Acta Oncologica, 2007; 46: 97–104

informa
healthcare

ORIGINAL ARTICLE

The psychometric properties of the Swedish Multidimensional Fatigue Inventory MFI-20 in four different populations

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Abstract
The Multidimensional Fatigue Inventory (MFI-20) scale is widely used for measuring fatigue in cancer care. This questionnaire has been translated into Swedish and used in Swedish cancer populations, and the aim of this study was to test the validity and reliability of the Swedish version in four populations, with a total of 584 patients. The participants were classified into four groups: palliative cancer patients, cancer patients receiving radiation therapy, non-cancer outpatients, and a group of hospital staff. The MFI-20 consists of five subscales of fatigue: General Fatigue (GF), Physical Fatigue (PF), Reduced Motivation (RM), Reduced Activity (RA) and Mental Fatigue (MF). We have tested the convergent validity of the MFI-20 using the Category Ratio instrument (CR-10). The validity and the reliability of MFI-20 were acceptable. All subscales of the MFI-20 were correlated, and all were also correlated with the CR-10 score ($p \leq 0.001$). *General Fatigue* was highly correlated with *Physical Fatigue* for the three patient groups, but this was not the fact for healthy staff. Deleting some items increased Cronbach's α of the subscale to which these items belonged (where α measures the reliability of the results). The level of non-response was low (less than 1.2%) and there was no pattern to the items omitted. We conclude that the MFI-20 is a valid and reliable instrument for measuring fatigue in patients and in healthy individuals. The results support, to some extent, earlier findings and one item can be removed from the Swedish version of the MFI-20.

Fatigue is a common symptom in cancer patients [1], in other patients [2–4], and in the general population [5,6]. Although fatigue is experienced almost universally, we still do not know clearly how the experience of fatigue differs between different patient populations. There is no clear definition of fatigue, and this leads to difficulties when designing and interpreting experimental studies. One such difficulty is how to assess fatigue. Several fatigue assessment instruments have been developed [1,7], both for the general population and for various patient populations. Fatigue is one of the most distressing symptoms [8], but progress in its management has not advanced as rapidly as the management of other cancer-related symptoms such as pain, nausea and vomiting. The differences in the definition of fatigue and how it is measured make it difficult to compare different groups of patients.

A Dutch research group [9] developed the Multidimensional Fatigue Inventory (MFI-20) in 1995. This questionnaire arose from a literature review that showed that fatigue is a multidimensional concept [10]. The Dutch group subsequently carried out a qualitative study using semi-structured interviews to gain insight into the patients' view on fatigue related to cancer, with a focus on fatigue that follows treatment [11]. The MFI-20 was tested on cancer patients receiving radiotherapy, patients with chronic fatigue syndrome, and several groups of healthy volunteers (psychology students, medical students, army recruits and junior physicians) in order to determine its psychometric properties [9]. The results showed that the instrument has high internal consistency and high validity [9]. The psychometric properties of the MFI-20 were tested further in a study of Dutch and Scottish cancer patients

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(Received 22 May 2006; accepted 11 September 2006)

ISSN 0284-186X print/ISSN 1651-226X online
DOI: 10.1080/02841860601009430

receiving radiotherapy [12]. The internal consistency of the subscales was satisfactory; Cronbach's α coefficient ranged from 0.79 to 0.93, showing that the MFI-20 is a reliable instrument [12]. Schwarz et al. [13] collected normative data from an adult German population, and they found values of Cronbach's α between 0.72 and 0.87, and pairwise correlation coefficients between 0.65 and 0.82. The MFI-20 has been translated into Swedish and used in Swedish cancer populations. The MFI-20 was translated into Swedish from the English version. A native English translator prepared a professional Swedish translation. The instrument was then back translated into English and clinically tested [14]. The final version has been used in a study that assessed patients receiving curative radiation therapy for cancer, before treatment, during treatment, and one month and 3 months after the treatment was concluded [14]. The internal consistency of the instrument was satisfactory; Cronbach's α ranged from 0.75 to 0.94. Another study used the Swedish version of the MFI-20 for women diagnosed with uterine cancer, Cronbach's α ranged from 0.82 to 0.90 [15].

The MFI-20 is probably the most commonly used cancer-related fatigue questionnaire in Europe [13]. The study described, and aimed to evaluate its validity and reliability when measuring fatigue among patients receiving palliative care.

Materials and methods

Study population and questionnaire

The selection criteria for the four participant groups were as follows: cancer patients receiving radiation therapy (RT), palliative cancer patients (PC), outpatients at a medical clinic (OP), and hospital staff (HS). Table I gives information about the four groups.

Data was collected at the end of radiation therapy treatment for the RT group (n = 100, 19 declined participation) and from the PC group on admission to the clinic (n = 284, 55 declined participation). It was collected at a visit to the outpatient's clinic for the OP group (n = 145, 31 declined participation), and during an educational event for the HS group (n = 220, 58 declined participation).

The MFI-20 consists of five subscales of fatigue: General Fatigue (GF), Physical Fatigue (PF), Reduced Motivation (RM), Reduced Activity (RA), and Mental Fatigue (MF). The questionnaire comprises 20 items for which the person must specify the extent to which the particular statements relates to him/her on a five-point scale, ranging from *Yes, that is true* to *No, that is not true*. Table II lists the items of the MFI-20.

The Borg Category Ratio scale (CR-10) is a unidimensional fatigue scale consisting a vertical line labelled 0 (*Not at all*) to 10 (*Extremely Strongly*), with

Table I. Characteristics of participants in the study. The four groups are: RT-patients during radiotherapy, PC-patients admitted for palliative care, OP-patients attending an outpatient clinic, and HS-hospital staff.

	RT		PC		OP		HS	
Study sample	n	%	n	%	n	%	n	%
Gender	81		229		114		160	
Female number	73	90	138	60	43	28	146	80
Male number	8	10	91	40	71	62	14	20
Age (years)								
Median	59		69		73		37	
Mean	59		68		71		38	
Min-Max	26–76		30–92		41–97		19–62	
Diagnosis								
Gastro-intestinal			71	31				
Gynecology	18	22	40	18				
Lung			33	14				
Urological	6	7	23	10				
Breast	53	66	13	6				
Blood/lymp	3	4	20	9				
CNS	1	1	12	5				
Head-Neck			9	4				
Unknown			8	3				
Heart					31	27		
Heart + other diseases*					68	60		
Parkinson					7	6		
Other					8	7		

*patients with more than the heart disease e.g. diabetes

Table II. Item list and subscales of the MFI-20.

MFI-20 dimension	Item no.	Item list
General Fatigue	1	I feel fit
	5	I feel tired
	12	I am rested
	16	I tire easily
Physical Fatigue	2	Physically I feel only able to do a little
	8	Physically I can take on a lot
	14	Physically I feel I am in a bad condition
	20	Physically I feel I am in an excellent condition
Mental Fatigue	7	When I am doing something, I can keep my thoughts on it
	11	I can concentrate well
	13	It takes a lot of effort to concentrate on things
	19	My thoughts easily wander
Reduced Activity	3	I feel very active
	6	I think I do a lot in a day
	10	I think I do very little in a day
	17	I get little done
Reduced Motivation	4	I feel like doing all sorts of nice things
	9	I dread having to do things
	15	I have a lot of plans
	18	I don't feel like doing anything

one additional maximum point [11]. There are verbal descriptors at fixed points on the scale, and the question the scale poses is: "*How tired have you been feeling during the last days"?* [16]. The CR-10 instrument has been used to measure fatigue in several studies [14,17] and has shown to be more sensitive to measure general fatigue than the Visual Analog Scale (VAS) and the Lickert scale [17].

The reliability of a measuring tool can be assessed in several different ways. The method chosen depends to a certain extent on the aspect of the reliability concept that is of greatest interest. The *internal consistency* approach to estimate an instrument's reliability is probably the most used method today [18]. This is the best method for assessing one of the most important sources of measurements error in instruments, the sampling of items [18]. To assess validity an approach for *construct validity* that involves assessing the degree to which two methods of measuring a construct are similar was chosen. The most direct evidence of convergence comes from the correlations between two different methods for measuring the same trait [18].

Statistical analysis

SPSS 13.0 was used to carry out statistical analysis. Cronbach's α was used to test the reliability of the results [19]. We calculated inter-item correlations to determine how reliable the scales are, producing matrices of correlation coefficients between the items. This method is useful when evaluating sum scales, scales that are made up of several items that are believed to measure the same concept [20]. Item analysis requires a sample size of 100 – 200 respondents to obtain data for information of the internal structure of the scale [19]. The method is based on the calculation of correlation coefficients, and provides information separately for each subscale, including only items for that subscale [19]. The method is particularly useful with multidimensional scales if each item is part of only one subscale, as was the case here. Each item was also correlated with the other subscales in the instrument. The convergent validity of the MFI-20 measures how the new instrument relates to a previously existing scale believed to measure the same concept. We determined the correlation between results from the MFI-20 and those from the Category Ratio instrument (CR-10) in order to determine the convergent validity of the former. Descriptive data are presented as percentages (%), mean values (m) and standard deviation (SD), while results of the reliability (internal consistency) analysis and the item analysis are presented as Cronbach's α and Pearson's correlation coefficients. Gender differences are presented as mean inter-item correlations (miic).

The Research Ethics Committee at Karolinska Institute granted ethical permission (Reference Number: 97-191) for this study.

Results

The mean values and SD for the MFI-20 and CR-10 for the different groups are presented in Table III.

Values of Cronbach's α of the MFI-20 ranged from 0.67 to 0.94 (see Table IV). The results for patients in the PC group had lowest α in four subscales (the exception being *Reduced Motivation)* , while the results for patients in the RT group had the highest α in four subscales (the exception being *Physical Fatigue)* .

The inter-item correlation coefficients ranged between 0.21 and 0.90, with lower values for the PC group.

The α value increased if an item was removed from the subscales concerning items 2, 3, 9, 13 or 19: *Physical Fatigue* (item 2) for the PC and RT groups: *Reduced Activity* (item 3) for all groups: *Reduced Motivation* (item 9) for the OP group:

Table III. Mean (m) and standard deviation (SD) for the MFI-20 subscales, and CR–10 as reported by the different groups.

	RT		PC		OP		HS	
Patient sample	m	SD	m	SD	m	SD	m	SD
General Fatigue	13.5	5.1	16.8	3.7	11.0	4.7	10.8	4.4
Physical Fatigue	12.6	5.0	17.8	3.2	11.1	5.1	8.4	4.0
Mental Fatigue	10.2	4.5	11.7	4.3	8.7	3.8	8.7	3.6
Reduced activity	13.1	5.5	16.9	3.6	10.9	4.2	8.3	3.5
Reduced motivation	9.9	4.5	11.1	4.7	8.3	3.6	7.0	2.9
CR–10	3.8	2.9	4.9	2.9	2.5	2.0	2.6	2.1

RT-patients receiving radiotherapy, PC-patients in palliative cancer care, OP-patients attending an outpatient clinic and HS-hospital staff. Response scale for the MFI–20 subscales are 4–20, for the CR–10 scale 0–11.

Mental Fatigue (item 13) for the HS group, and *Mental Fatigue* (item 19) for the RT and PC groups (Table IV). This may indicate that there is a problem with the formulation of the items, or that some items may be classified under an incorrect subscale. It may, indeed, call into question the relevance of any item to the subscales.

Analysing the different items correlations to the other three items in their own subscale and also to the other subscales an analysis of the corrected item to total were performed and presented in Table V. The scores on the subscales were highly correlated ($p \leq 0.001$). The *General Fatigue* and the *Physical Fatigue* subscales were highest correlated with each other in all groups. The correlation between the MFI-20 subscales and scores on the CR-10 ranged between 0.37 to 0.74 ($p \leq 0.001$ for all subscales and CR-10), with the *General Fatigue* subscale having the highest correlation with the CR-10 scale.

Two items (items 1 and 16) in the *General Fatigue* subscale were highly correlated with the *Physical Fatigue* subscale for all groups except the HS group. Two items (items 2 and 14) in the *Physical Fatigue* subscale were highly correlated with the *General Fatigue* subscale for the RT and the PC groups. Item 19 in the *Mental Fatigue* subscale was correlated with *General Fatigue* for the PC group and with *Reduced Activity* for the HS group. Item 3, in the *Mental Fatigue* subscale, had higher correlation coefficients with three of the other subscales than it had with its own subscale for almost all groups, and it had the highest correlation with the *Physical Fatigue* subscale. Item 9, in the *Reduced Motivation* subscale, was more highly correlated with the *Physical Fatigue* subscale for the RT group than with its own subscale. Item 9 was also more highly correlated with all other subscales for the OP group than it was with its own subscale, the highest correlation being with *Physical Fatigue*. The pattern for Item 18 was the same, higher correlations to all other subscales for all groups, with the highest correlation being with the *Reduced Motivation* subscale.

Gender differences were analyzed for the PC and the OP groups. No statistical differences were found concerning age, between male and female participants, and no systematic pattern was shown in the item analysis between genders. Male patients in the PC group had somewhat higher inter-item correlations in the *General Fatigue* subscale than female patients, miic 0.50 vs. 0.39 respectively. In the *Physical Fatigue* subscale α increased if deleting item 2 for the male patients in the PC group (from 0.78 to 0.80). In the *Reduced Activity* subscale item 3 revealed very low or even no correlations with the other items in the same subscale for the PC group, this was most evident for the male patients. Item 9 in the *Reduced Motivation* subscale also showed low or no correlations to the other items in its own subscale, this was most evident for the male patients in both the PC and the OP groups.

There was no systematic pattern in omitted items, and the level of non-response was very low (less than 1.2%).

Discussion

We have tested the reliability of the MFI-20 using three reliability tests: inter-item correlation, corrected item-to-total correlation and Cronbach's α. All show that the instrument is reliable. Values of α greater than 0.70 are considered to show that the data is reliable [21], and all but two of our results satisfy this condition. Smets et al. [9] have presented similar results. The two exceptions are *Mental Fatigue* for the PC group (0.68) and *Reduced Motivation* for the HS group (0.67), with values somewhat under 0.70. The inter-item correlation coefficients were all relatively high, showing that the individual items of a subscale are related. Almost all correlation coefficients exceeded 0.30. Results from the analysis showed that if item 2, 3, 9, 13 or 19 were deleted an increase in α was evident, this is in concordance with results from a factor analysis of the French Canadian translation of the MFI-20 [22]. Fillion et al. [22] question whether item 19

Table IV. Values of Cronbach's alpha for the MFI-20 subscales[a], MFI-20 inter-item correlations[b], α if item deleted[c], MFI-20 subscale correlation coefficients[d], and correlation coefficients between MFI-20 scores and scores on the CR-10 scale[e].

MFI-20 Subscale	α[a]	Inter-item Correlations[b]						α if item deleted[c,*]				Correlations[d]					
														GF Correlations			
General Fatigue		1 v.s 5	1 v.s 12	1 v.s 16	5 v.s 12	5 v.s 16	5 v.s 16	**1**	**5**	**12**	**16**	**GF**	**PF**	**MF**	**RA**	**RM**	**CR-10[e]**
RT	.89	.61	.70	.65	.70	.76	.63	.87	.85	.86	.86		.88	.59	.80	.66	.74
PC	.76	.37	.44	.45	.46	.56	.39	.72	.68	.72	.68		.74	.44	.58	.43	.60
OP	.89	.66	.63	.72	.67	.73	.63	.86	.85	.87	.85		.83	.52	.76	.62	.70
HS	.85	.56	.63	.49	.67	.64	.54	.83	.78	.79	.83		.72	.66	.67	.55	.71
														PF Correlations			
Physical Fatigue		2 v.s 8	2 v.s 14	2 v.s 20	8 v.s 14	8 v.s 20	14 v.s 20	**2**	**8**	**14**	**20**	**GF**	**PF**	**MF**	**RA**	**RM**	**CR-10**
RT	.87	.54	.55	.55	.76	.71	.68	.88	.81	.82	.83			.60	.82	.75	.73
PC	.76	.45	.39	.37	.44	.59	.60	.77	.70	.70	.68			.30	.57	.38	.50
OP	.93	.71	.78	.70	.74	.77	.82	.91	.91	.89	.90			.44	.79	.67	.53
HS	.83	.55	.52	.50	.51	.48	.79	.82	.82	.75	.77			.51	.68	.54	.56
														MF Correlations			
Mental Fatigue	v.s	7 v.s 11	7 v.s 13	7 v.s 19	11 v.s 13	11 v.s 19	13 v.s 19	**7**	**11**	**13**	**19**	**GF**	**PF**	**MF**	**RA**	**RM**	**CR-10**
RT	.85	.82	.57	.48	.68	.58	.44	.79	.74	.83	.87				.64	.58	.52
PC	.68	.73	.33	.21	.37	.23	.23	.53	.51	.65	.73				.34	.25	.42
OP	.79	.62	.44	.37	.62	.55	.37	.75	.65	.75	.79				.63	.59	.40
HS	.74	.68	.38	.47	.38	.43	.24	.61	.62	.75	.72				.66	.53	.46
														RA Correlations			
Reduced Activity		3 v.s 6	3 v.s 10	3 v.s 17	6 v.s 10	6 v.s 17	10 v.s 17	**3**	**6**	**10**	**17**	**GF**	**PF**	**MF**	**RA**	**RM**	**CR-10**
RT	.94	.76	.76	.75	.84	.82	.90	.95	.93	.91	.92					.74	.62
PC	.72	.37	.32	.23	.53	.38	.54	.73	.62	.59	.67					.50	.42
OP	.87	.54	.48	.57	.61	.70	.81	.88	.83	.82	.78					.76	.53
HS	.76	.43	.35	.31	.51	.55	.56	.77	.67	.70	.69					.63	.42
														RM Correlations			
Reduced Motivation		4 v.s 9	4 v.s 15	4 v.s 18	9 v.s 15	9 v.s 18	15 v.s 18	**4**	**9**	**15**	**18**	**GF**	**PF**	**MF**	**RA**	**RM**	**CR-10**
RT	.85	.48	.61	.75	.37	.74	.55	.79	.84	.85	.74						.69
PC	.74	.32	.42	.42	.26	.56	.47	.69	.70	.70	.60						.37
OP	.76	.26	.56	.58	.23	.46	.56	.67	.79	.69	.63						.46
HS	.67	.25	.41	.51	.21	.39	.26	.54	.66	.64	.56						.37

Reliability analyses for the sample separately including: a) the analysis of Cronbachs alpha for each subscale in the MFI-20, b) inter-item correlations for the separate items in the subscales against the other item in the same subscale, c) α if item deleted, presenting the α value for the subscale if the analysed item was deleted and d) the correlations between the different subscales in the MFI-20 and validity analysis e) correlations between the different subscales in the MFI-20 and the CR-10 scale. RT-patients receiving radiotherapy, PC-patients in palliative cancer care, OP-patients attending an outpatient clinic, and HS-hospital staff. [*]Numbers on a coloured background highlight items that, if they were deleted, would increase α.

Table V. Corrected item-to-total correlation coefficients and the correlation between each item and the subscales in the MFI-20.

MFI-20 Subscale	α	Item-GF **Correlations**				Item-PF **Correlations**				Item-MF **Correlations**				Item-RA **Correlations**				Item-RM **Correlations**			
General Fatigue		**1**	**5**	**12**	**16**	**1**	**5**	**12**	**16**	**1**	**5**	**12**	**16**	**1**	**5**	**12**	**16**	**1**	**5**	**12**	**16**
RT	.89	.73	.79	.76	.77	.77	.74	.74	.81	.52	.52	.48	.54	.70	.65	.65	.78	.64	.50	.57	.59
PC	.76	.52	.59	.54	.59	.66	.59	.39	.63	.24	.40	.39	.30	.53	.40	.36	.52	.33	.34	.32	.32
OP	.89	.76	.78	.72	.79	.84	.66	.59	.80	.40	.45	.48	.47	.74	.62	.57	.73	.58	.48	.52	.59
HS	.85	.78	.87	.86	.81	.69	.57	.53	.63	.51	.54	.50	.63	.56	.58	.48	.61	.47	.44	.43	.50
Physical Fatigue		**2**	**8**	**14**	**20**	**2**	**8**	**14**	**20**	**2**	**8**	**14**	**20**	**2**	**8**	**14**	**20**	**2**	**8**	**14**	**20**
RT	.87	.69	.74	.77	.80	.61	.78	.77	.75	.43	.61	.57	.44	.54	.78	.77	.71	.62	.63	.69	.63
PC	.76	.55	.52	.60	.60	.48	.61	.58	.65	.20	.25	.27	.22	.36	.50	.46	.49	.21	.29	.34	.35
OP	.93	.70	.69	.81	.79	.79	.81	.87	.84	.41	.36	.43	.35	.68	.71	.74	.71	.65	.60	.62	.55
HS	.83	.54	.55	.62	.65	.61	.59	.75	.72	.44	.47	.43	.33	.54	.56	.56	.49	.41	.53	.44	.38
Mental Fatigue		**7**	**11**	**13**	**19**	**7**	**11**	**13**	**19**	**7**	**11**	**13**	**19**	**7**	**11**	**13**	**19**	**7**	**11**	**13**	**19**
RT	.85	.50	.58	.55	.36	.48	.58	.61	.34	.73	.85	.65	.56	.54	.64	.54	.46	.50	.56	.61	.28
PC	.68	.36	.33	.29	.29	.27	.20	.15	.21	.58	.61	.40	.28	.33	.27	.14	.24	.30	.25	.01	.14
OP	.79	.48	.45	.38	.33	.40	.38	.31	.28	.57	.77	.56	.51	.53	.59	.43	.41	.56	.59	.41	.34
HS	.74	.61	.52	.37	.50	.52	.41	.26	.37	.67	.64	.40	.46	.66	.55	.29	.51	.51	.49	.35	.27
Reduced Activity		**3**	**6**	**10**	**17**	**3**	**6**	**10**	**17**	**3**	**6**	**10**	**17**	**3**	**6**	**10**	**17**	**3**	**6**	**10**	**17**
RT	.94	.80	.71	.71	.75	.81	.71	.75	.76	.47	.57	.63	.67	.79	.85	.94	.89	.68	.66	.68	.68
PC	.72	.52	.38	.51	.30	.52	.41	.46	.32	.19	.31	.31	.22	.38	.56	.63	.48	.49	.31	.34	.31
OP	.87	.62	.62	.61	.72	.68	.62	.64	.74	.38	.51	.53	.62	.59	.71	.74	.83	.61	.60	.59	.71
HS	.76	.52	.55	.48	.51	.51	.55	.42	.53	.38	.49	.55	.61	.45	.64	.60	.60	.47	.42	.51	.55
Reduced Motivation		**4**	**9**	**15**	**18**	**4**	**9**	**15**	**18**	**4**	**9**	**15**	**18**	**4**	**9**	**15**	**18**	**4**	**9**	**15**	**18**
RT	.85	.62	.55	.35	.63	.67	.67	.41	.70	.42	.53	.33	.60	.63	.59	.47	.73	.74	.61	.58	.84
PC	.74	.24	.40	.18	.45	.19	.36	.19	.41	.11	.29	.08	.28	.30	.34	.34	.49	.50	.48	.49	.64
OP	.76	.43	.48	.45	.53	.43	.59	.46	.58	.45	.41	.40	.59	.53	.53	.55	.66	.60	.36	.57	.71
HS	.67	.38	.31	.25	.65	.37	.36	.22	.61	.28	.38	.25	.58	.42	.34	.39	.67	.54	.36	.39	.54

RT-patients receiving radiotherapy, PC-patients in palliative cancer care, OP-patients at an outpatient clinic, and HS-hospital staff. Numbers on a grey background show correlation coefficients between an item and its own subscale. Numbers on a red background are the highest correlation coefficient for an item that correlates better with another subscale than its own.

suffers from a poor translation into French, and we also suggest that cultural differences or the idiomatic wording of the question, "*My thoughts easily wander",* plays a role. 'Concentration', rather than 'thought', is the focus of the other items in the *Mental Fatigue* subscale. The results of the present study support earlier results concerning item 19, and we suggest that the problematic item 19 should be removed from the Swedish version of the MFI-20. The gender differences presented was not evident and showed no systematic pattern. Hence, some of the mentioned problematic items in the other analysis recurred. Since there was divergence in gender participate the analysis could not be performed for all groups so this is a topic to be further studied.

Our results show that it is difficult to distinguish between the *General Fatigue* and the *Physical Fatigue* subscales. Smets et al. have also reported this [9], and results confirms by findings from Gentile et al. [23]. They retained the five scales until more information was available. We have shown that *General Fatigue* and *Physical Fatigue* are highly correlated (with correlation coefficients between 0.72 and 0.88) and we have shown that two items (items 1 and 16) from the *General Fatigue* subscale correlate more highly with the *Physical Fatigue* subscale for three of the patient groups (for the exception being the healthy HS group). This might be a consequence of the patients having difficulties in distinguishing general aspects from physical aspects of fatigue since the levels are high on both scales, while healthy individuals separate these two dimensions more clearly. One possible explanation may lie in the subjective experience of fatigue. An individual with an illness may well experience dimensions of fatigue unknown to the healthy person.

The convergent validity of the Swedish MFI-20 is good: each subscale of the MFI-20 was correlated with score on the CR-10 scale ($p \leq 0.001$).

We have analysed each item and the separate subscales in depth. However, we have not analysed the test-retest reliability, and we cannot draw any conclusions about how the instrument behaves in repeated measures. "Fatigue" may be a concept whose subjective experience alters rapidly, and it will be difficult to obtain reliable results from two measurements of a person's experience of fatigue within a short time.

Our results also show that the patients readily accept the MFI-20, since there were few omitted items, with no systematic pattern.

Several researchers have suggested that it is possible to reduce the number of items or to transform the subscales of the MFI-20 [22,23]. Our results, however, show that the Swedish version of the MFI-20 is a valid and reliable instrument for measuring fatigue in different patient populations and in healthy individuals. Our results provide support for the reduction of item 19 but not to further reduce the number of items or to reformulate the subscales.

Acknowledgements

This study was generously supported by The National Health Care Postgraduate School, Karolinska Institute, the Swedish Cancer Society and Stockholm County Council.

References

[1] Barnes EA, Bruera E. Fatigue in patients with advanced cancer: A review. Int J Gynecol Cancer 2002;12:424–8.
[2] Solano JP, Gomes B, Higginson IJ. A comparison of symptom prevalence in far advanced cancer, AIDS, heart disease, chronic obstructive pulmonary disease and renal disease. J Pain Sympt Manage 2006;31:58–69.
[3] Rupp I, Boshuizen HC, Jacobi CE, Dinant HJ, van den Bos GA. Impact of fatigue on health-related quality of life in rheumatoid arthritis. Arthritis Rheum 2004;51:578–85.
[4] Breukink SO, Strijbos JH, Koorn M, Koeter GH, Breslin EH, van der Schans CP. Relationship between subjective fatigue and physiological variables in patients with chronic obstructive pulmonary disease. Respir Med 1998;92:676–82.
[5] Hjermstad MJ, Fayers PM, Bjordal K, Kaasa S. Health-related quality of life in the general Norwegian population assessed by the European Organization for Research and Treatment of Cancer Core Quality-of-Life Questionnaire: The QLQ = C30 (+3). J Clin Oncol 1998;16:1188–96.
[6] Michelson H, Bolund C, Nilsson B, Brandberg Y. Health-related quality of life measured by the EORTC QLQ-C30–reference values from a large sample of Swedish population. Acta Oncol 2000;39:477–84.
[7] Schwartz AH. Validity of cancer-related fatigue instruments. Pharmacotherapy 2002;22:1433–41.
[8] Cooley ME, Short TH, Moriarty HJ. Symptom prevalence, distress, and change over time in adults receiving treatment for lung cancer. Psycho-Oncology 2003;12:694–708.
[9] Smets EM, Garssen B, Bonke B, De Haes JC. The Multidimensional Fatigue Inventory (MFI) psychometric qualities of an instrument to assess fatigue. J Psychosom Res 1995;39:315–25.
[10] Smets E, Garsen B, Schuster-Uitterhoeve A, de Haes J. Fatigue in cancer patients. Br J Cancer 1993;68:220–4.
[11] Smets EMA. Fatigue in cancer patients undergoing radiotherapy. Amsterdam: University of Amsterdam; 1997.
[12] Smets EM, Garssen B, Cull A, de Haes JC. Application of the multidimensional fatigue inventory (MFI-20) in cancer patients receiving radiotherapy. Br J Cancer 1996;73:241–5.
[13] Schwarz R, Krauss O, Hinz A. Fatigue in the general population. Onkologie 2003;26:140–4.
[14] Furst CJ, Ahsberg E. Dimensions of fatigue during radiotherapy. An application of the Multidimensional Fatigue Inventory. Support Care Cancer 2001;9:355–60.

[15] Ahlberg K. Cancer-related fatigue-experience and outcomes. Göteborg: The Sahlgrenska Academy at Göteborg University; 2004.
[16] Borg G. A category scale with ratio properties for intermodal and interindividual comparisons. In: Geissler H-G, Petzold P, editors. Psychophysical judgment and the process of perception. Berlin: VEB Deutscher Verlag der Wissenschaften; 1982.
[17] Grant S, Aitchison T, Henderson E, Christie J, Zare S, McMurray J, et al. A comparison of the reproducibility and the sensitivity to change of visual analogue scales, Borg scales, and Likert scales in normal subjects during submaximal exercise. Chest 1999;116:1208–17.
[18] Polit DH, Hungler BP. Nursing Research; Principles and Methods, 5th ed. Philadelphia: J.B. Lippincott Company; 1995.
[19] Spector. Summated rating scale construction-An introduction. Newsbury Park, California: Sage Publications, Inc; 1992.
[20] StatSoft ET. StatSoft Electronic Textbook. In: StatSoft, Inc; 1984–2003.
[21] Cronbach LJ. Coefficient alpha and the internal structure of tests. Psychometrika 1951;16:297–334.
[22] Fillion L, Gelinas C, Simard S, Savard J, Gagnon P. Validation evidence for the French Canadian adaptation of the Multidimensional Fatigue Inventory as a measure of cancer-related fatigue. Cancer Nursing 2003;26:143–54.
[23] Gentile S, Delaroziere JC, Favre F, Sambuc R, San Marco JL. Validation of the French 'multidimensional fatigue inventory' (MFI 20). Eur J Cancer Care (Engl) 2003;12: 58–64.