Restoring Depleted Resources: Efficacy and Mechanisms of Change of an Internet-Based Unguided Recovery Training for Better Sleep and Psychological Detachment From Work

David D. Ebert
Friedrich-Alexander University and Harvard University

Matthias Berking
Friedrich-Alexander University

Hanne Thiart
Leuphana University

Heleen Riper
Leuphana University and Vrije Universiteit Amsterdam

Johannes A. C. Laferton
Harvard University

Pim Cuijpers
Leuphana University and Vrije Universiteit Amsterdam

Bernhard Sieland and Dirk Lehr
Leuphana University

Objective: This randomized controlled trial evaluated the efficacy of an Internet-based intervention, which aimed to improve recovery from work-related strain in teachers with sleeping problems and work-related rumination. In addition, mechanisms of change were also investigated. Methods: A sample of 128 teachers with elevated symptoms of insomnia (Insomnia Severity Index [ISI] ≥ 15) and work-related rumination (Cognitive Irritation Scale ≥ 15) was assigned to either an Internet-based recovery training (intervention condition [IC]) or to a waitlist control condition (CC). The IC consisted of 6 Internet-based sessions that aimed to promote healthy restorative behavior. Self-report data were assessed at baseline and again after 8 weeks. Additionally, a sleep diary was used starting 1 week before baseline and ending 1 week after postassessment. The primary outcome was insomnia severity. Secondary outcomes included perseverative cognitions (i.e., work-related rumination and worrying), a range of recovery measures and depression. An extended 6-month follow-up was assessed in the IC only. A serial multiple mediator analysis was carried out to investigate mechanisms of change. Results: IC participants displayed a significantly greater reduction in insomnia severity (d = 1.37, 95% confidence interval: 0.99–1.77) than did participants of the CC. The IC was also superior with regard to changes in all investigated secondary outcomes. Effects were maintained until a naturalistic 6-month follow-up. Effects on insomnia severity were mediated by both a reduction in perseverative cognitions and sleep effort. Additionally, a greater increase in number of recovery activities per week was found to be associated with lower perseverative cognitions that in turn led to a greater reduction in insomnia severity. Conclusions: This study provides evidence for the efficacy of an unguided, Internet-based occupational recovery training and provided first evidence for a number of assumed mechanisms of change.

Keywords: insomnia, work stress, prevention, Internet-based self-help, mediators

Supplemental materials: http://dx.doi.org/10.1037/hea0000277.supp

This 2015 special supplemental issue of Health Psychology is supported by funding from the National Institutes of Health (NIH) Office of Behavioral and Social Sciences Research (OBSSR) to support the dissemination of research on eHealth and mHealth interventions, methods, and implications in the practice of health psychology. Trial registration: World Health Organization International Clinical Trial Registry No. DRKS00004984. David D. Ebert, Matthias Berking, Hanne Thiart, Bernhard Sieland, and Dirk Lehr are stockholders of Institut für Online-Gesundheitstrainings GmbH (Institute for Trainings Online), a research institute that implements evidence-based online trainings in routine mental health care.

Correspondence concerning this article should be addressed to David D. Ebert, Harvard Medical School, Harvard University, 180 Longwood, Boston, MA. E-mail: david.ebert@fau.de
Occupational stress is a common phenomenon associated with a range of severely negative health consequences (Bhui, Dinos, Stansfeld, & White, 2012). Successful recovery from work-related strain, defined as the restoration of depleted resources after work, is considered to be important in order to protect from the negative consequences of occupational stress and to maintain good health (Zijlstra & Sonnentag, 2006). Two processes can be considered especially important for effective recovery: sleep and psychological detachment from work.

Sleep is considered the most basic and important psychological and somatic recovery process. A number of longitudinal studies (Åkerstedt, Nordin, Alfredsson, Westerholm, & Kecklund, 2012; Åkerstedt et al., 2012; De Lange et al., 2009; Jansson & Linton, 2006; Linton, 2004; Pereira & Elfering, 2014) provide evidence for the negative effects of stress on the development and persistence of sleep problems. Prevalence rates for current insomnia range from 11.4% (Ursin, Baste, & Moen, 2009) to 23% (Kessler et al., 2011). Sleep problems are associated with lower affective well-being (Kompier, Taris, & van Veldhoven, 2012), increased risk of depression (Baglioni et al., 2011), and lower occupational performance (Kessler et al., 2011). There is also increasing evidence that low sleep quality and sleep deprivation affect reactivity to stressors (Vandekerckhove & Clydts, 2010) and lower the psychological threshold for the perception of stress from cognitive demands (Minkel et al., 2012), which may lead to a downward spiral between the effects of work stress and sleep impairment.

Another necessary process for effective recovery from work-related strain is considered to be the effective psychological detachment from work at the end of the working day (Sonnentag, 2012). The failure to unwind from work, in its intensive forms of detachment from work at the end of the working day (Sonnentag, 2012), may lead to a downward spiral between the effects of work stress and sleep impairment.

Studies on the indirect effects of occupational stress, perseverative cognitions, and sleep found that sleep quality mediates the relationship between rumination and fatigue (Querstret & Croupley, 2013), and that there is increasing evidence that indicates that the inability to stop worrying about work during free time may be an important mechanism in the relationship between work stress and sleeping problems (Berset et al., 2011; Pereira & Elfering, 2014; Radstaak et al., 2014). For example, Berset and colleagues found that work-related rumination fully mediated the association between stress at work and self-reported sleep quality. It has also been found that worry mediated the effect of daily stressors on heart rate variability during waking and the subsequent nocturnal sleep period (Brosschot et al., 2007). A recent diary study showed that psychological detachment from work partially mediated the effect of stressors at work on ambulatory actigraphy-assessed sleep onset latency and sleep duration (Pereira & Elfering, 2014).

There is ample evidence for the successful treatment of clinical primary insomnia with cognitive–behavioral therapy (CBT; Ellis & Barclay, 2014), but studies that include participants with sub-threshold insomnia complaints have had findings of lower effect sizes (Koffel, Koffel, & Gehrman, 2014). Research on interventions targeting impaired sleep (i.e., without a clinical diagnosis of insomnia) in stressed employees, however, is scarce and tends to yield mixed results (Willert et al., 2010; Dalgaard et al., 2014; Suzuki et al., 2008).

Considering (a) the extensive evidence on the association of stress and poor psychological detachment from work on impaired sleep, (b) their adverse consequences, and (c) evidence that interventions for employees with work-related mental health problems are often less effective when they do not take work-related aspects into account (Blonk, Brenninkmeijer, Lagerved, & Houtman, 2006; Nieuwenhuijzen et al., 2014), the limited amount of intervention research on combined interventions that target recovery by improving effective psychological detachment from work and sleep is surprising.

Our own group recently developed an intervention (GET.ON Recovery) that aims to improve recovery from work-related strain by applying cognitive–behavioral and metacognitive techniques for insomnia and perseverative cognitions (Querstret & Croupley, 2013) and by promoting healthy restorative behavior, such as recreational activities and boundary tactics (Kreiner, Hollensbe, & Sheep, 2009). The intervention was developed in an Internet-based guided self-help format in order to address potential limitations of face-to-face psychological occupational health interventions that include restricted availability, reach, high costs, and threshold to utilize (Ebert et al., 2014a; Junge et al., 2015). In a randomized controlled trial with 128 employees that experienced work-related rumination and sleeping problems, we found the intervention to be effective in reducing insomnia severity and fostering mental detachment from work (Thiart, Lehr, Ebert, Berking, & Riper, 2015). However, given the novelty of the approach, replication is clearly indicated before a widespread dissemination can be considered. Moreover, the study evaluated only an intervention that included substantial professional support (of up to 3 hr total per participant). Although it is less resource-intensive than most individual CBT interventions, it is still time consuming. Because costs of Internet-based interventions, after initial development, are substantially linked to professional guidance time, this clearly limits the possible reach of the intervention and consequently its potential to reduce the negative consequences of occupational strain at the population level. However, a number of studies on unguided Internet- and computer-based stress management interventions did not find any significant effects (Billings, Cook, Hendrickson, & Dove, 2008; Wiegand et al., 2010). It remains yet unclear whether an unguided intervention could be effective in enhancing recovery from work-related strain, and thus evaluating the unguided intervention delivery format appears promising.

Moreover, there is yet no evidence on whether the multicomponent intervention GET.ON Recovery works according to its proposed mechanisms. The intervention was developed on the basis of theoretical assumptions and above reviewed empirical evidence on the prospective and reciprocal association of (work-related) perseverative cognitions, sleep, and adverse health consequences. It is assumed that a better psychological detachment from work and improved sleep both have direct positive effects on health and well-being. Moreover, it is also assumed that by targeting perseverative cognitions, sleep is also
indirectly improved. In line with the cognitive model of insomnia, “the attention-intention-effort pathway” (Espie, Broomfield, MacMahon, Macphee, & Taylor, 2006), it is hypothesized that normal and automatic sleep processes become disrupted when individuals explicitly intend to sleep and engage in efforts to produce sleep. Sleep effort has been suggested to be an important mechanism in the psychological treatment of insomnia complaints (Espie, Broomfield, MacMahon, Macphee, & Taylor, 2006). However, it has to the best of our knowledge not yet been tested empirically (Schwartz & Carney, 2012). Thus, it is further assumed that a reduction in sleep effort is associated with a reduction of insomnia complaints. On the basis of the principles of health behavior change specified in the Health Action Process Approach (Schwarzer, 2008), the training also aims to increase the number of recreational activities, thereby fostering positive emotions that are considered to be important to broaden and build resources. It is assumed that an increase in recreational activities is associated with better mental detachment from work, and that this in turn leads to a reduction of sleeping problems. Finally, it is also assumed that an increase in recreational activities is associated with greater mental well-being, both through direct effects as well as through indirect effects via enhancing mental detachment from work.

This study aimed at strengthening the evidence base for Internet-based recovery interventions by investigating the effectiveness of an unguided recovery intervention in teachers with heightened levels of work-related rumination and impaired sleep. Moreover, we aimed to investigate a number of assumed mechanisms of change.

Method

Design

A two-armed randomized controlled trial (RCT) was conducted between May 2013 and November 2014 to compare unguided iRECT (GET.ON Recovery, intervention condition [IC]) to a wait-list control condition (CC). We included 128 teachers in order to be able to detect an effect size of \( d = 0.50 \) at posttreatment based on a power (\( 1 - \beta \)) of 0.80 in a two-tailed test with \( \alpha = .05 \). The intervention was evaluated in a sample of teachers (1) because teachers are often considered to be highly affected by work-related stress (Lear, Hillert, & Keller, 2009); (2) to strengthen the internal validity of the study; and (3) because teachers usually have low boundaries between work and private life and thus face the risk for an insufficient psychological detachment from work. Assessments took place at baseline (T1) and posttreatment (8 weeks, T2; Figure 1). We also assessed an extended 6-month follow-up (6-MFU) in the IC. This study was approved by the University of Marburg ethics committee (no. 2014-20K).

Participants and Procedure

Participants were recruited using e-mail distribution lists to schools sent by the Ministry of Education in the German state of Nordrhein-Westfalen. People who applied for study participation received a letter online with detailed information about the study procedures and were asked to provide an e-mail address to participate. Applicants were asked to complete online screening questionnaires including a 7-day sleep diary. Participants meeting all of the inclusion and none of the exclusion criteria were randomly allocated to study conditions using an automated computer-based random integer generator (randlist). Inclusion criteria were (a) primary, secondary, or vocational school teachers, (b) over the age of 18, (c) currently employed, (d) experiencing insomnia symptoms as measured by a score of \( \geq 15 \) on the Insomnia Severity Index (ISI; (Bastien, Vallières, & Morin, 2001), (e) experiencing low levels of psychological detachment from work (i.e., work-related rumination) as measured by a score of \( \geq 15 \) on the Cognitive Irritation subscale of the Irritation Scale (IS; Mohr, Müller, & Rigotti, 2007), and (f) access to the Internet. Subjects that were receiving psychological help for their sleep problems or showing suicidal ideation (Beck Depression Inventory—II, Item 9, \( \geq 1 \)) were excluded from participation. People who took sleep medication were not excluded from the study, but were requested to keep their medication constant during the study period. We chose a score of \( \geq 15 \) on the ISI because this indicates elevated levels of insomnia complaints (Morin, 1993) and a cut-off of \( \geq 15 \) on the IS because this indicates an above-average level of rumination (Mohr et al., 2007).

Intervention

The Internet-based recovery training (GET.ON Recovery; detailed description in the work of Thiart et al., 2013) consists of six sessions. The sessions focus on the following: Session 1: psychoeducation on recovery from work-caused stress (i.e., interconnection between sleep, psychological detachment, and the utilization of recreational activities) and sleep hygiene; Session 2: stimulus control and sleep restriction; Session 3: boundary tactics (i.e., practical behaviors that help to distinguish work and private life and thus foster psychological detachment from work (Kreiner et al., 2009) and a gratitude journal before going to sleep that aims to focus the participant’s attention on pleasant experiences and divert from fixation on rumulative thoughts (Emmons & McCullough, 2003); Session 4: psychoeducation on work-related rumination and worrying, their effects on sleep, and strategies to overcome such perseverative cognitions; Session 5: metacognitive techniques (Wells et al., 2009; i.e., detached mindfulness and attention training in order to cope with perseverative cognitions; and Session 6: future plans, in which participants reflect on strategies that they tried that were helpful and which they want to continue to apply in future daily routines. Each session can be completed in approximately 45 to 60 min. Sessions are interconnected, meaning that once a specific technique is introduced, participants are continuously asked to review their progress with the application of the techniques and set specific goals for the next week. In every session, participants actively plan the implementation of recreational activities into daily life according to the behavioral-activation approach. Additionally, participants are asked to choose at least one new exercise to apply throughout the forthcoming week. We advised participants to complete one session per week. Sessions consist of articles, exercises, and testimonials, and include interactive elements such as audio and video clips. The training is adaptive because the content is tailored to the specific needs of the individual participant by continuously asking participants to choose among various response options. Subsequent content is then modified depending on the participant's response. Participants were encouraged to keep a daily online recovery diary including items on total sleep time, time in bed, work-related rumi-
nation in the evenings, and frequency of recreational activities. Participants who did not want to log in to the Website on a daily basis were provided with a paper-and-pencil diary. The version evaluated in the present study was fully automated, and participants did not receive any support beyond that which was provided in a technical support hotline (e-mail, phone). Development of the intervention took place at the Leuphana University Lueneburg. An advisory panel consisting of experts from occupational mental health, clinical psychology, software development, and E-Mental Health was involved in the development. The initial program draft was pilot-tested in the target population and revised on the basis of user feedback. The software architecture was provided by Minddistrict GmbH.

**Measures**

**Primary outcome measure.** Insomnia severity was measured with the ISI (Bastien et al., 2001). This instrument has seven items that are answered on a 5-point Likert scale (e.g., “To what extent

![Flow Chart](image-url)
do you consider your sleep problem to interfere with your daily functioning currently?”). The total score ranges from 0 to 28. Internal consistency was \( \alpha = .86 \) in the present study.

**Secondary outcome measures.** In further secondary analyses, the effect of the intervention on additional outcomes was explored. The specific instrument used, number of items, range of items, reliabilities found at T2 in this study, some examples of instrument questions, and citations are listed parenthetically. Higher scores usually indicate better recovery except for depression, rumination, worrying, and sleep quality. There were 11 total additional secondary outcomes included. These were as follows: (1) depression (Center for Epidemiological Studies’ Depression Scale; 20 items ranging 0–3, with total range 0 to 60; \( \alpha = .90 \); e.g., “I felt that everything I did was an effort” [Hautzinger & Bailer, 1993]; (2) work-related strain/rumination (Cognitive Irritation Scale [CIS]; 3 items ranging 0–7, with total range 3–28; \( \alpha = .91 \); e.g., “Even at home I have to think about problems at work”); higher scores indicate greater rumination; Mohr, Rigotti, & Müller, 2007); (3) worrying (Penn State Worry Questionnaire, Ultra Brief Version, past week [PSWQ-PW]; 3 items ranging 0–6, with total range 0–18; \( \alpha = .84 \); e.g., “Once I started worrying, I could not stop”; Stöber, 2002); (4) recovery experiences (Recovery Experience Questionnaire; 16 items ranging 1 to 5; with 4 subscales: psychological detachment from work, \( \alpha = .89 \), e.g., “During time after work, I don’t think of my work at all”; relaxation, \( \alpha = .91 \), e.g., “During time after work, I kick back and relax”; mastery, \( \alpha = .86 \), e.g., “During time after work, I do things that are challenging”; control, \( \alpha = .91 \), e.g., “During time after work, I decide myself what I do”; Sonnentag & Fritz, 2007); (5) frequency of recovery activities per week (Recreation Experience and Activity Questionnaire; 21 items ranging from 0 [never] to 4 [at least 4 times per week], with total range 0–84; \( \alpha = .86 \); Lehr, 2015); (6) recuperation in sleep (Recuperation in Sleep subscale; 7 items ranging 1–5; \( \alpha = .91 \); e.g., “How relaxed did you feel upon waking up?”; Görtelmeyer, 2011); (7) sleep quality (Pittsburgh Sleep Quality Index; 1 item ranging 1–4; e.g., “During the past month, how would you rate your sleep quality overall?”); Buysse, Reynolds, Monk, Berman, & Kupfer, 1989); (8) sleep effort (Glasgow Sleep Effort Scale [GSES]; 7 items ranging 0–2; \( \alpha = .76 \); e.g., “I worry about not sleeping if I cannot sleep”); (9) sleep efficiency (assessed with an online sleep diary used each day for 7 days before baseline and 7 days after T2. In the diary, participants recorded the time at which they left their beds each morning, their previous evening’s bedtime, and their total hours of sleep. Sleep efficiency was computed using this diary data with the following formula days: total hours of sleep/evening’s bedtime—time out of bed in the morning]); (10) days with insomnia (days with a sleep efficiency below 80% were classified as a day with insomnia); and finally (11) user satisfaction (Client Satisfaction Questionnaire [CSQ-8], adapted to the online-context; 8 items ranging 1–4, with total range 0–32; \( \alpha = .94 \); e.g., “I would recommend this training to a friend in need of similar help”; Attkisson & Zwick, 1982).

**Statistical Analysis**

All analyses were conducted according to the Consolidated Standards of Reporting Trials (CONSORT) statement using intention-to-treat procedures (ITT). Analyses were performed with IBM SPSS version 22. A significance level of .05 (two-sided) was used for all outcome variables.

Multiple imputation with 100 estimates per missing value was used to handle missing data. Little’s overall test of randomness indicated missing data completely at random (\( \chi^2 = 21.64, df = 644, p = 1.0 \)), and therefore multiple imputations of missing data could be conducted. The assumed superiority of iRECT when compared to CC was tested with regard to (a) change in primary and secondary outcomes from baseline (T1) to postintervention (T2), (b) amount of participants with reliable change in the primary outcome, and (c) amount of participants who reach a nearly symptom-free state. Differences in change from baseline to post-treatment between the IC and CC were assessed using analysis of covariance with baseline levels as covariates. Within- and between-groups Cohen’s \( d \) and its 95% confidence intervals (CIs) were calculated as a measure of effect size on the basis of differences between baseline and follow-up scores, standardized by the pooled standard deviation of the change scores.

**Reliable change.** To determine the numbers of participants achieving a reliably positive outcome, we coded participants as responders or nonresponders according to the widely used Reliable Change Index (RCI; Jacobson & Truax, 1991). Accordingly, participants were considered responders if their ISI-10 score differed by more than \(-5.01 \) points from baseline to postassessment (RCI score = 1.96).

**Symptom-free status.** Following the suggestion from Morin (Bastien et al., 2001), we can classify participants as symptom-free if their score falls below 8 on the ISI. We also calculated odds ratios and the number needed to treat (NNT), which indicates the number of participants that have to be treated to generate one additional positive outcome.

**Stability of treatment effects.** We also examined the stability of gains in the IC in order to investigate whether maintenance strategies following intervention discontinuation are indicated.

**Mediators.** A number of assumed mechanisms of change of this multicomponent intervention were tested with a serial multiple mediator model with age and sex as covariates. Such models allow for the simultaneous consideration of multiple mechanisms and provide the possibility to compare effect sizes of indirect effects through different mediators. We hypothesized that (1) the intervention effect on the primary outcome, change in insomnia severity, is mediated by a change in perseverative cognitions (i.e., worry) (Group [GR] → PSWQ → ISI); (2) there is an indirect effect from the intervention over sleep effort on change in insomnia severity (GR → GSES → ISI); and (3) that the effect of the intervention on the increase in recreational activities is associated with reduced perseverative cognitions, and that this in turn leads to a reduction of sleeping problems (GR → ReaQ → PSWQ → ISI). Supplemental Figure 1 displays a graphical representation of the hypothesized associations. The sample size limited us in the estimation of more complex models, such as also considering direct and indirect effects on depression as one relevant long-term consequence of work-related strain. We used the PROCESS macro for SPSS (v. 2.13.1) with bias corrected bootstrapping (1000) to obtain 95% CIs for testing the total indirect effect and the specific indirect effects. Bias corrected bootstrapping has been found to perform better with regard to power than do alternatives for testing on indirect effects (Fritz & Mackinnon, 2007), and it requires no assumptions regarding the shape of the sampling distribution of the
indirect effect. An indirect effect was considered significant if the 95% CI for the coefficient estimate did not include zero.

**Results**

**Participants**

The enrollment and flow of participants throughout the study is summarized in Figure 1. Table 1 presents the baseline characteristics of the study participants. The total sample consisted of 128 teachers with an average age of 48.5 years (SD = 9.9). Ninety-five were female (74.2%), and the average work experience was 21 years (SD = 11.2). Only 15 (11.7%) had participated in any traditional mental health promotion training before. Table 2 shows descriptive data for all outcome variables on each assessment point. At baseline, the mean score for the primary outcome, insomnia severity, was 18.27 (SD = point. At baseline, the mean score for the primary outcome, insomnia severity, was 18.27 (SD = 4.93 (95% CI: 3.12–11.76).

**Primary Outcome Analyses—Insomnia Severity**

The IC showed a significantly greater improvement on the primary outcome from baseline to posttest, F(1, 125) = 60.86, p < .001, compared to the CC (see Table 3). The effect size, according to Cohen’s criteria, was large (d = 1.37; 95% CI: 0.99–1.77). At posttest, significantly more participants of the IC were classified as symptom-free state compared to the CC (see Table 3). The effect size, according to Cohen’s criteria, was large (d = 1.09, p = .38), compared to the CC (see Table 3). The effect size, according to Cohen’s criteria, was large (d = 1.09, p = .38), compared to the CC (see Table 3). The effect size, according to Cohen’s criteria, was large (d = 1.09, p = .38), compared to the CC (see Table 3). The effect size, according to Cohen’s criteria, was large (d = 1.09, p = .38), compared to the CC (see Table 3). The effect size, according to Cohen’s criteria, was large (d = 1.09, p = .38), compared to the CC (see Table 3). The effect size, according to Cohen’s criteria, was large (d = 1.09, p = .38), compared to the CC (see Table 3). The effect size, according to Cohen’s criteria, was large (d = 1.09, p = .38), compared to the CC (see Table 3). The effect size, according to Cohen’s criteria, was large (d = 1.09, p = .38), compared to the CC (see Table 3). The effect size, according to Cohen’s criteria, was large (d = 1.09, p = .38), compared to the CC (see Table 3). The effect size, according to Cohen’s criteria, was large (d = 1.09, p = .38), compared to the CC (see Table 3). The effect size, according to Cohen’s criteria, was large (d = 1.09, p = .38), compared to the CC (see Table 3). The effect size, according to Cohen’s criteria, was large (d = 1.09, p = .38), compared to the CC (see Table 3). The effect size, according to Cohen’s criteria, was large (d = 1.09, p = .38), compared to the CC (see Table 3). The effect size, according to Cohen’s criteria, was large (d = 1.09, p = .38), compared to the CC (see Table 3). The effect size, according to Cohen’s criteria, was large (d = 1.09, p = .38), compared to the CC (see Table 3). The effect size, according to Cohen’s criteria, was large (d = 1.09, p = .38), compared to the CC (see Table 3). The effect size, according to Cohen’s criteria, was large (d = 1.09, p = .38), compared to the CC (see Table 3).

**Secondary Outcome Analyses**

Table 3 presents the results of the secondary outcomes. Significant effects in favor of the IC were found for all outcomes. The majority of effect sizes were moderate to large, ranging between d = 0.26 (95% CI: 0.09–0.61) for days with insomnia to d = 1.37 (95% CI: 0.80–1.56) for psychological detachment from work.

**Six-Month Outcome and Maintenance of Gains**

A repeated-measures analysis of variance (see Table 3) showed significant, medium, and large within-group effects from baseline to a naturalistic 6-MFU in the IC for most outcomes (d = 0.75–1.88). Effects on recovery control and mastery were significant, but effect sizes were only small to medium. There were no substantial negative changes from posttreatment to the 6-MFU, indicating that effects were stable over time.

**Complete Case Analysis**

Complete case analysis (without imputation of missing data) closely corroborated the ITT analysis, as most effects found in the ITT analysis were also significant and of similar size in the complete analysis. Similarly to the ITT analysis, large effect sizes were observed for baseline to posttreatment (d = 1.25; 95% CI: 0.82–1.68) and for baseline to 6-MFU changes (d = 2.12; 95% CI: 1.57–2.67) in insomnia severity. The effect sizes for secondary outcomes were moderate to large, ranging from 0.44 (95% CI: 0.05–0.83) for recreational activities to 1.42 (95% CI: 0.98–1.86) for psychological detachment. Six-month effect sizes ranged from 0.63 (95% CI: 1.12–0.14) for relaxation to 2.12 (95% CI: 1.57–2.67) for insomnia severity. Only the 6-month effect on recovery mastery was not significant 0.18 (95% CI: −0.30–0.66).

**Intervention Usage and User Satisfaction**

Of the 64 individuals who were assigned to the IC, 7 (10.9%) participants dropped out before Session 1 of the intervention. Session 1 was completed by 57 (89.1%), Session 2 by 50 (78.1%), Session 3 by 47 (73.4%), Session 4 by 44 (68.8%), Session 5 by 35 (54.7%), and all sessions by 31 (48.4%) participants. On average, participants completed 4.13 modules (SD = 2.24), which is 68.83% of the intervention. Linear regression indicated that participants who completed more treatment modules achieved a greater decrease in the primary outcome, insomnia severity (b = −1.09, SE = .38, p = .007. 95% CI: −1.86 to −0.32). The regression coefficient suggested that with each extra module com-

---

**Table 1**

*Demographic Characteristics: Means/Counts, Standard Deviations/Percentages at Baseline*

<table>
<thead>
<tr>
<th>Demographic</th>
<th>All*</th>
<th>IC*</th>
<th>CC*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>128</td>
<td>64</td>
<td>64</td>
</tr>
<tr>
<td>Ethnicity Caucasian</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Years of occupational experience</td>
<td>21.0</td>
<td>10.4</td>
<td>11.2</td>
</tr>
<tr>
<td>Females</td>
<td>74.2</td>
<td>70.3</td>
<td>78.1</td>
</tr>
<tr>
<td>Married/partnership</td>
<td>82.8</td>
<td>82.9</td>
<td>82.8</td>
</tr>
<tr>
<td>On sick leave</td>
<td>3.0</td>
<td>3.1</td>
<td>1.6</td>
</tr>
<tr>
<td>Experiences with occupational mental health trainings</td>
<td>11.7</td>
<td>10.9</td>
<td>12.5</td>
</tr>
<tr>
<td>Experiences with psychotherapy</td>
<td>49.2</td>
<td>48.4</td>
<td>50.0</td>
</tr>
</tbody>
</table>

Note. IC = intervention condition; CC = control condition.

* N = 128. * N = 64. * N = 64.
completed, the drop in insomnia severity from baseline to posttreatment was greater by 1.09 points on the ISI. However, there was only a trend toward significance for the prediction of baseline to 6-MFU changes ($b = -1.09, SE = .62, p = .08, 95\% CI: -2.36–0.17$). Mean time spent for completing all modules per participant was 205 min ($SD = 94.20$, range: 15–450). Adherence to specific exercises to be carried out in daily life was assessed by asking participants in the session following the one in which this

### Table 2

**Means and Standard Deviations of Outcome Variables at All Assessments (Intention-to-Treat Sample)**

<table>
<thead>
<tr>
<th>Outcome variable</th>
<th>Baseline (T1)</th>
<th>Posttreatment (T2)</th>
<th>6-MFU (T3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
</tr>
<tr>
<td><strong>Sleep</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insomnia severity</td>
<td>18.27</td>
<td>2.78</td>
<td>17.70</td>
</tr>
<tr>
<td>Sleep efficiency</td>
<td>.78</td>
<td>.09</td>
<td>.79</td>
</tr>
<tr>
<td>Recuperation in sleep</td>
<td>2.48</td>
<td>.62</td>
<td>2.30</td>
</tr>
<tr>
<td>Sleep quality</td>
<td>3.05</td>
<td>.42</td>
<td>3.03</td>
</tr>
<tr>
<td>Sleep effort</td>
<td>6.13</td>
<td>2.41</td>
<td>6.48</td>
</tr>
<tr>
<td>Days with insomnia</td>
<td>3.42</td>
<td>2.15</td>
<td>3.16</td>
</tr>
<tr>
<td>Perseverative cognitions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work-related rumination</td>
<td>17.94</td>
<td>2.68</td>
<td>18.77</td>
</tr>
<tr>
<td>Worrying</td>
<td>10.27</td>
<td>4.27</td>
<td>18.77</td>
</tr>
<tr>
<td>Recovery experiences</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recovery control</td>
<td>3.07</td>
<td>.95</td>
<td>2.94</td>
</tr>
<tr>
<td>Recovery mastery</td>
<td>2.61</td>
<td>.83</td>
<td>2.44</td>
</tr>
<tr>
<td>Psychological detachment</td>
<td>1.89</td>
<td>.65</td>
<td>1.92</td>
</tr>
<tr>
<td>Relaxation</td>
<td>2.75</td>
<td>.75</td>
<td>2.66</td>
</tr>
<tr>
<td>Recreational activities</td>
<td>49.61</td>
<td>10.06</td>
<td>49.16</td>
</tr>
<tr>
<td><strong>Mental health</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depression</td>
<td>21.13</td>
<td>7.61</td>
<td>22.65</td>
</tr>
</tbody>
</table>

**Note.** IC = intervention condition; CC = control condition; T1 = baseline; T2 = postintervention; T3 = 6-month follow-up. *Not assessed at T3.

### Table 3

**ANOVA Results For Differences in Change From Baseline to Posttreatment Between Intervention and Control Conditions and Baseline to 6-Month Follow-Up Changes in Intervention Condition (Intention-to-Treat Sample)**

<table>
<thead>
<tr>
<th>Outcome variable</th>
<th>Differences in change between IC and CC from baseline to posttreatment (T1 – T2)</th>
<th>Baseline to 6-month follow-up changes (T1 – T3) in IC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ANCOVA F$_{df}$</td>
<td>Cohen’s $d^b$ (95% CI)</td>
</tr>
<tr>
<td><strong>Sleep</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insomnia severity</td>
<td>60.86 ,125***</td>
<td>1.37 (.99–1.77)</td>
</tr>
<tr>
<td>Sleep efficiency</td>
<td>12.125**</td>
<td>.46 (.27–.98)</td>
</tr>
<tr>
<td>Recuperation in sleep</td>
<td>54.09 ,125***</td>
<td>1.18 (.92–1.68)</td>
</tr>
<tr>
<td>Sleep quality</td>
<td>41.07 ,125***</td>
<td>1.13 (.76–1.51)</td>
</tr>
<tr>
<td>Sleep effort</td>
<td>22.32 ,125**</td>
<td>.84 (.48–1.20)</td>
</tr>
<tr>
<td>Days with insomnia</td>
<td>5.14 ,125*</td>
<td>.26 (.09–.61)</td>
</tr>
<tr>
<td>Perseverative cognitions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work-related rumination</td>
<td>36.03 ,125***</td>
<td>1.06 (.69–1.43)</td>
</tr>
<tr>
<td>Worrying</td>
<td>17.45 ,125***</td>
<td>.74 (.38–1.10)</td>
</tr>
<tr>
<td>Recovery experiences</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recovery control</td>
<td>18.63 ,125***</td>
<td>.76 (.40–1.12)</td>
</tr>
<tr>
<td>Recovery mastery</td>
<td>14.18 ,125***</td>
<td>.67 (.31–1.02)</td>
</tr>
<tr>
<td>Psychological detachment</td>
<td>95.07 ,125***</td>
<td>1.72 (1.32–2.13)</td>
</tr>
<tr>
<td>Relaxation</td>
<td>28.56 ,125**</td>
<td>.95 (.58–1.31)</td>
</tr>
<tr>
<td>Recreational activities</td>
<td>6.79 ,125**</td>
<td>.46 (.11–.82)</td>
</tr>
<tr>
<td><strong>Mental health</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depression</td>
<td>22.98 ,125**</td>
<td>.85 (.49–1.21)</td>
</tr>
</tbody>
</table>

**Note.** ANCOVA = analysis of covariance; IC = intervention condition; CC = control condition; T1 = baseline; T2 = postintervention; T3 = 6-month follow-up; CI = confidence interval; ANOVA = analysis of variance.

- ANOVA with baseline score as covariate.
- Effect size for difference in change from baseline to posttest standardized by the pooled standard deviation of the change scores.
- ANOVA = analysis of variance.
- *Repeated-measures ANOVA.
- **IC within-group effect size.
- *Not assessed at 6-month follow-up.

* $p < .05$.  ** $p < .01$.  *** $p < .001$. 


specific exercise was the core focus. It was asked whether they carried out the planned exercises completely, partly, or not at all. In Session two, 50.88% (n = 29) of the intervention starters (n = 57) indicated that they implemented recreational activities in their daily life in the planned frequency, 35.09% (n = 20) indicated that they achieved to implement them only partly, and 17.54% (n = 1) indicated that they did not at all implement additional recreational activities. The respective numbers for the implementation of recreational activities in daily life between Sessions two and three were 35.09% (n = 20), 47.37% (n = 27), and 0% (n = 0). With regard to carrying out sleep restriction between Sessions two and three, 63.16% (n = 36) indicated in Session three to have succeeded in doing it most of the days, whereas 17.54% (n = 10) indicated that they succeeded seldom or not at all. In Session four, in which participants were able to choose among different optional exercises, 17.54% (n = 10) chose the exercise “my strengths,” which is a reflection of which skills participants would theoretically need in a stress situation and how these skills and competencies were already present in the past; 42.11% (n = 24) chose “cognitive restructuring of sleep related dysfunctional thoughts,” and 12% (n = 7) chose the “worry chair,” which is a paradox intervention in which participants write a daily worry diary at a fixed “worry time” on a “worry chair.” In Session five, 35.09% (n = 20) indicated that they carried out the chosen exercise daily or most of the days, and 19.30% (n = 11) carried it out only seldom or not at all. User satisfaction was very high: mean score of the Multiple Serial Mediation Model. Group: intervention versus control group; recreational activities: Recreation Experience and Activity Questionnaire; perseverative cognitions: Penn State Worry Questionnaire; sleep effort: Glasgow Sleep Effort Scale; insomnia severity: Insomnia Severity Index. * p < .05. ** p < .01. *** p < .001.

Mechanisms of Change

The multiple serial mediation model and all respective coefficients of the model are presented in Figure 2. Below, we describe the results for the tests of the indirect effects. Results for each of

Figure 2. Standardized regression coefficients of the total direct effect and of the Multiple Serial Mediation Model. Group: intervention versus control group; recreational activities: Recreation Experience and Activity Questionnaire; perseverative cognitions: Penn State Worry Questionnaire; sleep effort: Glasgow Sleep Effort Scale; insomnia severity: Insomnia Severity Index. * p < .05. ** p < .01. *** p < .001.

Discussion

This randomized controlled trial evaluated the effects of an unguided Internet-based recovery training, which aims to teach employees health restorative behavior. Results support the effectiveness of the intervention on recovery activity and experiences (psychological detachment, mastery, control, number of recreational activities), sleep (insomnia severity, sleep efficiency, sleep quality, recuperation in sleep), perseverative cognitions (worrying, rumination), and mental health–related (depression) outcomes. An extended 6-MFU indicated that the effects remained stable over the long term. A greater number of treatment modules completed was associated with greater change in the primary outcome. Perseverative cognitions and sleep effort have been confirmed as relevant mechanism of change in insomnia severity, and the effect of recreational activities on insomnia was found to affect insomnia severity through its effects on perseverative cognitions.

The size of the effects found are somewhat surprising, because it has been previously found that Internet-based self-help interventions without guidance tend to be far less effective than interventions that include some sort of professional support (Baumeister, Reichler, Munzinger, & Lin, 2014). However, there do exist a few examples of target conditions such as alcohol abuse (Riper et al., 2014) in which differences between guided and unguided interventions were not detected, although these findings were only of a correlational nature. Nevertheless, the large effects demonstrated in the present trial may indicate that guidance is not necessary for this specific type of intervention in this specific target population in order to achieve clinically meaningful results. In fact, there are other studies on insomnia interventions that found large effects without applying intensive guidance (Espie et al., 2012; Ritterband et al., 2009), although these trials included at least some minimal personal contact, either through a face-to-face diagnostic session.
or a coach that moderated an online forum. In addition, other unguided Internet-based insomnia treatments found much lower effect sizes or nonsignificant effects compared to control groups (Riley, Mihm, Behar, & Morin, 2010; Suzuki et al., 2008), and a recent direct comparison of guided and unguided insomnia treatment found the guided treatment to be superior (Lancee, van den Bout, Sorbi, & van Straten, 2013). Nevertheless, even if unguided interventions do yield lower effects in direct comparisons, their potential on the population level may be greater, because unguided interventions have a wider reach and more participants can be treated for the same costs (Ebert et al., 2014b). On the other hand, it may be the case that employees will be less willing to participate in an intervention if no support is given, which would result in lower overall effects in the target population. Thus, future studies should compare the acceptability, effectiveness, and cost-effectiveness of guided and unguided recovery trainings.

To the best of our knowledge, the only other study to date that investigated an intervention to improve recovery from work-related strain by fostering psychological detachment from work and sleep evaluated a face-to-face occupational health group training in a quasi-experimental nonrandomized control group design (Hahn, Binnewies, Sonntag, & Moja, 2011). The authors of this pioneering study found small- to medium-sized effects for sleep quality ($d = 0.43$), medium-to-large effects for recovery relaxation ($d = 0.61$) and mastery ($d = 0.70$), large effects for psychological detachment ($d = 0.99$), and no significant effects on burnout.

Interestingly, the intervention’s effects on depressive symptoms ($d = 0.85$) were as large as those found in treatments for major depression (Cuijpers, Huibers, Ebert, Koole, & Andersson, 2013). This may indicate the special potential in targeting both psychological detachment and insomnia complaints together in this target condition in order to reduce long-term mental health consequences of work-related rumination and impaired sleep. Given that both impaired sleep (Baglioni et al., 2011), and perseverative cognitions (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008) have been shown to be longitudinally predictive of depression and that rumination is considered to be an antecedent of insomnia (Vahle-Hinz et al., 2014), there could be a high potential in such recovery interventions to prevent the onset of depressive disorders.

To the best of our knowledge, the present study is the first that showed that the effect of a psychological intervention on impaired sleep is mediated by perseverative cognitions, such as worry. This finding is in line with research indicating that the inability to stop worrying about work during free time may be an important mechanism in the relationship between work stress and sleeping problems (Bers et al., 2011; Pereira & Elfering, 2014; Radstaak et al., 2014). Most psychological interventions that aim to improve sleep also target cognitions, but these interventions usually target dysfunctional sleep-related and not general perseverative cognitions. The present results indicate that targeting perseverative cognitions also positively influences insomnia complaints, and thus may be a valuable target in interventions that aim to improve sleep. Whether the effect of perseverative cognitions on sleep can be explained through an increased general cognitive arousal, as hyperarousal models of insomnia would suggest (Riemann et al., 2010), or through other mechanisms needs to be explored in future studies.

Reduced sleep effort has been suggested to be one of the core mechanisms of psychological interventions for sleep (Espie et al., 2006; Schwartz & Carney, 2012). However, the present trial is the first that provided empirical evidence for this assumption.

This study has the following limitations. First, the results should be viewed in the context of the studied population, which comprised a sample of highly educated, mostly female teachers. The findings may only be valid for populations with comparable demographics and job-related characteristics (e.g., high education, low boundaries between work and private life). Second, the elaborate study inclusion process typically used for an RCT (i.e., completion of two self-report assessments, sending of informed consent) may have led to the self-selected inclusion of individuals who may be more motivated than one could expect outside of a research context. As a result, the results may not be generalizable to unguided interventions without a similar inclusion process. Third, the 6-MFU was only assessed in the IC and not in the CC. Although results show that achieved changes in the IC were stable over time, we cannot rule out the possibility that the CC could have also improved over time, and that the superiority of the recovery training could be diminished over time. However, a previous study evaluating a therapist-supported intervention format found that this was not the case (Thiart et al., 2015), and untreated sleeping problems usually persist over time (Morin et al., 2009). Fourth, there was considerable attrition. Although this is common in Internet-based intervention studies, especially with long-term follow-up (Eysenbach, 2005), and we applied state-of-the-art methods to handle missing data (Schafer & Graham, 2002), we cannot completely rule out a potential bias caused by missing data. Fifth, sleep efficiency was assessed using a daily sleep diary. Future studies should measure sleep parameters based on actigraphy in order to objectively measure sleep efficiency. Sixth, we did not assess whether the participants differed at baseline or follow-up in terms of proportion that took sleep medication, and we did not control for it in the statistical analysis. Thus, we are unable to rule out whether this may have biased the results. Seventh, the sample size did not allow us to examine more complex mediation mechanisms. Therefore, although the serial multiple mediator analysis confirmed core assumptions about the change mechanisms on insomnia severity, several questions remain unclear. For example, the intervention was developed under the assumption that targeting perseverative cognitions, sleep, and recreational activities also affect mental health and well-being, both directly and indirectly. Moreover, one needs to keep in mind that the current mediation analyses were based on only two time points. In order to draw conclusions with regard to the causality of the assumed mechanism, future longitudinal studies with repeated assessments of putative mediators are needed. Eighth, it remains unclear which elements of this multicomponent intervention were the most successful in contributing to the effect of the intervention and which elements are not as effective.

In conclusion, our data suggest that recovery trainings focusing on psychological detachment from work and sleep can result in substantial benefits for teachers. This study further adds to the growing evidence that Internet-based self-help interventions have a high potential for delivering occupational health interventions and suggests that guidance from health care professionals is not necessarily required to achieve clinically meaningful results.
References


Received January 23, 2015
Revision received May 29, 2015
Accepted July 18, 2015