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The relationships between stress, physical activity, mood, cognitive-emotional abilities, personality traits, and sleep

Albertas Skurvydas[1,2], Agne Predkeliene[3,4], Neringa Baranauskienė[3,4], Daiva Mockeviciene[5], Asta Sarkauskiene[2], Dovile Valanciene[6], Ausra Lisinskiene[3,4], Ramune Dirvanskiene[7] and Daiva Majauskiene[1,4*]

Abstract

Background Sleep quality and duration are shaped by a complex interplay of behavioral, psychological, and sociodemographic factors. This study aimed to examine the relationships between physical activity, perceived stress, mood, personality traits, and cognitive- emotional abilities in relation to adult sleep patterns.

Methods A cross-sectional study was conducted with 1,140 participants (27.1% men, 72.9% women; aged 18–64). Sleep parameters were assessed using items adapted from the Pittsburgh Sleep Quality Index. Additional validated tools measured physical activity (IPAQ), perceived stress (PSS-10), mood (BRUMS), emotional intelligence (SSREIT), personality traits (BFI), moral decision-making, and cognitive reflection. Statistical analyses included chi-square tests, two-way ANOVAs, and multi-step general linear modeling.

Results Women reported higher levels of perceived stress, fatigue, emotional intelligence, and empathetic decision-making, while men showed greater vigor, BMI, and leisure-time physical activity. No significant gender differences were found in sleep duration or latency, although men tended to go to bed later. Sleep outcomes were most strongly influenced by demographic factors, including age, gender, place of residence, education, and physical job demands. Psychological variables, including fatigue, anger, and vigor, also played a significant role. Additionally, personality traits like neuroticism, conscientiousness, and openness, along with body mass index, perceived health, and leisure-time physical activity, were important predictors of sleep quality. Conversely, other expected psychosocial factors—such as happiness, perceived stress, sedentary behavior, emotional intelligence, depression, confusion, and work-related moderate to vigorous physical activity—were not found to be significant.

Conclusions Our findings indicate that sleep indicators are related to various sociodemographic factors, personality traits, overall health, mood profiles, and notably, physical activity during leisure time. However, we did not find any significant connections between sleep indicators and cognitive-emotional abilities, such as emotional intelligence, cognitive reflection, and empathy.

Trial registration

Keywords Sleep, Sleep wake disorders, Motor activity, Stress, Psychological, Mood disorders, Personality, Sex factors

*Correspondence:
Daiva Majauskiene
daiva.maja@gmail.com

Full list of author information is available at the end of the article

Introduction

A meta-analysis by Cappuccio at al [1] suggests that both short and long sleep durations can influence mortality risk. Research indicates that quality sleep is essential for several health aspects, including cardiovascular health, mental well-being, cognition, memory consolidation, immunity, reproductive health, and hormone regulation [1]. Furthermore, physical activity can improve sleep quality, as noted by Baranwal et al. [2]. Studies have identified two lifestyle factors associated with sleep disturbances: sedentary behavior and participation in physical exercise [3]. Exercise has been shown to effectively alleviate symptoms of sleep disturbances, particularly in individuals who lead a highly sedentary lifestyle. Epidemiological and laboratory evidence find an association between sleep loss and an increased risk of obesity [4].

Recent influential studies reveal that poor sleep is one of the eight key risk factors for cardiovascular disease. While the rates of poor nutrition, insufficient physical activity, and smoking are expected to decline over time, inadequate sleep is likely to become an increasing concern [5].

Research indicates that the duration of sleep is linked to a higher occurrence of depression. Both inadequate and excessive sleep can increase the risk of developing depression [6].

Furthermore, studies indicate a dose-response relationship between sleep duration and phenotypic age. Specifically, longer sleep duration is associated with regular physical activity, while shorter sleep duration, even when combined with increased exercise, is often linked to a higher phenotypic age [7]. This relationship follows an inverted U-shaped pattern, meaning that both short and long sleep durations can negatively impact phenotypic age.

Sleep health is increasingly recognized as a multidimensional construct that plays a vital role in overall well-being. According to Buysse [8] and Hale et al. [9], it comprises five key components—sleep duration, continuity, timing, alertness, and quality—all of which contribute to physical and mental health. Recent research emphasizes the importance of maintaining consistent sleep and wake times, as irregular sleep patterns and increased variability are linked to adverse health outcomes [10]. In addition, perceived stress has been consistently associated with poorer sleep quality, with higher stress levels impairing the ability to fall asleep and maintain restorative sleep [11].

Exercise improves both physical and mental health, benefiting cardiovascular fitness, circulation, sleep quality, and mood. According to Garber et al. [12], regular physical activity has a positive effect on total sleep time, sleep efficiency, and sleep onset latency. Additionally, research by Kredlow et al. [13] shows that exercise leads to moderate improvements in overall sleep quality.

Our recent studies indicate that one or two nights of sleep deprivation has a greater impact on executive function than on motor function [14, 15]. Additionally, it has been found that logical thinking remains unaffected by variations in sleep duration [16]. Furthermore, research shows that the COVID-19 pandemic has resulted in reduced sleep duration among elderly women [17]. Notably, studies have demonstrated that students' happiness, vitality, and self-esteem are not influenced by sleep quality, as measured by the Pittsburgh Sleep Quality Index [18]. Research shows that the mood profile in men and women of all ages improves with leisure-time physical activity rather than work-related physical activity [19, 20]. Furthermore, our data, along with findings from other researchers, clearly demonstrate a strong association between physical activity and emotional intelligence; specifically, higher levels of physical activity correlate with improved emotional intelligence [16, 17, 21]. There seems to be an inverse relationship between emotional intelligence and the efficiency of solving logical tasks. This suggests that individuals with higher emotional intelligence may rely less on purely analytical reasoning when approaching problem-solving [16, 17].

Sleep affects both the generation and regulation of emotions through several mechanisms, including situation selection, situation modification, attentional deployment, cognitive change, and possibly response modulation [22–24].

Sleep disruption is associated with increased activity in the sympathetic nervous system and the hypothalamic-pituitary-adrenal (HPA) axis. This disruption can lead to various metabolic effects, alterations in circadian rhythms, and heightened pro-inflammatory responses [25]. In otherwise healthy adults, the short-term effects of sleep disruption include increased stress responsiveness, physical pain, reduced quality of life, emotional distress, mood disorders, and impairments in cognitive function, memory, and performance. For adolescents, sleep disruption adversely affects psychosocial health, academic performance, and increases engagement in risk-taking behaviours.

Severe short sleep has been associated with lower cognitive ability across all four tests conducted. In a study involving mice, researchers found heightened activation of inflammatory pathways in specific subgroups of neurons from both the sleep-deprived and recovery sleep groups. Additionally, increased expression of oxidative stress and integrated stress response pathways was observed in GABAergic neurons during sleep deprivation [7]. The study found that morning alertness is not genetically predetermined but can be enhanced by improving sleep habits, increasing physical activity, and making suitable dietary choices [26].

Sleep deprivation affects various emotional processes, including basic functions like recognizing, responding to, and expressing emotions. It also impacts more complex social and emotional abilities, such as feelings of loneliness, willingness to help others, aggressive behaviours, and charisma [27]. Additionally, research has shown a strong connection between sleep disturbances and mental health problems, including anxiety, depression, and even suicidal thoughts.

Neuroticism is consistently associated with poorer sleep quality, as confirmed by multiple studies reporting moderate effect sizes [28]. Individuals with higher levels of neuroticism tend to experience more sleep disturbances, such as insomnia, nightmares, and reduced sleep continuity. These findings highlight neuroticism as a key personality trait influencing sleep behavior and outcomes.

Neuroticism was associated with greater variability in sleep duration, continuity, and subjective sleep quality, whereas conscientiousness predicted more stable patterns in both sleep duration and continuity. Extraversion, agreeableness, and openness were generally not linked to objectively recorded sleep behaviors but were associated with higher subjective sleep quality ratings [29]. Research shows that inadequate sleep negatively impacts our ability to empathize with others who are suffering [30]. Poor sleep quality is linked to reduced emotional sensitivity and a lower capacity for perspective-taking. Even short-term disruptions in sleep can significantly decrease levels of empathy and prosocial behavior. These findings suggest that insufficient sleep can have not only individual consequences but also broader social implications, potentially diminishing empathy and mutual understanding within society [30]. Youssef et al. [31] discovered that increased stress results in a higher likelihood of individuals making non-utilitarian decisions, and that women tend to make significantly fewer utilitarian decisions compared to men. Other researchers have demonstrated that participants who showed stronger support for utilitarian solutions had higher scores on measures of psychopathy, Machiavellianism, and a sense of meaninglessness in life [32].

Despite the studies mentioned earlier, it is still unclear how various sleep parameters—such as sleep duration, bedtime, sleep onset latency, and wake-up time—are influenced by a complex array of factors. These factors include the nature of physical activity (such as work-related versus leisure-time activities), mood, cognitive-emotional abilities (including emotional intelligence, logical thinking, and empathy), personality traits, subjective health and happiness, perceived stress, body mass index (BMI), and sociodemographic characteristics. In other words, we have yet to find research that examines the key determinants of sleep quality in such a comprehensive and integrated manner.

This study aims to clarify the complex relationships between key indicators of sleep (as dependent variables) and a variety of independent variables. These independent variables include aspects of physical activity and sedentary behavior, levels of perceived stress, mood states (such as depression, anger, fatigue, confusion, and vigor), cognitive-emotional abilities, subjective measures of health and happiness, body mass index (BMI), age, gender, place of residence, job-related physical demands, and educational background. We hypothesize that leisure-time physical activity, as opposed to physical activity performed during work, is positively correlated with sleep indicators. Additionally, we anticipate that, along with traditional factors influencing sleep—such as age, gender, BMI, and others—perceived stress, mood disturbances, personality traits, subjective health and happiness, and cognitive-emotional abilities—including emotional intelligence, logical thinking, and empathy—will serve as significant predictors of sleep health. By testing these hypotheses, this study aims to enhance our understanding of the behavioral and psychological factors that affect sleep and to inform targeted interventions designed to improve sleep health across various populations.

Methods

Participants

A total of 1,140 people took part in the study, of whom 309 (27.1%) were identified as men and 831 (72.9%) as women. The age range was between 18 and 64 years. Socio-demographic data (gender, age, education, occupation, place of residence) can be found in Table 1.

Consent to participate

Informed consent was obtained from all participants, in which the aims of the study, the anonymity of the participants and the possibility of cancelling participation at any time were pointed out. The study complied with the Declaration of Helsinki and was approved by the University of Klaipėda (Protocol No. STIMC-BTMEK-09).

Instruments

Physical activity was assessed with the long International Physical Activity Questionnaire (IPAQ) [33], which covers four domains: work, transport, home, and leisure. The questionnaire records the frequency (days per week) and average duration (hours/minutes per day) of activities. Total weekly activity was calculated by weighting time spent at different intensities with corresponding metabolic equivalents (METs): vigorous – 8.0, moderate – 4.0, low – 3.3.

Table 1 Comparison of physical activity, sleep, health, psychological, and emotional parameters between women and men

Variable		**Women (Mean ± SD)**	**Men (Mean ± SD)**	***p*-value**	**Cohen's d**
Demographic parameters	Sample size	831	309		
	Age, years	41.9 ± 11.6	41.2 ± 11.2	0.134	0.06
	Living in the City (%)	74.3	73.1	0.6	
	Higher Education (%)	69.8	61.9	< 0.001	
	Sedentary or Standing Job (%)	87.3	78.9	< 0.001	
Sleep Parameters	Sleep Duration (h)	7.34 ± 0.94	7.28 ± 0.87	0.372	0.07
	Time to Bed (h)	22.95 ± 0.86	23.10 ± 0.91	0.011	-0.17
	Time to Fall Asleep (min)	17.82 ± 14.9	16.70 ± 15.48	0.266	0.07
	Wake-up Time (h)	7.18 ± 1.24	7.10 ± 1.29	0.388	0.06
Psychological Well-being	Health (score)	2.85 ± 0.70	3.03 ± 0.71	< 0.001	-0.25
	Happiness (score)	7.94 ± 1.53	8.00 ± 1.58	0.561	-0.04
	Perceived Stress (score)	16.81 ± 7.50	14.16 ± 6.48	< 0.001	0.38
	Stress (score)	3.56 ± 3.54	3.11 ± 3.31	0.047	0.13
	Depression (score)	2.81 ± 3.61	2.43 ± 3.30	0.086	0.11
	Anger (score)	2.45 ± 3.26	2.31 ± 2.98	0.493	0.04
	Fatigue (score)	5.60 ± 4.36	4.45 ± 3.80	< 0.001	0.29
	Confusion (score)	3.06 ± 3.54	2.64 ± 3.12	0.053	0.13
	Vigor (score)	8.73 ± 3.79	9.99 ± 3.60	< 0.001	-0.34
Cognitive & Emotional Abilities	Logic (score)	2.21 ± 0.97	2.27 ± 0.92	0.363	-0.06
	Empathy Decision (score)	1.76 ± 0.29	1.62 ± 0.33	< 0.001	0.46
	Emotional Intelligence (score)	128.3 ± 16.9	122.2 ± 19.7	< 0.001	0.34
Physical Health, Physical Activity (MVPA)	BMI (kg/m^2)	24.42 ± 4.60	26.50 ± 4.93	< 0.001	-0.44
	Sedentary Behavior (min/day)	546.71 ± 282.90	559.03 ± 285.63	0.517	-0.04
	Leisure (min/week)	483.23 ± 721.07	611.23 ± 862.12	0.020	-0.16
	Work (min/week)	611.82 ± 986.76	706.52 ± 1003.48	0.155	-0.10

The subjective assessment of health was based on a four-point scale: poor health (1 point), satisfactory (2 points), good (3 points) and excellent (4 points). Two categories were formed for further analysis: poor health and good health. The use of a self-assessment questionnaire is a reliable method of recording the quality of health of women and men.

Satisfaction was rated on a 10-point scale, with 1 indicating very low satisfaction and 10 indicating very high satisfaction.

Body mass index (BMI). We calculated the BMI based on the height and weight values provided by the respondents.

Perceived stress was assessed using the 10-item Perceived Stress Scale (PSS-10) [34], where participants rated their feelings over the past month on a 0–4 Likert scale. Scores range from 0 to 40, with higher values indicating greater stress.

Emotional intelligence was assessed with the 33-item Schutte Self-Report Emotional Intelligence Test (SSREIT) [35], which includes four subscales: perception of emotions (10 items), coping with own emotions (9 items), coping with others' emotions (8 items), and use of emotions (5 items). Items are rated on a 1–5 scale, giving total scores from 33 to 165, with higher scores indicating greater EI.

Mood was assessed with the 24-item Brunel Mood Scale-LTU (BRUMS-LTU) [36], comprising six subscales (tension, depression, anger, vigour, fatigue, confusion), each with four items rated on a 0–4 Likert scale. Subscale scores range from 0 to 16, referring to participants' current mood. The BRUMS-LTU demonstrated good internal consistency (Cronbach's α = 0.74–0.90).

Personality traits were assessed with the 44-item Big Five Inventory (BFI) [37], measuring extraversion, agreeableness, conscientiousness, neuroticism, and openness. Items are rated on a 1–5 scale, with subscale scores calculated as the mean of relevant items.

Sleep habits were assessed with questions adapted from the Pittsburgh Sleep Quality Index (PSQI) [38], covering bedtime, sleep latency, wake-up time, and total sleep duration. These measures were used to describe sleep behaviour and categorise data for analysis.

Sleep habits were evaluated using questions from the Pittsburgh Sleep Quality Index (PSQI). These questions addressed key aspects such as bedtime, sleep latency, wake-up time, and total sleep duration. Respondents were asked the following questions:

1. "At what time in the evening do you usually go to bed?"

2. "How many minutes does it typically take you to fall asleep each night?"
3. "At what time do you usually wake up in the morning?"
4. "How many hours do you usually sleep per night?"

It is important to note that the responses do not necessarily have to correspond to the total time spent in bed. These questions align with the components of the PSQI related to bedtime, sleep latency, wake-up time, and total sleep duration. They were utilized to describe sleep behavior and to categorize data for further analysis.

Moral decision-making was assessed with three high-conflict personal dilemmas [39], requiring participants to choose utilitarian ("appropriate") or non-utilitarian ("inappropriate") responses. For analysis, the total number and percentage of utilitarian vs. non-utilitarian decisions were calculated.

Cognitive reflection was measured with the 3-item Cognitive Reflection Test (CRT) [40], which assesses the ability to suppress intuitive but incorrect responses in favour of more deliberate and logical ones. Scores represent the total number of correct answers.

Statistical analysis

The interval data are presented as means ± standard deviations. Normality of all interval data was confirmed using the Kolmogorov-Smirnov test. Two-way analyses of variance (ANOVA) were performed to examine the effects of the independent variables (age and gender) on the dependent variables (sleep duration, bedtime, sleep latency and wake-up time). Statistical significance was set at $p < 0.05$ for all tests. To compare men and women, Cohen's d was calculated to estimate effect sizes for group differences. If significant effects were found, Tukey's post hoc test for multiple comparisons within each repeated measures ANOVA was applied. In addition, chi-square tests (χ^2) and the corresponding p-values were calculated separately for men and women. A structured, multi-step general linear modeling (GLM) approach was implemented to assess how various sleep parameters—specifically sleep duration, bedtime, sleep latency, and wake-up time—are affected by several demographic variables, including age, gender, education, living situation, and job physical demands. Additionally, the model considered mood-related factors such as depression, anger, confusion, fatigue, and vigor, as well as perceived stress scale (PSS), happiness, health, personality traits, emotional intelligence (EI), decision-making based on empathy, logical thinking, and levels of physical activity during both work and leisure time. Sedentary behavior and body mass index (BMI) were also included as independent variables in this analysis. In the first step, univariate linear regressions were conducted to evaluate the individual relationships between each predictor and academic outcomes. For each regression, we calculated unstandardized coefficients (B), standardized coefficients (Beta), p-values, and the Akaike Information Criterion (AIC). Predictors with a p-value below 0.10 were selected for further model development. In the second step, we examined the selected variables for multicollinearity using the variance inflation factor (VIF), applying a conservative cutoff of VIF < 2. We also utilized a Pearson correlation matrix to ensure that no pairwise correlations exceeded 0.80. No multicollinearity was found, and all candidate predictors were retained. In the third step, we constructed a multivariable linear regression model for each academic subject using the eligible predictors. Each final model included unstandardized and standardized coefficients, corresponding p-values, and overall model fit statistics, such as AIC, R^2, and adjusted R^2. To enhance model simplicity and guard against overfitting, we sequentially excluded variables with p-values ≥ 0.05, re-estimating the models at each step. Only statistically significant predictors ($p < 0.05$) that were conceptually meaningful were retained in the final models. All statistical analyses were performed using IBM SPSS Statistics software (version 22; IBM SPSS, Armonk, NY, USA).

Results

Significant differences were observed between men and women across several parameters (see Table 1).

Men reported higher participation in independent exercise ($p < 0.05$), rated their health more positively ($p < 0.001$), and exhibited greater levels of vigor in their mood ($p < 0.001$). In contrast, women demonstrated higher levels of perceived stress ($p < 0.001$), emotional intelligence ($p < 0.001$), empathetic decision-making ($p < 0.001$), and mood fatigue ($p < 0.001$). Additionally, men had a higher BMI ($p < 0.001$) and engaged in more moderate-to-vigorous physical activity during their leisure time ($p = 0.020$). No significant differences were found in sedentary behavior, sleep duration, time to fall asleep, or wake-up time; however, men tended to go to bed later ($p = 0.011$).

The analysis of sleep habits revealed notable similarities and minor differences between men and women (see Fig. 1). A higher percentage of both women (approximately 73%) and men (around 68%) reported going to sleep before 11:00 p.m. However, a slightly larger proportion of men (32%) tended to go to sleep later compared to women (27%), although the difference was not statistically significant ($p > 0.05$). Regarding sleep latency, about half of the participants in both gender groups fell asleep within 15 min, with a slightly higher percentage of men (53%) compared to women (50%), again indicating no significant difference ($p > 0.05$). The remaining respondents reported taking longer than 15 min to fall asleep.

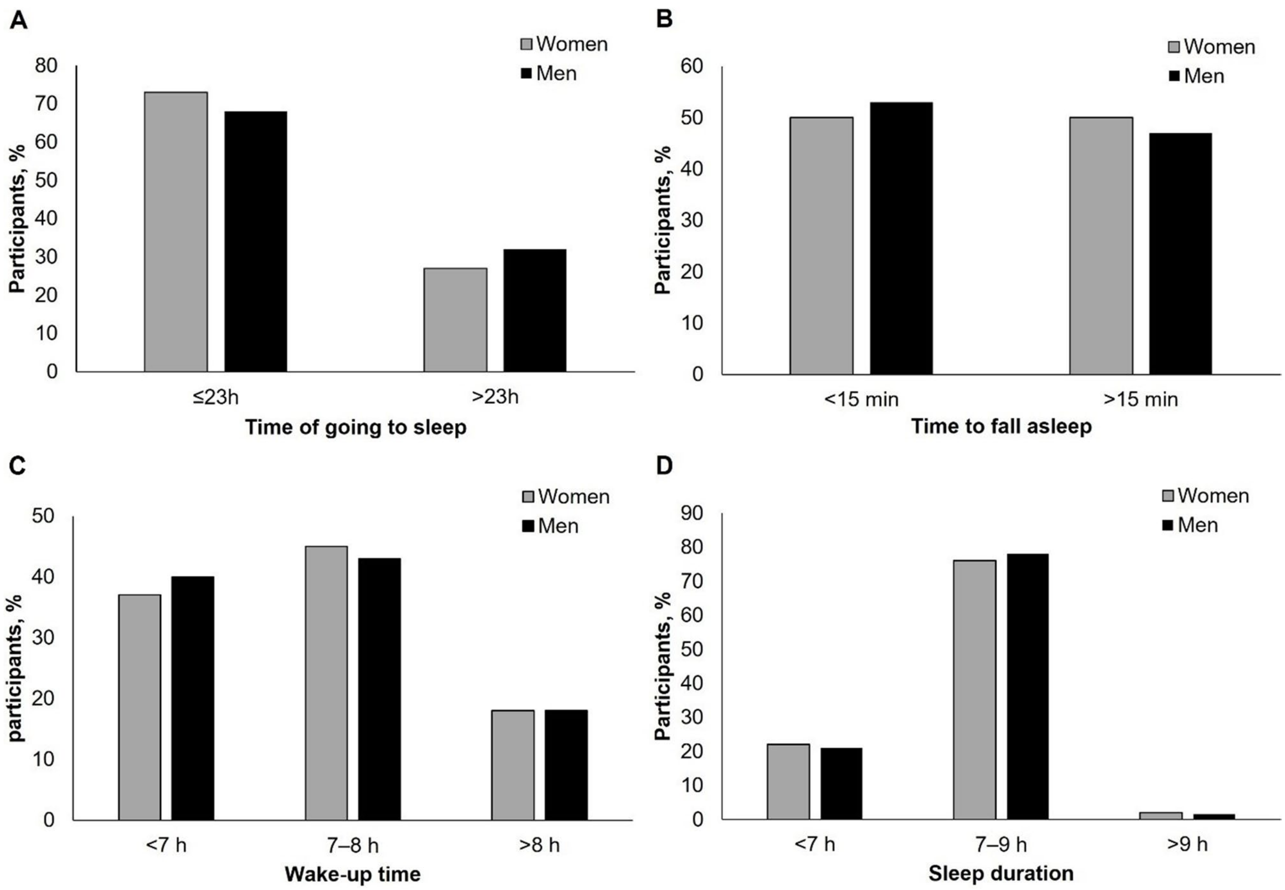

Fig. 1 Sleep patterns by gender: (**A**) time of going to sleep, (**B**) time to fall asleep, (**C**) wake-up time, and (**D**) sleep duration

Wake-up time data showed that most participants woke up between 7 and 8 a.m., with this pattern being more common among women (46%) than men (43%) ($p > 0.05$). A slightly higher percentage of men (40%) than women (37%) woke up before 7 a.m., while around 17% in both groups woke up after 8 a.m. In terms of sleep duration, the majority of respondents reported sleeping between 7 and 9 h per night: 76% of women and 78% of men ($p > 0.05$). Shorter sleep durations of less than 7 h were reported by 22% of women and 20% of men, while longer sleep durations of more than 9 h were relatively uncommon, accounting for only 1–2% of each group.

A two-way ANOVA revealed a significant effect of age group on sleep duration ($F(2,1125) = 19.05$, $p < 0.001$). In contrast, the effects of gender ($F(1,1125) = 1.84$, $p = 0.176$) and the interaction between gender and age group ($F(2,1125) = 2.15$, $p = 0.117$) were not significant (see Fig. 2A). Tukey's HSD post-hoc test indicated that women aged 18–29.9 years had significantly longer sleep durations compared to those aged 30–49.9 years ($p < 0.001$) and those aged 50 + years ($p < 0.001$). No significant difference was found between the 30–49.9 and 50 + age groups ($p = 0.422$). For men, a significant difference was observed only between the 18–29.9 and 50 + age groups ($p = 0.0005$), while no significant difference was noted between the 18–29.9 and 30–49.9 age groups ($p = 0.233$). The two-way ANOVA also found a significant effect of gender on bedtime ($F(1,1125) = 5.34$, $p = 0.021$) and age group ($F(2,1125) = 5.51$, $p = 0.004$), while the interaction effect was not significant ($F(2,1125) = 0.085$, $p = 0.918$) (see Fig. 2B). However, Tukey's HSD post-hoc test revealed that bedtime differences between age groups were not statistically significant for either men or women ($p > 0.05$). Concerning wake-up time, the two-way ANOVA showed a significant effect of age group ($F(2,1125) = 63.80$, $p < 0.001$) and a significant interaction effect between gender and age group ($F(2,1125) = 3.36$, $p = 0.035$). The main effect of gender was not significant ($F(1,1125) = 2.88$, $p = 0.089$) (see Fig. 2C). Tukey's HSD post-hoc test indicated that wake-up times varied significantly across all age groups for both men and women ($p < 0.001$), with older age groups waking up earlier. For time to fall asleep, the two-way ANOVA found no significant effects of age group ($F(2,1125) = 1.38$, $p = 0.253$), gender ($F(1,1125) = 1.14$, $p = 0.287$), or their interaction ($F(2,1125) = 0.68$, $p = 0.508$) (see Fig. 2D). Tukey's HSD post-hoc test confirmed that there were no significant differences between any age groups for either gender

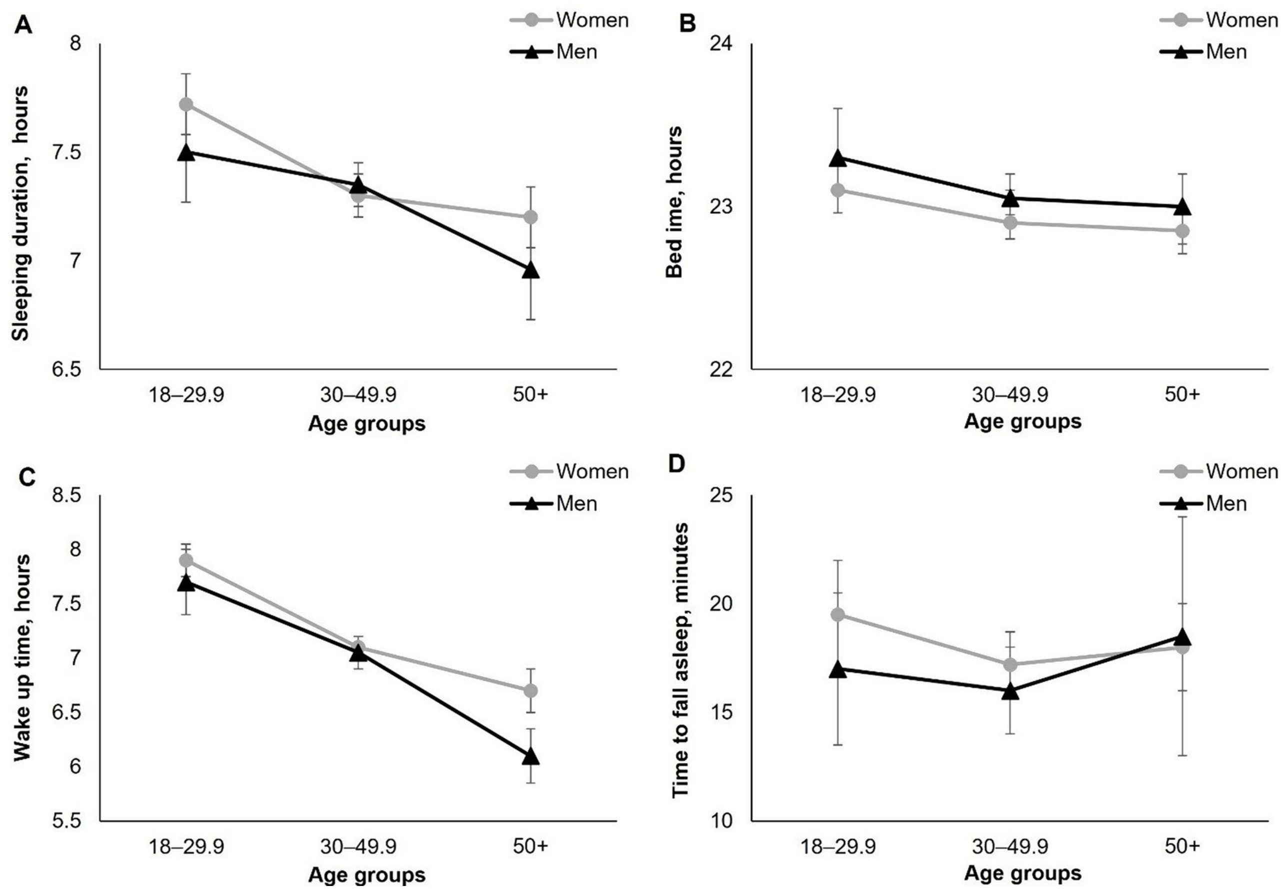

Fig. 2 Sleep duration (**A**), bedtime (**B**), wake-up (**C**), and time to fall asleep (**D**) vary by age for both women and men

($p > 0.05$). Women aged 50 and older sleep longer than men in the same age group ($p < 0.05$) (Fig. 2A) and tend to wake up later ($p < 0.05$) (Fig. 2C).

The final regression analyses demonstrated that several sociodemographic, psychological, and behavioral factors significantly predicted sleep outcomes (Table 2). Specifically, sleep duration was found to be shorter among older individuals ($p < 0.001$), those experiencing higher levels of fatigue ($p = 0.009$), individuals reporting lower levels of vigor ($p = 0.032$), those with personal traits neuroticism ($p = 0.019$), and individuals with a higher body mass index (BMI) ($p = 0.032$). Conversely, increased leisure-time physical activity ($p = 0.001$) and a higher level of education ($p = 0.011$) were associated with longer sleep duration. Overall, this model accounted for 6.2% of the variance in sleep duration (Adjusted $R^2 = 0.062$).

Men generally went to bed later ($p = 0.013$), whereas rural residents tended to have earlier bedtimes ($p < 0.001$). This model accounted for 3.3% of the variance in bedtime (Adj. $R^2 = 0.033$).

When examining the time it takes to fall asleep, we found that longer sleep onset latency was linked to living in rural areas ($p = 0.001$), having traits of neuroticism ($p = 0.008$), and higher levels of anger ($p = 0.047$). Conversely, individuals who rated their health more positively had shorter sleep onset latency ($p = 0.044$). Overall, this model accounted for 5.5% of the variance in sleep onset latency (Adjusted $R^2 = 0.055$).

Wake-up times were influenced by a variety of factors. Earlier wake-up times were associated with several predictors, including older age ($p < 0.001$), living in rural areas ($p = 0.001$), having more energy (vigor) ($p = 0.003$), higher levels of conscientiousness ($p = 0.001$), and a higher body mass index (BMI) ($p = 0.032$). In contrast, later wake-up times were linked to having physically demanding jobs ($p = 0.002$), higher education levels ($p < 0.001$), and a greater openness to new experiences ($p = 0.006$). This model explained the greatest proportion of variance in wake-up times, accounting for 16.5% of the variability (Adj. $R^2 = 0.165$).

Interestingly, other predictors of sleep indicators—such as happiness, perceived stress, sedentary behavior, emotional intelligence, empathy, logic, depression, confusion, and personality traits (extraversion, agreeableness)—as well as work-related MVPA—did not reach statistical significance (all $p > 0.05$).

Table 2 Final regression models for sleep outcomes

Dependent Variable	Significant Predictors	Standardized Beta	*p*-value	AIC	R^2	Adjusted R^2
Sleep duration	Age	-5.55	< 0.001	2970.6	0.084	0.062
	Education	2.23	0.026			
	Fatigue	-2.60	0.009			
	Vigor	-2.15	0.032			
	MVPA-leisure	3.55	0.001			
	BMI	-2.15	0.032			
	Neuroticism	-2.98	0.019			
Bedtime	Gender (women vs. men)	2.49	0.013	2911.1	0.056	0.033
	Living place (rural vs. urban)	-3.72	< 0.001			
Time to fall asleep	Living place (rural vs. urban)	3.28	0.001	9347.4	0.077	0.055
	Anger	1.99	0.047			
	Health	-2.02	0.044			
	Neuroticism	3.28	0.008			
Wake-up time	Age	-9.12	< 0.001	3558.4	0.185	0.165
	Living place (rural vs. urban)	-3.21	0.001			
	Education	3.35	< 0.001			
	Physical job demands	3.10	0.002			
	Vigor	-2.94	0.003			
	Conscientiousness	-3.22	0.001			
	Openness	2.76	0.006			
	BMI	-2.14	0.032			

Discussion

This study provides valuable insights into the key factors that affect sleep quality and duration. The most significant factors identified include age, living environment, education level, mood (including vigor, fatigue, and anger), personality traits, physical demands of the job, overall health, and body mass index (BMI). It is somewhat surprising that logical thinking, emotional intelligence, perceived stress, depression, and happiness are not directly related to sleep parameters. Studies indicate that moderate to vigorous physical activity (MVPA) during work hours and sedentary behavior do not affect sleep parameters, while MVPA during leisure time is directly associated with sleep duration.

Future research should focus on personalized sleep interventions, especially those aimed at reducing stress, optimizing the balance of physical activity between leisure and work, and managing body weight to improve sleep quality. Additional studies should examine how age-related changes in mood and physical activity patterns interact with sleep. This could lead to more effective, evidence-based strategies for enhancing sleep across various demographic groups. These results challenge prior assumptions that cognitive and emotional intelligence contribute to sleep regulation [20, 21], highlighting instead the greater importance of psychological and physical factors.

Our findings differ from previous research that identifies stress as a significant factor impacting sleep quality [11, 22, 23]. In our study, the Perceived Stress Scale (PSS) showed no significant correlation with any of the sleep indicators. However, we found that time taken to fall asleep was significantly affected by the mood variable of anger—specifically, higher levels of anger were associated with longer sleep onset latency. Additionally, higher scores in fatigue and vigor were linked to shorter total sleep duration. Furthermore, increased vigor levels correlated with earlier wake times. In summary, mood seems to be a critical determinant of sleep quality in our sample. Additionally, our study supports the growing body of literature indicating that physical activity has a positive impact on sleep [12, 13]. We found that only leisure-time physical activity improves sleep, while work-related physical activity tends to worsen it. This distinction underscores the need to differentiate between beneficial voluntary or leisure exercise and occupational exertion, which may contribute to fatigue and hinder recovery [19, 20]. These findings support the "physical activity paradox," which highlights that not all physical activity is beneficial for health—particularly when it is obligatory and lacks balance with recovery [41].

Our findings regarding body mass index (BMI) are consistent with previous research that connects body weight to sleep quality [4]. A higher BMI is frequently associated with disrupted sleep due to metabolic and respiratory issues, underscoring the importance of maintaining a healthy weight for achieving optimal sleep health.

We found no significant associations between cognitive abilities—such as logical thinking and emotional intelligence—and sleep quality. This contrasts with earlier studies that suggested cognitive factors could influence sleep behavior [7]. This discrepancy may be due to differences in research methods, highlighting the need for further investigation into the complex relationships among cognition, empathy, and sleep.

Our study revealed an interesting finding: empathy—a cognitive-emotional trait often linked to social understanding and interpersonal sensitivity—did not significantly predict any core sleep parameters. This finding contrasts with some previous research indicating that sleep deprivation might diminish empathic responses [30]. One possible explanation for this discrepancy is that while sleep may influence how empathy is expressed, the trait-level of empathy itself does not directly impact sleep architecture or timing. Our findings indicate that, unlike mood or personality traits such as neuroticism, conscientiousness, and openness, empathy may have a limited effect on nightly sleep behavior. This highlights the importance of distinguishing between traits that affect our sleep and those that are influenced by sleep deprivation.

Our findings support the increasing evidence that personality traits significantly influence sleep regulation. Notably, neuroticism emerged as the strongest predictor of sleep disruptions. This aligns with previous studies that consistently link higher levels of neuroticism to increased sleep disturbances, such as insomnia, nightmares, and reduced sleep continuity [28, 29]. Individuals with high neuroticism also exhibited greater variability in both sleep duration and subjective sleep quality. However, in our study, the personality traits conscientiousness and openness were inversely and directly associated with wake-up time, respectively. These findings highlight the importance of considering personality characteristics, particularly neuroticism conscientiousness and openness when developing personalized interventions to enhance sleep health. Research has shown that neuroticism, the hypothalamic-pituitary-adrenal (HPA) axis, and sleep are linked in a harmful cycle [42]. Neuroticism is connected to poor sleep quality and increased activity of the HPA axis. Conversely, sleep deprivation can disrupt the HPA axis, which may worsen symptoms of neuroticism.

Our findings confirm that sociodemographic factors—especially age, education, gender, and living environment—significantly influence sleep patterns. Older adults reported shorter sleep durations and earlier wake-up times, which aligns with previous studies on age-related circadian changes [10]. Additionally, higher education levels and whether individuals lived in urban or rural settings were associated with different sleep timing patterns, supporting earlier research that links lifestyle factors and environment to sleep behavior. These results highlight the importance of considering sociodemographic context in interventions aimed at improving sleep health.

Limitations. This study offers valuable insights into the factors influencing sleep quality; however, several limitations must be acknowledged. First, the cross-sectional design limits our ability to draw causal inferences, making it difficult to determine whether the identified factors directly affect sleep or if they are consequences of poor sleep. Longitudinal studies are needed to clarify these relationships. Second, self-reported measures of sleep quality and physical activity may introduce recall bias or subjective misinterpretations, which can compromise data accuracy. Future research could benefit from using objective measures for sleep monitoring and activity tracking, such as actigraphy, to enhance reliability. Additional limitations involve potential sampling bias from online self-selection, the lack of objective sleep measures (such as actigraphy), and possible shared-method variance due to dependence on self-reports. Furthermore, we did not investigate specific sleep-related factors, such as insomnia and experiences of bullying during childhood, both of which can impact sleep and mental health outcomes. According to Baldini et al. [43], these factors are significantly associated with an increased risk of suicide among adolescents. A key limitation of this study is that, although several significant predictors were identified, the final models explained only a modest proportion of the variance in sleep outcomes, with adjusted R^2 values ranging from 0.033 to 0.165. This indicates that many other biological, environmental, and social factors influencing sleep were not included in the current analysis. Future research should consider a broader range of variables to enhance explanatory power.

Conclusion

Our findings indicate that sleep indicators are related to various sociodemographic factors, personality traits, overall health, mood profiles, and notably, physical activity during leisure time. However, we did not find any significant connections between sleep indicators and cognitive-emotional abilities, such as emotional intelligence, cognitive reflection, and empathy. Among the sleep indicators, wake-up time proved to be the most predictable outcome, while sleep duration, sleep latency, and bedtime showed only modest explanatory power. Despite these results, the models explained only a limited proportion of the variance, indicating that many complexities related to sleep remain unexplained. This highlights the need for future research to investigate additional biological, environmental, and social factors that may influence sleep.

Abbreviations

ANOVA	Two-way analyses of variance
BFI	Big Five Inventory
BMI	Body mass index
BRUMS-LTU	Brunel Mood Scale – Lithuanian version

CRT	Cognitive Reflection Test
EI	Emotional Intelligence
HPA	Hypothalamic–Pituitary–Adrenal
IPAQ	International Physical Activity Questionnaire
MVPA	Moderate-to-vigorous physical activity
PA	Physical activity
PSQI	Pittsburgh Sleep Quality Index
PSS-10	Perceived Stress Scale
SSREIT	Schutte Self-Report Emotional Intelligence Test

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Author contributions
The author declares that she has no competing interests.

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Data availability
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
Informed consent was obtained from all participants, emphasizing the study's goals, participant anonymity, and the option to withdraw at any time. The study adhered to the Declaration of Helsinki and received approval from Klaipėda University (Protocol No. STIMC-BTMEK-09).

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Author details
[1]V.KavolisTransdisciplinary Research Institute, Vytautas Magnus University, Donelaicio st. 52, Kaunas 44248, Lithuania
[2]Department of Sports, Faculty of Health Sciences, Klaipeda University, Klaipeda 92294, Lithuania
[3]Educational Research Institute, Vytautas Magnus University, Kaunas 44248, Lithuania
[4]Education Academy, Vytautas Magnus University, Kaunas 44248, Lithuania
[5]Department of Holistic Medicine and Rehabilitation, Faculty of Health Sciences, Klaipeda University, Klaipeda 92294, Lithuania
[6]Faculty of Law, Vilnius University, Vilnius 10221, Lithuania
[7]Institute of Psychology, Faculty of Philosophy, Vilnius University, Vilnius 03101, Lithuania

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References

1. Cappuccio FP, D'Elia L, Strazzullo P, Miller MA. Sleep duration and All-Cause mortality: A systematic review and Meta-Analysis of prospective studies. Sleep. 2010;33(5):585–92. https://doi.org/10.1093/sleep/33.5.585.
2. Baranwal N, Yu PK, Siegel NS. Sleep physiology, pathophysiology, and sleep hygiene. Prog Cardiovasc Dis. 2023;77:59–69. https://doi.org/10.1016/j.pcad.2023.02.005.
3. You Y, Chen Y, Fang W, et al. The association between sedentary behavior, exercise, and sleep disturbance: a mediation analysis of inflammatory biomarkers. Front Immunol. 2023;13. https://doi.org/10.3389/fimmu.2022.1080782.
4. Beccuti G, Pannain S. Sleep and obesity. Curr Opin Clin Nutr Metab Care. 2011;14(4):402–12. https://doi.org/10.1097/MCO.0b013e3283479109.
5. Joynt Maddox KE, Elkind MSV, Aparicio HJ, et al. Forecasting the burden of cardiovascular disease and stroke in the united States through 2050—Prevalence of risk factors and disease: A presidential advisory from the American heart association. Circulation. 2024;150(4):e65–88. https://doi.org/10.1161/CIR.0000000000001256.
6. Dong L, Xie Y, Zou X. Association between sleep duration and depression in US adults: A cross-sectional study. J Affect Disord. 2022;296:183–8. https://doi.org/10.1016/j.jad.2021.09.075.
7. You Y, Chen Y, Liu R, et al. Inverted U-shaped relationship between sleep duration and phenotypic age in US adults: a population-based study. Sci Rep. 2024;14(1):6247. https://doi.org/10.1038/s41598-024-56316-7.
8. Buysse DJ. Does It Matter? Sleep. 2014;37(1):9–17. https://doi.org/10.5665/sleep.3298. Sleep Health: Can We Define It?.
9. Hale L, Troxel W, Buysse DJ. Sleep health: an opportunity for public health to address health equity. Annu Rev Public Health. 2020;41:81–99. https://doi.org/10.1146/annurev-publhealth-040119-094412.
10. Sletten TL, Weaver MD, Foster RG, et al. The importance of sleep regularity: a consensus statement of the National sleep foundation sleep timing and variability panel. Sleep Health. 2023;9(6):801–20. https://doi.org/10.1016/j.sleh.2023.07.016.
11. Zhao X, Lan M, Li H, Yang J. Perceived stress and sleep quality among the non-diseased general public in China during the 2019 coronavirus disease: a moderated mediation model. Sleep Med. 2021;77:339–45. https://doi.org/10.1016/j.sleep.2020.05.021.
12. Garber CE, Blissmer B, Deschenes MR, et al. Quantity and quality of exercise for developing and maintaining Cardiorespiratory, Musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. Med Sci Sports Exerc. 2011;43(7):1334. https://doi.org/10.1249/MSS.0b013e318213fefb.
13. Kredlow MA, Capozzoli MC, Hearon BA, Calkins AW, Otto MW. The effects of physical activity on sleep: a meta-analytic review. J Behav Med. 2015;38(3):427–49. https://doi.org/10.1007/s10865-015-9617-6.
14. Skurvydas A, Zlibinaite L, Solianik R, et al. One night of sleep deprivation impairs executive function but does not affect psychomotor or motor performance. Biol Sport. 2020;37(1):7–14. https://doi.org/10.5114/biolsport.2020.89936.
15. Skurvydas A, Kazlauskaite D, Zlibinaite L, Cekanauskaite A, Valanciene D, Karanauskiene D, Zuoziene IJ, Majauskiene D, Mickeviciene D, Satas A. Effects of two nights of sleep deprivation on executive function and central and peripheral fatigue during maximal voluntary contraction lasting 60s. Physiol Behav. 2021;229:113226. https://doi.org/10.1016/j.physbeh.2020.113226.
16. Skurvydas A, Lisinskiene A, Lochbaum M, et al. Physical Activity, Stress, Depression, emotional Intelligence, logical Thinking, and overall health in a large Lithuanian from October 2019 to June 2020: age and gender differences adult sample. Int J Environ Res Public Health. 2021;18(23):12809. https://doi.org/10.3390/ijerph182312809.
17. Skurvydas A, Lisinskiene A, Majauskiene D, et al. Do physical Activity, BMI, and wellbeing affect logical thinking? Int J Environ Res Public Health. 2022;19(11):6631. https://doi.org/10.3390/ijerph19116631.
18. Majauskiene D, Istomina N, Valanciene D, et al. Factors influencing students' happiness, vitality, and self-esteem. Front Psychol. 2024;15. https://doi.org/10.3389/fpsyg.2024.1463459.
19. Skurvydas A, Istomina N, Dadeliene R, et al. Mood profile in men and women of all ages is improved by leisure-time physical activity rather than work-related physical activity. BMC Public Health. 2024;24(1):546. https://doi.org/10.1186/s12889-024-17806-5.
20. Skurvydas A, Istomina N, Dadeliene R, et al. Leisure-time physical activity improves happiness, health, and mood profile better than work-related physical activity. PLoS ONE. 2024;19(7):e0307744. https://doi.org/10.1371/journal.pone.030774.
21. Laborde S, Dosseville F, Allen MS. Emotional intelligence in sport and exercise: A systematic review. Scand J Med Sci Sports. 2016;26(8):862–74.
22. Goldstein AN, Walker MP. The role of sleep in emotional brain function. Annu. Rev. Clin. Psychol. 2014;10(Vol. 10, 2014):679–708. https://doi.org/10.1146/annurev-clinpsy-032813-153716.
23. Palmer CA, Alfano CA. Sleep and emotion regulation: an organizing, integrative review. Sleep Med Rev. 2017;31:6–16. https://doi.org/10.1016/j.smrv.2015.12.006.
24. Sharon O, Simon EB, Shah VD, Desel T, Walker MP. The new science of sleep: from cells to large-scale societies. PLoS Biol. 2024;22(7):e3002684. https://doi.org/10.1371/journal.pbio.3002684.

25. Medic G, Wille M, Hemels ME. Short- and long-term health consequences of sleep disruption. Nat Sci Sleep. 2017;9:151–61. https://doi.org/10.2147/NSS.S134864.
26. Vallat R, Berry SE, Tsereteli N, et al. How people wake up is associated with previous night's sleep together with physical activity and food intake. Nat Commun. 2022;13(1):7116. https://doi.org/10.1038/s41467-022-34503-2.
27. Ben Simon E, Vallat R, Barnes CM, Walker MP. Sleep loss and the Socio-Emotional brain. Trends Cogn Sci. 2020;24(6):435–50. https://doi.org/10.1016/j.tics.2020.02.003.
28. Guerreiro J, Schulze L, Garcia i Tormo A, et al. The relationship between big five personality traits and sleep patterns: A systematic review. Nat Sci Sleep. 2024;16:1327–37. https://doi.org/10.2147/NSS.S467842.
29. Križan Z, Hisler G. Personality and sleep: neuroticism and conscientiousness predict behaviourally recorded sleep years later. Eur J Pers. 2019;33(2):133–53. https://doi.org/10.1002/per.2191.
30. Gordon-Hecker T, Choshen-Hillel S, Ben-Simon E, Walker MP, Perry A, Gileles-Hillel A. Restless nights, cold hearts: poor sleep causally blunts empathy. Int J Clin Health Psychol. 2025;25(1):100548. https://doi.org/10.1016/j.ijchp.2025.100548.
31. Youssef FF, Dookeeram K, Basdeo V, Francis E, Doman M, Mamed D, Maloo S, Degannes J, Dobo L, Ditshotlo P, Legall G. Stress alters personal moral decision making. Psychoneuroendocrinology. 2012;37(4):491–8. 10.1016.
32. Bartels DM, Pizarro DA. The mismeasure of morals: antisocial personality traits predict utilitarian responses to moral dilemmas. Cognition. 2011;121(1):154–61.
33. Craig CL, Marshall AL, Sjöström M, et al. International physical activity questionnaire: 12-Country reliability and validity. Med Sci Sports Exerc. 2003;35(8):1381. https://doi.org/10.1249/01.MSS.0000078924.61453.FB.
34. Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. J Health Soc Behav. 1983;24(4):385–96.
35. Schutte NS, Malouff JM, Hall LE, et al. Development and validation of a measure of emotional intelligence. Pers Indiv Differ. 1998;25(2):167–77. https://doi.org/10.1016/S0191-8869(98)00001-4.
36. Terry PC, Skurvydas A, Lisinskiene A, et al. Validation of a Lithuanian-Language version of the Brunel mood scale: the BRUMS-LTU. Int J Environ Res Public Health. 2022;19(8):4867. https://doi.org/10.3390/ijerph19084867.
37. John OP, Donahue EM, Kentle RL. The big five inventory - Versions 4a and 54. University of California, Berkeley, Institute of Personality and Social Research.; 1991.
38. Buysse DJ, Reynolds CF, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh sleep quality index: A new instrument for psychiatric practice and research. Psychiatry Res. 1989;28(2):193–213. https://doi.org/10.1016/0165-1781(89)90047-4.
39. Greene JD, Nystrom LE, Engell AD, Darley JM, Cohen JD. The neural bases of cognitive conflict and control in moral judgment. Neuron. 2004;44(2):389–400. https://doi.org/10.1016/j.neuron.2004.09.027.
40. Frederick S. Cognitive reflection and decision making. J Economic Perspect. 2005;19(4):25–42. https://doi.org/10.1257/089533005775196732.
41. Holtermann A, Krause N, van der Beek AJ, Straker L. The physical activity paradox: six reasons why occupational physical activity (OPA) does not confer the cardiovascular health benefits that leisure time physical activity does. Published Online Febr. 2018;1. https://doi.org/10.1136/bjsports-2017-097965.
42. Nicolaides NC, Vgontzas AN, Kritikou I, Chrousos G. November 24). HPA axis and sleep. In: De Groot LJ, et al. editors. Endotext [Internet]. MDText.com, Inc.; 2020.
43. Baldini V, Gnazzo M, Maragno M, Biagetti R, Stefanini C, Canulli F, Varallo G, Donati C, Neri G, Fiorillo A, Plazzi G. Suicidal risk among adolescent psychiatric inpatients: the role of insomnia, depression, and social-personal factors. Eur Psychiatry. 2025;68(1):e42.

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