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SLEEP QUALITY AND THE LEVEL OF PERCEIVED STRESS IN MEDICAL STUDENTS

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Sleep is a very important aspect of human life, as it is responsible for regulation of the circadian cycle, body regeneration and reduction of harmful metabolites. Sleep deprivation can be associated with chronic stress, which can have an extremely negative impact on bodily function. The presented study covered 220 students of medical faculties; their correlations between the sleep quality and the level of perceived stress were analyzed. Sleep quality was measured using the PSQI (Pittsburgh Sleep Quality Index), and perceived stress was measured using PSS-10 (10-Item Perceived Stress Scale). A high correlation was shown between the PSQI and PSS-10 results ($r_s = 0.60$), which means that people who were characterized by a low sleep quality also showed a high level of perceived stress. Among the PSQI components that were the most correlated with PSS-10, can be counted in such components as C1 (subjective sleep quality, $r_s = 0.50$), C2 (sleep latency, $r_s = 0.51$), and C7 (daytime dysfunctions, $r_s = 0.52$). Mobile phone usage at bedtime has also been demonstrated to correlate with poor sleep quality. The study shows a significant relationship between sleep quality and the level of perceived stress, which has also been shown in other studies.

Keywords: circadian rhythm; sleep disturbances; sleep quality; stress level; sympathetic nervous system.

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Sleep is a functional state of the nervous system, in which consciousness and muscle tension are supressed. The biological purpose of sleep is rest and regeneration, as well as a reduction in adenosine and toxic metabolites that accumulate in the body during the day. In addition, sleep plays an important role in the process of memory consolidation and the analysis of emotional experiences. Good quality sleep is one that allows metabolism to regenerate, nervous and the musculoskeletal systems. The structural complexity of the human brain and the amount of interactions in neural networks require a complexed regulation of sleep, both neural and endocrine. Synchronization of biological rhythms is the basis for proper functioning. Among these rhythms, the rhythm of sleep and wakefulness plays a very important role (Jaworek et al., 2017; Zakaria et al., 2016). Therefore, sleep is a particularly controlled neurobiological process, which is key for proper functioning. Some authors note that sleep is of the brain, by the brain and for the brain (Anderson & Bradley, 2013; Hobson, 2005). Incorrect sleep duration or circadian rhythm destabilizers and deprivators, such as smartphones with strong blue light luminescence, may negatively affect sleep quality (Munezawa et al., 2011) and, consequently, contribute to the dysregulation of the hydrocortisone economy and the over-reactivity of the sympathetic nervous system, which may be manifested by excessive stress, a state of psychomotor agitation or even psychosomatic disorders (Kosticova et al., 2019).

At this point, Selye's theory of stress should be mentioned, known as the General Adaptation Syndrome, which was already described in 1950. On this theory, stress has three phases: the alarm phase, the resistance phase, and the exhaustion phase. In the alarm phase, the body's resources are mobilized in response to the stressor, because the sympathetic nervous system is activated and then adrenaline and hydrocortisone are released into the bloodstream. The resistance phase is characterized by staying on high alert, manifested by elevated blood glucose levels, persistently high levels of epinephrine and hydrocortisone, as well as rapid breathing and increased blood pressure. When a stressor acts on the body for too long, there is an exhaustion phase, which means that all resources are exhausted and the susceptibility to disease and death increases. Thus, according to Selye's theory, prolonged stress has tremendous psychosomatic consequences (Selye, 1950).

In light of the presented theory, chronic stress that can be caused by a lack of sleep may affect the body in a very negative manner. The pituitary gland begins to overproduce the adrenocorticotropic hormone, which contributes to the increased production of hydrocortisone in the adrenal cortex. A higher level of hydrocortisone causes an increased breakdown of proteins and production of glucose from amino acids without compromising the glycogen stores from the liver (Bagrowski, 2018; Frindt et al., 2006). Strong or prolonged stress can lead to the destruction of the adrenal cortex, which is essential for the proper functioning of the body. Psychobiologically, exhaustion ensues when the body is no longer able to adapt to a stressful situation. Therefore, chronic stress, through the constant stimulation of the sympathetic nervous system, may have a destructive effect on the body (Bagrowski, 2020; Dugiel et al., 2012; Sandi & Haller, 2015).

It should also be mentioned that stress can also have a negative impact on the quality of sleep. Polysomnographic studies have shown that psychosocial stress decreases in slow wave sleep, REM sleep, and sleep efficiency, but it increases in the waking hours (Kim & Dimsdale, 2007). Workload and spending time in a stressful environment may result in shorter sleep (Almojali et al., 2017), and even exposure to stress itself may make falling asleep difficult. Bad sleep quality and chronic stress can also lead to insomnia and disturbances of the circadian rhythm (Kalmbach et al., 2018). In the light of the presented research, it should be stated that the relationship between sleep quality and stress level is most likely two-sided.

The purpose of the present paper is to assess the correlation of sleep quality with the level of perceived stress and to compare the level of stress in people with high and low sleep quality. In order to detail the problem of the work, research hypotheses were formulated.

A correlation analysis will show that the better sleep quality, the lower the stress level.

An analysis of the correlation value will enable the identification of a domain of the quality of sleep, which is most closely related to the stress level.

METHOD

Participants

The study was conducted online among medical students in 2020. The survey was carried out during the holiday season in order to exclude stressors associated with the study program, e.g., exams or projects. Standardized questionnaires were used for the survey, and participation in it was voluntary. The subjects agreed to participate and they were not compensated for that. The study was consulted with the bioethics committee, but due to the fact that it does not constitute a clinical trial or an experiment, no special consent was required.

The study group consisted of 220 students ($F = 164$, $M = 56$) aged 19 to 29 ($M = 21.6$, $M_e = 21$, $SD = 2.32$, $V = 10.7\%$), full-time studies ($n = 171$) and part-time ($n = 49$) in medical faculties. The sample size was difficult to calculate, as the exact number of active medical students in Europe is unknown. Therefore, the practical rules proposed by Roscoe (1975) were applied, so that the number of participants in the study should be in the range of 30–500. In addition, as a general rule, sample sizes of 200 to 300 respondents provide an acceptable margin of error and fall before the point of diminishing returns. Therefore, the sample size of 220 was considered appropriate. This study follows strictly the rules to ensure reliable data generation and analyses at the ensuing stage.

Measures

The quality of sleep and the level of perceived stress were assessed with using questionnaires in all participants of the study.

Sleep quality was tested using the PSQI (Pittsburgh Sleep Quality Index) questionnaire, consisting of nine questions with subitems (19 items in total) and covers typical sleep habits. In this questionnaire, the participants were asked to assess the quality of their sleep during the previous four weeks by determining such components as sleep time, sleep problems, and mood related to somnolence. The last question is about subjective sleep quality. The results of the questionnaire allow the assessment of seven domains of the PSQI scale: C1—subjective sleep quality, C2—sleep latency, C3—sleep duration, C4—habitual sleep efficiency, C5—sleep disturbances, C6—use of sleeping medication, C7—daytime dysfunction. Each of these domains is assessed according to the interpretation key on a scale from 0 to 3, where 0 denotes no difficulty in a given component, and 3 means huge difficulty. The total score for all components of the PSQI scale ranges from 0 to 21 points—the higher the score, the worse the quality of sleep. People with a maximum result of 5 points are considered to have a very good sleep (Buysse et al., 1989). The PSQI has internal consistency and reliability coefficient (Cronbach's alpha) of 0.83 for its seven components.

The PSS-10 scale (10-Item Perceived Stress Scale) was used to assess the level of perceived stress. This questionnaire consists of 10 questions that concern subjective feelings related to personal situations and everyday life, as well as the degree of coping with difficult situations. Respondents give their answers on a scale from 0 (*never*) to 4 (*very often*), and the overall score on the scale is the sum of all points. Scores between 0–13 points are treated as a low level of perceived stress, while scores between 20–40 points indicate a high stress level. The results in the range of 14–19 points are treated as an average result (Cohen et al., 1983). Cronbach's alpha for the PSS-10 has a reliability score of 0.78.

In the study, the original versions of the PSS-10 and PSQI questionnaires were used, because the respondents were European, but of different nationalities (mostly

Poles and Ukrainians, but some students of different origin took part in the study as well), while all of the respondents know English at least at the B2 level (confirmed by appropriate certificates or study programmes). The researchers concluded that the original form would not be susceptible to overinterpretation and would allow better application of the results for international research.

The questionnaire also included additional questions regarding age, gender and the mode of study (full-time or part-time). The authors of the study also added a question about duration of cell phone use just before going to bed, and the answer variants were as follows: "I do not use the phone before going to bed", "I use it for about 15 minutes", "I use it for about 30 minutes", "I use it for about 1 hour", "I use it until I fall asleep".

Procedure

The volunteers who agreed to participate in the study completed a questionnaire, the components of which are described in the section "Measures". Then, based on the responses obtained in the questionnaires, the scores on the PSS-10 and PSQI scale were calculated for each subject. After collecting all the results, a collective data analysis was performed.

To perform the statistical analysis, the Statistica package (version 13.3) was used. The following statistical tests were used: the Shapiro–Wilk test (to test the normality of the distribution of variables), the Mann–Whitney *U* test (for the comparison of the groups in terms of scores) and the Spearman's rank correlation coefficient (to investigate the correlation between sleep disturbance and stress levels). Due to the lack of equality of the groups and the lack of normality of the distribution, non-parametric tests were used.

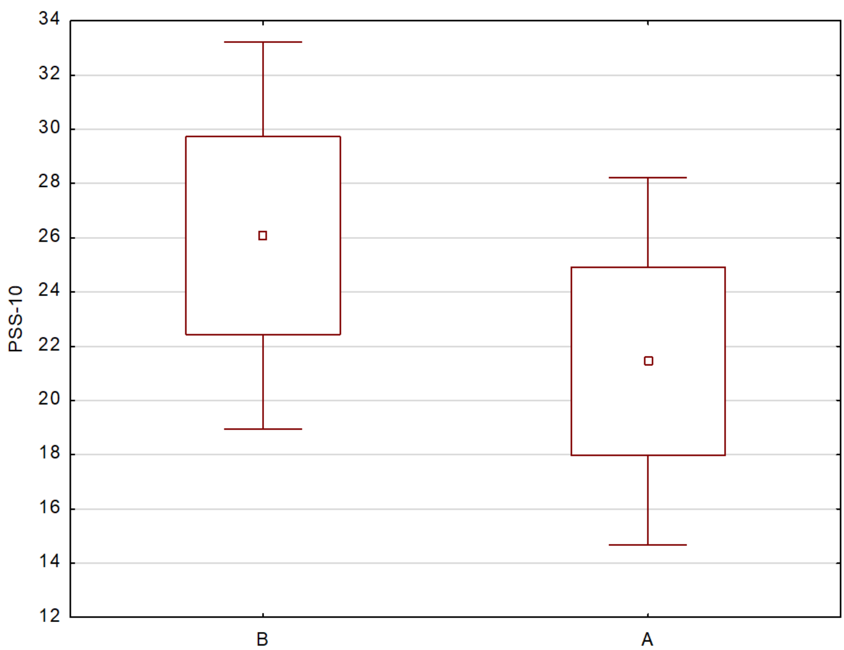
RESULTS

The results of the PSS-10 questionnaire ranged from 15 to 37 ($M_e = 23$; $V = 17.8\%$), and the interpretation of the results showed that there was no one characterized by a low level of stress, while the largest group were people with a high level of perceived stress ($n = 148$). The remaining people ($n = 72$) presented an average level of perceived stress. The results of the PSQI questionnaire ranged from 0–14 ($M_e = 6$, $V = 43.7\%$) and made it possible to distinguish two groups from among the respondents: people with good sleep quality (Group A: PSQI < 6) and those with poor quality sleep (Group B: PSQI > 5). Groups A and B were compared for PSS-10 scores, and statistical significance was measured using the Mann–Whitney *U* test.

Group A consisted of 98 people, and the PSS-10 results were in the range of 15–30 ($M = 21.45$, $M_e = 21$, $SD = 3.45$, $V = 16.1\%$). Group B consisted of 122 respondents, whose PSS-10 scores were in the range of 18–37 ($M = 26.08$; $M_e = 26$; $SD = 3.64$; $V = 14.0\%$). The mentioned statistics are presented in Figure 1. In order to check whether the level of perceived stress differs between the groups, the Mann–Whitney *U* test was performed. Its results indicate statistically significant differences in this range ($p = 0.002$) with the test statistic value of $Z \approx 7.93$. This means that the level of perceived stress in people in group A and people in group B is significantly different. In the light of the presented results, there are therefore grounds for rejecting the null hypothesis and considering the observed differences non-accidental.

Figure 1

Distribution of PSS-10 Scores in Groups A (PSQI < 6) and B (PSQI > 5)



The presented data and the statistical test show that the group characterized by good quality sleep (PSQI < 6) showed a significantly lower level of perceived stress (according to PSS-10) than the group with low quality sleep (PSQI > 5). However, for a more detailed analysis of the individual components, an analysis of Spearman's rho correlation was also performed for each of the PSQI domains (C1–C7) and PSS-10. The results of the statement are presented in Table 1.

Table 1

Analysis of Spearman's Rho Correlation Between PSS-10 and PSQI and Individual PSQI Domains

PSQI domain	Correlation with PSS-10	Correlation strength (Guilford, 1973)
C1: Subjective sleep quality	$r_s = .50$	High correlation
C2: Sleep latency	$r_s = .51$	High correlation
C3: Sleep duration	$r_s = .41$	Average correlation
C4: Habitual sleep efficiency	$r_s = .42$	Average correlation
C5: Sleep disturbances	$r_s = .45$	Average correlation
C6: Use of sleeping medication	$r_s = .39$	Average correlation
C7: Daytime dysfunction	$r_s = .52$	High correlation
PSQI: General sleep quality	$r_s = .60$	High correlation

For all the calculated test values, the significance level is $p < .001$, which means that the relationship of the presented features is statistically significant. The highest linear relationship of PSS-10 was demonstrated for the total PSQI score ($r_s = .60$), and the lowest—for the PSQI—C6 domain ($r_s = .39$). The C1, C2 and C7 domains showed a similar level of correlation with PSS-10 (sequentially: $r_s = .50$, $r_s = .51$, $r_s = .52$). It should be mentioned that the differences between the correlation coefficients for C1, C2 and C7 were small and did not turn out to be statistically significant.

The questionnaires included a question about using the phone at bedtime. It has been shown that the longer the time of using the telephone at bedtime, the higher the dysfunction of sleep. The results of the statement are presented in Table 2.

Table 2
Analysis of Spearman's Rho Correlation Between Using Phone at Bedtime and PSQI and Individual PSQI Domains

PSQI domain	Correlation with phone usage time in bed before sleep	Correlation strength (Guilford, 1973)
C1: Subjective sleep quality	$r_s = .29$	Weak correlation
C2: Sleep latency	$r_s = .43$	Average correlation
C3: Sleep duration	$r_s = .26$	Weak correlation
C4: Habitual sleep efficiency	$r_s = .31$	Average correlation
C5: Sleep disturbances	$r_s = .38$	Average correlation
C6: Use of sleeping medication	$r_s = .22$	Weak correlation
C7: Daytime dysfunction	$r_s = .34$	Average correlation
PSQI: General sleep quality	$r_s = .43$	Average correlation

There was neither a high correlation between duration of phone usage before sleep and PSQI score nor any of PSQI domains score. However, an average correlation was shown in several components.

DISCUSSION, CONCLUSIONS AND LIMITATIONS

The conducted results allowed the research hypotheses to be answered. The verification is presented in Table 3.

In the present study, it was shown that the quality of sleep is clearly related to the level of perceived stress. Students with a good quality sleep have lower levels of stress than students with a poor quality sleep. After correlation tests it turned out that the relationship between the quality of sleep and the level of perceived stress is not accidental, and the PSQI components that are most correlated with the level of perceived stress are: C1—subjective sleep quality, C2—sleep latency and C7, i.e., daytime dysfunction, such as somnolence, lack of alertness or decreased energy. However, the correlation analysis does not allow the direction of the relationship to be determined, therefore the presented study does not explain whether the high level of stress results from poor sleep quality or whether low sleep quality is the result of an increased general level of stress. Some studies indirectly confirm the presented conclusions and indicate the direction of the relationship between stress and sleep quality—as a rule, it is observed that a lack of sleep or poor quality of sleep increases the level of stress (Munezawa et al., 2011; Kosticova et al., 2019). Other studies have shown that stress before sleep affects sleep latency and decreases early slow-wave activity (Goldberg, 2020; Ackermann et al., 2019). It is possible that not only pre-sleep stress increases sleep latency, but also an elevated overall stress level may increase sleep latency. Studies conducted among patients with Posttraumatic Stress Disorder (PTSD) have shown that people with PTSD are characterized by increased daytime drowsiness (Westermeyer et al., 2010). It is possible that people characterized by an increased general level of stress may also show drowsiness and other daytime dysfunctions. An experimental study is probably necessary to verify the direction of the aforementioned dependence.

Table 3
Verification of Research Hypotheses

	Hypothesis	Result
1.	Correlation analysis will show that the better the quality of sleep, the lower the stress level.	*p*—significant result *r*—high correlation
2.	The analysis of the correlation value will allow for the identification of a domain of the quality of sleep, which is most closely related to the level of stress.	Highest correlation for the C7 domain (daytime dysfunction)

No correlation analysis was performed for PSS-10 and PSQI scores regarding sex or age. However, it should also be mentioned that the questionnaires did include a question about using the phone at bedtime. It has been shown that the longer the time of using the telephone at bedtime, the higher the sleep latency, the risk of sleep disturbances and the subjective assessment of sleep quality. This observation is consistent with other studies (Munezawa et al., 2011; Alshobaili & Al Yousefi, 2019), however, the presented study did not focus on this issue, as the question about telephone use (e.g. frequency of use or type of content) should be expanded and a more detailed analysis should be carried out. Using the phone at bedtime may be associated with unfavorable psychological phenomena, such as Revenge Bedtime Procrastination (Kroese et al., 2014), therefore a detailed examination of the causes seems to be crucial. Other studies indicate that poorer quality of sleep is correlated not only with using the phone immediately before going to bed, but also a long-term use of the phone during the day, even if the phone is put down right before going to bed (Rafique et al., 2020). The complexity of the problem indicates the need for further research in this direction.

The range of the PSS-10 questionnaire results and their variability turned out to be lower than expected. According to the presented data, none of the study participants was characterized by a low level of stress (PSS-10 < 14). Most of the respondents presented a high level of stress (PSS-10 > 19), despite the fact that the study was conducted during the holiday season. It is not entirely clear why there was an elevated level of stress among the respondents. It is possible that there are important stressors that may have influenced the outcomes, so the authors suggest that a broader study should be conducted to take into account important stressors other than sleep quality disturbances.

Despite the aforementioned limitations of the presented study, the verification of research hypotheses is consistent with the results of other studies (Alotaibi et al., 2020; Herawati & Gayatri, 2019). However, a similar analysis could turn out to be more clinically significant, taking into account also the medical factors of sleep disorders, both the causes (e.g., algodystrophic pain) and the effects (e.g., sympathicotonia), as well as stressors, psychosocial factors and psychosomatic disorders (Goślińska et al., 2020; Hayashida, 2021; Heitzman, 2009; Pereira & Elfering, 2014).

CRediT Author Statement

Bartosz Bagrowski (60%): conceptualization, methodology, validation, formal analysis, investigation, data curation, project administration, writing (original draft, review, and editing), supervision.

Joanna Gutowska (40%): conceptualization, formal analysis, resources, visualization, project administration, writing (original draft).

REFERENCES

Ackermann, S., Cordi, M., La Marca, R., Seifritz, E., & Rasch, B. (2019). Psychosocial stress before a nap increases sleep latency and decreases early slow-wave activity. *Frontiers in Psychology*, *10*, 20. https://doi.org/10.3389%2Ffpsyg.2019.00020

Almojali, A. I., Almalki, S. A., Alothman, A. S., Masuadi, E. M., & Alaqeel, M. K. (2017). The prevalence and association of stress with sleep quality among medical students. *Journal of Epidemiology and Global Health*, *7*(3), 169–174. https://doi.org/10.1016/j.jegh.2017.04.005

Alotaibi, A. D., Alosaimi, F. M., Alajlan, A. A., & Abdulrahman, K. A. (2020). The relationship between sleep quality, stress, and academic performance among medical students. *Journal of Family & Community Medicine*, *27*(1), 23–28. https://doi.org/10.4103/jfcm.JFCM_132_19

Alshobaili, F. A., & Al-Yousefi, N. A. (2019). The effect of smartphone usage at bedtime on sleep quality among Saudi non-medical staff at King Saud University Medical City. *Journal of Family Medicine and Primary Care*, *8*(6), 1953–1957. https://doi.org/10.4103%2Fjfmpc.jfmpc_269_19

Anderson, K. N., & Bradley, A. J. (2013). Sleep disturbance in mental health problems and neurodegenerative disease. *Nature and Science of Sleep*, *5*, 61–75. https://doi.org/10.2147/NSS.S34842

Bagrowski, B. (2018). Szkodliwy wpływ długotrwałego stresu na stan układu ruchu [Harmful influence of long-lasting stress on the condition of motor system]. *Edukacja Biologiczna i Środowiskowa*, *3*(68), 10–15. https://doi.org/10.24131/3247.180302

Bagrowski, B. (2020). Neurobiologia stresu [Neurobiology of stress]. In J. Nyćkowiak & J. Leśny (Eds.), *Badania i Rozwój Młodych Naukowców w Polsce: Vol. 5. Nauki medyczne i nauki o zdrowiu* (pp. 13–18). Młodzi Naukowcy.

Buysse, D. J., Reynolds, C. F., Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The Pittsburgh Sleep Quality Index: A new instrument for psychiatric practice and research. *Psychiatry Research*, *28*(2), 193–213. https://doi.org/10.1016/0165-1781(89)90047-4

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior*, *24*, 385–396.

Dugiel, G., Tustanowska, B., Kęcka, K., & Jasińska, M. (2012). Przegląd teorii stresu [An overview of theories of stress]. *Acta Scientifica Academiae Ostroviensis: Sectio B*, 47–70.

Frindt, A., Zoń, A., & Bielański, P. (2006). Stres jako forma zachowania się zwierzęcia [Stress as a form of animal behavior]. *Wiadomości Zootechniczne*, *44*(1), 15–18.

Goldberg, Z. L., Thomas K. G. F., & Lipinska G. (2020). Bedtime stress increases sleep latency and impairs next-day prospective memory performance. *Frontiers in Neuroscience*, *14*, 756. https://doi.org/10.3389/fnins.2020.00756

Goślińska, J., Graczykowski, M., Hejdysz, K., & Skibiński, K. (2020). Pinoterapia – innowacyjna polska metoda [Pinotherapy—An innovative Polish method]. *Rehabilitacja w Praktyce*, *2*, 14–22.

Guilford, J. P. (1973). *Fundamental statistics in psychology and education*. McGraw-Hill.

Hayashida, T., Shimura, A., Higashiyama, M., Fujimura, Y., Ono, K., & Inoue, T. (2021). Psychosomatic stress responses and sleep disturbance mediate the effects of irregular mealtimes on presenteeism. *Neuropsychiatric Disease and Treatment*, *17*, 315–321. https://doi.org/10.2147/NDT.S292249

Heitzman, J. (2009). Zaburzenia snu – przyczyna czy skutek depresji? [Sleep disturbances—cause or result of depression?]. *Psychiatria Polska*, *43*(5), 499–511.

Herawati, K., & Gayatri, D. (2019). The correlation between sleep quality and levels of stress among students in Universitas Indonesia. *Enfermería Clínica*, *29*(2), 357–361. https://doi.org/10.1016/j.enfcli.2019.04.044

Hobson, J. A. (2005). Sleep is of the brain, by the brain and for the brain. *Nature*, *437*(7063), 1254–1256.

Jaworek, J., Leja-Szpak, A., Nawrot-Porąbka, K., Szklarczyk, J., Kot, M., Pierzchalski, P., Góralska, M., Ceranowicz, P., Warzecha, Z., Dembinski, A., & Bonior, J. (2017). Effects of melatonin and its analogues on pancreatic inflammation, enzyme secretion, and tumorigenesis. *International Journal of Molecular Sciences*, *18*(5), 1014. https://doi.org/10.3390/ijms18051014

Kalmbach, D. A., Anderson, J. R., & Drake, C. L. (2018). The impact of stress on sleep: Pathogenic sleep reactivity as a vulnerability to insomnia and circadian disorders. *Journal of Sleep Research*, *27*(6), e12710. https://doi.org/10.1111/jsr.12710

Kim, E. J., & Dimsdale, J. E. (2007). The effect of psychosocial stress on sleep: A review of polysomnographic evidence. *Behavioral Sleep Medicine*, *5*(4), 256–278. https://doi.org/10.1080%2F15402000701557383

Kosticova, M., Geckova, A. M., Dobiasova, E., & Veselska, Z. D. (2019). Insufficient sleep duration is associated with worse self-rated health and more psychosomatic health complaints in adolescents. *Bratislavske Lekarske Listy*, *120*(10), 783–788. https://doi.org/10.4149/bll_2019_131

Kroese, F. M., De Ridder, D. T. D., Evers, C., & Adriaanse, M. A. (2014). Bedtime procrastination: Introducing a new area of procrastination. *Frontiers in Psychology*, *5*, 611. https://doi.org/10.3389/fpsyg.2014.00611

Munezawa, T., Kaneita, Y., Osaki, Y., Kanda, H., Minowa, M., Suzuki, K., Higuchi, S., Mori, J., Yamamoto, R., & Ohida, T. (2011). The association between use of mobile phones after lights out and sleep disturbances among Japanese adolescents: A nationwide cross-sectional survey. *Sleep*, *34*(8), 1013–1020. https://doi.org/10.5665/SLEEP.1152

Pereira, D., & Elfering, A. (2014). Social stressors at work, sleep quality and psychosomatic health complaints—a longitudinal ambulatory field study. *Stress and Health: Journal of the International Society for the Investigation of Stress*, *30*(1), 43–52. https://doi.org/10.1002/smi.2494

Rafique, N., Al-Asoom, L. I., Alsunni, A. A., Saudagar, F. N., Almulhim, L., & Alkaltham, G. (2020). Effects of mobile use on subjective sleep quality. *Nature and Science of Sleep*, *12*, 357–364. https://doi.org/10.2147%2FNSS.S253375

Roscoe, J. T. (1975). *Fundamental research statistics for the behavioral science* (2nd ed.). Holt, Rinehart, & Winston.

Sandi, C., & Haller, J. (2015). Stress and the social brain: Behavioural effects and neurobiological mechanisms. *Nature Reviews: Neuroscience*, *16*(5), 290–304. https://doi.org/10.1038/nrn3918

Selye, H. (1950). Stress and the general adaptation syndrome. *British Medical Journal*, *1*, 1383–1392. https://doi.org/10.1136%2Fbmj.1.4667.1383

Westermeyer, J., Khawaja, I., Freerks, M., Sutherland, R. J., Engle, K., Johnson, D., Thuras, P., Rossom, R., & Hurwitz, T. (2010). Correlates of daytime sleepiness in patients with posttraumatic stress disorder and sleep disturbance. *Primary Care Companion to the Journal of Clinical Psychiatry*, *12*(2), PCC.07m00563. https://doi.org/10.4088%2FPCC.07m00563gry

Zakaria, R., Ahmad, A. H., & Othman, Z. (2016). The potential role of melatonin on memory function: Lessons from rodent studies. *Folia Biologica*, *62*(5), 181–187. https://fb.cuni.cz/volume-62-2016-no-5#articFB2016A0022