ECRONICON OPEN ACCESS

EC DENTAL SCIENCE
Review Article

The Need for Sleep and Relaxation

R Michael Buch[1] and J Anthony von Fraunhofer[2]*

[1]*Chief Science Officer, Young Living, Lehi, Utah, United States*
[2]*Professor Emeritus, University of Maryland, Maryland, United States*

***Corresponding Author:** J Anthony von Fraunhofer, Professor Emeritus, University of Maryland, Maryland, United States.

Received: October 16, 2019; **Published:** November 15, 2019

Abstract

Sleep affects almost every system, metabolic process and type of tissue in the body to the extent that it is vital for the health and proper functioning of the mind and body. Chronic lack of sleep and/or poor-quality sleep increases the risk of many health issues.

This article discusses the nature of sleep, sleep patterns and dreaming. It also addresses insomnia and hyposomnia. The stages of sleep and brain activity during sleep are reviewed together with sleep mechanisms.

Sleep aids, notably the use of lavender essential oil aromatherapy in facilitating sleep, are discussed together with the anxiolytic effects of aromatherapy and aerial lavender diffusion.

Keywords: *Sleep; Relaxation*

Introduction

The need for sleep and its benefits have been recognized since time immemorial and there are numerous literary references to this essential activity, some examples being the following:

- To Sleep, Perchance to Dream (William Shakespeare, Hamlet, Act III, Scene I).
- Sleep, which will not be commanded (Byron: Marino Faliero IV).
- Blest be the man who first invented sleep (Cervantes: Don Quixote II.68).
- Early to bed, early to rise makes a man healthy, wealthy and wise (Benjamin Franklin).

Notwithstanding these literary aphorisms and that everyone needs sleep, the biological purpose of sleep is actually a mystery despite decades of research. It is known that sleep affects almost every system and type of tissue in the body, including such essential organs as the brain, heart and lungs which govern bodily processes such as metabolism, immune function, mood and disease resistance. Research studies have also established that a chronic lack of sleep and/or poor-quality sleep increases the risk of many health issues [1]. Disorders such as hypertension, cardiovascular disease, diabetes, depression and obesity may accompany a pattern of regular sleep deficits in adults.

Although, as indicated above, the biological importance of sleep is not precisely known, the general consensus is that the brain performs its "housekeeping" and general maintenance during sleep, activities that cannot be performed during the day. Thus, it appears that during sleep, the brain repairs cellular damage, remove toxins that accumulate during the day, boosts diminishing energy supplies and inducts or consolidates memories. It is also during sleep that dreaming occurs, as discussed later.

Sleep patterns

Overall, sleep is a complex and dynamic process but just how much sleep is enough varies from person to person. Although most adults need 7 - 9 hours a night, people over 60+ years in age experience sleep that tends to be shorter and "lighter", and also may be interrupted by multiple awakenings. In contrast, babies initially sleep as much as 16 to 18 hours per day. This extended sleep pattern apparently stimulates growth and development, especially for the brain. School-age children and teens also need more sleep than mature adults, requiring on average about 9.5 hours of sleep per night [2].

Notwithstanding the recognized need for sleep, significant numbers of people get less sleep than is actually necessary. There are various causes for this, including longer work or studying hours, familial demands on time, the availability of round-the-clock entertainment and many other activities, including the perceived need for an ever-expanding social life and the need "to stay connected" on social media. This is particularly true for school-age and college students whose lives are crammed with classroom/lecture theater activities, homework and essay assignments, various school or college sports and social activities as well as the pervasive and highly demanding electronic screens, all of which contribute to sleep deficits.

Many people assume that they can catch up on missed sleep during the weekend but, depending on the degree of sleep-deprivation, sleeping longer on the weekends may not adequately reduce the deficit and often cannot be achieved due to societal and other pressures/demands on time.

Overall, the research work of sleep scientists indicates that chronically sleep deprived people are more likely to be overweight, suffer from cardiovascular disease, strokes, various infections and certain types of cancer than "normal" sleepers and those not experiencing sleep deficits.

A very recent study has been conducted with older patients in China who had received eradication treatment for *H. pylori*-infected peptic ulcer disease[a] (PUD) [3]. The study showed that poor sleep quality predicts subsequent PUD recurrence and supports the findings of previous studies which showed that older patients who reported poor sleep quality were more likely to have PUD. The authors suggested that melatonin, a hormone produced by the pineal gland and which regulates sleep and wakefulness, might also intervene in the relationship between sleep quality and the recurrence of PUD.

Melatonin is a potent stimulant of bicarbonate, the latter accelerating ulcer healing by neutralizing gastric acid secretion, increasing gastric mucosal blood flow, and interfering with prostaglandin-dependent pathways. Melatonin may also protect against PUD recurrence by scavenging free radicals and accelerating mucosal microcirculation. On the other hand, multiple nighttime awakenings may lead to melatonin deficiency which, in turn, may adversely affect subsequent PUD recurrence.

The overall conclusion from this study is that properly treating and preventing sleep problems in older patients with previous *H. pylori*-infected PUD may reduce the prevalence of PUD recurrence.

Insomnia

Lack of sleep due to demands on the body and mind is not the same thing as insomnia, which is a common sleep disorder that can make it both hard to fall asleep and difficult to stay asleep. Even worse, insomnia can cause sufferers to wake up too early and then be unable to get back to sleep, and insomniacs often still feel tired when they wake up. Insomnia not only can wreak havoc on the individual's energy level and mood but also can severely impact health, work performance and quality of life.

[a]*Helicobacter pylori (H. pylori)* overgrowth in the gut is a common cause of PUD.

It should be noted that many adults experience short-term or *acute* insomnia at some time in their lives. Acute bouts of insomnia can last for days or weeks and are usually caused by stress or a traumatic event. Acute insomnia, however, does not necessarily morph into chronic insomnia and may "cure" itself over time.

Chronic insomnia is when sufferers have the condition over periods of a month or longer. Whereas chronic insomnia is usually considered to be a psychological condition, it can be caused by various medical conditions and, frequently, by medications administered for hypertension, heart disease, thyroid disease, birth control and asthma. Although a common cause of insomnia is depression, chronic insomnia can also signify underlying sleep disorders.

It is common for people with age-related neurological disorders such as Alzheimer's disease and Parkinson's disease to experience sleep disturbances. However, it is unclear whether these diseases (and many others) are caused by lack of sleep or whether the onset and presence of the diseases are the cause of the sleep disturbance.

Hyposomnia

The scientific term for a reduction in a person's sleep time, commonly as a result of insomnia or some other sleep disturbance, is hyposomnia. There are, however, people (approximately 1 - 5% of the population) that appear to require less, often markedly less, sleep than the average person [4]. Some of these people require as little as 4 hours a night and still function remarkably well, sometimes better than the average person who sleeps for much longer periods each night. In fact, it appears that if the duration of "normal" sleepers is reduced to six hours, a negative impact often becomes apparent after only a few days.

Many famous people in history were renowned for requiring little sleep, including Benjamin Franklin, Thomas Edison and Margaret Thatcher, the UK's longest serving Prime Minister. In modern times, President Donald Trump and former presidents Bill Clinton and Barak Obama are noted for requiring little sleep. Many successful business people also are known to require little sleep including Marissa Mayer (Yahoo CEO), Jack Dorsey (Twitter founder and Square CEO), Jay Leno (former host of 'The Tonight Show), and Martha Stewart (chair of Martha Stewart Omnimedia).

Recent research [5] suggests that this reduced need for sleep is due to a rare genetic mutation of the β_1-Adrenergic receptor (sometimes referred to as the *DEC2* gene). Studies indicate that the brains of people with the DEC2 mutation perform the same clean-up process as normal sleepers but in a shorter period of time with the same or possibly greater efficiency. What process or processes are involved in this is unknown. It is also not known whether DEC2 mutation sleepers dream to the same degree as normal sleepers. It appears, however, that not only may naturally short sleepers have a different internal clock, they also tend to be upbeat, ambitious, highly energetic and have an excellent metabolism. Interestingly, there is some evidence for subclinical hypomanic[b] symptoms in naturally short sleepers.

Brain activity during sleep

As stated above, sleep is a complex and dynamic process that is important to several brain functions, notably how neurons communicate with each other.

Several structures within the brain are involved with sleep and include the hypothalamus, the brain stem, the thalamus, the pineal gland, the basal forebrain and the amygdala. The hypothalamus contains groups of nerve cells that act as control centers affecting sleep and arousal, and within the hypothalamus is the suprachiasmatic nucleus (SCN). The latter comprises clusters of cells that receive information about light exposure directly from the eyes and control the behavioral rhythm[c].

[b]Hypomania is quite distinct from mania in that there is no significant functional impairment whereas mania is usually defined as manifesting significant functional impairment and may have psychotic features.

[c]People with damage to the SCN may sleep erratically throughout the day because of an inability to match their circadian rhythms with the natural light-dark cycle. Interestingly, most blind people maintain some ability to sense light and can modify their sleep/wake cycle.

The brain stem, at the base of the brain, communicates with the hypothalamus to control the transitions between wake and sleep. This structure includes the pons, medulla and midbrain. "Sleep-promoting cells" within the hypothalamus and the brain stem produce GABA[d], which acts to reduce the activity of arousal centers in the hypothalamus and the brain stem. The brain stem together with the pons and medulla have a special role in rapid eye movement (REM) sleep, sending signals to relax muscles involved in body posture and limb movements. This muscle relaxation during sleep may be essential in preventing violent movements and acting out of dreams.

The thalamus relays information from the senses to the cerebral cortex, the latter part of the brain that interprets and processes information from short- to long-term memory. During most stages of sleep, the thalamus is quiescent and helps the brain "tune out" the external world, but during REM sleep, the thalamus becomes active and sends the cortex images, sounds and other sensations that populate dreams.

The pineal gland, located within the brain's two hemispheres, receives signals from the SCN and increases production of melatonin[e], the hormone that regulates sleep and wakefulness. The possible role of melatonin in peptic ulcer disease was discussed earlier.

The basal forebrain, near the front and base of the brain, also promotes sleep and wakefulness, while a part of the midbrain acts as an arousal system. Release of adenosine by cells in the basal forebrain supports the sleep drive whereas caffeine, a known mental stimulant, counteracts sleepiness by blocking the actions of adenosine. Finally, the amygdala, which is involved in processing emotions, becomes increasingly active during REM sleep.

Stages of sleep

There are two basic types of sleep: rapid eye movement (REM) sleep and non-REM sleep, the latter having three different stages. Each type of sleep is linked to specific brain waves and neuronal activity, with the brain cycling through all stages of non-REM and REM sleep several times during a typical night. Interestingly, increasingly longer and deeper periods of REM sleep occur towards the morning. It appears that memory consolidation most likely requires both non-REM and REM sleep.

Stage 1: Non-REM sleep is the changeover from wakefulness to sleep and lasts several minutes. During this period of relatively light sleep, the heartbeat, breathing and eye movements slow, and muscles relax although often with occasional twitches. This stage of sleep is when the brain waves begin to slow from their daytime wakefulness patterns.

Stage 2: Non-REM sleep is a period of light sleep prior to entering deeper sleep, and both the heartbeat and breathing slow, and muscles relax even further. In this stage, the body temperature drops, and eye movements cease. Although brain wave activity slows, there are brief bursts of electrical activity and a higher portion of repeated sleep cycles are spent in stage 2 sleep than in other sleep stages.

Stage 3: Non-REM sleep is the period of deep sleep that is necessary to ensure relaxation and refreshment of the body and brain. This deep or slow-wave sleep (SWS) occurs over longer periods during the first half of the night. In this stage, brain waves and the heartbeat and breathing slow to their lowest levels during sleep and muscles achieve maximum relaxation. In fact, waking the sleeper during this stage of sleep can be difficult.

[d]GABA (gamma-aminobutyric acid, or γ-aminobutyric acid) is the principal inhibitory neurotransmitter in the developmentally mature central nervous system and its primary role is to reduce neuronal excitability throughout the nervous system.

[e]It has been found that sightless people who cannot coordinate their natural wake-sleep cycle using natural light can stabilize their sleep patterns by taking small amounts of melatonin at the same time each day. In fact, it appears that alternating peaks and valleys of melatonin over time are important for matching the body's circadian rhythm to the external, i.e., daily, cycle of light and darkness.

REM sleep: First occurs about 90 minutes after falling asleep and is discernible by rapid side-to-side eye movement behind closed eyelids. In REM sleep, brain wave activity becomes closer to that found during wakefulness while breathing becomes faster and irregular, and both the heart rate and blood pressure increase to near-waking levels. Most dreaming occurs during REM sleep, although dreaming may still occur in non-REM sleep. Fortunately, the brain (notably the brain stem, pons and medulla) emits signals that temporarily paralyze arm and leg muscles to prevent "acting out" of dreams. Interestingly, as a person ages, less time is spent in REM sleep.

Sleep mechanisms

The body has two internal biological mechanisms, namely circadian rhythm and homeostasis, which operate together to regulate when the body/brain is awake or asleep.

Circadian rhythms direct a wide variety of body functions, including the daily fluctuations in wakefulness, body temperature, various metabolic processes, the release of hormones as well as the timing of sleep and the tendency to awaken without an alarm clock. The body's "biological clock", based approximately on a 24-hour day, controls most circadian rhythms and though these mechanisms synchronize with environmental cues such as light and temperature throughout the day, circadian rhythms will continue even in the absence of light and temperature cues.

Disruption of natural circadian rhythms, as for example with night shift workers, often causes problems with falling asleep for such individuals and they often have trouble staying awake at work because the sleep-wake cycle is disordered. Likewise, people flying to a different time zone often suffer from "jet lag" because their circadian rhythms are no longer synchronized with the time of day so that there is a mismatch between their internal clocks and the actual/local time. This mismatch is why many travelers will take melatonin to help them sleep while flying and reduce jet lag symptoms.

Sleep-wake homeostasis[f] is the process whereby the body keeps track of the need for sleep, basically reminding the body to sleep after a certain time of wakefulness and regulating sleep intensity. The "sleep drive" increases in strength the longer a person is awake and with extended periods of sleep deprivation, both factors leading to longer and deeper sleep.

Many factors affect individual sleep-wake needs, including medical conditions, the genetic mutations cited above, medications, stress, sleep environment, and diet although the greatest influence is the exposure to light. The latter effect is the result of specialized cells in the retina which process light and tell the brain whether it is day or night; these cells can advance or delay the sleep-wake cycle. In particular, exposure to light can make it difficult to fall asleep and, if awakened, make the return to sleep more difficult, as occurs when people fall asleep with the room lit up.

Dreaming

Everyone dreams and although the average person dreams for about 2 hours each night, most people either cannot remember their dreams in the morning or can only recall a small percentage. The exact purpose of dreaming is unknown, but it is thought to be involved in processing emotions. Daily events often invade thoughts during sleep, and people suffering from stress or anxiety have a greater likelihood of disturbing or even frightening dreams. Hormonal fluctuations also influence dreams and dreaming, and a recent study of a large sample of women indicated that the hormonal milieu of the luteal phase of menopause[g] appears to influence dream content.

[f]Homeostasis is the term for the ability of a system to regulate variables such that internal conditions remain stable and relatively constant. Examples of homeostasis include the regulation of temperature, the sleep-wake cycle and the internal pH balance.

[g]The luteal phase is the stage of the menstrual cycle which occurs after ovulation but before the start of the period. It is during this phase of the cycle that the lining of the uterus normally thickens in preparation for a possible pregnancy.

Although the opinion of some sleep scientists is that dreams are little more than noise in the brain and have no substantive purpose or function, this attitude ignores the tenets of virtually all wisdom traditions that dreams are an important source of revelation or prophecy [6].

Although dreams may be experienced in all stages of sleep, they appear to be most vivid in REM sleep. Interestingly, some people dream in color whereas others only recall dreams in black and white.

Neuroimaging research studies [7] indicate that REM sleep is characterized by a specific pattern of regional brain activity and this heterogeneous distribution of brain activity during sleep may explain many features of dreams. Further, specific dream characteristics suggest that there is activation of selective brain regions during sleep. This integration of neuroimaging data of sleep, mental imagery, and dream content indicates neurobiological support for the importance of sleep and dreaming in important psychological functions such as emotional regulation [8].

Research studies indicate that dreaming is essentially a neurophysiologic state characterized by high activity in brain areas associated with imagery [9]. This appears to be why the brain during sleep can creatively solve some problems which the waking mind was unable to resolve, especially those requiring vivid visualization. These findings also provide support for the old adage that the best way to resolve problems and issues is to sleep on them.

Aids to sleep

In theory, one should be able to "nod off" within a few minutes of the head hitting the pillow. Unfortunately, theory and reality often do not meet when it comes to sleep.

Whereas most people prefer, if not require, a darkened room and silence in order to fall asleep, some people will happily drop off with both the television and the light on. Likewise, many people find that background noise such as music, the sounds of nature and other soothing audio offerings facilitate falling asleep.

There are, however, certain criteria and practices that are almost universal in preventing a person from falling asleep:

1. Eating a large meal during the evening.
2. Drinking caffeinated beverages during the evening.
3. Exercising late in the day or evening.
4. Reviewing problems and complex situations once in bed.
5. Becoming overtired.

There are, however, various approaches and/or practices that can aid sleep that do not involve alcohol, prescription medications or other chemical aids.

Aromatherapy using aromasticks or a diffuser has been recognized for centuries as being beneficial to falling asleep and staying asleep but until relatively recently, most reports of the benefits of aromatherapy have been anecdotal. This situation has now changed. It has been found that, aromatherapy, notably with lavender essential oil, not only aids sleep but ensures that users awaken refreshed [10-13]. The use of pure high-quality lavender oil that is uncontaminated with adulterants and diluents, for example, pure therapeutic grade lavender essential oil, is necessary to avoid side-effects such as morning headaches and migraines. This use of aromatherapy is remarkably effective in promoting sleep and relaxation with many mental (and physical) conditions [10,14-16]. The anxiolytic efficacy of aromatherapy, particularly with lavender oil, is remarkable [10,17], especially for pre-operative and PTSD patients [10-12,18].

A clinical study performed several years ago [19] confirmed the benefit of lavender oil aromatherapy in modifying sleep and mood. It was found that lavender increased the percentage of deep or slow-wave sleep (SWS) in both men and women and all subjects reported higher vigor the morning after lavender exposure. The latter finding indicates the increased percentage of SWS required for restoration of brain and body functions. Interestingly, lavender also increased stage 2 (light) sleep and decreased rapid-eye movement (REM) sleep as well as the time needed awaken after first falling asleep in women but had the opposite effect on men. Overall, it was concluded that lavender aromatherapy has a mild sedative effect and has practical application as a novel, non-photic[h] method of promoting deep sleep in young men and women. The gender-dependent sleep effects are, as yet, unexplained.

The findings of the Chinese study [3] that poor sleep quality can be a predictor of PUD recurrence is of importance for older adults. The study data appear to be a strong indication that nighttime use of lavender in a diffuser to induce relaxation and sleep is an important health finding. The study also points to the importance of the gut-brain connection to human health.

Conclusion

Poor sleep patterns and disturbances are recognized as an important health and public health problem that affects physical, mental and emotional health and well-being. The need for sleep, and sleep deficit, is a growing and serious problem across modern society, affecting teenagers, adults and even schoolchildren.

The scientific literature over the past 30 years has provided considerable support to the long-held but anecdotal view that lavender oil aromatherapy is beneficial to relaxation and sleep. It has also been established that users not only have modified and improved sleep patterns but also awaken in the morning with increased vigor.

Clinical research now clearly indicates that inhalation of essential oils, notably pure lavender oil, may be a safe and effective alternative to pharmaceuticals and other interventions for mild to moderate sleep disturbance.

Bibliography

1. Kronholm E., *et al*. "Trends in self-reported sleep duration and insomnia-related symptoms in Finland from 1972 to 2005: a comparative review and re-analysis of Finnish population samples". *Journal of Sleep Research* 17.1 (2008): 54-62.
2. National Institute of Neurological Disorders and Stroke: NIH Publication No. 17-3440c. Brain Basics: Understanding Sleep (2019).
3. Fang B., *et al*. "Effect of subjective and objective sleep quality on subsequent peptic ulcer recurrence in older adults". *Journal of the American Geriatrics Society* 67.7 (2019):1454-1460.
4. Monk TH., *et al*. "A sleep diary and questionnaire study of naturally short sleepers". *Journal of Sleep Research* 10.3 (2001): 173-179.
5. Shi G., *et al*. "A rare mutation of β1-adrenergic receptor affects sleep/wake behaviors". *Neuron* (2019): 10.
6. Paulson S., *et al*. "Dreaming: a gateway to the unconscious?" *Annals of the New York Academy of Sciences* 1406.1 (2017): 28-45.
7. Desseilles M., *et al*. "Cognitive and emotional processes during dreaming: a neuroimaging view". *Consciousness and Cognition* 20.4 (2011): 998-1008.

[h]Non-photic stimulus generally refers to any non-light input to the circadian clock. This would include internally administered endogenous neurotransmitters such as serotonin agonists and melatonin.

8. Scarpelli S., *et al*. "The Functional Role of Dreaming in Emotional Processes". *Frontiers in Psychology* 10 (2019): 459.

9. Barrett D. "Dreams and creative problem-solving". *Annals of the New York Academy of Sciences* 1406.1 (2017): 64-67.

10. von Fraunhofer J.A. "Essential Oils from the Ground Up". Life Rich Publishing, Bloomington, IN (2019).

11. Dyer J., *et al*. "The use of aromasticks to help with sleep problems: A patient experience survey". *Complementary Therapies in Clinical Practice* 22 (2016): 51-58.

12. Lillehei AS and Halcon LL. "A systematic review of the effect of inhaled essential oils on sleep". *The Journal of Alternative and Complementary Medicine* 20.6 (2014): 441-451.

13. Hirokawa K., *et al*. "Effects of lavender aroma on sleep quality in healthy Japanese students". *Perceptual and Motor Skills* 114.1 (2012): 111-122.

14. Schäfer L., *et al*. "Nocturnal Olfactory Stimulation for Improvement of Sleep Quality in Patients with Posttraumatic Stress Disorder: A Randomized Exploratory Intervention Trial". *Journal of Traumatic Stress* 32.1 (2019):130-140.

15. Roozbeh N., *et al*. "Effect of lavender on sleep, sexual desire, vasomotor, psychological and physical symptom among menopausal and elderly women: A systematic review". *Journal of Menopausal Medicine* 25.2 (2019): 88-93.

16. Lytle J., *et al*. "Effect of lavender aromatherapy on vital signs and perceived quality of sleep in the intermediate care unit: a pilot study". *American Journal of Critical Care* 23.1 (2014): 24-49.

17. Malcolm BJ and Tallian K. "Essential oil of lavender in anxiety disorders: Ready for prime time?" *Mental Health Clinician* 7.4 (2018): 147-155.

18. Franco L., *et al*. "Both lavender fleur oil and unscented oil aromatherapy reduce preoperative anxiety in breast surgery patients: a randomized trial". *Journal of Clinical Anesthesia* 33 (2016): 243-249.

19. Goel N., *et al*. "An olfactory stimulus modifies nighttime sleep in young men and women". *Chronobiology International* 22.5 (2005): 889-904.

Volume 18 Issue 12 December 2019