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## The importance of sleep in selected diseases

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# Abstract

Introduction: There are specific differences in physiological and biochemical processes during sleep. Adenosine and melatonin are involved in the regulation of circadian rhythms. During sleep, you can observe the secretion of growth hormone, a reduction in cortisol secretion, and a decrease in muscle tone and blood pressure. Sleep can have a major impact on the development of systemic diseases.

Aim of the study: A review of the literature aimed at identifying selected negative factors influencing the quality of sleep and systemic diseases which are related to sleep disorders.

State of knowledge: Factors that negatively affect sleep include stress, as well as excessive time spent in front of light-emitting screens. Long-term lack of sleep increases the risk of obesity, diabetes, cardiovascular diseases and psychiatric diseases.

Summary: Sleep plays an important role in the proper functioning of the body. Its quality is affected by many factors. Sleep disorders can be both the effect and cause of many diseases. Especially in diagnosing psychiatric diseases, attention should be paid to the occurrence of sleep disorders.

# Key words: sleep, stress, mobile phone, obesity, atrial fibrillation, mental diseases

#### Introduction

The functioning of the human body is based on an approximately 24-hour repeating rhythm, which is called the diurnal cycle. The diurnal cycle is regulated by an endogenous biological pacemaker which is the suprachiasmatic nucleus located in the anterior part of the hypothalamus [1]. The diurnal cycle determines the most favorable time for sleep.

The exact significance of sleep in human physiology is still not well understood. However, it is known that there are specific variations in physiological and biochemical processes during sleep. One of the better understood chemical compounds associated with sleep is adenosine. During the waking period, adenosine concentrations increase continuously and signal the need for sleep (somnogenic effect). However, during sleep adenosine is broken down [2].

The diurnal rhythm is also closely related to the level of melatonin in the bloodstream. Melatonin is a sleep-regulating hormone produced mainly in the pineal gland. The synthesis of this hormone is blocked by stimulation from the suprachiasmatic nucleus due to stimulation of visual receptors by ambient light. The increased need for sleep usually occurs about 2 hours after the onset of melatonin secretion. Diseases such as diabetic neuropathy or Alzheimer's disease and certain medications such as  $\beta$ -blockers or non-steroidal anti-inflammatory drugs interfere with melatonin production and may be associated with sleep disturbances [3].

An important aspect of the role of sleep in human functioning is the changes in hormone levels in the blood. For example, during sleep, growth hormone (GH) is secreted, which affects carbohydrate metabolism and through insulin-like growth factors stimulates anabolic processes. Another hormone that exhibits circadian rhythmicity is cortisol - its level drops sharply the most in the middle of the biological night and rises sharply in the morning [4].

During sleep, there is also a decrease in blood pressure, a decrease in respiratory rate, and a decrease in body fluid pH and muscle tone. A decrease of approximately 10-20% in blood pressure during sleep is considered normal [5, 6].

Sleep also affects the immune system, because during sleep some cytokines are released, for example interleukin 12, which is a component of the inflammatory process. When the amount of sleep is disturbed, the production of cytokines and antibodies involved in fighting infection may be reduced [7].

An important aspect of sleep is the reduction of basal metabolism by approximately 15% [8]. Sleep deprivation can affect glucose metabolism and levels of certain hormones - decreasing leptin levels and increasing ghrelin levels, which can lead to metabolic disorders. Therefore, long-term sleep deprivation increases the risk of obesity, diabetes, and cardiovascular disease [9].

Sleep also plays a role in neurogenesis and the formation of connections between nerve cells, which affects learning and memory. It has been proven that lack of sleep leads to impaired neurogenesis and results in decreased hippocampal volume, ultimately leading to increased risk of cognitive impairment and psychiatric diseases [10].

The amount of sleep requirement is an individual factor. Specific genes such as the Clock gene at the molecular level are involved in the regulation of the human diurnal rhythm. Studies show a correlation between abnormal expression of these genes and the risk of bipolar disorder, depression, autism spectrum disorders, schizophrenia, anxiety disorders and attention deficit hyperactivity disorder [11].

#### Factors negatively affecting sleep

Stress

There is a high prevalence of stress reported among medical students worldwide [12]. University students represent a subset of the global population that appears to be at higher risk for poor sleep quality [13]. During the academic course, the student is constantly confronted with various situations that cause psychological pressure and anxiety [13]. This may be influenced by factors such as an extensive curriculum, numerous academic demands, and frequent and difficult exams [12]. High levels of perceived anxiety have a negative impact on attention, memory, and problem-solving skills [13]. Additionally, medical students may not prioritize sleep - by the demands placed on them, they reduce their sleep time in order to have extra hours to study and work. Thus, they develop poor sleep habits, especially in the run-up to exams [12].

Studies show that students experiencing high stress during long studies are more likely to have sleep disorders [14]. This is a cause for concern because it can carry negative consequences such as adverse effects on quality of life, emotional and physical health, and learning [12]. In addition, the irregularity of the sleep-wake cycle caused by school schedules and academic demands seems to contribute to an increased state of anxiety [13].

Although some studies have shown that a certain level of stress has a good effect on physiological functioning and can facilitate learning (so-called favorable stress), it is well documented that high levels of stress (so-called anxiety or adverse stress) have a negative effect on the physical and mental health of students [12].

Studies conducted in the United States, Australia, India, and other countries have shown that students with poor sleep quality had poorer exam grades and were more depressed than their peers [12]. Although poor sleep quality has been proven to be associated with lack of concentration, impaired memory function, and poor academic performance, students with sleep problems may not be fully aware that lack of sleep can negatively affect exam preparation and performance and impair their ability to perform cognitively [12].

In a study conducted by Abdullah I. Almojali et al. [12] 263 medical students completed a questionnaire consisting of three parts: the first focusing on demographic and lifestyle information, the second, which was The Kessler Psychological Distress Scale (K10), and the third, the Pittsburgh Sleep Quality Index (PSQI).

The study showed that according to the K10 scale, mild stress was experienced by 61 students (23.2%), moderate stress was experienced by 35 students (13.3%), and severe stress was experienced by 44 students (16.7%), while the prevalence of poor sleep quality (PSQI score $\geq$ 5) among the surveyed students was 76% (n=200). In addition, we found that a larger proportion of the subjects (73.4%, n=193) slept less than seven hours per night - the average time was 5.8 ± 1.3 hours of actual sleep. It is noteworthy that only 32.3% (n=84) of the students explicitly stated that their sleep quality was fairly bad or very bad, while the majority (67.7%, n=176) rated their sleep quality as fairly good or very good. Participants' responses to the question, "how often have you had trouble sleeping for other reasons, please describe," were most commonly related to stress, with 47% of responses providing explanations such as nightly repetition, thinking about the future, working on a research project, and anxiety about exams. Justifications such as cell phone use and social media browsing (16%), excessive noise (11%), and taking naps in the evening or afternoon (8%) were the next most popular.

This study found a statistically significant association between stress and poor sleep quality, while there was no significant association between stress and gender, academic year, grade point average, coffee, tea or energy drink consumption [12].

Many studies [15, 16, 17] have shown that sleep and stress are closely related to the hypothalamic-pituitary-adrenal (HPA) axis, which may explain the close relationship

between these two factors. Sleep deprivation, as a stressor, has a pronounced effect on sleep architecture and circadian rhythms [12].

Based on the findings of Abdullah I. Almojali et al. [12] medical students should be educated on sleep hygiene and the negative consequences of poor sleep quality, additionally there should be academic counseling centers that focus on promoting good sleep hygiene and enhancing learning skills and coping with stressful environments.

Cell phones and television

Today's youth are surrounded by media products such as televisions, computers, electronic games, the Internet, and the cell phone. Evidence suggests that many young people regularly surf the Internet or watch television shows, which often leads to a decline in their sleep quality [15, 16]. According to psychologists and sociologists, addictive Internet use is identified as a behavioral problem that affects sleep quality and that sleep, as an essential component of development, can significantly affect thinking, behavior, and emotional wellbeing [18].

Although television and computers are similar in the intensity of light displayed, they differ in the way they are used. In front of a television, viewers typically sit or lie down in a comfortable position about three meters from the screen, changing channels with a remote control [19].

When using computer displays and cell phones, users are very close to the light they emitfifty to seventy centimeters from the screen [15, 17]. In addition, the operation of these devices is active, involving both the mental and physical operator [19].

Light-stimulated retinal cells transmit electrical signals to the hypothalamus, which is essential in regulating sleep and wake cycles and rhythms. The strength and variability of the light emitted by the aforementioned devices and the duration of light exposure to the retina interfere with the body's normal release of melatonin (a hormone that controls sleep), causing changes in the quality of sleep. These biological effects can cause sleep deprivation and disrupt diurnal rhythms, affecting productivity, health, and safety [19].

The use of light-emitting electronic devices before bedtime has been shown to increase the time to fall asleep, affect the diurnal rhythm, suppress melatonin levels, delay entry into REM phase, and affect the frequency of REM phase during sleep. Studies have shown that light exposure before 24:00 leads to delays in the diurnal phase, while exposure after 24:00 triggers phase progression, thus altering sleep cycles [19].

Sleep is critical to maintaining physical and mental health [20]. Many adolescents use cell phones at night, exposing themselves to shortwave light, which can affect sleep and neurobehavioral function. Chronic, inappropriate exposure to shortwave light causes the diurnal timing system to malfunction, resulting in sleep problems and depressive symptoms. Researchers have reported a potential link between cell phone use and psychological symptoms in college students, suggesting that depression and sleep disturbances were a consequence of high rates of information and communication technology use. Furthermore, the study suggested that there may be a causal relationship between sleep patterns and mental health in adolescents, which showed that late bedtime and short sleep duration may result in anxiety and depression. The mechanism through which short sleep affects adolescents' emotional and behavioral functioning may involve increased negative mood and decreased ability to regulate emotions [20, 21].

### **Obesity and sleep disorders**

Obesity is currently known as a global epidemic. WHO claims that there are approximately 552 millions obese people in the world and 1.6 billion overweight people [22]. Poor quality of sleep may be a consequence and a cause of obesity. Studies show that people with higher BMI sleep longer and have episodes of daytime sleepiness. Their quality of sleep is poorer [23]. During sleep, the body regulates the levels of hormones produced by adipose

tissue. Sleeping too little may lead to decrease of leptin levels which is a hormone that suppresses appetite. The lack of sleep may also increase the levels of ghrelin which leads to gastric secretion and stimulates the appetite [24]. In a study conducted on 65 000 women, it was shown that women sleeping 7 hours per day are 15% less likely to develop obesity than women sleeping 5 or less hours per day [25]. In another study, it was demonstrated that every additional hour of sleep reduces the risk of obesity by 30% [26]. Reducing the amount of sleep has been shown to increase the desire to consume products with higher energy density and high carbohydrate content [25, 26, 27]. It is important to mark that stress plays a significant role in obesity and sleep disorders. Sleeping too little reduces the body's resistance to stressful situations. Eating is a way to relieve tension and negative emotions. Chronic stress may increase the appetite and disturb the metabolism [28].

### Atrial fibrillation and sleeping disorders

Atrial fibrillation (AF) is the most frequent supraventricular tachyarrhythmia. AF occurs in about 1% of adults, more often in men. The incidence of AF increases with age and it is found in about 10% of people over 80 years old [29, 30]. Many studies confirmed the relation between sleep disorders and increased incidence of arterial hypertension and ischemic heart disease. These diseases may also be the cause of AF [31, 32, 33]. Most authors claim that development of these diseases may be connected to disturbed breathing during sleep. During the NREM (non-rapid eve movement) phase, the activity of the sympathetic nervous system decreases and the influence of the parasympathetic system increases. It decreases heart rate and blood pressure. The activity of the sympathetic nervous system increases with the REM (rapid eye movement) phase of sleep [34]. Excessive activation of the sympathetic nervous system may be caused by sleep deprivation [35]. Several studies have shown that short-term sleep deficiency may cause excessive activation of the sympathetic nervous system and sleep deprivation is related to an increase of norepinephrine concentration in the urinary [36, 37]. According to different studies, sleep disorders are associated with a decline in plasma levels of norepinephrine and epinephrine as well as a reduction in heart rate. However, all scientists agree that sleep disorders are a reason for the abnormal function of the autonomic system. It may contribute to atrial fibrillation [38].

### Mental diseases and sleep disorders

Sleep disorders associated with mental disorders may manifest as excessive somnolence, insomnia or sleep disturbances [39]. They may be a significant clinical symptom or an undesirable symptom of the applied therapy [39, 40]. There is no clear evidence that sleep disorders are the cause of depression, but it is already known that their analysis becomes an extremely useful indicator for assessing the risk of developing depression and the risk of relapse after remission [41].

Patients suffering from depression report symptoms such as: difficulty in falling asleep, insomnia, lack of rest and regeneration after sleep [41, 42]. The image of sleep disorders will affect primarily the kind of depressive disorders. The more endogenous factors contribute to their formation, the deeper and more persistent sleep disturbances will be, and the specific symptom will then be too early waking up. Difficulties with falling asleep will dominate in reactive disorders [43]. The etiology of both insomnia and depression is unknown. In both cases one can speak of genetic predispositions to disclose symptoms and significant role in the stress and life events [41]. During manic disorders, insomnia also occurs, which is manifested by shortening the length of sleep and a problem with its initiation [39].

The studies demonstrated that children with depression, which are struggling with sleep disorders, compared with those not struggling with sleep disorders had a higher severity of depressive symptoms and had comorbid anxiety disorders [40]. Moreover, studies conducted among children aged 13–16 and adults have shown that patients reporting suicidal

thoughts were more likely to experience insomnia and nightmares than those who denied suicidal thoughts [44, 45]. In connection with the primary prevention of suicides draws attention to the need to monitor the quality of sleep in patients [41].

### Summary

Sleep has a significant impact on the functioning of the human body. Literature indicates that stress and blue light emitted by screens negatively affect sleep quality. Sleep deprivation lowers the body's resistance to stressful situations, while chronic stress can increase appetite and disrupt metabolism. The result can be obesity. At the same time, obesity can also be a cause of sleep disorders, as people with a high BMI sleep longer and their sleep quality is reduced. Studies also confirm a link between the presence of sleep disorders and an increased risk of hypertension and ischemic heart disease. This is due to impaired breathing during sleep. Sleep disorders also have a strong association with mental illness. Their analysis is an important part of assessing the risk of developing depression and the risk of relapse after remission. Sleep disturbances occur in depression, reactive disorders and manic episodes. In light of the facts cited above, it can be concluded that sleep is not only a physiological need, but also its quality can be helpful in diagnosing many disorders.

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