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Association Between Stress and Human Sleep

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Abstract

Sleep is a biological requirement for human life, along with drink, food, sleep and air is a vital biochemical constituent of human life. Analogous to eating food and different from breathing air, satisfying this biological necessity requires intended behavior on the individual's part. Still, there is a lot of variances in sleep habits and practices., even if many of these performances are genetically and intrapersonal identified (e.g., it is not a coincidence that most people like to sleep at night and that most humans sleep in a stereotyped postural reclined fashion). As a consequence, sleep is also influenced by social variables, environmental factors, and personal factors. Acute stress is an important adaptive reaction that allows an organism to deal with risky environmental inputs on a daily basis. The response to stress may deteriorate and ultimately cause health harm if it is sustained and unchecked. Both acute and chronic stressors have significant effects on sleep architecture and circadian rhythms, according to animal models of stress in rodents. Stress makes the hypothalamo-pituitary-adrenal axis to become active, which is one of the main physiological reactions it causes. The hypothalamo-pituitary-adrenal axis regulates sleep-wake cycles and affects how the sleep-wake cycle changes as a result of exposure to short-term or long-term stresses in both animals and humans. Severe sleep disorders in people can be caused by a malfunction of the neuroendocrine system that regulates sleep. Fragmented and unpredictable sleep may be caused by ageing, which replicates the steady decline of the hypothalamo-pituitary-adrenal axis in elderly persons. Patients with mental illnesses, shift workers, or chronic insomniacs exhibit aberrant hypothalamo-pituitary-adrenal secretory activity and related sleep difficulties.

Keywords: Sleep, Sleep Quality, Stress

A mini review article **Corresponding Author*, e-mail: doaa.mahmoud@med.svu.edu.eg

1. Introduction

The bidirectional interaction between sleep and stress affects the central nervous system (CNS) and metabolism, and it may be one of the fundamental mechanisms contributing to the rise in metabolic illnesses including obesity and diabetes. [1] Melatonin and other hormones from the hypothalamic-pituitary-adrenal (HPA) axis regulate the sleep-wake cycle, and their malfunction can cause problems with sleep. The HPA axis becomes hyperactive as a result of sleep loss [2].

An imbalance in sleep duration and numerous neuroendocrine impacts have been linked to a variety of stressful situations, including low socioeconomic status and persistent work overload [3]. In fact, the HPA axis and sleep regulation have long been shown to interact in a mutual way [4]. A sleep disorder called insomnia is characterized by problems getting to sleep, remaining asleep, or getting restorative sleep. It is often accompanied with daily impairment or distress [5].

Stress and sleep deprivation have become endemic, having a significant impact on the metabolic process, as a result of the new lifestyle that job and family have forced upon us, as well as medical and psychological issues, as well as social changes brought on by the internet and television. It's significant to note that stress hormone levels are positively correlated with shorter sleep duration, and both are linked to overweightness, metabolic syndrome, and eating disorders [6].

2. Sleep definition

Sleep is an emergent variety of several physiological activities that are largely planned by neurobiological mechanisms that affect frequent physiological structures. As a result, there have been numerous expansions over the previous few decades that have illuminated these neurological mechanisms as bases for sleep and wake [7] with particularly fascinating work being done in the fields of functional genetics/genomics [8,9] and molecular processes of control associated to sleep [10].

3. Function of sleep

Because every living thing sleeps occasionally, sleep is physiologically important [11]. The majority of sleep scientists concur that it is unrealistic to think of sleep as having just one function [12]. Sleep has been defined in a wide variety of animals, including humans, birds, fish, flies (like Drosophila melanogaster), and more primitive creatures like worms (like C. elegans). Sleep may be detrimental to an animal because it reduces its alertness to potential predators and keeps it from feeding or reproducing. However, animals do not consistently feel this tension. The aforementioned physiological processes may need to be maintained at high levels through sleep in order to improve the animal's capacity for survival and reproduction. There have been many developments in our understanding of the fundamental processes that control sleep over the past 150 years However, redundant molecules and processes that also serve other physiological requirements regulate sleep, which has made it more difficult for us to comprehend how it works [13].

4. Sleep regulation

Wakefulness increases energy-related chemicals and pathogens via their respective pathogen recognition receptors, which in turn signals sleep-regulatory molecules and thus promotes sleep. The chemicals that control sleep signal neurotransmitters by acting on certain receptors. The neurotransmitters modify ion channels, changing sleep and cortical EEG activity as well as EPSPs and IPSPs [14].

5. Sleep quality

What Is Sleep Quality?

Sleep quantity and quality are distinct entities. Sleep quality assesses how healthy you sleep, whereas sleep quantity amounts how considerably sleep you contract each night. It's straightforward to quantity how much sleep you get as it's easy to tell if you're receiving the necessary amount each night, which for adults is typically 7-9 hours. It's more of an art than a science to gauge how well you sleep. The following traits typically characterize good sleep quality: [15]

- Within 30 minutes or less after getting into bed, you fall asleep.
- Typically, you have a full night's sleep and only occasionally wake up.
- You are capable of getting the appropriate count of hours of sleep for your age.
- If you do wake up you fall back asleep within twenty minutes.
- When you wake up in the morning, you feel refreshed, rejuvenated, and energized.

6. Causes of insufficient sleep

6.1. Shift work

Shift work sleepiness disorder, late sleep phase, advanced sleep phase, sleep-wake cycle that is not conditioned, irregular sleep-wake cycle, and jet lag are all circadian rhythm sleep disorders that can be influenced by chronic variations, interruptions, or misalignments of the circadian clock in connection to outside cues and the earth's natural cycle of light and darkness [16].

6.2. Sleep Disorders

The prevalence of insomnia in the universal population varies depending on diagnostic standards from 10 to 48%. [17]. Although the prevalence of periodic limb movement syndrome in the general population has not been thoroughly examined, it is believed to range between 0.1 to 13%. [18]. When left untreated, these diseases are linked to inadequate sleep quality and quantity, which causes daytime drowsiness and increases transience, illness, absences from work, and decreased production [19].

6.3. Poor hygiene of sleep

Poor sleep settings, irregular sleep/wake schedules, relations between the room and non-sleep performances that disrupt sleep, as well as participation in arousal-inducing activities right before bedtime, are just a few of the sleep habits that can make it difficult to initiate and maintain sleep. sleeplessness that results from untreated sleeplessness negatively affects presentation and health, but handling with behavioral rehabilitations administered by a specialist frequently fixes the issue [20].

6.4. Medications

Several antidepressants may have an impact on daytime alertness and sleep. When first taken, monoamine oxidase and several tricyclic antidepressants (MAO) inhibitors may have a sedative effect during the day, although over time, this effect may reduce. Sedation during the daytime is a common side effect of serotonin, selective serotonin reuptake inhibitors (SSRIs) and norepinephrine reuptake inhibitors. Although they may cause daytime drowsiness, serotonin antagonist/reuptake inhibitors can enhance the quality of nighttime sleep. A sedative effect is possible with antipsychotic, anxiolytic, and antiepileptic medications, as well as with first-generation Type 1 (H1) receptor antagonists (antihistamines). Diphenhydramine, a first-generation antihistamine, is a popular over-the-counter sleep aid that is also FDA-approved for the treatment of allergies. Daytime sleepiness is a common side effect of painkillers, especially triptans (serotonin receptor agonists typically used to treat migraine) and opioids. Other medicines may have energizing effects that tend to prevent sound sleep at night. These include theophylline, phenylpropanolamine, pseudoephedrine, and corticosteroids. Caffeine can also disrupt sleep if it is ingested advanced in the day in reasonable to high levels. [21]. Since restless or brief sleep is insufficiently curative, any medicine that disturbs sleep is likely to cause daytime weariness.

6.5. Light

Liable to the timing, wavelength, and brightness of light contact, it can have either beneficial or detrimental influences on sleep and alertness [22]. Light normally modifies the autonomic and neuroendocrine systems, particularly melatonin, to synchronize circadian rhythms to the environment [23]. Bright light stimulates arousal and frequently improves cognition, particularly in tasks demanding continuous attention.

7. Health impact of inadequate sleep

Inadequate sleep brought on by sleep deficiency, sleep restriction, and/or sleep disturbance has been related to a diversity of detrimental effects on both psychological and physical health. Sleep is an essential physiological function. Without enough sleep, the whole brain's activation levels significantly fall, with areas involved in higher-order intellectual processing, general alertness, and demonstrative/

affective control showing the most deactivation. [24]. Additionally, it is recognized that sleep issues are linked to a higher risk of anxiety, depression, suicide and substance abuse. [25] Seven of the top 15 reasons of death in the U.S., such as hypertension, cardiovascular disease, accidents, septicemia and diabetes are linked to inadequate sleep length [26].

8. Assessment of sleep quality

Good sleep quality is crucial for well-being of human [27]. Self-rating indices are frequently connected with other measures, including environmental factors, sleep timing, physiologically derived indices, pharmacologic interventions, polysomnographic parameters, and the incidence of sleep conditions, as a general approach to measuring the quality of sleep [28]. The Pittsburgh Sleep Quality Index (PSQI), a self-report questionnaire consists of 19 questions divided into 7 fields (sleep disturbance, sleep latency, sleep duration, daytime dysfunction, subjective sleep quality , sleep efficiency, and use of sleep medicine) and the National Institutes of Health Patient-Reported Outcomes Measurement Information System (PROM) are the techniques greatest frequently used in this field [29]. The respondent scores the quality of their sleep using a novel single-item Sleep Quality Scale (SQS) [30], which has five categories (from dreadful to excellent) during a 7-day recall span.

9. Definition of stress

Stress was described as an experimental paradigm that upsets an animal's environment. These include ecological stressors including community isolation, nighttime food and water deficiency, social overthrow, and home cage disturbances, as well as physical irritants like handling constraint, occlusal disharmony, and foot shock. The effectiveness of these stimuli as preclinical representations of the community stressors linked to an elevated risk of psychological disease in humans has already been established [31].

10. Mechanism of stress

Large-scale epidemiological research has established that stress raises the chance of having mental health difficulties as an adult, both early in life and later. [32, 33]. The neurobiological paths connecting childhood difficulties to the future development of adult mental diseases have been explained by a number of theories, including changes in the hypothalamic-pituitary stress system, atypical immunological responses, and ongoing changes in molecular, epigenetic, and cellular forms of plasticity. The immune system reacts to stimuli and communicates with the central nervous system via a number of mechanisms, including cytokine signalling, vagal innervation, and the lymphatic system. [34]. Stressful life events have been linked to heightened levels of pro-inflammatory cytokines in children as well as a high chance of developing mental illness as an adult. [35]

Such cytokine spikes could lead to changes in cortical microglia, which could then be linked to anatomical and functional abnormalities in the brain that put people at risk for mental illness.[36] This is supported by reports of alterations in microglial markers in a variety of mental diseases, including depression. [37], anxiety [38]and autism spectrum disorders [36].

A new PET imaging study found that individuals with schizophrenia and those who are very susceptible to psychosis have increased microglial activity. Additionally, in the population at risk, there was a positive correlation between increased microglial activation and increased symptom severity.[39] suggesting a link between risk of psychosis and neuroinflammation. Microglia, which are myeloid cells, constitute the main form of adaptive immune response in the central nervous system (CNS). In addition to having an inflammatory response, these cells also influence neuronal function during embryonic synaptic pruning [40] and plasticity in the healthy brain [41]and are able to quickly react to even little alterations in the brain. Microglia keep an eye on synapses' functionality, modify extracellular spaces to affect neuroplastic changes, and phagocytose synaptic components to remove them. [42]. Numerous alterations occur in microglia in response to damaging stimuli [43]. these include a rise in quantity brought on by proliferating things.[44] and through enrolment of monocytes from the marginal blood [45]. or-inflammatory cytokines are also produced by the inflammatory microglial response, and many cell surface antigens are expressed. Iba-1 has been used most frequently among these to examine microglia because of its unique expression in both active and dormant microglial cells [38].

The ramified morphologies of microglia in the healthy adult central nervous system are characterized by long, thin processes that enable the microglia to scan the local environment for pathogens or dangerous substances. [46]. The processes of the microglia retract in response to insults, and the cell body enlarges, giving the microglia an amoeboid form [46]**.** An expanded soma and hypertrophic branch morphology are linked to chronic inflammatory conditions [47]. There is evidence that some of these modifications happen in response to psychological stress as well as more traditional inflammatory stimuli like infection.[48]

11. Association between stress and human sleep

An expanded soma and hypertrophic branch morphology are linked to chronic inflammatory conditions. Exogenous treatment of each of the primary HPA axis mediators has an effect on the architecture of sleep. The different components of the immune system have an impact on our sleep patterns as well. In order to control some of the connections between stress and sleep, immunological function, which can be affected by both short- and long-term stressors, may be essential. Experimental data support the stressful nature of human sleep loss. Therefore, chronic sleep deprivation may hasten the onset of metabolic and cognitive effects of glucocorticoid excess, including cognitive impairments and lower glucose tolerance. Stress is thought to be a major element linking shift work with adverse health impacts, such as difficulty sleeping. Shift workers' sleep may be impacted by stress-related endogenous (such as circadian, metabolic, and hormonal) and exogenous (such as circulation, children playing, and home sounds) factors. Fragile sleep patterns are also a result of social stressors such as parental responsibilities and family structure upheaval [49].

12. Conclusions

Stress and sleep have a bidirectional relationship that affects the central nervous system (CNS) through a

number of different mechanisms. One of the key physiological responses to stress is the activation of the hypothalamo-pituitary-adrenal axis. In both animals and humans, the hypothalamo-pituitary-adrenal axis controls sleep-wake cycles and influences how the sleep-wake cycle alters as a result of exposure to short- or long-term stimuli. Severe sleep disorders in people can be caused by a malfunction of the neuroendocrine system that regulates sleep.

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