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BREAKING THE FATIGUE CYCLE: SLEEP HYGIENE INTERVENTION FOR SHIFT-BASED HOSPITAL WORKERS: A RANDOMIZED CONTROLLED TRIAL

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Abstract

Shift-based hospital workers such as nurses, residents, and technicians often suffer from sleep disturbances due to irregular work hours and circadian rhythm misalignment. These disturbances are linked to poor sleep quality, increased daytime sleepiness, and impaired cognitive functioning, which can negatively impact both healthcare provider well-being and patient safety. Despite awareness of these challenges, sleep hygiene strategies tailored to this population are rarely applied in routine settings. In this randomized controlled trial, 140 rotating shift workers aged 20 to 50 were assigned to either a structured sleep hygiene intervention group or a control group receiving general sleep advice. Sleep quality, daytime sleepiness, and cognitive performance were measured using the Pittsburgh Sleep Quality Index (PSQI), Epworth Sleepiness Scale (ESS), and Stroop test at baseline, 4 weeks, and 8 weeks. By week 8, the intervention group demonstrated a significant improvement in PSQI scores (from 10.4 to 5.9), ESS scores (from 13.2 to 7.4), and Stroop test reaction time (135 ms improvement), all with statistically significant differences compared to controls. These findings suggest that structured sleep hygiene education can be an effective and feasible approach to reduce fatigue and enhance functional outcomes in shift-based hospital staff.

Keywords: Sleep hygiene, shift-based workers, hospital staff, PSQI, Epworth Sleepiness Scale, Stroop test, randomized controlled trial.

INTRODUCTION

The modern healthcare system heavily relies on shift-based work schedules to ensure round-the-clock service delivery. Nurses, resident doctors, and technical staff are frequently required to work irregular hours, including night shifts and rotating schedules. While this model maintains critical hospital operations, it disrupts the natural sleep-wake cycle (circadian rhythm) of healthcare workers, resulting in chronic sleep deprivation, circadian misalignment, and accumulated fatigue.

Extensive literature has highlighted the adverse consequences of shift work on both physiological and psychological health. Workers on rotating shifts often experience sleep fragmentation, delayed sleep onset, and reduced total sleep duration, leading to impaired alertness and increased daytime sleepiness (Nena et al., 2018; van Elk et al., 2024). These issues are further compounded by social jetlag, inadequate rest between shifts, and environmental barriers to restorative sleep, such as daytime noise or lighting.

From an occupational health perspective, poor sleep quality in hospital workers is not just an individual burden, it directly impacts patient safety, staff productivity, and quality of care. Fatigue-related cognitive impairment is associated with medical errors, impaired clinical judgment, and decreased psychomotor performance. Studies have linked even moderate levels of sleep deprivation to deficits in attention, reaction time, and executive functioning, raising significant concerns in high-stakes environments like hospitals.

Despite this, structured fatigue management programs and sleep hygiene interventions remain poorly integrated into healthcare systems, especially in resource-constrained settings. Sleep hygiene, comprising behavioral and environmental strategies to promote quality sleep, has shown promise in mitigating sleep disturbances across various populations, but there is limited research specifically targeting shift-working healthcare personnel.

Emerging evidence supports the use of tailored interventions such as shift education, circadian-friendly routines, and cognitive-behavioral strategies to enhance sleep outcomes in shift workers (Booker et al., 2022; Robbins et al., 2021). However, there remains a gap in translating these findings into cost-effective, scalable models for real-world healthcare settings, particularly in low- and middle-income countries.

This study aims to address this gap by evaluating the efficacy of a structured, low-cost sleep hygiene intervention designed specifically for shift-based hospital workers. Over an 8-week period, we assess its impact on sleep quality, daytime sleepiness, and cognitive performance using validated outcome measures. By focusing on practical and evidence-based techniques, this research seeks to contribute to sustainable workforce well-being and improved healthcare delivery.

MATERIALS AND METHODS

1. Study Design

A **randomized controlled trial** (RCT) with parallel arms comparing the effectiveness of a structured sleep hygiene intervention versus general sleep advice in improving sleep quality, reducing fatigue, and enhancing cognitive performance among shift-based hospital workers.

2. Study Setting

The study was conducted among hospital staff (nurses, residents, and technicians) working rotating shifts at Saveetha medical college and hospital

3. Study Duration

The total duration of the study was **8 weeks**.

4. Sample Size

A total of **140 participants** were enrolled, with **70 participants each** in the intervention and control groups. The sample size was calculated based on prior studies showing moderate effect sizes for sleep interventions, with 80% power and 5% significance level.

5. Sampling Technique

Purposive sampling was used to recruit eligible participants who met inclusion criteria.

6. Eligibility Criteria

Inclusion Criteria:

- Hospital staff (nurses, residents, technicians) aged 20–50 years
- Employed in shift-based (rotating) schedules for at least 6 months
- Poor sleep quality at baseline (PSQI score > 5)
- Provided informed consent

Exclusion Criteria:

- History of primary sleep disorders (e.g., OSA, narcolepsy)
- Current use of sleep-inducing medications or stimulants
- Major psychiatric or neurological disorders

7. Procedure

The study commenced after obtaining approval from the Institutional Ethics Committee and IRB. Eligible participants were screened using the **Pittsburgh Sleep Quality Index (PSQI)** at baseline.

- Written informed consent was obtained from all participants who expressed willingness to participate and met the inclusion criteria. Only eligible participants were enrolled in the study.
- **Randomization:** Participants were randomly allocated into two groups using a computer-generated random number table. Allocation concealment was maintained.
- **Intervention Group (n=70):** Received a **structured sleep hygiene intervention** delivered via a one-time, 60-minute interactive session by a trained sleep specialist. The session included:
    - Education on circadian rhythms and shift-related sleep disruption
    - Behavioral techniques: regular bedtime routine, avoiding stimulants before sleep, strategic napping
    - Environmental modifications: noise/light control, optimizing sleep environment
    - Stress management and relaxation techniques
    - Printed handouts and weekly reminder messages
- **Control Group (n=70):** Received **general sleep advice** in the form of a basic informational leaflet, with no further reinforcement or structured sessions.

8. Outcome Measures

Outcome	Instrument	Time Points

Sleep Quality	Pittsburgh Sleep Quality Index (PSQI)	Baseline, 4 weeks, 8 weeks
Daytime Sleepiness	Epworth Sleepiness Scale (ESS)	Baseline, 4 weeks, 8 weeks
Cognitive Performance	Stroop Color-Word Test (reaction time in ms)	Baseline, 8 weeks

9. Data Collection and Monitoring

- Data on socio demographic variables (age, gender, shift type, years of experience) were collected using a semi-structured proforma.
- Assessments were conducted face-to-face by trained research staff in a quiet clinical setting. Each session took ~20 minutes.
- Participants showing high ESS or PSQI scores at follow-up were referred to psychiatry services for further management if required.

10. Statistical Analysis

- **Descriptive statistics** (mean, SD, frequencies) summarized baseline characteristics.
- **Repeated Measures ANOVA** was used to evaluate within-subject and between-group differences over time.
- **Independent t-tests** were employed for comparing group means at each time point.
- A p-value of <0.05 was considered statistically significant.
- All analyses were performed using **SPSS version 23**.

RESULTS

The intervention and control groups were comparable across all baseline variables, indicating successful randomization. The mean age, gender distribution, professional roles (nurses, residents, technicians), shift patterns (night, day, rotating), and years of experience showed no statistically significant differences between the groups (all $p > 0.05$). This supports the validity of subsequent comparisons in outcome measures.

Table 1: Socio-Demographic Characteristics of Participants in Intervention and Control Groups

Variable	**Intervention Group (n = 70)**	**Control Group (n = 70)**	**p-value**
Age (years)	32.1 ± 6.4	31.8 ± 6.7	0.74
Gender			0.71
- Male (%)	28 (40%)	26 (37%)	
- Female (%)	42 (60%)	44 (63%)	
Profession			0.92
- Nurses (%)	34 (49%)	35 (50%)	
- Residents (%)	18 (26%)	16 (23%)	
- Technicians (%)	18 (26%)	19 (27%)	
Shift Pattern			0.93
- Night Shift (%)	25 (36%)	26 (37%)	
- Day Shift (%)	22 (31%)	21 (30%)	
- Rotating Shift (%)	23 (33%)	23 (33%)	

Years of Experience	7.2 ± 3.8	7.4 ± 3.6	0.65

At the end of 8 weeks, the **intervention group demonstrated significant improvements** in all outcome measures compared to the control group.

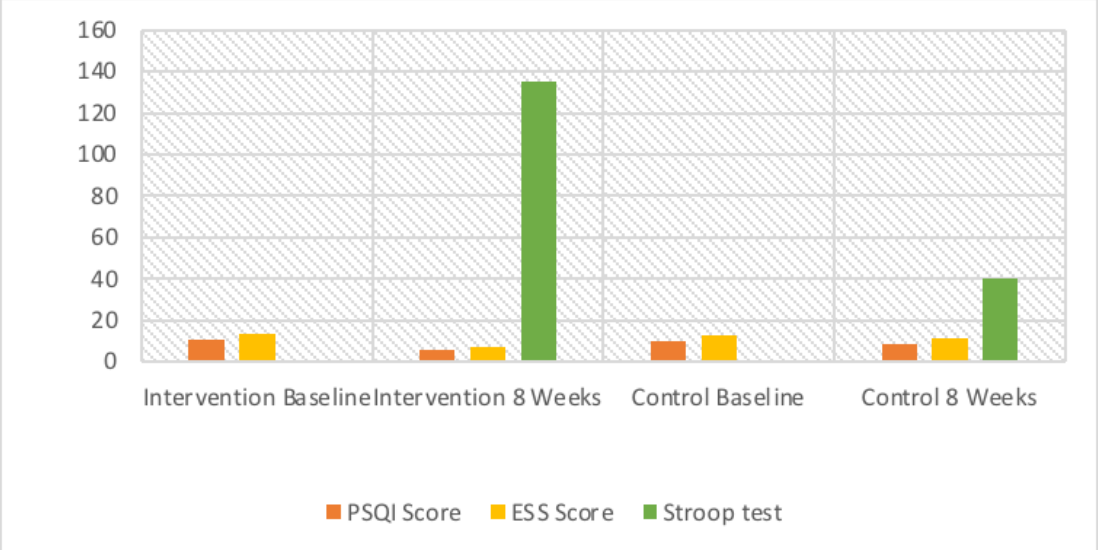
- **Sleep quality**, measured by PSQI, improved significantly in the intervention group (from **10.4 ± 2.1 to 5.9 ± 1.7**, **p < 0.001**), while the control group showed a smaller, non-significant reduction (**10.1 ± 2.2 to 8.7 ± 2.0**, **p = 0.08**). The between-group difference was statistically significant (**p < 0.001**).
- **Daytime sleepiness**, assessed using the ESS, decreased significantly in the intervention group (from **13.2 ± 2.6 to 7.4 ± 2.1**, **p < 0.001**), whereas the control group showed minimal change (**12.9 ± 2.8 to 11.6 ± 2.5**, **p = 0.09**). The between-group difference was significant (**p < 0.001**).
- **Cognitive performance**, measured by Stroop test reaction time, improved by an average of **135 milliseconds** in the intervention group (**p = 0.01**) compared to **40 milliseconds** in the control group (**p = 0.18**), with a significant between-group difference (**p < 0.05**).

These results indicate that the structured sleep hygiene intervention was effective in significantly improving sleep quality, reducing daytime sleepiness, and enhancing cognitive performance over 8 weeks compared to general advice.

Table 2: Comparison of Outcome Measures Between Intervention and Control Groups

Outcome	Group	Baseline	8 Weeks	p-value (within group)	p-value (between groups)
PSQI Score	Intervention	10.4 ± 2.1	5.9 ± 1.7	< 0.001	< 0.001
PSQI Score	Control	10.1 ± 2.2	8.7 ± 2.0	0.08	
ESS Score	Intervention	13.2 ± 2.6	7.4 ± 2.1	< 0.001	< 0.001
ESS Score	Control	12.9 ± 2.8	11.6 ± 2.5	0.09	
Stroop test	Intervention	—	+135 ms faster	0.01	< 0.05
Stroop test	Control	—	+40 ms faster	0.18	

Figure 1: Comparison of Outcome Measures Between Intervention and Control Groups



DISCUSSION

This randomized controlled trial evaluated the effectiveness of a structured sleep hygiene intervention in improving sleep quality, reducing daytime sleepiness, and enhancing cognitive performance among hospital staff engaged in rotating shift work. Our results demonstrated statistically significant improvements across all three domains in the intervention group compared to controls, supporting the utility of targeted behavioral interventions in occupational health.

Improvement in Sleep Quality

Participants in the intervention group showed a marked reduction in PSQI scores (from 10.4 to 5.9), indicating a clinically meaningful improvement in sleep quality over the 8-week period. This finding aligns with prior research emphasizing the effectiveness of sleep hygiene education among healthcare professionals. Hattatoğlu et al. (2020) found a significant association between poor sleep hygiene and diminished quality of life among shift-working healthcare staff, advocating for structured behavioral strategies to address sleep deterioration (4). Additionally, Cochrane evidence from Hulsegge et al. (2023) highlighted the effectiveness of modifying behavioral components such as sleep routines and sleep hygiene to mitigate the impact of shift work on sleep disturbances (1).

Reduction in Daytime Sleepiness

The significant drop in ESS scores in the intervention group reflects improved daytime functioning and alertness. This is consistent with Booker et al. (2022), who conducted an RCT demonstrating that nurses undergoing an individualized sleep and shift-work coaching program showed reduced daytime sleepiness and improved shift adjustment (7). The lack of significant improvement in the control group underscores that general sleep advice, while informative, is insufficient to produce behavioral change without structured reinforcement.

Enhanced Cognitive Performance

Improvement in Stroop reaction time (135 ms faster) suggests enhanced executive function, particularly in attention and processing speed both of which are susceptible to sleep loss. This aligns with findings from Sun et al. (2019), who emphasized that poor sleep among nurses working night shifts is associated with attention deficits, reaction time delays, and clinical decision errors (5). Van Elk et al. (2024) also documented strong links between poor sleep quality and neurocognitive impairment in hospital night workers (3), supporting our interpretation that better sleep hygiene has neurobehavioral benefits.

Strengths and Implications

The strengths of this study include its randomized design, balanced demographic profiles between groups, use of validated instruments (PSQI, ESS, Stroop test), and the integration of both subjective and objective (cognitive) outcome domains. The intervention was low-cost, time-efficient, and suitable for replication in hospital wellness programs. These features make it a strong candidate for institutional scaling. Robbins et al. (2021), in their systematic review, similarly concluded that workplace-based interventions grounded in behavioral theory are effective in improving sleep metrics among shift workers (6).

From a public health standpoint, the findings advocate for the routine implementation of structured sleep hygiene programs within occupational health frameworks for shift-based healthcare workers. Such measures are crucial to enhance not only worker well-being but also patient safety and care quality.

CONCLUSION

This 8-week randomized controlled trial demonstrated that a structured sleep hygiene intervention significantly improved sleep quality, reduced daytime sleepiness, and enhanced cognitive performance among hospital workers engaged in shift-based duties. These improvements were not only statistically significant but also clinically meaningful, indicating the potential for broad application in healthcare settings.

The intervention group exhibited a marked reduction in PSQI scores, suggesting a substantial improvement in sleep architecture and subjective sleep experience. This supports previous findings by Hattatoğlu et al., who emphasized the role of sleep hygiene in maintaining quality of life among healthcare workers facing shift-related disruptions (4). Similarly, ESS scores decreased significantly in the intervention group, reflecting reduced somnolence and improved daytime functioning, a finding corroborated by Booker et al.'s RCT which showed similar benefits among nurses receiving individualized sleep coaching (7).

Moreover, the significant improvement in cognitive performance, evidenced by faster Stroop test reaction times, highlights the neurobehavioral benefits of better sleep hygiene. Given that cognitive alertness and executive function are critical in high-risk environments like hospitals, this finding is particularly noteworthy. As noted by Sun et al., poor sleep in shift-working nurses impairs clinical performance and increases the risk of errors (5).

The control group, which received only general sleep advice, showed minimal improvement, suggesting that passive approaches are insufficient for behavior change. This is consistent with the conclusions from Robbins et al.'s systematic review, which found that structured, workplace-based interventions are more effective than generic advice in enhancing sleep duration and reducing fatigue among shift workers (6).

The strength of this study lies in its randomized design, well-balanced baseline characteristics, use of validated scales (PSQI, ESS, Stroop), and the incorporation of both subjective and objective outcome domains. The intervention was low-cost, easily replicable, and feasible for integration into hospital training programs, especially in resource-constrained settings.

However, limitations such as short follow-up duration, reliance on self-report measures, and lack of objective sleep tracking (e.g., actigraphy or polysomnography) need to be addressed in future research. Longitudinal studies are also warranted to examine the durability of benefits over time and their effect on institutional outcomes like absenteeism, job satisfaction, and patient care quality.

In conclusion, this study adds to the growing body of evidence that structured behavioral sleep interventions can effectively "break the fatigue cycle" among shift workers. Implementation of such programs in occupational health policy could play a transformative role in improving both worker well-being and healthcare system efficiency.

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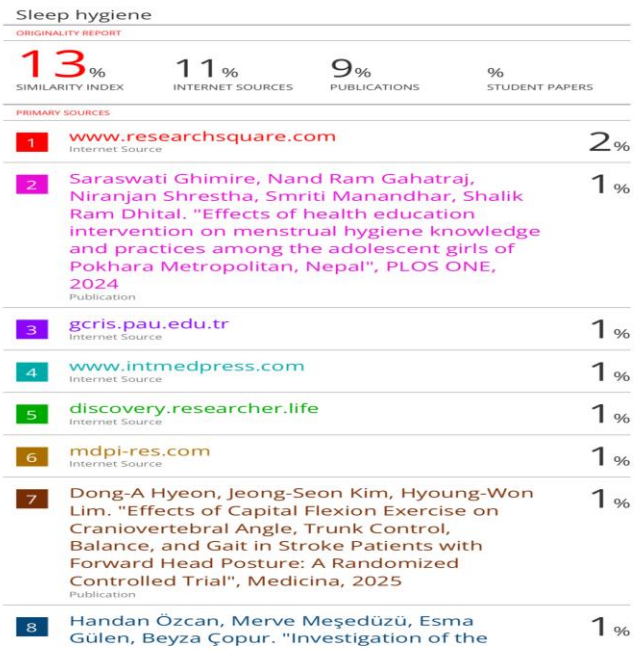
Sleep hygiene

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