Factors Associated with Sleep Quality of High School Students

Guanao Li

Ulink College of Shanghai, 559 South Laiting Road, Jiuting Town, Songjiang District, Shanghai, 201615, China
Corresponding Author: Guanao Li, Email: 1470974684@qq.com

Abstract
Sleep problems for adolescents are getting worse and become an issue that cannot be ignored. I reviewed the literature about factors associated with sleep quality. According to previous studies, I found that milk shows positive impact on sleep quality. Smoke, coffee, phone using, higher temperature, and higher light intensity have negative effects on sleep quality. To verify the results from the literature and investigated potentially new factors with sleep quality, I conducted a survey among high school students. The questionnaires surveyed on the eating habits, sleeping environment, and daily habits with sleep quality which is evaluated by Pittsburgh Sleep Quality Index (PSQI). As a result, I figured out that half of the factors have the similar relationship as the literature, while the effects are not significant in the questionnaire. Then I discussed problems occurred in the investigation and methods can be applied to improve the accuracy.

Keywords
Sleep quality; Factor; High school students; Pittsburgh Sleep Quality Index

Introduction

Sleep occupies a large part in the human's entire life span. Sleep is indispensable for the growth and development of adolescents and it is also essential for maintaining their physical health and psychological well-being. A clear increasing trend in sleep disturbance is found and insomnia becomes a serious public health issue (Gradisar et al., 2011). Previous studies reported that the prevalence of insomnia among adolescents worldwide ranged from 16.9% to 34.0% (Ohayon et al., 2000; Hsying et al., 2013). This could lead to negative impact on many aspects of adolescents' lives, such as dysfunction and depression (Roberts et al., 2002).

Considering the significance of sleep quality, there are many studies concentrating on the associated factors of sleep. For instance, some studies concerned about the food on the sleep quality. Among them, alcohol has side effect on the sleep quality (Chan et al., 2013), while some

Citation: Guanao Li. (2022) Factors Associated with Sleep Quality of High School Students. The Journal of Young Researchers 4(13): e20220610

Received on May 7, 2022; Accepted on May 10, 2022; Published on June 10, 2022

other food, such as milk and dairy products, are beneficial to the sleep quality. Environment conditions also have impact on adolescents' sleep, adolescents in home with electric lighting tend to have later bedtimes than those without electric lighting. Besides, better sleep hygiene is positively correlated with sleep duration (Billows et al., 2009). Meanwhile, the significant effects of sleep quality on the daily life are also investigated in many studies. The poor sleep quality is usually associated with the prevalence of some diseases, including hypertension (Li et al., 2015), type 2 diabetes (Cappuccio et al., 2010), cardiovascular disease (Cappuccio et al., 2011), obesity (Morselli et al., 2010), and cognitive impairment (Sindi et al., 2018). Better sleep quality and longer sleep duration are also beneficial to better school performance (Dewald et al., 2010). However, most of previous studies were carried out in professional laboratories and under the supervision of experimental equipment. These experiments are out of touch with real life and therefore the results of the experiments may be deviated from practical situation. In this investigation, I reviewed related literature in detail to figure out the factors related to the significance of sleep quality. I also conduct a questionnaire survey on high school students around us, which is about eating habits, daily habits, and sleep quality. Therefore, my research results not only include the laboratory research, but also are combined with the actual situation, which is helpful to improve the practicality of sleep-related research.

In this study, I concentrated on the importance of sleep and methods of evaluating sleep quality. I also tried to find out the factors affecting sleep quality of adolescents by giving a questionnaire to high school students. I reviewed several researches about protective and risk factors for adolescents' sleep and found out that eating habits, environment conditions, and daily habits have a variety of effects on sleep. In addition, the poor sleep quality can lead to problems on learning abilities, cognitive function, and school performance. To verify the effectiveness of previous studies, I conducted a survey on the students about the factors associated with sleep quality. Finally, I figured out that coffee, milk and smoke have positive effects on the sleep quality, while using a phone, high light intensity and high temperature have negative effects.

The Impact of Sleep: School Performance

School performance can be assessed by various approaches and can be classified into several subjective and objective aspects. The subjective aspects include self-reported grade point average, parents or teacher reports on the student's grade, behavior ratings, and reports on general school function. There are also some objective aspects on the sleep quality, such as grade point average from the record and scores of standardized tests (Dewald et al., 2010). Sleep quality can be measured by subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, and sleep onset time. It is common for children and adolescents to regulate and maintain daily sleep, which can be regarded as a sign of poor sleep quality (Liu et al., 2002). Based on the previous studies, the lack of sleep duration or disruption of sleep have negative effects on brain activity overnight, and brain activity is necessary for neurocognitive function. Sleep problems can fundamentally influence complex tasks that require abstract thinking, creativity, integration, and planning (Dahl et al., 1996). It is because the insufficient or low-quality sleep during adolescence would impair the executive function of the prefrontal cortex (Harrison et al., 1998), and prefrontal cortex is involved in the tasks which require high order of neurocognitive function (Simmions et al., 1987). Therefore, the poor sleep quality can consequently result in the decline of learning

abilities and school performance (Meijer et al., 2008).

In addition, insufficient sleep is associated with poor attention and performance in children and adolescents. Sleep deprivation can sometimes provoke symptoms of attention deficit hyperactivity disorder (ADHD), including distractibility, impulsivity, and difficulty with effortful control of attention. There is also emerging evidence that sleep deprivation has significant influence on the ability to perform complex tasks or tasks that require attention in two or more areas at the same time. These two factors illustrate that the insufficient sleep have negative impact on school performance (Ronald et al., 1999).

The Impact of Sleep: Prevalence of Disease

Insufficient sleep has terrible impact on all the living creatures. In the animal experiments, the final consequence of prolonged sleep deprivation in animals is death. Rats would die within 2 to 3 weeks when they are deprived of sleep (Rechtschaffen et al., 2002). Early studies also recorded the fatal outcome of prolonged sleep deprivation in dogs. Murine models, such as mice and rats, have also demonstrated the prejudicial effects of prolonged sleep deprivation on a variety of systems with significant changes, including endocrine, metabolic, and immune system (Rechtschaffen et al., 1983). While long-term sleep deprivation experiments are not possible on humans, over the past few decades, some evidences show that habitually shortening or lengthening sleep is associated with higher mortality (Rechtschaffen et al., 1983). The mechanisms behind these associations are not fully understood. The potentially adverse physiological effects of short sleep duration can lead to negative health outcomes, such as cardiovascular disease, diabetes, and obesity, and all of them are associated with an increased risk of death (Spiegel et al., 2005).

At the population level, adults sleeping 7-8 hours per night were associated with the lowest risk and morbidity of cardiovascular disease (Buxton et al., 2010). Sleep deprivation is associated with altered autonomic nervous system function, which affects blood pressure and may increase the risk of cardiovascular morbidity and mortality (Lusardi et al., 1999). A growing number of observational and prospective studies reported the associations between sleep duration, impaired sleep, and metabolic risk, including obesity or body mass index (BMI), and type 2 diabetes (Marashall et al., 2008; Patel et al., 2008). In cross-sectional studies, short sleep duration, which means less than 5 hours sleep duration per night, has been found to increase the possibility of obesity for 1.5 times, and BMI also increases by 0.35 kg/m^2 for each hour of sleep reduction (Cappuccio et al., 2008). Longitudinal study of sleep reported that short sleep duration may increase the risk of obesity (Patel et al., 2008). Several large observational studies showed that short ($\leq$ 5 hours or 6 hours per night) sleep duration increases the possibility of type 2 diabetes and impaired glucose tolerance (Knutson et al., 2010).

The Impact of Sleep: Emotion Regulation and Behavior Problems

Sleep deprivation is associated with increased negative emotions and heightened emotional responses to visual scenes and faces (Goldstein et al., 2014), as well as altered emotional memory processing (Payne et al., 2011; Payne et al., 2008). Therefore, sleep deprivation has a moderating effect on the onset of psychiatric disorders, such as anxiety and major depression (Walker et al., 2010). Preliminary evidence suggests that sleep deprivation also negatively affects mood and mood regulation for adolescents after chronic (Baum et al., 2014)

and acute (Talbot et al., 2010) doses of sleep restriction. In addition, polysomnography (PSG) records of psychiatric inpatients aged 7 to 16 years showed that 95% of them had moderate to severe sleep problems (Shahid et al., 2012). Similar sleep disruptions can be seen in some other patients, including depression (Lovato et al., 2014), ADHD (Owens et al., 2008), impulse control disorders (Scott et al., 2013), anxiety disorders (Gregory et al., 2005) and bipolar disorder (Jackson et al., 2003). The association between sleep problems and mental diseases suggests the critical role of sleep on the adolescents' mental health.

Numerous studies have shown that sleep deprivation is also related to poor emotional function in adolescents with undiagnosed psychiatric disorders. For example, in nonclinical samples, less sleep duration is usually associated with more depressive symptoms, more feeling of hopelessness (Fredriksen et al., 2004), and more anxiety (Baglioni et al., 2010). The risk of insufficient sleep in adolescents is also evident in many large epidemiological studies. Some high school adolescents reported that getting 7, 6, 5, or less than 5 hours of sleep per night at school would increase risks of the following behaviors, including drunk driving, carrying a weapon, fighting, contemplating suicide, suicide attempt, smoking, alcoholism, marijuana use, sexual adventure, and texting while driving (Meldrum et al., 2014).

Sleep Quality Assessment: Polysomnography (PSG)

PSG refers to a systematic process for collecting physiological parameters during sleep and it is a procedure that utilizes electroencephalography, electrooculography, electromyography, electrocardiography, and pulse oximetry, as well as airflow and respiratory effort, to assess the underlying cause of sleep disturbances. In practice, various measurement techniques are used to simultaneously and continuously record neurophysiological, cardiorespiratory, other physiological and physical parameters over several hours. This provides information about the function of multiple organ systems and their interaction with sleep stages. PSGs are primarily used to diagnose sleep related breathing disorders (SRBDs), including central sleep apnea and sleep-related hypoventilation/ hypoxia. Positive airway pressure (PAP) titration sleep studies are modified PSGs that evaluate the effectiveness of PAP therapy in treating SRBDs. Additionally, PSGs can also be used to diagnose sleep-related seizures, periodic limb movement (PLM) disorder, parasomnias, and central hypersomnia.

Sleep Quality Assessment: Actigraphy Devices

Actigraphy is a non-invasive and objective monitoring device which assesses sleep/wake patterns based on exercise records. Actigraphy devices are worn on the wrist, ankle, or hip and contain an accelerometer that monitors and collects body movement. Actigraphy does not require specialized technicians and is useful for studying specific populations. Two common types of actigraphy devices are core accelerometer and wrist actigraphy which are used to record a digitally integrated measurement of gross motor activity. Whereas the core accelerometer is typically worn on the trunk and used to predict energy expenditure and activity data, the wrist actigraphy is worn on an extremity. The actigraphy devices can assess the sleep and wake time. The smaller movements of the wrist as compared to the trunk are used to infer time spent asleep and wake.

Factors Affecting Sleep Quality: Diet

Milk has positive impact and coffee has

generally negative impact on the sleep quality. Caffeine generally increases alertness and reduces sleepiness, and it can also negatively affect sleep quality. The reason is that caffeine intake during the day decreases the 6-sulfatoxymelatonin at next night, which is one of the mechanisms of sleep disruption (Clark et al., 2017). In a recent review, most experimental studies showed that caffeine intake negatively affects sleep latency, sleep duration, sleep efficiency, and relative duration of deep sleep (Clark et al., 2017). Previous research (Drake et al., 2013) studied the effects of taking 400 mg of caffeine at three time points before participants' usual bedtime and found that even intaking 6 hours before bedtime, caffeine significantly disrupted sleep. The study also found there is no difference in total sleep time when caffeine was taken immediately before bed or 3 hours before bed. A study of thousands of randomly selected residents of three European countries (Iceland, Sweden, and Belgium) collected data on sleep characteristics and use of psychoactive substances, including coffee (Janson et al., 1995). They found that caffeine intake did not induce sleep problems or other sleep disturbances when age, gender, smoking, and seasonal changes are under control. Therefore, the impact of caffeine consumption on sleep quality becomes complicated.

Consumption of milk and dairy products is generally believed to promote good sleep quality and have a positive impact on physical and mental health. As for the mechanism, it is believed that milk and dairy products contain large amounts of melatonin-synthesis tryptophan (Try). Melatonin, synthesized from tryptophan via serotonin, is known to induce sleep in humans (Sanlier et al., 2020). It inhibits the action of the inhibitory neurotransmitter gamma-aminobutyric acid (GABA) (Zeng et al., 2014). Milk and dairy products anti-inflammatory effects due to their content of antioxidant and anti-inflammatory components, as well as changes in activity within the brain-gut-microbiome axis (Bosscher et al., 2009). Cross-sectional studies present the relationship between high milk intake, ease of falling asleep, and early phenotype (Sato-Mito et al., 2011). The circadian rhythm is regulated by the biological clock, which is largely influenced by light and diet. Eating Try-rich foods for breakfast and exposure to light during the day can accelerate the secretion of melatonin at night (Fukushige et al., 2014). Therefore, milk has a positive relationship with sleep quality.

Factors Affecting Sleep Quality: Daily Habits

In population-based studies as well as laboratory or clinical studies using polysomnography, several studies reported a negative association between smoking and sleep quality in both adults (Breslau et al., 1996) and adolescents (Patten et al., 2000). An explanation for the relationship between smoking and sleep quality is the key chemical compound in tobacco named nicotine, which leads to the compulsive addiction (Centers for Disease Control and Prevention, 2010). It has pharmacological effect on the central nervous system by stimulating the release of neurotransmitters, including dopamine, serotonin, norepinephrine, acetylcholine, and gamma-amino butyric acid, which contributes to the possibly increasing sleep latency and sleep disturbances (Jaehne et al., 2012). It is also found that smokers without sleep problems at 15 years old were more likely to report sleep problems at 19 years old than never smokers. Smoking cessation can decrease the risk of sleep problems in both adolescents and adults and may reduce sleep disturbances, daily function-related problems, and health problems related to poor sleep quality.

Greater use of cell phones at night are

associated with worse sleep quality (Caumo et al., 2020). The emission of light composed of significant bluish wavelengths from computer and TV monitors is known to interfere with biological circadian processes and affect sleep regulation, and the general pattern of using smartphones nowadays also interferes sleep. On school days, longer and later nighttime use of cell phones can be attributed to shorter sleep duration and poorer sleep quality. Previous studies demonstrated that cell phone use was associated with adverse sleep outcomes, such as shortened sleep duration or delayed bedtime (Hale et al., 2015).

Factors Affecting Sleep Quality: Sleep Environment

Thermal environment, among many factors such as health states, emotional states and bedding conditions, are primary causes of sleep disturbance (Okamoto-Mizuno et al., 2012). High air temperature generally reduces total sleep time, duration of rapid eye movement and slow wave sleep, and also increases sleep onset latency and wakefulness (Lan et al., 2014). A slightly increased than optimal air temperature results in a decrease of subjective sleep quality (Strøm-Tejsen et al., 2016). Recently, the effects of moderate heat or cold exposure on human sleep have been studied. The results show that human sleep is sensitive to air temperature, while moderate heat or cold exposure results in the increased sleep onset latency and slow-wave sleep (SWS).

Light environment during sleep could also influence the sleep. Lights-on sleep was associated with increased stage 1 sleep (N1), decreased SWS, and increased arousal index. Light stimulates retinal ganglion cells (Gooley et al., 2003), and the stimulation triggers non-visual responses directly related to the central circadian pacemaker and the suprachiasmatic nucleus to suppress melatonin secretion (Brainard et al., 2001). Inhibition of melatonin may affect homeostatic sleep regulation and affect neural activity in synchronous neocortical and thalamocortical networks manifested by reduced SWA and spindles (Cajochen et al., 1998). Reduced spindle incidence and power may be affected by reduced SWA itself (Marshall et al., 2006). Close association with spindle rate and sleep stability provide additional supports that sleep with lights on is associated with poor sleep quality, and melatonin may be involved in circadian regulation of sleep (Dang-Vu et al., 2010).

Survey Design

To investigate factors related to the sleep quality, I designed a questionnaire about the frequency of daily behaviors and sleep quality. The daily behaviors in the questionnaire are mostly based on the previous studies. The questionnaire contains four parts, including eating habit, daily habit, sleeping environment, and sleep quality self-assessment. As for the eating habit, it involves the frequency of drinking coffee, milk, alcohol, and eating behavior before sleep. The subjects have five choices, including never, once a day, once every three or four days, once a week, and once a month for every question. For daily habit, it includes the frequency of smoking and watching exciting programs. The subjects can choose never, once per week, twice per week, or three times or more per week in these questions. The time duration of using electronic devices is also included and presented in the form of gap filling. For sleeping environment, it includes light intensity, noise intensity, and temperature in the bedroom. The subjects can rate from 0 to 100 for these three questions: 0 is the lowest and 100 is the highest. Sleep quality is evaluated by Pittsburgh sleep quality index (PSQI) which is widely used in the studies about sleep. The PSQI can provide a reliable, valid, and standardized

measurement of sleep quality, and it also discriminates the "good" and "poor" sleepers. The higher scores of PSQI indicates the poorer sleep quality. Generally, PSQI provides a brief and clinically useful assessment of various sleep disturbances that might affect sleep quality.

Sample

I collected 51 questionnaires in the survey. The subjects' ages are in the range of 16 to 19 years old and the average age is 17.45. The subjects are high school students in Shanghai with 29 males and 22 females. The questionnaires are written in the So Jump online and sent by social media. The So Jump can collect questionnaires and save the original data. It also provides results in every single questionnaire and overall percentage report.

Data Analysis

In this investigation, the data was further proceeded and classified. Inappropriate answers and extreme values were deleted. The data was divided into three sections according to their content (eating habits, daily habits, and sleeping environment). For every question in each section, the data was further classified into two groups. According to the score of every question, the subjects were divided into two groups. One group contains subjects with higher scores for this question, while the other corresponds to the lower scores. Then I compared the sleep quality of two groups, to investigate the relationship between eating habits, daily habits, sleeping environment, with sleep quality. To ensure the numbers of subjects in each group were similar, coffee and milk intake frequency were divided into two groups with less than 40 % and more than 60 % of the maximal frequency. Time of using a phone was divided into two groups with less than 25% and more than 50% of the maximal time. Smoking frequency was divided into two groups with less than 33% and more than 67% of the maximal frequency. Light intensity was divided into two groups with less than 10% and more than 80% of the maximal light intensity. Air temperature was divided into two groups with less than 50 % and more than 50 % of the maximal temperature score. I used unpaired sample t-test to evaluate the difference of sleep quality between two groups in each question. The t-test is used to compare whether the difference between two groups is significant.

Pearson correlation coefficient is applied to calculate the correlation between eating habit, daily habits, and sleeping environment with sleep quality, respectively. The results about the frequency are converted into numbers, where low frequency corresponds to small value and high frequency corresponds to high value. The Pearson correlation coefficient is between -1 and 1, and it indicates a positive correlation when it is greater than 0, while it indicates a negative correlation when it is minus. The absolute value of Pearson correlation coefficient reflects the degree of correlation, and the larger absolute value corresponds to higher correlation between the two variables.

Results of the Questionnaires

I used Pearson correlation to investigate the relationship between eating habits, sleep habits, sleeping environment, and sleep quality. As for the eating habits, eating some food has positive relation with sleep quality. The frequency of taking coffee and milk have negative correlation with scores of PSQI (r_{coffee}=-0.020, r_{milk}=-0.109), indicating the positive correlation with sleep quality. As for the daily habit, time of using a phone has negative correlation with scores of PSQI (r_{phone}=-0.046), which means positive effect on the sleep quality. In contrast, frequency of smoking has positive correlation with PSQI score and negative impact on sleep quality (r_{smoke}=0.043). As for the sleeping environment, high light intensity and

temperature have positive correlation with PSQI score, indicating the negative effects on the sleep quality (r_{light}=0.082, $r_{temperature}$=0.132). Therefore, from the questionnaire and Pearson correlation, I figured out that coffee, milk and smoke have positive effects on the sleep quality, while using a phone, high light intensity and high temperature have negative effects. However, the correlation is not obvious, as the Pearson correlation coefficient is in the range of -0.109 to 0.132. The absolute value is less than 0.3.

Table 1. The PSQI scores of different groups with different eating habits, sleeping environment, and daily habits

Related factors	Average PSQI score	Average PSQI score	P-value
Eating habits			
Coffee	7.50 (High frequency)	8.00 (Low frequency)	0.335
Milk	7.63 (High frequency)	8.89 (Low frequency)	0.501
Sleeping environment			
Light	8.50 (Bright)	7.35 (Dark)	0.484
Temperature	7.24 (Hot)	8.62 (Cold)	0.287
Daily habit			
Using a phone	7.58 (Long time)	7.86 (Short time)	0.830
Smoke	9.25 (High frequency)	8.26 (Low frequency)	0.679

The differences in sleep quality between high frequency and low frequency of coffee intake, milk intake, phone use, and smoke are evaluated by the t-test. The differences in sleep quality between high and low intensity of light, high and low temperature are also assessed by the same method. As shown in Table 1, the groups with high frequency of taking coffee and milk show lower PSQI score and greater sleep quality than the group with low frequency, while the difference is not significant (p_{coffee}=0.335, p_{milk}=0.501). The group of high temperature has little better sleep quality than low temperature group ($p_{temperature}$=0.287). Long time of using a phone also presents little better sleep quality than short time of using a phone (p_{phone}=0.830). While, high light intensity has poorer sleep quality than low light intensity. High frequency of smoking also shows poorer sleep quality has poorer sleep quality than lower frequency of

smoking. However, the differences between two groups are not significant (p_{light}=0.484, p_{smoke}=0.679). In general, higher frequency of taking coffee and milk, higher temperature, and longer time of using a phone have positive effect on sleep quality. While high light intensity and high frequency of smoking have negative effects on sleep quality. However, all the differences are not significant between different groups.

The Comparison between the Literature and the Questionnaires

Based on the results from Pearson correlation and t-test between two groups, I concluded that high frequency of taking coffee, milk, and using a phone can promote sleep quality. High light intensity and high frequency of smoking have negative effects on sleep quality. However, all the effects are not significant. The p-values in t-test are more than 0.05, while the correlation coefficients are less than 0.3. There is a different result showed by these two tests. In Pearson correlation, higher temperature shows negative impact on sleep quality, while the difference is not significant. In contrary, higher temperature has positive relationship with sleep quality in t-test. The difference is still not significant for both tests.

Comparing the sleep-related factors in literature and questionnaires from high school students, I realized that half of the results are the same, while others are different. Milk shows positive impact on sleep quality, while smoke, and higher light intensity have negative influence on sleep quality. These results are the same according to the literature and questionnaires. For other factors, coffee, phone using, and high air temperature in the bedroom are all associated with poorer sleep quality from the literature. However, these factors show opposite results according to questionnaire. Therefore, the results from the literature are partly consistent with the actual situation of high school students, but the difference is not particularly significant in actual situation.

Considering the differences between the literature and questionnaires, I found out that some factors have similar effects on sleep quality, while the difference is not significant in the actual questionnaire, which may be due to the small sample in the high school students. Besides, the option settings are not sufficiently differentiated. Another reason behind this is that the overall PSQI score does not accurately reflect sleep quality. PSQI score consists of scores from different sections. Unbalanced scores in different sections can result in the similar overall scores. The scores of aspects related to sleep quality can be different although the overall scores are the same. Due to the limitation of this investigation, I expect that further studies can be improved in several ways. The sample number can be increased to reduce the impact of special results on the overall experiment. Options can be set at more extremes to maximize the differences between the data of two groups. Another point is that the detailed scores in PSQI should also be considered.

Conclusion

According to previous studies, I found that milk shows positive impact on sleep quality. Smoke, coffee, phone using, higher temperature, and higher light intensity have negative influence on sleep quality. For the investigation, I concluded that high frequency of taking coffee, milk and using a phone can promote sleep quality. High light intensity and high frequency of smoking

have negative effects on sleep quality. However, the impacts of higher temperature on sleep quality are opposite in Pearson correlation and t-test. All the differences are not significant. Half of the results are matched in the literature and questionnaire: milk shows positive impact on sleep quality, smoke and higher light intensity have negative influence on sleep quality. In contrary, the rest show different results. Coffee, phone using and temperature are all associated with poorer sleep quality from the literature. However, these factors show opposite results according to questionnaire.

Conflict of Interests: the author has claimed that no conflict of interests exists.

References

1. Baglioni, C., Spiegelhalder, K., Lombardo, C., & Riemann, D. (2010). Sleep and emotions: a focus on insomnia. *Sleep medicine reviews,* 14(4), 227-238. https://doi.org/10.1016/j.smrv.2009.10.007
2. Baum, K.T., Desai, A., Field, J., Miller, L.E., Rausch, J., & Beebe, D.W. (2014). Sleep restriction worsens mood and emotion regulation in adolescents. *The Journal of Child Psychology and Psychiatry,* 55(2), 180-90. https://doi.org/10.1111/jcpp.12125
3. Billows, M., Gradisar, M., Dohnt, H., Johnston, A., McCappin, S., & Hudson, J. (2009). Family disorganization, sleep hygiene, and adolescent sleep disturbance. *Journal of Clinical Child and Adolescent Psychology,* 38(5), 745-752. https://doi.org/10.1080/15374410903103635
4. Bosscher, D., Breynaert, A., Pieters, L., & Hermans, N. (2009). Food-based strategies to modulate the composition of the intestinal microbiota and their associated health effects. *Journal of Physiology and Pharmacology*, 60(6), 5–11.
5. Brainard, G.C., Hanifin, J.P., Greeson, J.M., Byrne, B., Glickman, G., Gerner, E., & Rollag, M.D. (2001). Action spectrum for melatonin regulation in human: evidence for a novel circadian photoreceptor. *The Journal of Neuroscience,* 21(16), 6405-6412. https://doi.org/10.1523/JNEUROSCI.21-16-06405.2001
6. Breslau, N., Roth, T., Rosenthal, L., & Andreski, P. (1996). Sleep disturbance and psychiatric disorders: a longitudinal epidemiological study of young adults. *Biological Psychiatry,* 39(6), 411-418
7. Buxton, O.M., & Marcelli, E. Short and long sleep are positively associated with obesity, diabetes, hypertension, and cardiovascular disease among adults in the United States. (2010). *Social Science & Medicine,* 71(5), 1027-1036. https://doi.org/10.1016/j.socscimed.2010.05.041
8. Buxton, O.M., Pavlova, M., Reid, E.W., Wang, W., Simonson, D.C., & Adler, G.K. (2010) Sleep restriction for 1 week reduces insulin sensitivity in healthy men. *Diabetes,* 59(9), 2126-2133. https://doi.org/10.2337/db09-0699
9. Cajochen, C., Krauchi, K., Danileko, K.V., & Wirz-Justice, A. (2002). Evening administration of melatonin and bright light: interactions on the EEG during sleep and wakefulness. *Journal Sleep Research,* 7(3), 145-157. https://doi.org/10.1046/j.1365-2869.1998.00106.x
10. Cappuccio, F.P., Cooper, D., D'Elia, L., Strazzullo, P., & Miller, M.A. (2011). Sleep duration predicts cardiovascular

outcomes: a systematic review and meta-analysis of prospective studies. *European Heart Journal,* 32(12), 1484-1492. https://doi.org/10.1093/eurheartj/ehr007

11. Cappuccio, F.P., D'Elia, L., Strazzullo, P., & Miller, M.A. (2010). Quantity and quality of sleep and incidence of type 2 diabetes: a systematic review and meta-analysis. *Diabetes Care,* 33(2), 414-420. https://doi.org/10.2337/dc09-1124
12. Cappuccio, F.P., Taggart, F.M., Kandala, N.B., & Currie, A. (2008). Meta-analysis of short sleep duration and obesity in children and adults. *Sleep,* 31(5), 619-626. https://doi.org/10.1093/sleep/31.5.619
13. Caumo, G.H., Spritzer, D., Carissimi, A., & Tonon, A.C. (2020). Exposure to electronic devices and sleep quality in adolescents: A matter of type, duration, and timing. *Sleep health,* 6(2), 172-178. https://doi.org/10.1016/j.sleh.2019.12.004
14. Centers for Disease Control and Prevention (US); National Center for Chronic Disease Prevention and Health Promotion (US); Office on Smoking and Health (US). How Tobacco Smoke Causes Disease: The Biology and Behavioral Basis for Smoking-Attributable Disease: A Report of the Surgeon General. Atlanta (GA): Centers for Disease Control and Prevention (US). (2010).
15. Chan, J.K.M., Trinder, J., Andrewes, H.E., Colrain, I.M., & Nicholas, C.L. (2013) The acute effects of alcohol on sleep architecture in late adolescence. *Alcohol Clinical & Experimental Research,* 37(10) 1720-1728. https://doi.org/10.1111/acer.12141
16. Clark, I., & Landolt, H.P. (2017). Coffee, caffeine, and sleep: a systematic review of epidemiological studies and randomized controlled trials. *Sleep Medicine Reviews,* 31, 70-78. https://doi.org/10.1016/j.smrv.2016.01.006
17. Dahl, R.E., The regulation of sleep and arousal: development and psychopathology. (1996). *Development and Psychopathology,* 8(1), 3–27. https://doi.org/10.1017/S0954579400006945
18. Dang-Vu, T.T., McKinney, S.M., Buxton, O.M., Solet, J.M., & Ellenbogen, J.M. (2010). Spontaneous brain rhythms predict sleep stability in the face of noise. *Current Biology,* 20(15), R626-R627. https://doi.org/10.1016/j.cub.2010.06.032
19. Dewald, J.F., Meijer, A.M., Oort, F.J., Kerkhof, G.A., & Bogels, S.M. (2010). The influence of sleep quality, sleep duration and sleepiness on school performance in children and adolescents: A meta-analytic review. *Sleep Medicine Reviews,* 14(3) 179-189. https://doi.org/10.1016/j.smrv.2009.10.004
20. Drake, C., Roehrs, T., Shambroom, J., & Roth, T. (2013) Caffeine effects on sleep taken 0, 3, or 6 hours before going to bed. *Journal Clinical of Sleep Medicine,* 9(11). https://doi.org/10.5664/jcsm.3170
21. Fredriksen, K., Rhodes, J., Reddy, R., & Way, N. (2004). Sleepless in Chicago: tracking the effects of adolescent sleep loss during the middle school years. *Child development,* 75(1), 84–95. https://doi.org/10.1111/j.1467-8624.2004.00655.x
22. Fukushige, H., Fukuda, Y., Tanaka, M., Inami, K., Wada, K., Tsumura, Y. Kondo,

M., Harada, T., Wakamura, T., & Morita, T. (2014). Effects of tryptophan-rich breakfast and light exposure during the daytime on melatonin secretion at night. *Journal of Physiology Anthropology,* 10, 679-708.

23. Goldstein, A.N., & Walker, M.P. (2014). The role of sleep in emotional brain function. *Annual review of clinical psychology,* 10, 679-708.
24. Gooley, J.J., Lu, J., Fischer, D., & Saper, C.B. (2003). A broad role for melanopsin in nonvisual photoreception. *The Journal of Neuroscience,* 23(18), 7093-7106. https://doi.org/10.1523/JNEUROSCI.23-18-07093.2003
25. Gradisar, M., Gardner, G., & Dohnt, H. (2011). Recent worldwide sleep patterns and problems during adolescence: a review and meta-analysis of age, region, and sleep. *Sleep Medicine,* 12(2), 110-118. https://doi.org/10.1016/j.sleep.2010.11.008
26. Grandner, M.A., Hale, L., Moore, M., & Patel, N.P. (2010). Mortality associated with short sleep duration: The evidence, the possible mechanisms, and the future. *Sleep Medicine Review,* 14(3), 191-203. https://doi.org/10.1016/j.smrv.2009.07.006
27. Gregory, A.M., Caspi, A., Eley, T.C., Moffitt, T.E., O'Connor, T.G., & Poulton, R. (2005). Prospective longitudinal associations between persistent sleep problems in childhood and anxiety and depression disorders in adulthood. *Journal of abnormal child psychology,* 33, 157–163.
28. Hale, L., & Guan, S. (2015). Screen time and sleep among school-aged children and adolescents: a systematic literature review. *Sleep Medicine Review,* 21, 50-58. https://doi.org/10.1016/j.smrv.2014.07.007
29. Harrison, Y. & Horne, J.A. (1998). Sleep loss impairs short and novel language tasks having a prefrontal focus. *The Journal of Sleep Research,* 7(2), 95–100. https://doi.org/10.1046/j.1365-2869.1998.00104.x
30. Jackson, A., Cavanagh, J., & Scott, J. (2003). A systematic review of manic and depressive prodromes. *Journal of affective disorders.* 74(3), 209–217. https://doi.org/10.1016/S0165-0327(02)00266-5
31. Jaehne, A., Unbehaun, T., Feige, B., Lutz, U.C., Batra, A., & Riemann, D. (2012). How smoking affects sleep: a polysomnographical analysis. *Sleep Medicine,* 13(10), 1286-1292. https://doi.org/10.1016/j.sleep.2012.06.026
32. Janson, C., Gislason, T., de Backer, W., Plaschke, P., Bjornsson, E., Hetta, J., Kristbjamason, J., Vermeire, P., & Boman, G. (1995) Prevalence of sleep disturbances among young adults in three European countries. *Sleep.* 18(7), 589–597. https://doi.org/10.1093/sleep/18.7.589
33. Knutson, K.L. (2010). Sleep duration and cardiometabolic risk: A review of the epidemiologic evidence. *Best Practice & Research Clinical Endocrinology & Metabolism,* 24(5), 731-743. https://doi.org/10.1016/j.beem.2010.07.001
34. Knutson, K.L., & Van Cauter, E. (2008). Associations between sleep loss and increased risk of obesity and diabetes. *Annals of the New York Academy Sci,* 1129(1), 287-304. https://doi.org/10.1196/annals.1417.033
35. Komada, Y., Okajima, I., & Kuwata, T.

(2020). The effects of milk and dairy products on sleep: a systematic review. *International Journal of Environmental Research and Public Health,*17(24), 9440. https://doi.org/10.3390/ijerph17249440

36. Lan, L., Lian, Z.W., Huang, H.Y., & Lin, Y.B. (2014). Experimental study on thermal comfort of sleeping people at different air temperatures. *Building and Environment,* 73, 24-31. https://doi.org/10.1016/j.buildenv.2013.11.024
37. Li, Y.V.A., Fernandez-Mendoza, J. (2015). Insomnia with physiological hyperarousal is associated with hypertension. *Hypertension,* 65(3), 644–650. https://doi.org/10.1161/HYPERTENSIONAHA.114.04604
38. Liu, X., & Zhou, H. (2002). Sleep duration, insomnia and behavioral problems among Chinese adolescents. *Psychiatry Research,*111(1), 75–85. https://doi.org/10.1016/S0165-1781(02)00131-2
39. Liu, X., Uchiyama, M., Okawa, M., & Kurita, H. (2000). Prevalence and correlates of self-reported sleep problems among Chinese adolescents Sleep. *Journal Sleep Research Sleep Medicine,* 23(1), 27-34. https://psycnet.apa.org/doi/10.1093/sleep/23.1.1
40. Lovato, N., & Gradisar, M. (2018). A meta-analysis and model of the relationship between sleep and depression in adolescents: recommendations for future research and clinical practice. *Sleep medicine reviews.* 18(6), 521–529. https://doi.org/10.1016/j.smrv.2014.03.006
41. Lusardi, P., Zoppi, A., Preti, P., Pesce, R.M., Piazza, E., & Fogari, R. (1999). Effects of insufficient sleep on blood pressure in hypertensive patients: A 24-h study. *American Journal of Hypertension,* 12(1), 63-68. https://doi.org/10.1016/S0895-7061(98)00200-3
42. M. Hysing, S., Pallesen, K.M., Stormark, A.J., & Lundervold, B., Sivertsen Sleep patterns and insomnia among adolescents: a population-based study. *J Sleep Res,* 22 (5) (2013), pp. 549-556
43. Marshall, L., Helgadottir, H., Molle, M., & Born, J. (2006). Boosting slow oscillations during sleep potentiates memory. *Nature.* 444, 610–613.
44. Marshall, N.S., Glozier, N., & Grunstein, R.R. (2008). Is sleep duration related to obesity. A critical review of the epidemiological evidence. *Sleep Medicine Review,* 12(4), 289-298. https://doi.org/10.1016/j.smrv.2008.03.001
45. Meijer, A.M. Chronic sleep reduction, functioning at school and school achievement in preadolescents. (2008). *Journal of Sleep Research,* 17(4), 395–405. https://doi.org/10.1111/j.1365-2869.2008.00677.x
46. Meldrum, R.C., & Restivo, E. (2014). The behavioral and health consequences of sleep deprivation among U.S. high school students: relative deprivation matters. *Preventive medicine.* 63,24–28. https://doi.org/10.1016/j.ypmed.2014.03.006
47. Mitru, G., Millrood, D.L. & Mateika, J.H. (2002). The impact of sleep on learning and behavior in adolescents. *Teachers College Record,* 104, 704–726.

48. Morselli, L., Leproult. R., Balbo, M., & Spiegel, K. (2010). Role of sleep duration in the regulation of glucose metabolism and appetite. *Best Practice & Research Clinical Endocrinology & Metabolism.* 24(5), 687–702. https://doi.org/10.1016/j.beem.2010.07.005
49. Ohayon, M.M., Roberts, R.E., Zulley, J., & S. Smirne, R.G. (2000). Priest Prevalence and patterns of problematic sleep among older adolescent. *Journal of the American Academy Child & Adolescent Psychiatry,* 39(12), 1549-1556. https://doi.org/10.1097/00004583-200012000-00019
50. Okamoto-Mizuno, K. (2012). Effects of thermal environment on sleep and circadian rhythm. *Journal of Physiology and Anthropology,* 31, 14.
51. Owens, J.A. (2008). Sleep disorders and attention-deficit/hyperactivity disorder. *Current psychiatry reports.* 10, 439–444.
52. Patel, S.R., & Hu, F.B. (2008). Short sleep duration and weight gain: a systematic review. *Obesity,*16, 643-653. https://doi.org/10.1038/oby.2007.118
53. Patten, C.A., Choi. W.S., Gillin, J.C., & Pierce, J.P. (2000). Depressive symptoms and cigarette smoking predict development and persistence of sleep problems in US adolescents. *Pediatrics,* 106(2), e23. https://doi.org/10.1542/peds.106.2.e23
54. Payne, J.D., & Kensinger, E.A. (2011). Sleep leads to changes in the emotional memory trace: evidence from FMRI. *Journal of Cognitive Neuroscience.* 23(6), 1285-1297. https://doi.org/10.1162/jocn.2010.21526
55. Payne, J.D., Stickgold, R., Swanberg, K., & Kensinger, E.A. (2008). Sleep preferentially enhances memory for emotional components of scenes. *Psychology Science,* 19(8), 781-788. https://doi.org/10.1111%2Fj.1467-9280.2008.02157.x
56. Rechtschaffen, A., Gilliland, M.A., Bergmann, B.M., & Winter, J.B. (1983). Physiological correlates of prolonged sleep deprivation in rats. *Science,* 221(4606), 182-184. https://doi.org/10.1126/science.6857280
57. Rechtschaffen, A., & Bergmann, B.M. (2002). Sleep deprivation in the rat: An update of the 1989 paper. *Sleep,* 25, 18-24.
58. Roberts, R.E., Roberts, C.R., & Chen I.G. (2002). Impact of insomnia on future functioning of adolescents. *Journal of psychosomatic research,*53(1), 561-569. https://doi.org/10.1016/S0022-3999(02)00446-4
59. Ronald, E., & Dahl, M.D. (1999). The Consequences of Insufficient Sleep for Adolescents: Links Between Sleep and Emotional Regulation. *Phi Delta Kappan,* 80(5), 354-359.
60. Sanlier, N., & Sabuncular, G. (2020). Relationship between nutrition and sleep quality, focusing on the melatonin biosynthesis. *Sleep Biology Rhythms.* 18, 89–99.
61. Sato-Mito, N., Sasaki, S., Murakami, K., Okubo, H., Takahashi, Y., Shibata, S., Yamada, K., & Sato, K. the Freshmen in Dietetic Courses Study II group. (2011). The midpoint of sleep is associated with dietary intake and dietary behavior among young Japanese women. *Sleep Medicine,* 12(3), 289–294. https://doi.org/10.1016/j.sleep.2010.09.012
62. Scott, N., Blair, P.S., Emond, A.M., Fleming, P.J., Humphreys, J.S., &

Gringras, P. (2013). Sleep patterns in children with ADHD: a population-based cohort study from birth to 11 years. *Journal of sleep research.* 22(2),121–128. https://doi.org/10.1111/j.1365-2869.2012.01054.x

63. Shahid, A., Khairandish, A., Gladanac, B., & Shapiro, C. (2012). Peeking into the minds of troubled adolescents: the utility of polysomnography sleep studies in an inpatient psychiatric unit. *Journal of Affect Disorders.* 139(1), 66-74. https://doi.org/10.1016/j.jad.2012.01.034
64. Shilo, L., Sabbah, H., Hadari, R., Kovatz, S., Weinberg, U., Dolev, S., Dagan, Y., & Shenkman. (2002). The effects of coffee consumption on sleep and melatonin secretion. *Sleep Medicine.* 3(3), 271–273. https://doi.org/10.1016/S1389-9457(02)00015-1
65. Simmons, R.G., Burgeson, R., Carlton, F.S. & Blyth, D.A. (1987). The impact of cumulative change in early adolescence. *Child Development,* 58(5), 1220-1234. https://doi.org/10.2307/1130616
66. Sindi, S., Kåreholt, I., Johansson, L., Skoog, J., Sjoberg, L., Wang, H.X., Johansson, B., Fratiglioni, L., Soininen, H., Solomon, A., Skoog, I., & Kivipelto, M. (2018). Sleep disturbances and dementia risk: a multicenter study. *Alzheimer's Dementia,* 14(10), 1235–1242. https://doi.org/10.1016/j.jalz.2018.05.012
67. Spiegel, K., Knutson, K., Leproult, R., Tasali, E., & Van Cauter, E. (2005). Sleep loss: a novel risk factor for insulin resistance and Type 2 diabetes. *Journal of Applied Physiology,* 99(5), 2008-2019. https://doi.org/10.1152/japplphysiol.00660.2005
68. Storfer-Isser, A., Lebourgeois, M.K., Harsh, J., Tompsett, C.J., & Redline, S. (2013). Psychometric properties of the adolescent sleep hygiene scale. *Journal of Sleep Research,* 22(6), 707-716. https://doi.org/10.1111/jsr.12059
69. Strøm-Tejsen, P., Mathiasen, S., Bach, M., & Petersen, S. (2016). The effects of increased bedroom air temperature on sleep and next-day mental performance. In: The 14th International Conference of Indoor Air Quality and Climate-Indoor Air 2016. *Belgium, Ghent.*
70. Talbot, L.S., McGlinchey, E.L., Kaplan, K.A., Dahl, R.E., & Harvey, A.G. (2010). Sleep deprivation in adolescents and adults: changes in affect. *Emotion,* 10(6),831-841. https://psycnet.apa.org/doi/10.1037/a0020138
71. Walker, M.P., & Harvey, A.G. (2010). Obligate symbiosis: sleep and affect. *Sleep Medicine Review.* 14(4),215-217. https://doi.org/10.1016/j.smrv.2010.02.003
72. Zeng, Y., Yang, J., Du, J., Pu, X., Yang, X., Yang, S., & Yang, T. (2014). Strategies of Functional Foods Promote Sleep in Human Being. *Current Signal Transduction Therapy,* 9(3),148–155.