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THE MULTIDIMENSIONAL FATIGUE INVENTORY (MFI) PSYCHOMETRIC QUALITIES OF AN INSTRUMENT TO ASSESS FATIGUE

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Abstract—The Multidimensional Fatigue Inventory (MFI) is a 20-item self-report instrument designed to measure fatigue. It covers the following dimensions: General Fatigue, Physical Fatigue, Mental Fatigue, Reduced Motivation and Reduced Activity. This new instrument was tested for its psychometric properties in cancer patients receiving radiotherapy, patients with the chronic fatigue syndrome, psychology students, medical students, army recruits and junior physicians. We determined the dimensional structure using confirmatory factor analyses (LISREL's unweighted least squares method). The hypothesized five-factor model appeared to fit the data in all samples tested (AGFIs > 0.93). The instrument was found to have good internal consistency, with an average Cronbach's alpha coefficient of 0.84. Construct validity was established after comparisons between and within groups, assuming differences in fatigue based on differences in circumstances and/or activity level. Convergent validity was investigated by correlating the MFI-scales with a Visual Analogue Scale measuring fatigue ($0.22 < r < 0.78$). Results, by and large, support the validity of the MFI.

INTRODUCTION

Commonly, the term fatigue refers to a normal, everyday experience that most individuals report after inadequate sleep or rest, or after exertion of physical power. People also report feelings of fatigue after mental effort or when they lack the motivation to initiate activities.

Apart from this everyday use, the term fatigue also describes a symptom considered to indicate the presence of disease. Persistent fatigue is probably the symptom most frequently reported to physicians. An overview of studies on fatigue in primary care [1] showed that prevalence rates vary between 7 and 45%. This large range in prevalence rates can most likely be attributed to differences in the working definition of fatigue and to differences in measuring methods.

Many physical diseases, in particular chronic diseases such as cancer, multiple sclerosis, arthritis, renal disease, and HIV infection are associated with fatigue [2–5].

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Fatigue is also the key symptom of the chronic fatigue syndrome. In addition, it is generally considered an important aspect of depression.

Besides being an indicator of disease, fatigue may also result from medical treatment. For example, feelings of fatigue lasting several weeks are common during post-surgery periods of convalescence [6]. Treatments for cancer such as radio- or chemotherapy, are also acknowledged to induce feelings of tiredness [2]. Finally, several medications such as analgesics, psychopharmaca and sleeping-agents may induce daytime fatigue.

Fatigue has been found to negatively affect cancer patients' self-care [7] and social activities [8]. The consequences of fatigue are also reflected in its detrimental effect on patients' quality of life [9, 10].

Because of its high prevalence and increasingly acknowledged negative effect on the patient's well-being, fatigue has become an important research variable. Besides being investigated as a symptom or side-effect, it has also been studied as a precursor of disease [11], as a diagnostic criterion [12], and as an outcome-variable by which treatment is evaluated [13]. Whatever the reason may be for including fatigue as a variable, its assessment has to be reliable and valid.

Instruments available to assess fatigue in patients can be divided into one-dimensional instruments and multidimensional instruments. Of the one-dimensional measures of fatigue, the Visual Analogue Scale (VAS) as for example used by Krupp *et al.* [3] is the simplest. Pearson and Byars [14] developed a 10-item Fatigue Feeling Checklist that was used in studies on the effects of cancer treatment [15, 16]. Examples of other one-dimensional fatigue questionnaires are the Rand Index of Vitality [17], the Tiredness Scale [18] and the Fatigue Severity Scale [19]. Examples of more comprehensive instruments that include a fatigue subscale are the EORTC-Quality of Life Questionnaire [10] and the Profile of Mood States (POMS) [13].

Multidimensional measures include a two-dimensional fatigue-scale as used by Wessely and Powell [20] in their study on the chronic fatigue syndrome. The questionnaire contains a physical fatigue and a mental fatigue scale.

The Fatigue Symptom Checklist (FSCL) is a multidimensional questionnaire which was used by Haylock and Hart [15] and by Kobashi and co-workers [21] in cancer patients. The original FSCL contains 30 symptoms and was divided into three subscales, based on a factor analysis: (1) general feelings of sleepiness, with items like "feel tired in the legs" and "want to lie down"; (2) mental feelings of fatigue, with items like "difficulty in thinking" and "become nervous"; and (3) specific bodily sensations, such as "headache" and "dizziness" [22]. Piper and colleagues developed an instrument to measure the experience of fatigue in patients, which they termed the Piper Fatigue Self-report Scale (PFS) [23]. This instrument consists of 41 visual analogue scales representing the temporal, intensity, affective and sensory dimensions of fatigue. Results were obtained in a sample of breast and lung cancer patients. Whether the assumed dimensions of fatigue were reflected in the actual data of the patient population was not mentioned. Many patients had difficulties completing the questionnaire. The authors, however, report excellent reliability and moderate construct validity of the instrument. The last questionnaire to be discussed, is the 48-item Dutch questionnaire, developed by Vertommen and Leyssen [12]. The instrument was tested on a student- and patient-population, yielding a three-factor solution: general fatigue, mental fatigue and somatic symptoms, for both groups.

One-dimensional measures of fatigue are frequently used in studies including patient samples. One can, however, question their adequacy. Individuals with the same overall fatigue score may differ in their experiences. One person might, for instance, feel physically exhausted and mentally alert, while a second one feels mentally tired but physically fit. The use of one-dimensional instruments excludes this possibility of a complete description of the fatigue experience of patients. The available, more comprehensive multi-dimensional instruments have two major drawbacks. They are—except for the instrument developed by Wessely and Powell—either lengthy, which might hamper completion in patient groups for whom fatigue is a key symptom, or they contain other somatic symptoms beside those referring directly to tiredness, such as 'headache' in the FSCL. This induces the risk of contamination of fatigue with somatic illness.

Prompted by the lack of an instrument meeting these problems, we decided to develop (1) a short questionnaire that, (2) would not contain any somatic items, and (3) had to be multidimensional. The present paper describes the development of this questionnaire and the research investigating its dimensional structure, reliability and validity.

METHOD

The questionnaire

At the onset of developing the questionnaire five dimensions of fatigue were postulated based on the manners in which fatigue can be expressed. Firstly, fatigue can be expressed by general remarks of a person concerning his or her functioning, for example "I feel rested". Secondly, by referring to physical sensations, related to the feeling of tiredness. Thirdly, by referring to cognitive symptoms, such as having difficulty concentrating. These three dimensions, labelled General, Physical and Mental Fatigue correspond with scales formed by factor-analyses as reported by others [12–21].

The term fatigue is also used to describe a lack of motivation to start any activity [24]. This resulted in the fourth dimension, labelled Reduced Motivation. The final dimension refers to a frequently occurring, although not necessary consequence of fatigue, namely a reduction in activity, and is labelled Reduced Activity. We termed the resulting instrument the Multidimensional Fatigue Inventory (MFI).

In constructing the questionnaire, an equal number of items for each of the five postulated dimensions was strived for. Items were worded in a positive and a negative direction to prevent tendencies towards the response set. For each dimension the number of positively, and respectively negatively formulated items should be well balanced and redundancy of the number of items had to be precluded: the more parsimonious the questionnaire the better. However, because of difficulties in formulating equally acceptable positively and negatively framed items, it was decided to leave the test-version out of balance. Items were later removed based on the results obtained.

Ultimately, results are presented in this paper on the MFI consisting of 24 statements for which the person has to indicate on a 7-point scale to what extent the particular statement applies to him or her (Fig. 1). The statements refer to aspects of fatigue experienced during the previous days. Higher scores indicate a higher degree of fatigue.

Procedure

To test the MFI with patients, data were gathered from a heterogeneous group of cancer patients treated with radiotherapy and from individuals who participated in a study investigating the chronic fatigue syndrome.

First year psychology students, and medical students, completed the questionnaire to investigate the properties of the instrument when used with healthy persons under normal circumstances. In addition, the MFI was filled in twice by junior physicians, before and after 5–6 wk of their first practical training in internal medicine. This sample was included to investigate the MFI when used in conditions assumed to induce fatigue. Typical for this medical training period is the large number of new impressions, late hours and high emotional burden. We also wanted a sample for which we assumed that fatigue was primarily the result of physical effort. Therefore, data were obtained from two groups of army recruits.

1. I feel fit	yes, that is true	☐☐☐☐☐☐☐	no, that is not true
2. Physically I feel only able to do a little	yes, that is true	☐☐☐☐☐☐☐	no, that is not true
3. I feel very active	yes, that is true	☐☐☐☐☐☐☐	no, that is not true
4. I am not up to much	yes, that is true	☐☐☐☐☐☐☐	no, that is not true
5. Thinking requires effort	yes, that is true	☐☐☐☐☐☐☐	no, that is not true

1. Investigators interested in using the instrument should contact the first author. An authorised English version is available. For academic use, permission will be granted at no charge, but while still under development, investigators will be requested to share their results with the authors so that reliability and validity testing can proceed appropriately.

These soldiers were assessed either during their stay in the barracks, or in the second week of a physically intensive military training program.

To investigate whether the assumption of five dimensions was supported by the data, confirmatory factor analyses were conducted. An advantage of confirmatory over exploratory factor analysis is that one can specify a priori the kind of interpretation one prefers. In an exploratory factor model the researcher does not specify the structure of the relationships among the variables in the model. In the confirmatory factor model, however, the researcher poses constraints, preferably motivated by theory, determining the relation between variables, common factors and unique factors. The instrument must be shown to measure the same construct in different groups to compare results from one sub-group to another. The factor-structure was therefore investigated for the various study-groups, with the exception of the junior physicians. (For this group only validity data will be presented.) Next, internal consistency was assessed for all scales.

Assessing the construct validity of the MFI had high priority in this investigation. Construct validity is generally determined by testing hypotheses concerning the construct to be measured. First, assessment of the construct validity of the MFI was based on comparisons between groups that supposedly differ in fatigue. Patients with CFS and radiotherapy patients were assumed to be more fatigued than the students and the army recruits in the barrack situation. It was also assumed that junior physicians during training and army recruits during exercise would be more fatigued than the students and the soldiers in the barrack situation.

Secondly, construct validity was determined based on hypothesized differences in fatigue within a sample, resulting from differences in activity. For this purpose, psychology students were asked to indicate whether they had done any exceptional activities in the days before completing the questionnaire. Students who for example reported that they had gone out a good deal were expected to have higher scores than students who did not report any exceptional activities during the previous days. In addition, an increase in fatigue scores was expected in junior physicians between the two assessments.

Convergent validity is an indicator of the degree to which a newly developed instrument is related to already existing instruments intended to measure the same construct under investigation. In order to investigate convergent validity of the MFI, radiotherapy patients were asked to indicate the intensity of their fatigue as experienced during the previous days on a 100 mm Visual Analogue Scale (VAS), ranging from 'not at all tired' too 'extremely tired'.

Subjects

A heterogeneous group of cancer patients ($n = 111$) completed the questionnaire, at the out-patient clinic immediately after receiving radiation, using a cross-sectional design. One-hundred and thirteen patients were asked to participate. Two patients refused because they felt too tired. The average age of this sample was 61 yr. Of the respondents, 59 were male and 52 female. The sample of chronic fatigued patients consisted of patients who experienced severe, disabling fatigue, of definite onset, lasting for more than 12 months. Three hundred and ninety-five self-referred patients were sent a postal questionnaire.

Table I.—Results of the confirmatory factor analyses for a five-factor solution (model 1), a four-factor solution with the scales for General and Physical Fatigue combined (model 2) and a four-factor solution with the scale for General Fatigue excluded. All Chi-square data are significant at $p < 0.001$.

	Model 1			Model 2			Model 3		
	Chi^2 242 df	GFI*	AGFI	Chi^2 246 df	GFI	AGFI	Chi^2 164 df	GFI	AGFI
RT**	475.4	0.97	0.97	484.9	0.97	0.97	328.0	0.97	0.96
CF	838.7	0.97	0.96	882.0	0.97	0.96	660.0	0.97	0.96
PS	1271.2	0.99	0.99	1308.3	0.99	0.99	852.4	0.99	0.98
MD	709.2	0.96	0.95	742.2	0.96	0.95	535.4	0.96	0.94
AR	816.0	0.98	0.98	826.7	0.98	0.98	508.3	0.98	0.98

* GFI = Goodness of Fit, AGFI = Adjusted Goodness of Fit

** RT = Radiotherapy patients, CF = Chronic Fatigued patients, PS = psychology students, MD = medical students, AR = Army recruits.

Ninety per cent completed and returned the questionnaire ($n = 357$). Mean age was 39 yr. There were 89 males and 268 females. First year psychology students ($n = 481$) completed the questionnaire during an obligatory test session. The sample consisted of 146 females and 335 males with a mean age of 24 yr. All medical students who were approached during a regular course completed the questionnaire ($n = 158$). This student group had a mean age of 21 yr. It consisted of 84 males and 72 females. Forty-six junior physicians completed the questionnaire twice, before and after 5–6 wk of their first practical training in internal medicine. Mean age was 25 yr, the sex distribution was 20 males *vs* 26 females. Finally, army recruits were assessed. One group during their stay in the barracks ($n = 160$) and one group in the second week of a physically intensive militairy training program ($n = 156$). All recruits were male. Mean age was 21 yr.

Statistical procedures

An indication for the acceptability of the MFI was obtained by assessing the non-response for individual items. To assess the structure of the MFI, that is to which degree or probability the hypothesized model fitted the data, Lisrel's VII Unweighted Least Squares method was used [25]. Reported indices of the fit of the model include the Chi-square statistic, the Goodness of Fit Index (GFI) and the Adjusted Goodness of Fit Index (AGFI). A good fit is indicated by a low Chi-square statistic and a high GFI and AGFI. In our hypothetical model it was assumed that fatigue is best described by the five dimensions of the MFI, namely General Fatigue, Physical Fatigue, Reduced Activity. Reduced Motivation and Mental Fatigue. Each item was allowed to load on one factor only, but the different factors were allowed to correlate. To test for internal consistency, Cronbach's alpha coefficients were calculated for each of the resulting scales.

As an indication of construct validity, group differences were calculated using univariate analyses of variance. Using a Bonferroni-correction, the alpha per test was 0.01, to have an overall alpha of 0.05 [26]. B-Tukey procedures were performed for follow-up tests. The alpha-level for this procedure was set at 0.05. To assess convergent validity, correlation coefficients were calculated between VAS-scores and the MFI-scales.

RESULTS

Acceptability

The MFI was well accepted in both general and clinical populations. Taking all samples together, 96% of the respondents completed the MFI without omitting items. The number of missing items was equal for all five dimensions. The sample with the highest non-response was the group of radiotherapy patients; 12 patients (11%) omitted one or more items. In this sample, the highest number of missing data for an item was five (4.5%).

Structure

Table I shows that the AGFIs for the hypothesized five-factor solution are 0.96

Table II.—Cronbach's Alpha coefficients for the separate scales of the MFI for radiotherapy patients (RT), Chronic fatigued patients (CF), psychology students (PS), medical students (MD) and army recruits (AR)

	RT	CF	PS	MD	AR
General Fatigue	0.84	0.83	0.90	0.85	0.85
Physical Fatigue	0.86	0.85	0.93	0.90	0.89
Reduced Activity	0.83	0.79	0.86	0.79	0.53
Reduced Motivation	0.79	0.82	0.76	0.66	0.57
Mental Fatigue	0.77	0.91	0.87	0.93	0.82

or higher for all the samples investigated. This implies that the original five-factor model is supported by the data.

Besides the five-factor model, two alternate models were tested. In one model, the dimensions General and Physical Fatigue were combined because of the high inter-correlations between these two factors (all $rs > 0.72$). In a second four-factor model, the dimension for General Fatigue was removed. This was based on the assumption that this scale might not add any new information to the other four scales. The two alternate four-factor models turned out to be equally acceptable as the original five-factor solution. All AGFIs were 0.94 or higher (see Table I).

Reliability

Data regarding the Cronbach's alphas for the five-factor model are presented in Table II.

The MFI-scales show good (>0.80) internal consistency in the majority of cases. Reasonable (>0.65) internal consistency is obtained in most other cases. Exceptions are the scales for Reduced Motivation and Reduced Activity in the sample of army recruits, with Cronbach's alphas of 0.57 and 0.53, respectively.

Reduction of items

As we intended to have balanced scales, four items had to be removed, resulting in a 20-item version of the MFI. Removal was based on the following criteria: (1) item-residual correlations smaller than 0.50; (2) a difference between item-residual and item-scale correlations smaller than 0.10, or (3) an item-scale correlation not reaching significance at the 0.01 level. Results concerning validity of the instrument are based on the 20-item version of the instrument.

Validity

Construct validity

Between groups comparisons. Results of the univariate tests showed significant differences between groups with $p<0.001$, for all the scales. The results of the follow-up analyses are presented in Table III.

All scales appeared to discriminate between groups, but the degree to which they discriminated varied. The scale for General Fatigue showed the lowest number, the scale for Reduced Activity the highest number of group differences.

Table III.—Differences in MFI scale-scores between the samples (B-Tukey procedure, alpha = 0.05). *Significant difference, E = expected difference.

General Fatigue	Mean	(SD)	1	2	3	4	5	6	7
1. Chronic Fatigued patients	25.36	(3.9)	—						
2. Radiotherapy patients	16.24	(7.8)	*	—					
3. Soldiers (training)	16.96	(6.5)	*		—				
4. Junior physicians	15.17	(5.8)	*			—			
5. Psychology students	14.51	(6.6)	E*	E	E*	E	—		
6. Medical students	16.10	(6.8)	E*	E	E*	E	*	—	
7. Soldiers (barrack)	13.51	(6.5)	E*	E*	E*	E			—
Physical Fatigue	**Mean**	**(SD)**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1. Chronic Fatigued patients	24.11	(4.3)	—						
2. Radiotherapy patients	14.88	(6.9)	*	—					
3. Soldiers (training)	13.21	(6.8)	*		—				
4. Junior physicians	11.12	(5.5)	*	*		—			
5. Psychology students	13.16	(6.2)	E*	E*	E	E*	—		
6. Medical students	12.53	(6.3)	E*	E*	E	E		—	
7. Soldiers (barrack)	11.40	(7.1)	E*	E*	E	E	*		—
Reduced Activity	**Mean**	**(SD)**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1. Chronic Fatigued patients	20.16	(6.2)	—						
2. Radiotherapy patients	15.63	(7.8)	*	—					
3. Soldiers (training)	10.32	(3.7)	*	*	—				
4. Junior physicians	10.22	(5.1)	*	*		—			
5. Psychology students	13.20	(5.7)	E*	E*	E*	E*	—		
6. Medical students	12.30	(5.7)	E*	E*	E*	E*		—	
7. Soldiers (barrack)	11.29	(5.2)	E*	E*	E	E	*		—
Reduced Motivation	**Mean**	**(SD)**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1. Chronic Fatigued patients	15.53	(6.8)	—						
2. Radiotherapy patients	12.96	(7.5)	*	—					
3. Soldiers (training)	11.78	(5.2)	*		—				
4. Junior physicians	9.24	(4.6)	*	*	*	—			
5. Psychology students	10.43	(4.7)	E*	E*	E*	E	—		
6. Medical students	7.61	(4.0)	E*	E*	E*	E	*	—	
7. Soldiers (barrack)	10.35	(5.2)	E*	E*	E	E		*	—
Mental Fatigue	**Mean**	**(SD)**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1. Chronic Fatigued patients	19.70	(7.0)	—						
2. Radiotherapy patients	10.06	(6.1)	*	—					
3. Soldiers (training)	13.54	(6.2)	*	*	—				
4. Junior physicians	10.97	(6.0)	*		*	—			
5. Psychology students	15.25	(6.0)	E*	E*	E	E*	—		
6. Medical students	14.70	(7.7)	E*	E*	E	E*		—	
7. Soldiers (barrack)	12.07	(7.3)	E*	E	E	E	*	*	—

Higher scores for CFS-patients as compared to those of students and soldiers in the barracks were expected. Also expected were the higher scores of radiotherapy patients on Reduced Activity, Physical Fatigue and Reduced Motivation as compared to students. However, cancer patients and students did not differ on General Fatigue and scores of patients were even lower on Mental Fatigue.

Table IV.—Univariate *F*-tests for group-differences on subscales of the MFI. Alpha = 0.01

	General Fatigue	Physical Fatigue	Reduced Activity	Reduced Motivation	Mental Fatigue
Psychology students with vs students without prior exceptional activity (df 1,473)					
F-ratio	44.544	18.767	0.131	5.555	4.420
p-value	0.000	0.000	0.909	0.019	0.036
Soldiers during barrack-life vs soldiers during Training (df 1,314)					
F-ratio	20.408	5.759	3.535	6.652	3.882
p-value	0.000	0.017	0.061	0.010	0.050
Pre- vs post-test of junior physicians (df 1,45)					
F-ratio	22.762	7.752	0.755	2.078	3.138
p-value	0.000	0.013	0.389	0.156	0.083

We assumed that junior physicians and soldiers, both during their training periods, would score higher than the students and the soldiers during barrack-life. For soldiers, these expectations were confirmed for General Fatigue only, and partly for Reduced Motivation; no differences were found for Physical and Mental Fatigue, while students had even higher Reduced Activity scores than soldiers in training. Junior physicians were, contrary to our expectations, no more fatigued, and for some scales even less fatigued, than comparison groups.

Within groups comparisons. Table IV shows the results of the comparisons within groups and between conditions. Significant differences in the direction expected are obtained for General and Physical Fatigue between psychology students who did and did not report fatiguing activities during the previous days.

Differences between conditions. We expected that army recruits under barrack-life would have lower scores than soldiers during a military training program. The results presented in Table IV show that this expectation was confirmed for General Fatigue and Reduced Motivation. but not for the remaining three scales.

Finally, in junior physicians, the fatigue scores were expected to be lower before than during their first practical internal medicine training. The results indicate that a significant difference was obtained only for General Fatigue.

Convergent validity

As expected, all correlations obtained in the group of radiotherapy patients between the VAS-fatigue scores on the one hand and the MFI-subscales on the other were significant. They range from 0.77 for General Fatigue, 0.70 for Physical Fatigue, 0.61 for Reduced Activity, 0.56 for Reduced Motivation (all with $p<0.001$) to 0.23 for Mental Fatigue ($p<0.01$).

DISCUSSION

The MFI was developed as a tool to assess fatigue in a comprehensive way, with a special interest in fatigue as experienced by patients. It was our intention to

construct a short, easy to administer questionnaire that would nevertheless provide information on the nature of the experience, and its intensity.

Structure

The hypothetical five-factor model that had guided the choice of items fitted the data in all the samples tested. Two alternate four-factor models turned out equally acceptable: a model in which the dimensions General and Physical Fatigue were combined, and a model in which the dimension General Fatigue was removed.

Although one should preferably choose the most parsimonious solution, we decided to retain the five-factor structure until more information on the behaviour of the separate scales in relation to other constructs is available. If it turns out that using both General and Physical Fatigue does not provide additional information, these two scales may be combined.

Internal consistency

The scales of the MFI show reasonable to very good internal consistency in most samples, except for Reduced Activity and Reduced Motivation in the group of army recruits. An explanation for the unsatisfactory reliability coefficients in soldiers might be found in their specific circumstances. Possibly, the content of the items in these scales does not reflect this situation, which is highly structured and leaves little room for own motivational factors in the initiation of activity. This may have resulted in an inconsequent response pattern.

Validity

The results, by and large, support the validity of the MFI. The instrument can detect expected differences in fatigue between groups. within groups and between conditions. Some expectations, however, were not fulfilled and need further clarification. For instance, the group difference between the scores of the radiotherapy patients and the students is smaller than initially anticipated for General Fatigue. No satisfactory explanation is available for this finding. It may, however, be accounted for in part by what appeared to be a rather intensive social life of the student populations. This may have taken its toll in a general experience of fatigue, however, without an increase in physical fatigue or a decrease in activity or motivation.

Another unexpected finding was the comparatively low scores of junior physicians and army recruits during their respective training periods. Typical for the circumstances of both groups is that they find themselves in situations that require great effort. This increase of effort may result in a general experience of fatigue which is not expressed in a reduction of activity, motivation or cognitive functioning. It may also be hypothesized that individuals in these structured situations only feel tired at short moments during the day, for example before going to bed. The MFI is probably less suited for assessment of this kind of fatigue. A final explanation may be that it is socially undesirable for these individuals to report fatigue in general, or to report specific attributes of fatigue such as physical exhaustion in soldiers or concentration problems in junior physicians.

The results obtained with the subgroups of psychology students differing in activity level, the scores of the two groups of soldiers, and the repeated measurement in junior physicians, all show that the scale for General Fatigue is more sensitive than

the other scales to differences in fatigue resulting from changes in circumstances. Reduced Activity appears to be the least sensitive. Only when fatigue is intense and chronic, as in disease, may a reduction in activity emerge. When it is of relatively short duration, and can be restored with rest, fatigue might not be expressed in a reduction of activity.

Finally, convergent validity is satisfactory. However, the comparatively low correlation between the visual analogue scale and the scale for Mental Fatigue in the group of radiotherapy patients requires explanation. Radiotherapy patients also score lowest on Mental Fatigue as compared to the other groups. A tentative explanation might be based on the relative age of this group of respondents, which is much higher than in any of the other groups. It could be argued that the elderly are more reluctant to admit any difficulties with their cognitive abilities. An alternative explanation is that older individuals have a frame of reference for cognitive functioning that differs from that of younger persons, and consequently notice fewer difficulties.

As for the interrelationship between the separate scales, this was closest between the scales General Fatigue and Physical Fatigue. Both scales showed consistent and distinct differences between groups, within groups, and between conditions, according to expectations. Given the apparent sensitivity of General Fatigue for changes in fatigue levels, it could be argued that when a short instrument is required only this scale should be used. The sensitivity results on Physical Fatigue were regarded as non-significant. However, because of the application of a Bonferroni-correction, testing has been somewhat conservative. With larger groups this scale would probably have confirmed the expectations. The patient groups differed from the comparison groups as expected on the scale for Reduced Activity. They scored significantly higher. The soldiers and junior physicians after training, however, scored lower than the other groups, which was unexpected. The scale Reduced Motivation behaved as expected in most tests. The scores on this scale were unexpectedly low in radiotherapy patients and in junior physicians after training. As far as conclusions may be drawn from the groups in this study, it is somewhat doubtful whether the scale Mental Fatigue validly reflects fatigue.

Given the prevalence and sometimes serious consequences of fatigue, research efforts aimed at developing a reliable and valid instrument for assessment are essential. It is anticipated that this line of research will contribute to a better understanding of fatigue, its prevalence, characteristics, course and correlates. An understanding of the likelihood of fatigue in a given condition—and its severity and accompanying symptoms—can enhance the health professional's ability to evaluate individual cases, inform patients, and plan and evaluate therapy.

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