Dimensions of Fatigue during Radiotherapy

An Application of the Swedish Occupational Fatigue Inventory (SOFI) on Cancer Patients

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The aims of this study were primarily to evaluate the applicability of the Swedish Occupational Fatigue Inventory (SOFI) on cancer patients, secondly to describe the development of fatigue in patients, receiving full dose radiotherapy with a curative intent. A questionnaire was completed by 81 cancer patients at four occasions; before treatment, during the last week of treatment, 1 and 3 months, respectively, after treatment. The fatigue increased significantly at the end of treatment, as compared to pretreatment, and decreased after treatment. The highest fatigue ratings concerned lack of energy, lack of motivation and sleepiness. The five SOFI-dimensions explained more than half of the variance in the overall rating of fatigue, and the internal consistency of the dimensions were good. However, the ratings were on the lower part of the scale and the dimensions correlated more than expected. Thus, the relevance of the SOFI for use also among patients is only partially supported, and studies with larger samples are needed for further testing of the inventory.

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Fatigue is one of the most frequently occurring symptoms in patients with cancer (1, 2). Being a common symptom in all stages of the disease it is also a common side effect of anti cancer treatment, such as radiotherapy (3), chemotherapy (4), or biological therapy (5). Patient characteristics such as gender, anaemia, metabolic factors, nutritional status in addition to medication have been related to fatigue (6). Particularly in radiation therapy, factors such as the dose, target volume and the radiation quality have been reported to influence fatigue (7). The intensity of fatigue seems to culminate at the end of treatment and decline thereafter (3, 8).

Previous research has been describing and characterizing fatigue in different groups of cancer patients and treatment settings (7, 9). The underlying mechanisms of fatigue are more or less unknown and therefore it is still not possible to distinguish different qualitative characteristics, or fatigue in different groups of patients, from an etiological point of view. It is not clear to what extent fatigue as a symptom of sickness differs from fatigue after work, but the construct of fatigue may differ depending on what context the perception refers to. A fundamental but difficult question concerns the meaning of the concept fatigue, and how it best can be defined. The problem with the word fatigue is that people may be referring to distinctly different states although they are using the same term, and thereby misunderstandings may arise. For example, a feeling of being tired may be described with the expressions 'weary', 'strained', or 'sleepy'. The concept of fatigue is diffuse in ordinary language, but important in that it describes a very common phenomenon. Many researchers have, therefore, been tempted to propose their own definitions and classifications (for example, see (10–12)). Despite the multitude of proposed definitions and subcategories, it must be concluded that there is no general agreed-upon definition of fatigue. This means that it is still necessary to define what features are referred to as fatigue, at the operational level in each specific context.

Mostly, perceived fatigue has been measured by unidimensional scaling, including a single question about how tired the person feels (for example, see (13)). Much effort has been devoted to developing such rating scales. Borg (14) has developed several rating scales which have been correlated with physiological responses and physical load. In particular the RPE (ratings of perceived exertion) and CR10 (category ratio) scales have been frequently used. However, even if an unidimensional rating is very usable because of its simplicity it gives no information about possible qualitative differences in perceptions of fatigue. The different states of fatigue most commonly discussed

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are physical and mental fatigue (for example, see (15)). Other major states of fatigue that have been studied are sleepiness (16) and discomfort (17). A Swedish instrument, the Swedish Occupational Fatigue Inventory (SOFI), has recently been developed for measuring fatigue in five dimensions (18). Initially, in a questionnaire survey, 705 employees from different occupations described their perceived fatigue by rating 95 verbal expressions. Factor analyses resulted in five dimensions of work related perceived fatigue. These dimensions were called lack of energy, physical exertion, physical discomfort, lack of motivation and sleepiness. Besides from measuring physical and mental fatigue the SOFI thus includes sleepiness. The SOFI consisted of 25 items, and each dimension was assessed by five items. The proposed five-dimensional model of perceived fatigue has been evaluated in two laboratory experiments (19, 20) and two field studies (21, 22).

Some questionnaires measuring fatigue have been developed for clinical use. A simple, and thereby appealing, instrument consists of a fatigue scale where mental and physical fatigue are measured (15). One example of instruments for use specifically among cancer patients is the multidimensional fatigue inventory (MFI) (23, 24). The validity of this inventory was evaluated through confirmatory factor analysis and the factors were interpreted as general fatigue, physical fatigue, mental fatigue, reduced motivation and reduced activity. The MFI has been used in Dutch and English (24).

As far as the authors know, no Swedish multidimensional instrument for use among patients has been developed. Thus, the aims of the present study were primarily to evaluate the applicability of the SOFI on Swedish cancer patients, secondly to describe the dimensions and development of perceived fatigue in cancer patients, receiving full dose radiotherapy with a curative intent. The SOFI has previously been used in different occupational settings, as referred to earlier, but not yet among other groups suffering from fatigue. An additional question was, therefore, if the perceived fatigue of this group of patients was comparable to some previously studied (22) occupations with very high workload.

Table 1

Characteristics of the patients [a]

Patients	Male	Female	Total
Approached	12	141	153
Excluded	2	51	53
Included	10	90	100
Completed study	8	73	81
Age			
≤30	0	1	3
31–50	2	11	17
51–70	6	51	51
> 70	0	10	10
Diagnoses			
Breast	0	52	52
Urological	7	1	8
Gynaecological	0	17	17
Lymphoma	1	2	3
Miscellaneous	0	1	1
Dose			
≤20 Gy	0	1	1
21–40 Gy	3	14	17
41–50 Gy	0	56	56
> 51 Gy	5	2	7
Fraction			
1.50–1.75 Gy	2	5	7
1.76–2.00 Gy	6	68	74
Length of treatment			
3 weeks	2	0	2
4 weeks	1	14	15
≥5 weeks	5	59	64
Treatment target			
Upper trunk	1	55	56
Lower trunk	7	18	25

[a] Nineteen persons did not complete the study and were thus excluded from the analyses.

MATERIAL AND METHODS

Patients

Cancer patients referred for radiotherapy (RT) to the Department of Oncology, Radiumhemmet, Karolinska Hospital, were approached and asked for participation in the study. The study design has been reviewed and approved by the local ethics committee. Eligible patients were those who where going to receive curative treatment for cancer located within the trunk, i.e. the thorax, the abdomen, the pelvis and the back. Patients should be above 18 years of age and should not be receiving chemotherapy concurrently. Of the 153 patients referred for RT with a curative intent from November 1997 until February 1998, 110 patients fulfilled the criteria for inclusion. Ten of these patients did not agree to participate. The most frequent diagnoses were breast cancer (64%) and gynaecological cancer (21%). The mean total dose for all patients was 47.04 Gy with a fraction of 1.92 Gy, Table 1.

Procedure

All of the eligible patients received written information sent by post, describing the purpose and the procedure of the study along with the invitation notice to attend radiotherapy. At the first consultation the patients were given additional information by a research nurse and were asked for consent. The patients filled in the same set of questionnaires at four occasions. The first occasion was at the consultation before treatment when the initial treatment adjustments were made, the second occasion was at the last week of treatment (week 3–5), the third and fourth occasions were at 1 and 3 months, respectively, after the

Table 2

Cronbach's α for the five SOFI-scales, for each measurement occasion [a]

Occasion	Lack of energy	Physical exertion	Physical discomfort	Lack of motivation	Sleepiness
1	0.90	0.73	0.83	0.87	0.90
2	0.95	0.77	0.84	0.96	0.92
3	0.96	0.76	0.86	0.97	0.91
4	0.95	0.83	0.87	0.96	0.92

[a] Occasion: 1 = before radiotherapy (RT), 2 = last week of RT, 3 = 1 month after RT, 4 = 3 months after RT, n = 81.

completion of radiation treatment. At the first and second occasions the research nurse administered the questionnaires. At the last two occasions, the questionnaires were sent home by post.

Questionnaire

Perceived fatigue was assessed with the SOFI, the CR10-scale (14) and the KSS-scale (Karolinska sleepiness scale) (25). The questions concerned how the person had been feeling during the last days. The established rating scales CR10 and KSS were here used as references for the SOFI.

The SOFI consisted of 25 verbal expressions, with a seven-grade response scale. The two extreme values of the numerical response scale are verbally defined, 0 = 'not at all' and 6 = 'to a very high degree'. The CR10-scale consisted of one explicit question of how tired the person had been feeling, and was supposed to give an overall assessment of the intensity of fatigue. The KSS consisted of one explicit question of how sleepy or alert the person had been feeling. The hospital anxiety and depression scale (HADS) (26) was used to control for the level of anxiety and depression. HADS scores are defined as 0–7 = non-cases, 8–10 = doubtful cases, 11–21 = cases.

Comparison groups

Data from a previous study, where five occupations with high levels of workload reported fatigue (22), was used for comparison with the present sample. The occupational groups were:

Teachers in the senior stage of comprehensive schools in Stockholm, who rated their fatigue after a day with many lessons.

Firemen in fire departments in Stockholm, who rated their fatigue after fire-fighting for at least 20 min. The fire-fighting was a simulated practice situation for experienced firemen, with very high physical demands in heat.

Cashiers in supermarkets in Stockholm, who rated their fatigue after a work shift with more than 2 h at the cash register.

Bus drivers in the city area of Stockholm. The work schedules were irregular and based on a three-shift schedule. The bus drivers were asked to rate their fatigue after a morning or afternoon shift.

Locomotive engineers, who rated their fatigue after a night shift with conveyance of goods.

Statistical procedure

To obtain a simple measure of each SOFI-dimension, a mean of the five ratings (for each individual and from each occasion) was calculated. Means and confidence intervals on group level were then calculated. Differences between the four measurement occasions were examined with analyses of variance for repeated measures. The p-values of 0.05 or less were regarded as statistically significant. Differences between the first and last occasion were examined by constructing their 95% confidence intervals according to standard procedures, based on t-distributions. The correlations between variables were calculated with Pearson's product moment correlation. The common variance of the ratings on the SOFI and the CR10-scale was calculated with multiple regression analyses (method En-

Table 3

Results from multiple regression analyses, with the CR10-scale as the dependent variable and the SOFI-dimensions as the independent variables [a]

Occasion	0.00	0.000	−0.00	0.000	−0.00	0.000	−0.00	0.000	0.00	0.000	0.00
Occasion	Lack of energy		Physical exertion		Physical discomfort		Lack of motivation		Sleepiness		
	β	p	β	p	β	p	β	p	β	p	r^2
1	0.22	0.181	0.19	0.154	0.11	0.433	−0.28	0.053	0.54	0.002	0.56
2	0.65	0.001	−0.16	0.237	−0.18	0.228	−0.08	0.645	0.51	0.005	0.59
3	0.84	0.001	−0.11	0.391	−0.05	0.696	−0.21	0.306	0.27	0.092	0.60
4	0.49	0.033	−0.08	0.586	0.06	0.682	0.04	0.848	0.28	0.126	0.58

[a] Standardized regression coefficients, β, significance level, p, and multiple regression coefficient, r^2. Occasion: 1 = before radiotherapy (RT), 2 = last week of RT, 3 = one month after RT, 4 = three months after RT, n = 81.

Table 4

Pearson product moment correlations (r∗) between the fatigue instruments (SOFI, KSS and CR10) and the intercorrelations between the SOFI-dimensions, from the second measurement occasion, n = 81

	Lack of energy	Physical exertion	Physical discomfort	Lack of motivation	Sleepiness	KSS
CR10	0.71	0.45	0.33	0.65	0.73	0.70
KSS	0.60	0.49	0.42	0.58	0.75	
Lack of energy	–					
Physical exertion	0.61	–				
Physical discomfort	0.74	0.67	–			
Lack of motivation	0.80	0.48	0.56	–		
Sleepiness	0.77	0.69	0.56	0.81	–	

∗ Coefficients $> 0.22 = p < 0.05$, $> 0.27 = p < 0.01$, $> 0.36 = p < 0.001$.

ter, i.e. all dependent variables were entered in the same analysis). As a measure of the internal consistency of each SOFI-dimension, Cronbach's alpha (α) was calculated.

RESULTS

The SOFI

The internal consistency (Cronbach's α), for each SOFI dimension and each measurement occasion, was calculated. The fatigue dimensions showed a relatively good internal consistency, in particular lack of energy (range 0.90–0.96), lack of motivation (range 0.87–0.97) and sleepiness (range 0.90–0.92). The α-values for physical exertion (range 0.73–0.83) and physical discomfort (range 0.73–0.87) were somewhat lower (Table 2).

In order to assess the relation between overall and specific fatigue for cancer patients, multiple regressions were conducted. The ratings on the CR10-scale were defined as the dependent variable, and the fatigue-dimensions constituted the independent variables. The results showed that the five dimensions together explained 56–60% of the variance (r^2) in the overall ratings of fatigue. The dimensions lack of energy, sleepiness, and to some extent lack of motivation, contributed most to the overall fatigue (Table 3).

The correlations between the qualitative aspects of fatigue (SOFI, KSS) and the overall rating of fatigue (CR10) indicates that lack of energy, lack of motivation and sleepiness correlated higher with the overall rating of fatigue. As expected, the KSS correlated highest with the SOFI-dimension sleepiness. The intercorrelations between the five SOFI-dimensions varied from 0.48 to 0.81 (Table 4).

Fatigue in radiotherapy

In general, for the whole group of patients, the mean ratings of perceived fatigue did not exceed 2 on the response scale from 0 to 6. However, the reported fatigue seemed to peak during the last week of treatment (Table 5), with the exception of perceived exertion, which remained at the same level 1 month after treatment. The analyses of variance indicated statistical differences between the four rating occasions on lack of energy ($df = 3$, $F = 3.15$, $p < 0.05$), lack of motivation ($df = 3$, $F = 3.74$, $p < 0.05$), sleepiness ($df = 3$, $F = 4.57$, $p < 0.01$), the KSS ($df = 3$, $F = 11.59$, $p < 0.001$) and the CR10-scale ($df = 3$, $F = 3.03$, $p < 0.05$). The highest levels of fatigue, regardless of measurement instrument, were thus reported at the end of treatment. No statistical difference was found between the fatigue ratings from the first and the last measurement

Table 5

Means∗ (m), 95% confidence interval (95% CI) for ratings of fatigue (SOFI, CR10, KSS) from four occasions

Occasion	1	2	3	4
	m (95% CI)	*m* (95% CI)	*m* (95% CI)	*m* (95% CI)
Lack of energy	0.85 (0.58–1.11)	1.74 (1.34–2.13)	1.41 (1.05–1.77)	1.08 (0.79–1.38)
Physical exertion	0.98 (0.73–1.22)	1.22 (0.95–1.49)	1.23 (0.96–1.50)	1.14 (0.86–1.43)
Physical discomfort	1.02 (0.75–1.29)	1.42 (1.08–1.75)	1.18 (0.86–1.49)	1.22 (0.92–1.52)
Lack of motivation	0.76 (0.52–1.01)	1.38 (1.01–1.74)	1.23 (0.90–1.56)	0.92 (0.64–1.20)
Sleepiness	0.91 (0.65–1.17)	1.78 (1.42–2.13)	1.27 (0.95–1.58)	0.99 (0.71–1.27)
CR10	2.41 (1.92–2.91)	3.82 (3.18–4.46)	2.81 (2.29–3.32)	2.27 (1.85–2.70)
KSS	4.47 (4.05–4.89)	5.39 (4.95–5.84)	4.72 (4.27–5.17)	4.15 (3.69–4.61)

∗ Response scale for the SOFI factors, 0–6, for the CR10 scale, 0–11 and for the KSS-scale, 1–9. Occasion: 1 = before radiotherapy (RT), 2 = last week of RT, 3 = one month after RT, 4 = three months after RT, n = 81. Higher numbers indicate more fatigue.

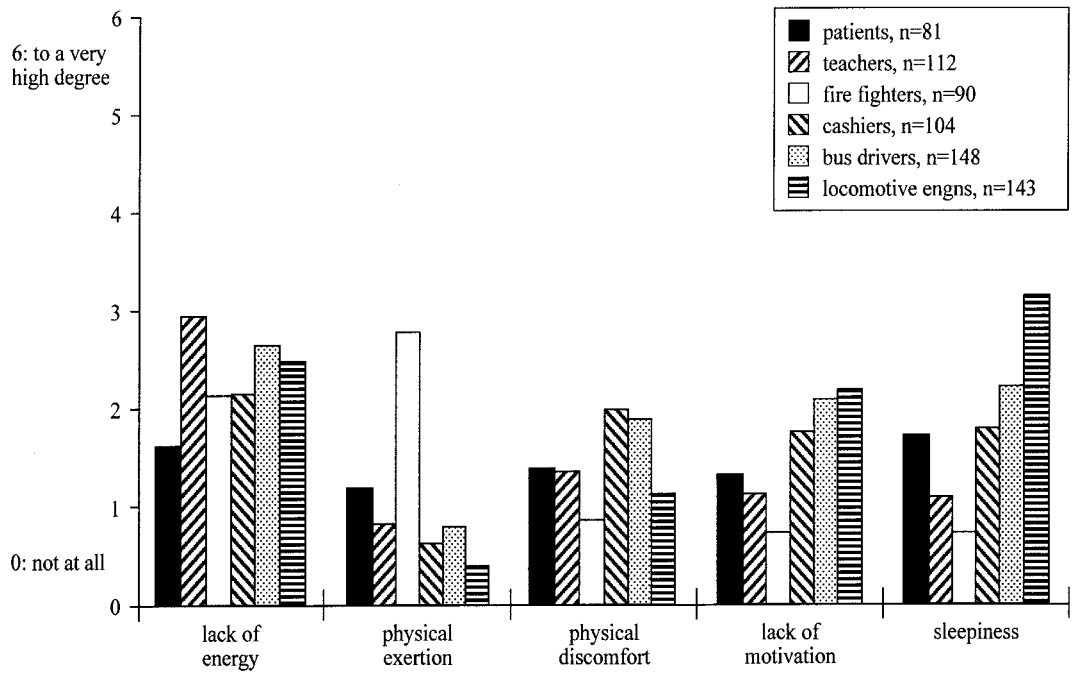

Fig. 1. Ratings of fatigue (SOFI) from patients at the end of radiotherapy and five occupational groups after work.

occasions. That is, the recovery, concerning fatigue 3 months after treatment, seemed complete. However, the ratings on the SOFI-dimensions were not entirely back on the initial levels. No difference in intensity levels of fatigue was found between patients with cancer located in the upper or lower trunk.

Nineteen patients chose not to participate at all measurement occasions. However, no substantial differences, in reported fatigue (from the first occasion), diagnosis or age, between the compliers and non-compliers could be seen.

The group as a whole could initially not be described as anxious ($m = 5.06$, $SD = 4.04$) or depressed ($m = 3.73$, $SD = 3.20$), and no change appeared during the following three measurement occasions. However, three patients were classified as anxiety cases at all four measurement occasions, and 11 patients were classified as cases at one or some but not all, occasions. No patient was classified as a depression case at all four measurement occasions, but 11 patients were classified as cases at one or some occasions, but not all, occasions. The correlations between anxiety and the qualitative aspects of fatigue (coefficients between 0.35–0.58), and depression and fatigue (coefficients between 0.33–0.73), were all statistically significant. The results indicate that in particular lack of motivation is related to depression.

Further, the reports of fatigue from the present sample of patients undergoing radiotherapy were compared with data from five occupational groups with very high, and very different, workload. The ratings of fatigue from the patients and from the five occupational groups are illustrated in the Figure. The comparison indicates that the occupational groups reported a differentiated pattern in perceived fatigue, while the patients to a lesser extent differentiated between the dimensions of fatigue Fig. 1.

DISCUSSION

More than half, 56–60%, of the variance (r^2) in the overall ratings of fatigue (CR10) was explained by the five SOFI-dimensions. This is lower than, but still comparable with, the 68% of explained variance previously obtained for five occupational groups (22). Also, the psychometric properties, in terms of internal consistency of the five SOFI dimensions, were good also for the present sample (Table 2). This regards in particular lack of energy, lack of motivation and sleepiness. However, the reported fatigue in this group of patients was on the lower part of the rating scale. The present sample contained no patients with lung cancer, who previously have been shown to suffer more from fatigue, as compared to other diagnoses (8). This could, at least partially, explain the moderate intensity levels in reported fatigue. Further, the dimensions of the SOFI are, of course, related as they represent different states of perceived fatigue. But the relatively high intercorrelations (Table 4) obtained in this study indicates that the dimensions are overlapping and that the dimensional structure may not have been reproduced. Thus, these results indicate that the relevance of the SOFI for use among cancer patients is only partially supported.

In general, treatment with radiation affected fatigue as the ratings increased during the last week of radiotherapy.

Similar effects have previously been shown (8, 27, 28). Regarding the qualitative dimensions of fatigue, it was primarily lack of energy, sleepiness and lack of motivation that increased at the end of radiotherapy. After treatment the ratings of fatigue decreased, even if the recovery was not complete (Table 5). Thus, the dimensions lack of energy, lack of motivation and sleepiness seemed to best describe the fatigue reported by the patients. This was statistically supported as the common variance of the fatigue-dimensions and the CR10-scale indicated that lack of energy and sleepiness were the most important aspect of fatigue for this population (Table 3). Further, the correlations between the fatigue-dimensions and the CR10-scale indicated that lack of motivation was related to the CR10-scale (Table 4).

The fatigue reported by the present sample of patients seemed to be more general than specific, as compared to some occupational groups. The comparison may, however, be interpreted with some caution as the occupational groups were younger (mean 24–47 years) than the patients (men = 57 years, women = 59 years). Even though, the patients reported a fatigue that seemed to be of a mental character (Table 3 and Table 4), even if they were treated for a physical disease. As no particular dimension characterized the patients reported fatigue, several interpretations are possible. For example, there may be other dimensions that better describes the fatigue of this group, a more refined measurement instrument may be necessary, or a single unidimensional rating may be enough to get the necessary information.

Anxiety and depression is often assumed be related to fatigue (for example, see (7, 29)), but this sample was not found to be anxious (with the exception of three patients) or depressed as measured by HADS. The correlations between anxiety and depression and fatigue measured with SOFI were, in spite of this, all statistically significant, and the highest coefficient was found between depression and lack of motivation. However, previous studies have come to inconclusive results. For example, depression has been found to be related to fatigue among patients with chronic fatigue syndrome (30), but not among patients with an advanced cancer disease (31).

In conclusion, the applicability of the SOFI for use among this group of patients is primarily supported by (a) the relatively large amount of explained variance of the CR10-ratings, and (b) the psychometric properties of the SOFI. However, no specific fatigue dimension was found to describe the patient's feelings. The intercorrelations were rather high, which indicates that the dimensions to a certain extent are overlapping. Thus, further studies with larger samples are needed in order to test the generalizability of the SOFI more thoroughly. With a larger sample it would be possible to re-test the dimensional structure of the SOFI. Additional important questions could also be addressed with a more heterogeneous sample. For example, are there any physiological or psychological factors that characterizes the most tired patients? Are there any differences in fatigue between diagnoses, genders, irradiated volume, and duration of treatment? Answers to such questions are essential, as enhanced understanding of fatigue makes it possible to develop interventions that may improve the patient's quality of life.

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