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Sleep physiology in recovery from burnout

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ABSTRACT

This study aimed to investigate the role of sleep physiology in recovery from burnout, in particular the relation between sleep and changes in fatigue and whether those changes would be related to return to work.

23 white-collar workers on long-term sick leave (>3 months) due to a burnout related diagnosis and 16 healthy controls were subjected to polysomnographic recordings at baseline and after 6–12 months' rehabilitation. Occupational status, subjective sleep quality, fatigue, anxiety and depression were assessed. Recovery from burnout was accompanied by improved sleep continuity. Significant interaction effects were seen for number of arousals, sleep fragmentation, sleep latency, sleep efficiency and time of rising. The burnout group improved significantly on all symptom variables although the post-treatment levels did not reach the levels of the controls. Recovery from fatigue was related to a reduction of the arousal from sleep and was the best predictor of return to work.

1. Introduction

In Sweden the amount of long-term (>30 days) sick leave has more than doubled over a period of 10 years (RFV, 2003; Weber and Jaekel-Reinhard, 2000). Most of this increase appears to be due to a long-term exposure to stress, with fatigue as the dominating symptom, but also including some depression and anxiety. "Fatigue" is a relatively loosely defined concept but most definitions assume that it is a state when energy loss exceeds energy availability (Grandjean, 1968; Piper, 1986), due to extended physical, emotional or mental activity, and/or to poor restoration, for example, inadequate sleep. Fatigue is also defined as an inadequate behavioral adaption to stress, developing from tiredness to exhaustion, with common attributes irrespective of etiology (illness, work, extended leisure or sport activities) (Olson, 2007; Olson et al., 2008). However this study focuses on fatigue due to work-related stress. In the absence of an existing diagnosis, the state was early labeled as "burnout" in accordance with the criteria of Maslach et al. (2001) or Melamed et al. (2006). In addition, the diagnostic category "Z73.0" of the ICD-10 (the 10th revision of the International Classification of Diseases) (WHO, 1992) was commonly used. Recently, the Swedish Board of Health and Welfare added "exhaustion syndrome" as a supplementary diagnosis to the Swedish version of the ICD-10 (Socialstyrelsen, 2005). "Work-related adjustment disorder" has also been proposed to cover the whole continuum of mild to severe burnout complaints (van der Klink et al., 2003).

Burnout levels seem to be stable over several years (Shirom, 2005; Taris et al., 2005) and most definitions emphasize the chronic character of burnout and its resistance to spontaneous recovery of the state of exhaustion (Maslach et al., 2001; Schaufeli and Buunk, 1996; Shirom, 1989). Despite a growing number of burnout rehabilitation studies, effective interventions to manage burnout are scarce (Schaufeli et al., 2001; McCray et al., 2008). In a randomized, treatment controlled study, comparing a no-treatment condition with two intervention conditions (cognitive behavioral treatment (CBT) and activation intervention focused on graded activity and workplace interventions) recovery from burnout symptoms and work ability were unrelated (Blonk et al., 2006). In this study both treatment groups exhibited symptom recovery similar to the no-treatment condition. The exhaustion

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levels decreased significantly within the first 4 months of sick leave but remained above the clinical cut-off score as assessed with the Maslach Burnout Inventory. Consistent with this, another study of clinically burned-out individuals who received CBT, showed recovery from exhaustion in 8.8 months of treatment (Mommersteeg et al., 2006). The exhaustion levels remained elevated however, compared to healthy controls and stabilized at that level 6 months after treatment. This study did not have any non-treatment condition. Both studies showed comparable results for depressed mood, anxiety and sleep problems (Blonk et al., 2006; Mommersteeg et al., 2006). Stenlund et al. (2009) found no difference between CBT and Qigong, although burnout indicators were significantly improved. Very similar results were seen in a comparison between individual or group stress management therapy or care as usual (de Vente et al., 2008). The results seem to indicate that pronounced recovery from burnout occurs across a relatively short period of time, but that the effect may be partly spontaneous, regardless of therapy.

Apart from fatigue, insomnia symptoms, like trouble falling asleep, non-refreshing sleep, early awakening and others have been reported in persons with high burnout scores in questionnaire studies (Grossi et al., 2003; Melamed et al., 1999; Vela-Bueno et al., 2008) and in sleep diary studies (Söderström et al., 2004; Ekstedt et al., 2006). The latter two studies are the only ones using polysomnography (electroencephalography, electro-oculography, and electromyography) to describe physiological sleep parameters. The results show a higher frequency of arousals from sleep, with poor restoration from sleep in individuals with high burnout scores but still at work (Söderström et al., 2004), In individuals on long-term sick leave with burnout related diagnoses (Ekstedt et al., 2006) more sleep fragmentation, decreased sleep efficiency (time in bed spent asleep), increased sleep latency, decreased slow wave sleep and decreased slow wave activity was seen. Sleep problems appeared to affect burned-out individuals independent of co-morbid major depression, suggesting that sleep problems are independent concomitant symptoms in burnout, despite their strong relationship with depression (Ekstedt et al., 2006; Shirom, 2005).

Changed sleep physiology in burnout may not only be yet another symptom of burnout; it might also be part of a mechanism, contributing to the cardinal symptom of fatigue. Indeed, acute sleep loss (Drummond and Brown, 2001) and sleep fragmentation (Jones and Harrison, 2001) are associated with increased sleepiness, impaired psychomotor and vigilance performance (Van Dongen et al., 2003; Horne, 1988), as well as impairment of executive function tasks like memory, creativity and planning skills (Horne, 1988; Bonnet and Arand, 2003). There are, however, only few studies that have tried to link impaired sleep to burnout in prospective studies. In one of these, Armon et al. (2008) found that insomnia at one point in time predicted burnout 18 months later (while controlling for initial burnout). Sonnenschein et al. (2007) demonstrated in a diary study that daily variation in fatigue was related to reports of impaired sleep, and that sleep played an important role in both symptom improvement and return to work (Sonnenschein et al., 2008). In a retrospective, qualitative study, Ekstedt and Fagerberg, 2005 found that severe difficulties sleeping were reported to precede the manifestation of burnout. None of these studies however used physiological measures of sleep, and there is a complete lack of information on how sleep physiology reflects, or is related to, recovery from burnout.

The main purpose of the present study was to investigate in what way sleep physiology, would change with recovery (regardless of cause) from burnout in a group on long-term (>90 days) sick leave with a burnout related diagnosis. A related question was whether there would be a correlation between a presumable reduction of burnout and changes in sleep physiology. Since the diagnosis of burnout is based mainly on the presence of high levels of fatigue, the latter was used to represent degree of recovery. Depression and anxiety are overlapping symptoms with burnout and it was, therefore, necessary to adjust for their role in any relation between fatigue and sleep physiology. A second criterion of recovery was return to work; a variable that does not seem to have been studied previously in relation to rehabilitation from burnout. A second purpose of the present study was to investigate the relation between recovery from burnout and return to work. The baseline study referred to above (Ekstedt et al., 2006) also used a technique of self-ratings every 3 h per day and found increased diurnal levels of being fatigued, sleepy and wound-up during weekdays as well as during weekends. A third purpose of the present study was to investigate whether improvement in burnout would be related to changes in these variables.

2. Methods

2.1. Participants

Twenty-three burnout patients (7 men, 16 women, mean age 44 ± 2) and 16 healthy controls (4 men, 12 women, mean age 43 ± 2) participated in the study.

The burnout group was recruited from the registers of an insurance company serving white-collar workers. 58 volunteers were examined and included if: (1) they fulfilled clinical symptoms of burnout: exhaustion impaired cognitive functioning due to long-term exposure to work-related stress; (2) they showed no Axis I or Axis II disorders, based on a Structured Clinical Interview (SCID) for DSM-IV, 4th edition (Association, 1994; First et al., 1997a, 1997b) and (3) they were on sick leave (fulltime) since at least 3 months. Lacking a formal ICD diagnosis, the Z73.0 (WHO, 1992) was used as an important additional inclusion criterion. When the included patients later were re-evaluated using the new diagnosis "exhaustion syndrome" according to the Swedish version of the ICD-10 (Socialstyrelsen, 2005) all were found to fulfill the criteria for that diagnosis.

The participants were assessed psychiatrically by an experienced clinician, using the Structured Clinical Interview (SCID) for DSM-IV, 4th edition (Association, 1994; First et al., 1997a, 1997b). Before the interview, participants completed questionnaires to assess previous life events (Deykin et al., 2001). Individuals with ongoing major depression and other Primary Axis I disorders were excluded from the study. No patients fulfilled criteria for an Axis II disorder. Other exclusion criteria were: heavy snoring and sleep apnea (as evidenced in self-reports and oxygen desaturation measurements). Eight patients were treated with Selective Serotonin Reuptake Inhibitors (SSRI) and five were taking SSRI and sleep-promoting drugs. Ten patients were non-medicated at baseline. At follow-up the prevalence of SSRI-intake was reduced to six and three still remained on both SSRI + sleep drugs. There were no use of beta-receptor blockers and other medication known to interfere with sleep. On the basis of the written report and/or the SCID-I assessment, the precipitating factors at the time of the illness were work-related problems in 70%, and family stress plus work-related stress in 52%. In 10 cases the psychiatric assessment was scheduled after the patients had entered the study, and from the 32 originally included patients 4 were excluded since the clinical examination revealed an Axis II diagnosis. One participant dropped out for family reasons. From these 27 patients 23 patients fulfilled the pre- and post-rehabilitation protocol.

Healthy controls were contacted through internal advertisement at the insurance company. Out of 45 volunteers 16 full-time white-collar workers (similar to the patients with respect to gender, age and occupation) were recruited. The Structured Clinical Interview (SCID) revealed no Axis I or Axis II disorders. None of the controls used hypnotics or antidepressants. There was no significant difference in other types of medical treatment between patients and controls. After recruitment, the participants were given verbal information about the procedures, and all signed a consent form. There was no monetary incentive involved for the patient group (which was on sick leave) but the control group received an economic compensation of $\approx$€220. The study was approved by the Ethics Committee of Karolinska Institutet.

2.2. Procedure

The burnout patients underwent a multi-modal rehabilitation program at a stress clinic in Stockholm. The program is based on accepted Cognitive Behavioral Therapeutic methods with the aim of reducing stress. The CBT interventions focused on stress coping strategies by enhancing the individuals' behavioral/emotional/cognitive skills, and consists of psychoeducation (for example, stress reactions, affect, medication, the balance between daytime activity and rest), awareness of individual responses, social and time-management skills and cognitive restructuring (Jones and Johnstone, 2000; Beck, 1979). The CBT interventions also included relaxation training according to Bernstein and Borkovec (1973) aimed to reduce arousal. Treatment of sleep disorder was not an explicit focus of the CBT. In addition an individual–organization interaction was undertaken through a contact person, which supported the communication with the supervisor at the workplace.

The rehabilitation program included 15 group sessions and was spread over a 6-month period. During the same period the participants also underwent 15 group sessions of physiotherapy, based on Body Awareness Therapy (Roxendal, 1985) and 8 patients underwent 10 sessions of individual psychotherapy with a length of 45 min.

All participants were subjected to polysomnographic (PSG) recording in their homes (after one night of habituation) at baseline and at follow-up after 6–12 months. Seasonal variations were held under control in that the PSG assessments were conducted in spring (March–April) or autumn (September–October) with as similar light/dark conditions as possible. Three persons in the treatment group were assessed February–November, but their sleep did not differ in any essential way from that of the others. The control group was followed-up in November. Subjective sleep quality, work, fatigue, and mood variables were assessed in questionnaires in connection with the PSG measures, at the same times. Bedtime and time of rising was at the discretion of the participants and in accordance with their habitual pattern. Three months after the rehabilitation program was completed the occupational status was followed-up in a short questionnaire.

2.3. Measures

2.3.1. Polysomnography (PSG)

Sleep was recorded polysomnographically using "Embla" recorders (Flaga HF®) with two electroencephalographic (EEG) derivations C3–A2 and C4–A1, one chin electromyographic (EMG) derivation and two electro-oculogram (EOG) derivations (oblique derivations). Ag/AgCl electrodes were used. Sleep stages were scored visually in 30-s epochs according to Rechtschaffen and Kales (1968). Sleep scoring was blind to group membership. Arousals were scored using the American Sleep Disorders Association criteria (ASDA, 1992). An arousal was defined as an EEG shift to at least alpha activity from stages 2 to 4 or Rapid Eye Movement (REM) sleep, preceded by at least 10 s of uninterrupted sleep (stages 2–4 or REM). During REM sleep an increase in EMG-activity was required. For an arousal to be scored it had to last for more than 3 s and for less than 15 s. Sleep onset latency was scored as time from 'eyes closed' to the first epoch of at least three consecutive sleep epochs (stage 1 or other sleep stages). All participants were screened for desaturations during sleep, to rule out sleep apnea.

2.3.2. Questionnaires

The main outcome variable was a fatigue index, as used in the previous study (Ekstedt et al., 2006). The fatigue index is based on a the multidimensional characteristics of fatigue comprising cognitive and physical dimensions of fatigue and a global perception of persistent fatigue which was the core symptom appearing early in the trajectory of burnout (Ekstedt and Fagerberg, 2005). It contained three items: "to what extent have you experienced; 'persistent fatigue'; 'physical exhaustion'; and mental fatigue'; during the last 3 months?" The response alternatives varied from 6 = 'always/almost every day', 5 = 4–5 times per week, 4 = 1–3 times per week, 3 = sometimes/several times per month, 2 = seldom/a few times per year to 1 = 'never/not at all' (Cronbach's alpha = 0.86). In addition, the Shirom–Melamed Burnout Questionnaire (SMBQ) was used (Kushnir and Melamed, 1992; Melamed et al., 1992). It contains 22 items on fatigue, tension, anxiety and cognitive impairment and correlates highly with the emotional exhaustion subscale of the Maslach Burnout Inventory MBI (Maslach et al., 1996) and with the Pines Burnout Measure (Pines et al., 1981). It was not used as an outcome variable since it contains other items than fatigue. The Beck Depression Inventory (BDI) (Beck et al., 1961), and the Beck Anxiety Inventory (BAI) (Beck et al., 1988) were used to assess depression and anxiety.

Habitual sleep quality was assessed with the Karolinska Sleep Quality Index (SQI) (Åkerstedt et al., 2002), which includes: initiation and maintenance of sleep, with five items; 'sleep quality, 'calmness of sleep', 'ease of falling asleep' and 'sleep throughout the allotted time'. The response alternatives were 6 = always/almost every day, 5 = very often/≥4 days per week, 4 = mostly/several days per week, 3 = sometimes/several times per month, 2 = seldom/a few times per year and 1 = never. The SQI has been validated against polysomnography and shows good correlations with objective sleep parameters (Åkerstedt et al., 1997).

The participants also completed a sleep and wake diary for 1 week in conjunction with the polysomnographic sleep recordings. Daytime ratings included sleepiness, mental fatigue and variations of being wound-up and were carried out at awakening (around 7 am) and approximately at 10 am, 2 pm, 8 pm and at bedtime. Sleepiness was rated on the Karolinska Sleepiness Scale (KSS) ranging from 1 to 9 (very alert to extremely sleepy, fighting sleep, an effort to remain awake). It has been validated against electrophysiological indices of sleepiness (Åkerstedt and Gillberg, 1990). Mental fatigue was rated on a 9-point scale ranging from 1 = very fresh to 9 = totally exhausted (Ekstedt et al., 2006). The response alternatives of being wound-up during the day varied from 1 "very relaxed" to 9 "extremely wound-up" (Söderström et al., 2006).

'Return to work' was assessed 3 months after the intervention with questions about the extent to which they had returned to work, full or part-time, or to what degree they still were on sick leave or had received early retirement pension.

Treatment with SSRI and sleep drugs was assessed before and after treatment and a dichotomous variable labeled treatment (SSRI and sleep drugs) vs non-treatment was used as a control variable in the regression analysis.

2.4. Statistical analysis

For EEG changes and recovery from burnout symptoms across time, a repeated-measures analysis of variance (ANOVA) using two within group factors: groups (burnout patients and healthy controls) and time (baseline to follow-up). For the development of sleepiness, wound-up and mental fatigue, time of day was used as a third within group factor. This included correction for sphericity using the Huyhn–Feldt procedure (Huynh and Feldt, 1976). However for clarity, the unadjusted degrees of freedom are given. All values in the analyses are expressed as mean ± standard error (SE). Stepwise regression analysis (backwards elimination) was carried out in order to investigate how sleep improvement was related to recovery from the core symptom of burnout (i.e. fatigue). The change ($T_2 - T_1$) of fatigue index was used as a dependent variable and change in physiological sleep as predictors. In addition, a logistic regression analysis was carried out to identify the relation between work resumption and symptom recovery. Also Pearson correlation coefficients were calculated between the physiological variables, fatigue, mood and control factors. The internal consistency of the indexes used in the analysis was tested by computing the alpha coefficient (Cronbach, 1951). All calculations were carried out using Statview software (version 5.0.1; SAS Institute Inc., Cary, NC) and SPSS 11.0 for Macintosh (SPSS Inc., Chicago, IL). An alpha level of 0.05 was considered to be of statistical significance.

3. Results

3.1. Symptom recovery

Table 1 presents the subjective ratings of burnout, fatigue, sleep quality, depression and anxiety in the two groups. All variables showed significant main effects. The significant interaction effects show that the burnout group improved on all symptom variables at follow-up as compared to the healthy reference group, which remained on the same level. Independent *t*-tests revealed, however, that the follow-up measures were still impaired compared to healthy individuals, with respect to the fatigue index (t_{35} = 5.4, $p < 0.001$), burnout score (t_{35} = 3.8, $p < 0.001$), depression (BDI t_{36} = 5.3, $p < 0.001$), anxiety (BAI t_{34} = 3.3, $p < 0.01$) and sleep quality (SQI t_{34} = −2.9, $p < 0.01$).

3.2. Diurnal pattern of being wound-up, sleepiness, and mental fatigue

All the three variables showed significant effects of group and time of day, with worse values for the burnout group. Also the interaction between group and time of day was significant,

Table 1
Results of an analysis of variance on burnout symptoms among the burnout patients and healthy references at baseline and at follow-up. Results presented in mean ± standard error.

	Burnout group (n = 23)		Healthy reference (n = 16)		*G*	*T*	*G* × *T*
	Baseline	Follow-up	Baseline	Follow-up			
Burnout-SMBQ (l–7 = high)	5.7 ± 0.2	3.5 ± 0.3	1.7 ± 0.2	1.8 ± 0.3	<0.001	0.003	0.002
Fatigue index (l–6 = high)	4.8 ± 0.2	3.4 ± 0.2	1.8 ± 0.2	1.8 ± 0.1	<0.001	<0.001	0.001
Anxiety, BAI	18 ± 2	11 ± 2	2 ± 0.5	2 ± 0.6	<0.001	0.009	0.001
Depression, BDI	22 ± 2	14 ± 2	1.7 ± 0.5	2 ± 0.6	<0.001	0.003	<0.001
Sleep quality index (l–6 = good)	2.8 ± 0.2	4.3 ± 0.1	5.0 ± 0.1	4.9 ± 0.1	<0.001	0.001	<0.001

Note: df = l/33–35. SMBQ = Shirom–Melamed Burnout Questionnaire; BAI = Beck Anxiety Inventory; BDI = Beck Depression Inventory; *G* = group; *T* = time (baseline to follow-up).

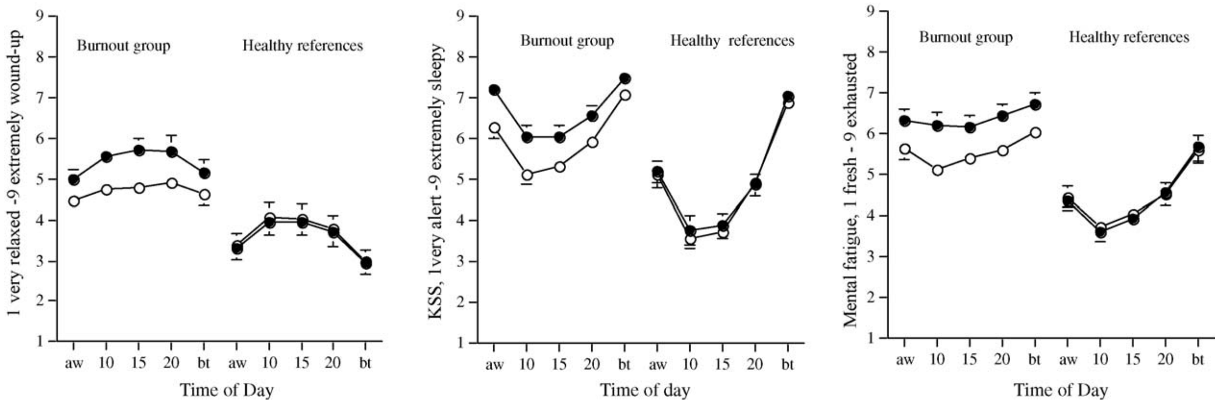

Fig. 1. Diurnal variation (aw = awakening to bt = bedtime), mean ± SE of sleepiness, KSS, being wound-up and mental fatigue in the burnout group and healthy reference group at baseline (●) and follow-up (○).

Table 2
Results from the 3-factor ANOVA for repeated measures for wound-up, sleepiness, KSS, and mental fatigue ratings across days at baseline and follow-up.

	df		G	ToD	C	G × ToD	G × C	C × ToD	G × ToD × C
Wound-up (1—relaxed to 9—extremely upwinded)	1/32/128	F	19***	14***	3.6*	2.8*	5.9*	0.6	0.7
Sleepiness, KSS (1–9 extremely sleepy)	1/32/128	F	27***	78***	12**	8.5***	7.5**	1.3	1.0
Mental fatigue (1–9 exhausted)	1/32/128	F	26***	29***	6.8*	6.9***	8.5**	0.5	0.5

The table includes original degrees of freedom (df) before Huyn–Feldt adjustment; G = groups, ToD = time of day, C = condition (baseline and follow-up).
F-ratio and p-values after epsilon correction:
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

indicating a more shallow development across the day for the burnout group. The key result, however, was the interaction between group and condition (before–after) and this effect was significant, indicating that the burnout group had changed (improved) on all the three variables (Fig. 1; Table 2).

Table 3 shows the results from the analysis of sleep physiology. Significant interaction effects were seen for number of arousals, sleep fragmentation, wake after sleep onset (WASO), sleep onset latency (SOL), sleep efficiency and time of rising. In all cases sleep improved in the burnout group while it remained essentially the same in the reference group. A moderately increased WASO and decreased sleep efficiency were seen in the control group at follow-up. Significant effects of time were seen for bedtime, number of arousals, fragmentation, and slow wave sleep latency. There was no significant difference in sleep variables between the medicated and non-medicated patients before or after treatment except for SOL, which was longer in medicated patients at baseline (medicated: mean 29.8 ± 6 min, non-medicated: 12.3 ± 2 min, $t_{21} = -2.29$, $p < 0.05$).

3.3. Regression analyses of changes in sleep, burnout symptoms and return to work

In order to investigate the relationship between changes in sleep physiology and recovery from burnout symptoms and possible confounding factors, correlations (Pearson) were computed between change in fatigue index and the PSG variables that had changed across rehabilitation ($T_2 - T_1$). Also baseline measures (T_1) and improvement ($T_2 - T_1$) in BDI, BAI and SSRI treatment, as well as age and gender were tested since that may have some

Table 3
PSG measured sleep in burnout patients and healthy references.

	Burnout group (n = 23)		Healthy reference(n = 16)		p for F value		
	Baseline	Follow-up	Baseline	Follow-up	Group	Time	Group × time
Bedtime (h)	23:20 ± 15	22:55 ± 0.17	23:05 ± :18	22:55 ± 0.10	0.380	0.039	0.537
Time of rising (h)	7:15 ± 17	7:55 ± 15	6:42 ± :13	6:07 ± 07	0.002	0.253	0.002
TST (min)	387 ± 17	399 ± 14	396 ± 10	376 ± 15	0.490	0.752	0.190
Sleep onset latency (min)	29 ± 6	13 ± 3	9 ± 1	12 ± 2	0.020	0.057	0.007
Sleep efficiency (%)	81 ± 2	88 ± 0.9	93 ± 0.6	88 ± 1	0.011	0.585	0.002
Awakenings stage 0 (#)	14 ± 0.8	16 ± 1	13 ± 0.9	14 ± 2	0.169	0.468	0.805
Arousals/h (#)	19 ± 2	12 ± 0.8	12 ± 1	11 ± 1	0.017	<0.001	0.003
Fragmentation index/h (#)	24 ± 2	17 ± 0.8	16 ± 1	16 ± 1	0.011	0.001	0.003
WASO (%)	16 ± 2	10 ± l	7 ± 0.6	13 ± 2	0.215	0.808	<0.001
Stage 1 (%)	4.9 ± 0.5	3.7 ± 0.4	3.3 ± 0.3	3.2 ± 0.4	0.072	0.102	0.136
Stage 2 (%)	42 ± 2	44 ± 2	41 ± 1	45 ± 2	0.924	0.058	0.535
SWS latency (min)	19 ± 2	23 ± 3	14 ± 1	19 ± 3	0.245	0.037	0.820
SWS (%)	10.1 ± 0.9	10.2 ± l	15.4 ± 1.5	14.6 ± 1	0.016	0.336	0.508
REM sleep latency (min)	92 ± 9	102 ± 11	65 ± 4	77 ± 11	0.037	0.220	0.927
REM (%)	19 ± 1	18 ± 1	23 ± 1	20 ± 2	0.059	0.054	0.315

Note: df = 1/35–37. TST = total sleep time; SWS = slow wave sleep (stages 3 + 4); WASO = wake time after sleep onse; REM = Rapid Eye Movement.

explanatory role. Change in fatigue index ($T_2 - T_1$) was correlated (df as subscript) with change in number of arousals ($r_{34} = 0.46$, $p < 0.01$), sleep efficiency ($r_{34} = -0.34$, $p < 0.05$), and WASO ($r_{34} = 0.36$, $p < 0.05$), change in BAI ($r_{33} = 0.47$, $p < 0.01$) and T_1 SSRI treatment ($r_{37} = 0.41$, $p < 0.01$). There were no significant correlations with change in fatigue index and change in: BDI ($r_{33} = -0.24$, n.s.), SSRI treatment ($r_{34} = 0.043$), BAI ($r_{36} = 13$, n.s.), or with BDI ($r_{36} = -0.16$, n.s.) at baseline, or gender ($r_{37} = -0.13$, n.s.) or age ($r_{37} = -0.004$, n.s.).

Secondly, the significant correlations from the analysis above were tested in a stepwise regression analysis against change in fatigue as the dependent variable. Using change in the physiological sleep variables (WASO, sleep efficiency and frequency of arousals) in a first step, only change in the number of arousals became significant (adjusted $R^2 = 20\%$; $F_{1/35} = 9.6$; $\beta = -0.47$; $p < 0.001$). After adding possible confounders, change in BAI and frequency of arousals ($F_{1/22} = 9.5$; ∂BAI $\beta = -0.41$; ∂frequency of arousals$\beta = -0.40$; $p < 0.05$) became significant predictors, explaining 34% of the change in the fatigue index. SSRI treatment, change in WASO and change in sleep efficiency did not enter the model.

Three months after treatment 12 of the burnout patients were still on sick leave, eight worked part-time and three had returned to work full time. In order to estimate the relationship between burnout symptoms at follow-up and work resumption, a logistic regression analysis was carried out. For this purpose return to work (RTW) was operationalized into a binary dependent variable (yes or no) where 'yes' represents individuals with a full or part-time return to work ($n = 11$), and 'no' denotes individuals still on sick leave ($n = 12$). The burnout symptoms with the strongest correlation to RTW at follow-up were used as independent variables. This yielded the fatigue index ($r = 0.73$, $p < 0.001$) and the Beck Anxiety Index (BAI) ($r = -0.571$, $p < 0.01$). Beck Depression Index (BDI) ($r = -0.223$, n.s.), the sleep quality index (SQI) ($r = 0.221$, n.s.) and the burnout index (SMBQ) ($r = -0.309$, n.s.) had very low correlations to RTW and were not included in the model. The analyses brought out the fatigue index as the only predictor of RTW (negative relation) (odds ratio [OR] = 39.0, $p < 0.01$, 95% confidence interval [CI] = 1.9–838).

4. Discussion

Ratings of, fatigue, burnout, sleep quality, anxiety, depression and several polysomnographic variables were significantly improved in the burnout group at follow-up, while the control group remained essentially on the same level. In the burnout group about half the participants had returned to full or part-time work.

With regard to ratings of burnout, rather little other work is available, but the present results are similar to findings by Mommersteeg et al. (2006). In both studies burned-out participants markedly improved from before to after treatment, compared to a healthy group. However, the burnout group did not reach the symptom levels of the healthy controls with respect to fatigue, burnout and depression. This is in agreement with the clinical picture of this group and the results from other studies (Mommersteeg et al., 2006; Blonk et al., 2006; van Rhenen et al., 2007). Doubts have been raised about whether further spontaneous decrease will occur after the first phase of recovery (Mommersteeg et al., 2006; Blonk et al., 2006).

The present study also showed that the repeated ratings across the day support the questionnaire data with a significant reduction for the burnout group (improvement) in being wound-up, fatigued, or sleepy. Taken together, the results indicate a clear improvement in the key characteristics of burnout across a one-year period, also supported by the return to work for the majority of participants. The improvement may or may not be attributed to the specific treatment or to spontaneous recovery. However, design of the present study and that of Mommersteeg et al. (2006) does not permit a conclusion on causality and the studies by Stenlund et al. (2009) and de Vente et al. (2008) seem to suggest that CBT may not be necessary for recovery from burnout.

Previous studies had found that subjectively rated sleep improved with improvement of burnout (Sonnenschein et al., 2007). This was found also in the present study. However, notwithstanding the improvement, the post-treatment levels still had not reached control group levels for most parameters. A recent study indicates that subjective lack of sleep improvement (diary ratings) may complicate burnout improvement (Sonnenschein et al., 2007) and the study by Armon et al. (2008) showed insomnia to predict incidence of burnout. Also, a retrospective study has found that the fatigue symptoms appeared early in the burnout trajectory, but were not taken seriously at that point (Ekstedt and Fagerberg, 2005). These findings seem to indicate a role for impaired sleep in the development of burnout.

One of the main contributions of the present study is the demonstration that also sleep physiology improves with recovery from burnout. The results showed shortened sleep latency, increased sleep efficiency, reduced number of arousals, reduced fragmentation rate, and reduced time awake after sleep onset. At the second point of measurement many variables had reached levels seen in the healthy controls, suggesting normal sleep (Littner et al., 2003). The major exception was SWS, which did not increase with recovery, which had been expected from the low levels at pre-treatment and from the role of SWS as an indicator of sleep quality (Horne, 1992). Possibly, recovery of SWS takes a longer time, but testing this hypothesis requires a longer follow-up time. Since no similar studies of sleep physiology have been carried out the results need confirmation in other studies but the results indicate that sleep continuity is impaired during burnout and markedly improved with recovery from fatigue.

A second contribution of the present study is that the reduction of fatigue was related to a reduction in the number of arousals per hour. This finding, together with studies of experimental sleep fragmentation (Bonnet and Arand, 2003) and chronic sleep restriction (Van Dongen et al., 2003), suggests the possibility of a link between reduced fatigue and reduced number of arousals. There are also several studies showing that disturbed sleep is related to increased levels of proinflammatory cytokines, which are potent inducers of fatigue (Vgontzas et al., 2004a, 2004b, 2002) and important components of the sickness experience (Dantzer, 2001). Still, the present design does not permit any conclusion about a causal relation between poor sleep and fatigue in burnout. However, if the notion is supported, early treatment for disturbed sleep might help prevent the development of burnout.

The analyses also showed that change in the use of SSRI substances did not affect the relation between changes in arousals and fatigue. Change in depression was another variable that did not affect this relation. Change in anxiety became a significant predictor, but mainly added explanatory power without detracting explanatory power from arousals. This suggests that the relation between the changes in arousals and fatigue was not mediated by changes in anxiety.

The Melamed burnout scale (Kushnir and Melamed, 1992; Melamed et al., 1992) showed a weaker link with polysomnographical changes. It is not clear why, but it does contain other dimensions than the key characteristic "fatigue", for example, tension, anxiety and memory problems. This may have attenuated the relation between the Melamed scale and polysomnography.

Return to work correlated with low levels of fatigue at the second measurement. This link seems logical since fatigue is the key symptom associated with the sick listing. One would have expected a correlation with reduction of fatigue (and perhaps also with reduction in arousals). As suggested above, the final, absolute, level may be more important than the size of the reduction. Work resumption was also correlated with anxiety (BAI). Physiological stress and being wound-up are prevalent symptoms in clinical insomnia (Morin et al., 2003) and were correlated to sleep fragmentation in the early stage of burnout (Ekstedt et al., 2004). Neurobiological mechanisms were not measured in the present study, but anxiety and being wound-up might also be related to a greater brain metabolism and a failure of the arousal mechanism to decline from waking to sleep states, which in insomnia has been associated with daytime fatigue (Nofzinger et al., 2004).

This study also showed an association between fatigue recovery and work resumption, which in other studies did not necessarily coincide (Huibers et al., 2004). It has been suggested that persistent fatigue and work-resumption result from different underlying processes and may need different interventions. Leone et al. (2008) noted that while work-related factors are important in the prognosis of recovery from burnout, health-related factors seem to be more important in the prognosis of prolonged fatigue. The treatment program in this study included individual–organization interaction that may have contributed to the positive correlation between symptom recovery and return to work. However, all patients had not returned to work at follow-up and it has been emphasized a need for better interventions to promote return to work (Nieuwenhuijsen et al., 2003).

One limitation of this study was the lack of a placebo group. No conclusions can be drawn about whether the improvement was spontaneous or an effect of treatment. However, the treatment effect per se was not the purpose of this study, but in further studies it would be worthwhile to evaluate a strict treatment protocol in a randomized controlled trial, which would provide valid information about the effectiveness of a sleep intervention program. A further limitation is the naturalistic design, which, while necessary for the purpose of the study, may involve confounding by co-morbidity. The selection procedure resulted in a population of white-collar workers, which is not necessarily representative of other individuals on sick leave for burnout-like diagnoses in the general population. Some caution must also be applied when interpreting the results of this study because of the relatively small sample size, whereby an association that is actually present might be missed (type II error).

Seasonal factors may have played a role in mood and sleep changes since there was a delay in assessment of 6 months in some cases. Rather the symptom recovery became smaller than expected, since the delay was from spring (March/April) to fall (September/October) when depressive mood is more frequently experienced. But no difference in improvement was seen between the half that was followed-up after 6 months and those after one year (results not shown). This underscores the difficulties to recover from chronic burnout symptoms. Only the control group was followed-up in November, which possibly may explain their deteriorated sleep efficiency and WASO at the second assessment.

In summary the present study has shown a strong improvement of sleep physiology with recovery from burnout and a relation between improved sleep and a reduction of fatigue, as well as a relation between low fatigue and return to work. It is suggested that impaired sleep continuity may be part of the fatigue component in burnout. It also appears that return to work is related to the degree of fatigue. Further research is needed into the role of sleep in recovery from burnout.

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