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Measuring fatigue among women with Sjögren's syndrome or rheumatoid arthritis: a comparison of the Profile of Fatigue (ProF) and the Multidimensional Fatigue Inventory (MFI)

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Abstract

Background: Fatigue is common in both Sjögren's syndrome (SS) and rheumatoid arthritis (RA) and can restrict functioning.

Aims: We tested whether fatigue has multiple aspects among women with SS or RA.

Methods: The 16-item Profile of Fatigue (ProF) and the 20-item Multidimensional Fatigue Inventory (MFI) were completed by 82 White-British women aged 35-79 years (mean 60.4); 34 were diagnosed with SS for a mean of 7.0 years and 48 were diagnosed with RA for a mean of 14.5 years. The ProF measures four somatic 'facets' of fatigue and two mental 'facets'; the MFI contains four somatic 'dimensions' and one mental 'dimension'. The structures of the items from both measures were tested by principal component factor analysis using varimax rotation.

Results: No significant differences in fatigue were found between the women with SS or RA. Five factors explained a total of 76% of the variance of the MFI; six factors explained 94% of the ProF. Mental fatigue items from both questionnaires loaded onto separate factors from somatic fatigue items; the two original facets of mental fatigue in the ProF were replicated. The four somatic fatigue facets of the ProF were generally replicated but the somatic dimensions of the MFI did not replicate as clearly. Equivalent facets/dimensions correlated well between the two questionnaires ($r \geq 0.65$).

Conclusions: Both the ProF and the MFI distinguish between somatic and mental fatigue in SS and RA but the ProF appears better at resolving somatic facets of fatigue.

Introduction

Fatigue has been described as somatic and mental exhaustion that interferes with a person's ability to carry out physical and cognitive activities and can be persistent and overwhelming (Piper, 1989). Chronic fatigue is a prominent symptom of many autoimmune rheumatic diseases, including Sjögren's syndrome (SS) (Godaert et al., 2002) and rheumatoid arthritis (RA) (Pollard et al., 2006). This chronic fatigue differs from normal fatigue when healthy that is 'earned' by being physically and/or cognitively active (Hewlett et al., 2005b). It has been suggested that psychological measurement has to be used to assess fatigue as it is inherently a cognitive-behavioural phenomenon that is not reducible to physiological states (Meek et al., 2000). Indeed, fatigue has been raised as an important outcome by a considerable proportion of RA patients in a UK multicentre study (Hewlett et al., 2005a) and has been argued to be a better indicator of SS patients' functioning than biological tests such as erythrocyte sedimentation rate or levels of haemoglobin or antinuclear antibodies (Barendregt et al., 1998).

Quantitative answers to a set of questions succeed in measuring a psychological state or process only when the scores form a psychometrically reliable and valid scale (Anastasi & Urbina, 1997; Robinson et al., 1991). This is especially relevant to patient-assessed health outcomes such as fatigue (Kirwan et al., 2005). A scale with good psychometric properties first has face or content validity: that is, the question items that cover the relevant aspects of the issue as judged by involved parties, who are the patients in the case of chronic fatigue. The question items within a scale also must be answered consistently with each other (internal reliability), as judged by analyses such as item-total correlations or Cronbach's α. By these internal criteria of validity, a questionnaire

may have two or more distinct scales which are identified by atheoretical exploratory or hypothesis-confirmatory factor analyses. It is also important to compare a scale to other scales of the same concept (convergent validity) and to scales of concepts that are hypothesised to be unrelated (divergent validity). Contrasts between groups known to differ on levels of the concept in question provide discriminant validity.

Smets et al. (1995) developed the Multidimensional Fatigue Inventory (MFI) to assess five aspects of fatigue that they noted in existing literature on illness. Evidence in support of its validity was provided following completion by patients with cancer or chronic fatigue syndrome and by students, junior physicians and army personnel. The MFI has also been used to assess fatigue in a variety of other illnesses (Breslin et al., 1998; Lou et al., 2001; Minderhoud et al., 2003; Smets et al., 1996; Unal et al., 2001; van Tubergen et al., 2002) including SS (Barendregt et al., 1998; Godaert et al., 2002) and RA (Barendregt et al., 1998).

Smets et al. (1995) reported that the MFI can distinguish five 'dimensions' of fatigue that they created to reflect factors from previous questionnaire studies and named General Fatigue, Physical Fatigue, Reduced Activity, Reduced Motivation and Mental Fatigue. These five dimensions have been further supported by principal components analysis of the responses of cancer patients by Meek et al. (2000): a five-factor structure explained 74% of the variance, although the item loadings were reported to differ from those of Smets et al. (1995); no detail was presented regarding these differences. However, the internal consistency was good for four of the dimensions (Cronbach's $\alpha >$ 0.80) and acceptable for Reduced Motivation ($\alpha = 0.71$) (Meek et al., 2000, using the criteria of 'good' and 'acceptable' given by Robinson et al., 1991).

Barendregt et al. (1998) found that patients with SS or RA had higher scores than their healthy controls on all five dimensions of the MFI, although they did not retest the structure or internal consistency of factors which is important given the differences in structure reported by Meek et al. (2000). Furthermore, the scores of patients with SS were significantly higher than those with RA for General Fatigue and Mental Fatigue, although this difference disappeared when symptoms of depression were controlled for. In another study, Godaert et al. (2002) reported that only General Fatigue and Physical Fatigue were significantly greater for patients with SS than healthy participants. Such distinctions among dimensions of the MFI add support to the view that fatigue is not a unitary phenomenon and so its assessment must be multidimensional if the symptomatology of chronic fatigue is to be better understood and managed.

It is important to use a measure that not only captures the diversity of fatigue but describes symptoms that are specific to fatigue and not caused by symptoms characteristic of the disease group measured. Certain items of the MFI, such as "Physically I feel I am in bad condition", could be confounded by inflammatory symptoms in both SS and RA.

In order to increase the content validity of quantitative assessment of fatigue in patients with SS, Bowman et al. (2003, 2004a) utilised the qualitative technique of allowing patients with SS to provide their own accounts of variations in fatigue and other clinical features of the disease as the sole basis of the wordings of the items in a new questionnaire tool. As mentioned by Bowman et al. (2004a) for as yet unpublished data on single-phrase question items (long form), the resulting Profile of Fatigue and

Discomfort (ProFaD) contained six 'facets' of fatigue (comprising a separable Profile of Fatigue from the Profile of Discomfort) which formed two overarching 'domains': the domain of Somatic Fatigue contained the facets Need Rest, Poor Starting, Low Stamina and Weak Muscles while the facets of Poor Concentration and Poor Memory formed the domain of Mental Fatigue. The somatic and mental domains were replicated in the short form of ProF in which each facet is represented by a single question combining all the phrases of the items in that facet (Bowman et al., 2004a). When the single-phrase items of the long form of the ProF were translated into Swedish by Strömbeck et al. (2005), the construct validity of the six facets was supported among patients with SS and healthy controls. In addition, 70% of these Swedish patients reported that the ProF items adequately described their experience of fatigue. In this paper we retain the labels 'domains' and 'facets' for the hierarchically arranged subscales of the ProF to distinguish them from the 'dimensions' of the MFI.

Similarly to findings by Barendregt et al. (1998) and Godaert et al. (2002) with the MFI, Bowman et al. (2004a) found that patients with SS rated the severity of their fatigue on all six facets of the Profile of Fatigue (ProF) to be significantly greater than did healthy participants, while patients with RA rated only the four somatic facets as significantly more severe than healthy participants. Patients with RA rated greater fatigue also than patients with SS on three facets within the Somatic Fatigue domain: Poor Starting, Low Stamina and Weak Muscles. All of these differences remained statistically significant after controlling for age, depression and anxiety.

To assess convergent validity, Bowman et al. (2004a) compared scores on the ProF to the fatigue components of two generic instruments for health-related quality of life, the

Medical Outcome Study Short-Form 36 (SF-36; Ware et al., 1993) and the brief form of the World Health Organization's cross-cultural quality of life questionnaire (WHOQOL-BREF; The WHOQOL Group, 1998). Scores from patients with SS, RA or systemic lupus erythematosus (SLE) and healthy participants correlated strongly between the somatic facets of the ProF and both the SF-36 Vitality scale and the WHOQOL-BREF Physical domain. Strömbeck et al. (2005) also found that the somatic facets of the ProF, after translation into Swedish, correlated well with the SF-36 Vitality scale and with a single-item fatigue score in patients with SS and in healthy controls.

In summary, these findings support the use of the ProF as a multifaceted assessment of fatigue in SS, RA and SLE. However, it is important to provide further evidence of convergent validity by comparing the ProF with a multidimensional measure of fatigue that has been previously administered to patients with rheumatic disease. The present study therefore aimed to assess the convergent validity of the ProF with the MFI in SS and RA and to test Bowman et al.'s (2004a) assertion that distinct facets of the ProF closely parallel MFI dimensions. These measures have not previously been psychometrically assessed concurrently. It was hypothesised that both the ProF and the MFI would demonstrate their original multifactorial nature with strong associations occurring between the equivalent facets/dimensions: Need Rest (ProF) with General Fatigue (MFI), Weak Muscles (ProF) with Physical Fatigue (MFI), Low Stamina (ProF) with Reduced Activity (MFI), Poor Starting (ProF) with Reduced Motivation (MFI) and both mental fatigue facets of the ProF, Poor Concentration and Poor Memory, with the MFI's single Mental Fatigue dimension. The limited number of patients available made it desirable to combine data from SS and RA and so it was important to see if the weak

evidence that patients with RA rate their somatic fatigue as greater than patients with SS was replicated in this sample.

Method

Participants

For the sake of homogeneity of the sample, only White-British women were included since they currently represent the great preponderance of diagnoses in the UK of SS (Bowman et al., 2004b) and RA (Symmons et al., 2002). Given that the primary aim of the present study was to provide further evidence of the reliability and validity of the 16 item ProF, we based our sample size estimate on the need to have a minimum of five participants per item in factor analyses (Tabachnick & Fidell, 2000). We therefore required analyses of data from at least 80 participants to meet this criterion.

Forty-four patients attending Rheumatology clinics at University Hospital Birmingham with an existing diagnosis of primary SS fulfilling the American-European Consensus Criteria (Vitali et al., 2002) were invited to participate in this study; 34 of these patients (77%) agreed to participate and returned completed questionnaires. Participants' ages ranged from 35 to 76 years (mean 58.9, SD 9.6). The duration of the rheumatic disease (years since medical diagnosis) in these patients ranged from 1 to 20 years (mean 7.0, SD 5.0). There were no significant differences between participants and patients who chose not to take part in age [$t(42) = 0.62$, $p = 0.55$] or duration of disease [$t(42) = 0.04$, $p = 0.97$].

Ninety patients with an existing diagnosis of RA (but not secondary SS) fulfilling the American College of Rheumatology criteria (Arnett et al., 1988) were also invited to

participate in this study; 48 of these patients (53%) returned completed questionnaires. Participants' ages ranged from 36 to 79 years (mean 61.5, SD 11.6). Duration of the disease ranged from 1 to 39 years since diagnosis (mean 14.5, SD 8.9). As with the SS sample there were no significant differences between participants with RA and the patients who chose not to participate in either age [$t(88) = -0.67$, $p = 0.50$] or duration of disease [$t(88) = -1.54$, $p = 0.13$].

The mean age of all 82 respondents was 60.4 years (SD 10.8) and the mean duration of their illness was 11.2 years (SD 8.3). There was no significant difference in ages between the SS and RA samples [$t(80) = -1.08$, $p = 0.29$] but the duration of the disease was significantly longer in the RA sample than in the SS sample (means given above), $t(80) = -4.76$, $p < 0.001$.

Procedure

Patients who attended the Sjögren's clinic at the University Hospitals Birmingham were informed of the nature of this study and invited to participate. The questionnaires were distributed in two ways to those who consented. Participants who attended the monthly Sjögren's clinic during the study period were given the questionnaire packs during their clinic visit; the packs were posted to the other participants. Patients with RA were sent a written invitation to take part in this study; those who agreed to participate were then posted the questionnaire pack. All participants answered the questionnaires at home and returned the completed forms in the pre-paid envelope provided. Multicentre Research Ethics Committee approval was gained and all of the participants gave informed consent in writing before providing data.

Measures

Each questionnaire pack contained the long form of the ProFaD (Bowman et al., 2004a) and the MFI (Smets et al., 1995), together with other questionnaire instruments, the results from which are to be reported elsewhere. The ProF and the MFI were stapled separately and therefore not necessarily answered in a set order.

The long form of the ProF contains 16 items across six fatigue-related facets: Need Rest (NR; four items), Poor Starting (PS; three items), Low Stamina (LS; three items) and Weak Muscles (WM; two items) form the domain of Somatic Fatigue (i.e. 12 items in total in this domain) while Poor Concentration (PC; two items) and Poor Memory (PM; two items) form the domain of Mental Fatigue (i.e. four items in total in this domain). In each item, the respondent is invited to rate level of fatigue during the past two weeks. All items use the eight numerals 0 to 7 as response options, with 0 labelled 'no problem at all' and 7 'as bad as imaginable'. The numbers chosen for items within a specific facet are averaged and so the facet scores can range from 0 to 7, where 0 indicates lack of fatigue. The four somatic fatigue facet scores are averaged to create a score for the domain of Somatic Fatigue. The same procedure is applied the two facets in the Mental Fatigue domain. Finally, an overall fatigue score is created by averaging these two domain scores. All scores therefore remain within the 0-7 range (see Figure 1).

The MFI is a 20-item self-report questionnaire that covers five different aspects of fatigue; these are General Fatigue (GF), Physical Fatigue (PF), Reduced Activity (RA), Reduced Motivation (RM), and Mental Fatigue (MF). Each aspect is represented by four items, two of which indicate fatigue and two of which are contradictory of fatigue (and hence are reverse-scored). For each item, participants are asked to consider how

they have felt "lately" and to rate the statement in one of five boxes running from the anchors of "yes that is true" (scored 5) to "no, that is not true" (scored 1). MFI dimension scores therefore range from 4 to 20.

Statistical analyses

One-way multivariate analyses of variance (MANOVAs) in the multiple fatigue scores were conducted between disease groups for the five MFI dimensions, the six ProF facets and the two ProF domains (Somatic and Mental Fatigue), with a priori planned t-tests between each individual facet or domain of differences in scores between the two patient groups.

Principal components analysis (PCA) with varimax rotation was used to ascertain the factor structures of responses to the ProF and the MFI in the combined samples of women with SS or RA. Separate PCAs were run for the ProF and the MFI with varimax rotation of the same number of factors as in the originally reported structures (i.e. six for the ProF and five for the MFI). We describe an item as loaded on a factor if the loading is 0.5 or greater; this criterion provides patterns that avoid items loading on multiple factors if a lower criterion is used and avoid items loading on no factors with a higher criterion.

Convergent validity of the questionnaires was assessed in two ways, firstly by conducting PCA on the combined items of both measures and secondly with Pearson's product-moment correlations between each the six facets of the ProF and the matching dimensions of the MFI. Fisher's z transformation (Howell, 2003) was used to assess if

one correlation was significantly greater than another. The internal consistency of each facet/dimension was assessed using Cronbach's α.

Results

Severity of facets/dimensions of fatigue in SS and RA

Participants' ratings of their fatigue severity on the ProF (up to 7 for "extremely") indicated a moderate to high level of fatigue, from a mean of 2.94 for Poor Memory in SS to 4.64 for Low Stamina in RA (Figure 1). Participants with SS did not rate their fatigue significantly differently from participants with RA between the ProF domains of Somatic Fatigue and Mental Fatigue [$F(2, 79) = 0.61$, $p = 0.55$] or across the more specific individual somatic and mental facets of the ProF [$F(6, 75) = 1.23$, $p = 0.30$] which form these domains. In analyses of the individual facets, the participants with RA gave a higher mean score for weak muscles as more severe (mean 4.28, SD 1.84) than did participants with SS (mean 3.50, SD 2.03) but this difference did not reach statistical significance, $t(80) = 1.81$, $p = 0.07$.

The participants' ratings in the MFI also indicate a moderate to high level of fatigue (Figure 2). The mean overall total score for fatigue (out of 100) was 62.71 (SD 18.85) for participants with SS and 65.23 (SD 18.34) for participants with RA ($t(80) = 0.61$, $p = 0.55$). Mean scores for dimensions of the MFI (out of 20) ranged from 10.73 for Reduced Motivation in RA to 15.58 for General Fatigue in RA. Again, participants with SS did not score significantly differently from participants with RA across the dimensions of the MFI ($F(5, 76) = 1.00$, $p = 0.43$).

Given the lack of reliable differences in scores between the two disease groups, all the data could be combined in each factor analysis.

Factor structure of the ProF

The six-factor rotation to test the original structure of the ProF explained 94% of the variance in all the responses, although Factor 6 had an eigenvalue less than 1 (Table 1). All sixteen items had at least one loading above 0.52 and all but one item above 0.63. The highest loading (0.64-0.87) of each item was on a factor with the highest loading of all the other items of the original facet of ProF, except nearly identical loadings (just above 0.5) for "Hard to get going" on Factors 1 and 4.

The items of the four somatic facets loaded most highly onto three factors (1, 3 and 4), with the facets Need Rest and Low Stamina not being separated (Table 1). These factors were fully differentiated from Factors 2 and 5, on which items from the mental facets loaded highly.

However, the distinction between Poor Concentration and Poor Memory was not complete**:** the items of Poor Concentration also weakly associated with the items of Poor Memory. The structure of the original ProF was thus well supported. The internal consistency of each of the six facets was also excellent: each had $\alpha > 0.90$ (Table 4).

Factor structure of the MFI

The five-factor rotation to test the five dimensions of the MFI explained a total of 76% of the variance (Table 2) with all factors having eigenvalues greater than 1. However, the responses to the question items of each original dimension did not all load clearly

onto the same one of the five factors. The most distinct dimension was that of Mental Fatigue, with responses to all four items loading above 0.7 onto Factor 2 with no item from another dimension. All the items from General Fatigue and Physical Fatigue loaded above 0.5 onto a single factor and they were accompanied by the Reduced Activity items 'very active' and 'get little done'. This factor therefore provides partial support for an overarching construct of somatic fatigue. However, the item 'get little done' loaded slightly more strongly onto Factor 3 with the other Reduced Activity items 'do a lot in a day' and 'do very little in a day'. The items forming the Reduced Motivation dimension did not load together on a single factor. Rather, the Reduced Motivation item 'lots of plans' loaded separately from all other items onto Factor 5, while the item 'want to do nice things' did not load above 0.5 on any factor.

Despite these slight deviations from the original dimensions of the MFI, there was good internal consistency among the items originally assigned to each dimensions (Table 4). The only dimension with $\alpha < 0.80$ was Reduced Motivation.

Combined factor structure of the MFI and ProF

When the responses to the twenty items of the MFI were included with the sixteen ProF responses in a principal components analysis with six factors rotated, each factor had an eigenvalue greater than 1 and the solution explained 79% of the variance (Table 3).

The ProF's domain of Somatic Fatigue was fully supported by all its items and no Mental Fatigue items loading onto the first factor (Table 3). However, this performance did not distinguish among the domain's four facets, Need Rest, Poor Starting, Low Stamina and Weak Muscles, as the ProF did without statistical interactions with MFI

items (Table 2). In contrast, only the MFI items from Physical Fatigue, the majority of items in General Fatigue and one item from Reduced Activity had loadings above 0.5 on this factor (Table 3). The General Fatigue item 'rested' did not load above 0.5 on any factor, although it did load most heavily on this first factor. The Reduced Motivation items of the MFI again did not load cohesively onto a single factor; instead, they each loaded above 0.6 on factors separate from all other fatigue items.

The items of the ProF's two Mental Fatigue facets and the MFI's dimension of Mental Fatigue all loaded on a single factor (Table 3). Thus, again, analysis of the ProF in combination with the MFI obscured distinctions between facets achieved by patients' own words used in the ProF.

The MFI Mental Fatigue item 'keep my thoughts' loaded above 0.5 with three of the four items in the MFI's Reduced Activity dimension; these loadings were similar when the MFI was analysed alone (Table 2). This indicates these three items may be ambiguous between somatic activity and mental activity.

Relations between ProF facets and MFI dimensions

The concurrent validity of the six ProF facets and the five MFI dimensions was further tested by correlating the scores of related facets/dimensions (Table 4). Correlation coefficients for the matching facets/dimensions were all at least 0.65 ($p < 0.001$). The Mental Fatigue dimension of the MFI correlated more strongly with the Poor Concentration facet of the ProF ($r = 0.83$) than with the Poor Memory facet of the ProF with the Mental Fatigue dimension ($r = 0.65$), $z = 2.59$ for difference in r, $p < 0.01$.

Discussion

The findings from the present study reaffirm the previously reported factor structure of the ProF and partly support the original item assignments of the MFI. Principal components analyses of both separate and combined sets of data supported the split between domains of somatic and mental fatigue in both the ProF and the MFI.

However, the two instruments performed differently with regard to separate subscales within somatic fatigue and mental fatigue. Several MFI somatic items loaded upon factors different from the dimensions to which they were assigned by Smets et al. (1995). In addition, an item in the single Mental Fatigue dimension of the MFI loaded on the same factor as some somatic fatigue items. In contrast, the two mental fatigue facets of the ProF, Poor Memory and Poor Concentration, were replicated in the analysis of items solely from the ProF. Furthermore, when MFI item responses were put into the same analysis as responses to the ProF, Poor Memory and Poor Concentration were conflated into a single factor containing all mental fatigue items. The distinction between somatic facets of the ProF was also lost the combined analysis including MFI items. That is, the distinctions within chronic fatigue in SS and RA resolved by the ProF were blurred by the MFI.

This study's six-factor rotation of responses to the ProF by SS and RA patients combined did not replicate the previously observed distinction between the somatic facets Need Rest and Low Stamina in separate analyses of data from SS, RA or SLE (Bowman et al., 2004a; Strömbeck et al., 2005). It may be that responses to these facets' items do not perform in the same way in patients with RA as in patients with SS and combining their data forces these two facets' items' concepts into one less precise

construct. Several wordings of in the facets Need for rest and Lack of stamina provided by patients with SS in the initial qualitative work for the ProF (Bowman et al., 2004a) resemble the description of fatigue as 'wipe out' in the subsequent qualitative study by Hewlett et al. (2005b). Participants with SS or RA in the present study rated these two ProF facets as their most severe fatigue, as they did for the MFI dimensions of General Fatigue and Physical Fatigue, which also overlapped in five-factor rotation of the MFI in SS and RA combined.

The Reduced Motivation dimension of the MFI was the only one demonstrating internal consistency that was borderline acceptable in the present study, reaffirming the pattern seen in cancer (Meek et al., 2000). These items were also rated the least severe by both SS and RA patients. These items' concepts may diverge from fatigue itself; for instance, low motivation could be related to mood rather than to lack of physical capability. Fatigue may make activities more difficult but it does not necessarily influence the inclination to undertake them.

Bowman et al. (2004a) found that, after controlling for age, depression and anxiety, patients with RA rated their fatigue as somewhat more severe than patients with SS did across the Poor Starting, Low Stamina and Weak Muscles facets of the ProF. There were signs of a worse experience of Weak Muscles for patients with RA in the present study without these controls. No differences were found between patients with RA or SS for any of the dimensions of the MFI. With the MFI, Barendregt et al. (1998) did find that patients with SS rated their General Fatigue and Mental Fatigue as more severe than those with RA but not once depression was controlled for. Any increase in muscular fatigue specific to RA therefore appears to be small at most.

The present study tested the claim by Bowman et al. (2004a) that the distinct facets of fatigue captured by the ProF closely parallel the dimensions of fatigue in the MFI. The claim was well supported not only by combined principal components analyses (showing items from the two instruments to load on the same factors) and also by direct correlation between facet/dimension scores from the different instruments. However the current data do not account for depression which may have been particularly associated with respondents' ratings of Poor Starting or Reduced Motivation. Nevertheless, the present results did not follow the pattern in aspects of fatigue that has previously been attributed to depression (Barendregt et al., 1998).

Any conclusions drawn from the present study are tentative as the present samples were relatively small in comparison to the number of items analysed. Moreover, there may have been differences in fatigue between the participants and those who were invited to take part but declined. The limited number of participants also prevented separate factor analyses of RA and SS patients' responses with this study. However, as no significant differences were found between respondents with the different diagnoses on any of the facets/dimensions, the results from the combined groups are unlikely to be attributable to group mean differences.

The ProF and the MFI were stapled separately in this study and so participants may have differed in the sequence in which they answered the two questionnaires. Psychometrically more robust results would be obtained by randomising the order of presentation of scales and items within each scale.

A major limitation of the present study and other published studies on both the ProF and the MFI, and most other health-related quality of life instruments, is that assessments are made only once. Both questionnaires ask participants to evaluate their symptoms over a specified period of time. Godaert et al. (2002) highlighted the fact that such single aggregated assessments cannot reflect the dynamics of the experience of fatigue, The scores may be influenced by 'response shift' (Carr, 2002). More specifically, Stone et al. (1997) found that people with RA reported moderate levels of fatigue upon waking which declined between 10am and noon and then increased during the remainder of the afternoon and evening. The original elicitation of wordings for the ProF was by diary at three times of day (Bowman et al., 2003, 2004a), increasing the possibility that the instrument is sensitive to such variation. We are currently using the question items in the ProF as a state measure at different times of day, because such data are essential to a clearer understanding of chronic fatigue in rheumatic disease.

The present study followed the participant inclusion criteria of Bowman *et al*. (2004a) and so the data come just from white women above the age of 35. Consequently, these results by themselves cannot be generalised to a wider population. Research is needed to assess the validity of the ProF as a measure of fatigue in men with rheumatic disease, in other ethnic groups and in other conditions involving chronic fatigue. The ProF also needs to be tested for sensitivity to change following an intervention targeted at reducing fatigue in rheumatic disease.

In summary, the present study's findings replicated the similarities in factor structure of both the ProF and MFI relatively well and demonstrated good internal consistencies and strong relationships between the equivalent subscales of the two measures. Both

measures can provide a comprehensive assessment of fatigue to evaluate progress alongside physiological measures for patients with SS and RA. This supports their validity and continued use in future research, although the ProF provides somewhat more distinct subscale scores, perhaps because it is based completely upon patients' words.

Authors' note

A manual describing the Profile of Fatigue and Discomfort (ProFaD), including both long and short forms is available on request from Prof. David Booth at D.A.Booth@Bham.ac.UK

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TABLE 1. Loadings of items onto principal components and the variances they account for in six-factor rotation of responses to the 16 items of the ProF

Item (abbreviated)	Domain	Facet	Factor loadings					
			1	2	3	4	5	6
Need to rest	Somatic	NR	**0.70**	0.20	0.32	0.30	0.30	0.34
Tired	Somatic	NR	**0.81**	0.32	0.29	0.27	0.21	0.09
Exhausted	Somatic	NR	**0.71**	0.18	0.39	0.31	0.28	-0.22
Need to sleep	Somatic	NR	**0.82**	0.25	0.24	0.22	0.26	-0.11
Hard to get going	Somatic	PS	**0.53**	0.31	0.42	**0.50**	0.25	-0.06
Taking effort	Somatic	PS	0.46	0.29	0.39	**0.69**	0.17	0.08
It's a battle	Somatic	PS	0.47	0.31	0.32	**0.70**	0.22	0.00
Hard to keep going	Somatic	LS	**0.64**	0.30	0.42	0.44	0.13	0.06
Easily worn out	Somatic	LS	**0.76**	0.33	0.37	0.31	0.17	0.02
Lack of energy	Somatic	LS	**0.71**	0.31	0.44	0.29	0.17	0.16
Lack of muscle strength	Somatic	WM	0.33	0.21	**0.83**	0.30	0.17	0.00
Feeling weak	Somatic	WM	**0.50**	0.18	**0.78**	0.22	0.10	0.05
Not thinking clearly	Mental	PC	0.32	**0.55**	0.14	0.20	**0.71**	0.02
Hard to concentrate	Mental	PC	0.38	**0.54**	0.21	0.20	**0.67**	0.03
Forgetting things	Mental	PM	0.24	**0.87**	0.12	0.20	0.22	0.09
Making mistakes	Mental	PM	0.25	**0.86**	0.24	0.19	0.20	-0.07
Variance accounted for (R^2)			0.33	0.19	0.17	0.14	0.10	0.02

Items in bold loaded > 0.49; ProF: Profile of Fatigue; NR: Need Rest; PS: Poor Starting; LS: Low Stamina; WM: Weak Muscles; PC: Poor Concentration; PM: Poor Memory

TABLE 2. Loadings of items onto principal components and the variances accounted for in five-factor rotation of responses to the 20 items of the MFI

Item (abbreviated)	Order	Dimension	Factor loadings				
			1	2	3	4	5
Fit	1	GF	**0.80**	0.26	0.24	0.10	0.05
Tired	5	GF	**0.73**	0.15	0.07	0.35	0.15
Rested	12	GF	**0.59**	0.48	0.14	0.20	0.04
Tire easily	16	GF	**0.70**	0.17	0.14	0.29	-0.03
Do little	2	PF	**0.77**	0.16	0.03	0.37	-0.05
Take on a lot	8	PF	**0.76**	0.19	0.21	0.12	0.14
Physically bad condition	14	PF	**0.65**	0.18	0.26	0.21	0.03
Physically excellent condition	20	PF	**0.85**	0.14	0.22	-0.03	0.10
Very active	3	RA	**0.81**	0.18	0.30	0.20	0.18
Do a lot in a day	6	RA	0.45	0.22	**0.74**	-0.02	0.05
Do very little in a day	10	RA	0.24	0.14	**0.85**	0.23	0.14
Get little done	17	RA	**0.53**	0.31	**0.55**	0.43	0.02
Want to do nice things	4	RM	0.49	0.33	0.28	0.08	0.17
Dread doing things	9	RM	0.43	0.20	0.22	**0.68**	-0.06
Lots of plans	15	RM	0.16	0.07	0.14	0.12	**0.93**
Don't feel like doing anything	18	RM	0.23	0.21	0.08	**0.80**	0.26
Keep my thoughts	7	MF	0.10	**0.77**	0.42	-0.06	0.09
Concentrate well	11	MF	0.37	**0.76**	-0.03	0.13	0.17
Effort to concentrate	13	MF	0.28	**0.80**	0.09	0.34	-0.10
Thoughts easily wander	19	MF	0.15	**0.86**	0.14	0.16	0.02
Variance accounted for (R^2)			0.32	0.17	0.11	0.10	0.06

Items in bold loaded > 0.5; MFI: Multidimensional Fatigue Inventory; GF: General Fatigue; PF: Physical Fatigue; RA: Reduced Activity; RM: Reduced Motivation; MF: Mental Fatigue

TABLE 3. Loadings of items onto principal components in a six-factor rotation of responses to the 36 items of the ProF and MFI

Item (abbreviated)	Facet or dimension	Factor loadings					
		1	2	3	4	5	6
Need to rest	NR-ProF	**0.75**	0.30	0.12	0.09	0.41	-0.04
Tired	NR-ProF	**0.78**	0.37	0.16	0.16	0.30	0.03
Exhausted	NR-ProF	**0.79**	0.36	0.08	0.21	0.14	-0.05
Need to sleep	NR-ProF	**0.76**	0.38	0.09	0.11	0.25	-0.01
Fit	GF-MFI	**0.64**	0.17	0.35	0.24	0.40	0.00
Tired	GF-MFI	**0.56**	0.13	0.16	0.46	0.39	0.07
Rested	GF-MFI	0.49	0.44	0.19	0.25	0.37	-0.04
Tire easily	GF-MFI	**0.65**	0.14	0.29	0.33	0.06	-0.02
Hard to get going	PS-ProF	**0.78**	0.40	0.08	0.18	0.13	0.02
Taking effort	PS-ProF	**0.75**	0.33	0.09	0.24	0.26	0.12
It's a battle	PS-ProF	**0.71**	0.41	0.03	0.25	0.25	0.15
Dread doing things	RM-MFI	0.37	0.16	0.27	**0.72**	0.07	-0.06
Want to do nice things	RM-MFI	0.29	0.34	0.20	0.15	**0.60**	0.11
Lots of plans	RM-MFI	0.12	0.10	0.21	0.11	0.06	**0.86**
Don't feel like doing anything	RM-MFI	0.17	0.31	0.02	**0.77**	0.11	0.30
Hard to keep going	LS-ProF	**0.81**	0.31	0.21	0.10	0.20	0.17
Easily worn out	LS-ProF	**0.83**	0.36	0.21	0.14	0.21	0.05
Lack of energy	LS-ProF	**0.81**	0.33	0.20	0.15	0.25	0.08
Very active	RA-MFI	**0.62**	0.17	0.36	0.30	0.45	0.17
Do a lot in a day	RA-MFI	0.27	0.23	**0.71**	0.02	0.36	0.10
Do very little in a day	RA-MFI	0.22	0.11	**0.81**	0.19	0.05	0.18
Get little done	RA-MFI	0.46	0.30	**0.57**	0.42	0.13	0.07
Lack of muscle strength	WM-ProF	**0.86**	0.23	0.08	0.10	-0.07	0.08
Feeling weak	WM-ProF	**0.90**	0.18	0.11	0.09	-0.04	0.11
Do little	PF-MFI	**0.58**	0.13	0.15	0.49	0.30	-0.05
Take on a lot	PF-MFI	**0.66**	0.14	0.38	0.19	0.16	0.13
Physically bad condition	PF-MFI	**0.66**	0.16	0.33	0.20	0.05	0.11
Physically excellent condition	PF-MFI	**0.59**	0.07	0.34	0.14	**0.53**	0.03
Not thinking clearly	PC-ProF	0.36	**0.82**	0.13	0.07	0.21	0.12
Hard to concentrate	PC-ProF	0.44	**0.83**	0.11	0.10	0.14	0.08
Forgetting things	PM-ProF	0.33	**0.75**	-0.04	0.06	0.22	0.25
Making mistakes	PM-ProF	0.44	**0.68**	-0.09	0.09	0.11	0.27
Keep my thoughts	MF-MFI	0.05	**0.64**	**0.56**	-0.01	0.07	-0.07
Concentrate well	MF-MFI	0.34	**0.76**	0.21	0.31	-0.10	-0.15
Effort to concentrate	MF-MFI	0.27	**0.68**	0.18	0.21	0.13	0.02
Thoughts easily wander	MF-MFI	0.12	**0.84**	0.25	0.15	0.04	-0.06
Variance accounted for (R^2)		0.34	0.18	0.09	0.08	0.07	0.03

Items in bold loaded > 0.5; ProF: Profile of Fatigue; MFI: Multidimensional Fatigue Inventory; NR: Need Rest; GF: General Fatigue; PS: Poor Starting; RM: Reduced Motivation; LS: Low Stamina; RA: Reduced Activity; WM: Weak Muscles; PF: Physical Fatigue; PC: Poor Concentration; PM: Poor Memory; MF: Mental Fatigue

TABLE 4. Internal consistency the facets of the ProF and the dimensions of the MFI and correlation coefficients between the corresponding two

ProF facet	α	MFI dimension	α	r***
Need Rest	0.96	General Fatigue	0.85	0.86
Weak Muscles	0.94	Physical Fatigue	0.86	0.75
Low Stamina	0.97	Reduced Activity	0.89	0.72
Poor Starting	0.96	Reduced Motivation	0.68	0.66
Poor Concentration	0.97	Mental Fatigue	0.89	0.83
Poor Memory	0.92	(as above)		0.65

*** All correlations between scores from matching MFI and ProF facets/dimensions are significant at $p < 0.001$

Legends of Figures

Figure 1. Mean ratings (and standard errors) of scores from patients with SS (dark columns) and RA (light columns) for the six facets of the ProF, for the two domains and as an overall combined score. The Somatic Fatigue score is the mean of items representing Need Rest, Poor Starting, Low Stamina and Weak Muscles; Mental Fatigue is the mean of items representing Poor Concentration and Poor Memory; Overall Fatigue is the mean of all items.

Figure 2. Mean ratings (and standard errors) of patients with SS (dark columns) and RA (light columns) for the five dimensions of the MFI.

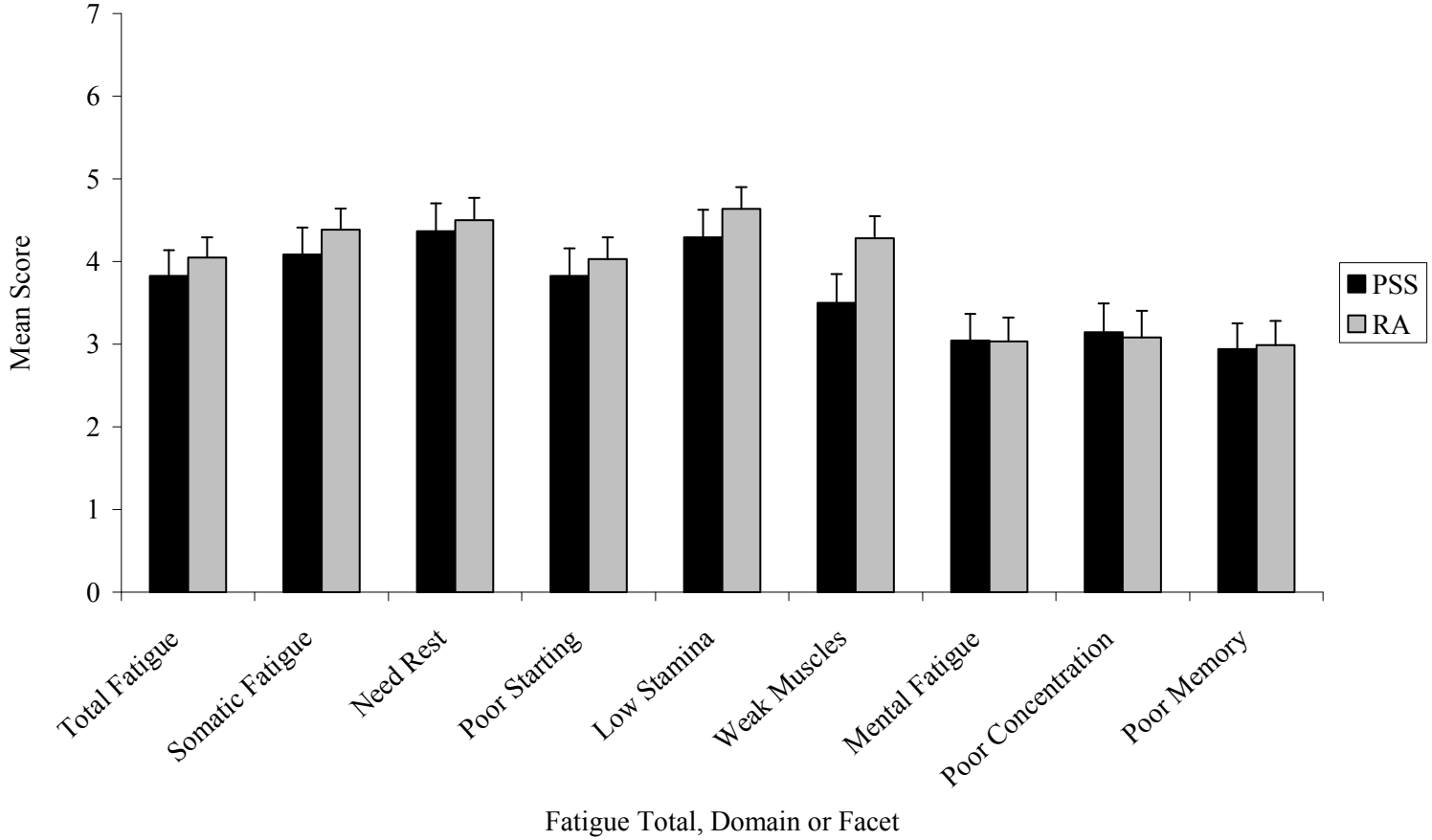
Mean Score
7
6
5
4
3
2
1
0
PSS
RA
Total Fatigue
Somatic Fatigue
Need Rest
Poor Starting
Low Stamina
Weak Muscles
Mental Fatigue
Poor Concentration
Poor Memory
Fatigue Total, Domain or Facet

Figure 1

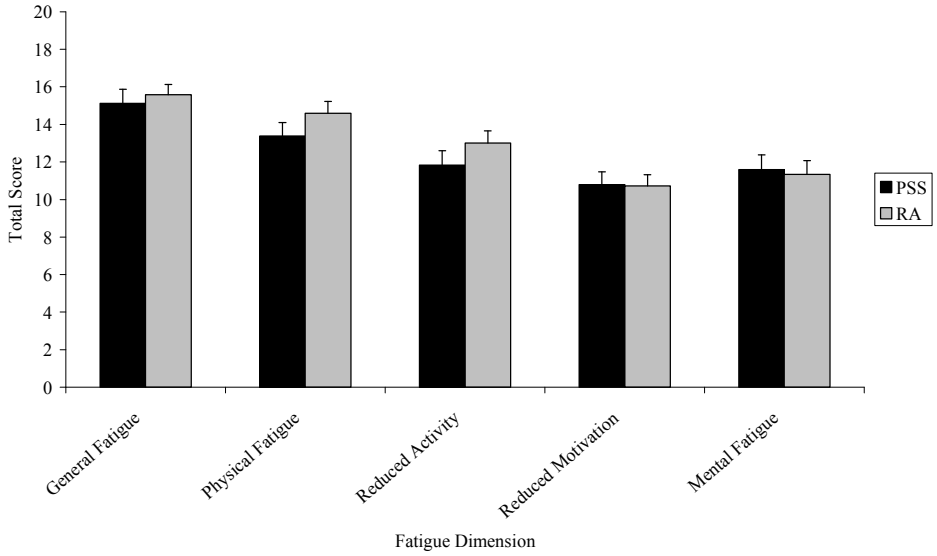
20
18
16
14
12
10
8
6
4
2
0
Total Score
PSS
RA
General Fatigue
Physical Fatigue
Reduced Activity
Reduced Motivation
Mental Fatigue
Fatigue Dimension

Figure 2.