Sleep and Cognitive Failures Improved by a Three-Month Stress Management Intervention

Morten V. Willert, Ane Marie Thulstrup, Janne Hertz, and Jens Peter Bonde
Aarhus University Hospital

*Work-related stress is a major occupational health problem. Prominent symptoms are impaired sleep and cognitive ability. Participants (*N = *102) were randomized to either an intervention or a wait-list control group. Outcomes, measured at baseline, 3, 6, and 9 months, were the Basic Nordic Sleep Questionnaire, Cognitive Failures Questionnaire, and Digit Span test. Data were analyzed using repeated measures analyses of variance. Self-reported quality of sleep improved in the intervention group. Relative to the control group, an effect size of* d = −0.64, CI [−1.05, −0.24], *was found. For cognitive failures, an effect size of* d = −0.57, CI [−0.90, −0.24], *was found, favoring the intervention. Gains were maintained at follow-up. Digit Span scores did not differ between groups. In conclusion, the intervention had medium effects on self-reported sleep and cognitive errors.*

Keywords: cognitive–behavior therapy, group treatment, wait-list control, sleep, cognitive performance

In Western societies, work-related stress, defined by symptoms of sustained arousal and reactivity to demands at work, has been identified as a significant occupational health problem and constitutes a major source of staff absenteeism (Borg et al., 2000).

In the clinic, poor quality of sleep, such as trouble falling asleep, frequent nightly wakings, early awakening, and bedtime ruminations, are some of the most commonly reported symptoms in individuals with complaints of work-related stress. Other frequently reported symptoms are cognitive failures in

Morten V. Willert, Ane Marie Thulstrup, Janne Hertz, and Jens Peter Bonde, Aarhus University Hospital.

We thank Greta Lassen Lund for dedicatedly leading half of the stress management groups and would also like to thank Esben Hougaard for valuable comments on a version of this article.

Correspondence concerning this article should be addressed to Morten V. Willert, Aarhus University Hospital, Noerrebrogade 44, Building 2C, DK-8000, Aarhus C, Aarhus, Denmark. E-mail: morten.willert@aarhus.rm.dk

International Journal of Stress Management
2010, Vol. 17, No. 3, 193–213

1072-5245/10/$12.00 DOI: 10.1037/a0019612

everyday tasks, for example, forgetting what one was doing, forgetting what to fetch, forgetting names and appointments, and similar problems related to deficiencies in attention and memory. In addition, complaints regarding reduced problem-solving and learning abilities are also frequent (Schaufeli & Enzmann, 1998). These symptoms are seen as impediments to perform satisfactorily at work.

SLEEP AND STRESS

Sleep is recognized as a fundamental human need (Maslow, 1943), and poor quality of sleep has been associated with a number of adverse health outcomes, ranging from increased risk of mortality (Kripke, Garfinkel, Wingard, Klauber, & Marler, 2002), heart disease (Nilsson, Nilsson, Hedblad, & Berglund, 2001), and diabetes (Nilsson, Rööst, Engström, Hedblad, & Berglund, 2004) to predicting long-term sick leave (Akerstedt, Kecklund, Alfredsson, & Selen, J2007). Normal duration of sleep in Western societies is estimated as 7–8 hr per night; duration of sleep below 6 and above 9 hr per night has been found to be associated with increased mortality (Youngstedt & Kripke, 2004).

Work characteristics, including effort–reward imbalance and demand–control imbalance, have been associated with poor quality of sleep (De Lange, Taris, Kompier, Houtman, & Bongers, 2004; Kudielka, Von Kanel, Gander, & Fischer, 2004). The causality of these associations can be assumed to be bidirectional because adverse psychosocial work conditions can lead to poor sleep through heightened hypothalamic–pituitary–adrenal axis activation, with special focus on the role of the hormone cortisol, and an increase in nightly ruminations. On the other hand, poor quality of sleep can reversely color the perception of the working environment in a negative direction, as degraded quality of sleep has been found to impair the individual capacity for problem solving and handling of everyday tasks (Beersma, 1998), making the handling of work tasks seem harder when one is not properly rested.

According to a review by Akerstedt (2006), earlier cross-sectional studies have demonstrated that stress is closely related to impaired sleep. It has also been shown that apprehension of a difficult next working day is related to poorer sleep quality. Sleep recordings demonstrate that stress is associated with shortened sleep, fragmentation, and possibly a reduction in the deepest stages of sleep. This opens a feedback mechanism, where shortened or disturbed sleep may act as a stressor in itself, as the following working day requires more effort, thus adding to the individual's psychophysiological stress reaction. However, as Akerstedt concluded much knowledge is still lacking, particularly on the effects of real-life work stress investigated in longitudinal research designs.

From the field of sleep research, the diagnosis of primary (psychophysiological) insomnia is based on subjective complaints of difficulties falling or staying asleep or nonrestorative sleep that is associated with distress or daytime impairments. It is more common among women, middle-aged or older adults, and patients with medical or psychiatric disorders. In clinical practice, sleep disturbances are assessed by the individual's subjective experiences of disturbed sleep, and often focus on how to overcome barriers preventing good quality of sleep. In laboratory, or basic, sleep research, insomnia or other sleep disturbances may be measured by polysomnography, which monitors physiological parameters such as brain activity, eye movements, muscle activity, and heart rhythm during sleep, and aims at gaining a greater understanding of sleep disturbances. Our main focus in the present article is on the role of sleep disturbances from a clinical practice perspective.

Subjective and objective measures of sleep are not always in accord with one another. However, in a recent study, a group of patients suffering from severe occupational burnout had poorer quality of sleep on subjective and objective measures of sleep when compared with a group of healthy controls (Ekstedt et al., 2006).

In a review by Morin et al. (2006) of psychological treatments for primary insomnia, treatments based on cognitive–behavior therapy and targeted specifically at sleep problems have been found to produce reliable changes in several parameters, among these sleep efficiency and time awake after sleep onset. Morin et al. noted that there is a need for additional prospective and randomized controlled studies of comorbid insomnia contrasting outcomes when sleep is or is not directly targeted in treatment (p. 1410). It is proposed that the present study could be one such study, where participants with primary symptoms of work-related stress exhibit comorbid signs of insomnia and participate in a stress management intervention that does not directly target sleep.

COGNITIVE PERFORMANCE AND STRESS

Cognitive failures, as conceptualized by Broadbent, Cooper, FitzGerald, and Parkes (1982), denote cognitive-based errors in performing simple everyday tasks that a person should normally be capable of executing without error. Cognitive failures have been investigated in a number of settings and have been associated with work-related stress, burnout, chronic fatigue syndrome, and psychiatric illness (Mahoney, Dalby, & King, 1998; Van Der Linden, Keijsers, Eling, & Van Schaijk, 2005; Wagle, Berrios, & Ho, 1999; Wearden & Appleby, 1997).

Impairment in cognitive performance, as measured by neuropsychological tests, has been associated with chronic stress (Sandström, Rhodin, Lundberg, Olsson, & Nyberg, 2005), but the exact nature and strength of the relationship is yet unclear.

MAINTAINING ROLE OF IMPAIRED SLEEP AND COGNITION

Poorer sleep and reduced cognitive ability can be viewed as consequences of work-related stress as well as maintaining factors for the worker's (dis)ability to meet the demands required by the job. It is in the latter maintaining capacity that poor sleep and reduced cognitive ability are understood in the present context. This understanding is equivalent to that of cognitive–behavior therapy for depression, where depressive symptoms are seen as signs of depression as well as factors that are actively maintaining the depression (Beck, Rush, Shaw, & Emery, 1979).

The American Academy of Sleep Medicine (Morgenthaler, et al. 2006) has put forth evidence-based recommendations on techniques for treatment of primary and secondary insomnia, including cognitive–behavior therapy, sleep restriction, paradoxical intervention (i.e., remain passively awake), stimulus control, sleep hygiene, relaxation training, and biofeedback training. However, these techniques are not directed at stressed workers per se, although they may be effective for this group also.

To our knowledge, there are no studies investigating whether quality of sleep, amount of cognitive failures, and cognitive performance can be modified by an occupational stress management intervention directed at individuals with elevated symptoms of work-related stress. Besides increasing the existing knowledge base for stress management, such a study will provide further insight into the relationship between psychosocial stressors on the one side and sleep quality and cognitive functioning on the other side.

The aim of this study was to investigate changes in self-reported sleep, amounts of cognitive failures, and cognitive performance following a curative 3-month group-based stress management intervention addressing actively help-seeking individuals in the general working population with substantial amounts of work-related stress. We hypothesized that the stress management intervention would bring about greater positive changes on the outcome measures compared with a control condition.

This is the second report on the trial known by the acronym MARS (Measures Against Work-Related Stress). The first report was on changes in perceived stress and coping dimensions following the intervention (Willert, Thulstrup, Hertz, and Bonde, 2009).

STUDY POPULATION AND METHOD

Design and Timeframe

The study was carried out within a randomized wait-list control design (see Figure 1). Participants were randomized to either the intervention group or to a wait-list control group. Outcome variables were measured at baseline and at 3-, 6-, and 9-month follow-up.

The sample size needed was calculated to be 90 participants. This allowed detection of a between-groups difference of 1 standard deviation from the score at baseline on the main outcome measure of the study, the Perceived Stress Scale (S. Cohen & Williamson, 1988). The sample size calculation was based on setting the significance level to 95%, power to 80%, standard deviation to 5, intraclass correlation coefficient to .15, and average cluster size to 9. The scales used in the present investigation share psychometric properties with the Perceived Stress Scale, and the above sample size was therefore deemed sufficient in the present context as well. To allow for a 10% dropout, we included 102 participants.

Randomization in blocks of six was used and was achieved using the RANNOR computer algorithm of the SAS statistical software package. The randomization procedure was handled by an external consultant and placed in sealed envelopes handled by the project secretary. To ensure equal group impact and minimize intraclass correlation, we mixed participants from the intervention and the wait-list control condition when forming groups.

Participants were included over a period of 10 months from December 2006 through September 2007, with groups commencing in succession from January through December 2007.

Referral

Persons from the working population (18–67 years of age) in the municipality of Aarhus, Denmark, and its surrounding communities could participate in the study. Referral was available for local general practitioners, union social workers, and through direct inquiry. All potential participants were assessed by a physician, either by their general practitioner prior to referral or by a resident occupational physician. Advertisement for the project was done through letters sent to local general practitioners, meetings with union social workers, a Web site, and announcements in a local newspaper.

We did not a priori know the total universe of potential participants from the study's population base of approximately 660,000 citizens. For reference, however, we did know that the annual referral of patients with psychological

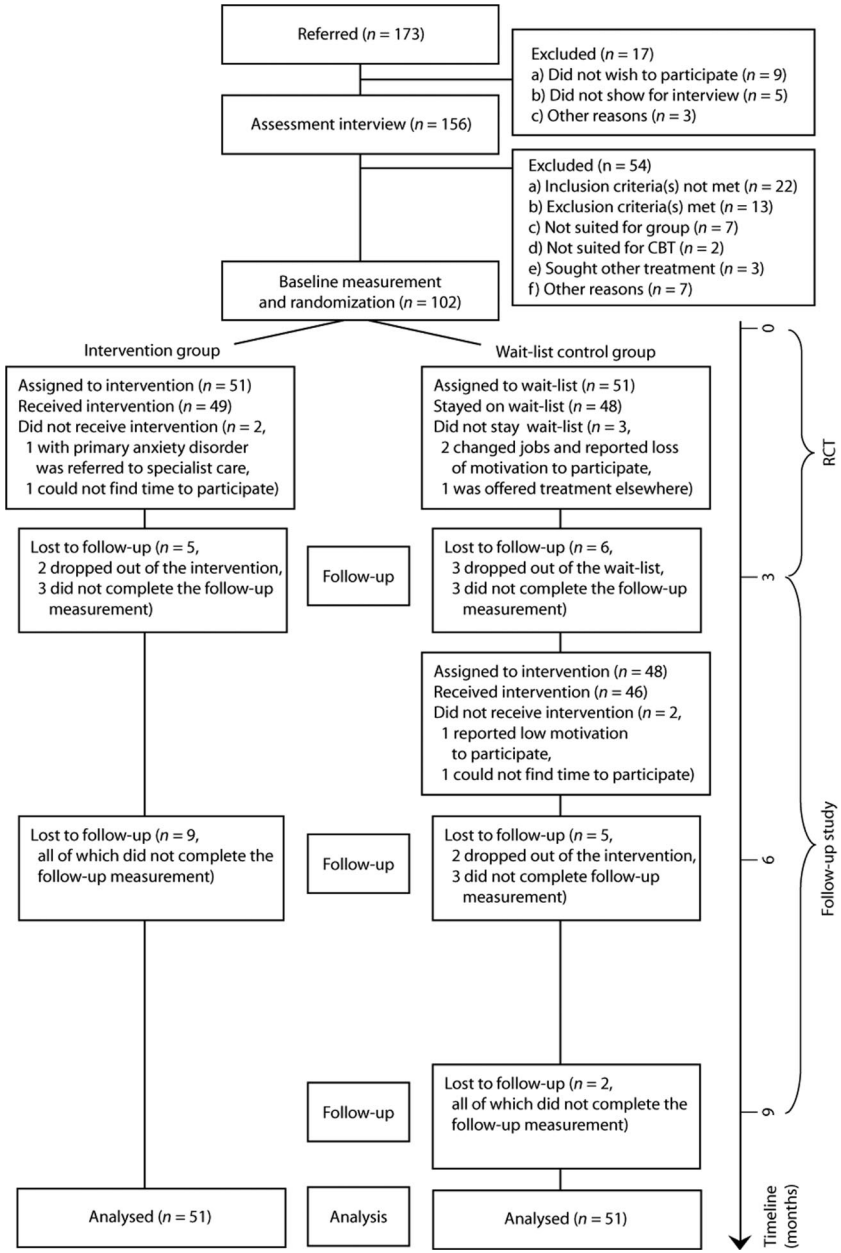

Figure 1. Flowchart of participants' progress through the phases of the trial.

complaints to the Department of Occupational Medicine, where the project took place, was 300 persons per year before the project was initiated. To be referred, one's general practitioner or union social worker must have read the information given about the new project, or for the self-referred participants, they must have read the local newspaper in the week the project was advertised. These random selection factors may have influenced the population sample that did get referred to the project.

In total, 173 persons were referred to participate (see Figure 1). Of this group, 156 persons were invited to an assessment interview to determine eligibility, and 17 potential participants were excluded (see Figure 1 for reasons). From the assessment interview, we invited 102 persons to participate, and 54 persons were not included (see Figure 1 for reasons). All persons not included were informed about alternatives.

Assessment

Potential participants were given a semistructured assessment interview by a clinical psychologist (>5 years' training). The interview covered the following topics: current work status (at work, partial or full sick leave), duration of sick leave and expected return to work, account of events at work leading to current situation, physiological and psychological symptoms of stress, family/social life, and personal coping style, duration of contact with general practitioner, current medication, history of previous psychiatric treatment, and current use of alcohol or psychoactive stimulants.

In addition to the interview, the Perceived Stress Scale (S. Cohen & Williamson, 1988), the List of Threatening Experiences questionnaire (Brugha, Bebbington, Tennant, & Hurry, 1985), Basic Nordic Sleep Questionnaire (Partinen & Gislason, 1995), and Outcome Rating Scale (Miller, Duncan, Brown, Sparks, & Claud, 2003) were used when assessing eligibility.

Eligibility

Inclusion criteria were persistent symptoms of work-related stress, defined by physiological and psychological symptoms of sustained arousal lasting more than 4 weeks, and elevated reactivity of symptoms to demands at work. Motivation to remain employed and, if on sick leave, a planned return to work within 4 weeks were required. Participants were either on sick leave, through assessment by their doctor, or working. For the latter, a score of 20 points or above on the Perceived Stress Scale was required (equaling

1 standard deviation above the population mean; S. Cohen & Williamson, 1988).

Exclusion criteria were more than 26 consecutive weeks of sick leave, substantial psychosocial strains outside of work, bullying as the main problem, severe psychiatric condition or a history of repeated psychiatric conditions, and current abuse of alcohol or psychoactive stimulants.

Allocation

After the baseline measurement, an independent person opened an envelope containing the participants' allocation. After randomization, 51 participants were in the wait-list control group, and 51 participants made up the intervention group. In the first 3 months after baseline, six participants dropped out from both the intervention and the wait-list control groups (see Figure 1).

Intervention

There were eight 3-hr sessions over a period of 3 months with nine participants each. Sessions were led by one of two experienced clinical psychologists. Groups met for weekly 3-hr sessions the first 4 weeks and then every fortnight for the remaining four sessions. Topics for the sessions were (a) introduction to cognitive–behavior therapy, (b) psychoeducation about stress, (c) identification of dysfunctional thinking, (d) modification of dysfunctional thinking, (e) communication and stress, (f) communication skills training, (g) implementation of strategies at work, and (h) review of techniques. The main focal point for the intervention throughout the sessions was coping with stressful situations at work and implementing new coping strategies at the workplace through homework assignments between group sessions.

The first group session was an introduction to the course as a whole and techniques used in cognitive–behavior therapy. The subsequent seven sessions were formatted as follows: Each group session was initiated by a short mindfulness exercise, "Breathing Space." After this, participants reported on the progress of their homework and any success or difficulties they had met. The topic of the day's session was then presented by the group leader in a slideshow presentation and discussed with the group. After the presentation, the group split into smaller units of two or three participants to do group work on the topic of the session. In some group sessions dealing with communication skills, group work was substituted with role-playing exercises. Each

session ended with new homework assignments and a discussion detailing each participant's approach to the assignment. (Further information regarding the intervention is available by contacting the first author.)

In the second group session, Bootzin's (2000) recommendations for cognitive–behavioral treatment of insomnia, as well as healthy sleeping habits, were introduced. Apart from this session, the topic of sleep was not included in the intervention manual.

Outcome Measures

Outcomes were self-reported quality of sleep, number of hours spent in bed, amount of everyday cognitive failures, and the Digit Span test. Each outcome is described in detail below. By relying mainly on self-report measures, the clinical practice perspective of the study is underlined, as we gain information on participants' perception of their sleep and cognitive ability, rather than the more objective measures one can obtain from basic laboratory research on sleep and cognition.

Basic Nordic Sleep Questionnaire

The Danish version of the Basic Nordic Sleep Questionnaire (BNSQ; Partinen & Gislason, 1995) was used to assess quality of sleep. The scale has been shown to have good internal consistency, and has been used in a range of both epidemiological and clinical settings (Partinen & Gislason, 1995).

A selection of seven items regarding quality of sleep was made from the original 27 items in the full BNSQ. The full BNSQ contains questions on a broad selection of sleep disturbances, among these snoring and sleep apnea, which were deemed less relevant to the participant with work-related stress. The selected items reflected our best clinical judgment of relevant sleep problems encountered in the study population.

The seven selected items covered the domains of overall sleep quality, trouble falling asleep, waking during the night, number of wakings per night, early wakening, sleepiness in the morning, and sleepiness during the day. Each item was scored on a 5-point Likert scale. Item 1 ranged from 1 (*good*) to 5 (*poor*); Items 2, 3, and 5 ranged from 1 (*never or only once a month*) to 5 (*every night or almost every night*); Item 4 ranged from 1 (*no wakings*) to 5 (*at least five wakings*); Item 6 ranged from 1 (*never or only once a month*) to 5 (*every morning or almost every morning*); and Item 7 ranged from 1 (*never or only once a month*) to 5 (*every day or almost every day*). Respondents were asked to assess their sleep within the past 4 weeks prior to

responding. A Cronbach's alpha of .69 was found for the selected items and the present sample.

On the BNSQ, the respondents were also asked to state at what time they typically go to bed in the evening and rise in the morning, making it possible to calculate the number of hours spent in bed during the night.

Cognitive Failures Questionnaire

The Cognitive Failures Questionnaire (CFQ; Broadbent et al., 1982) was used to measure everyday cognitive errors. The questionnaire was designed to assess the frequency of lapses in three areas, perception, memory, and motor function, and was proposed by the authors to tap a single factor coined "cognitive failures." The questionnaire consists of 25 items that are scored on a 5-point Likert scale ranging from 0 (*never*) to 4 (*very often*). Respondents were asked to assess the amount of cognitive failures within the past 4 weeks prior to filling out the questionnaire. In the present sample, a Cronbach's alpha of .90 was found, comparable to the Cronbach's alpha of .91 reported by Broadbent et al. (1982).

Digit Span Test

In the laboratory, participants were assessed with the Digit Span test (Wechsler, 1997), which is a short neuropsychological test assessing working memory attention span. Normative data derived from a Danish population sample exist for this test (Nielsen, Knudsen, & Daugbjerg, 1989).

Statistical Analysis

Statistical analyses were performed using the STATA (Stata Corp. LP, College Station, TX) and WinPEPI (Brixton Health, London, England) software packages. The data were analyzed blinded by letting an external consultant recode the grouping variable. The blinding was kept unbroken until final conclusions had been drawn on the results.

Baseline characteristics were compared using the chi-squared test of comparable distributions and Student's t test.

Outcome analyses were performed as intention-to-treat with mixed model univariate repeated measures analysis of variance. Model validation was performed using Bland–Altman plots, QQ plots of the residuals, and sum residual plots. Estimates are reported with 95% confidence intervals.

To enable comparison between changes on different measures, we calculated effect sizes using Cohen's *d* (J. Cohen, 1988). Calculating Cohen's *d* is a method commonly used to derive standardized mean differences on a given scale or questionnaire. It measures changes over time in terms of standard deviations from the original distribution at baseline, and is calculated as d = mean(a) – mean(b)/(pooled variance of a and b). Results are interpreted using the following guidelines: small $d < 0.5$ *SD*, medium $d =$ 0.5–0.8 *SD*, and large $d > 0.8$ *SD*.

RESULTS

Baseline Characteristics

Demographic and baseline characteristics for the intervention group and the wait-list control group are presented in Table 1. No significant differences were found between the two groups at baseline.

Outcome Measures

In the present study design, the control condition was discontinued as the timeframe moved beyond 3 months after baseline. Therefore, the results from the analysis of the outcome measures fall in two parts. In the baseline to 3 months timeframe, the results from the randomized controlled trial are reported. From 3 to 9 months, the results from the follow-up study are reported.

Randomized Controlled Trial

To provide a visual presentation of the results, Figure 2 outlines changes from baseline to the 3-month measurement on quality of sleep (BNSQ), hours spent in bed per night (BNSQ), cognitive failures (CFQ), and the Digit Span test.

The results regarding quality of sleep, hours spent in bed per night, amount of cognitive failures, and working memory attention span are presented for the randomized controlled trial in Table 2. After presenting the scores at baseline for both groups, the changes in estimates from baseline to 3 months are displayed first as the 0–3 months' change in absolute numbers with a corresponding *p* value, and second as standardized mean differences, represented by Cohen's *d*.

At baseline, the two groups are comparable on all four outcomes. Looking at changes over time, different patterns emerge for the different

Table 1. Demographic and Baseline Characteristics

Characteristic	Group	
	Intervention	Wait-list control
Gender, *n* (%)		
Female	41 (80.4)	43 (84.3)
Male	10 (19.6)	8 (15.7)
Mean (range) age (years)	44 (28–61)	46 (24–58)
Referred by, *n* (%)		
General practitioner	24 (47.1)	29 (56.9)
Union	4 (7.8)	6 (11.8)
Self-referred	23 (45.1)	16 (31.4)
Sick leave		
Full	20 (39.2)	20 (39.2)
Partial	14 (27.5)	16 (31.4)
Contacted general practitioner[a], *n* (%)	49 (96.1)	50 (98.0)
Education, *n* (%)		
9 years	10 (9.8)	11 (10.8)
12 years	41 (40.2)	39 (38.2)
Higher education[b], *n* (%)		
Short (<3 years)	18 (17.6)	14 (13.7)
Medium (3, 4 years)	28 (54.9)	29 (56.9)
Long (>4 years)	5 (9.8)	7 (13.7)
Mean (range) years in workforce	18 (1–38)	17 (2–37)
Occupation (by field), *n* (%)		
Social	14 (27.5)	15 (29.4)
Health	7 (13.7)	9 (17.7)
Teaching	9 (17.7)	5 (9.8)
Administration	10 (19.6)	3 (5.9)
Other	10 (19.7)	13 (25.5)
Taking medication, *n* (%)	21 (41.2)	25 (49.0)
Taking medication for, *n* (%)		
Depression	15 (29.4)	10 (19.6)
Hypertension	2 (2.0)	5 (4.9)
Hypothyroidism	4 (3.9)	4 (3.9)

[a] As shown under "Referred by", not all participants were referred by their general practitioner. However, all but three participants had contacted their genereral practitioner about their current problems prior to being referred either by the general practitioner, the union or via self-referral, lending to the severity of their current problems. [b] Denotes the length and level of higher education that participants have completed. Higher education is defined as a vocational education (school or university degree) that qualifies one for specific occupation or occupational field.

outcomes. On the BNSQ, both groups showed significant within-group changes over time. However, the score of the intervention group improved at 3 times the rate of the wait-list control group. The difference between the amount of change in the two groups shows a significant between-groups effect size of $d = 0.64$.

Because the total score on the BNSQ is a composite measure of both quantitative and qualitative aspects of sleep, we performed subanalyses at the item level to investigate the internal consistency of the measure. In the subanalysis, we found that the scores on all items favored the intervention

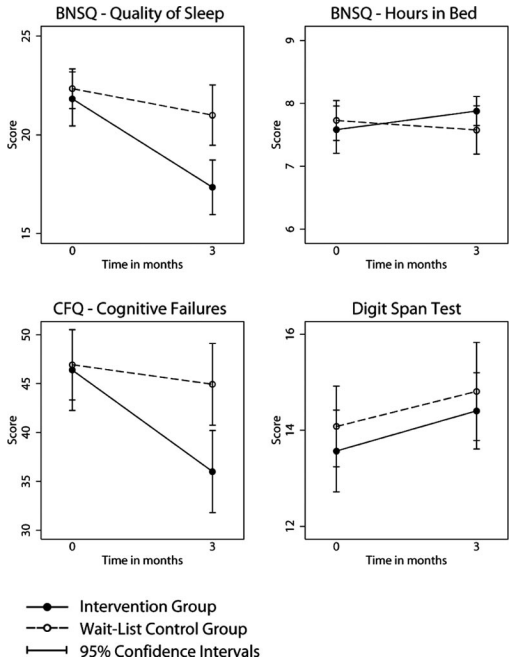

Figure 2. Changes on outcome measures from baseline (0–3 months).

over the wait-list control condition, and the combined effect of that is reflected in the total score displayed in Table 2.

Regarding number of hours spent in bed, the intervention group reported spending more time in bed, whereas the wait-list control group reported spending less time. Neither of these within-group changes, nor the between-groups difference, reached statistical significance.

On the CFQ, we found a significant within-group change in the intervention group that was roughly 5 times greater than the changes in the wait-list control group. The difference between the amount of change in the two groups shows a significant between-groups effect size of $d = 0.57$.

Finally, on the Digit Span test, we see improvements in both groups of roughly the same magnitude. As a result, the between-groups difference was very small ($d = 0.02$).

Follow-Up Study

After being put on a waiting list for 3 months, the participants in the wait-list control group were offered the stress management intervention.

Table 2. Changes Over Time From the Randomized Controlled Trial

	Baseline			0–3 months changes				
Variable	*M*	*SD*	95% CI	*M* change	*p*	95% CI	*d*	95% CI
Basic Nordic Sleep Questionnaire								
Intervention	21.82	4.72	[20.53, 23.12]	−4.45	.000	[−5.80, −3.11]	−0.94	[−1.23, −0.66]
Wait-list control	22.40	4.75	[21.09, 23.70]	−1.42	.041	[−2.77, −0.06]	−0.30	[−0.58, −0.01]
Intervention effect	—	—	—	−3.04	.000	[−4.95, −1.13]	−0.64	[−1.05, −0.24]
Hours in bed								
Intervention	7.58	1.13	[7.27, 7.89]	0.27	.081	[−0.03, 0.58]	0.24	[−0.03, 0.52]
Wait-list control	7.73	1.14	[7.42, 8.05]	−0.12	.441	[−0.43, 0.19]	−0.11	[−0.38, 0.17]
Intervention effect	—	—	—	0.39	.076	[−0.04, 0.83]	0.35	[−0.04, 0.74]
Cognitive Failures Questionnaire								
Intervention	46.15	13.84	[42.35, 49.95]	−9.97	.000	[−13.13, −6.81]	−0.72	[−0.95, −0.49]
Wait-list control	47.09	13.99	[43.25, 50.93]	−2.05	.219	[−5.32, 1.22]	−0.15	[−0.38, 0.09]
Intervention effect	—	—	—	−7.92	.001	[−12.47, −3.37]	−0.57	[−0.90, −0.24]
Digit Span test								
Intervention	13.57	3.14	[12.71, 14.43]	0.79	.043	[0.03, 1.56]	0.25	[0.01, 0.49]
Wait-list control	14.08	3.14	[13.22, 14.94]	0.74	.058	[−0.03, 1.50]	0.24	[−0.01, 0.48]
Intervention effect	—	—	—	0.05	.925	[−1.03, 1.13]	0.02	[−0.33, 0.36]

Note. The effect of the intervention is estimated as the between-groups difference of the changes from 0 to 3 months.

From this point, the two groups were no longer comparable in a randomized controlled design. However, the two groups were still followed independently and continued to supply information on the effect of the intervention. Table 3 shows the analysis on scores of the BNSQ, number of hours spent in bed, and scores on the CFQ and the Digit Span test in the 3- to 6-month timeframe for the intervention group as well as in the 3- to 9-month timeframe for the wait-list control group.

In the 3- to 6-month interval, no significant changes occurred within the intervention group, which was now no longer receiving treatment. On the two measures that improved significantly from baseline to 3 months (BNSQ and CFQ; see Table 2), the gains achieved were maintained at this 3-month follow-up.

From 3 to 6 months, the wait-list control group received the stress management intervention. Significant within-group changes occurred on the BNSQ ($d = 0.33$) and the CFQ ($d = 0.63$). No significant changes were observed for hours spent in bed or the Digit Span test.

Finally, in the interval from 6 to 9 months, where the wait-list control group was being followed up 3 months after termination of treatment, no significant changes occurred on any of the measures.

DISCUSSION

The results indicate that subjectively experienced quality of sleep and amount of cognitive failures can be positively affected by a stress management program. In accordance with guidelines for the interpretation of effect sizes (J. Cohen, 1988), the effect of the intervention can be labeled as medium to large for quality of sleep and cognitive failures. In the follow-up part of the trial, the effects of the intervention were maintained on both measures as the timeframe moved beyond 3 months after baseline.

Regarding the number of hours spent in bed per night, we found no differences between the two groups. The mean time spent in bed fell between 7 and 8 hr for both groups at all time points, which is within the normal human range (Kronholm et al., 2008). When juxtaposing the changes in quality of sleep with hours spent in bed, one can infer that although both groups spent approximately the same number of hours in bed, the intervention group had more potential to recuperate during those hours, given the higher quality of sleep experienced, reflecting less trouble falling asleep, fewer nightly wakings, less proneness to early morning wakenings, and less morning and daytime fatigue.

One can compare the findings from the present study with cognitive–behavior therapy for primary insomnia, originating from the field of sleep

Table 3. Scores at 3 Months and Within-Group Changes Over Time From the Follow-Up Study

	3 months		3–6 months				6–9 months			
Variable	*M*	95% CI	*M* change	*p*	95% CI	*d*	*M* change	*p*	95% CI	*d*
Basic Nordic Sleep Questionnaire										
Intervention	17.37	[16.03, 18.70]	−0.13	.853	[−1.52, 1.26]	−0.03	—	—	—	—
Wait-list control	20.98	[19.65, 22.32]	−1.58	.029	[−3.00, −0.16]	−0.33	−0.47	.546	[−2.00, 1.06]	−0.10
Hours in bed										
Intervention	7.86	[7.54, 8.18]	−0.22	.171	[−0.53, 0.09]	−0.20	—	—	—	—
Wait-list control	7.61	[7.29, 7.93]	−0.17	.299	[−0.50, 0.15]	−0.15	−0.13	.478	[−0.49, 0.22]	−0.12
Cognitive Failures Questionnaire										
Intervention	36.18	[32.32, 40.03]	−2.51	.121	[−5.70, 0.67]	−0.18	—	—	—	—
Wait-list control	45.04	[41.14, 48.93]	−8.95	.000	[−12.32, −5.59]	−0.63	0.00	.998	[−3.36, 3.36]	0.00
Digit Span										
Intervention	14.36	[13.47, 15.25]	0.05	.909	[−0.75, 0.84]	0.01	—	—	—	—
Wait-list control	14.82	[13.93, 15.71]	0.21	.605	[−0.60, 1.02]	0.07	−0.11	.796	[−0.96, 0.74]	−0.04

research. In the present study, where symptoms of insomnia were comorbid with a wider range of symptoms associated with work-related stress, the stress management intervention provided reliable changes on measures of subjective sleep quality, although the intervention did not target sleep problems extensively.

On the Digit Span test, we observed no differences between the intervention and wait-list control condition. Within both groups, we found a rise over time in the participants' scores. This rise was in all probability a test–retest effect, which is commonly found in repeated neuropsychological testing (Lezak, 1995). When compared with the normative data from a Danish sample (Nielsen et al., 1989), scores on the Digit Span test are slightly above the sample means. There is no indication that participants in the present sample could not belong to the general population regarding working memory attention span. With the limited evidence presented here, there is no reason to assume that more fundamental neuropsychological impairments in working memory attention span have been sustained by the participants as a result of their prolonged stress reaction.

As mentioned in the introduction, impairment in cognitive performance measured by neuropsychological tests has been associated with chronic stress (Sandström et al., 2005). In the present context, participants had a stress reaction for up to 6 months, but participants with chronic stress conditions (i.e., more than 26 consecutive weeks of sick leave) were not included. This difference in sampling could account for some of the difference in the findings regarding cognitive impairment measured by neuropsychological testing.

Whether the Digit Span test is an appropriate measure of cognitive functioning can be debated. It was originally included in the study to obtain an objective measure of cognitive functioning to contrast the self-report data obtained with the CFQ. Methodological concerns in terms of practicability and feasibility also played a role in the selection of this measure. On the other hand, it may be too simple a tool to properly tap the complexities of the full scope of human memory and attention.

Limitations

The wait-list control design imposes limitations regarding the conclusions one can draw compared with a conventional controlled design. Letting the wait-list control group cross over and receive the treatment has been an ethical and logistical consideration in attempting to ensure a high degree of motivation in the control group while still maintaining a partially controlled design. It was feared that participants randomized to a control condition

throughout the trial would have low motivation to continue participating after their allocation or be prone to seek help elsewhere while acting as controls.

Apart from its practical and logistical considerations, it can be argued that the wait-list control design does offer an opportunity to investigate whether the effect of the intervention can be replicated in the wait-list control group when offered the intervention 3–6 months after baseline. The intervention effect on the two outcome measures in the randomized controlled part of the study, quality of sleep and cognitive failures, was mimicked when the wait-list control group received the intervention 3–6 months after baseline, as seen in Table 3.

The use of self-report data to assess sleep and everyday cognitive failures is a limitation of the current study, and may potentially reduce the weight of the conclusions one can draw. In an intervention trial, self-report data are vulnerable to participants' expectations of change rather than actual change. Also, in sleep research, objective and subjective measures of sleep are not always highly correlated. However, in a study by Ekstedt et al. (2006), patients suffering from severe occupational burnout had poorer quality of sleep on subjective and objective measures of sleep, but there may be differences between the study population assessed by Ekstedt et al. and our study population.

Relying mainly on self-report data highlights the emphasis we have put on a clinical practice perspective rather than a basic laboratory approach. As pointed out above, the subjective improvement in sleep and cognitive ability reported by the participants after the intervention, may not necessarily be reflected in an actual improvement in sleep if measured in the laboratory. However, from a clinical perspective, the subjective experience of better sleep and cognitive ability may positively affect participants' perception of their own work ability, and thus may promote actively managing their work situation.

We do not regard subjective and objective measures of sleep or cognitive ability as mutually exclusive. In future studies, we recommend that subjective measures of sleep and cognitive failures be used in conjunction with objective measures to further understanding of their interconnection.

Comparisons and Evaluation of Findings

To our knowledge, no previous studies have investigated the effect of a stress management intervention on sleep and cognition. However, a number of studies have investigated the connection between stress and either sleep or impairment in cognitive ability.

A strong association has been found between psychosocial strain experienced at work and poor quality of sleep (Eriksen, Bjorvatn, Bruusgaard, &

Knardahl, 2008; Knudsen, Ducharme, & Roman, 2007; Kudielka et al., 2004). In the light of these findings, we propose that the stress management intervention is effective in lowering the perceived psychosocial work strain and improves the quality of sleep experienced.

Work stress has been associated with cognitive failures (Mahoney et al., 1998; Van Der Linden et al., 2005). In a similar fashion to the argument made on stress and sleep, we propose that lowering the participants' stress through a stress management intervention also lowers the amount of cognitive failures.

In terms of clinical relevance, the findings from the present study point to the stress management intervention's impact on areas critical for performing at work. Occupational injuries (Akerstedt, Fredlund, Gillberg, & Jansson, 2002) and loss in productivity (Ricci, Chee, Lorandeau, & Berger, 2007) have been associated with fatigue and poor quality of sleep. Poor sleep and fatigue have also been associated with long-term sick leave absence (Akerstedt et al., 2007), which is a burden on organizations and society that has been increasingly reported in countries across the European Union in recent years (Borg et al., 2000). In this light, an intervention that improves quality of sleep, reduces fatigue, and improves everyday cognitive performance is an asset for both the individual and the employing organization.

Conclusion

In conclusion, this study has shown that the stress management intervention has a medium effect on improving self-reported quality of sleep and reducing reports of everyday cognitive failures when compared with a wait-list control condition. The gains achieved during the intervention were maintained at 3-month follow-up. Hours spent in bed per night and working memory attention span were within normal ranges and were not affected by the intervention.

REFERENCES

Akerstedt, T. (2006). Psychosocial stress and impaired sleep. *Scandinavian Journal of Work, Environment and Health, 32,* 493–501.

Akerstedt, T., Fredlund, P., Gillberg, M., & Jansson, B. (2002). A prospective study of fatal occupational accidents—Relationship to sleeping difficulties and occupational factors. *Journal of Sleep Research, 11,* 69–71.

Akerstedt, T., Kecklund, G., Alfredsson, L., & Selen, J. (2007). Predicting long-term sickness absence from sleep and fatigue. *Journal of Sleep Research, 16,* 341–345.

Beck, A., Rush, A., Shaw, B., & Emery, G. (1979). *Cognitive therapy of depression*. New York: Guilford Press.

Beersma, D. G. (1998). Models of human sleep regulation. *Sleep Medicine Reviews, 2,* 31–43.

Bootzin, R. (2000). Cognitive–behavioral treatment of insomnia: Knitting up the ravelled sleeve of care. In D. T. Kenny, J. G. Carlson, F. J. McGuigan, & J. L. Sheppard (Eds.), *Stress and health: Research and clinical applications* (pp. 243–266). Amsterdam, the Netherlands: Harwood Academic.

Borg, V., Brouwers, A., Kuhn, K., Neboit, M., Méreau, P., & Nogareda, S. (2000). *Research on work-related stress*. Brussels, Belgium: European Agency for Safety and Health at Work.

Broadbent, D. E., Cooper, P. F., FitzGerald, P., & Parkes, K. R. (1982). The Cognitive Failures Questionnaire (CFQ) and its correlates. *British Journal of Clinical Psychology, 21* (Pt. 1), 1–16.

Brugha, T., Bebbington, P., Tennant, C., & Hurry, J. (1985). The List of Threatening Experiences: A subset of 12 life event categories with considerable long-term contextual threat. *Psychological Medicine, 15,* 189–194.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. Hillsdale, NJ: Erlbaum.

Cohen, S., & Williamson, G. (1988). The social psychology of health. In S. Spacapan & S. Oskamp (Eds.), *The social psychology of health: Claremont Symposium on Applied Social Psychology* (pp. 31–67). Newbury Park, CA: Sage.

De Lange, A. H., Taris, T. W., Kompier, M. A. J., Houtman, I. L. D., & Bongers, P. M. (2004). The relationships between work characteristics and mental health: Examining normal, reversed and reciprocal relationships in a 4-wave study. *Work & Stress, 18,* 149–166.

Ekstedt, M., Söderström, M., Åkerstedt, T., Nilsson, J., Søndergaard, H., & Aleksander, P. (2006). Disturbed sleep and fatigue in occupational burnout. *Scandinavian Journal of Work, Environment and Health, 32,* 121–131.

Eriksen, W., Bjorvatn, B., Bruusgaard, D., & Knardahl, S. (2008). Work factors as predictors of poor sleep in nurses' aides. *International Archives of Occupational and Environmental Health, 81,* 301–310.

Knudsen, H. K., Ducharme, L. J., & Roman, P. M. (2007). Job stress and poor sleep quality: Data from an American sample of full-time workers. *Social Science & Medicine, 64,* 1997–2007.

Kripke, D. F., Garfinkel, L., Wingard, D. L., Klauber, M. R., & Marler, M. R. (2002). Mortality associated with sleep duration and insomnia. *Archives of General Psychiatry, 59,* 131–136.

Kronholm, E., Partonen, T., Laatikainen, T., Peltonen, M., Härmä, M., Hublin, C., . . . Sutela, H. (2008). Trends in self-reported sleep duration and insomnia-related symptoms in Finland from 1972 to 2005: A comparative review and re-analysis of Finnish population samples. *Journal of Sleep Research, 17,* 54–62.

Kudielka, B., Von Kanel, R., Gander, M. L., & Fischer, J. E. (2004). Effort-reward imbalance, overcommitment, and sleep in a working population. *Work & Stress, 18,* 167–178.

Lezak, M. (1995). *Neuropsychological assessment* (3rd ed.). New York: Oxford University Press.

Mahoney, A. M., Dalby, J. T., & King, M. C. (1998). Cognitive failures and stress. *Psychological Reports, 82*(Pt. 2), 1432–1434.

Maslow, A. (1943). A theory of human motivation. *Psychological Review, 50,* 370–396.

Miller, S., Duncan, B., Brown, J., Sparks, J., & Claud, D. (2003). The Outcome Rating Scale: A preliminary study of the reliability, validity and feasibility of a brief visual analog measure. *Journal of Brief Therapy, 2,* 91–100.

Morgenthaler, T., Kramer, M., Alessi, C., Friedman, L., Boehlecke, B., Brown, T., . . . Swick, T. (2006). Practice parameters for the psychological and behavioral treatment of insomnia: An update. An American Academy of Sleep Medicine report. *Sleep, 29,* 1415–1419.

Morin, C., Bootzin, R., Buysse, D., Edinger, J., Espie, C., & Lichstein, K. (2006). Psychological and behavioral treatment of insomnia: Update of the recent evidence (1998–2004). *Sleep, 29,* 1398–1414.

Nielsen, H., Knudsen, L., & Daugbjerg, O. (1989). Normative data for eight neuropsychological tests based on a Danish sample. *Scandinavian Journal of Psychology, 30,* 37–45.

Nilsson, P. M., Nilsson, J. A., Hedblad, B., & Berglund, G. (2001). Sleep disturbance in association with elevated pulse rate for prediction of mortality—Consequences of mental strain? *Journal of Internal Medicine, 250,* 521–529.

Nilsson, P. M., Rööst, M., Engström, G., Hedblad, B., & Berglund, G. (2004). Incidence of diabetes in middle-aged men is related to sleep disturbances. *Diabetes Care, 27,* 2464–2469.

Partinen, M., & Gislason, T. (1995). Basic Nordic Sleep Questionnaire (BNSQ): A quantitated measure of subjective sleep complaints. *Journal of Sleep Research, 4*(Suppl. 1), 150–155.

Ricci, J. A., Chee, E., Lorandeau, A. L., & Berger, J. (2007). Fatigue in the U.S. workforce: Prevalence and implications for lost productive work time. *Journal of Occupational and Environmental Medicine, 49,* 1–10.

Sandström, A., Rhodin, I. N., Lundberg, M., Olsson, T., & Nyberg, L. (2005). Impaired cognitive performance in patients with chronic burnout syndrome. *Biological Psychology, 69,* 271–279.

Schaufeli, W., & Enzmann, D. (1998). *The burnout companion to study and practice*. London: Taylor & Francis.

Van Der Linden, D., Keijsers, G., Eling, P., & Van Schaijk, R. (2005). Work stress and attentional difficulties: An initial study on burnout and cognitive failures. *Work & Stress, 19,* 23–36.

Wagle, A. C., Berrios, G. E., & Ho, L. (1999). The Cognitive Failures Questionnaire in psychiatry. *Comprehensive Psychiatry, 40,* 478–484.

Wearden, A., & Appleby, L. (1997). Cognitive performance and complaints of cognitive impairment in chronic fatigue syndrome (CFS). *Psychological Medicine, 27,* 81–90.

Wechsler, D. (1997). *WAIS–III administration and scoring manual*. San Antonio, TX: Psychological Corporation.

Willert, M., Thulstrup, A., Hertz, J., & Bonde, J. P. (2009). Changes in stress and coping from a randomized controlled trial of a three-month stress intervention. *Scandinavian Journal of Work, Environment and Health, 35,* 145–152.

Youngstedt, S. D., & Kripke, D. F. (2004). Long sleep and mortality: Rationale for sleep restriction. *Sleep Medicine Reviews, 8,* 159–174.