The Effects of Nicotine on Sleep Quality

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Abstract

Nicotine is a stimulant found in cigarettes that is reported to cause a decrease in the quality of sleep in young adults when compared to non-smokers. Factors including frequency of cigarette smoking, dependency, and even nicotine intensity influence sleep quality. The information explored in this paper covers topics including the distinguishable effects of nicotine product types, measures of nicotine dependence, the effects of nicotine withdrawal, and the importance of quality sleep. The use of questionnaires, longitudinal studies, logistical regressions, and baseline data were analyzed and show that nicotine product type, nicotine dependence (ND) level, frequency of cigarette consumption, withdrawal symptoms, and withdrawal intolerance are directly associated with increased insomnia symptoms, sleep disturbances, sleep apnea, and a lack of rapid eye movement (REM) sleep. The results show that even the purpose of nicotine intake and compensatory behaviors can create various sleeping impairments and associated behaviors including mood variability, concentration issues, fatigue, and irritability. Furthermore, nighttime smokers are found to have an increased amount of sleep disturbances compared to non-night smokers and engage in higher rates of smoking which generates lower quality sleep. Collectively, the results show cigarette smoking and dependency are associated with a decline in sleep quality in young adults. The health effects related to smoking and poor sleep should urge the analyzed population to seek smoking cessation treatment, possible medical withdrawal assistance, and a polysomnography examination.

The Effects of Nicotine on Sleep Quality

Introduction

With 30.8 million U.S. adults estimated to be current smokers, nicotine's controlling presence in society has been marked with increased strength, availability, and appeal to various age groups. The effects of smoking have been well documented and researched beginning in the 1960's with the Surgeon General's first report on the health repercussions of smoking, informing the public that smoking causes severe health problems including lung cancer, bronchitis, and coronary heart disease (*The 1964 Reporting on Health*). However, the in-depth correlation between nicotine and sleep has only recently surfaced into modern studies, despite sleep research being present in scientific literature as early as 1584. In this paper, I will be investigating and articulating how nicotine dependence (ND), methods of nicotine inhalation, and withdrawal produce decreased sleep quality in adults.

Background

Many organizations such as the Center for Disease Control and Prevention (CDC), the American Heart Association, and the World Health Organization are responsible for providing readily available information and research to the public regarding topics related to health. As new laws and regulations related to the marketing, creation, and distribution of nicotine products increases, companies must alter their approach and products to satisfy specified guidelines. This everchanging market coupled with improved medical technology allows for great insights into how we are directly affected by the products we ingest.

Nicotine and Brain Function

Nicotine is a chemical that is acquired from tobacco leaves which are processed into various routes of administration including skin contact, oral contact, or smoking (inhalation)

(Tiwari et al., 2020). When nicotine is ingested through inhalation, its chemical compounds enter the blood stream and brain through nicotinic receptors at the quickest rate and causes the release of epinephrine (adrenaline) (Quattrocki et al., 2000). This neurotransmitter is partially responsible for the increased heart rate, blood pressure, and overall vascular restriction related to smoking (NIDA, 2021). Accompanying this is the release of other neurotransmitters including dopamine and serotonin, which are responsible for reward systems within the brain. Collectively, the release of these neurotransmitters combined with repetitive psychologic rewards result in effortless nicotine addiction, dependence, and related withdrawal given the lack of any of these variables (NIDA, 2021).

Negative Effects of Nicotine

Nicotine ingestion within the body can result in side effects to almost every major organ and system within the body. Ingestion through inhalation can cause nausea and vomiting, while negatively affect the heart, lungs, kidneys, liver, respiratory system, central nervous system, and immunological system (Mishra et al., 2015). In relation to the brain, nicotine ingestion increases prefrontal cortex activity and affects respiration rhythm resulting in shallower breaths and erratic breathing (Mishra et al., 2015).

Sleep and Brain Function

Research shows that sleep is an important factor related to both mental and physical health. Specifically, much of our cognitive, behavioral, and physical processes rely on a minimum of 7 hours of sleep per day to keep the body and brain healthy (Eugene & Masiak, 2015). Throughout a person's sleep cycle they will engaged in two types of sleep: non-rapid eye movement (NREM) and rapid eye movement (REM). Both NREM and REM cycles can be further divided into stages to characterize variation of sleep deepness and brain wave processes.

The order of sleep stages and their related time-percentages are as follows: N1 (5%), N2 (45%), N3 (25%), N2, and REM (25%). This cycle is repeated throughout sleep every 90 to 110 minutes (Patel et al., 2022).

Negative Effects of Low-Quality Sleep

Low-quality sleep can be characterized by three main characteristics: decreased length of sleep (deprivation), sleep disturbances, and the inability to sleep (insomnia). Low-quality sleep is directly related to memory difficulties, cognition issues, hallucinations, heightened obesity risk, diabetes, cardiovascular disease, depression, and anxiety (Patel et al., 2022). Furthermore, insomnia increases physical morbidity, sleep cycle disorders, daytime impairment, and accidents (Patel et al., 2022). Overall, high-quality sleep is necessary to prevent a decline in well-being and quality of life.

Smoking, Nicotine Dependence, and Sleep Quality

In a study on the relationship between nicotine dependence and sleep quality, cigarette smokers reported having lowered sleep quality when compared to non-smokers. The study investigates how cigarette smoking, nicotine dependence, and sleep are related by means of longitudinal investigation and collected data. This is done using three objectives that are present within this research: 1) report young adult poor sleep frequency in smokers. 2) outline the relationship between smoking behavior and sleep quality. 3) overview how ND and sleep quality are related (Dugas et al., 2017). Unlike prior research, this study considers the number of cigarettes smoked rather than implicating an indicator for smoking. The relationship between ND and sleep quality was found to be correlated, with more dependent smokers experiencing increased amounts of sleep disturbances, increased daytime dysfunction, and lowered sleep quality. The article stresses the importance of understanding this relationship as the young

adulthood stage finds important and drastic changes related to life which can be negatively affected by decreased sleep quality.

Description of Sample

The participants of the study consisted of 182 male and 223 female young adult smokers with a mean age of 24. Of the 405 participants, 45% were acquired to be daily smokers and the remaining requiring to have smoked more than 100 cigarettes within the past year for eligibility.

Methods

Smoking frequency data was collected based on past-year smoking frequency the total number of cigarettes smoked within the past month. Withdrawal, cravings, self-medication symptoms, Modified Version of the Fagerstorm Tolerance Questionnaire (mFTQ), and the ICD-10 criteria for tobacco dependence were identified as nicotine dependence indicators. Sleep quality was measured using the Pittsburg Sleep Quality Index (PSQI). The indicator results as well as sleep quality measures were collected using a self-report questionnaire completed by the sample in 2011-2012.

Fagerstorm Tolerance Questionnaire

The modified version of this questionnaire measures ND levels in individuals ages 14-20. ND is measured using basic scoring outlined between scores 0-9 indicating level of dependence. The questionnaire contains a test-retest reliability at a 2-month interval ($r = .71$) and internal consistency (Cronbach alpha = .75) (Prokhorov et al., 2020).

Pittsburg Sleep Quality Index

The PSQI derives its scores from 7 components of sleep measured on a 0-3 scale with a global score range of 0-21. The components measured are subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbance, use of sleep medication, and daytime

dysfunction (Buysse et al., 1989). The questionnaire contains test-retest reliability (r = .87) and reliability with internal consistency (Cronbach's alpha = .83) (Chiu & Hsu, 2016).

Results

With a PSQI score greater than 5, 36% of the sampled participants recorded having poor sleep quality. Odds ratios pertaining to specific variable controls were used to measure the association of specific exposures and results. With odds ratios (OR) and exposures calculated at a 95% confidence interval, higher cigarette consumption (1.03(1.001-1.05)), withdrawal symptoms that occur more frequently (1.05(1.004-1.10)), cravings (1.05(1.004-1.10)), higher mTFQ scores (1.14(1.02-1.27)), and greater dependence on tobacco (1.19(1.04-1.36)) were associated with a decreased sleep quality (Dugas et al., 2017). This data demonstrates the association that smoking and ND have on the quality of sleep that an individual experiences. The isolation of specific variable exposures to their outcomes combined with the longitudinal self-reports confidently expresses this relationship.

Nicotine Product Type on Sleep Quality

In a study that explores cigarette use on adults and documents its effects on sleep health and quality, main and interactive effects of both combustible and e-cigarette use are used to measure differentiation in sleep duration, latency, disturbances, daytime dysfunction/alertness, and perception of sleep. Being the first study to examine the effects of cigarette type on sleep quality, the number of cigarettes and amount of e-cigarette use is used to predict variances in sleep schedules and related quality. The results show that the type of cigarette use does affect specified variables, including unique outcomes on sleep quality when products are used in combination or individually. Furthermore, interactive effects were also found with the use of sleeping medications and compensatory behaviors such as caffeine intake (So et al., 2021).

Description of Sample

The sample consisted of 227 current smokers who engage in both combustible and e-cigarette use. Demographic information related to the participants was recorded and included "age, sex, race, ethnicity, the highest level of education (1 = grade 6 or less to 8 = graduate/professional degree), annual household income (1 = $0‑$4999 to 8 = $75,000 or higher), and marital status (1 = married/living with someone, 2 = widowed, 3 = separated, 4 = divorced/annulled, 5 = never married)" (So et al., 2021). A majority of the sample were Caucasian (78%), female (53.6%), and had a mean age of 36.89. Inclusion criteria for the study required participants to be between the ages of 18-65, are current dual cigarette users, and provided consent.

Methods

Three questionnaires were used to measure both sleep quality and smoking history: the PSQI, the Smoking History Questionnaire (SHQ), and the E-Cigarette Smoking History Questionnaire (EC-SHQ). The SHQ and EC-SHQ both measure current and past use of respective cigarette type and describe the samples daily cigarette use (CPD).

Results

Results for the study were separated into predictors of global sleep quality, sleep onset latency, sleep duration, daytime dysfunction, and sleep medication use. These predictors were examined for evidence of interactions of concurrent and separate use.

Global Sleep Quality

As separate predictors, e-cigarette frequency was found to increase PSQI scores, but combustible cigarette frequency contrived a significant main effect (b = .08, SE = .03, P = .04). The interaction of both methods and increased CPD were associated with increased PSQI scores (b = .005, SE = .003, P = .047); however, only high combustible cigarette use was associated with overall worse global sleep quality (So et al., 2021). **Figure 1** demonstrates the low to high frequency comparison of both combustible and e-cigarette PSQI scores.

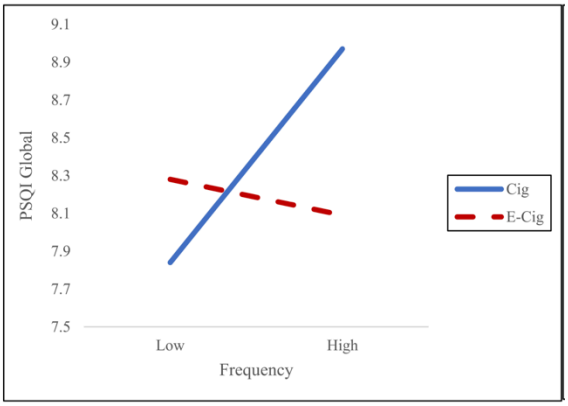

Figure 1

Sleep Onset Latency (SOL)

Neither combustible or e-cigarette use accounted for significant variance or prediction of change in SOL.

Sleep Duration

The frequency of both methods of cigarette use were determined to be a significant predictor of sleep duration (ΔR^2 = .03, b = .02, P = .008) (So et al., 2021). This effect of the predictor resulted in an association between CPD and decreased sleep duration.

Daytime Dysfunction Due to Sleepiness

E-cigarette use and frequency were determined to be a significant predictor of daytime dysfunction (b = .02, SE = .01, P = .01). Frequency of e-cigarette use and daytime dysfunction were positively correlated, which associated the dysfunction to sleepiness caused by e-cigarette use (So et al., 2021).

Predicting Sleep Medication Use

A significant interaction of both combustible and electronic cigarette frequency on sleep medication was determined (b = .002, SE = .001, P = .02). Higher frequency use of only combustible cigarettes were found to increase the use of sleep medication (So et al., 2021). **Figure 2** illustrates the PSQI scores related to cigarette frequency.

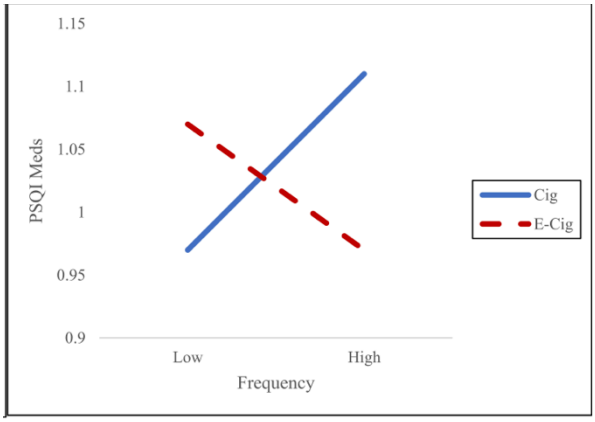

Figure 2

Insomnia Induced by Withdrawal

In this study, nicotine withdrawal is examined for association with clinical insomnia symptoms and diagnosis which relates to poor sleep quality. With prior evidence showing higher rates of insomnia among the smoking population, it is determined that sleep duration and quality are more frequently decreased in regular smokers (United States Centers for Disease Control and Prevention, 2016). The intolerance for withdrawal symptoms were believed to be associated with sleep disturbance. Prior to this research, three main explanations were used to describe why smokers experience higher rates of insomnia and related symptoms: 1) nicotine is a stimulant. 2) 19% of smokers smoke intermittently between sleep and wake (Rieder et al., 2001). 3) insomnia is considered a symptom of nicotine withdrawal (Lape et al., 2022). This is the first known research to directly compare the effects of nicotine withdrawal on the ability to begin and/or maintain sleep.

Effects of Insomnia

Insomnia is defined by the U.S. Institute of Medicine Committee as "A difficulty initiating or maintaining sleep or nonrestorative sleep". Elevations of sleep loss at any level can cause detrimental consequences in physical health such as: obesity, diabetes, cardiovascular disease, stroke, mortality, as well psychological disorders including: anxiety, depression, mental distress, and social impairments (Institute of Medicine (US) Committee on Sleep Medicine and Research, 2006). Although insomnia factors are highly prevalent, treatment remains abundant and successful with behavioral and pharmacological therapies (Institute of Medicine (US) Committee on Sleep Medicine and Research, 2006).

Participants

The study sample included 224 current tobacco smokers which were majority Caucasian (58.5%) male (57.1%) with a mean age of 41.5, who meet the criteria of smoking ≥ 15 cigarettes per day with no recent quitting attempts or use of pain medications (Lape et al., 2022).

Methods and Measurements

Four measurements and self-reports were used to measure insomnia, withdrawal, related discomfort, and distress intolerance: the Insomnia Severity Index (ISI), Intolerance for Smoking Abstinence Discomfort Questionnaire (IDQ-S), Heaviness of Smoking Index, and the Distress Intolerance Index.

Results

The results showed withdrawal and related intolerance to be associated with insomnia symptoms, severity, and functioning (Lape et al., 2022). The results can be characterized by intolerance for withdrawal and clinical insomnia, and related severity and impact.

Withdrawal Intolerance and Clinical Insomnia

Scores from the IDQ-S showed withdrawal intolerance to be positively associated with higher probabilities of placing into a clinical insomnia range on the ISI. Likelihood of scoring into this placement doubled for every point increase ([AOR] = 1.95, CI = 95%, p = .001). A Lack

of Cognitive Coping scores were not associated with ISI clinical insomnia criteria (Lape et al., 2022).

Withdrawal Intolerance and Insomnia Severity/Impact

Both ISI severity and impact were found to be significantly affected by predictors related to withdrawal. Withdrawal intolerance scores found association with scored on ISI severity (β = .283, P < .001, ΔR^2 = .066) and impact (β = .389, p < .001, ΔR^2 = .125). Intolerance scores were responsible for 7% variance in the severity of insomnia symptoms, and a 13% effect on functioning impact (Lape et al., 2022).

Conclusion

Different methods of nicotine inhalation, nicotine dependence, and withdrawal factors produce decreased sleep quality in adults. Brain function related to nicotine intake and sleep both result in detriment to human health when not properly managed and understood. Participants who smoked were shown to experience decreased sleep quality based on higher consumption, withdrawal symptoms, and related scores and criteria with higher levels of nicotine dependence. This demonstrates that by taking steps towards lowering nicotine consumption both throughout the day and during sleep, factors such as daytime dysfunction and cognitive impairments can be avoided. Furthermore, the method of inhalation related to nicotine intake had effects on quality of sleep and the likelihood of using sleep medications for sleep initiation and/or maintenance. While combustible cigarettes are proving to have a more noticeable effect on sleep quality, e-cigarettes are masking the effects of nicotine with less reports but greater instances of effects

during daytime activity. Lastly, the effects of withdrawal were found to increase insomnia symptoms and diagnoses. The consequences of insomnia and its symptoms are well documented in research and, when present, are proven to decrease the quality of sleep and life in a healthy individual. Overall, it is important to recognize the detrimental magnitudes nicotine has on sleep and the immediate impacts a lack of quality sleep can have on physical and mental health.

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