Insomnia symptoms and their association with workplace productivity: cross-sectional and pre-post intervention analyses from a large multinational manufacturing company

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ABSTRACT

Background: Symptoms of insomnia are common and might impact work productivity. We investigated the relationship between insomnia symptoms and workplace productivity in a global manufacturing company.
Methods: Within an uncontrolled, cross-sectional study, employees from a US-based company were invited to participate in an online evaluation comprising the Sleep Condition Indicator (SCI) measuring symptoms of insomnia (high score indicating better sleep), 2 items of the Work Productivity and Impairment Index (WPAI) measuring 'presenteeism' and 'absenteeism' (high score indicating loss of work productivity) and 1 item of the Perceived Stress Scale (PSS) from January 2015 onwards. Pre-post, within-subject data were collected to preliminary test effects of 'sleep tips' and digital cognitive behavioral therapy (dCBT).
Results: In 2798 employees [72% male; mean age 46.3(SD11.8) yrs] sleep was poorest in plant staff [SCI = 3.70(2.73)], then retail staff [4.34(3.02)], then office staff [4.95(2.83): overall $F(2,2786) = 43.7, P < .0001$]. More insomnia symptoms were associated with WPAI presenteeism ($r = -.489, P < .0001; R^2 = 23.9\%$). Insomnia symptoms also were the strongest predictor of work-related productivity, with stress only contributing a further 9%. A regression model for 'absenteeism' was statistically significant but of limited predictive value ($R^2 = 3.4\%$). In a sample of 214 employees with pre- and post-intervention data, the SCI of those exposed to sleep tips significantly increased from 5.36(3.28) to 6.01(3.22), [$t(123) = -3.02, P = .003$] and from 3.08(2.24) to 6.03(2.97) for those who accessed dCBT [$t(89) = -8.40, P < .001$].
Conclusion: Symptoms of insomnia are associated with poor work productivity. Additionally, targeted insomnia interventions may offer potential to improve sleep and work productivity.

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Introduction

Consideration of what governs daytime performance typically is considered to revolve around daytime factors. However, the basic capacity to be awake, alert and engaged derives fundamentally from consolidated night-time sleep. As Tononi & Cirelli[1] put it: *"sleep is the price we pay"* for wakefulness. Inadequate sleep has two important health consequences. The first is intrusion of sleep into wakefulness. When wakefulness is maintained, homeostatic sleep pressure increases and sleep cannot be avoided, irrespective of stimulation. 'Microsleeps' comprising a few seconds when the person may seem superficially awake but the polysomnogram (PSG) actually shifts from waking characteristics to sleep, become irresistible, especially during the biological night.[2] The second documented consequence of sleep deprivation is performance deterioration, especially cognitive impairment.[3,4] Indeed, under certain circumstances, sleep may be inevitable also during the wake period even when people are well rested. The term 'local sleep' therefore is now used to denote times when local populations of neurons in the cortex may fall asleep.[5] One related concern is that people who are cognitively impaired through insufficient sleep often lack recognition of their impairment.[6]

Inadequate sleep can arise either from behavioral sleep deprivation (insufficient sleep opportunity) or from having a sleep disorder

of which there are 6 families: see ICSD-3[7] and DSM-5.[8] As an example of the effects of sleep disorder, insomnia has been associated with a wide range of adverse consequences including absenteeism, workplace accidents, increased likelihood of unethical behavior, poor concentration, lower productivity, impaired decision-making and increased sleepiness.[9–15] Of course, the relationship between sleep and wakefulness is bi-directional; and in the work context, shift schedules often disrupt the circadian system which regulates sleep, and confers risk for the development of sleep disorder.[16,17] For all the above reasons, sleep is increasingly regarded internationally as a public health policy priority.[18–21]

The development of psychometrically robust self-report measures to appraise both insomnia and work productivity, now allows us to explore these important relationships, at scale and in real world settings. The present study focuses therefore upon measurable relationships of insomnia with presenteeism and absenteeism in a large manufacturing company. For our purposes we consider presenteeism to reflect loss of productivity for employees whose health problems have not necessarily led to actual absenteeism.[22] We will also consider the potential effects of demographic factors, work role and perceived stress in understanding the relationship between sleep and productivity, and will present data suggesting that improving symptoms of insomnia may be associated with improved productivity within a manufacturing company.

Participants and methods

Participants

All participants were employed by a global manufacturing company with approximately 24,000 US-based employees. Employees were made aware of the *Sleepio™* program, via a combination of emails, articles on corporate intranet sites, posters and home mailers in January 2015, after this point signup was closed. No inclusion or exclusion criteria were used. Employees received no incentives for participation in the program which comprised 3 key components: (i) a sleep awareness campaign delivered at the population level and designed to get employees thinking about and prioritizing their sleep; (ii) a brief online personal sleep test consisting of a number of questions about the employee's sleep and its daytime impact, resulting in a detailed sleep report to the individual, providing 'light touch' sleep tips (https://www.sleepio.com/articles/): and (iii) an online sleep improvement program, providing digital cognitive behavioral therapy (dCBT)[23] delivered over weekly sessions of between 10-20 minutes each for those with complaints of insomnia (https://www.sleepio.com). Exploratory analyses were performed in a subsample of participants providing post-treatment data (n = 214) to assess the impact of providing sleep tips and the online sleep improvement program.

Design

This is an uncontrolled, cross-sectional study incorporating a small scale within-subjects interventional component.

Assessment measures

All employees were invited to complete an online 'sleep test'. This test incorporated questions about their type of sleep problem (falling asleep, staying asleep, waking too early) and the SCI-02, a validated short-form version of the 8-item Sleep Condition Indicator (SCI) which measures insomnia symptoms.[24] The SCI is a DSM-5 compliant measure with robust internal consistency ($\alpha \geq 0.86$) and convergent validity in relation to the Pittsburgh Sleep Quality Index and Insomnia Severity Index.[25,26] The SCI-02 comprises the items: "*Thinking about a typical night in the last month, how many nights a week do you have a*

problem with your sleep" (response options: 0–1, 2, 3, 4, 5–7 nights), and "*Thinking about the past month, to what extent has poor sleep troubled you in general*" (response options: "*not at all*", "*a little*", "*somewhat*", "*much*", "*very much*"). These 2 'best subset' items were derived using linear regression modelling in a combination of five validation studies with a total sample of 30,941 individuals, and correlate strongly with the SCI total score ($r = .90$).[24] SCI-02 scores are converted to a 10-point scale with '0' indicating the most severe problems, and '10' indicating no problems, for ease of understanding by the respondent. The SCI is sensitive to change following CBT.[23,27,28] A sub-sample completed the full SCI in a pre- and post-treatment test.

The online assessment also comprised 2 items of the Work Productivity and Impairment questionnaire (WPAI).[29] The WPAI was developed as a PRO (patient-reported outcome) quantitative assessment of the amount of absenteeism, presenteeism and daily activity impairment attributable to a specific health problem. "Absenteeism" represents work time that is missed with a high score indicating more time from work missed, whereas "presenteeism" is defined as reduction in job effectiveness with a high score indicating productivity loss due to poor sleep. In this study employees were asked the following question concerning presenteeism: "*Over the past 2 weeks, how much did poor sleep affect your productivity while you were working?*" and answered on a scale ranging from '0' "*no effect*" through to '100' "*unable to work*". Scores therefore may be represented as a percentage. Absenteeism was evaluated by the question "*Over the past 2 weeks, how many hours did you miss from your work per week because of problems associated with your sleep? (Include sick days, late starts, early finishes etc.)*". The WPAI is sensitive to the daytime effects of insomnia.[30]

The Perceived Stress Scale (PSS) is the most widely used psychological instrument for measuring the degree to which situations in one's life are appraised as stressful.[31] The 4-item short-form has strong psychometric properties (PSS-4)[32,33] and in this study we selected item 1 from the PSS-4 for inclusion in the online assessment: "*Over the past 2 weeks, how often have you felt that you were unable to control the important things in your life?*", measured on a 5-point scale ranging from '0' "*not at all*" through to 4 "*very often*". Whilst we acknowledge the limitations in using a single item, it has been reported that other items of the PSS exhibit statistically significant differential item functioning by sex, race and/or education, whereas this one item remains robust.[34] Of the four short-form items, Item 1 also has the strongest factor loading on perceived distress.[35]

Finally, sex, age and information on employment were also collected.

Interventions

As an exploratory analysis, the effects of dCBT and 'sleep tips' on insomnia and presenteeism and absenteeism were studied pre and post-treatment. Depending on their level of insomnia complaint users were offered 'sleep tips' or digital Cognitive Behavioral Therapy (dCBT). The 'sleep tips' consist of several leaflets relating to sleep and insomnia in different situations, such as pregnancy, jet lag or the basics of sleep. An overview of the leaflets can be found at https://www.sleepio.com/articles. Users could indicate which manuals they preferred to receive.

The dCBT program (Sleepio™) is an online, fully automated program specifically designed for insomnia[23] based on previously published CBT techniques[36] which can be accessed via web and associated iOS app. Users receive 6 sessions of about 10 to 20 minutes from an animated personal therapist in which core behavioural techniques and cognitive techniques are introduced. The behavioural techniques include sleep restriction during which the sleep window reduced to enhance sleep consolidation, stimulus control which suggests getting out of bed after 15–20 min of wakefulness, and relaxation for which the user is advised to tense and relax muscles.