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RESEARCH PAPER

A comprehensive psychometric evaluation of the UK FIM + FAM

Lynne Turner-Stokes[1,2] and Richard J. Siegert[1,3]

[1]King's College London, School of Medicine, Department of Palliative Care, Policy and Rehabilitation, London, UK, [2]Regional Rehabilitation Unit, Northwick Park Hospital, London, UK, and [3]School of Public Health and Psychosocial Studies and School of Rehabilitation and Occupational Studies, Auckland University of Technology, Auckland, New Zealand

Abstract

Purpose: To evaluate the psychometric properties of the UK FIM + FAM. *Methods*: (a) A systematic literature review integrating the evidence for psychometric qualities of both the original and UK versions, and (b) exploratory and confirmatory factor analysis of admission/discharge data from an inpatient general neuro-rehabilitation cohort using parametric and non-parametric techniques. A prospective cohort of 459 patients with a male:female ratio of 57:43 and mean age of 44.5 (SD 14.3) years participated in this study. *Results*: Seven published articles together demonstrated acceptable utility, concurrent validity, inter-rater reliability and responsiveness of the UK FIM + FAM. Factor analysis demonstrated that all items loaded high (>0.58) on the first principal component and distinct *motor* and *cognitive* factors emerged after rotation. A four-factor solution also demonstrated four distinct, interpretable dimensions (Physical, Psychosocial, Communication and Extended Activities of Everyday Living (EADL)). Mokken analysis of the second data set confirmed these dimensions. Cronbach's αs were 0.97 and 0.96 for the motor and cognitive domains and 0.90–0.97 for the subscales. Analysis of responsiveness demonstrated ''large'' effect sizes (0.86–1.29). *Conclusions*: The UK FIM + FAM, including the newer EADL module, is a valid, reliable scale of functional independence. It has high internal consistency in two domains and four subscales and is responsive to changes occurring in a general inpatient neuro-rehabilitation population.

➤ Implications for Rehabilitation

- The UK FIM + FAM is a valid, reliable scale of functional independence, which is responsive to changes occurring in a general inpatient neuro-rehabilitation population.
- It can be used to derive a reliable, single score of overall independence and also yields specific information in two main domains and four separate subscales of independence: *Physical*, *Psychosocial*, *Communication* and *Extended Activities of Daily Living (EADL)*.
- The newer EADL item module provides added value, measuring functional independence for community-based activities.

Keywords

Extended activities of daily living, factor analysis, Mokken analysis, neurological rehabilitation, psychometrics, UK FIM + FAM

History

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Introduction

Global measures of disability such as the Functional Independence Measure (FIM) [1] and Functional Assessment Measure (FIM + FAM) [2] are widely used internationally to measure outcome from inpatient rehabilitation programmes. At the individual clinical level, they provide valid and reliable information about a person's requirements for assistance with essential tasks of daily living, and on a group level, they can be used to measure and compare outcomes across different practices and populations. Consequently, it is important to understand their metric properties in the population in which they are to be used.

Address for correspondence: Prof Lynne Turner-Stokes, King's College London, Department of Palliative Care, Policy and Rehabilitation, Cicely Saunders Institute, Bessemer Road, Denmark Hill, London SE5 9PJ, UK. Tel: +44-(0)-207-848-5357. Fax: +44-(0)-207-848-5358. E-mail: lynne.turner-stokes@dial.pipex.com

The FIM is an 18-item ordinal measure of disability which includes 13 motor items and five cognitive items [3]. It was developed in the 1980s by a national task force in the United States (US) and is now one of the most commonly used generic outcome measures in rehabilitation. Its psychometric properties have been very thoroughly evaluated in the world literature [3–6]. The FAM does not stand alone (hence the abbreviation ''FIM + FAM'') but adds a further 12 items to the FIM primarily addressing cognitive and psychosocial function.

- The original US version of the FAM was developed in the early 1990s, for evaluating outcomes after traumatic brain injury [2,7]. Although the US FAM and original training materials are still accessible from the TBI COMBI (Centre for Outcomes Measurement in Brain Injury) website [8], the US version is no longer actively maintained or centrally collated.
- The UK version of the FAM was developed in the mid-1990s by the United Kingdom FIM + FAM Users Group [9] in collaboration with the US originators, to translate it into

UK-English and address the known subjectivity and inconsistency of some items. The resulting tool was shown to have improved reliability and utility in comparison with the US version [9]. It has continued to be revised and developed, with the addition of a six-item Extended activities of Daily Living (EADL) module (to extend the upper range of the instrument) and an active programme for training and accrediting users [10].

The two versions are structurally similar, so that the psychometric performance of the US version has relevance for the UK FIM + FAM. However, they are sufficiently different so that the UK version requires validation in its own right.

Although originally conceptualised for use with traumatic or diffuse brain injury, many of the FAM items are more widely applicable in other neurological conditions, including spinal cord injury and progressive neurological conditions. For this reason, the UK FIM + FAM has gained in popularity over the last decade, effectively taking over where development of the US version ceased and it is now the version that continues to be promoted and developed. It has recently been adopted as the principal outcome measure for neuro-rehabilitation in the UK national dataset for specialist rehabilitation (UK Rehabilitation Outcomes Collaborative [11,12]) and is increasingly being explored as an outcome measure for rehabilitation in other countries, including Australia, New Zealand, Europe and South America. It is therefore pertinent to examine its psychometric properties in the broader neuro-rehabilitation group in which it will be applied.

The aim of this article is to examine the extent to which the UK FIM + FAM satisfies the criteria of the Medical Outcomes Trust for a psychometrically robust measure [13]. These nine criteria include content validity, internal consistency, criterion validity, construct validity, reproducibility, responsiveness, floor/ceiling effects and interpretability.

- Part 1 of this article reports a brief systematic review and assimilation of the existing literature on the psychometric properties of both the original US version and the UK FIM + FAM.
- In Part 2, in order to address the identified gaps in the literature, we used a combination of parametric and non-parametric techniques to explore dimensionality, internal consistency and responsiveness of the UK FIM + FAM in a large consecutive cohort of inpatients representing the diagnostic diversity of a general neuro-rehabilitation sample.

Part 1: A Systematic review of US FIM + FAM and UK FIM + FAM studies

Methods

To identify existing studies on psychometric aspects of the US and the UK FIM + FAM, we searched the following databases using the search terms *Functional Assessment Measure.mp* and *FIM + FAM.mp*: Medline 1948 – November 2012, Embase 1980 – November 2012, PsycINFO 1806 – November 2012. Studies concerned with the psychometric properties of the FIM + FAM, as well as studies that were not primarily psychometric but might report relevant statistics (e.g. predictive validity), were identified by two investigators (L.T.S. and R.J.S.) on the basis of the title or abstract.

Results

We recovered 16 articles reporting on the psychometric qualities of the US FIM + FAM [2,7,14–27] and seven [9,10,12,28–31] on the UK FIM + FAM (six relating to the main scale and one to the EADL module). Appendix 1 summarises the existing literature and also highlights the contribution of new psychometric data presented in this article. The 16 articles on the US version reported a range of important psychometric properties including utility, reliability, validity, dimensionality (i.e. factor structure), responsiveness and floor/ceiling effects. In general, the US FIM + FAM had good psychometric properties, although several papers raised concerns about ceiling effects when it is used in outpatient or community settings.

The seven papers on the UK version reported good psychometric properties for responsiveness, utility, inter-rater reliability and concurrent validity. One raised concerns regarding ceiling effects in an outpatient setting [28]. To date, only two articles have examined responsiveness of the UK FIM + FAM [28,29], and only one has examined the psychometric properties of the newer Extended Activities of Daily Living module – reporting inter-rater and test–retest reliability [10]. We found no previously published reports on the internal consistency or the factor structure of the UK FIM + FAM.

Part 2: Scaling properties and dimensionality of the UK FIM + FAM in a mixed neuro-rehabilitation cohort

Methods

The FIM + FAM scale

The content of the US and UK FIM + FAM are shown in Table 1. The 18-item FIM component is common to both.

Both US and UK versions of the FAM comprise 12 additional items which are scored on the same seven-level structure as the FIM – each item being rated on seven levels with a score ranging from 1 – ''Total dependence'' to 7 – ''Complete independence''.

Three items in the UK FIM + FAM differ from the US version [9]: ''Concentration'' replaces ''Attention''; ''Safety awareness''

Table 1. Content of the US and UK FIM + FAM – all items are scored on a range of 1–7.

FIM items – 18 items (common to both instruments)	US FAM items – 12 items	UK FAM items – 18 items
Eating	Swallowing	Swallowing
Grooming	Car transfers	Car transfers
Bathing	Community mobility	Community mobility
Dressing – upper body	Reading	Reading
Dressing – lower body	Writing	Writing
Toileting	Speech intelligibility	Speech intelligibility
Bladder management	Emotional status	Emotional status
Bowel management	Adjustment to limitations	Adjustment to limitations
Bed, chair, wheelchair transfers	Employability	Use of leisure time[a]
Toilet transfers	Orientation	Orientation
Tub and shower transfers	Attention	Concentration[a]
Walking/wheelchair locomotion	Safety judgment	Safety awareness[a]
Stairs		
Comprehension		**UK EADL items**
Expression		Meal preparation
Social interaction		Laundry
Problem solving		Housework
Memory		Shopping
		Financial management
		Work/education[b]

[a]Items that are re-defined in the UK FIM + FAM.
[b]Work education has been added subsequent to the data collection for this analysis.
FIM, Functional Independence Measure; FAM, Functional Assessment Measure; EADL, Extended Activities of Daily Living.

Table 2. Participants' demographic characteristics ($n = 459$).

Demographic	Mean (SD)	Range
Age	44.5 (14.3) years	15–82
Length of stay	101 (61) days	12–435
	N	%
Male:Female	262:197	57:43
Diagnosis:		
Acquired brain injury	384	84%
Aetiology:		
Vascular	256	67%
Traumatic	67	17%
Inflammatory	23	6%
Hypoxic	21	5%
Tumour	14	4%
Other	3	1%
Spinal cord injury	38	8%
Other neurological conditions:	37	8%
Peripheral nerve disorders[a]	33	7%
Progressive (e.g. multiple sclerosis)	4	1%

[a]Peripheral nerve disorders include Guillain–Barré Syndrome, critical illness neuropathy, etc.

replaces ''Safety judgement''; and ''Use of leisure time'' replaces ''Employability''. In addition, a module addressing extended activities of daily living has been developed to address reported ceiling effects of the UK FIM + FAM in community rehabilitation settings [10]. Five items (see Table 1) were originally included, to which a sixth item addressing ''Working ability'' has recently been added.

Participants and setting. Data were analysed from a tertiary specialist inpatient rehabilitation service in London (catchment population in excess of five million) for patients with complex neurological disability. In this unit, the UK FIM + FAM has been routinely collected as part of routine clinical practice since 1999, although the EADL items were introduced gradually and only collected for all patients since August 2007.

UK FIM + FAM scores are routinely rated by the multidisciplinary treating team within 10 days of admission and during the last seven days before discharge. The unit is the national training centre for the UK FIM + FAM, so that all staff receive full training and regular updates on its application. From a cohort of 764 consecutive patients admitted between January 1999 and December 2009, 459 had complete FIM + FAM data (including the EADL items) on admission and discharge. All 305 scores with missing EADL data were for admissions prior to August 2007. Between August 2007 and December 2009, data collection was complete for all admissions ($n = 188$). Demographic characteristics of the cohort ($n = 459$) are shown in Table 2.

Ethics approval. The data were gathered routinely in the course of clinical practice. Approval has been granted by the Harrow Research Ethics Committee (ref no. 04/Q0405/81) for reporting this centre's clinical data retrospectively for research and audit purposes.

Analysis. As this is the first examination of factor structure within the UK FIM + FAM, our two-stage analysis included both exploratory and confirmatory components. FIM + FAM data are ordinal and often skewed, so we used a combination of parametric and non-parametric techniques. To do this, we divided the sample at random (using the PASW v.18 *select cases* function) into two smaller samples of 225 (parametric, exploratory factor analysis (EFA)) and 234 (non-parametric, Mokken scale analysis). For both samples, we included each participant's admission and discharge FIM + FAM ratings, in order to maximise the range of ability sampled. This also doubled the sample size.

Stage 1 – EFA

We first applied an EFA to the pooled admission/discharge scores of the first sample ($n = 450$). Even though they are based on parametric assumptions, principal components and factor analysis are widely used in this context and have generally been considered appropriate for the initial stage of exploring and describing the relationships among a large set of variables, even where assumptions of normality may not strictly hold [32]. The EFA was completed using PASW-18 software (SPSS, Chicago, IL). The Kaiser–Meyer–Olkin and Bartlett's test both indicated that the correlation matrix was suitable for factor analysis [33]. The choice of principal component analysis and Varimax rotation was made because these methods typically provide clear, interpretable solutions [34] and also to allow for direct comparison with the one previous factor analysis of the US FIM + FAM by Hawley et al. [16]. On the basis of that previous factor analysis, we rotated two components [16]. However, our principal components analysis revealed four components with eigenvalues >1 (suggesting four substantial sources of variance), so we also examined a four-factor solution.

Stage 2 – Confirmatory Mokken analysis

We used Mokken analysis in our confirmatory analysis of the second pooled dataset ($n = 468$), to see if the dimensions identified from the EFA could be confirmed using non-parametric methods. Mokken scaling analysis of polytomous items was undertaken using MSPWIN 5.0 software [35]. In addition to examining the full 35-item scale, we also tested the subscales based on the two-factor and four-factor solutions provided by the EFA.

Unlike parametric methods, such as confirmatory factor analysis (CFA) or Rasch [36–38], Mokken analysis makes no assumptions concerning the distribution underpinning the data. It calculates Loevinger's H coefficient for a scale, and each of its individual items, to determine if they satisfy the requirements for a stochastic or probabilistic Guttman scale [39]. H values < 0.30 are considered to reflect a poor item and values for the scale as a whole are interpreted as follows: H values in the range 0.30–0.40 reflect a *weak* scale, 0.40–0.50 a *medium* scale and $H > 0.50$ reflects a *strong* scale. Hence, any scale that fulfils the criteria for a robust scale in Mokken terms can be considered a reliable, unidimensional, ordinal scale that is suitable for rank-ordering persons.

Interpretation and responsiveness

After completing EFA and CFA on the split dataset, internal consistency of the identified subscales was evaluated using Cronbach's α for the entire dataset (including both admission and discharge scores). Despite the ordinal nature of FIM + FAM data, parametric and non-parametric evaluation of responsiveness in this large dataset gave very similar results. Here, we report the evaluation of responsiveness (change between admission and discharge) within the various subscales using paired t tests. Effect sizes are calculated using Cohen's d, taking account of the correlation between the means, and interpreted according to Cohen (0.2 = Small, 0.5 = Medium, 0.8 = Large) [40]. (A non-parametric analysis of responsiveness is available from the authors on request.)

Results

Stage 1 – EFA and internal consistency

The results of the principal components analysis with two-factor Varimax rotations are presented in Table 3.

Table 3. Principal components analysis with two- and four-factor varimax rotations of 30 FIM + FAM and five EADL items ($n = 450$)[a].

Item	Median (IQR)[a]	Single factor 1st PC	Two factors		Four factors			
			Motor	Cognitive	Physical	Psycho-social	Com'n	EADL
Eating	5 (5–7)	0.79	0.52	(0.61)	0.57			
Swallowing	7 (6–7)	0.65	(0.34)	(0.58)	0.51		(0.53)	
Grooming	5 (4–7)	0.89	0.63	(0.63)	0.62			
Bathing	4 (3–6)	0.89	0.77		0.73			
Dressing – upper	5 (3–7)	0.88	0.68	(0.55)	0.66			
Dressing – lower	3 (2–6)	0.87	0.84		0.76			
Toileting	5 (2–7)	0.84	0.85		0.84			
Bladder management	6 (3–7)	0.74	0.67		0.74			
Bowel management	6 (3–7)	0.72	0.64		0.74			
Transfers – bed/chair	5 (3–7)	0.85	0.86		0.86			
Transfers – toilet	5 (2–6)	0.85	0.87		0.87			
Transfers – tub/shower	4 (1–6)	0.80	0.87		0.81			
Car transfer	3 (1–5)	0.79	0.85		0.73			
Locomotion	5 (1–6)	0.79	0.79		0.75			
Stairs	1 (1–6)	0.71	0.86		0.78			
Community mobility	1 (1–3)	0.74	0.75					0.71
Comprehension	6 (4–7)	0.67		0.84			0.73	
Expression	5 (3–7)	0.68		0.84			0.81	
Reading	5 (4–7)	0.66		0.79			0.70	
Writing	4 (2–6)	0.70		0.77			0.73	
Speech intelligibility	7 (4–7)	0.59		0.65			0.74	
Social interaction	6 (5–7)	0.71		0.77		0.75		
Emotional status	6 (3–7)	0.63		0.61		0.68		
Adjustment	5 (3–6)	0.76		0.65		0.69		
Use of leisure time	6 (3–6)	0.81		0.67		0.51		
Problem solving	5 (2–6)	0.81		0.78		0.68		
Memory	5 (3–7)	0.75		0.77		0.73		
Orientation	7 (4–7)	0.75		0.80		0.72		
Concentration	6 (4–7)	0.75		0.76		0.74		
Safety awareness	4 (2–6)	0.82		0.67		0.60		
Meals	2 (1–5)	0.78	0.73					0.67
Laundry	1 (1–2)	0.60	0.59					0.78
Housework	1 (1–2)	0.61	0.66					0.77
Shopping	1 (1–3)	0.68	0.68					0.79
Financial management	1 (1–3)	0.57		0.55				0.58

All factor loadings rounded to two decimal points. Loadings <0.50 removed for clarity.
[a]IQR = 25th–75th centiles; all items included the full a score range of 1–7.
PC, principal component; Com'n, communication; EADL, Extended Activities of Daily Living.

The first two components extracted accounted for 66% of the total variance in responses. All items loaded strongly on the first principal component (i.e. above 0.55). Table 3 also shows a reasonably clear two-factor structure, with the 35 items falling into a *Motor* and a *Cognitive* factor. Within the EADL module, all items loaded on the Motor factor, with the exception of *Financial management* which loaded on the Cognitive factor. Similarly, the results of the four-factor analysis also showed show four clear, interpretable factors corresponding to the following dimensions of independence: Physical independence, Psychosocial independence, Communication and Extended Activities of Everyday Living (EADL). In this solution, *Community Mobility* loaded onto the EADL factor.

A modest degree of overlap was seen for some items. The *Eating, Grooming* and *Dressing upper body* items loaded onto both Motor and Cognitive factors and *Swallowing* loaded onto both the Physical and the Communication factors in the four-factor solution. For pragmatic reasons (and in line with the well-established Motor and Cognitive subscales of the FIM and FIM + FAM [16]), we elected to place all four of these items within the Motor and Physical parts of the scale. This led to the identification of two principal ''domains'' (*Motor*: 20 items (range score 20–140) and *Cognitive*: 15 items (range score 15–105)) and four ''subscales'' (*Physical*: 15 items (range score 15–105), *Psychosocial*: 9 items (range score 9–63), *Communication*: 6 items (range score 6–42) and *EADL*: 5 items (range score 5–35). These were then tested in the confirmatory analysis.

Stage 2 – Confirmatory Mokken analysis

Table 4 presents Loevinger's *H* coefficient for the overall scale and each individual item within each scale for the full 35-item scale and the subscales of the two- and four-factor solutions provided by the EFA. The *H* coefficient of the full 35-item scale was 0.64 reflecting a strong scale. For the *Motor* and *Cognitive* scales, the *H* coefficient was 0.82 and 0.65, respectively, once again reflecting strong scales. The *H* coefficient values for individual items were high across all three scales and always well above the accepted 0.30 cut-off. In the four-factor solution, once again *H* coefficient values for each subscale were high, ranging from 0.67 to 0.82, indicative of strong scales. Individual item *H* coefficient values were also all high (i.e. >0.50) and all well above the accepted cut-off (i.e. $H > 0.30$).

Consistency. Consistency was tested for these across the whole dataset. The full-scale reliability (internal consistency) was high with Cronbach's $\alpha = 0.98$ for the full scale and item-total correlations ranging from 0.56 to 0.88. Cronbach's α was 0.97 and 0.96, respectively, for the *Motor* and *Cognitive* domains, and 0.97, 0.95, 0.92 and 0.90, respectively, for the *Physical, Psychosocial, Communication* and *EADL* subscales.

Table 4. *H* coefficient values from Mokken analysis for 30 item FIM + FAM and five EADL items and for two- and four-factor based solutions ($n = 468$).

	Median (IQR)[a]	Single factor	Two factors		Four factors			
		Total scale	Motor	Cognitive	Physical	Psycho-social	Com'n	EADL
Eating	5 (5–7)	0.70	0.82		0.82			
Swallowing	7 (6–7)	0.73	0.78		0.78			
Grooming	5 (4–7)	0.69	0.80		0.80			
Bathing	4 (3–6)	0.71	0.85		0.85			
Dressing – upper	5 (3–7)	0.69	0.81		0.81			
Dressing – lower	4 (2–6)	0.69	0.85		0.86			
Toileting	5 (1–7)	0.68	0.86		0.86			
Bladder management	6 (3–7)	0.65	0.77		0.77			
Bowel management	6 (3–7)	0.63	0.77		0.77			
Transfers – bed/chair	5 (2–7)	0.69	0.86		0.86			
Transfers – toilet	5 (2–6)	0.68	0.86		0.86			
Transfers – tub/shower	4 (1–6)	0.66	0.83		0.83			
Car transfer	3 (1–6)	0.66	0.82		0.82			
Locomotion	5 (1–6)	0.66	0.80		0.80			
Stairs	1 (1–6)	0.66	0.84		0.84			
Community mobility	2 (1–3)	0.70	0.79					0.68
Comprehension	6 (5–7)	0.56		0.68			0.73	
Expression	6 (3–7)	0.56		0.66			0.77	
Reading	6 (4–7)	0.54		0.64			0.72	
Writing	5 (2–6)	0.54		0.58			0.70	
Speech intelligibility	6 (4–7)	0.52		0.58			0.71	
Social interaction	6 (4–7)	0.57		0.65		0.71		
Emotional status	6 (3–7)	0.48		0.53		0.58		
Adjustment	4 (2–6)	0.60		0.68		0.76		
Use of leisure time	6 (3–6)	0.66		0.68		0.72		
Problem solving	5 (2–6)	0.64		0.72		0.77		
Memory	5 (3–7)	0.56		0.67		0.75		
Orientation	7 (4–7)	0.63		0.69		0.76		
Concentration	6 (4–7)	0.59		0.65		0.73		
Safety awareness	4 (2–6)	0.63		0.71		0.75		
Meals	2 (1–5)	0.68	0.77					0.76
Laundry	1 (1–2)	0.69	0.78					0.67
Housework	1 (1–2)	0.69	0.80					0.68
Shopping	1 (1–3)	0.68	0.75					0.72
Financial management	1 (1–3)	0.58		0.71				0.52
Scale *H* coefficient		0.64	0.82	0.65	0.82	0.72	0.72	0.67

[a]IQR = 25th–75th centiles; all items included the full a score range of 1–7.
Com'n, Communication; EADL, Extended Activities of Daily Living.

Table 5. Scales and domain scores on admission and discharge, and change scores ($n = 459$).

	Admission		Discharge				Paired *t* tests			
	Mean (SD)	Range	Mean (SD)	Range	Mean difference	95% CI	*t*	df		Effect size (Cohen's d)
Subscales										
Physical	55.2 (26.0)	15–105	77.2 (26.7)	15–105	22.1	20.5, 23.6	27.6	457	<0.001	1.29
Psychosocial	40.0 (15.9)	9–63	46.9 (14.5)	9–63	7.0	6.2, 7.7	18.1	457	<0.001	0.86
Communication	22.9 (9.2)	5–35	26.6 (8.1)	5–35	3.7	3.3, 4.1	18.2	458	<0.001	0.87
EADL	8.8 (5.1)	6–41	16.7 (9.1)	6–42	7.9	7.2, 8.5	22.7	458	<0.001	1.21
Domains										
Motor	63.9 (28.0)	20–133	85.8 (30.7)	19–132	22.0	20.3, 23.6	26.2	457	<0.001	1.24
Cognitive	64.7 (24.4)	15–105	76.3 (22.6)	15–105	11.7	10.7, 12.7	22.0	457	<0.001	1.05

EADL, Extended Activities of Daily Living; CI, confidence interval.

Responsiveness. Change in domain and subscale scores between admission and discharge is shown in Table 5. Significant changes were seen in all four subscales with ''large'' effect sizes ranging from 0.86 to 1.29. Figure 1 shows a composite ''FAM-splat'' for the full sample, depicting the change in median scores at item level.

Discussion

The systematic review of existing literature on the psychometric properties of the UK FIM + FAM supported the psychometric robustness of the UK FIM + FAM, although as with the US version, ceiling effects can be a problem with outpatient samples. The analysis of new data from a large, mixed neuro-rehabilitation cohort demonstrated that the UK FIM + FAM has a highly acceptable level of internal consistency or reliability. Moreover, the internal consistency was high not simply for the full 35-item scale, but also for the two *Motor* and *Cognitive* domains and the four subscales (*physical*, *psychosocial*, *communication* and *EADL*) similarly identified by factor analysis. This suggests that

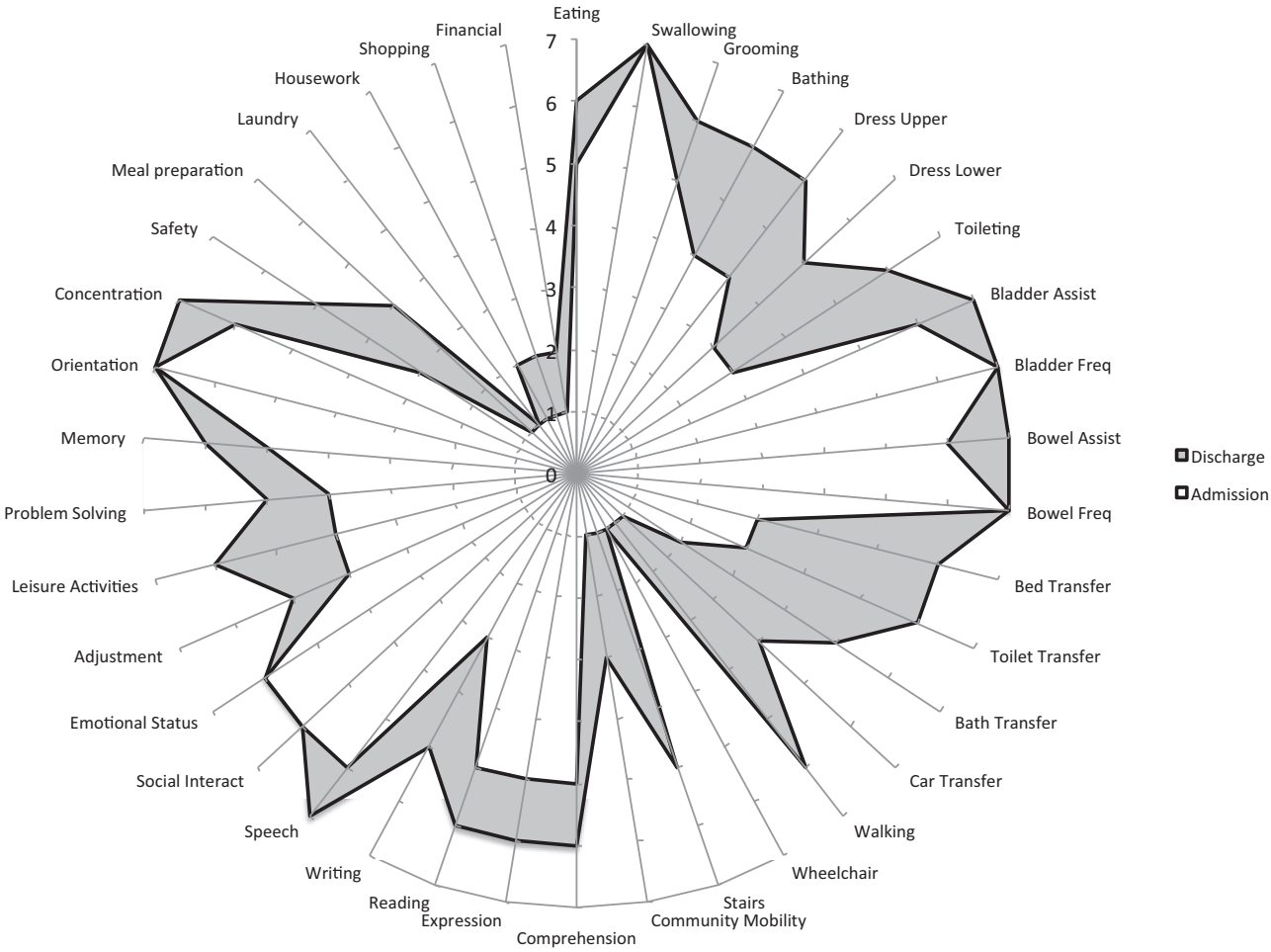

Figure 1. Composite FAM-splat – a radar chart illustrating the median item scores on admission and discharge. The FAM-splat provides graphic presentation of the disability profile in a radar chart. The FIM + FAM items are arranged as ''spokes'' of the wheel and the levels from 1 (total dependence) to 7 (total independence) run from the centre outwards. Thus a perfect score would be demonstrated as a large circle. The shaded area represents the difference between the median scores on admission and discharge.

the FIM + FAM is particularly useful measure as it can be used to derive a reliable, single score of overall independence and also yields specific information on four separate dimensions of independence. Mokken analysis confirmed that each of these constituted a reliable, unidimensional ordinal scale appropriate for rank-ordering persons.

In this analysis, we used a combination of parametric and non-parametric approaches for exploratory and confirmatory analysis, which to our knowledge is novel. We considered Mokken analysis uniquely suited for confirmatory analysis, given that it makes no assumptions about the nature of the distribution of responses on the item response scales and at the same time provides a robust index of unidimensionality. Whilst some might challenge this approach, we consider that it is helpful. If a plurality of approaches yields the same conclusions, it increases the likelihood that the findings are robust. This approach may also have application in other areas of rehabilitation measurement, where clinical data are typically ordinal and often are not normally distributed.

Our results are consistent with those of Hawley et al. [16] who reported a two-factor analysis of the US FIM + FAM with a large sample of patients with traumatic brain injury from 11 UK programmes. They also found a strong first principal component and two specific factors representing the motor and cognitive scales. However, they did not examine any alternative solutions such as the four-factor solution examined in the present study. Theirs is the only other factor analysis of the FIM + FAM that we are aware of, although other authors have examined dimensionality of the US FIM + FAM using Rasch analysis [14,15].

Limitations of the present research

The authors recognise a number of limitations to this study:

- First, all the analyses were completed on patients from a single tertiary rehabilitation service. Even though they were drawn from a very large catchment area (in excess of five million), the results require replication in an independent population.
- We used both admission and discharge scores, which were then randomised to the split samples used for exploratory and confirmatory analysis. This approach was used to ensure representation across the full score range for all items in both samples, which was achieved. However, as admission and discharge scores are expected to correlate, this may have inflated the degree of internal consistency giving an enhanced impression of homogeneity.
- We were not able to test the more recently added ''*Work*'' item in the EADL, as there was insufficient representation in this dataset. This will require evaluation in future analyses.

Conclusion

Notwithstanding the above limitations, the findings demonstrate that the UK FIM + FAM is a reliable measure of independent

functioning suitable for use in mixed inpatient neuro-rehabilitation settings. Our findings suggest that it may be acceptable to sum item scores into a single total figure, but that the instrument also provides meaningful scores on two and four sub-dimensions. In this study, all four subscales were responsive to change occurring during inpatient rehabilitation, with effect sizes ranging from 0.86 to 1.29. The data reported may inform power calculations for future studies that use the UK FIM + FAM as a primary outcome measure.

This study also provides the first examination of the relationship between the 30 FIM + FAM items and the five additional EADL items. The results suggested that these five items provide useful information on these more extended activities of everyday living and that they combined well with the existing 30 FIM + FAM items. In future publications, we plan to report the results of Rasch analysis to further explore the scaling properties of the UK FIM + FAM, as well as differential item functioning, across different groups of patients, according to impairment and localisation of neurological injury.

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Declaration of interest

Outcome measurement is a specific research interest of our centre. The UK FIM + FAM were both developed through this department, but is disseminated free of charge to trained users. Neither of the authors has any personal financial interests in the work undertaken or the findings reported. This manuscript presents independent research commissioned by the National Institute for Health Research in England (NIHR) under its Programme Grants for Applied Research funding scheme (RP-PG-0407-10185). The views expressed in this article are those of the authors and not necessarily those of the NHS, the NIHR or the Department of Health. Financial support for the preparation of this manuscript was also provided by the Dunhill Medical Trust and the Luff Foundation.

References

1. Hamilton BB, Granger CV, Sherwin FS, et al. A uniform national data system for medical rehabilitation. In: Fuhrer JM, ed. Rehabilitation outcomes: analysis and measurement. Baltimore (MD): Brookes; 1987:137–47.
2. Hall KM, Hamilton BB, Gordon WA, Zasler ND. Characteristics and comparisons of functional assessment indices: Disability Rating Scale, Functional Independence Measure, and Functional Assessment Measure. J Head Traum Rehabil 1993;8:60–74.
3. Hamilton BB, Laughlin JA, Fiedler RC, Granger CV. Interrater reliability of the 7-level Functional Independence Measure (FIM). Scand J Rehabil Med 1994;26:115–19.
4. Granger CV, Hamilton BB, Linacre JM, et al. Performance profiles of the Functional Independence Measure. Am J Phys Med Rehabil 1993;72:84–9.
5. Corrigan JD, Smith-Knapp K, Granger CV. Validity of the Functional Independence Measure for persons with traumatic brain injury. Arch Phys Med Rehabil 1997;78:828–34.
6. Ottenbacher KJ, Hsu Y, Granger CV, Fiedler RC. The reliability of the Functional Independence Measure: a quantitative review. Arch Phys Med Rehabil 1996;77:1226–32.
7. Hall KM, Mann N, High WMJ, et al. Functional measures after traumatic brain injury: ceiling effects of FIM, FIM + FAM, DRS, and CIQ. J Head Traum Rehabil 1996;11:27–39.
8. Wright J. The Center for Outcome Measurement in Brain Injury (COMBI). Available from: http://www.tbims.org/combi [last accessed 17 Dec 2012].
9. Turner-Stokes L, Nyein K, Turner-Stokes T, Gatehouse C. The UK FIM + FAM: development and evaluation. Clin Rehabil 1999;13:277–87.
10. Law J, Fielding B, Jackson D, Turner-Stokes L. The UK FIM + FAM Extended Activities of Daily Living module: evaluation of scoring accuracy and reliability. Disabil Rehabil 2009;31:825–30.
11. Turner-Stokes L, Sutch S, Dredge R. Healthcare tariffs for specialist inpatient neurorehabilitation services: rationale and development of a UK casemix and costing methodology. Clin Rehabil 2011;26:264–79.
12. Turner-Stokes L, Williams H, Sephton K, et al. Engaging the hearts and minds of clinicians in outcome measurement – the UK Rehabilitation Outcomes Collaborative approach. Disabil Rehabil 2012;34:1871–9.
13. Terwee CB, Bot SD, de Boer MR, et al. Quality criteria were proposed for measurement properties of health status questionnaires. J Clin Epidemiol 2007;60:34–42.
14. Linn RT, Blair RS, Granger CV, et al. Does the Functional Assessment Measure (FAM) extend the Functional Independence Measure (FIM) instrument? A Rasch analysis of stroke inpatients. J Outcome Meas 1999;3:339–59.
15. Tesio L, Cantagallo A. The Functional Assessment Measure (FAM) in closed traumatic brain injury outpatients: a Rasch-based psychometric study. J Outcome Meas 1998;2:79–96.
16. Hawley CA, Taylor R, Hellawell DJ, Pentland B. Use of the Functional Assessment Measure (FIM + FAM) in head injury rehabilitation: a psychometric analysis. J Neurol Neurosurg Psychiatr 1999;67:749–54.
17. Hobart JC, Lamping DL, Freeman JA, et al. Evidence-based measurement: which disability scale for neurologic rehabilitation? Neurology 2001;57:639–44.
18. Donaghy S, Wass PJ. Interrater reliability of the Functional Assessment Measure in a brain injury rehabilitation program. Arch Phys Med Rehabil 1998;79:1231–6.
19. McPherson K, Berry A, Pentland B. Relationships between cognitive impairments and functional performance after brain injury, as measured by the Functional Assessment Measure (FIM + FAM). Neuropsychol Rehabil 1997;7:241–57.
20. McPherson KM, Pentland B. Disability in patients following traumatic brain injury – which measure? Int J Rehabil Res 1997;20:1–10.
21. McPherson KM, Pentland B, Cudmore SF, Prescott RJ. An interrater reliability study of the Functional Assessment Measure (FIM + FAM). Disabil Rehabil 1996;18:341–7.
22. Hall KM, Bushnik T, Lakisic-Kazazic B, et al. Assessing traumatic brain injury outcome measures for long-term follow-up of community-based individuals. Arch Phys Med Rehabil 2001;82:367–74.
23. Powell J, Heslin J, Greenwood R. Community based rehabilitation after severe traumatic brain injury: a randomised controlled trial. J Neurol Neurosurg Psychiatr 2002;72:193–202.
24. Seel RT, Wright G, Wallace T, et al. The utility of the FIM + FAM for assessing traumatic brain injury day program outcomes. J Head Traum Rehabil 2007;22:267–77.
25. Vogele B, Lehmann S, Aschlimann A. Translation, cross-cultural adaption, and reliability of the German version of the Functional Assessment Measure. Neurologie Rehabil 2009;15:308–14.
26. Alcott D, Dixon K, Swann R. The reliability of the items of the Functional Assessment Measure (FAM): differences in abstractness between FAM items. Disabil Rehabil 1997;19:355–8.
27. Gurka JA, Felmingham KL, Baguley IJ, et al. Utility of the Functional Assessment Measure after discharge from inpatient rehabilitation. J Head Traum Rehabil. 1999;14:247–56.
28. Wilson FC, Wheatley-Smith L, Downes C. Analysis of intensive outpatient neuro-rehabilitation outcomes using FIM + FAM(UK). NeuroRehabilitation 2009;24:377–82.
29. Turner-Stokes L, Williams H, Johnson J. Goal attainment scaling: does it provide added value as a person-centred measure for evaluation outcome in neurorehabilitation following acquired brain injury? J Rehabil Med 2009;41:528–35.
30. Siegert RJ, Turner-Stokes L. Psychometric evaluation of the Northwick Park Dependency Scale. J Rehabil Med 2010;42:936–43.
31. Jorge L, Marchi G, Hara P, Battistella L. Brazilian version of the Functional Assessment Measure: cross-cultural adaptation and relaibility evaluation. Int J Rehabil Res 2011;34:89–91.
32. Tabachnick BG, Fidell LS. Using multivariate statistics. 4th ed. Needham Heights (MA): Allyn & Bacon; 2001.

33. Pett MA, Lackey NR, Sullivan JJ. Making sense of factor analysis: the use of factor analysis for instrument development in health care research. Thousand Oaks (CA): Sage Publications; 2003.
34. Thompson B. Exploratory and confirmatory factor analysis: understanding concepts and applications. Washington (DC): American Psychological Association; 2004.
35. Molenaar IW, Sijtsma K, Boer P. MSP5 for Windows: a program for Mokken scale analysis for polytomous items: (Version 5.0) User's Manual. Groningen: iec ProGAMMA; 2000.
36. Mokken RJ, Lewis C. A nonparametric approach to the analysis of dichotomous items. Appl Psychol Meas 1982;6:417–30.
37. Sijtsma K, Molenaar IW. Introduction to nonparametric item response theory. In: Jaeger RM, ed. Measurement methods for the social sciences 5. Thousand Oaks (CA): Sage Publications; 2002.
38. Van Schuur WH. Mokken scale analysis: between the Guttman scale and parametric item response theory. Polit Anal 2003;11:139–63.
39. Loevinger J. The technic of homogeneous tests compared with some aspects of ''scale analysis'' and factor analysis. Psychol Bull 1948;45:507–30.
40. Cohen J. Statistical power analysis for the behavioural sciences. 2nd ed. Hillsdale (NJ): Lawrence Erlbaum Associates; 1988.

Appendix 1

Clinimetric evaluation of the US FIM + FAM and UK FIM + FAM according to the Medical Outcomes Trust framework

Attribute	Criteria	Evaluation – US version	Evaluation – UK version
Conceptual and measurement model	***The rationale for and description of the concept and the populations that the measure is intended to assess***		
	Clinical content and design	• A global measure of disability, designed primarily for use in patients with acquired brain injury. • FIM + FAM is a 30-item ordinal scale which extends the scope of the 18-item FIM, by adding 12 items primarily addressing psychosocial and cognitive aspects of function (which are often the principal factors limiting independent function in this group) [1]. • Items are scored on a seven-point scale ranging from 1 (total dependence) to 7 (complete independence). • Persons are rated by a multidisciplinary team of clinicians on the basis of observed performance not potential or capability, except for ''Employability'' which is rated on the basis of presumed capability.	• The UK version retains the same overall structure as the US version – 12 FAM items added to the 18 FIM items are scored on the seven-point scale structure, and rated similarly by a multidisciplinary team on the basis of observed performance [2]. • Intended for a similar group of patients, the UK version was designed by a multicentre Development Group, in collaboration with the FAM originators, to address the subjective nature of some of the items. Ten ''troublesome'' items were identified and adjusted [2]. • The FIM items remain consistent across the two versions. • Item level definitions differ slightly for the UK FAM items (see ''Content'' below) • A five-item module addressing extended activity of daily living (EADL) was also developed [3].
	Dimensionality	Data from two studies of patients with TBI: $n = 60$ [4], $n = 965$ [5]; and one of stroke patients $n = 376$ [6]: • Two distinct principal components representing Motor and Cognitive functioning [5]. • Three Rasch studies reported a number of misfitting items for full 30 items and for Motor and Cognitive subscales analysed separately. Indicates neither the full scale nor two subscales are entirely unidimensional [4–6]	**Data from present study ($n = 459$) mixed neuro-rehabilitation inpatients:** • **A strong principal component with all 35 items loading >0.55 on it. On rotation clear two-factor (Motor and Cognitive functioning) and four-factor solutions (Physical, Psychosocial, Communication and EADL)** • **Mokken scaling *H* coefficient values of 0.64, 0.82 and 0.65 for Full Scale, Motor and Cognitive scales, respectively ($H > 0.50$ indicates a ''strong'' scale).** • ***H* coefficients for four subscales Physical ($H = 0.82$), Psychosocial ($H = 0.72$), Communication ($H = 0.72$), EADL ($H = 0.67$).**
Reliability	***The degree to which the instrument is free from random error***		
	Internal consistency	Data from two studies of patients with TBI: $n = 965$ [5], $n = 60$ [4]; and one of mixed neuro-rehabilitation, $n = 149$ [7] • Cronbach's α for full scale	**Data from present study ($n = 459$) mixed neuro-rehabilitation inpatient sample:** • **Cronbach's α for Full Scale = 0.98, Motor subscale = 0.97 and**

(continued)

Attribute	Criteria	Evaluation – US version	Evaluation – UK version
		FIM + FAM = 0.96, Motor subscale = 0.99, Cognitive subscale = 0.98 [5,7] • Rasch person and item consistency high at 0.91 and 0.93, respectively [4]	**Cognitive subscale = 0.96.** • **Cronbach's α for Physical (0.97), Psychosocial (0.95), Communication (0.92) and EADL (0.90) subscales** • **Rasch analysis is currently underway – not yet published.**
	Reproducibility	Data from two studies of patients with neurological injury – mainly ABI $n = 30$ [8]; and severe TBI $n = 53$ [9]: • Kappa ranged from 0.35 to 0.95 for 29/30 items [8] • ICCs ranged from good (0.60–0.74) to excellent (0.75–1.0) for 29/30 items [9]	Data from one vignette-based study of 28 clinician raters scoring individually and then in teams [2]: • Modest improvement in scoring accuracy of UK FIM + FAM in comparison with US version. Accuracy for individual item ratings improved from 75% (US) to 77% (UK) for and team accuracy from 84% to 86% [2] • Kappa ranged from 0.57 to 0.85 (for individual raters) and from 0.60 to 0.94 (for team ratings) across the 30 items. For EADL module, one vignette-based study: 50 vignettes and 12 clinician raters [3]: • Agreement with ''gold standard scores'' was high. Kappa ranging from 0.88 to 0.97 (individual ratings) and 0.93–1.0 (team ratings) [3]. • Inter-rater agreement ranged from Kappa 0.68 to 0.92 (individuals) and from 0.74 to 1.0 (teams). • Test–retest agreement Kappa values ranged from 0.92 to 1.0 (individuals) and 0.89–0.99 (teams) [3]:
Validity	***The degree to which the instrument measures what it purports to measure***		
	Content	• 30 items tap different aspects of six important aspects of independence: self-care, bowel and bladder management, mobility, communication, psychosocial function and cognition	• Covers the same range of function as the FAM, with the exception of employability • Three items are significantly altered: ○ ''Use of Leisure time'' replaces ''Employability''; ○ ''Concentration'' replaces ''Attention'': ○ ''Safety Awareness'' replaced ''Safety Judgement''. • The five-item EADL module covered community-based activities: Meal preparation, Shopping, Laundry, Housework, Financial management [3]: • A sixth item (Work) has recently been added, but has not yet been fully tested.
	Criterion-related	Not testable – no accepted gold standard currently exists	As for the US version – not testable
	Concurrent	Data from five studies of patients with TBI: $n = 48$ [10], $n = 332$ [1], $n = 612$ [11], $n = 167$ [12], $n = 54$ [13]; acquired brain injury $n = 52$ [14]; and inpatient neuro-rehabilitation ($n = 149$) [7]. • Positive Spearman correlations between five FIM + FAM dimensions (comprehension, problem-solving, memory, orientation, attention) and seven standard neuropsychological tests – 29/40 correlations significant [14]. • Correlation with the OPCS (rho 0.82) [13] • Correlations with the DRS were	Data from one study of patients with acquired brain injuries (all causes) $n = 164$ [15]; and a mixed neuro-rehabilitation inpatient sample, $n = 569$ [16]. • Strong positive correlations between the FIM + FAM and the Barthel Index (rho = 0.84); moderate correlation (rho = 0.38) with personal goal attainment scores [15] Strong positive correlation between UK FIM + FAM Motor scores and nursing dependency (NPDS) (rho 0.82–0.85) and between UK FIM + FAM Cognitive scores and NPDS Cognitive items (rho 0.76–0.77) [16]

(continued)

Attribute	Criteria	Evaluation – US version	Evaluation – UK version
		FIM + FAM motor 0.68, FIM + FAM cognitive 0.75 [1] • FAM employment item correlated −0.86 and −0.96 with DRS *level of function* and DRS *employability* items, respectively [10] • FAM items displayed modest advantage over the FIM in predicting employment and community integration at 24 months post-TBI [12]. • High correlations between FIM, FIM + FAM Total, BI, FIM motor, FIM Cognitive, FIM + FAM Motor, FIM + FAM Cognitive – Pearson's $r = 0.96$–0.99 [7] • Direction, magnitude and pattern of FIM + FAM correlations with six measures of similar and different constructs were as predicted supporting its convergent and discriminant validity	
Responsiveness	***Ability to detect change over time where real changes occur***		
	Change: admission to discharge	Data from two studies of patients with TBI $n = 94$ [17] and $n = 105$ [18]; and one inpatient neuro-rehabilitation, $n = 149$ [7]. • Standardised response means ($n = 139$) for FIM and FIM + FAM were 0.48 and 0.42, respectively [7]. • Difference between Outreach ($n = 48$) and Information ($n = 46$) groups on change scores not significant for total score and all five subscales due to ceiling effects at intake [17]. • Paired *t* tests showed only two items (bowel management and bladder management) did not show significant improvement ($n = 105$). Clinically meaningful improvements detected by 20/30 items in ≥60% of patients. • FIM + FAM Motor score below the ceiling predicted referral for on-going therapy services with a sensitivity of 0.88 and specificity of 0.65 [18].	Data from one study of $n = 65$ neuro-rehabilitation outpatients [19]; and $n = 164$ inpatients with acquired brain injury [15]; in addition to **data from this study ($n = 459$)** • Neuro-rehabilitation outpatient programme. Mean admission–discharge change scores for Motor (12.0), Cognitive (7.3) and FIM + FAM total score (19.3) all clinically significant [19]. • Neuro-rehabilitation inpatient programme: Median admission–discharge change scores for Motor, Cognitive and FIM + FAM total score all clinically significant [15]. **Data from this study confirm that significant changes were seen during inpatient rehabilitation across both FIM + FAM motor and cognitive domains (effect size 1.24 and 1.05, respectively) and across the four subscales (Effect sizes 0.86–1.29)**
Floor/Ceiling effects	No. respondents with highest or lowest possible score	Data from five community-based TBI programmes (total $N = 919$) and one inpatient stroke study ($n = 376$) [6]: • Ceiling effects reported for community resident TBI survivors [4,10,11,17,18] and inpatient stroke rehabilitation [6]	Data from one neuro-rehabilitation outpatient study, $n = 65$ [19]: • Ceiling effects on individual items at the start of programme ranged from 4.6% to 90.8% and at discharge from 18.5% to 93.8% [19]
Interpretability	***The degree to which easily understood meaning can be assigned to the quantitative scores***		
	Clinical meaning	• FIM + FAM provides two scores, one for motor independence and one for cognitive/behavioural independence, both of which are readily understood by clinicians • The cognitive items are noted to be more subjective and less ''image-able'' than the motor items, and so harder to rate reliably [20]	• **As for the US version, the UK FIM + FAM divides into Motor and Cognitive domains.** • The UK FIM + FAM software generates a ''FAM-splat'' providing an ''at-a-glance'' summary of change in the individual items of the FIM + FAM [21]
Burden	***The time, effort or other demands of administering the instrument***		
	Time to administer	• Approximately 35 min	• Approximately 30 min
Alternative modes of administration			

(continued)

Attribute	Criteria	Evaluation – US version	Evaluation – UK version
Cultural and language adaptations		• Manual includes item level definitions and decision trees as for the FIM • UK FIM + FAM [2] • German adaptation and translation [22]. ICCs for single FAM items ranged from 0.08 to 0.87 for inter-rater and from 0.50 to 0.99 for intra-rater reliability.	• Manual includes item level definitions and decision trees as for the FIM • Brazilian version [23] in Brazilian Portuguese. Intra-rater ICCs for 12 FAM items ranged from 0.60 to 0.94. ICCs for inter-rater reliability ranged from 0.51 to 0.90 across 12 items.

Data from this study are given in bold.

BI, Barthel Index; FIM, Functional Independence Measure; FAM, Functional Assessment Measure; FIM + FAM, Functional Independence Measure plus Functional Assessment Measure; ICC, Intra-Class Correlation.

References for Appendix 1

1. Hall KM, Hamilton BB, Gordon WA, Zasler ND. Characteristics and comparisons of functional assessment indices: disability Rating Scale, Functional Independence Measure, and Functional Assessment Measure. J Head Traum Rehabil 1993;8:60–74.
2. Turner-Stokes L, Nyein K, Turner-Stokes T, Gatehouse C. The UK FIM + FAM: development and evaluation. Clin Rehabil 1999; 13:277–87.
3. Law J, Fielding B, Jackson D, Turner-Stokes L. The UK FIM + FAM Extended Activities of Daily Living module: evaluation of scoring accuracy and reliability. Disabil Rehabil 2009;31:825–30.
4. Tesio L, Cantagallo A. The Functional Assessment Measure (FAM) in closed traumatic brain injury outpatients: a Rasch-based psychometric study. J Outcome Meas 1998;2:79–96.
5. Hawley CA, Taylor R, Hellawell DJ, Pentland B. Use of the Functional Assessment Measure (FIM + FAM) in head injury rehabilitation: a psychometric analysis. J Neurol Neurosurg Psychiatr 1999;67:749–54.
6. Linn RT, Blair RS, Granger CV, et al. Does the Functional Assessment Measure (FAM) extend the functional independence measure (FIM) instrument? A Rasch analysis of stroke inpatients. J Outcome Meas 1999;3:339–59.
7. Hobart JC, Lamping DL, Freeman JA, et al. Evidence-based measurement: which disability scale for neurologic rehabilitation? Neurology 2001;57:639–44.
8. McPherson KM, Pentland B, Cudmore SF, Prescott RJ. An inter-rater reliability study of the Functional Assessment Measure (FIM + FAM). Disabil Rehabil 1996;18:341–7.
9. Donaghy S, Wass PJ. Interrater reliability of the Functional Assessment Measure in a brain injury rehabilitation program. Arch Phys Med Rehabil 1998;79:1231–6.
10. Hall KM, Bushnik T, Lakisic-Kazazic B, et al. Assessing traumatic brain injury outcome measures for long-term follow-up of community-based individuals. Arch Phys Med Rehabil 2001;82:367–74.
11. Hall KM, Mann N, High WMJ, et al. Functional measures after traumatic brain injury: ceiling effects of FIM, FIM + FAM, DRS, and CIQ. J Head Traum Rehabil 1996;11:27–39.
12. Gurka JA, Felmingham KL, Baguley IJ, et al. Utility of the Functional Assessment Measure after discharge from inpatient rehabilitation. J Head Traum Rehabil 1999;14:247–56.
13. McPherson KM, Pentland B. Disability in patients following traumatic brain injury – which measure? Int J Rehabil Res 1997;20:1–10.
14. McPherson K, Berry A, Pentland B. Relationships between cognitive impairments and functional performance after brain injury, as measured by the Functional Assessment Measure (FIM + FAM). Neuropsychol Rehabil 1997;7:241–57.
15. Turner-Stokes L, Williams H, Johnson J. Goal Attainment Scaling: does it provide added value as a person-centred measure for evaluation outcome in neurorehabilitation following acquired brain injury? J Rehabil Med 2009;41:528–35.
16. Siegert RJ, Turner-Stokes L. Psychometric evaluation of the Northwick Park Dependency Scale. J Rehabil Med 2010;42:936–43.
17. Powell J, Heslin J, Greenwood R. Community based rehabilitation after severe traumatic brain injury: a randomised controlled trial. J Neurol Neurosurg Psychiatr 2002;72:193–202.
18. Seel RT, Wright G, Wallace T, et al. The utility of the FIM + FAM for assessing traumatic brain injury day program outcomes. J Head Traum Rehabil 2007;22:267–77.
19. Wilson FC, Wheatley-Smith L, Downes C. Analysis of intensive outpatient neuro-rehabilitation outcomes using FIM + FAM(UK). NeuroRehabilitation 2009;24:377–82.
20. Alcott D, Dixon K, Swann R. The reliability of the items of the Functional Assessment Measure (FAM): differences in abstractness between FAM items. Disabil Rehabil 1997;19:355–8.
21. Turner-Stokes L, Williams H, Sephton K, et al. Engaging the hearts and minds of clinicians in outcome measurement – the UK Rehabilitation Outcomes Collaborative approach. Disabil Rehabil 2012;34:1871–9.
22. Vogele B, Lehmann S, Aschlimann A. Translation, cross-cultural adaption, and reliability of the German version of the Functional Assessment Measure. Neurologie Rehabil 2009;15:308–14.
23. Jorge L, Marchi G, Hara P, Battistella L. Brazilian version of the Functional Assessment Measure: cross-cultural adaptation and relaibility evaluation. Int J Rehabil Res 2011;34:89–91.