

Association Between Chronotype, Social Jetlag, Stress and Sleep in Bulgarian Sports Students

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Abstract: The aim of this study was to evaluate the association between chronotype, stress, sleep and social jetlag (SJL) in Bulgarian sports students. In total, 29 male and female university students were surveyed using the Horne-Ostberg morningness-eveningness questionnaire, smart watch for measuring the peripheral skin temperature, perceived stress scale (PSS), Pittsburgh sleep quality index (PSQI) and a self-report questionnaire to determine SJL. It was determined that 2 students were morning type (MT), 7 were evening type (ET) and 20 were intermediate type (IT). Temperature measurements confirmed that. Mann-Whitney U test showed an association between stress scores and gender groups, PSQI scores showed association with PSS groups, chronotype and SJL. Females were more stressed than males. Students with high SJL levels ($n = 7$) were ET ($n = 5$). In our sample ET ($n = 7$) were more than MT ($n = 2$). Usually athletes tend to be MT. Age has a great influence in chronotype expression. ET perceived more stress and experienced more frequent daytime dysfunction than MT and IT. Collectively, these results suggest that stress levels are higher when imbalance exists between more than one circadian rhythm disruption indicators. Also training schedules should be arranged when taking into account circadian preferences.

Keywords: Chronotype, Stress, Sleep, Athletes, Students.

Introduction

The importance of circadian rhythms and sleep in maintaining our physiological and biochemical processes, and achieving optimal cognitive and physical performance continues to emerge [14]. This relationship is particularly important for sports students. They are in a stage when they exhibit different patterns of sleep and circadian timing such as shorter sleep duration, late chronotype, and high levels of social jetlag (SJL). Sleep-wake cycle is governed by the interaction of two systems – circadian and sleep. In modern society, sleep is influenced by social cues. There may be differences in the sleep and functioning at different times of the day depending on the individual circadian clock. These differences are called chronotype or circadian typology [1]. There are three groups of chronotypes – morning type (MT), intermediate type (IT), and evening type (ET) [15]. Chronotypes differ in their circadian function from either biological parameter (e.g., sleep-wake, body temperature, melatonin, and cortisol) or cognitive performance (e.g., attention, memory, executive functions) [2]. A non-invasive method to confirm the chronotype results from morningness-eveningness questionnaire (MEQ) is to measure skin temperature, the rhythm of which is known to be correlated to the core body temperature (CBT) rhythm with a measured phase occurring slightly earlier than the CBT minimum [12]. During the onset of sleep, there is an increase of distal skin temperature (e.g., hands) triggered by increased skin blood flow and resulting in heat loss,

which downregulates CBT. It was proposed that the onset of melatonin secretion in the late evening may act as a modulator of vascular tone, leading to changes in distal temperature then fall of CBT [10]. Skin temperature is easily recorded in humans using wireless data loggers [7, 16]. Under a day-oriented schedule, distal temperature rhythms are inverted compared with the CBT rhythm, and display higher amplitude when measured in either controlled (e.g., circadian rhythms) or field conditions [11, 12]. ET have higher skin temperature in the early morning than MT because they go to bed later. And because of that ET has been related to a number of health problems. These health issues are often connected with the “time lag” between the circadian clock and the social clock. The SJL measures the inconsistency between circadian and social clock which often leads to a chronic sleep loss [18]. MT, on the contrary, tend to develop sleep debt during the weekend [20]. Although the negative effects of SJL and stress on people are known, this is somehow inevitable for athletes who simultaneously hold the role of a student. They experience a lot of additional demands that may disturb their sleep-wake rhythm [13]. SJL can be a chronic condition and a reason for high stress levels [19]. Chronotype can influence both the severity of SJL and the susceptibility to stress. Therefore, it is important to adapt students’ chronotype regarding SJL and to develop specific schedules for promoting sleep quality. The aim of this paper was to explore the relationship between chronotype, perceived stress, sleep quality and social jetlag in university athletes.

Materials and methods

Participants

The study was conducted from April to May 2024 in the laboratory of the Department of Physiology and Biochemistry at National Sports Academy “Vasil Levski”, Sofia, Bulgaria in accordance with the research ethical code of the University. Participants from different sports were screened for eligibility and informed consent was taken. The subjects included in this study were between 19 and 23 years old. Total of 40 students were screened based on inclusion criteria and 29 students fulfilled them. The inclusion criteria were: age of 19-25 years, good health (no drugs used 2 months prior the measurements), not taking night shifts and submission of all tests and measurements.

Measures

The subjects were examined for the inclusion criteria and baseline data. Demographic and anthropometric data of the participants were collected – height (in centimeters) and body mass (in kilograms). The participants who met the inclusion requirements completed the questionnaire for morningness-eveningness circadian rhythms [8]. Then skin temperature (wrist temperature) was measured to confirm the results from MEQ. All 29 subjects completed and the perceived stress scale (PSS) [6]; Pittsburgh sleep quality index (PSQI) [5] and self-report questionnaire (SRQ) to determine SJL status.

MEQ [8] comprises 19 items, with usually 4 or 5 answers that are scored from 1 to 4 or 5 points. The higher scores, the more intense the morningness preference. The total scores range from 16 (definite ET) to 86 (definite MT). The MEQ is a reliable instrument for chronotype assessment (with Cronbach’s alpha (α), value of 0.75).

Peripheral skin temperature was assessed two times per day in one day at the wrist on the nondominant hand. Temperature measurements were done by a wristband (A series smart bracelet V0338, China). The accuracy of the measurements is ± 0.10 °C. The detection range is noncontact type, 2 cm to the object for most accurate measuring.

Perceived stress was assessed by the PSS [6]. It is a 10 item scale that evaluates the intensity of perceived stress during the previous month. The responses are given on a 5 point Likert-type scale. The total scores range from 0 (no stress) to 40 points (extreme stress).

PSQI [5] was developed in 1989. It assesses sleep quality over a one month time interval. The questionnaire includes 19 items (4 of them are descriptive, and the remaining 15 are weighted on 0-3 scale) that allow distinguishing 7 components that are summed to produce a global score (range from 0 to 21 where higher scores indicate lower sleep quality). Results above 5 indicate “poor sleep”. In this study, the cut-off criteria for “low sleep” quality were set at 6 or more points. The originally reported Cronbach’s alpha (α) in [5] was 0.83.

Procedure

Before the start of the activities, the participants of the study were informed about the aim of the research. Following ethical principles of academic research, each participant was assured that could resign from further participation at any stage of the study and that the collected data would be used for scientific purposes only. The participants individually filled out a set of questionnaires, and each received detailed feedback on the results obtained. Then a single measurement of wrist temperature was conducted with a smart watch twice per day.

Statistical analyses

All analysis were executed using software platform SPSS for Windows (IBM® SPSS® Statistics V19, statistical package for the social sciences). Data gathered in the study were normally distributed. The comparison between the student athlete groups in accordance with MEQ and PSS were conducted by employing T-test, Kruskal-Wallis H test and Mann-Whitney U test. The statistical significance was set at $p \leq 0.05$. The effect size was measured with eta-squared test (η^2). Variables that were statistically significant ($p \leq 0.05$) were included in the results.

Results and discussion

Participant characteristics

The general characteristics of the participants are presented in Table 1. The mean age of all subjects was 21 ± 0.8 . The mean weight and body mass index were statistically significant according to gender. The mean chronotype scores of all participants was 46.3 ± 7 , which indicates IT. Definite MT and definite ET are not presented in our sample. Individuals defined as ET were seven – more than those two assigned as MT. The wrist temperature measurements confirmed the expressed chronotype from MEQ. Mean scores from PSS was 20 and shows moderate levels of stress. We did not find association between PSS scores and chronotype. Mean PSQI scores was 6.1 which indicates sleep loss. Our results showed that there is association between PSQI scores and stress groups, but no association with chronotype. We also used a SRQ to determine the difference between sleep hours in free days and work days and our sample was divided into 3 groups: no SJL (≤ 1 h/week), moderate SJL (1-2 h/week) and high SJL (≥ 2 h/week). Then it was found that there is association between SJL groups and scores of MEQ and PSQI. However, there was no connection between SJL and PSS scores.

Table 1. General characteristics of the participants divided by subgroups.
The data are presented as mean \pm standard deviation (SD),
(^a) indicates statistical significance ($p \leq 0.05$)

Characteristics					
Groups	Numbers of participants	Age, [years]	Body mass, [kg]	Height, [cm]	Body mass index, [kg/m ²]
Gender					
Male	16	21 \pm 1.0	73.5 \pm 4.9	178.0 \pm 6.3	23.2 \pm 1.5
Female	13	20 \pm 0.6	57.8 \pm 8.7	167.8 \pm 4.3	20.5 \pm 2.4
<i>p</i>		> 0.05	0.04 ^a	> 0.05	0.03 ^a
Chronotype					
MT	2	21 \pm 0.7	59.0 \pm 2.8	168.0 \pm 2.8	20.9 \pm 1.6
IT	20	21 \pm 0.9	68.3 \pm 11.1	174.0 \pm 7.0	22.3 \pm 2.4
ET	7	20 \pm 0.4	63.5 \pm 10.0	172.5 \pm 8.2	21.2 \pm 2.2
<i>p</i>		> 0.05	> 0.05	> 0.05	> 0.05
Stress level					
High	4	20 \pm 0.5	65.6 \pm 7.6	175.0 \pm 7.5	21.1 \pm 2.2
Moderate	19	21 \pm 0.9	68.0 \pm 10.0	174.0 \pm 7.1	22.4 \pm 2.3
Low	6	21 \pm 0.5	60.0 \pm 12.9	167.1 \pm 7.6	21.1 \pm 3.0
<i>p</i>		> 0.05	> 0.05	> 0.05	> 0.05

Social jetlag, sleep, stress and chronotype

Kruskal-Wallis H test showed that chronotype scores had strong association with SJL groups ($\chi^2(2) = 14.8, p = 0.001$). The within group comparison of the three chronotypes was done with Mann-Whitney U test, which revealed that ET subjects were with higher levels of SJL compared to IT and MT. Kruskal-Wallis H test failed to represent that PSQI scores had association with SJL groups and with chronotype. But Mann-Whitney U test showed that there is association between PSQI scores and SJL groups (moderate SJL – high, $p = 0.05$). Then we examined the PSQI subgroups (use of sleep medications, daytime dysfunction, sleep efficiency and sleep disturbance). It was found that all SJL groups had reported daytime dysfunction ($p = 0.05$) and MT had better sleep efficiency than IT ($p = 0.04$). The results are presented in Table 2.

Our results revealed the relationship between PSQI subgroups and stress, as well. When we examined the relationship between PSQI subgroups and stress, with Mann-Whitney U test, the results exposed that:

- subjects with high stress reported sleep quality problems more often than those with moderate stress ($p = 0.05$);
- subjects with moderate stress reported sleep disturbance more often than those with low stress ($p = 0.03$).

Table 2. Comparison of SJL groups by MEQ and PSQI scores.
 The data are presented as mean \pm standard deviation (SD),
^(a) indicates statistical significance ($p \leq 0.05$)

Chronotype	Participants: total number out of 29, <i>n</i> [%]	MEQ scores by SJL groups			
		No SJL total <i>n</i> = 9, <i>n</i> [%]	Moderate SJL total <i>n</i> = 13, <i>n</i> [%]	High SJL total <i>n</i> = 7, <i>n</i> [%]	<i>p</i> -value
MT	2 [6.9]	2 [52.9 \pm 5.3]	–	–	–
IT	20 [69.0]	7 [46.8 \pm 5.7]	11 [48.0 \pm 5.7]	2 [43.0 \pm 8.0]	–
ET	7 [24.0]	–	2 [37.1 \pm 8.0]	5 [26.0 \pm 4.0]	–
<i>p</i> -value	–	0.03 ^a [1:2]	0.005 ^a [2:3]	0.001 ^a [1:3]	< 0.001 ^a (all)
PSQI scores	29 [100]	Mean \pm SD			<i>p</i> -value
		5.7 \pm 2.3	5.5 \pm 1.5	7.8 \pm 2.9	0.05 ^a

All participants ($n = 29$) completed the MEQ. The mean MEQ score was 46.3 ± 7 . According to the mean scores from MEQ there was no difference in chronotype distribution when comparing participants by age and by level of physical activity. This finding was most likely due to the relatively small sample size. Surprisingly, in our sample there were more ET ($n = 7$) than MT ($n = 2$). And ET females ($n = 3$) were more than MT females ($n = 2$). One reason may have been the age of the subjects (mean age for females 20). Women (in their early 20's) have body clocks that are delayed, with the delay reaching its peak at around the age of 20 years (i.e., they manifest a late chronotype) [9]. In previous study we found that chronotype and perceived stress are strongly related ($\eta^2 = 0.302$; ET had higher stress scores than IT and MT) [22]. But, interestingly, in the present study there was no association found. This may be due to small sample size, expressed IT and moderate levels of stress in the sample.

The main purpose of the presented study was to examine how sleep, chronotype and stress could be interrelated in Bulgarian sport students. Our results showed that sleep is associated with stress, chronotype and SJL ($\eta^2 = 0.166$). Sleep efficiency, use of sleep medications and daytime dysfunction scores as well as total sleep quality scores of IT individuals and ET individuals were found to be significantly higher than MT ($p \leq 0.05$). Similar to our findings was the results in [21]. Also, females ($n = 5$) experienced more often sleep disturbances, like daytime dysfunction, than males ($n = 0$) and more often consumed sleep medications. That is in accordance with [4]. Our study results showed issues with the sleep efficiency (time spent sleeping) according to chronotype (in IT compared to MT, $p = 0.04$) and sleep quality according to stress (in moderate stressed subjects compared to low stressed subjects ($p = 0.03$)). Authors in [13] reported that the perceived stress (measured by a questionnaire and related to everyday life) is a significant mediator in the relation between the chronotype and sleep quality (partial mediation), which means that perceived stress can further aggravate sleep problems that arise from the chronotype of an individual. We found a connection between daytime dysfunction and stress, and between daytime dysfunction and SJL in our sample. These negative effects over the sleep quality of sports students are, probably, due to frequent changes of beds, bedrooms, nosy environment, when there are many people sleeping in the

same room [17]. Also our results may be due to the fact that classes usually start early in the morning, which may be a reason for a greater perception of stress among students, especially when they were assigned with ET. This was supported by the results in [3].

A questionnaires, although a subjective method, is useful, inexpensive and suitably informative for a general assessment of a group's chronotype, perceived stress and sleep quality.

Limitations

The presented results should be approached with some caution. It is mainly due to the small number of MT individuals and that we did not examine in which phase of the menstrual cycle the females were. Yet, perceived stress and sleep were assessed solely on the basis of self-description, and future research should take into account its biological markers, e.g. hormone levels.

Conclusion

Students with an evening type had higher levels of social jetlag than morning type and intermediate type. Because of that, they find it difficult to actively participate in morning activities. We believe that determination of an athlete's chronotype through a questionnaire should be done in any case, if possible and that effective coping with stress may be a buffer to help reduce sleep problems. Measurements of peripheral skin temperature, done by a wristband, are suitably informative and useful methods to verify the results from subjective methods for assessing chronotype.

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References

1. Adan A., S. N. Archer, M. P. Hidalgo, L. Di Milia, et al. (2012). Circadian Typology: A Comprehensive Review, *Chronobiology International*, 29, 1153-1175.
2. Alshana O., M. H. Khan (2022). Impacts of Chronotype on Personality, Stress-anxiety, and Physical Activity in a University Teaching Staff, *Journal of Global Scientific Research*, 7 (1), 2011-2018.
3. Arbinaga F., S. Fernandez-Cuenca, E. J. Fernández-Ozcorta, M. D. Toscano-Hermoso, et al. (2019). Level of Physical Activity and Sleep Characteristics in University Students, *Sleep Science*, 12(4), 265-271.
4. Bryan L., A. Wells (2024). How Is Sleep Different For Men and Women. <https://www.sleepfoundation.org/how-sleep-works/how-is-sleep-different-for-men-and-women> (access date 05 February 2026)
5. Buysse D. J., C. F. Reynolds III, T. H. Monk, S. R. Berman, et al. (1989). The Pittsburgh Sleep Quality Index: A New Instrument for Psychiatric Practice and Research, *Psychiatry Research*, 28, 193-213.
6. Cohen S., T. Kamarck, R. Mermelstein (1983). A Global Measure of Perceived Stress, *Journal of Health and Social Behavior*, 24(4), 385-396.
7. Hasselberg M. J., J. McMahan, K. Parker (2013). The Validity, Reliability, and Utility of the iButton® for Measurement of Body Temperature Circadian Rhythms in Sleep/Wake Research, *Sleep Medicine*, 14(1), 5-11.

8. Horne J. A., O. Ostberg (1976). A Self-assessment Questionnaire to Determine Morningness-eveningness in Human Circadian Rhythms, *International Journal of Chronobiology*, 4(2), 97-110.
9. Komada Y., Y. Ikeda, M. Sato, A. Kam, et al. (2019). Social Jetlag and Menstrual Symptoms Among Female University Students, *Chronobiology International*, 36(2), 258-264.
10. Krauchi K., C. Cajochen, M. Pache, J. Flammer, et al. (2006). Thermoregulatory Effects of Melatonin in Relation to Sleepiness, *Chronobiology International*, 23(1-2), 475-484.
11. Krauchi K., K. Konieczka, C. Roescheisen-Weich, B. Gompfer, et al. (2014). Diurnal and Menstrual Cycles in Body Temperature are Regulated Differently: A 28-day Ambulatory Study in Healthy Women with Thermal Discomfort of Cold Extremities and Controls, *Chronobiology International*, 31(1), 102-113.
12. Krauchi K., A. Wirz-Justice (1994). Circadian Rhythm of Heat Production, Heart Rate, and Skin and Core Temperature Under Unmasking Conditions in Men, *American Journal of Physiology*, 267(3), R819-R829.
13. Litwic-Kaminska K., M. Kotysko (2020). Sleep Quality of Student Athletes and Non-athletes – The Role of Chronotype, Stress and Life Satisfaction, *Sleep Science*, 13(4), 249-255.
14. McGinnis G. R., S. T. Thompson, C. D. Aguilar, M. B. Dial, et al. (2022). Chronotype and Social Jetlag Influence Performance and Injury During Reserve Officers' Training Corps Physical Training, *International Journal of Environmental Research and Public Health*, 19(20), 13644.
15. Montaruli A., L. Galasso, A. Caumo, E. Ce, et al. (2017). The Circadian Typology: The Role of Physical Activity and Melatonin, *Sport Sciences for Health*, 13(3), 469-476.
16. Polugrudov A. S., A. S. Panev, V. V. Smirnov, N. M. Paderin, et al. (2016). Wrist Temperature and Cortisol Awakening Response in Humans with Social Jetlag in the North, *Chronobiology International*, 33(7), 802-809.
17. Rankov K. (2020). Sleep Hygiene in Sport, *Oxidation Communications*, 43(4), 870-886.
18. Roenneberg T., K. V. Allebrandt, M. Meroow, C. Vetter (2012). Social Jetlag and Obesity, *Current Biology*, 22(10), 939-943.
19. Watson J. C. (2016). The Effect of Athletic Identity and Locus of Control on the Stress Perceptions of Community College Student-athletes, *Community College Journal of Research and Practice*, 40(9), 729-738.
20. Wittmann M., J. Dinich, M. Meroow, T. Roenneberg (2006). Social Jetlag: Misalignment of Biological and Social Time, *Chronobiology International*, 23(1-2), 497-509.
21. Yun J. A., Y. S. Ahn, K. S. Jeong, E. J. Joo, et al. (2015). The Relationship Between Chronotype and Sleep Quality in Korean Firefighters, *Clinical Psychopharmacology and Neuroscience*, 13(2), 201-208.
22. Zaharinova M., N. Zaekov, K. Rankov, M. Nikolova (2022). Association Between Chronotype, Stress, and Gender in Bulgarian Sports Students, *International Scientific Congress "Applied Sports Science"*, 2, 58-62.

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