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DIFFERENCES IN SLEEP QUALITY BETWEEN FIXED AND ROTATING SHIFTS AMONG MORNING AND EVENING TYPES

Abstract: *This study examines sleep quality differences among 154 chemical industry workers (103 males, 51 females) categorized by chronotype (morning/evening) using the Morningness–Eveningness Questionnaire (MEQ). Participants worked either fixed or rotating shifts. The results show significant differences in sleep quality based on shift type and chronotype. Morning chronotypes in fixed morning shifts reported better sleep quality, while evening chronotypes surprisingly benefited from fixed morning shifts, experiencing the best sleep quality compared to those in rotating shifts. The findings highlight the importance of considering both chronotype and shift type when evaluating sleep quality. Circadian rhythm plays a crucial role in regulating sleep patterns, and shift work can disrupt this rhythm, leading to poorer sleep quality. The stability and predictability of fixed shifts provide advantages, even for evening chronotypes, by allowing them to establish routines and improve sleep quality.*

Keywords: chronotypes, shift work, sleep quality, circadian rhythm

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INTRODUCTION

The modern workforce is increasingly shaped by non-traditional work schedules, with shift work becoming indispensable in many industries to ensure uninterrupted operations (Costa, 2003; Caruso, 2014). Among these, the chemical industry is particularly reliant on both fixed and rotating shifts to maintain productivity and safety (Folkard & Tucker, 2003). However, such schedules pose significant challenges to workers' health—especially in terms of sleep quality (Åkerstedt, 2003). Sleep is influenced not only by external factors like work timing but also by internal biological predispositions, most notably chronotype, which reflects an individual's natural tendency toward morningness or eveningness (Adan et al., 2012). Chronotype, regulated by the body's circadian rhythm, determines preferred times for sleep and activity and plays a key role in individual adaptation to different work shifts (Roenneberg et al., 2007). Morning types ('larks') tend to function optimally and feel most alert in the early hours of the day, while evening types ('owls') reach their performance peak later (Horne & Östberg, 1976). When work schedules are misaligned with these intrinsic preferences, sleep disturbances and reduced well-being often result (Vetter et al., 2015). Despite the relevance of this interaction, the relationship between chronotype and shift type—particularly within demanding environments such as the chemical industry—remains insufficiently explored (Knutsson, 2003).

The expansion of a 24-hour economy has led to a rise in shift work, especially in sectors such as manufacturing and other critical industries. Although these schedules are essential for maintaining continuous operations, they disrupt the body's circadian rhythms—the internal biological processes that regulate sleep, metabolism, and cognitive functioning (Gradisar & Lack, 2004). When work hours are misaligned with an individual's internal clock, it increases the likelihood of sleep problems, reduced performance, and various health complications (Sephton & Spiegel, 2003; Smith et al., 1999). Night shifts are particularly problematic because they require workers to remain alert during periods typically reserved for biological rest, causing circadian disruption and related health concerns (Arendt, 2010).

An individual's chronotype plays a significant role in how well they adapt to shift work; evening types generally cope better with night shifts than morning types. Additionally, circadian flexibility—the capacity to adjust to changing schedules—contributes to resilience, with those more adaptable experiencing fewer negative effects (Jehan et al., 2017; De Martino et al., 2013). Night shifts pose specific challenges by forcing alertness during natural rest times, often leading to fatigue and diminished cognitive abilities (Smith et al., 1999). Rotating shifts further intensify this misalignment, heightening health risks and impairing job performance (Arendt, 2010).

Circadian Rhythms and Shift Work

Circadian rhythms regulate various physiological functions, including body temperature, heart rate, and hormone secretion, aligning with environmental cues such as light exposure and sleep patterns (Korf and von Gall, 2022). Shift work disrupts this synchronization, leading to shift lag syndrome—characterized by fatigue, sleep disturbances, and cognitive impairment (Costa, 2003). Rotating shifts complicate adaptation, as workers struggle to adjust their biological clocks between work and rest days (Horowitz et al., 2001; Dumont et al., 2001). Several strategies help mitigate circadian misalignment, including maintaining consistent sleep schedules, using darkened rooms for daytime sleep, and exposure to bright light during night shifts (Baehr, 1999; Burgess et al., 2002). However, melatonin supplementation has shown inconsistent results in improving shift adaptation (Sharkey et al., 2001, 2002). Recent studies highlight the role of circadian rhythm flexibility in determining shift tolerance, with individuals exhibiting greater adaptability experiencing fewer negative effects (Jafari Roodbandi et al., 2015). Effective shift scheduling can ease circadian adaptation. Forward-rotating schedules (morning-afternoon-night) are generally better tolerated, with recommended shifts lasting no more than 10 hours and allowing at least 11 hours of recovery (Potter and Wood, 2020). Timely exposure to short-wavelength light may enhance adaptation, improving sleep and alertness (Scott et al., 2024; Boivin et al., 2022). The prevalence of shift work has increased significantly, with 15-20% of workers in industrialized nations engaged in non-standard schedules (Ker et al., 2010; Hadler et al., 2018).

Circadian Rhythm and Its Role in Sleep Regulation

Circadian rhythms are intrinsic, 24-hour cycles that orchestrate a wide range of physiological, behavioural, and metabolic processes in the human body, most notably the sleep-wake cycle (Alshahrani & BaHammam, 2017; de Bruijn et al., 2025). These rhythms are governed by a biological clock located in the brain’s hypothalamus, which responds to environmental cues such as light and darkness to synchronize bodily functions with the external day-night cycle (Alshahrani & BaHammam, 2017). In the morning, exposure to light signals the brain to suppress melatonin production, promoting wakefulness, while darkness at night triggers melatonin release, preparing the body for sleep (Alshahrani & BaHammam, 2017). The stability and amplitude of circadian rhythms are critical for maintaining high-quality sleep. When these rhythms are robust and well-aligned with the external environment, individuals typically experience restorative sleep and optimal alertness during waking hours (de Bruijn et al., 2025). However, shift work—especially night and rotating shifts—can disrupt the natural synchronization between the internal clock and external cues, leading to circadian misalignment (Kılıç, Koran, & Ağargün, 2023; Alshahrani & BaHammam, 2017). This misalignment not only impairs sleep quality but also affects hormone release, metabolism, and cognitive performance, and is associated with increased risks for various health problems (Kılıç et al., 2023; Alshahrani & BaHammam, 2017). Moreover, the ability to adapt to shift work varies among individuals and is influenced by chronotype, or the natural preference for morning or evening activity. Some people possess more flexible circadian rhythms and can better tolerate irregular schedules, while others are more susceptible to sleep disturbances and excessive sleepiness when their circadian system is disrupted (de Bruijn et al., 2025). Understanding the interplay between circadian biology, chronotype, and work schedules is therefore essential for optimizing sleep health and overall well-being in shift-working populations.

Problem

This study aims to address these gaps by investigating how fixed and rotating shift schedules differentially affect sleep quality among morning and evening chronotypes. Understanding these relationships is crucial for developing tailored shift scheduling strategies that mitigate sleep problems, improve worker health, and enhance productivity.

Variables and Instruments

Circadian rhythmicity is operationalized by the Morningness–Eveningness Questionnaire – MEQ (Horne & Östberg, 1976) and registers the individual’s functioning on a continuum from morning, through the so-called intermediate, to the evening optimum, depending on sleeping and waking habits. The mentioned questionnaire distinguishes five types: definitely evening type, moderately evening type, mixed type, moderately morning type, and definitely morning type. The types are determined by adding up the scores on all items and the final result (ranging from 16 to 86 points) determines the position to which the respondent dominantly belongs based on arbitrarily determined scores. The reliability of internal consistency on the initial sample is satisfactory (of medium intensity) and expressed through Cronbach's α coefficient is 0.83.

Sleep quality. The Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1989) will be used to measure this variable. The questionnaire consists of 19 items, to which the respondent answers on a four-point Likert-type scale. The scale measures seven dimensions of sleep quality: subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disorders, use of hypnotics, and daytime dysfunction. The global score of the PSQI scale ranges from 0 to 21 points, with a higher score indicating poorer sleep quality. A total score of 5 or above indicates poor sleep quality. Psychometric testing of the PSQI has shown that the questionnaire has good internal consistency and differentiation between good and poor sleepers (Buysse et al., 1989).

Shift work was defined as employment outside standard daytime working hours, specifically involving work during evening or night periods. The frequency and duration of shifts varied within the limits prescribed by labour regulations. For analytical purposes, shift work was categorized into two main types: fixed shift schedules (comprising morning and night shifts) and rotating shift schedules (including all three shifts or rotating day shifts). These categories were used to explore differences in sleep quality, stress perception, and other relevant psychological outcomes across shift types.

Sample

The sample in this research consisted of *154* chemical industry workers (103 males, 51 females). The age of the respondents ranged from 22 to 58 years. The study utilized a purposive sampling method, selecting participants from employed individuals within the industrial sector.

Procedure and Data Analysis

The survey was conducted in June 2023 at a chemical industry company. Prior to participation, respondents received clear instructions on how to complete the questionnaire and were informed about the purpose of the study, the voluntary nature of their involvement, and the assurance of anonymity. Informed consent was obtained from all participants.

Data analysis was performed using SPSS software. To examine differences in sleep quality between employees working fixed and rotating shift schedules, an independent samples t-test was conducted. Additionally, a one-way analysis of variance (ANOVA) was used to determine whether there were statistically significant differences in sleep quality among three different shift types within a subgroup of workers identified as having a morning chronotype.

RESULTS AND DISCUSSION

The present study examined the impact of shift schedules and chronotype on sleep quality among employees working fixed and rotating shifts. The findings provide important insights into how different shift patterns affect sleep, with implications for occupational health and shift work management.

Hypothesis 1 stated that there would be statistically significant differences in sleep quality between employees working exclusively in fixed shift schedules and those working in rotating shift schedules.

Table 1. *Differences in sleep quality among employees working in fixed and rotating shifts*

Shift Schedule	N	Sleep Quality
Fixed	49	.7423
Rotating	97	.8449
t		-3.252
p		.001

As shown in Table 1., the results revealed a statistically significant difference in sleep quality between the two groups, $t(144) = -3.25$, $p = .001$.

Employees working in rotating shifts reported higher sleep quality scores (M=0.84) compared to those working fixed shifts (M=0.74), indicating that rotating shift workers experienced poorer sleep quality. These findings support the hypothesis that shift type is associated with significant differences in sleep quality, with rotating schedules being more detrimental to sleep. This aligns with previous research indicating that rotating shifts disrupt circadian rhythms more severely, leading to increased sleep disturbances and reduced restorative sleep (Costa, 2003; Åkerstedt, 2003). The frequent changes in work hours associated with rotating shifts likely hinder the body's ability to adapt, resulting in cumulative sleep debt and impaired sleep quality.

Hypothesis 2 stated that there are statistically significant differences in sleep quality depending on the type of shift work among workers with a morning circadian chronotype.

Table 2. *Differences in sleep quality based on shift type among workers with a morning chronotype*

Shift Schedule	N	Sleep Quality
Fixed – Morning Shift Only	25	1.0254
Rotating – All Three Shifts	41	1.2307
Rotating – Day Shifts Only	16	1.1160
F		3.516
p		0.032

As shown in Table 2., the results revealed a statistically significant difference in sleep quality scores between the shift groups, $F\ (3.51) = 4.10$, $p = 0.032$. Workers on rotating shifts covering all three shifts reported the highest mean sleep quality score (M=1.23), indicating poorer sleep quality compared to those working fixed morning shifts only (M=1.02) and those on rotating day shifts only (M=1.11). These results suggest that rotating shifts, especially involving night work, may be associated with diminished sleep quality in morning-type workers. This suggests that morning chronotypes, who naturally prefer early activity and sleep times, are particularly vulnerable to the disruptive effects of night and rotating shifts. The misalignment between their intrinsic circadian preferences and work demands likely exacerbates sleep difficulties. These findings corroborate prior studies showing that morning types struggle more with night shifts and rotating schedules, which can lead to increased fatigue and decreased well-being (Vetter et al., 2015; Juda et al., 2013).

Table 3. *Differences in sleep quality based on shift type among workers with an evening chronotype*

Shift Schedule	N	Sleep Quality
Fixed – Morning Shift Only	24	**0.4938**
Rotating – All Three Shifts	39	0.7152
Rotating – Day Shifts Only	9	0.5166
F		4.098
p		**0.018**

As shown in Table 3., the results revealed a statistically significant difference in sleep quality scores between the shift groups, F (4.09) = 4.10, p = 0.018. Workers engaged in rotating shifts encompassing all three shifts had the highest mean sleep quality score (M=0.72), indicating poorer sleep quality compared to those working fixed morning shifts only (M=0.49) and those working rotating day shifts only (M=0.52). This suggests that rotating shift work negatively affects sleep quality in evening-type workers as well. Although evening chronotypes generally tolerate later schedules better, the inclusion of night shifts and frequent rotation still appears to impair their sleep. This indicates that while evening types may have some resilience to night work, the instability and the irregularity of rotating shifts remain detrimental. These results extend previous research by highlighting that rotating shift work negatively affects sleep quality across chronotypes, though the degree of impact may vary (Adan et al., 2012; De Martino et al., 2013).

CONCLUSION

The results of this study reveal significant differences in sleep quality influenced by both shift type and individual chronotype. Morning chronotypes working fixed morning shifts reported consistently better sleep quality compared to those engaged in rotating shifts. Interestingly, evening chronotypes working fixed morning shifts also exhibited improved sleep quality, while those on rotating shifts experienced the poorest outcomes. Among workers covering all three shifts, morning chronotypes showed the lowest overall sleep quality, highlighting their particular vulnerability to irregular schedules. These findings underscore the critical importance of considering both chronotype and shift type when evaluating sleep quality and designing work schedules. The stability and predictability inherent in fixed morning shifts appear to provide substantial benefits, even for evening chronotypes, by enabling the establishment of consistent routines that enhance overall sleep quality. This suggests that schedule regularity and predictability may have a greater positive impact on sleep health than merely aligning shifts with circadian preferences.

Given the crucial role of the circadian rhythm in regulating sleep and activity patterns, disruptions caused by shift work can lead to poorer sleep quality and associated health risks. Therefore, practical scheduling adjustments are essential. Fixed shifts, particularly those tailored to workers' chronotypes, can help mitigate sleep disturbances and promote better health outcomes. For rotating shifts, reducing the frequency of night shifts and ensuring adequate recovery time between shifts may alleviate negative effects on sleep. Furthermore, incorporating chronotype assessments into shift assignment processes could enhance worker well-being, reduce fatigue, and improve productivity.

Overall, accommodating individual biological rhythms while maintaining schedule stability and predictability emerges as a key strategy to optimize sleep quality and support the health and performance of shift workers.

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REFERENCES

Adan, A., Archer, S. N., Hidalgo, M. P., Di Milia, L., Natale, V., & Randler, C. (2012). Circadian typology: A comprehensive review. *Chronobiology International*, 29(9), 1153–1175. https://doi.org/10.3109/07420528.2012.719971

Åkerstedt, T. (2003). Shift work and disturbed sleep/wakefulness. *Occupational Medicine*, 53(2), 89–94. https://doi.org/10.1093/occmed/kqg046

Alshahrani, S. M., & BaHammam, A. S. (2017). Impact of shift work on sleep and daytime performance among health care professionals. *Annals of Thoracic Medicine*, 12(3), 183–189.

Arendt, J. (2010). Shift work: Coping with the biological clock. *Occupational Medicine*, 60(1), 10–20. https://doi.org/10.1093/occmed/kqp162

Baehr, E. K., Fogg, L. F., & Eastman, C. I. (1999). Intermittent bright light and exercise to entrain human circadian rhythms to night work. *American Journal of Physiology – Regulatory, Integrative and Comparative Physiology*, 277(6), R1598–R1604.

Boivin, D. B., James, F. O., & Wu, A. (2022). Blue-enriched light exposure during night shifts improves alertness and performance: A randomized controlled trial. *Journal of Biological Rhythms*, 37(1), 45–58. https://doi.org/10.1177/07487304211065432

Burgess, H. J., Sharkey, K. M., & Eastman, C. I. (2002). Bright light, dark and melatonin can promote circadian adaptation in night shift workers. *Sleep Medicine Reviews, 6*(5), 407–420.

Buysse, D. J., Reynolds III, C. F., Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatry Research*, *28*(2), 193–213.

Caruso, C. C. (2014). Negative impacts of shiftwork and long work hours. *Rehabilitation Nursing*, 39(1), 16–25. https://doi.org/10.1002/rnj.107

Costa, G. (2003). Shift work and occupational medicine: An overview. *Occupational Medicine*, 53(2), 83–88. https://doi.org/10.1093/occmed/kqg045

de Bruijn, L., Berentzen, N. E., Vermeulen, R. C. H., et al. (2025). Chronotype in relation to shift work: A cohort study among 37,731 female nurses. *Journal of Sleep Research*, 34(2), e14308.

De Martino, E., et al. (2013). Chronotype and shift work tolerance: A review. *Chronobiology International*, 30(3), 355–365. https://doi.org/10.3109/07420528.2012.750971

Dumont, M., Paquet, J., & Carrier, J. (2001). *Circadian rhythm adaptation in shift workers: Effects on sleep and performance.* Sleep Medicine Reviews, 5(3), 239–250. https://doi.org/10.1053/smrv.2001.0150

Folkard, S., & Tucker, P. (2003). Shift work, safety and productivity. *Occupational Medicine*, 53(2), 95–101. https://doi.org/10.1093/occmed/kqg047

Gradisar, M., & Lack, L. (2004). Circadian rhythm and sleep disruption in shift work. *Sleep Medicine Reviews*, 8(3), 203–214. https://doi.org/10.1016/j.smrv.2004.02.003

Hadler, P., Neuert, C., & Lenzner, T. (2018). European Working Conditions Survey (EWCS). Cognitive Pretest. European Foundation for the Improvement of Living and Working Conditions

Horne, J. A., & Östberg, O. (1976). A self-assessment questionnaire to determine morningness-eveningness in human circadian rhythms. *International Journal of Chronobiology*, 4(2), 97–110.

Horowitz, T. S., Cade, B. E., Wolfe, J., & Czeisler, C. A. (2001). *Effects of partial circadian adjustments on sleep and vigilance quality during simulated night work*. Journal of Sleep Research, 11(3), 265–274. https://doi.org/10.1046/j.1365-2869.2002.00323.x

Jafari Roodbandi, A., Choobineh, A., & Daneshvar, S. (2015). Relationship between circadian rhythm amplitude and stability with sleep quality and sleepiness among shift nurses and health care workers. *International Journal of Occupational Safety and Ergonomics*, 21(3), 312–317.

Jehan, S., et al. (2017). Circadian rhythm flexibility and shift work adaptation. *Sleep Health*, 3(3), 200–206. https://doi.org/10.1016/j.sleh.2017.02.007

Juda, M., Vetter, C., & Roenneberg, T. (2013). Chronotype modulates sleep duration, sleep quality, and social jet lag in shift-workers. *Journal of Biological Rhythms*, 28(2), 141–151. https://doi.org/10.1177/074873041347855

Ker, K., Edwards, P. J., Felix, L. M., Blackhall, K., & Roberts, I. (2010). Caffeine for the prevention of injuries and errors in shift workers. *The Cochrane database of systematic reviews*, *2010*(5).

Kılıç, A., Koran, S., & Ağargün, M. Y. (2023). Healthcare shift workers' sleep quality, daytime sleepiness, and circadian preference. *Comprehensive Medicine*, 15(2), 156–164.

Knutsson, A. (2003). Health disorders of shift workers. *Occupational Medicine*, 53(2), 103–108. https://doi.org/10.1093/occmed/kqg048

Korf, H. W., & von Gall, C. (2022). Circadian physiology. In *Neuroscience in the 21st century: From basic to clinical* (pp. 2541-2576). Cham: Springer International Publishing.

Potter, G. D. M., & Wood, S. (2020). *Optimizing shift work schedules to improve circadian adaptation and worker health*. *Chronobiology International*, 37(8), 1125–1139. https://doi.org/10.1080/07420528.2020.1759836

Roenneberg, T., Wirz-Justice, A., & Merrow, M. (2007). Life between clocks: Daily temporal patterns of human chronotypes. *Journal of Biological Rhythms*, 18(1), 80–90. https://doi.org/10.1177/0748730402239679

Scott, A. J., Lack, L. C., & Lovato, N. (2024). The effects of short-wavelength light exposure on circadian phase and alertness in shift workers: A systematic review. *Sleep Medicine Reviews*, 68, 101654. https://doi.org/10.1016/j.smrv.2023.101654

Sephton, S. E., & Spiegel, D. (2003). Circadian disruption and health consequences. *The Lancet Oncology*, 4(8), 497–505. https://doi.org/10.1016/S1470-2045(03)01104-7

Sharkey, K. M., & Eastman, C. I. (2002). Melatonin phase shifts human circadian rhythms in a placebo-controlled simulated night-work study. *American Journal of Physiology-Regulatory, Integrative and Comparative Physiology, 282*(2), R454–R463.

Sharkey, K. M., Fogg, L. F., & Eastman, C. I. (2001). Effects of melatonin administration on daytime sleep after simulated night shift work. *Journal of Sleep Research, 10*(3), 181–192.

Smith, L., et al. (1999). Effects of shift work on sleep and performance. *Sleep*, 22(3), 317–326. https://doi.org/10.1093/sleep/22.3.317

Vetter, C., Devore, E. E., Ramin, C. A., Speizer, F. E., Willett, W. C., Schernhammer, E. S. (2015). Association between rotating night shift work and risk of coronary heart disease among women. *JAMA*, 315(16), 1726–1734. https://doi.org/10.1001/jama.2016.4454