International Journal of Medical Toxicology & Legal Medicine Volume 27, No. 1s, 2024
e-ISSN: 0974-4614
p-ISSN: 0972-0448

The Sleep-Athlete Paradox: Assessing Sleep Quality and Behavior Among Collegiate Athletes

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Received: 16.05.2024 Revised: 13.06.2024 Accepted: 21.07.2024

ABSTRACT
Poor sleep quality significantly impacts athletes' cognitive, motor, and emotional functioning. Assessment methods vary from objective tools to simple subjective approaches like sleep diaries and questionnaires. A cross-sectional study involving 107 university athletes utilized self-administered questionnaires (ASSQ and ASBQ) to assess sleep quality and behavior, ensuring a 95% confidence interval. Only 34% reported satisfactory sleep quality, with notable correlations between sleep difficulties and poor sleep behavior, and environmental conditions strongly linked to sleep difficulty scores. Personalized sleep education and interventions are essential for collegiate athletes to improve sleep hygiene and enhance performance.

Keywords: Athlete Sleep Screening Questionnaire, ASSQ, Athlete Sleep Behaviour Questionnaire, ASBQ, sleep behaviour

INTRODUCTION
Normal sleep consists of two main phases: non-rapid eye movement (NREM) sleep and rapid eye movement (REM) sleep. NREM is divided into four stages: N1, N2, N3, and N4. Sleep-onset latency is the time taken to transition from wakefulness to N1, the lightest stage. Typically, about 40 minutes after falling asleep, individuals reach N3, which should ideally comprise 25% of total sleep time. N3 is essential for restorative rest, preparing the brain for learning and alleviating sleep deficits accumulated during the day(Crabtree and Williams 2009).Healthy sleep patterns are strongly connected to various cognitive functions, including learning, memory, decision-making, and alertness; physical health factors like healing, recovery, metabolism, muscle growth, and weight management; as well as mental health concerns such as stress, anxiety, mood regulation, and emotional control. This is especially crucial for college-aged young adults, who are experiencing both rapid brain development and significant changes in the biological processes that regulate sleep patterns(Grandner, n.d 2017.; Gupta, et al. 2022; Jahrami et al. 2023).
Sleep deprivation is linked to a higher risk of musculoskeletal injuries, which is particularly concerning for young athletes. A systematic review confirmed a significant connection between chronic sleep loss and increased risk of sports-related injuries(Gao et al. 2019; Copenhaver and Diamond 2017).Poor sleep quality or insufficient sleep can significantly impact overall performance, especially for athletes traveling long distances for competitions and also impairs psychomotor skills, mood, motor abilities, and cognitive function(Duffield et al. 2014; Coel et al. 2023). Sleep leads to a proinflammatory state that can reduce resilience to infections and impact an athlete’s attendance and performance. Common effects of sleep loss in athletes include slower reaction times, more errors under pressure, and impaired ability to learn and apply strategies(Fullagar et al. 2015).
University life presents a unique set of challenges, including social adjustments, academic demands, and financial strain, which can cumulatively impact sleep habits and overall stress levels(Brown, et al. 2017; Amaral et al. 2018). The dual demands of athletic and academic pursuits expose student-athletes to a unique set of physical and mental pressures. To optimize their performance, foster holistic development, and promote overall well-being, it is crucial to examine and improve the extracurricular habits and routines that exist beyond the playing field and classroom(Leduc et al. 2020). Addressing these factors thoughtfully can help optimize the sleep of young athletes and, consequently, their performance.

Sleep assessment can be conducted using a combination of objective tools (PSG, activity trackers, smartphone apps, and wearable devices) and subjective reports (sleep diaries and questionnaires).Despite advanced techniques, sleep diaries and questionnaires remain straightforward and cost-effective for evaluating sleep patterns. They typically gather data on bed and wake times, lights-out time, daytime napping, sleepiness and alertness ratings, caffeine and alcohol consumption, exercise, and screen time over at least one week. These tools are commonly used for initial sleep screenings due to their ease of use and affordability(Anderson 2018).
This cross-sectional study was done to explore and describe the sleep habits and patterns of the university athletes as it is crucial for several reasons. Sleep is crucial for athletic performance, recovery, and overall health, and disruptions can greatly affect an athlete's physical and mental well-being. By examining sleep behaviours, this study aims to identify potential factors that influence sleep quality and duration, thereby informing strategies to enhance performance and health outcomes. Furthermore, the insights from this research can help create targeted interventions to enhance sleep hygiene in athletes, ultimately promoting their athletic success and long-term well-being.

Methodology
A cross-sectional study was conducted in the Kancheepuram district of Tamil Nadu, focusing on the population of Tamil Nadu University level athletes who volunteered to participate.Volunteers were recruited through an announcement, and they were asked to complete a registration form that gathered basic information, including gender, age, sports participation, medical history, treatment history, and details of any injuries and hospitalizations in the past six months. Among the volunteers, the study included athletes aged 18 to 26 years. Athletes who had major injuries requiring hospitalization in the last 6 months or who had pre-existing psychological issues were excluded from the study.Using a significance level of 0.05, a standard deviation of 2, a 95% confidence interval, and an absolute precision of 0.4, a sample size of 97 was determined using the online sample size calculator provided by the Department of Quantitative Health Science at the Cleveland Clinic(Riley et al. 2020). Factoring in a 10% non-response rate, a total of 107 participants were included in the study. Out of 132 registration forms received, 107 were selected based on the inclusion/exclusion criteria and in the order of receipt. The data on sleep quality and behaviour were collected using self-administered questionnaire of Athlete Sleep Screening Questionnaire (ASSQ)(Samuels et al. 2016) and Athlete Sleep Behaviour Questionnaire (ASBQ)(Driller et al. 2018).
The ASSQ is a clinical screening tool designed to assess athletes' sleep patterns, including quality, duration, and consistency. It generates a global Sleep Difficulty Score (SDS) based on the sum of answers to five Likert-scale questions. Higher SDS values suggest a greater likelihood of sleep-related issues. The severity of these issues is classified into categories: none (0–4), mild (5–7), moderate (8–10), and severe (11–17). The ASSQ evaluates factors that influence sleep, such as travel, chronotype (whether individuals are morning or evening types), and sleep-disordered breathing (e.g., apnoea). It also offers interventions tailored to SDS scores and these influencing factors(Samuels et al. 2016; Bender et al. 2018). The ASBQ evaluates athletes' sleep hygiene practices and offers recommendations as necessary. It asks athletes about the frequency of specific sleep and sports-related behaviours over the past month, with responses rated on a 5-point Likert scale. A global score, ranging from 18 to 90, is derived from the total of these ratings. A higher global score on the ASBQ reflects a greater likelihood of problematic sleep-related behaviours. According to the ASBQ authors, a global score of 36 or below indicates "good" sleep behaviour, scores between 37 and 41 signify "moderate" sleep behaviour, and a score of 42 or higher denotes "poor" sleep behaviour(Driller et al. 2018).
The study was conducted for a period of 3 months after obtaining approval from the institutional ethical committee and data were successfully collected form 101 participants. The data was entered into Microsoft Excel and analyzed using IBM SPSS version 23. Descriptive statistics, such as frequencies, percentages, means, and standard deviations, were employed to analyse participants' sociodemographic data along with their scores on the ASSQ and ASBQ. Spearman and Pearson correlations were applied to assess relationships between variables, while chi-square tests were used to explore non-parametric associations. Independent t-tests with Bonferroni correction and one way ANOVA were applied to evaluate differences in mean score. A p value of 0.05 were considered to be significant.

Results
Our study done among 101 colligate athletes who gave consent, 58% were female. Mean age of the study participants was 22.16±1.87 years. Mean height of the study participants was found to be 173.46±9.06, with 67.36±8.47 being the mean weight and mean BMI of 22.41±2.58. The mean ASBQ score of the study participants was found to be 44.30±11.17 and the mean sleep difficulty score was 7.19±2.83. (Fig 1) There were no significant difference observed between the male and female participants in terms of sleep behaviour. (Table 1) It was observed that 34% of participants reported being somewhat satisfied with their quality of sleep, while 27% were very dissatisfied. Regarding sleep, 75% took less than 30 minutes to fall asleep, while 13% took over

60 minutes. Additionally, 6% experienced trouble staying asleep weekly, 2% used sleep pills almost daily, and 16% used them 3-4 times a week past 1 month.
(Table 2) In evaluating routine and environmental factors affecting sleep, 6% of participants took afternoon naps lasting 2 hours or more. Additionally, 11% experienced over 1 hour of variation in bedtime, while 6% had similar variations in wake-up time. Furthermore, 23% frequently slept in less-than-ideal home environments, 3% slept in foreign environments, and nearly 32% reported that travel disrupted their sleep-wake routine. (Fig 2) While examining the effect of travel for sports events, 75% of study participants reported experiencing sleep disturbances while traveling for sports, and 66% indicated that travel negatively affected their performance.
(Table 3) Sleep disordered breathing was found in 32% of participants, with 24% being loud snorers—17% of whom reported frequent sleep disruption. Additionally, 26% experienced choking or gasping during sleep. While 47% never used stimulants, 11% were habitual users. A significant 92% refrained from alcohol within four hours of bedtime, yet 53% regularly used light-emitting devices in the hour before sleep. Eighteen percent reported thinking about non-sport-related issues in bed, and 16% frequently used sleeping pills, with the same percentage waking multiple times to use the bathroom at night. (Table 4) Although 38% of participants never exercised after 7 PM, around 14% always did. Additionally, 6% went to bed feeling thirsty, while 8% reported going to bed with sore muscles; 23% and 12% respectively experienced these conditions frequently. 13% thought about their sports performance while in bed, and 21% frequently experienced muscle twitching.While assessing the correlation between the sleep difficulty score and the environment, behaviour and sports related factors affecting the sleep a positive moderate corelation was observed between the sleep difficulty score and sports related factors ($r=0.331$, $p<0.001$). A positive and strong corelation was observed between the sleep difficulty score and behavioural factors ($r=0.522$, $p<0.001$) and a very strong positive corelation was established with the environment factors ($r=0.641$, $p<0.001$).
(Table 5) Our study found that all participants without sleep difficulties exhibited good or normal sleep behaviour, while those with moderate to severe sleep difficulties displayed poor sleep behaviour, with results showing high statistical significance. Additionally, 16% of morning chronotype participants and 43% of evening chronotype participants had good sleep behaviour, with a statistically significant association. Regression analysis revealed that Sports has a negative and non-significant corelation with SDS ($B = -0.110$, $\beta = -0.173$, $p = 0.104$), behaviour has a positive and significant corelation ($B = 0.146$, $\beta = 0.249$, $p = 0.033$) and environment had highly significant positive corelation with SDS ($B = 0.467$, $\beta = 0.574$, $p < 0.001$)

Discussion

To evaluate the sleep pattern and behaviour in our study participants ASSQ and ASBQ questionnaire were used. (Driller et al. 2018; Bender et al. 2018).In a study by Rebello et al., the mean age of participants was 20.3 ± 1.7 years, and the mean BMI was 23.3 ± 3.3 with 54% female participants, which was similar to our study population with a mean age of 22.16 ± 1.87 years and a mean BMI of 22.41 ± 2.58 and 58% being female participants. There were no significant gender difference observed, 34% of our participants met the threshold for adequate sleep (7+ hours), compared to 51% in their study. Both studies reported similar levels of sleep satisfaction, with 54% of participants in Rebello's study expressing satisfaction. Sleep dissatisfaction was a common component of insomnia and nomophobia(Ha et al. 2022). A strong positive correlation ($r = 0.558$, $p < 0.001$) was found between sleep difficulty scores and sleep behaviours in our study, compared to a significant correlation ($r = 0.31$, $p = 0.014$) in theirs. Notably, environment showed the strongest positive relationship with sleep difficulty scores, indicating that individuals with greater environmental awareness tend to have higher scores and behaviour also correlated positively with sleep difficulty scores in our study, suggesting that pro-social behaviour is linked to an increased self-directed search, while sports engagement showed a non-significant negative relationship with sleep difficulty scores. Most of these athletes exhibit sleep behaviours that do not support adequate sleep, which is consistent with our findings(Rebello et al. 2022). In their study, 11% and 24% of participants were classified with severe and moderate sleep problems, respectively, compared to 19% and 17% in our study. The ASBQ categorized 62% as having "poor" sleep behaviours, which aligns with our findings.
In a study of Swiss elite athletes, 18% reported multiple sleep risk factors: 9% experienced short sleep duration, 17% had difficulty falling asleep, 18% faced frequent sleep disruptions, and 6% were dependent on sleeping pills. In contrast, our study of collegiate athletes showed a higher prevalence of short sleep duration at 31%, with 13% reporting difficulty falling asleep and 16% experiencing frequent disruptions. Additionally, 16% used sleeping pills, similar to 19% in Rebello et al.'s study. Furthermore, 60% frequently used light-emitting technology an hour before bedtime, which is lower than findings from Rebello et al., with more than half of athletes in the previous study who did not meet adequate sleep thresholds(Benjamin et al. 2020; Rebello et al. 2022). The ASSQ proves useful in assessing varying levels of clinical sleep difficulties, while the ASBQ can complement it by identifying "cognitive and physiological arousal" factors. Together, they could inform educational workshops aimed at promoting optimal sleep hygiene in university athletes(Rebello et al. 2022). In another study done among the university student-athletes, 65% of the sample were classified as poor sleepers,

indicating that student-athletes may be disproportionately affected by sleep issues due to their unique schedules and irregular sleep patterns. Student-athletes exhibited greater fluctuations in sleep schedules, with notable variations in bedtime, time in bed, wake-up time, and time taken to fall asleep, reflecting more irregular sleep patterns in coherence to our study(Leduc et al. 2020). Sleeping ≥8 hours is linked to improved mood, sleep quality, energy, training quality, and reduced academic stress. Young athletes should aim for 8 to 9 hours of sleep, with 25% of that being deep sleep. To enhance sleep quality and duration, screen and television use before bedtime should be minimized. Additionally, limiting caffeine intake, planning meals and sleep cycles, and using noise-cancelling headphones and eyeshades can be beneficial. Athletes with better sleep habits are less likely to experience injury or illness, highlighting the importance of prioritizing sleep in stress management (Coel et al. 2023; Hamlin et al. 2021). Napping can positively impact athletic performance by enhancing physical and cognitive function, perception, psychological well-being, and nighttime sleep quality. It offers athletes a chance to boost their overall sleep without compromising nighttime rest, potentially leading to improved performance(Grandner, n.d.2017; Lastella et al. 2021). Consuming caffeinated energy drinks during exercise enhanced perceived muscle power, but also led to a higher incidence of adverse side effects like insomnia, nervousness and restlessness. Consuming it within 2 hours of bedtime may delay falling asleep, reduce slow-wave sleep, and shorten total sleep duration(Salinero et al. 2014).

Owing to the negative corelation of sports related factors with SDS, recent research indicates that engaging in vigorous exercise a few hours before bedtime does not negatively impact sleep quantity or quality. Specifically, intense or moderate exercise conducted 2-3 hours before going to sleep does not delay the time it takes to fall asleep or increase wakefulness during the night. In fact, such exercise may actually enhance the speed of falling asleep without compromising overall sleep quality(Myllymäki et al. 2011; Flausino et al. 2012). Poor sleep quality can also result from pain, medications, sleep disorders, and "sleep fragmentation," where frequent interruptions disrupt the sleep cycle. Additionally, difficulties falling asleep or returning to sleep can increase stress and reduce sleep quality. This age group typically has a biological night that starts around midnight, making it challenging to wake up early when external schedules demand earlier sleep. An optimal sleep environment should be cool, dark, and comfortable, but students often encounter noisy, bright, and distracting settings. Using the bed for activities like studying can further disrupt sleep, shortening duration and degrading quality(Grandner, n.d.2017; Trabelsi et al. 2024). Extended exposure to smartphone electromagnetic fields before bedtime can disrupt circadian and melatonin rhythms and also alters sleep architecture(Goel et al. 2023).

The body's capacity to meet daily demands with minimal effort is enhanced by strategically timing and coordinating all aspects of sleep and wakefulness(Pandi-Perumal et al. 2022). The impact of sleep on athletic performance is highly individualized and context-dependent, influenced by factors such as sport type, competition schedule, season phase, and personal sleep needs. Sleep plays a crucial role in brain plasticity and memory consolidation, facilitating skill acquisition and tactical learning for athletes at all levels. As it significantly affects long-term memory formation and learning processes, sleep is essential for athletic development and performance optimization.(Fullagar et al. 2023).

Conclusion

Our study revealed that sleep quality being a prevalent issue, with environmental factors, including the use of light-emitting devices before bed and suboptimal home sleep conditions and correlated strongly with sleep difficulties indicating that a conducive sleep environment is critical for optimizing sleep quality. Importantly, the study found that all participants without sleep difficulties exhibited good or normal sleep behaviour, whereas those with moderate to severe sleep issues displayed poor sleep behaviour. This underscores the importance of addressing sleep difficulties to enhance overall athletic performance and well-being. Given these findings, it is crucial to incorporate sleep education and interventions tailored to the unique schedules and challenges faced by collegiate athletes, aiming to improve sleep hygiene and, subsequently, athletic performance and health. Educators, trainers, therapist, and clinicians should collaborate to improve sleep for athletes. Effective monitoring systems are essential to ensure athletes follow good sleep practices. Coaches and athletes must proactively manage sleep to prevent disorders and ensure optimal performance

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Table 1: Frequency distribution of factors contributing to clinical sleep problem

Clinical sleep problem components in last 4 weeks		Frequency N(%)
Hours of actual sleep at night	5 to 6 hours	31(30.7)
	6 to 7 hours	36(35.6)
	7 to 8 hours	34(33.7)
Quality of sleep	Very satisfied	20(19.8)
	Somewhat satisfied	34(33.7)
	Neither satisfied nor dissatisfied	12(11.9)
	Somewhat dissatisfied	8(7.9)
	Very dissatisfied	27(26.7)
How long to fall asleep at night	15 mins or less	46(45.5)
	16 – 30 mins	30(29.7)
	31 – 60 mins	12(11.9)
	More than 60 mins	13(12.9)
Trouble staying sleep	None	35(34.7)
	Once or twice per week	47(46.5)
	Three or four times per week	13(12.9)
	Five to seven times per week	6(5.9)
Taken medicines to sleep	None	69(68.3)
	Once or twice per week	14(13.9)
	Three or four times per week	16(15.8)
	Five to seven times per week	2(2)

Table 2: Routine and environmental factor affecting sleep

Routine and environmental factors	Always	Frequently	Sometimes	Rarely	Never
Afternoon naps lasting two or more	6(5.9)	6(5.9)	53(52.5)	36(35.6)	0(0)

hours					
>1hr variation of bed time	11(10.9)	0(0)	44(43.6)	30(29.7)	16(15.8)
>1hr variation in wake up time	6(5.9)	4(4)	37(36.6)	15(14.9)	39(38.6)
Sleep in a less than ideal environment at home	0(0)	23(22.8)	44(43.6)	19(18.8)	15(14.9)
Sleep in foreign environments	3(3)	22(21.8)	38(37.6)	11(10.9)	27(26.7)
Travel disrupts sleep-wake routine	6(5.9)	26(25.7)	38(37.6)	14(13.9)	17(16.8)

Table 3: Behavioural factor affecting sleep

Behavioural factors	Always	Frequently	Sometimes	Rarely	Never
Use stimulants while training/competition	11(10.9)	14(13.9)	7(6.9)	22(21.8)	47(46.5)
Alcohol within 4 hrs of bed	0(0)	3(3)	6(5.9)	0(0)	92(91.1)
Use light-emitting technology in the hour leading up to bedtime	53(52.5)	7(6.9)	35(34.7)	0(0)	6(5.9)
Think, plan and worry about issues not related to my sport when I am in bed	18(17.8)	9(8.9)	40(39.6)	22(21.8)	12(11.9)
Use sleeping pills	0(0)	16(15.8)	7(6.9)	15(14.9)	63(62.4)
Use bathroom >1/night	0(0)	16(15.8)	19(18.8)	23(22.8)	48(47.5)
Snoring	0(0)	17(16.8)	6(5.9)	23(22.8)	55(54.5)

Table 4: Sports related factor affecting sleep

Sports related factors	Always	Frequently	Sometimes	Rarely	Never
Exercise after 7pm	14(13.9)	6(5.9)	30(29.7)	13(12.9)	38(37.6)
Go to bed feeling thirsty	6(5.9)	23(22.8)	20(19.8)	6(5.9)	46(45.5)
Go to bed with sore muscle	8(7.9)	12(11.9)	41(40.6)	20(19.8)	20(19.8)
Think, plan and worry about my sporting performance	13(12.9)	9(8.9)	30(29.7)	29(28.7)	20(19.8)
Muscle twitching	0(0)	21(20.8)	6(5.9)	27(26.7)	47(46.5)

Table 5: Association between Sleep difficulty score and modifiers with sleep behaviour among study participants

Sleep scoring components		Good sleep behaviour	Normal sleep behaviour	Poor sleep behaviour	Total N(%)	P value
Sleep difficulty score (SDS)	None	6	7	0	13(12.9)	<0.0001*
	Mild	14	6	32	52(51.5)	
	Moderate	0	0	17	17(16.8)	
	Severe	0	6	13	19(18.8)	
Chronotype	Morning	14	19	54	87(86.1)	0.024*
	Evening	6	0	8	14(13.9)	

p value <0.05 is considered to be significant

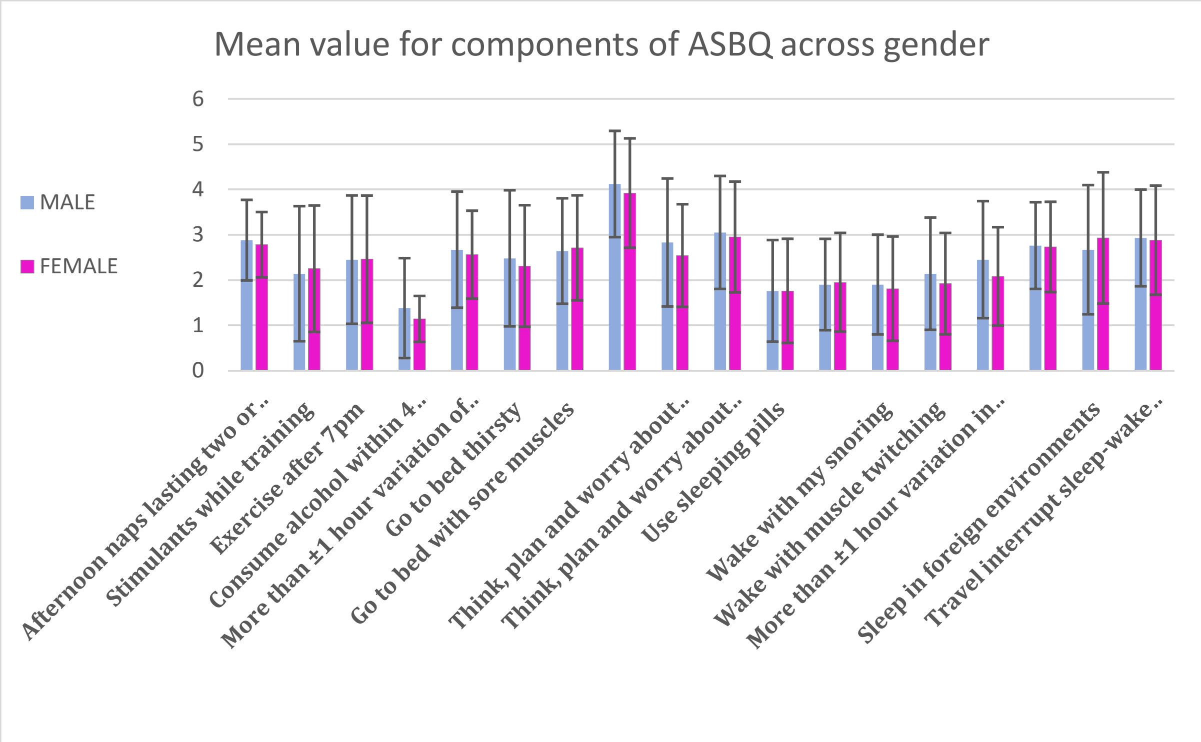

Figure 1: Difference in mean score of ASBQ components across gender

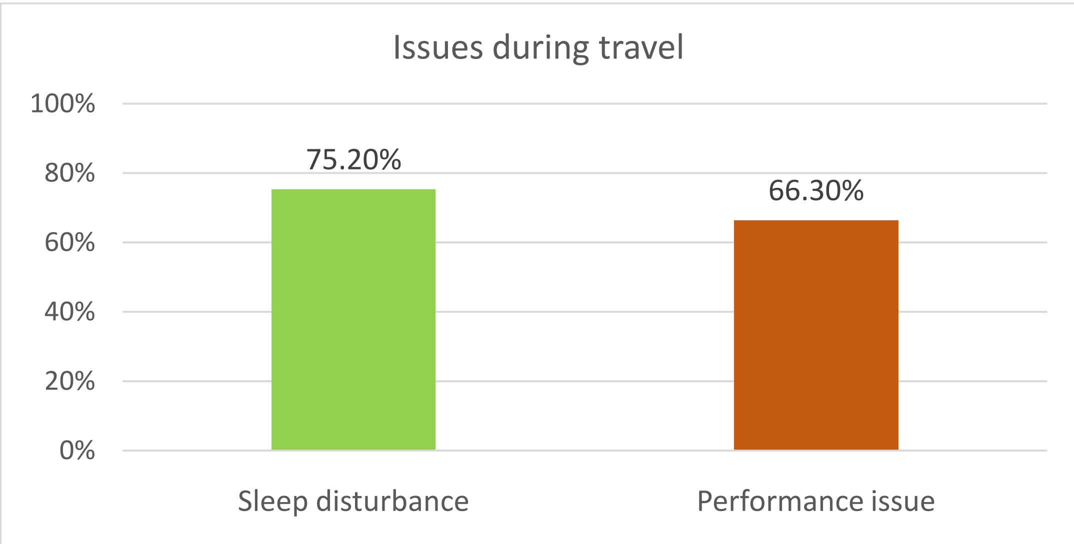

Figure 2: Challenges faced by the participants during travel