

Lifestyles and their Influence on Sleep Disorders

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Abstract

Sleep is a complex physiological event that occupies nearly one-third of human life. Poor sleep adversely affects several bodily systems. Prolonged sleep deprivation can lead to premature death. Adequate sleep duration and sleep quality are important for a healthy life. For most adults, sleep duration of 7 to 9 hours is healthy. Going to sleep rapidly, sleeping undisturbed through the night, and waking up refreshed are important qualities that should accompany an ideal sleep duration. The determinants of sleep duration and quality are diverse and include several physical and mental health factors. Lifestyle factors also play an important role. The five major lifestyles that adversely impact human health are smoking, obesity, excess alcohol consumption, lack of physical exercise, and an unhealthy diet. These can also disturb sleep duration and sleep quality, leading to sleep disorders. This manuscript provides a narrative review of the various interactions between these lifestyles and human sleep.

Keywords: sleep disorders, smoking, lifestyles, exercise, alcohol, diet, obesity

Introduction

Sleep is vital for life. It helps repair the body, allows tissue regrowth, rebuilds bone and muscle, strengthens the immune system, and allows memory consolidation¹⁻³. Restorative sleep is characterized by a sleep duration of between 7-9 hours per day, falling asleep easily, staying asleep without interruption, waking up feeling refreshed, and staying awake (without sleepiness, lack of alertness, fatigue, or irritability) during the day⁴⁻⁶. Sleep duration and quality, however, vary according to age – babies may sleep 16 to 18 hours per day, schoolchildren need about 9.5 hours of sleep per night, while at age 60, sleep is shorter, lighter, and may be interrupted by multiple awakenings^{7,8}. Poor sleep (sleep disorder) is commonly due to insomnia, sleep apnea, restless leg syndrome, narcolepsy, REM sleep behavior disorder, and circadian-related sleep disorder⁹. These can cause several problems. Children may become overly active, misbehave, be less attentive and suffer in school performance. They may also appear angrier, exhibit impulsiveness, have mood swings, and show a lack of motivation¹⁰. In adults, improper sleep may result in decreased work efficiency, absenteeism, accidents, and low productivity¹¹. Personal and social life is also often affected. The overall quality of life is diminished¹². Sleep disorders are often present in many chronic diseases¹³⁻²⁰. These include cardiovascular diseases (CVD)¹³, type 2 diabetes mellitus (T2DM)¹⁴, asthma¹⁵, hepatitis¹⁶, chronic kidney disease (CKD)¹⁷, metabolic disorders¹⁸, obesity¹⁹, and even some cancers²⁰. Patients with insomnia or obstructive sleep apnea (OSA) demonstrate an increased risk for several CVDs including, arrhythmias, atherosclerosis, coronary heart disease, heart failure, hypertension, and stroke. They

also increase the risk of several CVD causing metabolic disorders such as obesity, T2DM, and dyslipidemia¹³. The relationship between T2DM and sleep disturbances has been well studied. Sleep disorders increase the risk of T2DM by altering insulin sensitivity resulting in lower glucose tolerance. Hypoxia associated with several sleep disorders may lead to a lower pancreatic β -cell function. Disordered sleep may also increase the risk for T2DM by modulating the sympathetic nervous system, cortisol levels, melatonin actions and by increasing inflammation¹⁴. OSA is more common in patients with asthma, and CPAP treatments help improve comorbid asthma in these patients. Insomnia is also known to result in poor control of asthma¹⁵. Sleep problems are common in patients with cirrhosis of the liver. They are encountered in almost 60% of patients with untreated hepatitis C. In patients on interferon- α therapy, the incidence improves to 30%¹⁶. Sleep problems are noted in almost 50% of patients with early CKD, and this percentage increases as high as 80% in patients with end-stage kidney disease (ESKD)¹⁷. Metabolic dysfunction has been noted in patients with insufficient sleep, insomnia, sleep apnea, narcolepsy, and many other sleep disorders. This may lead to weight gain, obesity, and T2DM by food intake, disrupting energy balance, inflammation, impairing glucose tolerance, and insulin sensitivity. These abnormalities are not fully compensated by recovery sleep¹⁸. Several studies have established the causal relationship between short sleep duration and obesity. There is also a reverse causation as obesity leads to many co-morbidities (such as depression, gastrointestinal reflux disease, degenerative joint disease, asthma etc.) which deleteriously affect sleep¹⁹. Chen et al. reported that short sleep duration increased the risk of cancer in Asians while a long sleep duration increased the risk for colorectal cancer²⁰. Sleep disorders have a mutual relationship with many skin disorders²¹. Several dermatosis result in pruritus, pain, burning sensations, pain, or inability to move, disturbing sleep. A bidirectional relationship with psoriasis and insomnia, obstructive sleep apnea syndrome, and restless leg syndrome has been noted. They have also been linked with infertility²². Sleep cycles normally parallel the reproductive cycle. Caetano et al. reviewed 33 studies published in the past 20 years and surmised that disturbed sleep results in an increased risk of menstrual irregularity, lower sperm count, and concentration, and a lower percentage of sperm with normal morphology when compared with normal sleep²². Mental health may also be affected²³⁻²⁹. Sleep-related mental conditions include depression²², anxiety²³, attention-deficit/hyperactivity disorder²⁴, Asperger syndrome^{25,26}, schizophrenia²⁷, and borderline personality/antisocial personality^{28,29}. The relationship is usually bidirectional - most of these chronic non-communicable physical and mental diseases also interfere with normal sleep³⁰⁻³³. Poor sleepers face higher premature mortality³⁴. Sleep duration-mortality risk has been studied in several meta-analytic studies – these show a 10% to 12% increased risk of mortality for short sleep duration and a 30% to 38% increased risk of mortality for long sleep duration³⁵. Sleep is usually assessed by several techniques, including polysomnography, electrophysiological recordings of brain activity, muscle activity, and eye movements³⁶. Sleep disorders impart a high economic burden on society³⁷.

Discussion

Five lifestyles have been recognized as having a major impact on morbidity and mortality³⁸. The healthy behaviors are non-smoking, abstinence or low to moderate alcohol intake, a normal body

mass index, regular exercise, and a prudent quality of diet. According to Li et al.³⁹, adherence to these lifestyles significantly improves survival.

Smoking

Cigarette smoking is a major preventable cause of non-communicable diseases in the world⁴⁰. **Smoking is bi-directionally associated with sleep disorders.** Smokers are more likely to develop poor sleep habits while poor sleepers are more likely to start smoking⁴¹. Cohrs et al. found that difficulty falling asleep and short sleep duration was related to smoking, and this increased as the number of pack-years smoked increased⁴². Smoking-related suboptimal sleep has also been confirmed in studies in the US, Germany, and Australia⁴³⁻⁴⁵. Smoking is independently associated with OSA⁴⁶. Sleep apnea is a common medical condition that leads to disturbed sleep. Kashyap et al. found that current smoking was 35% in OSA patients compared to 18% in non-OSA patients⁴⁷. Several subsequent studies have confirmed a higher prevalence of smoking in OSA patients^{48,49}. Using polysomnography, Jaehne et al. found adult smokers, compared to nonsmokers, had more sleep apnea⁵⁰. Ioannidou et al. reported that using univariate analysis, the prevalence of OSA was 1.2 times higher in current smokers compared with never and former smokers combined⁵¹. They also found that the prevalence in former smokers was 1.49 times higher when compared with never smokers⁵¹. Heavy smokers are also diagnosed at an earlier age with OSA⁵². They exhibit increased apnea-hypopnea index (commonly referred to as AHI) and reduced oxygen saturation, to a higher degree than non-smokers with OSA⁵³. Smoking disturbs the sleep architecture via several mechanisms. Nicotine disturbs sleep by influencing sleep-regulating neurotransmitters⁵⁴. In OSA patients, smoking causes several harmful changes. These include chronic mucosal inflammation and damaged cilia function in the nose, thickening, and swelling of the uvular mucosa, impairment of the neuromuscular protective reflexes of the upper airway, and an accelerated loss of lung function⁵⁵⁻⁵⁷. Although smoking is a risk factor and worsens OSA, untreated OSA is also related to smoking addiction⁵⁸. Overall, smoking disrupts both the quantity and quality of sleep, leading to a reduction in the quality of life in these individuals⁵⁹.

Alcohol

Alcohol is normally a relaxant and may even have euphoric effects⁶⁰. It is commonly consumed during social occasions all over the world⁶¹. Because of its central nervous system depressant actions, it is often used as a non-prescription sleep-aid⁶². Evidence shows that a single alcoholic drink before sleep (in the evening) improves sleep patterns during the first half of sleep by reducing sleep onset latency and increasing non-rapid eye movement (NREM) sleep⁶³. It however disrupts sleep during the second half. These effects may be related to the effect of alcohol on gamma-aminobutyric acid (GABA) and dopamine⁶⁴. Alcohol, if taken in excess, has more detrimental effects on sleep⁶⁵. Alcohol and sleep disturbances are usually bi-directionally related⁶⁶. A prospective longitudinal study, involving 8,960 Finnish adults found that heavy drinking resulted in 1.5 higher odds of having problems with sleep⁶⁶. In the same study, poor sleepers were 1.3 more likely to be heavy drinkers⁶⁶. Alcohol intake has been implicated in sleep disturbances in children, adolescents, and adults^{65,67-69}. Sleep disruptions are common in binge drinkers and chronic alcohol abusers - and there appears to be a dose-response relationship⁷⁰.

These individuals usually demonstrate an increase in sleep onset latency and a reduced sleep duration. This is associated with an increased tendency to sleep during the normal 'awake' day period. Alcohol-dependent patients have more sleep problems than healthy individuals, and this, in turn, can facilitate the development of alcoholism⁷¹. Alcoholics admitted for treatment have a higher rate of insomnia compared to healthy individuals⁷². In addition, alcoholism has a positive association with OSA⁷³. Finally, the higher the sleep disturbance in alcoholics, the higher the relapse in those trying to quit⁷⁴.

Obesity

Body mass index (BMI) is widely used as a measure to define body weight⁷⁵. BMI is commonly measured by this equation: $BMI = [\text{weight (lb)}/\text{height (in)}] \times 703$. In adults (age over 18 years) BMI is categorized into several groups: < 19.9 (underweight), 20.0–24.9. (normal weight), and 25 to 29.9 (overweight). Obesity is defined as a BMI exceeding 30⁷⁶ and is subclassified into class 1 (30–34.9), class 2 (35–39.9), and class 3 or severe obesity (≥ 40). A BMI >50 is considered morbid obesity. The International Obesity Task Force recommends different BMI categories for Asians, due to their physical structure and increased percentage of abnormal fat accumulation. These are as follows: underweight (<18.5), normal (between 18.5 and 23), overweight (between 23 and 25), obese (between 25 and 30), severe obese (≥ 30). BMI is not used for children and adolescents aged 2 to 18 years; instead, a percentile scale based on the child's sex and age is used. Central (or visceral) obesity, as determined by a waist circumference >102 cm in males and >88 cm in females, a waist to hip ratio of more than 0.85 in. women and >0.9 in. men, and a waist-height ratio >0.5, appears to be more harmful than obesity defined by BMI⁷⁷. Obesity is strongly associated with several chronic diseases, including CVD, hypertension, T2DM, nonalcoholic fatty liver disease (NAFLD), gallbladder disease, pancreatitis, sleep apnea, and osteoarthritis⁷⁸. It also increases the risk of several cancers⁷⁹. Obesity also has a strong association with sleep disorders⁸⁰⁻⁹⁰. People who are obese have twice as many subjective sleep problems as those that are non-obese^{80,81}. Being obese or overweight is associated with a decreased amount of sleep compared to those with normal body weight⁸². Obese individuals often complain of daytime sleepiness and fatigue, even if they sleep undisturbed during the night⁸³. They may also suffer from ailments such as depression⁸⁴, gastro-esophageal reflux disease (GERD)⁸⁵, osteoarthritis⁸⁶, and asthma⁸⁷, all of which can further disrupt sleep. Obesity is also associated with OSA, a major cause of sleep fragmentation⁸⁸. Weight loss has a positive effect on sleep quality and duration^{89,90}. Sleep disturbances also increase the risk of obesity⁹¹. This may result from increased food intake or physical inactivity, both often causing poor sleep^{92,93}. The relationship is therefore bidirectional.

Exercise

One metabolic equivalent (MET) equals an energy expenditure of 1 kcal/kg/hour or an oxygen uptake of 3.5 ml/kg/min⁹⁴. Sedentary behavior involves an energy expenditure <1.5 METs⁹⁵, while exercise expends more than 1.5 METs - light-intensity activities expend less than 3 METs, moderate-intensity activities expend 3 to 6 METs, and vigorous activities expend 6 or more METs⁹⁶. Exercise may be an effective non-pharmacological intervention to improve sleep. Several studies have validated this beneficial effect^{97,98}, irrespective of the form of exercise

used⁹⁹. Acute and chronic aerobic exercise improves sleep in midlife and later life¹⁰⁰. A systemic review of thirteen studies suggested that resistance exercise also helps improve sleep quality¹⁰¹. In a study of older adults, both aerobic or resistance exercises significantly reduce sleep onset latency and medication use¹⁰². Even non-traditional exercises like Tai chi and yoga help improve sleep^{103,104}. As often noted with other lifestyle factors, exercise also helps improve several chronic co-morbid conditions such as CVD¹⁰⁵, DM¹⁰⁶, obesity¹⁰⁷, OSA¹⁰⁸, and depression¹⁰⁹ – all of these are known to impair restful sleep.

Diet

Diet plays an important role in maintaining good health. Controlling portions and restricting calories are important dietary interventions that help prevent overweight/obesity¹¹⁰. In some studies, normal-weight adults exhibit higher sleep efficiency than overweight or obese individuals¹¹¹. Weight loss thru dietary modification (combined with exercise) helps improve sleep¹¹². On the other hand, lack of sleep has been shown to increase snacking, the number of meals consumed per day, and the preference for energy-rich foods, increasing the tendency to gain excess body weight¹¹³⁻¹¹⁷. It has been estimated that for every 1 hour later start of eating, there is a 1.25 unit increase in percent body fat¹¹⁸. Further, eating late may also increase the risk of gastroesophageal reflux disease (GERD), which in turn may promote sleep fragmentation¹¹⁹. The relationship between macronutrient intake and healthy sleep is complex. A high fat intake, especially from saturated fats, leads to less restorative sleep¹²⁰. The 2007–2008 National Health and Nutrition Examination Survey results from 4,552 individuals, showed that a cholesterol-rich diet is associated with non-restorative sleep¹²¹. Intake of polyunsaturated fatty acids, docosahexaenoic acid (DHA), and arachidonic acid, on the other hand, appears to enhance sleep initiation and sleep duration.^{122,123} In a study of 395 healthy children from schools in the United Kingdom, supplementation with DHA over 16-weeks led to an improvement in sleep quality¹²². Catalá reported that DHA may play a role in converting serotonin into melatonin, thereby, promoting sleep¹²³. Alterations in both quantity and quality of carbohydrate intake can also influence sleep¹²⁴. High-carbohydrate meals with high glycemic indexes (especially high energy drinks and sugar-sweetened beverages) lead to poorer sleep quality¹²⁴. Carbohydrates with a high glycemic index cause compensatory hyperinsulinemia, which along with counter-regulatory hormone responses results in disturbed sleep¹²⁵. On the other hand, carbohydrates with high fiber, such as whole grains, fruits, and vegetables, are sleep friendly. As far as protein is concerned, a high protein intake diet helps sleep, especially in overweight and obese individuals¹²⁶. Tryptophan, an essential amino acid, is needed to produce serotonin, which in turn creates melatonin¹²⁷. Melatonin has a strong hypnotic and chronobiotic property¹²⁸ and helps sleep. Sleep quality can therefore be improved by eating foods rich in tryptophan or by taking a melatonin supplement. Deficiency of vitamins A, B, C, D, E, and K^{129,130}, and of minerals such as iron¹³¹, zinc¹³², calcium¹³³, and magnesium¹³⁴ is also associated with disturbed sleep. Some dietary supplements have been noted to improve sleep. These include Phlorotannins¹³⁵, GABA, Apocynum venetum leaf extract¹³⁶, Chlorophytum bovivianum root, and velvet bean¹³⁷. However, further studies are needed to confirm the therapeutic practicality of using these. Finally, stimulants like tea and coffee¹³⁸ and spicy foods¹³⁹ may also interfere with a night of restorative sleep. Overall, a balanced diet that is rich in non-starchy vegetables, fruits, whole

grains, and legumes, moderate in consumption of nuts, seafood, lean meats, low-fat dairy products, and vegetable oil, and limited or void in trans-fats, saturated fats, sodium, red meat, refined carbohydrates, and sugar-sweetened beverages is associated with good sleep¹⁴⁰. A prudent diet is also important in mitigating several chronic diseases, such as cardiovascular and respiratory disorders, several cancers, and T2DM¹⁴¹. Diets such as the Mediterranean¹⁴² and the dietary approaches to stop hypertension (DASH)¹⁴³, are primarily plant-based and rich in healthy ingredients and help improve sleep duration and quality.

Conclusion

Proper sleep is vital for a healthy life. It is necessary for bodily repair, consolidation of memories, and good mental health. Proper sleep is characterized by falling asleep easily and staying asleep (uninterrupted) for 7-9 hours. It is also associated with feeling refreshed after waking up and not feeling sleepy during the day. Several diseases, such as those involving the cardiovascular, respiratory, metabolic, and neurological systems, can alter sleep quantity and quality. Inadequate or fragmented sleep can in turn detrimentally affect these ailments. As this minireview shows, sleep can be adversely affected by several unhealthy lifestyles. These include smoking, excessive alcohol intake, excess body weight, sedentary behavior, and poor nutrition. Healthy lifestyles are therefore essential for regular salubrious sleep.

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