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Sleep Status and Chronotype in University Athletes with and without Chronic Low Back Pain: A Cross-Sectional Study

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Abstract

Objective This study aimed to evaluate the status of sleep, chronotype, and related variables of university athletes with and without chronic low back pain (CLBP),to find the correlation between CLBP, sleep difficulty score (SDS), and chronotype, and to determine if SDS and chronotype predict CLBP.

Methods Ninety-two university athletes [46 with CLBP (Age: 22.08±2.74 years) and 46 healthy athletes (Age: 22.32±3.11 years) completed the athlete sleep screening questionnaire (ASSQ), also, their demographic, anxiety, depression, and sports-related details were collected. A Pearson correlation and logistic regression models (univariate and multivariate) were used for the statistical analysis.

Results The results demonstrated a higher SDS and evening type preference in CLBP athletes, a significant negative correlation between CLBP and chronotype ($r = -0.40$, $p < 0.01$), a significant correlation between SDS and CLBP ($r = 0.25$, $p = 0.01$). SDS and chronotype were not found to be significant independent predictors of CLBP.

Conclusion This study concludes that there exists a correlation of CLBP, SDS, and chronotype However, despite the relationship, SDS and chronotype cannot predict CLBP.

Keywords
- sleep
- sports
- university athletes
- chronic low back pain
- chronotype
- pain

Introduction

Pain is a physical and emotional indicator of bodily harm that drives behavior. Chronic low back pain (CLBP) is defined as pain, muscle tension, or stiffness below the costal border and above the inferior gluteal folds[1] that lasts for 12 weeks or more.[2] A common musculoskeletal ailment, CLBP occurs in athletes of different sports and at varying degrees of expertise, and it is harmful to them, as it restricts their performance and places them in danger of retiring from sports too soon.[3] Sleep is an intricate reversible state of behavior in which a person is perceptually disconnected from and unresponsive to their surroundings.[4] Sleep is an important determinant of the health, well-being, and performance of collegiate athletes.[5] The development of pain as a side effect correlates with the development of sleep disruption in the general population. Sleep problems are present in 67% to 88% of people with chronic pain.[6] However, there is a lack of data on sleep disturbance in university athletes with CLBP. Sleep disturbance can have a negative influence on the athletes' physical performance, mental performance, risk of injury and recovery, medical health, and mental well-being.[7]

Approximately 55% to 60% of patients in the general population with low back pain (LBP) report impaired sleep after pain onset,[8] and over half suffer from insomnia.[9] Several studies conducted among non-athletes[10,11] have

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suggested that there is a correlation between poor sleep quality and LBP. Inadequate quantity or quality of sleep has also been identified as a risk factor for neck pain and LBP in female subjects,[12] and also in industrial employees being hospitalized because of LBP.[11] However, these studies have been conducted among the general population, and there has been a lack of focus on sleep in athletes suffering from CLBP.

The Pittsburgh Sleep Quality Index (PSQI), to measure sleep quality, the Sleep Hygiene Index, to examine sleep hygiene, and the Epworth Sleepiness Scale (ESS), to examine daytime sleepiness, are all questionnaires used in research. However, they do not seem to befit the population of athletes for sleep assessment as their validity and reliability have not been adequately assessed in this population. The Athlete Sleep Screening Questionnaire (ASSQ), an athlete-specific questionnaire, seems to be a simple and efficient screening tool to identify sleep problems and chronotypes among athletes.[13,14] Chronotype is an individuals 24-hour entrainment and activity-rest preference. Morning types wake up early, whereas evening types wake up late, and LBP is 1.5 times more common in evening chronotypes.[15] Anxiety is also linked to both eveningness and sleep disruption in the healthy population. Athletes with higher anxiety levels tend to be more susceptible to injury. Athletes may experience stress, fatigue, anxiety, and impaired sleep and mood, psychosocial factors that may predispose them to LBP. Depression has also been linked to evening chronotype preference in the general population of healthy subjects.[16] However, there is a lack of studies on the sleep status and chronotype in university athletes with CLBP. Therefore, the present study aimed to evaluate the sleep status, chronotype, and other sleep-related variables, and to find a correlation regarding CLBP, the Sleep Difficulty Score (SDS), and chronotype. The study also aimed to find if the SDS and the chronotype can independently predict CLBP. We hypothesized that there would be a higher SDS and a shift in chronotype toward evening type in athletes with CLBP. Additionally, we hypothesized that there would be a significant negative correlation between CLBP and chronotype, a significant positive correlation between CLBP and the SDS, and that the SDS and chronotype would be significant predictors of CLBP.

Materials and Methods

Study Population

The number of participants was determined through the G Power software (University of Kiel, Kiel, Germany), version 3.1.9.2, from a previous study[17] with a correlation value of 0.228, α level of 0.05, and power ($1-\beta$) of 0.90. The present study included 92 athletes: 46 with CLBP and 46 healthy athletes, based on effect estimations. CLBP was characterized as pain, muscle tension, or stiffness below the costal border and above the inferior gluteal folds[1] that lasted for 12 weeks or more.[2] The data were collected from various stadiums and sports complexes across Delhi NCR, India. The study population consisted of male university-level athletes with at least 1 year of athletic experience who spent at least 5 to 7 hours per week playing/practicing any sport (cricket, basketball, volleyball, football, badminton, or tennis). The CLBP athletes ($n = 46$) were required to have had LBP for 12 weeks or more and be free from any other musculoskeletal complaints. All athletes needed to understand and write in English and be aged between 18 and 30 years.

Study Questionnaire, Screening, and Data Collection

To fulfill the purpose of the study, 46 athletes with CLBP and 46 healthy athletes were asked to fill out the questionnaires. The presence of CLBP was based on the athlete's self-reported complaints of LBP and its duration, additionally assessed by an experienced physiotherapist. Athletes who were on any kind of medication were not included in the present study. Personal information (age, height, weight, and body mass index – BMI), the sports discipline at the university, and the number of years of involvement in the sport at the university level were noted. The ASSQ[13,14] was used to measure sleep factors, and it consists of 16 items about sleep difficulties, sleep-disordered breathing, travel, chronotype, and sleep optimization techniques. The SDS was assessed through five questions,[1,3–6] whereas the chronotype was assessed through four questions.[7–10,13,14] The ASSQ has a good internal consistency (Cronbach $\alpha = 0.74$), test-retest reliability ($r = 0.86$), a diagnostic sensitivity of 81%, specificity of 93%, a positive predictive value of 87%, and a negative predictive value of 90%.[13,14] The level of anxiety was assessed using the 7-item Generalized Anxiety Disorder (GAD-7) questionnaire.[18] Depression was assessed using the Patient Health Questionnaire-9 (PHQ-9), which consists of 9 questions.[19] The subjects were requested to complete the questionnaire in the presence of an investigator. All research participants provided written informed consent.

Statistical Analysis

The IBM SPSS Statistics for Windows (IBM Corp., Armonk, NY, United States) software, version 21.0, was used to analyze the data. Descriptive statistics (mean ± standard deviation, SD) and, when required, frequencies (percentages) were calculated for the athlete's' data. A cross-tabulation was used to denote variables (in terms of number (n) and its corresponding percentage) in athletes with and without CLBP. An independent samples *t*-test was used to compare the mean scores of the two groups. The correlation regarding CLBP, the SDS, and chronotype was calculated using the Pearson correlation. If a statistically significant correlation was found, a univariate logistic regression (enter method) was used to find the odds ratio (OR), 95% confidence interval (95%CI), and its *p*-value. A multivariate logistic regression model was used to find if the SDS and chronotype are independent predictors of CLBP. In model 1, SDS was the predictor, and, in model 2, chronotype was the predictor; in both models, we adjusted for common covariates such as age, BMI, number of years at university level participation, anxiety, and depression. Values of $p < 0.05$ were considered statistically significant.

Results

The mean values regarding the demographic characteristics, SDS, chronotype, and anxiety and depression scores of the two

Table 1 Characteristics of athletes with and without CLBP.

Variable	Mean ± SD		p-value
	CLBP (n = 46)	No CLBP (n = 46)	
Age (in years)[a]	22.08 ± 2.74	22.32 ± 3.11	0.69
Height (m)[a]	1.76 ± 0.07	1.77 ± 0.08	0.47
Weight (kg)[a]	71.97 ± 10.38	70.57 ± 10.4	0.52
BMI (kg/m^2)[a]	22.93 ± 2.45	22.28 ± 2.11	0.17
Anxiety score[a]	3.50 ± 2.46	2.39 ± 1.73	0.01*
Depression score[a]	4.00 ± 2.64	3.32 ± 2.32	0.19
Number of years at university level participation[a]	2.35 ± 1.38	2.66 ± 1.40	0.29
SDS[a]	5.56 ± 2.71	4.32 ± 1.94	0.01*
Chronotype[a]	6.84 ± 2.85	9.15 ± 2.32	< 0.001*
NPRS score	3.65 ± 1.76	–	–
Duration of pain (months)	14.29 ± 20.28	–	–

Abbreviations: BMI, Body Mass Index; CLBP, chronic low back pain; NPRS, Numeric pain rating scale; SD, standard deviation; SDS, Sleep Difficulty Score.
Notes: [a]An independent samples *t*-test was used for the group comparison. *Statistically significant difference.

groups are shown in ►**Table 1**. A Cross-tabulation of sports discipline, sleep, chronotype, depression, anxiety, and other sleep related characteristics of athletes with and without CLBP is shown in ►**Table 2**.

In the present study, we found a significant positive correlation between CLBP and the SDS ($r = 0.25$; $p = 0.01$), and a significant negative correlation between CLBP and chronotype ($r = -0.40$; $p < 0.001$) (►**Table 3**). A univariate regression analysis revealed that the SDS and chronotype were predictors of CLBP (►**Table 4**). Upon using a multivariate model for the SDS and chronotype, with age, BMI, number of years at university level participation, anxiety, and depression as covariates, we found that the SDS and chronotype were not significant independent predictors of CLBP. In both models, anxiety was also found to be significantly correlated with CLBP, thus impacting the ability of the SDS and chronotype to independently predict CLBP (►**Table 5**).

Table 2 Cross-tabulation of sports discipline, sleep, chronotype, depression, anxiety, and other sleep-related characteristics of athletes with and without CLBP

Variable		With CLBP n (%)	Without CLBP n (%)	p-value
Sports discipline	Cricket	10 (21.7)	10 (21.7)	0.02
	Basketball	19 (41.3)	5 (10.9)	
	Football	4 (8.7)	7 (15.2)	
	Volleyball	9 (19.6)	12 (26.11)	
	Badminton	2 (4.3)	6 (13.0)	
	Tennis	2 (4.3)	6 (13.0)	
SDS	None	18 (39.1)	25 (54.3)	0.05
	Mild	16 (34.8)	18 (39.1)	
	Moderate	11 (23.9)	3 (6.5)	
	Severe	1 (2.2)	–	
Chronotype	Evening type	10 (21.7)	1 (2.2)	<0.01
	Morning type	36 (78.3)	45 (97.8)	
Anxiety	Minimal	31 (67.4)	36 (78.3)	0.36
	Mild	14 (30.4)	10 (21.7)	
	Moderate	1 (2.2)	–	
	Severe	–	–	

(*Continued*)

Table 2 (*Continued*)

Variable		With CLBP *n* (%)	Without CLBP *n* (%)	*p*-value
Depression	Minimal	29 (63.0)	31 (67.4)	0.80
	Mild	15 (32.6)	14 (30.4)	
	Moderate	2 (4.3)	1 (2.2)	
	Moderately severe	–	–	
	Severe	–	–	
Naps per week	None	13 (28.3)	18 (39.1)	0.68
	Once or twice	21 (45.7)	16 (34.8)	
	Three or four times	8 (17.4)	8 (17.4)	
	Five to seven times	4 (8.7)	4 (8.7)	
Sleep disturbance while traveling	No	25 (54.3)	24 (52.2)	0.51
	Yes	21 (45.7)	22 (47.8)	
Experiencing daytime dysfunction while traveling for sport	No	28 (60.9)	31 (67.4)	0.02
	Yes	18 (39.1)	15 (32.6)	
Loud snorer	No	34 (73.9)	42 (91.3)	0.23
	Yes	12 (26.1)	4 (8.7)	
Choking, gasping, or stopping breathing for periods of time during sleep	No	44 (95.7)	41 (89.1)	
	Yes	2 (4.3)	5 (10.9)	
Caffeinated products per day	Less than 1 per day	15 (32.6)	19 (41.3)	0.59
	1-2 per day	12 (26.1)	14 (30.4)	
	3 per day	13 (28.3)	7 (15.2)	
	4 per day	3 (6.5)	4 (8.7)	
	5 or more per day	3 (6.5)	2 (4.3)	
Using electronic device within 1 hour of going to bed	Not at all	2 (4.3)	5 (10.9)	0.17
	1-3 times per week	4 (8.7)	10 (21.7)	
	4-6 times per week	5 (10.9)	4 (8.7)	
	Everyday	35 (76.1)	27 (58.7)	

Abbreviations: CLBP, chronic low back pain; SDS, Sleep Difficulty Score.

Table 3 Correlation regarding CLBP, SDS, and chronotype.

		CLBP
SDS	Correlation (*r*)	0.25
	p-value	0.01*
Chronotype	Correlation (*r*)	−0.40
	p-value	< 0.001*

Abbreviations: CLBP, chronic low back pain; SDS, Sleep Difficulty Score.
Note: *Statistically significant.

Table 4 Univariate logistic regression of SDS and chronotype as predictors of CLBP.

	OR (95%CI)	*p*-value
SDS	0.71 (0.58–0.85)	< 0.001*
Chronotype	1.26 (1.04–1.52)	0.01*

Abbreviations: 95%CI, 95% confidence interval; CLBP, chronic low back pain; OR, odds ratio; SDS, Sleep Difficulty Score.
Note: *Statistically significant.

Discussion

The main findings of the present study were a positive significant correlation between CLBP and the SDS, and a negative significant correlation between CLBP and chronotype; The SDS and chronotype were not found to be significant independent predictors of CLBP.

CLBP and the SDS

In the present study, we found a positive correlation between CLBP and the SDS. A higher mean ± SD value for the SDS was reported in the group of athletes with CLBP compared to those without the condition (5.56 ± 2.71 versus 4.32 ± 1.94 respectively), as well as a higher percentage of athletes with CLBP falling in the moderate and severe SDS categories

Table 5 Models of predictors of CLBP (multivariate regression analysis).

	OR (95%CI)	*p*-value
Model 1		
SDS	1.28 (1.03–1.58)	0.02*
Age (in years)	0.99 (0.80–1.24)	0.98
BMI (kg/m^2)	1.16 (0.94–1.43)	0.14
Depression	0.93 (0.72–1.21)	0.63
Anxiety	1.41 (1.03–1.92)	0.03*
Number of years at university level participation	0.83 (0.52–1.31)	0.42
Model 2		
Chronotype	0.66 (0.53–0.83)	$<$ 0.001*
Age (in years)	0.97 (0.77–1.23)	0.85
BMI (kg/m^2)	1.22 (0.97–1.53)	0.08
Depression	1.03 (0.79–1.36)	0.95
Anxiety	1.40 (1.03–1.90)	0.02*
Number of years at university level participation	0.98 (0.60–1.61)	0.95

Abbreviations: 95%CI, 95% confidence interval; BMI, Body mass index; CLBP, chronic low back pain; OR, odds ratio; SDS, Sleep Difficulty Score.
Note: *Statistically significant.

(►**Table 2**). The development of pain as a side effect correlates with the development of sleep disruption and vice versa.[20] In the literature, sleep disruption is increasingly being acknowledged as a clinically significant symptom in persons with CLBP. Although it is unknown if sleep disruption is a cause or a consequence of chronic pain, it is believed that when individuals are sleep-deprived, their pain increases.[21] Sleep disruption has been shown to have a detrimental impact on mood, pain intensity, and overall quality of life.[6] Lack of sleep or poor sleep quality tends to decrease the pain threshold and mental ability to manage pain, and it has been proposed that better daytime pain control may lead to increased quality of sleep.[22] Chronic pain has a vicious loop effect on sleep, with mutually detrimental interactions involving pain and sleep-related disorders in the general population.[23] The effects of poor sleep quality on pain perception are not well understood, and there is no proper biological mechanism linking sleep and pain. Evidence shows that lack of sleep increases the concentration of cytokines and inflammatory mediators, leading to a greater perception of pain.[24,25] Haack et al.[24] established a link between decreased sleep time, greater body pain perception, and elevated interleukin 6 (IL-6) levels in healthy women with experimentally-produced pain.[24] Heffner et al.[25] validated this finding by revealing that poor sleep quality is linked to elevated IL-6 levels and affective pain rating in persons with CLBP.[25] Sleep deprivation, regardless of duration or quality, certainly interferes with the normal control of inflammatory mediators and immunological processes, perhaps leading to increased neuronal sensitivity and perception of pain. However, despite the relationship between CLBP and the SDS, the SDS cannot independently predict CLBP.

CLBP and Chronotype

A scores ≤ 4 on the sum of questions 7 to 10 of the ASSQ indicates that the athlete is an evening type, whereas a score > 4 indicates that the athlete is of the morning type.[13,14] The evening chronotype was prevalent in athletes with CLBP (21.7%) compared to healthy athletes (2.2%), whereas the morning chronotype was prevalent in healthy athletes (98.7%) compared with CLBP athletes (78.3%) (►**Table 2**). The findings of the present study indicated that CLBP and chronotype move in the opposite direction: if one increases, the other decreases. This bidirectional relationship can be attributed to several factors. The CLBP-related sleep abnormalities include a substantial reduction in total sleep duration, increased night wakening, a delay in the initiation of sleep, and trouble sustaining sleep.[11] A recent study[26] found that evening and intermediate chronotypes are linked to debilitating musculoskeletal pain, although emotional discomfort, sleeplessness, and concomitant disorders also play a role.[26] Another research,[27] involving a small group ($n = 31$) of healthy men, reported that evening-type people are more sensitive to pain than morning-type people. Interestingly, people with the evening chronotype experience a higher degree of musculoskeletal pain compared with those with the morning chronotype. Pain may be influenced by circadian pain cycles and chronotypes taken together.[26] More recently, epidemiological studies[28] in the general population have revealed that subjects with the evening chronotype are more likely to experience LBP (OR = 1.5; 95% CI = 1.3–1.8) than people with the morning chronotype. However, despite the relationship between CLBP and chronotype, the chronotype of the athlete cannot independently predict CLBP.

Sleep-Related Dichotomous Variables

In the present study, there was no statistically significant difference in the number of naps per week: both athletes with and without CLBP reported a similar number, indicating no effect of CLBP on naps. On the contrary, according to one research,[29] persons with CLBP have poor daytime functioning and report an increase in daytime napping as a result of poor sleep quality, which has a substantial influence on pain perception, function, and quality of life.[29] Napping may reduce pain hypersensitivity, regardless of the vigilance status.[30] In the present study, there was a similar frequency distribution of sleep disturbance while traveling, suggesting that the presence or absence of CLBP does not impact this outcome. A dissimilar frequency distribution was found for experiencing daytime dysfunction while traveling for sport in athletes with and without CLBP, and a plausible reason could be uncomfortable positions in vehicles/aircraft during travelling, which might further strain the back and further compromise sleep due to pain; this, in turn, would result in poor daytime functioning. In the present study, we did not find any significant difference between the two group of the athletes in terms of loud snoring, choking, gasping, or stopping breathing for periods of time during sleep, intake of caffeinated products per day, and use of electronic devices every day within 1 hour of going to bed. According to the findings of other studies[31,32] as well, there is no relationship between caffeine use and LBP.

A potential strength of the present study is that the authors have used an athlete-specific questionnaire to assess sleep and chronotype. Although the present study contributed to important findings regarding the issue of CLBP and sleep in university athletes, a limitation is the inclusion of only male participants; future studies could consider gender variations too. We could not include female participants because, during the screening of CLBP athletes, we found only one female athlete with CLBP due to the fact that there is limited participation of females in Indian sports scenarios. We did not include this data in the study. Considering the gender variation in sleep, which indicates a higher prevalence of poor sleep quality in female subjects than in male subjects (65.1% versus 49.8% respectively),[33] a separate study on female athletes or a comparison of male and female athletes could be performed in the future.

Conclusion

We conclude that university athletes with CLBP have clinically significant sleep problems (higher SDS than healthy athletes), and that there is a significant correlation involving CLBP, the SDS, and chronotype; however, despite the association, the SDS and chronotype were not found to be significant independent predictors of CLBP.

Ethical Approval

All procedures in the present study were performed in accordance with the ethical standards of the institutional/national research committee (Institutional Ethics Committee, Jamia Millia Islamia, no. 24/5/322/JMI/IEC/2021) and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The study has been registered on the Clinical trials registry, (CTRI/2021/09/036675).

Informed Consent

Written informed consent was obtained from all individual athletes included in the study.

Data Availability

The statistical clinical data used to support the findings of this study are included in the article.

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Conflict of Interests

The authors have no conflict of interests to declare.

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