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EFFECT OF SHIFT WORK SLEEP DISORDER SYMPTOMS ON ATTENTION FUNCTION: A CROSS-SECTIONAL STUDY AMONG FACTORY WORKERS IN JEPARA

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ABSTRACT

Introduction: Attention plays a role in supporting productivity and safety in industrial environments, particularly among shift workers. Shift Work Sleep Disorder (SWSD), experienced by those on rotating or night shifts, is characterized by insomnia and/or excessive daytime sleepiness (EDS), both of which can decrease attentional function. These prevalence rates reaches up to 76.4% and 60.7% respectively, higher than in the general population. Attention impairment in shift workers has been linked to an increased risk of occupational accidents. **Objective**: To analyze the effect of SWSD symptoms on attention function among factory workers. **Methods**: A cross-sectional study was conducted in November 2024 involving 51 factory workers in Jepara. The Insomnia Severity Index, Epworth Sleepiness Scale, and Digit Span Test were employed to assess insomnia, EDS, and attention, respectively. Chi-square tests and logistic regression were used to analyze associations. **Results:** SWSD was found in 29.4% of participants and was significantly associated with attention impairment (RR = 2.4; 95% CI: 1.417–4.064; p = 0.002). Both insomnia (RR = 2.15; p = 0.016) and EDS (RR = 2.00; p = 0.019) increased the risk of impaired attention. Participants with both symptoms had the highest risk (RR = 2.17; p = 0.008). Multivariate analysis revealed that insomnia remained independently associated with impaired attention (AOR = 4.129; p = 0.018). **Conclusion**: EDS combined with insomnia increases the risk of attention impairment. Insomnia was found to be an independent predictor. These findings highlight the importance of sleep disorder screening to reduce the risk of attentional impairment and prevent occupational accidents in shift work.

INTRODUCTION

Attention is a crucial cognitive function that enables individuals to focus selectively on relevant stimuli while ignoring distractions.[1] This function is essential in maintaining work productivity, particularly in industrial settings with high demands and tight schedules.[2] Shift Work Sleep Disorder (SWSD), a circadian rhythm sleep disorder that manifests with symptoms of insomnia and/or excessive daytime sleepiness, both of which compromise alertness and cognitive performance caused by non-traditional work schedules such as rotating or night shifts, has been identified as a significant factor impairing attention.[3]

Insomnia becomes part of SWSD, which often has a high prevalence and directly impacts work safety and productivity. Insomnia in shift workers is reported to have a prevalence rate of 12.8% to 76.4%,

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higher than the general population rate of around 30-50%.[4] Meanwhile, shift workers exhibited a higher prevalence of excessive daytime sleepiness (60.7%) than individuals diagnosed with obstructive sleep apnea (40.7%) or regular workers (37.1%).[5,6]

Approximately 16% of industrial workers operate under shift schedules, with night shifts accounting for a substantial proportion of SWSD cases.[7] In Indonesia, a study in Denpasar found a 54.76% prevalence of SWSD among night shift workers.[3,8]

Jepara Regency has seen growing employment in the garment and footwear sectors. Despite adequate access to healthcare services, awareness of occupational health risks—particularly those related to sleep disorders and cognitive safety—remains limited among industrial workers. Data from 2022 to 2023 recorded 53 work-related injuries, with 22.6% occurring during evening and night shifts and 11.3% involving traffic accidents following night shifts. These incidents resulted in compensation costs amounting to IDR 149,354,011 over two years.[9,10] This study aims to examine the association between SWSD, particularly its symptoms of insomnia and excessive daytime sleepiness, and attentional function among factory workers in Jepara.

METHODS

This observational analytic study employed a cross-sectional design to examine the association between SWSD, insomnia, EDS, and attention function among factory workers. The study was conducted in November 2024 at the Parkland World Indonesia (PWI) factory in Jepara.

A total of 51 respondents were recruited using consecutive sampling based on inclusion criteria: factory workers under 65 years of age, minimum junior high school education, literate, and willing to participate. Exclusion criteria included a history of stroke, hypertension, diabetes, psychiatric disorders, sensory impairment, chronic organ disease, or primary headache disorders.

Data collection, as shown in figure 1, included demographic and medical history interviews, assessment of anxiety and depression using the Hamilton Anxiety and Depression Scales.

For evaluation of SWSD symptoms which characterized by insomnia and/or Excessive Daytime Sleepiness through the Insomnia Severity Index (ISI > 7) and Epworth Sleepiness Scale (ESS> 10), occurring in those who work during the typical sleep period, which is from 10:00 PM to 6:00 AM.

Attention function was assessed via Forward and Backward Digit Span Tests. If in the Forward Digit Span test the score is < 5 or in the Backward Digit Span test the score is < 4, then there is a impairment in attention function.

Statistical Analysis

Univariate analysis was used to describe respondent characteristics. Associations between SWSD, insomnia, EDS, and attention impairment were assessed using the χ^2 (chi-square) test. Risk ratios (RR) with 95% confidence intervals (CI) were calculated. Variables with a p-value < 0.25 in bivariate analysis were included in a multivariate logistic regression model to determine independent predictors of attention impairment. A p-value < 0.05 was considered statistically significant. Statistical analyses were conducted using IBM SPSS Statistics version 26.0.

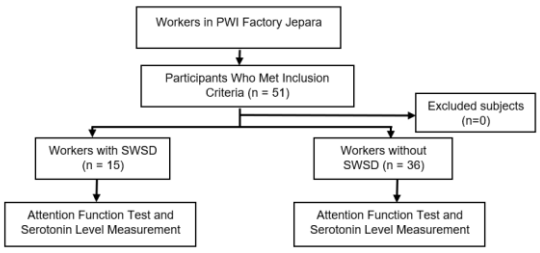

Fig 1. Flowchart Participant Selection and Analysis

RESULTS

A total of 51 factory workers participated in this study. As shown in table 1, the majority were male (54.9%), with an average age of 35.08 ± 7.57 years. All subjects had a minimum education level of junior high school, and most had worked for more than 5 years (39.2%). Among them, 17 (33.3%) were shift workers. SWSD was identified in 29.4% of the workers, and 47.1% showed signs of impaired attention function.

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Table 1. Subject characteristics

Variable	Freq (%)
Sex	
Female	23 (45.1)
Male	28 (54.9)
Division	
Production	23 (45.1)
Mechanical	11 (21.6)
Administration	7 (13.7)
Quality Control	5 (9.8)
Security	3 (5.9)
Manager	2 (3.9)
Shift Work	
Yes	17 (33.3)
No	34 (66.7)
Excessive Daytime Sleepiness	
EDS (ESS > 10)	30 (58.8)
Normal (ESS ≤ 10)	21 (41.2)
Insomnia	
Insomnia (ISI > 7)	27 (52.9)
No Clinical Insomnia (ISI 0-7)	24 (47.1)
SWSD	
SWSD	15 (29.4)
No Clinically SWSD	36 (70.6)
Attention Function	
Impaired	24 (47.1)
Normal	27 (52.9)

The association between SWSD and attention function is presented in Table 2. Among participants with SWSD, 50.0% had impaired attention, while only 11.1% had normal attention. In contrast, among those without SWSD, 50.0% had impaired attention, and 88.9% had normal attention function.

Table 2. Association between SWSD and Attention Function

Variable	Attention Function		Statistical Test	RR (95%CI)
	Impaired Freq (%)	Normal Freq (%)		
SWSD			$X^2 = 9.256$ p = 0.002*	2.4 (1.417-4.064)
SWSD	12 (50.0)	3 (11.1)		
No Clinically SWSD	12 (50.0)	24 (88.9)		

*χ^2 analysis significant p<0.05

The chi-square test showed a statistically significant association between SWSD and attention impairment (χ^2 = 9.256, p = 0.002). The risk of attention impairment was 2.4 times higher in participants with SWSD compared to those without (RR = 2.4; 95% CI: 1.417–4.064).

Table 3. Association Between Insomnia, Excessive Daytime Sleepiness (EDS), and Attention Impairment

Insomnia	EDS	n	Impaired Attention (n)	Impaired Attention (%)	RR (95% CI)	p-value
+	-	27	17	63.0%	2.15 (1.086-4.292)	0.016*
-	+	21	14	66.7%	2.00 (1.109 – 3.606)	0.019*
+	+	20	14	70.0%	2.17(1.209-3.896)	0.008*
-	-	23	7	30.4%	0.501 (0.252-0.9950	0.031*

*χ^2 analysis significant p<0.05

This study highlights the distinct and combined effects of insomnia and EDS on attention function among shift workers. Subgroup analysis, as shown in table 3, reveals that both insomnia and EDS are independently associated with a significantly increased risk of attention impairment.

Participants with insomnia but no EDS had a 2.15-fold higher risk of attention impairment (RR = 2.15; 95% CI = 1.086–4.292; p = 0.016), while those with EDS but no insomnia had a similar elevated risk (RR = 2.00; 95% CI = 1.109–3.606; p = 0.019). Interestingly, the combination of both insomnia and EDS was associated with the highest risk (RR = 2.17; 95% CI = 1.209–3.896; p = 0.008), indicating a potentially additive effect. Interestingly, the reference group (no insomnia, no EDS) demonstrated a significantly lower risk of attention impairment, with an RR of 0.501 (95% CI: 0.252–0.9950; p = 0.031), reinforcing the protective effect of the absence of sleep-related symptoms.

Table 4 presents the results of bivariate and multivariate analyses assessing the association between insomnia, EDS, and impaired attention. Both insomnia and EDS are core symptoms of SWSD, yet this analysis aimed to determine which of the two symptoms more strongly contributes to attentional dysfunction.

In the bivariate analysis, both insomnia (p = 0.016) and EDS (p = 0.019) were significantly associated with impaired attention. The relative risks were 2.15 and 2.00, respectively, suggesting that each symptom, when considered independently, was associated with approximately double the risk of attention impairment.

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However, in the multivariate logistic regression model, only insomnia remained significantly associated with impaired attention (adjusted OR = 4.129, 95% CI: 1.273–13.393; $p < 0.05$). In contrast, EDS did not retain statistical significance after adjustment (AOR = 2.144; 95% CI: 0.429–10.707; $p = 0.352$).

Table 4. Multivariate Analysis of Variables Affecting Attention Function

Variable	Attention Function		p-value	Multivariat
	Impaired (n = 24)	Normal (n = 27)		Adjusted OR (95%CI)
Insomnia (+)	17	10	0.018*	4.129 (1.273 – 13.393)
EDS (+)	14	7	0.352	2.144 (0.429 – 10.707

*χ^2 analysis significant $p<0.05$

DISCUSSION

This study explored the relationship between SWSD, insomnia, and EDS as symptoms of SWSD correlated to attentional function among industrial shift workers. Participants included a relatively balanced sample of men (54.9%) and women (45.1%), with statistical analysis confirming homogeneity between the groups. Findings revealed that 41.3% of participants experienced EDS, and 52.9% reported symptoms of insomnia. These rates are consistent with prior literature indicating that disrupted sleep-wake cycles and circadian misalignment in shift workers increase the likelihood of sleep disturbances and insomnia happening because of physiological hyperarousal.[11,12] EDS and insomnia may result from sleep deprivation, fragmented sleep, hypersomnia, or underlying neurological or psychiatric conditions.[4,13] However, this study excluded individuals with organic medical, psychiatric, and neurological disorders, as well as those taking medications affecting sleep, to focus on occupational influences.

Among the workers, 29.4% met diagnostic criteria for SWSD, characterized by persistent insomnia and/or EDS in the context of long-term shift work exposure. The remaining 70.6% of workers, despite not meeting the full criteria for SWSD, still reported one or both symptoms, suggesting a broader impact of shift work on sleep and circadian regulation beyond the strict diagnostic category.[14]

This study explored the association between Shift Work Sleep Disorder (SWSD), including its core symptoms—insomnia and excessive daytime sleepiness (EDS)—and attentional function among industrial shift workers. Participants included a balanced distribution of men (54.9%) and women (45.1%), with no significant differences in demographic characteristics between groups. The prevalence of insomnia (52.9%) and EDS (41.2%) among participants aligns with prior research, supporting the view that circadian misalignment and disrupted sleep-wake cycles in shift workers predispose individuals to sleep disturbances. Insomnia, in particular, is often linked to physiological hyperarousal, both cortical and autonomic, which may contribute to cognitive and emotional dysregulation.[12,15]

In this study, 29.4% of participants met the criteria for SWSD, while many others reported symptoms without fulfilling full diagnostic criteria, suggesting a broader sleep-related impact of shift work. A significant association was found between SWSD and attention impairment, consistent with earlier findings that SWSD contributes to slower reaction times, decreased vigilance, and increased risk of workplace accidents.[13,16] These effects are largely attributed to the disruption of prefrontal cortex function—an area essential for executive control and sustained attention—due to chronic sleep loss and irregular schedules.[17,18]

Subgroup analysis showed that insomnia and EDS independently increased the risk of impaired attention, with the highest risk observed in individuals experiencing both symptoms. This supports earlier findings which showed that while EDS impairs performance on simple tasks, insomnia is more strongly associated with deficits in complex cognitive functions such as sustained attention and executive processes.[19,20] Liu et al. further suggested that cortical hyperarousal in insomnia may preserve performance in simple tasks, whereas EDS tends to cause global reductions in attention, particularly in low-stimulation conditions.[21,22]

In line with these findings, multivariate analysis in this study revealed that only insomnia remained an independent predictor of impaired attention, whereas EDS lost statistical significance. This suggests that insomnia may be the primary driver of attentional dysfunction in SWSD, a result supported by a

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previous study that reported that insomnia without EDS experienced more severe neurocognitive and occupational impairments than insomnia with EDS.[23] Conversely, other studies, such as those by Anwary et al. and Terauchi et al., found that EDS can also independently contribute to attention impairment, particularly in contexts involving sleep deprivation and among older workers.[24,25] These differing results suggest that the cognitive impact of EDS may vary depending on demographic and work-related factors.

Taken together, the evidence indicates that both insomnia and EDS contribute to attention impairment but through distinct mechanisms: insomnia through hyperarousal and executive dysfunction, and EDS through reduced vigilance and reaction capacity. Understanding these differences is crucial when designing cognitive safety interventions in shift-based industries.

Despite these insights, this study has limitations. The use of self-reported instruments (ISI and ESS) may introduce information bias due to subjectivity. Selection bias may also be present, as participants able to complete the study may differ systematically from those who declined. The small sample size and single-center design further limit generalizability. Future studies with larger, more diverse populations across multiple industries and geographic settings are warranted.

In conclusion, this study reinforces existing evidence that both SWSD and its symptoms, insomnia and EDS, are associated with impaired attention among shift workers. Taken together, this evidence underscores the need for occupational health policy, comprehensive screening of insomnia and EDS among shift workers, and integration of shift management with cognitive safety programs in industrial sectors. Further research is needed to explore preventive strategies tailored for workforces.

ETHICAL APPROVAL

Ethical approval was obtained from the Research Ethics Committee, Faculty of Medicine, Diponegoro University (No. 542/EC/KEPK/FK-UNDIP/X/2024), and written informed consent was obtained from all participants.

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DECLARATION OF CONFLICTING INTERESTS

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

AUTHORS' CONTRIBUTIONS

Arinta Puspita Wati and Gita Fajar Wardhani participated in the design of the study, data collection, and initial analysis. Dwi Pudjonarko and Herlina Suryawati contributed to the interpretation of the data and provided critical revisions to the manuscript. Aditya Kurnianto and Retnaningsih were responsible for the statistical analysis, interpretation of the results, and drafting of the final manuscript. All authors read and approved the final version of the manuscript.

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