International Journal of Innovative Technologies in Social Science

e-ISSN: 2544-9435

Scholarly Publisher
RS Global Sp. z O.O.
ISNI: 0000 0004 8495 2390

Dolna 17, Warsaw,
Poland 00-773
+48 226 0 227 03
editorial_office@rsglobal.pl

ARTICLE TITLE	THE IMPORTANCE OF SLEEP AND THE CONSEQUENCES OF SLEEP DEPRIVATION
DOI	https://doi.org/10.31435/ijitss.4(48).2025.4375
RECEIVED	26 October 2025
ACCEPTED	26 December 2025
PUBLISHED	30 December 2025
LICENSE	The article is licensed under a **Creative Commons Attribution 4.0 International License.**

THE IMPORTANCE OF SLEEP AND THE CONSEQUENCES OF SLEEP DEPRIVATION

Dominika Walczak *(Corresponding Author, Email: dominikajwalczak@gmail.com)*
4th Military Clinical Hospital with Polyclinic SPZOZ in Wrocław, Wrocław, Poland
ORCID ID: 0009-0007-1629-871X

Adrian Kruk
Independent Public Provincial Combined Hospital in Szczecin, Szczecin, Poland
ORCID ID: 0009-0001-1749-6159

Aleksander Białoń
University Hospital in Krakow, Kraków, Poland
ORCID ID: 0009-0007-4447-7619

Weronika Ewa Nowak
Jan Mikulicz-Radecki University Clinical Hospital, Wrocław, Poland
ORCID ID: 0009-0006-8445-2072

Paweł Harbut
Medical University of Silesia in Katowice, Katowice, Silesia, Poland
ORCID ID: 0009-0001-0405-4407

Lidia Jurczenko
4th Military Clinical Hospital with Polyclinic SPZOZ in Wrocław, Wrocław, Lower Silesia, Poland
ORCID ID: 0009-0005-5075-629X

Igor Gawłowski
5th Military Clinical Hospital with Polyclinic in Kraków, Kraków, Poland
ORCID ID: 0009-0007-8895-4237

Aleksandra Dorosz
Lower Silesian Center of Oncology, Pulmonology, and Hematology in Wrocław, Wrocław, Poland
ORCID ID: 0009-0001-4956-5702

Katarzyna Jakubowska
4th Military Clinical Hospital with Polyclinic in Wrocław, Wrocław, Poland
ORCID ID: 0009-0006-6542-8309

Aleksandra Miśta
Provincial Specialist Hospital in Wrocław, Wrocław, Poland
ORCID ID: 0009-0007-1389-2596

ABSTRACT

Sleep is a fundamental biological process regulated by the circadian rhythm and is governed by complex neural mechanisms involving various brain regions and neurotransmitters. It consists of non-rapid eye movement (NREM) and rapid eye movement (REM) stages, each playing a distinct role in physiological and cognitive restoration. One leading theory, the Synaptic Homeostasis Hypothesis, suggests that sleep serves to rebalance synaptic strength accumulated during wakefulness, thereby preserving cognitive efficiency and promoting memory consolidation. Optimal sleep varies with age and is essential for maintaining physical, cognitive, and emotional health. However, modern lifestyles, characterized by increased screen time, irregular schedules, and a 24/7 work culture have contributed to widespread sleep deprivation, particularly among adolescents, shift workers, and high-demand professionals. Sleep deprivation, whether partial or total, is linked to a wide range of adverse health outcomes, including obesity, cardiovascular disease, cognitive decline, and increased accident risk. Chronic sleep deprivation also significantly impacts executive function and has been associated with sleep disorders such as obstructive sleep apnea, which further exacerbate health risks. Objective measures like actigraphy and EEG provide valuable insights into sleep quality and fragmentation beyond self-reported duration.

KEYWORDS

Sleep, Sleep Deprivation, Circadian Rhythm, Shift Workers, SHY

CITATION

Dominika Walczak, Adrian Kruk, Aleksander Białoń, Weronika Ewa Nowak, Paweł Harbut, Lidia Jurczenko, Igor Gawłowski, Aleksandra Dorosz, Katarzyna Jakubowska, Aleksandra Miśta. (2025). The Importance of Sleep and the Consequences of Sleep Deprivation. *International Journal of Innovative Technologies in Social Science*. 4(48). doi: 10.31435/ijitss.4(48).2025.4375

Introduction:

Sleep is a universal, essential biological process. It is categorized based on behavioural and physiological features into two main types: non-rapid eye movement (NREM) sleep, which consists of three stages (N1, N2, N3), and rapid eye movement (REM) sleep, which is marked by quick eye movements, muscle atonia and irregular brain activity seen on EEG. Circadian rhythm of sleep-wakefulness is regulated by the body's internal clock located in the suprachiasmatic nuclei of the hypothalamus. The brain regions involved in NREM sleep are primarily found in the ventrolateral preoptic nucleus of the hypothalamus, whereas those of REM sleep are located in pons. During sleep, various physiological processes across different organ systems undergo significant changes due to functional alterations in both the autonomic and somatic nervous systems. [1]

Methodology:

The literature used in this review was obtained through a narrative search of PubMed and Google Scholar. Publications from 2002 to 2025 were considered. Preference was given to articles focused on sleep deprivation.

Discussion:

Sleep is a complex process that is strictly controlled by various neurotransmitters. The transition between wakefulness and sleep depends on the right balance between glutamate and GABA, which stimulate or inhibit specific areas of the brain. Acetylcholine also plays an important role – it is responsible for maintaining wakefulness and influences the transition to the REM phase. Efficient switching between wakefulness and sleep, as well as between the NREM and REM phases, is essential for the proper functioning of the body. These changes are regulated by mutually inhibiting brain centres, and the mechanism itself is compared to a flip-flop switch, which allows for quick and unambiguous changes of state without transitional phases. Disruptions in this mechanism can lead to sleep fragmentation or narcolepsy. [2]

The Synaptic Homeostasis Hypothesis

The reason we need sleep seems fairly obvious: without it, we feel exhausted, irritable, and our cognitive abilities decline. After sleeping well, both mind and body feel rejuvenated, and we return to normal functioning. Yet, pinpointing exactly what processes sleep restores has been more difficult to determine. Sleep takes up a significant portion of our daily lives, is present throughout all stages of life from infancy to old age and has been observed in every carefully studied species, from fruit flies to humans. It is characterized by a temporary detachment from the surroundings, often paired with stillness. Given the dangers of reduced alertness and the lost opportunities for more active behaviours, the fact that the brain regularly enters this "offline" state suggests that sleep must fulfil a crucial biological role. The Synaptic Homeostasis Hypothesis (SHY) suggests that sleep's core function is to restore a balance in the synaptic strength, which becomes disrupted due to learning-related synaptic strengthening during wakefulness and synapse formation during development. [3] In essence, sleep is viewed as the "cost of plasticity." Strengthened synapses come with several drawbacks, such as increased energy demands, greater need for cellular resources at synapses, resulting in cellular stress, and changes in the supporting cells like glia. Moreover, heightened synaptic strength can impair the precision of neuronal responses and limit the brain's capacity to absorb new information. Sleep helps to restore optimal synaptic strength, easing the strain on the neurons and the surrounding cells. This process improves the specificity of the neural responses and the brain's ability to learn, boosts signal-to-noise ratios, and ultimately promotes the consolidation and integration of memories. [4]

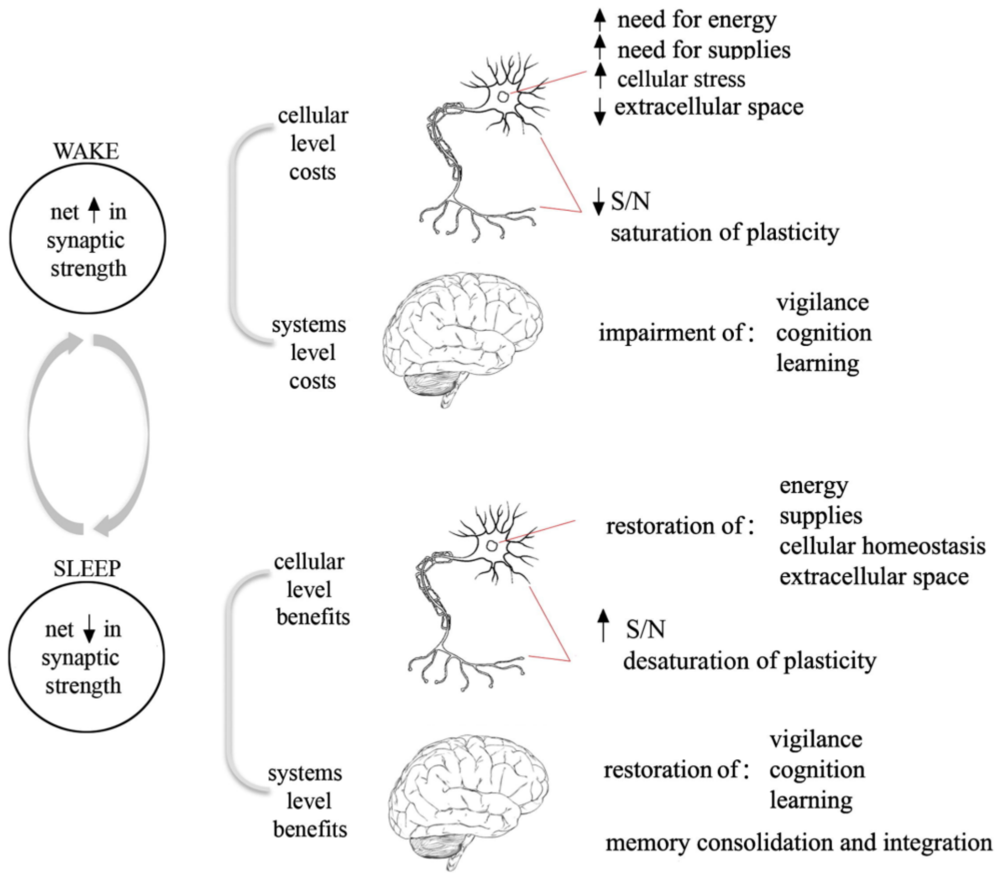

Fig. 1. *The Synaptic Homeostasis Hypothesis. Tononi G, Cirelli C.(2003) Sleep and synaptic homeostasis: a hypothesis. Brain Res Bull.; 62:143–150. doi:10.1016/j.brainresbull.2003.09.004. PMID: 14638388*

During wakefulness, the brain engages with the external world (the "grand loop") and processes only a limited set of inputs, determined by ongoing experiences—like meeting someone new. High levels of neuromodulators, such as noradrenaline from the locus coeruleus (LC), help ensure that any surprising or significant coincidences within this limited input range are transmitted through the brain, strengthening relevant synaptic connections. During sleep, in contrast, the brain is cut off from external sensory and motor input. This disconnection allows for the internal reactivation of the stored information, offering a broad sampling of past knowledge, including older memories about people and places. Neuromodulator levels drop, and neurons fire in synchronized ON/OFF patterns characteristic of NREM sleep (e.g., slow waves, spindles, and sharp-wave ripples). These conditions support synaptic down-selection: connections in well-integrated, frequently used circuits—especially those reinforced during wakefulness or strongly linked to past memories—are preserved. Meanwhile, weaker or rarely activated connections, particularly those that don't align well with existing knowledge, are gradually weakened and may eventually be pruned over a successive sleep-wake cycle. [4][5][6]

Sleeping norms

For sleep to effectively restore the body, it must fulfil a person's individual sleep requirements, be of a sufficient length, and maintain an adequate quality, which is age-dependent. [7, 8] Although the amount of sleep children need differs by child, recommendations cited by the Centers for Disease Control and Prevention are for 12 to 14 hours for children aged 1 to 3 years, decreasing to 11 to 13 hours for children aged 3 to 5, to 10 to 11 hours for children aged 5 to 10, and to 8½ to 9½ hours for adolescents [9].

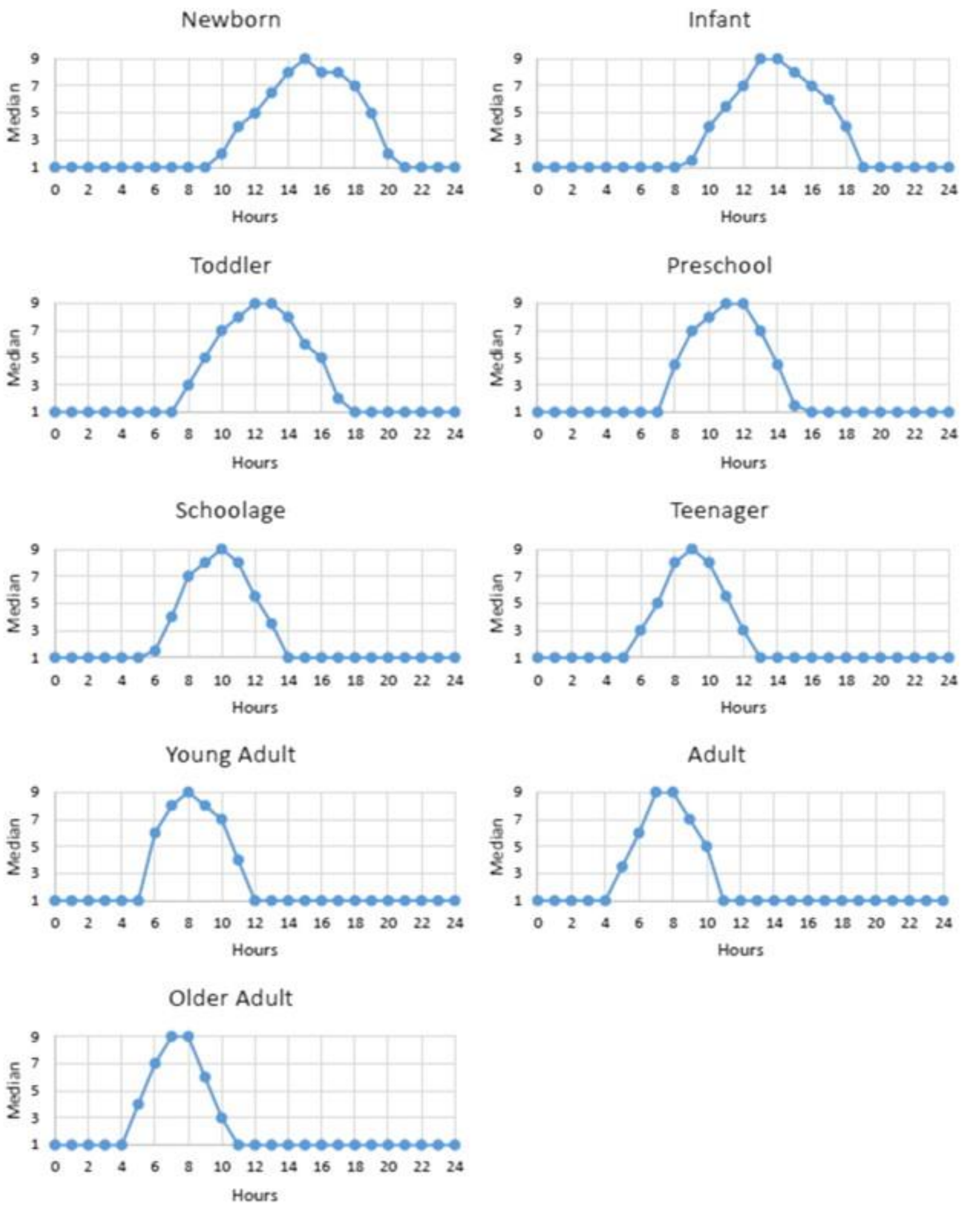

Fig. 2. *Hirshkowitz et al.Sleep Health: Journal of the National Sleep Foundation October 31, 2015 Retrieved from URL: https://pubmed.ncbi.nlm.nih.gov/29073412/*

During adolescence, sleep-wake patterns evolve as changes in the sleep regulation take place. These changes, influenced by the ongoing maturation of a physiological, psychological, and cognitive functioning, as well as shifts in circadian rhythm, lead to a greater tolerance for insufficient sleep in adulthood. This stage of life, marked by rapid growth and maturation, also brings numerous challenges related to both sleep and nutrition. [8] Although there is increasing focus on the importance of healthy sleep, a significant number of adults in the U.S. do not achieve the recommended sleep duration. As a result, enhancing sleep quality and duration has become a national priority with serious health and economic consequences. [10] Research increasingly shows that racial and ethnic minority populations are disproportionately impacted by sleep and circadian rhythm disruptions, which in turn contribute to existing disparities in chronic disease. The modern 24/7 lifestyle, amplified by widespread use of digital devices and social media, has made insufficient sleep common among children and adolescents, with potentially harmful effects on brain development, mental well-being, and cardiovascular health. [11] Moreover, recent studies have linked sleep deprivation to poor cardiometabolic outcomes, cognitive health impairments, and an increased risk of dementia in older adults, highlighting sleep as a modifiable risk factor in the 21st century. Consequently, improving sleep may play a crucial role in alleviating the burden of chronic illnesses. [12]. Additionally, regularly sleeping fewer than 7 hours per night has been linked to a range of negative health effects, including weight gain, obesity, diabetes, high blood pressure, heart disease, stroke, depression, and a higher risk of early death. An inadequate sleep is also associated with a weakened immune function, increased sensitivity to pain, reduced performance, more frequent mistakes, and a greater risk of accidents. [13]

Sleep deprivation

Sleep deprivation (SD) can be categorized into partial and total SD. Partial SD involves a shortened or disrupted night of sleep, while total SD refers to a complete lack of sleep for at least one night within the typical sleep-wake cycle. Total sleep deprivation is often the focus of research, likely because it allows easier tracking of the brain activity, as extended periods without sleep tend to lead to more noticeable cognitive impairments. However, research suggests that a chronic sleep restriction over time may have more detrimental effects than a single night of total sleep loss. [14,15] There are three key reasons why the concept of "quality over quantity" in sleep may be particularly relevant when considering a cognitive function. Firstly, a self-reported sleep duration can be prone to various biases, which may cause extreme values to actually reflect poor sleep quality rather than true differences in sleep length. [16] Secondly, conditions that negatively impact sleep quality are often also linked to reduced cognitive performance, potentially complicating the relationship between sleep and executive functioning. For instance, people with obstructive sleep apnea (OSA) frequently experience repeated awakenings during the night due to brief pauses in breathing. OSA is commonly associated with obesity and treatment-resistant hypertension, both of which are known risk factors for a cognitive decline, partly due to their effects on the brain's small blood vessels. [17,18] Thirdly, sleep patterns naturally change with age. The sleep efficiency defined as the proportion of time spent asleep between initially falling asleep and waking up in the morning, typically drops from about 89% in middle age to 79% by age 70. [19] Since cognitive abilities also tend to decline with age, especially in later years, it becomes challenging but essential to separate the effects of aging, sleep quality, and other contributing factors.

Several studies have explored the link between sleep quality and executive function using various methods. Actigraphy uses a wearable device that measures movements when going to bed to assess parameters like total sleep time (TST), sleep onset latency (SOL), wake after sleep onset (WASO), and general restlessness to gauge quality of sleep. EEG studies tend to use time in slow wave sleep (SWS), rapid eye movement sleep (REM), and non-REM sleep (nREM), as well as the presence and density of sleep spindles. [20] Other studies rely on participants reporting whether or not they had a restful and restorative sleep. Together, these may be used to give an indication of 'sleep quality', or of 'sleep fragmentation', rather than self-reported sleep duration. [21]

Sleep deprivation among workers

Chronic sleep deprivation is common in several professions, including medical residents, military personnel, and shift workers. Studying the effects of limited sleep can offer valuable insights—not only regarding the nature and function of sleep but also of practical importance for enhancing the health performance of individuals who are required to function effectively despite experiencing a minimal or disrupted sleep. [22] Shift work plays a vital role in maintaining the continuous operation of modern, 24/7 society, particularly in sectors such as healthcare, emergency services, hospitality, transportation, and manufacturing. To track global patterns in working conditions, the International Labour Organization and the

European Foundation for the Improvement of Living and Working Conditions conducted a study across 187 countries, covering around 1.2 billion workers (Eurofound and International Labour Organization, 2019). Their findings revealed that between 10% and 30% of employees work night shifts at least once per month. Additionally, 12% to 13% of the workforce in North America reported working either rotating or regular night shifts. [23] Shift work refers to job schedules that fall outside the standard 9-to-5 workday. These schedules often involve working early hours, condensed work-weeks with 12-hour shifts, and overnight work. Sleepiness is most common during night shifts and tends to peak toward the end of the shift. It is linked to a reduced alertness and poorer performance, posing significant risks to both health and safety. Individuals with a shift work sleep disorder may even falls asleep unintentionally while working or during their commuting home after a night shift. Unconventional work hours can have serious socioeconomic consequences, including a higher likelihood of workplace accidents, decreased job performance, and elevated public safety risks—particularly at night. [24,25]

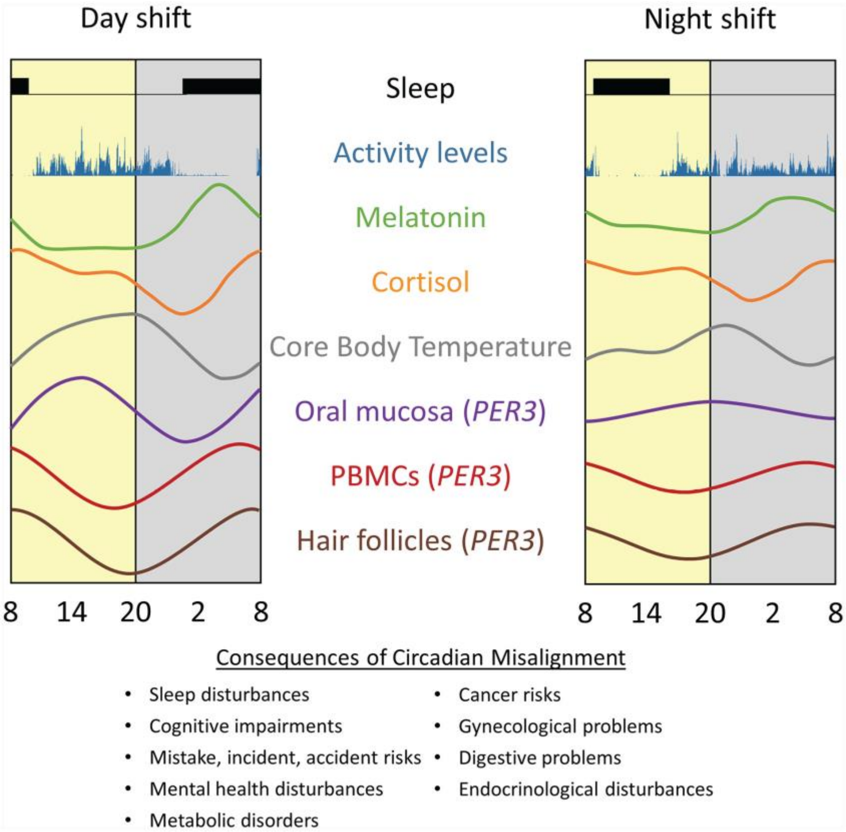

Fig. 3. *Diane B. Boivin Philippe Boudreau, and Anastasi Kosmadopoulos. Disturbance of the Circadian System in Shift Work and Its Health Impact Volume 37, Issue1 https://doi.org/10.1177/0748730421106421 Retrieved from URL: https://journals.sagepub.com/doi/10.1177/07487304211064218*

Economy

Additionally, on a societal scale, sleep deprivation leads to significant economic losses due to a reduced productivity, increased rates of illness, and higher mortality. In the United States, these losses are estimated to range from $280 billion to $411 billion per year, with projections suggesting a rise to between $318 billion and $456 billion by 2030. [26] The total accumulated cost of sleep-related economic impacts in the U.S. could reach between $4 trillion and $7 trillion by 2030. In Japan, sleep deprivation is estimated to cost over $138 billion annually, while Germany and the United Kingdom each face losses between $50 billion and $60 billion per year. In Australia, the yearly economic burden of insufficient sleep is estimated to fall between $35 billion and $45 billion. [27, 28]

Conclusions

Sleep is undoubtedly a biological process of fundamental importance for the proper functioning of the human body. It plays a key role in maintaining homeostasis, regulating metabolic processes, consolidating memory, and regenerating the nervous and immune systems. From a neurobiological perspective, sleep enables the reorganization of synaptic connections and the removal of unnecessary metabolic products from the central nervous system, including through the activation of the so-called glymphatic system. During sleep, especially in the REM (Rapid Eye Movement) phase, experiences are integrated and memory traces are consolidated, which translates into the ability to learn, process emotions, and think creatively. On a physiological level, sleep regulates hormone balance, which is important for circadian rhythms, metabolism, and weight control. Chronic sleep deprivation leads to cognitive impairment, reduced immunity, and an increased risk of cardiovascular disease, type 2 diabetes, and depression. Sleep norms depend primarily on age, but also on the type of work performed. Shift workers, who make up a large percentage of the total workforce, are the most exposed to sleep deprivation, which has serious health and economic consequences.

Ethical approval: Not applicable
The Funding Statement: Study did not receive any special funding.
Institutional review Board statement: Not applicable
Informed Consent Statement: Not applicable
Data Availability Statement: Not applicable
Conflict of interest statement: The authors of the paper report no conflict of interest
Declaration of the use of generative AI and AI-assisted technologies in the writing process. In preparing this work, the authors used Chat GPT for the purpose of improving language and readability. After using this tool, the authors have reviewed and edited the content as needed and accept full responsibility for the substantive content of the publication.

Conceptualization: Dominika Walczak and Adrian Kruk
Methodology: Aleksander Białoń, Weronika Ewa Nowak
Formal analysis: Lidia Jurczenko, Adrian Kruk
Investigation: Paweł Harbut, Weronika Ewa Nowak
Resources: Igor Gawłowski, Aleksander Białoń
Data curation: Aleksandra Dorosz, Paweł Harbut
Writing-rough preparation: Dominika Walczak
Writing - review and editing: Katarzyna Jakubowska
Visualization: Aleksandra Miśta, Aleksandra Dorosz

REFERENCES

1. S Chokroverty (2010) Overview of sleep & sleep disorders Chokroverty, S Indian Journal of Medical Research 131(2):p 126-140, February 2010. PMID: 20308738. Retrieved from URL: https://pubmed.ncbi.nlm.nih.gov/20308738/
2. Paulina Cieślik, Joanna M Wierońska.(2020) Central nervous system homeostasis and sleep: the role of cholinergic, glutamatergic and GABA-ergic neurotransmitter systems and the regulation of the sleep-wake/REM-NREM switch. Kosmos Issue 69 Nr 3: Neurobiologia snu. Instytut Farmakologii im. Jerzego Maja Polskiej Akademii Nauk. Retrieved from URL: https://doi.org/10.36921/kos.2020_2679
3. Tononi G, Cirelli C.(2003) Sleep and synaptic homeostasis: a hypothesis. Brain Res Bull.; 62:143–150. doi:10.1016/j.brainresbull.2003.09.004. PMID: 14638388 Retrieved from URL:https://pubmed.ncbi.nlm.nih.gov/14638388/
4. Giulio Tononi· Chiara Cirelli (2014). Sleep and the Price of Plasticity: From Synaptic and Cellular Homeostasis to Memory Consolidation and Integration. Brain Research Bulletin Volume 81, Issue 1p12-34 January 08, 2014 DOI:10.1016/j.neuron.2013.12.025 Retrieved from URL: https://pubmed.ncbi.nlm.nih.gov/14638388/
5. Murphy M, Riedner BA, Huber R, Massimini M, Ferrarelli F, Tononi G. (2009) Source modeling sleep slow waves. Proc Natl Acad Sci USA.;106:1608–1613. doi: 10.1073/pnas.0807933106. Retrieved from URL: https://pubmed.ncbi.nlm.nih.gov/19164756/
6. Cohen-Cory S. (2002) The developing synapse: construction and modulation of synaptic structures and circuits. Science; 298:770–776. doi:10.1126/science.1075510. Retrieved from URL:https://pubmed.ncbi.nlm.nih.gov/12399577/

7. Hirshkowitz M, Whiton K, Albert SM, Alessi C, Bruni O, DonCarlos L, Hazen N, Herman J, Katz ES, Kheirandish-Gozal L, Neubauer DN, O'Donnell AE, Ohayon M, Peever J, Rawding R, Sachdeva RC, Setters B, Vitiello MV, Ware JC, Adams Hillard PJ. (2015) National Sleep Foundation's sleep time duration recommendations: methodology and results summary. Sleep Health. 2015 Mar;1(1):40-43. doi: 10.1016/j.sleh.2014.12.010. Epub 2015 Jan 8. PMID: 29073412. Retrieved from URL: https://pubmed.ncbi.nlm.nih.gov/29073412/
8. Lorcán Mason, James Connolly, Lydia E Devenney, Karl Lacey Jim Donovan, Rónán Doherty. (2023) Sleep, Nutrition, and Injury Risk in Adolescent Athletes: A Narrative Review Nutrients Dec 13;15(24):5101. doi: 10.3390/nu15245101 DOI:10.3390/nu15245101 Retrieved from URL: https://pubmed.ncbi.nlm.nih.gov/38140360/
9. Jessica A. Williams, MA; Frederick J. Zimmerman, PhD; Janice F. Bell, PhD (2013) Norms and Trends of Sleep Time Among US Children and Adolescents. JAMA Pediatr Published Online: 2013;167;(1):5560. doi:10.1001/jamapediatrics.2013.423 Retrieved from URL: https://pubmed.ncbi.nlm.nih.gov/23403646/
10. Marco Hafner, Martin Stepanek, Jirka Taylor, Wendy M Troxel, Christian van Stolk (2017) Why sleep matters — the economic costs of insufficient sleep: a cross-country comparative analysis. Rand Health Q. 2017;6(4):11 PMID: 28983434 PMCID: PMC5627640 Retrieved from URL: https://pubmed.ncbi.nlm.nih.gov/28983434/
11. Foster RG. (2020) Sleep, circadian rhythms and health. Interface Focus. 2020 Jun 6;10(3):20190098. doi: 10.1098/rsfs.2019.0098. Epub 2020 Apr 17. PMID: 32382406; PMCID: PMC7202392. Retrieved from URL: https://pubmed.ncbi.nlm.nih.gov/32382406/
12. Ramos AR, Wheaton AG, Johnson DA. (2023) Sleep Deprivation, Sleep Disorders, and Chronic Disease. Prev Chronic Dis 2023;20:230197. DOI: http://dx.doi.org/10.5888/pcd20.230197 Retrieved from URL: https://pubmed.ncbi.nlm.nih.gov/37651644/
13. Watson NF, Badr MS, Belenky G, Bliwise DL, Buxton OM, Buysse D, Dinges DF, Gangwisch J, Grandner MA, Kushida C, Malhotra RK, Martin JL, Patel SR, Quan SF, Tasali E; Non-Participating Observers; Twery M, Croft JB, Maher E; (2015) American Academy of Sleep Medicine Staff; Barrett JA, Thomas SM, Heald JL. Recommended Amount of Sleep for a Healthy Adult: A Joint Consensus Statement of the American Academy of Sleep Medicine and Sleep Research Society. J Clin Sleep Med. 2015 Jun 15;11(6):591-2. doi: 10.5664/jcsm.4758. PMID: 25979105; PMCID: PMC4442216. Retrieved from URL: https://pubmed.ncbi.nlm.nih.gov/25979105/
14. Lo JC, Groeger JA, Santhi N, Arbon EL, Lazar AS, Hasan S, von Schantz M, Archer SN, Dijk DJ. (2012) Effects of partial and acute total sleep deprivation on performance across cognitive domains, individuals and circadian phase. PLoS One. 2012;7(9):e45987. doi: 10.1371/journal.pone.0045987. Epub 2012 Sep 24. PMID: 23029352; PMCID: PMC3454374. Retrieved from URL: https://pubmed.ncbi.nlm.nih.gov/23029352/
15. The consequences of sleep deprivation on cognitive performance Mohammad A. Khan and Hamdan Al-Jahdali. (2023) Neurosciences Journal April 2023 Apr;28(2):91-99. doi: 10.17712/nsj.2023.2.20220108. PMID: 37045455; PMCID: PMC10155483. Retrieved from URL: https://pubmed.ncbi.nlm.nih.gov/37045455/
16. Diane S Lauderdale, Kristen L Knutson, Lijing L Yan, Kiang Liu, Paul J Rathouz. (2008) Self-reported and measured sleep duration: how similar are they? Epidemiology. 2008 Nov;19(6):838-45. doi: 10.1097/EDE.0b013e318187a7b0. PMID: 18854708; PMCID: PMC2785092. Retrieved from URL: https://pmc.ncbi.nlm.nih.gov/articles/PMC2785092/
17. Carolina Lombardi, Eleonora Tobaldini, Nicola Montano, Anna Losurdo, Gianfranco Parati. (2017) Obstructive Sleep Apnea Syndrome (OSAS) and Cardiovascular System. Med Lav. 2017 Aug 28;108(4):276-282. doi: 10.23749/mdl.v108i4.6427. PMID: 28853425. Retrieved from URL: https://pubmed.ncbi.nlm.nih.gov/288534
18. Cliona O'Donnell, Anne M O'Mahony, Walter T McNicholas, Silke Ryan. (2021) Cardiovascular manifestations in obstructive sleep apnea: current evidence and potential mechanisms. Pol Arch Intern Med. 2021 Jun 29;131(6):550-560. doi: 10.20452/pamw.16041. Epub 2021 Jun 29. PMID: 34184854. Retrieved from URL: https://pubmed.ncbi.nlm.nih.gov/34184854/
19. Pace-Schott EF, Spencer RMC. (2011) Age-related changes in the cognitive function of sleep. Prog Brain Res. 2011;191:75–89. doi: 10.1016/B978-0-444-53752-2.00012-6. PMID: 21741545. Department of Psychology and Neuroscience, University of Massachusetts, Amherst, MA, USA. Retrieved from URL: https://pubmed.ncbi.nlm.nih.gov/21741545/
20. Miguel Marino, Yi Li, Michael N Rueschman, J W Winkelman, J M Ellenbogen, J M Solet, Hilary Dulin, Lisa F Berkman, Orfeu M Buxton (2013) Measuring sleep: accuracy, sensitivity, and specificity of wrist actigraphy compared to polysomnography. Sleep. 2013;36:1747–55. https://doi.org/10.5665/sleep.3142. Department of Biostatistics, Harvard School of Public Health, Boston MA ; Department of Family Medicine, Oregon Health and Science University, Portland, OR. Retrieved from URL: https://pubmed.ncbi.nlm.nih.gov/24179309/
21. Aayushi Sen, Xin You TaiSleep. (2023) Sleep Duration and Executive Function in Adults. Curr Neurol Neurosci Rep. 2023 Nov;23(11):801-813. doi: 10.1007/s11910-023-01309-8. Epub 2023 Nov 14. PMID: 37957525; PMCID: PMC10673787.Nuffield Department of Clinical Neurosciences, University of Oxford, Oxford, UK Division of Clinical Neurology, John Radcliffe Hospital, Oxford University Hospitals Trust, Level 6 West Wing, Oxford, UK. Retrieved from URL: https://pubmed.ncbi.nlm.nih.gov/37957525/

22. William D.S. Killgore. (2010) Effects of sleep deprivation on cognition. Progress in Brain Res. 2010;185:105-29. doi: 10.1016/B978-0-444-53702-7.00007-5. PMID: 21075236. Retrieved from URL: https://pubmed.ncbi.nlm.nih.gov/21075236/
23. Lee C Yong, Jia Li, Geoffrey M Calvert. (2017) Sleep-related problems in the US working population: prevalence and association with shiftwork status. Occup Environ Med. 2017 Feb;74(2):93-104. doi: 10.1136/oemed-2016-103638. Epub 2016 Sep 8. PMID: 27609325. Retrieved from URL: https://pubmed.ncbi.nlm.nih.gov/27609325
24. Diane B Boivin, Philippe Boudreau, Anastasi Kosmadopoulos. (2022) Disturbance of the Circadian System in Shift Work and Its Health Impact. Journal of Biological Rhythms. 2022;37(1):3-28. doi:10.1177/07487304211064218 Epub 2021 Dec 30. PMID: 34969316; PMCID: PMC8832572. Centre for Study and Treatment of Circadian Rhythms, Douglas Mental Health University Institute, Department of Psychiatry, McGill University, Montreal, QC, Canada.Retrieved from URL: https://pubmed.ncbi.nlm.nih.gov/34969316/
25. D B Boivin, P Boudreau. (2014) Impacts of shift work on sleep and circadian rhythms. Les impacts du travail posté sur le sommeil et les rythmes circadiens. Pathol Biol (Paris). 2014 Oct;62(5):292-301. doi: 10.1016/j.patbio.2014.08.001. Epub 2014 Sep 20. PMID: 25246026. Retrieved from URL: https://pubmed.ncbi.nlm.nih.gov/25246026/
26. Marco Hafner, Martin Stepanek, Jirka Taylor, Wendy M Troxel, Christian van Stolk (2017). Why sleep matters-the economic costs of insufficient sleep: A cross-country comparative analysis. Rand Health Q. 2017 Jan 1;6(4):11. PMID: 28983434; PMCID: PMC5627640. Retrieved from URL: https://pubmed.ncbi.nlm.nih.gov/28983434/
27. David Hillman, Scott Mitchell, Jared Streatfeild, Chloe Burns, Dorothy Bruck, Lynne Pezzullo. (2018). The economic cost of inadequate sleep. Sleep, 41. https://doi.org/10.1093/sleep/zsy083 Retrieved from URL: https://pubmed.ncbi.nlm.nih.gov/29868785/
28. Lisa C Lyons, Yann Vanrobaeys, Ted Abel. (2023) Sleep and memory: The impact of sleep deprivation on transcription, translational control, and protein synthesis in the brain. J Neurochem. 2023 Jul;166(1):24-46. doi: 10.1111/jnc.15787. Epub 2023 Mar 25. PMID: 36802068; PMCID: PMC10919414. Retrieved from URL: https://pubmed.ncbi.nlm.nih.gov/36802068/