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CLINICAL REVIEW

Sleep problems and work injuries: A systematic review and meta-analysis

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SUMMARY

Objectives: Sleep problems are a potential risk factor for work injuries but the extent of the risk is unclear. We conducted a systematic review and meta-analysis to quantify the effect of sleep problems on work injuries.
Methods: A systematic literature search using several databases was performed. Sleep problems of any duration or frequency as well as work injuries of any severity were of interest. The effect estimates of the individual studies were pooled and relative risks (RR) and 95% confidence intervals (CI) were calculated through random effects models. Additionally, the population attributable risk was estimated.
Results: In total, 27 observational studies (n = 268,332 participants) that provided 54 relative risk estimates were included. The findings of the meta-analysis suggested that workers with sleep problems had a 1.62 times higher risk of being injured than workers without sleep problems (RR: 1.62, 95% CI: 1.43–1.84). Approximately 13% of work injuries could be attributed to sleep problems.
Conclusion: This systematic review confirmed the association between sleep problems and work injuries and, for the first time, quantified its magnitude. As sleep problems are of growing concern in the population, these findings are of interest for both sleep researchers and occupational physicians.

Introduction

Occupational injuries are a major problem worldwide. Approximately 360,000 fatal occupational accidents occur yearly, and more than 960,000 workers become injured daily because of accidents.[1] The cost of work accidents and illness is over US$ 1,250,000 million a year.[2] To reduce the number of work injuries, it is necessary to know their risk factors. This knowledge could lead to developing countermeasures for preventing accidents.

Sleep problems may be a relevant risk factor for occupational injuries. Sleep is essential for the functioning of the human body. Disrupted sleep has numerous negative consequences, including increased mortality,[3,4] diabetes,[5,6] obesity,[7,8] burnout,[9] and poor performance.[10] Sleep problems are among the most common health complaints in the population. Estimates for the prevalence of sleep problems vary greatly. Recent reviews have indicated that 10–40% of the population suffer from insomnia,[11] 2–10% suffer from obstructive sleep apnea,[12] 4–29% suffer from restless legs syndrome,[13] and about 25% suffer from non-specific sleep-related problems.[14] Accordingly, the prevalence of sleep problems also varies in the working population, ranging from approximately 18% in Europe[15] to 23% in the United States.[16]

The role of sleep as a potential risk factor in accident prevention is still under debate. Narrative reviews reflect the strong belief and consensus among specialists that sleep problems have an impact on the occurrence of work injuries. The link between sleep restriction and on-the-job driving accidents is well established,[17–22] but evidence in other working areas is sparse.[23] Previous reviews have summarised only a few of the larger studies,[24] focused on costs[11,25] or conducted a narrative overview.[18,26,27] A systematic review was

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Abbreviations

Chi^2	Chi square (statistical test)
CI	confidence interval
ESS	Epworth sleepiness scale
I^2	statistical index of heterogeneity
IRR	incidence rate ratio
MeSH	medical subject headings
MOOSE	a proposal of reporting meta-analysis of observational studies in epidemiology
MSQ	mini sleep questionnaire
NA	not available
NOS	Newcastle-Ottawa scale
OR	odds ratio
p	*p*-value (statistical index of significance)
PAR%	population attributable risk percent
PSQI	Pittsburgh sleep quality index
RR	relative risk
STOP	obstructive sleep apnea questionnaire

published recently.[28] Reviews have focused on specific sleep disorders, such as obstructive sleep apnea,[12] insomnia,[11,25,28,29] sleep restriction,[18,30] or sleepiness.[24,26,27] However, to date, no review has quantified the impact of having any sleep problem on work injuries. Therefore, the aim of this work was to conduct a broad systematic review and a meta-analysis to quantify the relationship between sleep problems and work injuries other than work-related traffic accidents.

Methods

In conducting this review, we followed the illustrated, step-by-step guide for systematic reviews and meta-analyses by Pai et al.[31] and consulted the Cochrane handbook.[32] For reporting, we considered the guidelines for meta-analysis of observational studies in epidemiology (MOOSE).[33]

Identification of eligible studies

Electronic search

A highly sensitive search strategy was developed that allowed identification of all eligible articles published in psychological and medical journals for all years up to June 2011. The electronic search strategy combined three sets of search terms (see Appendix A). The first set was made up of terms characterising the exposure, the second set contained terms describing the outcome, and the third set specified the population. All terms within each set were combined with the Boolean operator OR, and then, the three sets were combined using AND. The Medline search was adapted to searching other databases. The search was not limited to a particular type of study design or publication language. The following electronic databases were searched on July 7th 2011 using both controlled vocabulary terms and relevant free text words:

- Medline (through PubMed; all years 1946 – present)
- Embase (through www.embase.com by Elsevier B.V. 2011; all years from 1947 – present)
- PsycInfo (through Ovid; Version: OvidSP_UI03.04.01.113, SourceID 54495, all years from 1806 – present)
- ISI Web of Science (through Web of Knowledge v.4.10, Thomson Reuters© 2010; all years from 1900 – present; SCI-EXPANDED (1899 – present) & SSCI (1898 – present))

Searching other sources

The reference lists of articles identified through database searches were examined to find additional relevant studies. Bibliographies of systematic and non-systematic review articles were also examined to identify relevant studies. We hand-searched the last year's issues of Sleep Medicine Reviews and of Occupational and Environmental Medicine as being the highest-ranking journals in the field of occupational and sleep medicine. We also hand-searched the last year's issues (between July 2010 and June 2011) of the following journals that published more than one relevant article identified by a preliminary literature search:

- Accident Analysis & Prevention (six times a year)
- Industrial Health (six times a year)
- Journal of Occupational Health (six times a year)
- Journal of Sleep Research (four times a year)
- Scandinavian Journal of Work, Environment & Health (six times a year)
- Sleep (twelve times a year)

Selection criteria

Type of studies

We included original articles from observational studies (prospective and retrospective cohort studies, case-control studies and cross-sectional studies). We did not consider case reports, case series and case only studies or analyses of single events such as the Exxon Valdez ferry disaster. Review articles and intervention studies were considered for inclusion in the discussion section. We excluded studies for which no relevant data could be extracted from the paper. For an article to be included, it was required to i) have an explicit measure of sleep problems, ii) have an explicit measure of work injury, iii) provide sufficient data to quantify the association between sleep problems and work injuries. Finally, only articles in English, French, German and Italian were selected for inclusion.

Sleep problems

The risk factor of interest in this review was a sleep problem of any duration, frequency and severity. Previous studies used various concepts to define sleep problems.[34] In this review, we considered all sleep disorders described in the international classification of sleep disorders (ICSD-2).[35] Accordingly, we also included studies investigating symptoms described in the ISCD-2. For analysis, we grouped the results by the investigated symptoms rather than the diseases due to a lack of classified sleep disorders. Sleep quality concerned problems falling asleep, midnight awakenings, early awakenings, poor sleep sufficiency, and troubles sleeping in general. Sleep quantity described the sleep duration. Under breathing-related sleep problems symptoms like snoring, difficulties or stop breathing were subsumed. Sleep medication meant the use of sleeping pills for inducing sleep. Daytime sleepiness included difficulties waking up, problems staying awake and falling asleep during daytime. Where there was more than one symptom used to describe a sleep problem, the relative risks were pooled in the "multiple symptoms" subgroup. Not considered was non-specific fatigue or fatigue as a specific consequence from a high workload or long working hours. Articles addressing related topics such as sleep stages, shift work, time of day and circadian rhythm were included only if sleep parameters were measured directly.

Work injury

The outcome of interest was a work injury of any severity (minor, major or fatal). In this review, the Eurostat methodology was