Jurnal SPORTIF: Jurnal Penelitian Pembelajaran
Vol. 12 No. 1, April 2026, pp. 100 - 114
https://doi.org/10.29407/js_unpgri.v12i1.23892

Differences in sleep quality and sleep behaviors between the preparation and competition phases in handball athletes

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Received: 4 November 2025; Revised: 2 January 2026; Accepted: 18 April 2026; Available online: 28 April 2026.

Abstract

Sleep quality and sleep behaviors are essential for athletes' recovery and performance; however, their variation across competitive phases remains insufficiently understood. This study aimed to examine differences in sleep quality and sleep behaviors between the preparation and competition phases among male handball athletes. A quantitative study with a comparative within-subject design was employed, using repeated measurements collected at two time points and analyzed to identify phase-based changes. The participants were 24 male handball athletes from Semarang City preparing for PORPROV 2023, selected using total sampling. Sleep quality and sleep behaviors were assessed using the Pittsburgh Sleep Quality Index (PSQI) and the Athlete Sleep Behavior Questionnaire (ASBQ). Data were collected during the preparation and competition phases and analyzed using descriptive statistics and paired-sample t-tests. The results showed a significant decline in sleep quality during the competition phase, reflected in higher PSQI scores (2.12 to 2.56; $p < 0.05$), increased sleep disturbances (3.4 to 4.1; $p < 0.05$), longer sleep onset latency (43 to 46 minutes; $p < 0.05$), and a marked rise in late-night exercise (1.3 to 3.6; $p < 0.01$), along with increased disturbance frequency (1.7 to 2.1 times; $p < 0.05$). In contrast, changes in sleep duration, stimulant use, and restroom interruptions were not statistically significant. These findings indicate that the competition phase is associated with measurable changes in both physiological and behavioral aspects of sleep and contributes to phase-specific evidence of sleep dynamics in team sports.

Keywords: Sleep quality, sleep behaviors, handball athletes, competition phase.

How to Cite: Romadhoni, W. N., Priambodo, N. E. N., & Nursantiko, D. R. (2026). Differences in sleep quality and sleep behaviors between the preparation and competition phases in handball athletes. *Jurnal SPORTIF : Jurnal Penelitian Pembelajaran*, *12*(1), 100–114. https://doi.org/10.29407/js_unpgri.v12i1.23892

Authors contribution: a – Preparing concepts; b – Formulating methods; c – Conducting research; d – Processing results; e – Interpretation and conclusions; f - Editing the final version.

INTRODUCTION

Achieving optimal performance in handball requires not only well-structured technical and physical training but also effective recovery

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processes, in which sleep plays a fundamental role (Wagner et al., 2014). Sleep quality and sleep behaviors are widely recognized as critical determinants of athletic performance, as they influence physiological recovery, cognitive function, and psychological readiness (Rebello et al., 2022). For handball athletes, sleep quality and sleep behaviors are especially critical due to the sport's unique physical, cognitive, and tactical demands. Handball requires explosive power, agility, rapid decision-making, teamwork, and sustained endurance, all of which are directly influenced by sleep (Mason et al., 2022). Empirical evidence has consistently shown that sleep is closely associated with reaction time, accuracy, and overall athletic output (Fullagar et al., 2015; O'Donnell et al., 2018).

Beyond general sleep quality, recent research has emphasized that athletes' sleep patterns are dynamic and influenced by contextual demands, particularly across different phases of training and competition (Kasmadi & Suhadi, 2024). While prior studies have established the foundational link between sleep and athletic performance, much of the existing literature relies on cross-sectional approaches that capture sleep at a single time point, thereby failing to reflect temporal variations that occur between preparation and competition phases (Cook & Charest, 2023). This limitation is critical because athletes are exposed to distinct physiological and psychological demands during these phases, which may lead to different sleep responses. In addition, although previous studies have highlighted the importance of sleep for recovery and injury prevention (Rygielski et al., 2024), limited attention has been given to how sport-specific factors, such as irregular training schedules, travel demands, and competitive pressure, influence sleep quality and sleep-related behaviors in real competitive contexts.

Sleep disruptions in athletes are influenced by multiple interacting factors that alter habitual sleep behaviors. Physically, high training loads and accumulated fatigue can delay sleep onset and impair recovery processes (Kasmadi & Suhadi, 2024). Psychologically, competitive

pressure, anxiety, and pre-match cognitive arousal contribute to increased sleep onset latency and fragmented sleep (Vitale et al., 2019). Environmentally, factors such as travel across cities, unfamiliar sleeping conditions, and irregular competition schedules further disrupt circadian rhythms (Rygielski et al., 2024). Additionally, behavioral factors, including late-night activities, stimulant use, and inconsistent sleep–wake routines during competition periods, reflect significant changes in athletes' sleep habits. Sleep disruptions are not only reflected in global sleep quality scores but also in specific behavioral and physiological indicators such as sleep disturbances, sleep onset latency, and sleep duration. Changes in these indicators may signal alterations in athletes' sleep patterns, particularly during competition phases when physical load and psychological stress are elevated. These combined disruptions can impair muscle recovery, disrupt hormonal balance, and reduce cognitive performance, ultimately affecting athletic performance (Charest & Grandner, 2020; Doherty et al., 2021).

Despite these developments, critical gaps persist in understanding how handball-specific stressors and temporal training phases modulate sleep quality and sleep behaviors. There remains limited empirical evidence examining phase-based differences in sleep quality and sleep behaviors among handball athletes in real competition settings. In particular, no study has systematically investigated these variables among handball athletes in Semarang City during the preparation and competition phases of PORPROV. This gap is important because sleep disturbances represent a modifiable factor that can be targeted to improve both recovery and performance. Understanding how sleep patterns and behaviors change across phases is, therefore, essential for developing more effective, context-driven strategies in sports performance management.

To address this gap, this study employs standardized instruments, namely the Pittsburgh Sleep Quality Index (PSQI) and the Athlete Sleep Behavior Questionnaire (ASBQ), which have been widely validated for assessing global sleep quality and athlete-specific sleep behaviors (Driller et al., 2018; Lu et al., 2022; Driller et al., 2023). These instruments enable

a comprehensive evaluation of both physiological and behavioral aspects of sleep, providing a more nuanced understanding of athletes' sleep patterns across different competitive phases.

Therefore, this study aims to examine differences in sleep quality and sleep behaviors between the preparation and competition phases among handball athletes. Beyond its local context, this study contributes to the broader field of sports science by providing empirical evidence on phase-specific sleep dynamics in team sports, particularly in high-intensity disciplines such as handball. The findings are expected to enhance understanding of how competition phases influence sleep patterns and to support the development of more precise, context-driven strategies for optimizing athlete recovery, performance readiness, and sleep management across different competitive environments.

METHOD

This study employed a comparative within-subject design to examine differences in sleep quality and sleep behaviors between two critical phases in sport, namely the preparation phase and the competition phase, among handball athletes. These phases represent distinct physical and psychological conditions that may influence athletes' recovery processes and performance readiness (Woods et al., 2020). By comparing the same athletes across two phases, this design allows for a more accurate assessment of phase-specific changes, free from the influence of inter-individual variability. It enables direct comparison of the same individuals across two distinct conditions.

The study involved 24 male handball athletes from Semarang City who were preparing to compete in the Central Java Provincial Sports Week (PORPROV) 2023. Participants were selected using a total sampling technique, in which all eligible athletes within the population were included. This approach was used to ensure that the sample adequately represented the target population and to minimize sampling bias.

Sleep quality and sleep behaviors were measured using two standardized and widely used instruments: the Pittsburgh Sleep Quality

Index (PSQI) and the Athlete Sleep Behavior Questionnaire (ASBQ) (Driller et al., 2018; Driller et al., 2023). The PSQI was used to assess global sleep quality, including components such as sleep duration, sleep efficiency, and sleep disturbances. In contrast, the ASBQ was used to evaluate athlete-specific sleep behaviors, including habits related to training schedules, pre-sleep activities, and environmental factors that may influence sleep. The use of these instruments is relevant to this study as they provide complementary measures of both general sleep quality and sport-specific sleep behaviors, capturing both physiological and behavioral aspects of sleep.

In this study, behavioral changes refer to differences in sleep-related behaviors observed between the preparation and competition phases. These changes were operationalized through specific indicators derived from the ASBQ, including late-night activity, stimulant use (e.g., caffeine consumption), and other behaviors that may influence sleep onset and sleep continuity. These indicators were analyzed alongside sleep quality measures to identify how behavioral patterns shift across phases and how they relate to changes in sleep quality.

Data collection was conducted at two time points. The first measurement was carried out during the preparation phase, defined as the period of regular training prior to competition. The second measurement was conducted during the competition phase, when athletes were actively participating in official matches. At each time point, participants completed the PSQI and ASBQ under similar conditions to ensure consistency in data collection. This repeated-measurement approach allows for direct observation of changes in sleep patterns and behaviors within the same individuals.

The data analysis followed a structured statistical procedure. Descriptive statistics, including means and standard deviations, were calculated to summarize participant characteristics and sleep variables in both phases. Inferential analysis was then conducted using paired-sample t-tests to compare sleep quality and sleep behaviors between the

preparation and competition phases. This statistical test was appropriate because it compares measurements obtained from the same participants across two conditions, allowing for the identification of statistically significant differences and providing evidence of behavioral and physiological changes in athletes' sleep patterns.

RESULT

This study investigated sleep quality and sleep behaviors among 24 male handball athletes in Semarang during two phases: the preparation and competition periods of PORPROV 2023. Using the Pittsburgh Sleep Quality Index (PSQI) and Athlete Sleep Behavior Questionnaire (ASBQ), it examined changes in sleep patterns as athletes shifted from preparation to competition. Participants provided informed consent, and the study followed ethical research guidelines.

Pittsburgh Sleep Quality Index (PSQI) Findings

Increased Sleep Disturbances During Competition: PSQI data showed a significant rise in sleep disturbances during competition compared to the preparation phase. Athletes reported more difficulty maintaining a regular sleep-wake schedule due to changes in training, travel demands, and competition-related stress. Environmental factors, including unfamiliar hotel settings with different bedding, temperatures, and noise levels, further disrupted sleep.

Data were collected from 24 male athletes who were prepared through a centralized training program to participate in PORPROV 2023, aged 18 to 23 years. The table below presents the comparative sleep quality scores of the athletes during the preparation and competition phases.

Table 1. Sample Demographics During Preparation Phases.

N	Mean (Sleep Duration)	Std. Deviation	Age	Bedtime (pm)	Wake time (am)
24	6.5	0.695	22±4	23:02 ± 0.43	05:32

Descriptive statistics for the sample during the preparation phase are presented in Table 1. A total of 24 handball athletes (N=24) participated in this study. The mean age of the athletes was 22 years, with a standard

deviation of 4 years (22±4 y), indicating a relatively young adult sample with some age variability.

Regarding sleep parameters, the mean sleep duration during the preparation phase was 6.5 hours, with a standard deviation of 0.695, indicating a moderate spread around the mean. The athletes typically went to bed at 11:02 PM. Their average wake-up time was consistently recorded at 05:32 AM. These findings provide a foundational understanding of the sleep habits of Semarang handball athletes prior to the competition phase.

Table 2. Sample Demographics During Competition Phases.

N	Mean (Sleep Duration)	Std. Deviation	Age	Bedtime (pm)	Wake time (am)
24	6.8	1.2	22±4	22:59 ± 0.46	05:47

Regarding sleep characteristics during this demanding period, the athletes reported a mean sleep duration of 6.8 hours (**Table 2**), accompanied by a standard deviation of 1.2. This suggests some variability in the total sleep time among the athletes, with some likely sleeping considerably less or more than the average. The average bedtime during the competition phase was 10:59 PM. This indicates a spread in athletes' bedtimes, influenced by individual schedules, late-night training, or recovery protocols. The mean wake-up time was consistently reported at 05:47 AM, indicating a relatively early start to the day for most athletes during this phase.

Table 3. Sleep Quality Metrics (PSQI)

Measure	Preparation	Competition	Change
Overall PSQI Score	2.12	2.56	+0.44
Sleep Disturbances	3.4	4.1	+0.7
Late-Night Exercise	1.3	3.6	+2.3
Stimulant Use	1.7	1.3	-0.4
Sleep Duration	6.5	6.8	+0.3
Sleep Onset Latency	43	46	+3
Restroom Interruptions	1.3	1.2	-0.1

Table 3 presents the comparison of sleep quality metrics (PSQI) between the preparation and competition phases. The overall PSQI score increased from 2.12 during the preparation phase to 2.56 in the competition phase, indicating a decline in sleep quality. This change is consistent with the increase in sleep disturbances, which rose from 3.4 to 4.1, indicating

that athletes experienced more frequent sleep interruptions during the competition phase.

In addition to these components, behavioral indicators related to sleep were also observed. Late-night exercise showed a substantial increase from 1.3 to 3.6, indicating a higher frequency of physical activity close to bedtime during competition. In contrast, stimulant use (caffeine) decreased slightly from 1.7 to 1.3, although this change was not statistically significant.

Sleep duration increased modestly from 6.5 to 6.8 hours, while sleep onset latency increased from 43 to 46 minutes, suggesting a longer time to fall asleep. Restroom interruptions remained relatively stable, with a slight decrease from 1.3 to 1.2.

Overall, the data in Table 1 indicate that the competition phase is associated with poorer sleep quality, characterized by increased disturbances, longer sleep onset latency, and notable changes in sleep-related behaviors.

Table 4. Sleep Behavior Metrics (ASBQ)

Behavior	Preparation	Competition	Difference
Sleep Duration	6.5	6.8	+0.3
Sleep Onset Latency	43	46	+3
Disturbances	1.7	2.1	+0.4
Restroom	1.3	1.2	-0.1

Table 4 shows that sleep duration increased slightly from 6.5 to 6.8 hours. However, this change was not statistically significant, while sleep onset latency (43 to 46 minutes) and disturbance frequency (1.7 to 2.1 times) increased, indicating less efficient, more fragmented sleep during the competition phase. Restroom awakenings remained relatively stable (1.3 to 1.2). Overall, these results suggest that despite a slight increase in sleep duration, the competition phase is associated with poorer sleep efficiency and measurable behavioral changes in athletes' sleep patterns.

Table 5. Statistical Test Results

Measure	Preparation	Competition	p-value
PSQI Score	2.12	2.56	<0.05
Sleep Disturbances	3.4	4.1	<0.05
Late-Night Exercise	1.3	3.6	<0.01
Stimulant Use	1.7	1.3	0.06
Sleep Duration	6.5	6.8	0.15
Sleep Onset Latency	43	46	<0.05
Disturbances	1.7	2.1	<0.05
Restroom	1.3	1.2	>0.05

Table 5 presents the results of the paired-sample t-test comparing sleep variables between the preparation and competition phases, showing significant increases in overall sleep quality scores (PSQI), sleep disturbances, late-night exercise, sleep onset latency, and frequency of disturbances ($p < 0.05$), which indicate a decline in sleep quality and changes in sleep-related behaviors during the competition phase; meanwhile, changes in stimulant use, sleep duration, and restroom interruptions were not statistically significant ($p > 0.05$), confirming that the competition phase is associated with measurable differences in both sleep quality and sleep behaviors in line with the research objective.

DISCUSSION

This study aimed to examine differences in sleep quality and sleep behaviors among male handball athletes between the preparation and competition phases. The findings demonstrate that the competition phase is associated with a decline in sleep quality and measurable changes in sleep-related behaviors. This is evidenced by a significant increase in overall PSQI scores (2.12 to 2.56, $p < 0.05$), sleep disturbances (3.4 to 4.1, $p < 0.05$), late-night exercise (1.3 to 3.6, $p < 0.01$), and sleep onset latency (43 to 46 minutes, $p < 0.05$). Although sleep duration slightly increased during competition, this improvement did not offset the negative impacts observed in other sleep parameters, indicating that athletes' sleep became less efficient and more fragmented during this phase.

The decline in sleep quality during the competition phase aligns with previous studies suggesting that competitive periods are associated with

disruptions in athletes' sleep patterns (Amin & Ashadi, 2021; Gupta et al., 2016; Lastella et al., 2018). The heightened difficulty in maintaining a consistent sleep–wake schedule during competitions can be attributed to altered training regimens, travel requirements, and psychological pressures inherent in competitive sports. These factors have been widely reported to affect sleep quality, particularly during high-demand competitive periods. The transition to unfamiliar sleeping environments, such as hotels, further exacerbates sleep disturbances. Discomfort from unfamiliar bedding, changes in ambient conditions, and increased environmental noise are plausible contributors that interfere with sleep continuity and reduce the quality of restorative sleep (Cunha et al., 2023; Ratutama & Qomaruddin, 2022).

A notable finding in this study is the significant increase in late-night exercise during the competition phase. The ASBQ data indicate that athletes engaged more frequently in late-night physical activity, which may reflect intensified training schedules and tactical preparations. However, engaging in vigorous activity close to bedtime can elevate physiological arousal, increase core body temperature, and delay sleep onset, ultimately reducing sleep efficiency. This finding is consistent with previous research showing that evening exercise can negatively impact sleep latency and overall sleep quality (Vitale et al., 2018). The observed increase in sleep onset latency further supports this interpretation, indicating that athletes required more time to initiate sleep during competition.

In contrast, changes in stimulant use and sleep duration were not statistically significant, suggesting that these variables did not substantially contribute to the observed decline in sleep quality. The slight decrease in caffeine consumption may reflect athletes' awareness of the importance of sleep for performance or stricter regulation during competition periods (O'Callaghan et al., 2018). Meanwhile, the modest increase in sleep duration indicates that athletes may attempt to compensate for increased physical and psychological demands by extending time in bed. However, the persistence of sleep disturbances and delayed sleep onset suggests

that additional sleep time alone is insufficient to restore sleep quality when fragmentation and inefficiency persist.

From a theoretical perspective, the increase in sleep disturbances and sleep onset latency can be explained by the arousal theory, which posits that heightened physiological and psychological activation interferes with the ability to initiate and maintain sleep (Oda & Shirakawa, 2014). In addition, the findings are consistent with the activation theory, which emphasizes that increased physical activity, particularly close to bedtime, elevates arousal levels and disrupts sleep regulation (Wang et al., 2024). The competition phase is a condition characterized by elevated demands and activation, which collectively contribute to reduced sleep quality.

Compared to previous studies, this research provides a more specific contribution by adopting a phase-based comparative approach within the same group of athletes. While earlier studies often rely on cross-sectional designs, this study demonstrates how sleep patterns and behaviors change dynamically between preparation and competition phases. This approach provides a clearer understanding of how competitive demands are associated with both physiological and behavioral aspects of sleep, highlighting the importance of examining specific behavioral indicators rather than relying solely on general sleep measures.

The findings have important practical implications for athletes and coaches. Managing the timing of physical activity, particularly by reducing late-night exercise, may serve as an effective strategy to improve sleep quality during competition. In addition, monitoring indicators such as sleep onset latency and disturbance frequency can provide more sensitive measures of sleep problems than total sleep duration alone. Addressing environmental factors, especially when athletes are required to sleep in unfamiliar settings, may also help minimize sleep disruptions and support recovery.

Despite these contributions, several limitations should be acknowledged. The sample size was limited to 24 male handball athletes, which may restrict the generalizability of the findings to other sports or

populations. In addition, individual differences such as coping strategies, psychological resilience, and competition experience were not examined, although these factors may influence sleep patterns. Future research should include larger, more diverse samples and additional variables to provide a more comprehensive understanding of sleep dynamics in athletes.

Overall, the findings of this study support the research objective by demonstrating that the competition phase is associated with significant differences in both sleep quality and sleep behaviors. These results highlight the importance of considering phase-specific changes in sleep when developing strategies to optimize athlete recovery and performance.

CONCLUSION

This study examined differences in sleep quality and sleep behaviors among male handball athletes in Semarang during the preparation and competition phases of PORPROV 2023. The findings show that the competition phase is associated with poorer sleep quality, reflected in increased sleep disturbances, longer sleep onset latency, and higher levels of late-night exercise, despite a slight but non-significant increase in sleep duration. These results indicate that sleep quantity alone does not reflect sleep adequacy and that sleep efficiency and continuity are more critical in competitive contexts.

This study provides phase-specific evidence that sleep disruption in athletes is reflected not only in overall sleep quality but also in observable behavioral changes. The use of a within-subject comparative approach further strengthens the understanding of dynamic sleep changes across phases. Practically, the findings highlight the importance of monitoring key sleep behaviors, particularly late-night activity and sleep onset latency, to support athlete recovery and performance during competition.

ACKNOWLEDGMENT

want to express our sincere gratitude to the Faculty of Sports Science, Universitas Negeri Semarang, for providing the financial support necessary for the completion of this research.

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