintains lifting one buttock for 3 s with the examiner's fingers passing between ischial tuberosity and seat: bilateral	2
6	Lift the either thigh and keep lifting leg for 3 s	Falls or cannot keep lifting leg for 3 s	0
		Maintains lifting foot from floor for 3 s with the examiner's fingers passing between thigh and seat: unilateral	1
		Maintains lifting foot from floor for 3 s with the examiner's fingers passing between thigh and seat: bilateral	2
7	Lift both thighs and keep lifting legs for 3 s	Falls or cannot keep lifting legs for 3 s	0
		Maintains for lifting feet from floor for 3 s with the examiner's fingers passing between thighs and seat	2
8	Buttock walk: forward and backward	Falls or cannot move without compensation used (move the supporting buttock)	0
		Alternately lifts one buttock and moves forward and backward without moving the support buttock	3
9	The examiner places a finger 20 cm posterior to the sacrum on the seat, and changes the number of fingers 3 times every second. Subject looks at examiner's fingers over their shoulder and states the number of fingers. (Before the test, state the number of fingers of the examiner 1 m in front of the eyes. If subject has language problems, imitate with subject's fingers.)	Falls or cannot state the number of fingers	0
		States the number of fingers 3 times	3
10	Raise either upper extremity to vertical position with maximum effort at shoulder neutral position: shoulder flexion	Falls or can not raise upper extremity until upper arm in a vertical position without shoulder abduction	0
	If subject has shoulder joint problems, tilt the pelvis forward and adduct bilateral scapulae while extending the trunk.	Raises either upper extremity until upper arm in a vertical position without shoulder abduction	3
		Total FACT score	/20

Starting position: sitting on the edge of a bed (height 40–45 cm), feet flat on support and thighs on bed, knees 90° flexed, no back and arm support. The participant gets 3 attempts for each item, item 1 to 10 in order. The best performance is scored for each item. Instructions can be verbal and nonverbal if needed.

Suga et al. showed that the standardized response mean (SRM) for FACT was large for acute stroke patients[6]. Ceiling effects for FACT were lower than trunk items for the TCT and Stroke Impairment Assessment Set (SIAS)[6]. In recent years, FACT is being used with increasing frequency in Japan, but few validity studies have been undertaken. We consider FACT to be treatment-oriented with excellent clinical feasibility for stroke physical therapy, and the performance of each FACT item can be used for exercise therapy.

The purpose of this study was to examine the criterion validity of FACT in a multicenter collaborative study and to identify the characteristics of FACT as a test instrument in terms of construct validity and feasibility.

PARTICIPANTS AND METHODS

This was a multicenter, cross-sectional study. Data measurements were conducted at three Japanese rehabilitation hospitals: Inzai General Hospital (Inzai, Chiba); Rehabilitation Amakusa Hospital (Koshigaya, Saitama); and Harajuku Rehabilitation Hospital (Shibuya, Tokyo). Participants were inpatients with subacute stroke admitted to a recovery-phase rehabilitation unit.

This study was approved by the Research Ethics Committee at Teikyo University of Science (approval no. 20A030). All participants provided written informed consent to participate prior to enrollment in the study.

The study included stroke patients with unilateral cerebral hemispheric lesions. The exclusion criteria were as follows: subarachnoid hemorrhage; non-first episode of stroke; activities limited by treatment for other disease; significant higher brain dysfunction or dementia making the examination difficult to perform; and walking limitations due to severe osteoarticular disease, pain, or vision impairment. Assessments were conducted within three days for each participant.

We measured basic characteristics (gender, age, diagnosis, lesion area, paralytic side, and number of days since onset), FACT, TIS, SIAS, trunk range of motion (ROM), Functional Independence Measure (FIM), gross motor function subscale of the Rivermead Motor Assessment (RMA-G), Functional Ambulation Categories (FAC), and balance test of the Performance Oriented Mobility Assessment (POMA balance). For trunk ROM, the values used were the sum of flexion and extension, right and left lateral flexion and rotation.

The TIS is scored from a minimum of 0 to a maximum of 23 points and was identified as reliable and valid by Verheyden et al[4]. The FIM is an activities of daily living (ADL) assessment comprising 13 motor items and 5 cognitive items, scored as 1–7 points per item (total score, 18–126 points).[7] The score for each FIM item is 1 or 2 for complete dependence (total or maximal), 3 −5 for modified dependence (moderate, minimal, or supervision), and 6 or 7 for independence (modified or complete)[7]. The SIAS consists of 22 items classified into 9 different functional impairments, each rated on a 3- or 5-point scale, with a minimum score of 0 and a maximum of 76[8, 9]. The trunk test consists of two tests: verticality; and abdominal MMT[8, 9]. The motor function test is rated on a 6-point scale of 0–5, while the trunk test is rated on a 4-point scale of 0–3[8, 9]. The RMA is a test divided into three sections: gross function (13 items); leg and trunk movements (10 items); and arm movements (15 items)[10]. The score is on a 2-point scale of 1 (possible) or 0 (not possible), with a maximum score of 13 points for the 13 items[10]. FAC is a test that uses a 15-m walking path and stairs and classifies walking ability into six levels based on the observed movements[11]. The lowest score is 0 and the highest is 5[11, 12]. A score of 0 indicates no functional ambulation, 1 or 2 indicates dependence on physical assistance, 3 indicates a need for supervision, and 4 or 5 indicates independence[12]. POMA was developed by Tinetti and is sometimes referred to as the Tinetti balance assessment tool or Tinetti balance test. The test consists of 16 items, with 9 related to balance and 7 to gait. The minimum score is 0 and the maximum is 28[13].

Normality was examined using the Shapiro–Wilk test. To clarify feasibility, we verified the difference in measurement time between FACT and TIS using the Wilcoxon signed-rank test. For the validation of measurement time, we used data only from those who had perfect scores on both the FACT and TIS tests, since FACT and TIS may not be performed for all items depending on the severity of trunk function. To clarify the criterion validity of FACT, the correlations between FACT and the TIS and SIAS trunk items were examined using Spearman's rank correlation coefficient. In addition, as a validation of the construct validity of FACT, the correlations of FIM, FAC, POMA balance, SIAS, RMA-G, and trunk ROM (thoracolumbar region) to FACT were examined using Spearman's rank correlation coefficient. Receiver operating characteristic (ROC) curves for FACT and TIS were created using FAC score ≥3 as indicative of independence, then areas under the ROC curve (AUCs) were obtained and cut-off values were determined using the Youden index based on sensitivity and specificity.

The level of significance for all tests was 5%. SPSS version 28.0 statistical software (IBM, Armonk, NY, USA) was used for all statistical analyses.

RESULTS

A flowchart of study participation is shown in Fig. 1. Among the patients admitted to the participating units, 73 ultimately participated in the study. Of those excluded, reasons for the 111 patients excluded for "other" reasons included transfer to another unit, inability to perform the assessment procedures due to illness or other reasons, and discharge before all assessments could be completed. Characteristics of the participants are shown in Table 2. The 73 participants comprised 35 males and 38 females, with a mean age of 67.5 ± 15.5 years, and mean interval since onset of 110 ± 41.6 days. The Shapiro–Wilk test showed that only FACT measurement time followed a normal distribution ($p<0.05$).

Figure 2 shows the distribution of measurement times for FACT and TIS. For FACT, the largest number of participants required 201–300 s, while the largest number in TIS required 301–400 s and several needed >800 s. Because 10 participants showed perfect scores for both FACT and TIS, a comparison of FACT and TIS measurement times was conducted with 10 participants. Mean measurement time was 212.6 ± 79.2 s for FACT and 372.4 ± 199.6 s for TIS, indicating a significantly shorter measurement time for FACT than for TIS.

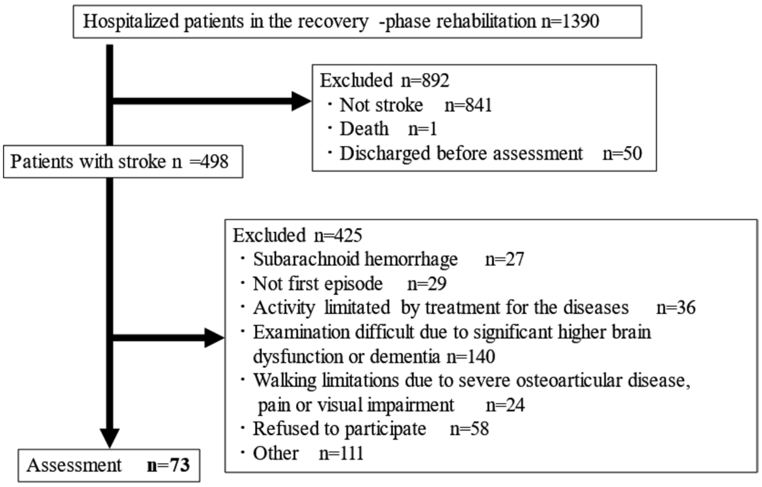

Fig. 1. Flowchart of participation in the study.

Table 2. Characteristics of the participants (n=73)

	Median (Q1–Q3) Mean ± SD
Gender (male/female)	35/38
Age (years)	67.5 ± 15.5
Diagnosis (infarction/cerebral hemorrhage/other)	38/32/3
Lesion area (putamen/thalamus/ACA area/MCA area/PCA area/brainstem/other)	19/16/4/12/1/6/15
Paralytic side (right/left)	41/32
Days since onset (days)	110.5 ± 41.6
FACT (points)	15 (6–20)
TIS (points)	16 (10–20)
FACT measurement time (s)	212.6 ± 79.2
TIS measurement time (s)	372.4 ± 199.6
SIAS (points)*	57 (43–67)
FIM total (points)	99 (78–115)
FIM motor (points)	69 (51–81)
FIM cognition (points)	30 (23–34)
FAC (0/1/2/3/4/5)	2/14/18/10/16/13
RMA gross function subscale (points)	8 (5–10)
POMA balance (points)	12 (6–15)
ROM sum of flexion and extension (degrees)*	55 (40–75)
ROM sum of right and left lateral flextion (degrees)*	57.5 (43.8–90)
ROM sum of right and left rotation (degrees)*	60 (40–80)

*n=72.
Only FACT measurement time was p>0.05 by Shapiro–Wilk test.
Q1: first quartile; Q3: third qurtile; ACA: anterior cerebral artery; MCA: middle cerebral artery; PCA: posterior cerebral artery; FACT: functional assessment for control of trunk; TIS: trunk impairment scale; SIAS: stroke impairment assessment set; FIM: functional independence measure; FAC: functional ambulation categories; RMA: rivermead motor assessment; POMA: performance oriented mobility assessment; ROM: range of motion.

For criterion validity, a strong and significant correlation was identified between FACT and TIS (r=0.896). In addition, FACT also correlated with the two Trunk balance tests of SIAS, verticality test (r=0.453) and abdominal MMT (r=0.594).

Table 3 shows the correlations between FACT and other tests for construct validity. Significant correlations were shown with all items for FACT (r=0.249–0.797). A strong correlation was shown between FACT and RMA-G (r=0.735) and POMA balance (r=0.797).

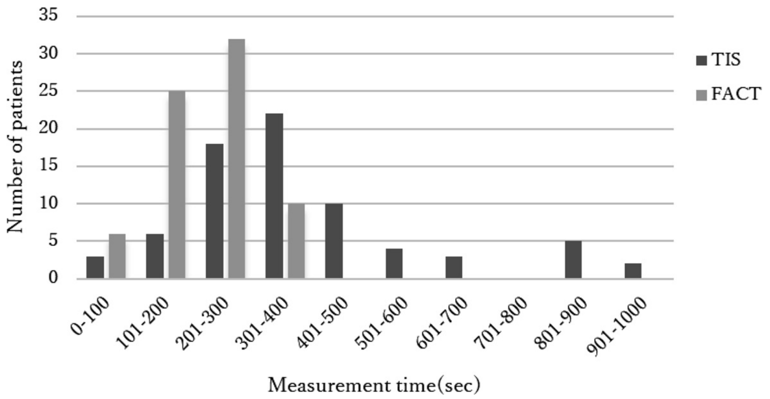

Fig. 2. Distribution of measurement times for FACT and TIS.
TIS: trunk impairment scale; FACT: functional assessment for control of trunk.

Table 3. Construct validity of FACT: correlation coefficients for FACT

SIAS (n=72)			FIM (n=73)			Other variables	
Motor function	Proximal UE	0.595**	Motor subscale	Eating	0.573**	FAC (n=73)	0.662**
	Distal UE	0.532**		Grooming	0.580**	RMA-G (n=73)	0.735**
	Proximal (hip) LE	0.680**		Bathing	0.651**	POMA balance (n=73)	0.797**
	Proximal (knee) LE	0.653**		Dressing, upper body	0.739**	ROM flex,ext (n=72)	0.568**
	Distal LE	0.600**		Dressing, lower body	0.722**	ROM lateral flexion (n=72)	0.460**
Tone	Muscle tone UE	0.446**		Toileting	0.720**	ROM rotation (n=72)	0.698**
	Muscle tone LE	0.411**		Bladder management	0.562**		
	DTRs UE	0.356**		Bowel management	0.588**		
	DTRs LE	0.249*		Transfers-bed/chair/wheelchair	0.705**		
Sensory function	Touch UE	0.360**		Transfer-toilet	0.679**		
	Touch LE	0.388**		Transfers-bath/shower	0.647**		
	Position UE	0.477**		Walk/Wheelchair	0.637**		
	Position UE	0.468**		Stairs	0.579**		
ROM	UE	0.571**	Motor FIM score		0.721**		
	LE	0.416**	Cognitive subscale	Comprehension	0.417**		
Pain		0.249*		Expression	0.442**		
Trunk balance	Verticality test	0.453**		Social interaction	0.336**		
	Abdominal MMT	0.594**		Problem solving	0.378**		
Visuospatial		0.260*		Memory	0.363**		
Speech		0.272*	Cognitive FIM score		0.435**		
Unaffected side	UE	0.464**	Total FIM score		0.693**		
	LE	0.376**					
Total SIAS score		0.665**					

Spearman’s rank correlation coefficient. *p<0.05, **p<0.01.
FACT: functional assessment for control of trunk; TIS: trunk impairment scale; SIAS: stroke impairment assessment set; UE: upper extremity; LE: lower extremity; DTR: deep tendon reflex; ROM: range of motion; MMT: manual muscle testing; FIM: functional independence measure; FAC: Functional Ambulation Categories; GFS of RMA: gross function scale of Rivermead motor assessment; POMA: performance-oriented mobility assessment.

Figure 3 shows the ROC curves for FACT and TIS, and Table 4 shows the cut-off values for judgment of independence in walking. AUCs for FACT and TIS were 0.809 and 0.812, respectively, and the cutoff values for walking independence were 9 and 13 points, respectively.

DISCUSSION

The Consensus-based Standards for the selection of health Measurement Instruments (COSMIN) taxonomy of the relationships of measurement properties is widely used for the classification of evaluation scales, and is broadly classified into reliability, validity, responsiveness, and interpretability, with reliability divided into reliability, internal consistency, and measurement error. Validity is divided into criterion validity, content validity (face validity), and construct validity, and construct validity include structural validity, hypothesis testing, and cross-cultural validity[14)]. FACT has been shown to be reliable[5)], responsive[6)], and predictive validity[15)]. This study examined criterion validity and construct validity.

FACT has indicated a high degree of reliability, as described above. In addition, several studies using FACT have been reported below. Ezure et al. investigated the relationship between FACT and ADLs in terms of construct validity[16)]. Sato et al. studied 163 stroke patients with logistic regression analysis for toileting independence and found that lower limb function on the paralytic side (SIAS), FACT, and Mini-Mental State Examination (MMSE) were adopted, with cut-off values of 8, 14, and 25 points, respectively[17)]. Multiple regression analysis by Sato et al. showed that FACT score on admission was associated with FIM gain (coefficient=0.875, 95% confidence interval [CI]=0.368–1.382, p=0.001) and FIM efficiency (coefficient=0.015, 95%CI=0.003–0.028, p=0.016)[15)]. Suga et al. clarified that the minimal clinically important difference (MCID) for FACT is 4 points in acute stroke patients[6)].

The present study clarified the feasibility, criterion validity, and construct validity of FACT. First, for feasibility, we clarified that measurement time was significantly shorter for FACT than for TIS. Mean measurement time for FACT was 212 ± 79.2 s, meaning that the average measurement time is about 3.5 min. A shorter measurement time reflects a lower burden of fatigue on the patient. Furthermore, FACT does not use special tools and does not involve positional changes, meaning that the feasibility is high. We were therefore able to show that FACT is easy to use in clinical physiotherapy.

Next, we were able to clarify criterion validity by showing correlations between FACT and TIS and the trunk items of the SIAS. Among these, the correlation coefficient for TIS was very high, at 0.896, indicating that FACT offers an index to

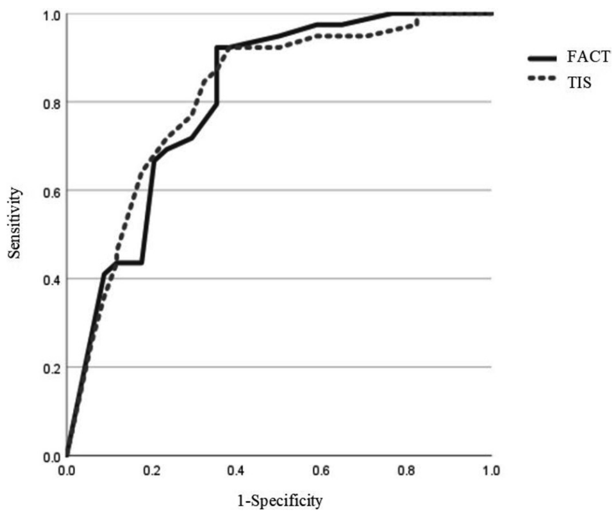

Fig. 3. Receiver operating characteristic curves for walking independence in FACT and TIS.
FACT: functional assessment for control of trunk; TIS: trunk impairment scale.s

Table 4. Cut-off values for judgment of independence (FAC score ≥3) in walking

	AUC (95%CI)	Cut-off point	Sensitivity	Specificity
FACT	0.809 (0.707–0.911)*	9	0.923	0.647
TIS	0.812 (0.710–0.914)*	13	0.923	0.618

*p<0.001.
AUC: area under the curve; CI: confidence interval; FACT: functional assessment for control of trunk; TIS: trunk impairment scale.

evaluate trunk function alongside TIS. This level of correlation is adequate compared to TIS criterion validity, which showed a correlation coefficient of 0.83 with the TCT[4].

Third, to clarify the construct validity of FACT, we examined the correlations between FACT and each test. FACT revealed significant correlations for each SIAS item and total score, each FIM item and total score, FAC, RMA-G, POMA balance and trunk ROM. Regarding the relationship between trunk ROM and movement, Kamijo and Yamamoto reported the relationship between trunk forward-bending ROM and gait[18], and Khallaf reported the relationship between trunk ROM and trunk control and balance[19]. In the relationship between FACT and SIAS, we clarified that a relationship exists between trunk function and other physical functions. Verheyden et al. showed a relationship between trunk function, balance, and gait[20]. Criekinge et al. conducted a systematic review of trunk biomechanical studies of after-stroke hemiplegic gait and reported the importance of adding trunk training to conventional rehabilitation, showing that hemiplegic gait increases longitudinal trunk sway, sagittal movement, and rotation of the upper trunk, and decreases trunk acceleration and movement toward the paralyzed side[21]. Regarding trunk function and upper limb function, a relationship was shown by Wee et al.[22] and Iso et al.[23], and Wee et al. also clarified that improved trunk control affects upper limb function[22]. In terms of ADL, we were also able to identify correlations between each of the FACT and FIM items. For trunk function and ADL, Ezure et al. reported that both FACT and Brunnstrom recovery stage showed significant correlations with FIM[16]. Fujita et al. also found that trunk function offers an early predictor of ADL in patients with acute stroke, and relationships between trunk function and ADL have also been reported in other studies of functions such as dressing[24] and toileting[17]. Correlations with POMA balance were obtained, helping to clarify the relationship between trunk function and balance. Criekinge et al. conducted a systematic review of trunk function and balance, finding that trunk training improved dynamic trunk control, sitting and balance and mobility in stroke patients[25]. Gamble et al. also conducted a systematic review and found that trunk control and dynamic balance improved when core stability exercises were added to usual-care physiotherapy[26]. The present study was also able to provide a correlation between FACT and RMA-G. The RMA-G is an assessment of the basic movements of getting up, standing up, getting in and out of bed, walking, climbing stairs, running, and jumping[10]. We were able to clarify that FACT is related to basic movements.

We also identified cutoff values for walking independence, with a cutoff value for FACT between independence and non-independence of 9 points. If FACT items are "possible" in order from Test 1, whether the patient is able to raise the lower limbs bilaterally on each side in "Test 6" represents the borderline between a score of 9 and no score and may be the determining factor for whether the patient can achieve assisted walking or requires monitoring. Although physical therapy programs are designed after comprehensive integration and interpretation, FACT can also be used to find trunk function as a factor in movement problems, and FACT performance can also be used as a program for that trunk function.

This study was able to show feasibility, criterion validity, and construct validity. One limitation of this study was the cross-sectional design, and the validity of FACT could not be fully confirmed.

In terms of future directions, we hope that FACT will see increasing use in the clinical practice of physical therapy and that more appropriate physical therapy programs will be implemented in the future.

This study investigated the feasibility, criterion validity, and structural validity of FACT. FACT showed shorter measurement time and higher feasibility than TIS. FACT correlated with existing trunk function tests, revealing criterion validity. Structural validity was also shown in correlations with ADL, walking ability, balance, physical function, basic movement, and ROM of the trunk.

Conflict of interest

The authors declare that they have no conflicts of interest.

REFERENCES

1) Bohannon RW: Gait performance of hemiparetic stroke patients: selected variables. Arch Phys Med Rehabil, 1987, 68: 777–781. [Medline]

2) Hachisuka K, Umezu Y, Ogata H: Disuse muscle atrophy of lower limbs in hemiplegic patients. Arch Phys Med Rehabil, 1997, 78: 13–18. [Medline] [CrossRef]

3) Collin C, Wade D: Assessing motor impairment after stroke: a pilot reliability study. J Neurol Neurosurg Psychiatry, 1990, 53: 576–579. [Medline] [CrossRef]

4) Verheyden G, Nieuwboer A, Mertin J, et al.: The Trunk Impairment Scale: a new tool to measure motor impairment of the trunk after stroke. Clin Rehabil, 2004, 18: 326–334. [Medline] [CrossRef]

5) Okuda Y, Ogino Y, Ozawa Y, et al.: Development and reliability of Functional Assessment for Control of Trunk (FACT). Rigakuryoho Kagaku, 2006, 21: 357–362 (in Japanese). [CrossRef]

6) Suga H, Sima C, Kakima H, et al.: Study of responsiveness and Minimal Clinically Important Difference (MCID) of Functional Assessment for Control of Trunk (FACT) in acute stroke patients. Rigakuryoho Kagaku, 2020, 47: 35–41 (in Japanese).

7) Data management service of the Uniform Data System for Medical Rehabilitation and the Center for Functional Assessment Research: Guide for use of the uniform data set for medical rehabilitation. Getzville: State University of New York at Buffalo, 1990.

8) Liu M, Chino N, Tuji T, et al.: Psychometric properties of the Stroke Impairment Assessment Set (SIAS). Neurorehabil Neural Repair, 2002, 16: 339–351. [Medline] [CrossRef]

9) Tsuji T, Liu M, Sonoda S, et al.: The stroke impairment assessment set: its internal consistency and predictive validity. Arch Phys Med Rehabil, 2000, 81: 863–868. [Medline] [CrossRef]

10) Lincoln N, Leadbitter D: Assessment of motor function in stroke patients. Physiotherapy, 1979, 65: 48–51. [Medline]
11) Mehrholz J, Wagner K, Rutte K, et al.: Predictive validity and responsiveness of the functional ambulation category in hemiparetic patients after stroke. Arch Phys Med Rehabil, 2007, 88: 1314–1319. [Medline] [CrossRef]
12) Holden MK, Gill KM, Magliozzi MR, et al.: Clinical gait assessment in the neurologically impaired. Reliability and meaningfulness. Phys Ther, 1984, 64: 35–40. [Medline] [CrossRef]
13) Tinetti ME: Performance-oriented assessment of mobility problems in elderly patients. J Am Geriatr Soc, 1986, 34: 119–126. [Medline] [CrossRef]
14) Mokkink LB, Terwee CB, Patrick DL, et al.: The COSMIN study reached international consensus on taxonomy, terminology, and definitions of measurement properties for health-related patient-reported outcomes. J Clin Epidemiol, 2010, 63: 737–745. [Medline] [CrossRef]
15) Sato K, Maeda K, Ogawa T, et al.: The functional assessment for control of trunk (FACT): an assessment tool for trunk function in stroke patients. NeuroRehabilitation, 2021, 48: 59–66. [Medline] [CrossRef]
16) Ezure A, Harada S, Ozawa Y, et al.: Relationship between trunk and ADL of hemiplegic stroke patients. Rigakuryoho Kagaku, 2010, 25: 147–150 (in Japanese). [CrossRef]
17) Sato A, Okuda Y, Fujita T, et al.: Cognitive and physical functions related to the level of supervision and dependence in the toileting of stroke patients. Phys Ther Res, 2016, 19: 32–38. [Medline] [CrossRef]
18) Kamijo F, Yamamoto S: Trunk function in hemiplegic patients: kinematic analysis of trunk bending and gait performance. Int J Physiother, 2016, 3: 273–279. [CrossRef]
19) Khallaf ME: Effect of task-specific training on trunk control and balance in patients with subacute stroke. Neurol Res Int, 2020, 2020: 5090193. [Medline] [CrossRef]
20) Verheyden G, Vereeck L, Truijen S, et al.: Trunk performance after stroke and the relationship with balance, gait and functional ability. Clin Rehabil, 2006, 20: 451–458. [Medline] [CrossRef]
21) Van Criekinge T, Saeys W, Hallemans A, et al.: Trunk biomechanics during hemiplegic gait after stroke: a systematic review. Gait Posture, 2017, 54: 133–143. [Medline] [CrossRef]
22) Wee SK, Hughes AM, Warner MB, et al.: Effect of trunk support on upper extremity function in people with chronic stroke and people who are healthy. Phys Ther, 2015, 95: 1163–1171. [Medline] [CrossRef]
23) Iso F, Mitsunaga W, Yamaguchi R, et al.: Relationship among trunk control, activities of daily living, and upper extremity function during the first week after stroke in patients with acute cerebral infarction. J Phys Ther Sci, 2022, 34: 315–319. [Medline] [CrossRef]
24) Fujita T, Sato A, Iokawa K, et al.: Quantifying lower extremity and trunk function for dressing in stroke patients: a retrospective observational study. Top Stroke Rehabil, 2018, 25: 341–344. [Medline]
25) Van Criekinge T, Truijen S, Schröder J, et al.: The effectiveness of trunk training on trunk control, sitting and standing balance and mobility post-stroke: a systematic review and meta-analysis. Clin Rehabil, 2019, 33: 992–1002. [Medline] [CrossRef]
26) Gamble K, Chiu A, Peiris C: Core stability exercises in addition to usual care physiotherapy improve stability and balance after stroke: a systematic review and meta-analysis. Arch Phys Med Rehabil, 2021, 102: 762–775. [Medline] [CrossRef]