

Sleep, work and mental health

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Abstract

Symptoms of insomnia are frequent among the working population. Insufficient sleep hampers daily performance by inducing feelings of tiredness, lower vigilance and impairments of memory. It also increases risk for occupational injuries, somatic and psychiatric disorders, and work disability. Finding sustainable solutions to improve sleep quality, by measures related to lifestyle, working environments and by implementing early therapeutic intervention with emerging symptoms, would be highly beneficial considering the burden sleep disturbances cause for individuals and society.

Introduction

Sleep plays an important role in health and well-being throughout life: for the brain and other organ systems. It is a necessity for restoring the energy resources of the body, restoration of synaptic homeostasis underlying learning and memory functions [1], and for removal of potentially neurotoxic waste products that accumulate in the brain during the waking period [2]. Disturbances in sleep have many adverse health effects. In experimental studies, sleep deprivation induces low-grade inflammation and deviation in energy metabolism in favour of atherosclerotic processes [3-5]. This is accompanied by changes in various neurobehavioural domains such as the feeling of tiredness, problems in learning and memory, as well as decreased vigilance, motivation and regulation of emotions [6]. In epidemiological studies, insufficient or qualitatively poor sleep increases the risk for somatic and psychiatric diseases, such as diseases of immune, metabolic, circulatory and cardiac systems, as well as mood disorders [7-9].

Sleep is regulated by complex neurophysiological processes that involve regulation of both timing of the sleep (the circadian process) and the amount of sleep, consisting of the duration and quality of sleep (the homeostatic component). The *circadian process* is controlled by an internal clock in the suprachiasmatic nuclei that is synchronized by external cues, predominantly the light-dark cycle. The *homeostatic process* is assumed to be mediated by sleep-inducing molecules, notably adenosine in an anatomically restricted area in the basal forebrain, and it reflects sleep pressure as a function of the time since the last adequate sleep. The interaction between these processes determines the sleep-wake cycle, its timing and the sleep depth [1].

As sleep is adaptive by its nature, it is also easily altered or even disturbed. Occasional disturbances in sleep belong in normal life, but chronic disturbances increase the risk for impaired function, development of somatic and mental disorders, and increased health care costs [10].

In the following review, we will describe the relationship of insomnia to mental health with a particular focus on the working age population and work environment.

Increasing trend of insomnia among the working population

Sleep disturbances are common in the general population. Epidemiological surveys reveal that about one-third of the general adult population reports at least occasional difficulties in sleeping. They also reveal that symptoms of insomnia have become more frequent during the past years and decades, particularly among the working population. In Finland, the prevalence of occasional or frequent insomnia-related symptoms increased from 21% to 38% and from 6% to 8%, respectively, between 1997 and 2003 among employees, with the steepest rise after the middle of the 1990s [11]. Among adolescents, there was an even more distinct, approximately two-fold increase in insomnia symptoms from the mid 1990s to 2008, after which the increase seems to have levelled out [12]. Reasons behind the increase of insomnia symptoms among both adult and adolescent populations remain to be untangled, but they might include factors related to modern working and schooling environments with busy schedules, globalized networks as well as working markets and mobile work. In addition, other modern lifestyle factors might be involved, such as the use of electronic media devices late into the night, encouraging later bedtimes and disturbing the innate 24-hour circadian rhythm [13]. For neurobiological mechanisms and general risk factors for insomnia, see Box 1.

The rise of insomnia symptoms in the Finnish population has co-occurred with the trend of increased prevalence of depressive disorders (from 7.3% in 2000 to 9.6% in 2011) [14]. This is of particular interest considering the strong evidence from neurobiological and epidemiological studies on a temporal and putatively and also a causal link between disturbed sleep and depressive mood, which will be discussed in the next section.

Box 1. Neurobiological mechanisms of insomnia.

Patients with insomnia display signs of increased arousal on autonomous and central nervous system. Their hormonal neural stress system is overactive, with increased levels of cortisol, increased heart rate, and changes in heart rate variability. Functional brain imaging studies [e.g. 52, 53] have revealed disinhibition of the arousal-promoting brain regions, leading to a decreased sleep drive and difficulties in falling asleep and maintaining the sleep. Thus, the neurobiological core of insomnia - an imbalance of sleep-wake regulation consists of *overactivity of the arousal systems* and *hypoactivity of the sleep-inducing systems*.

Typically, sleep disturbances documented by objective electrophysiological measurement of sleep (by polysomnography) are far less pronounced than would be expected from subjective reports [54]. This, along with findings on over-activity of the stress related physiological systems, has given rise to the *cognitive model of insomnia*. According to this model, excessive anxiety and dysfunctional beliefs about sleep leads to increased arousal and emotional distress, selective attentional monitoring of sleep-related threat cues, and an overestimation of the actual sleep deficit [55].

Various intrinsic (psychological and genetic) and external (environmental) factors have been linked to insomnia in epidemiological studies. *Psychological stress* increases the risk for insomnia, and personality traits related to the increased stress reactivity, such as liability to anxiety, associate with insomnia symptoms [56]. Also *childhood adversities* increase the risk for insomnia later in life, in particular poor childmother or child-father relationship, frequent fears of a family member, and serious conflicts in the family [57]. Family and twin studies provide evidence for a moderate *genetic component*, with heritability coefficients ranging from 20 to 55%. In a twin sample from Finland, the heritability estimates for subjectively experienced sleep showed a decreasing tendency in a follow-up of six years [20], which could be related to the effect of increasing age in triggering and maintaining symptoms of insomnia.

Insomnia as a risk factor for mental health problems

Transient disturbances in sleep are commonplace and may in some instances even serve to maintain good mental health. For example, considering the risk for developing post-traumatic stress disorder, short-term sleep loss directly after a trauma has been hypothesized to serve an adaptive function by preventing the strengthening of the traumatic experience [15].

More chronic disturbances are, however, a severe risk for mental and somatic health. Of psychiatric disorders, the link of disturbed sleep to depression is particularly well-established. The majority of patients with depressive disorder have symptoms of disturbances in sleep (insomnia or hypersomnia), which also belong to the diagnostic criteria of the disorder. Furthermore, sleep problems appear not only as an epiphenomenon of depressive disorder, but seem to be causally related to the disease pathology. Experimental studies in healthy subjects have revealed that acute sleep deprivation lowers mood [e.g. 16-18] particularly among individuals of morning-type chronotype [19], and a number of epidemiological studies reviewed and meta-analyzed in [8] show that insomnia confers a two-fold increased risk for development of depression in subsequent years. Our study, from a nationwide cohort including more than 18,000 adult twins [20], strongly suggested that this link is indeed temporally unidirectional: within a 6-year time frame, poor sleep predicted life dissatisfaction, an approximation for depressed mood with a correlation of $>.60$ with Beck Depression Inventory [21, 22], in a consistent pattern with a 2-to-3-fold risk, while life dissatisfaction did not significantly predict poor sleep [20]. Furthermore, the shared genetic component between poor sleep quality and life dissatisfaction was scanty, suggesting that most of the longitudinally observed associations between poor sleep and life dissatisfaction are causal, due to neurophysiological effects of sleep on the brain, the emotions and the experience of depressed mood.

Sleep-wake disturbances seem to present a more general hallmark for mood disorders, and they are of particular diagnostic and prognostic value among patients with bipolar disorder. Sleep deprivation can trigger a manic relapse in patients with bipolar disorder, and a reduced need of sleep is implied as one of the core symptoms of mania or hypomania. Furthermore, high-risk individuals for bipolar disorder exhibit more variable sleep durations and also have symptoms of sleep-wake disturbance during the inter-episode periods [23]. Consequently, due to their intrinsic sensitivity to disruption of sleep and circadian regulation, patients with bipolar disorder are

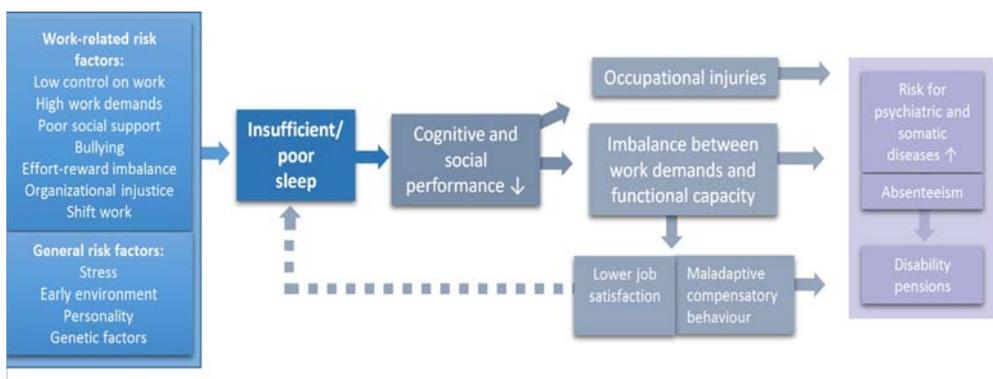
recommended, in the national current care guidelines, to live a life with a stable rhythm and, for example, to avoid irregular working hours in their working life (www.kaypahoito.fi, in Finnish).

In addition to traditional psychiatric disorders, disturbed sleep often presents with medically unexplained sensitivity symptoms, as well as functional pain and fatigue symptoms. These entities bring challenges for diagnostics, treatment, as well as for assessment of function and disability insurance practices.

Impaired daily functioning and sick leaves due to insomnia

As discussed above, the most striking adverse effects of insomnia on work ability are those related to the increased risk for somatic and psychiatric morbidity. However, even without any obvious medical disorder, disturbed sleep has adverse effects on an individual's functional capacity (Figure 1).

Figure 1. Work-related precipitating risk factors act in synergy with the general predisposing risk factors for developing symptoms of insomnia. Qualitatively poor or quantitatively insufficient sleep hampers cognitive and social performance at work. This may lead to a vicious circle where an imbalance between work demands and functional capacity leads to increased stress, maladaptive compensatory behaviour and lower job satisfaction, which in turn may aggravate the sleep problem. The risk for psychiatric and somatic diseases, such as mood disorders or diseases of immune, metabolic or circulatory systems, increases, as does work absenteeism and, eventually, disability pensions.



There is abundant data evidencing that qualitatively poor or quantitatively insufficient sleep hampers *cognitive and social performance* by inducing feelings of tiredness and leading to lower levels of attention and vigilance, slower reaction speed and impairments in memory and learning. It also increases vulnerability to *occupational injuries* even after accounting for a range of contributing factors, such as work stress, sleep length or alcohol use [24]. In addition to the direct negative effects of insufficient sleep, it will indirectly increase job strain due to imbalance between work demands and functional capacity, maladaptive compensatory behaviour (e.g. working overtime) and adverse career development and lower achievements. This will lead to lower job satisfaction, as well as social and economic losses involving adverse effects on mood [25, 26].

Qualitatively or quantitatively insufficient sleep also increases *absenteeism* from work [27]. According to a Finnish study, very short (5 hours or less) and very long (10 hours or more) sleep duration predicted more than double the amount of sickness absence days per year as compared to the optimal sleep duration of 7 to 8 hours, and a similar trend was observed with symptoms of disturbed sleep or insomnia [28]. It was estimated that direct costs due to sickness absence could decrease by up to 28% if sleep disturbances were to be fully addressed [28].

In the long run, the economic burden of *disability pensions* predicted by sleep disturbances is also remarkable [29, 30]. According to a study on employees of the city of Helsinki, insomnia symptoms predicted disability pensions for any reasons, and for psychiatric morbidity in particular [31]. In a study on public sector employees in Finland, frequent sleep disturbances predicted disability retirement due to mental disorders [32]. In concordance with these data, our study on a longitudinal population-based sample of twins showed that poor sleep quality predicted incident depression and disability retirement due to depressive disorder, with an approximate 3-fold increase in risk [9].

Risk factors of work environment for insomnia

Although employment, in general, has remarkable positive mental health effects [33] and unemployment increases the risk of insomnia [34], there are several work-related risk factors for insomnia (Figure 1). They act in synergy with the general risk for insomnia (see Box 1). Among public sector employees from Finland, low control over

working hours was associated with a higher prevalence and a higher incidence of sleep disturbances [35]. A systematic review has subsequently shown that good social support at work, control over work and organizational justice are related to fewer sleep disturbances, while high work demands, job strain, bullying and effort-reward imbalance were related to increased level of sleep disturbances [36].

A well-known work-related factor that is closely connected to disturbed sleep and related adverse health outcomes is *shift work*. Of the many health-related effects of shift work, disturbed sleep is the most common. Shift work disturbs the timing of the sleep, leading to circadian misalignment, poor sleep quality and disturbed sleep homeostasis [37, 38]. Individual sensitivity to the negative effects of shift work varies, with data suggesting that individuals of morning-type chronotype are prone to have more sleep disturbances during night shifts and those of evening-type chronotype during day shifts [see e.g. 39]. The most troublesome acute symptoms related to shift work are difficulties in getting to sleep, a shortened sleep and somnolence during working hours that continues into successive days off, and they are only partially amenable to amelioration by manipulating shift patterns [37]. A significant proportion (10% to 38%) of shift workers suffers from shift work disorder, a medical condition characterized by insomnia and excessive sleepiness [38]. As one-fifth of employees in Europe work in shifts, the problem affects millions of individuals across nations [40].

Adverse work stress, disturbed sleep and daytime tiredness may present as a vicious circle leading to burnout. *Burnout* is a common consequence of extended work stress combined with insufficient coping of the employee that shares overlapping features with sleep disturbances, such as daytime tiredness and a shortness of refreshing sleep, as well as with similar adverse health effects to those encountered in sleep disturbance, including changes in inflammatory and immune systems and cognitive and mood impairment [41, 42]. Aetiologically, work stress is an elementary precursor of burnout, whereas the aetiology of sleep disturbances is more heterogeneous. The relationship between burnout and insomnia is bidirectional: burnout predicts insomnia, and insomnia predicts burnout [43]. Besides, burnout is accompanied with a tendency for poor sleep quality, a lower sleep efficiency and daytime somnolence [44].

Concluding remarks

Above we have described how insufficient sleep hampers daily functioning and increases the risk for somatic and psychiatric disorders. Finding sustainable solutions to improve sleep quality among the general population - by measures related to lifestyle (diet, exercise, avoidance of substance abuse, stable circadian rhythm), working environment (mental hygiene at work and cognitive ergonomics, management and flexibility of working processes), stable working schedules or the possibility to influence working hours (forward-rotation in shift work) [45] - would be highly beneficial considering the economic burden sleep disturbances cause for society. Occupational health care, in co-operation with the employer and the employee, is responsible for adjusting the work environment safety and demands to fit with the employee's sleep-related vulnerabilities.

More clinical attention should be focused on sleep disturbances in occupational and psychiatric assessment and care. There are tools available for subjective and objective measurement of sleep quantity, quality and sleep-wake rhythm. Of them, sleep-wake diaries are particularly useful in routine assessment of the timing and variability of sleep, and may also help in identification of targets for behavioural interventions [10].

Among the therapeutic possibilities for insomnia, cognitive behavioural therapy for insomnia (CBT-I) and other psychological interventions, such as mindfulness-based therapy, have proven to be effective [46-50], although the lack of trained therapists may restrict their routine use in occupational health care. In addition to short-term group interventions conducted by trained nurses, computerised self-help CBT-I has shown to be an effective low-intensity treatment of insomnia [51]. Finally, since not all individuals can profit from psychological interventions, there is a need for alternative, novel therapeutic approaches.

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