

The Evolving E-Cigarette: A Comparison Narrative of Cigarette Smoke and E-Cigarette Vapour on Sleep

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Abstract:

Recent development of 'e-cigarettes' has increased the utilization by the common population, under the assumption of it being a safer alternative compared to conventional cigarettes. However, the harmful biological effects of e-cigarettes, or most commonly called vaping, are still not clear. This review aims to highlight the effect of conventional cigarettes on one's sleeping patterns and quality. The studies reported in this review were collected from the databases that included PubMed, ScienceDirect, Hindawi, ResearchGate, and AHA journals from 1994–2022. Studies that focussed on the effects of smoking on other aspects of one's health. Separate literature searches were conducted to analyse sleep quality among people that smoked cigarettes and people who used a vape. Literature reviews showed cigarette smoking caused a reduction in sleep quality and also an increased risk of sleep-related disorders. A review of articles concerning the association between vape and sleep also showed similar results, with vape users reporting shortened and poorer sleep quality compared to non-users. Data from this article can prove useful in shedding light on the deleterious impact of vape on sleep and overall general health, as the common notion of e-cigarettes being an acceptable and safe substitute is widely practiced among the younger population.

Key words: cigarettes, E-cigarettes, sleep disturbances, sleep quality, vape

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Introduction

Tobacco smoking is considered one of the prime public health concerns across the world, owing to its popularity and damaging effects on one's body. Evidence has proven tobacco from cigarette smoking can cause harmful effects on every system of the body, which include heart diseases, stroke, respiratory disorders and several aggressive cancers, such as cancers of the lung, oral and the throat¹. While there are other forms of smokeless tobacco; such as chewing gum or sniffing substitutes, conventional smoking remains predominant². Smoking has been shown to cause around 6 million deaths worldwide, all of which come under the category of preventable deaths². The global prevalence of smoking among adolescents was around 20%, with greater usage among males than females, especially in high-income countries³. There is a variety of reasons for this rise in utilization among teenagers, such as pressure to be accepted among peers, parental neglect, bad company, anxiety, depression and other mental health states that can contribute to the adoption of deviant behaviours.

E-cigarettes were developed in the early 2000s as an alternative to traditional cigarettes⁴. Research conducted in a US student population had the highest prevalence of e-cigarette use among the 18–24 years age group⁵.

E-cigarettes commonly known as vape, as the name suggests, use an electronic device to breathe vapour into the lungs⁵. It is the modern method of inhaling nicotine (which is present in conventional cigarettes) combined with flavoured water via a compact, mobile device⁶. The device runs on a battery and uses aerosols containing several other chemicals. The inhaled nicotine, flavours, and harmful chemicals directly enter the bloodstream after entering the lungs⁷. The increased use of e-cigarettes can be attributed to its features of nicotine dose adjustment and rich flavouring, which is one of the major factors that attract young adolescents. Although limited, some studies have

shown vapes to be comparatively safer than cigarettes⁸. However, this doesn't rule out the proven short-term harmful effects of e-cigarettes on overall health and quality of life.

One of the well-researched effects of conventional smoking is its effect on sleep quality. A study conducted among Chinese males, which included both smokers and non-smokers, showed increased sleep disturbances, prolonged SoL score (sleep onset latency), higher dopamine levels and lower **desaminotyrosine (DAT)** levels, when **cerebrospinal fluid (CSF)** assessment was conducted⁹. Sleep onset latency refers to the time taken by an individual to fall asleep after the lights are switched off. Increased dopamine can cause anxiety and physical excitation, thus causing difficulty in falling asleep. Another study conducted among Korean adults also showed lower sleep quality among smokers as compared to non-smokers¹⁰. Additionally, another study conducted among Chinese smokers showed greater sleep disturbances that were also positively associated with attempts to quit, followed by craving¹¹. A study conducted among US adolescents showed a greater incidence of sleep-related problems among e-cigarettes compared to non-smokers¹². Undergraduate students from Midwestern University, USA, that use e-cigarettes reported worsened sleep health. In addition, even non-daily vape users reported not having received good-quality sleep¹³.

While a small proportion of studies highlight the effects of e-cigarettes on sleep quality, there was an inverse association that was observed. Sleep deprivation may prompt young teens to commit to smoking, which include both cigarettes and vaping¹⁴.

Contrary to the popular notion among the young population that e-cigarettes don't pose any harm to their body, this review aims to illicit the negative, harmful effects of even short-term usage of e-cigarettes on sleeping patterns and quality of sleep. Sleep disturbances have significant potential to cause other health effects, such as

hypertension, diabetes, obesity and depression. Hence, it is of prime importance to stress on and educate the common population, especially the adolescent age group, as to the harmful impacts of vaping on their health.

The prime objective of this review was to emphasize the definitive relationship between vaping/e-cigarette consumption and its detrimental effects on sleep quality. This article aims to highlight the various aberrations in the sleep cycle, patterns and quality caused by vaping. It also aims to firmly establish the negative association between vaping and sleep quality. In addition to the above parameters, this article also tries to shed light on the negative impact of e-cigarettes on other aspects of health and well-being. The ultimate objective is to educate healthcare providers in spreading awareness regarding the negative impact of new-age e-cigarettes among the younger population. This review also encourages healthcare professionals, public health experts, medical students, as well as policymakers to maximise and augment the preventive strategies at the school level that can help in reducing smoking behaviour among at-risk teens.

Search strategy and selection criteria

A comprehensive literature search was conducted in 2023, to extract published work on sleep and hypertension. Published articles on the topic were collected by searching various databases that included PubMed, ScienceDirect, Frontiers, Hindawi, and ResearchGate, from 1994 until 2022. This time period showed an increase in the popularity and commercialization of substances; including tobacco and e-cigarettes. The keywords used for searching included: "Sleep quality", "Sleep disturbances", "Cigarette", "E-cigarette" and "Vape"

Inclusion criteria

- All studies published on conventional smoking and sleep quality

- Articles published from 1994 to 2023
- Restricted to English language

Exclusion criteria

- Articles that emphasized the effects of both forms of smoking on other aspects of health
- Abstracts only
- Case reports and Case series

Methodology

Both authors participated in the review process. SK and JM reviewed articles on conventional smoking and sleep quality. The review was completed within a period of two months. During the initial search for articles in the databases, 43 studies were extracted. A total of 34 articles were finally used after adopting the exclusion criteria. The articles used for this narrative review consisted of various study patterns, such as review articles, systematic reviews, meta-analytic studies, and cross-sectional studies. The information obtained from each publication was abstracted.

Results

Summary of Table 1

A total of 34 articles were downloaded from the databases. Out of these, a majority (13) of the studies were conducted in the USA, followed by studies conducted in China, Japan and Korea. Only about 3 articles were from European countries. The breakdown of the types of studies used in this review paper is as follows: 20 were cross-sectional studies, 2 were prospective studies, 3 were review articles, 2 were systematic review/meta-analysis and 1 was a polysomnographic analysis. About eight articles discussed the general topic of e-cigarettes: i.e., their prevalence, health risks, cessation, adverse health consequences, alongside interventions and health impacts. Around 26 articles focused on the adverse effects of e-cigarette use on sleep patterns, neurotransmitters and

Table 1 Summary of articles included in the narrative review

Ref.No.	Authors	Country	Year published	Database accessed from
1	Razzak HA, Harbi A, Ahli S.	United Arab Emirates	2020	PubMed
2	West R.	Narrative review	2017	PubMed
3	Nazir MA, Al-Ansari A, Abbasi N, Almas K.	Saudi Arabia	2019	PubMed
4	–	–	2024	Internet
5	–	–	–	Internet
6	Kelly SH, Lewy S.	–	2022	Internet
7	–	–	–	Internet
8	Marques P, Piqueras L, Sanz MJ.	Narrative review	2021	BMC
9	Li H, Liu Y, Xing L, et al.	China	2020	PubMed
10	Kang SG, Bae SM.	Korea	2021	Pubmed
11	Liao Y, Xie L, Chen X, et al.	China	2019	BMC
12	Riehm KE, Rojo-Wissar DM, Feder KA, et al.	United States of America	2019	PubMed
13	Brett EI, Miller MB, Leavens ELS, et al.	United States of America	2020	ScienceDirect
14	Holtz KD, Simkus AA, Twombly EC, et al.	United States of America	2022	PubMed
15	Gavidia M.	–	2020	Internet
16	Amiri S, Behnezhad S.	Iran	2020	PubMed
17	Silva WCDS, Costa a NL, Rodrigues DDS, et al.	Brazil	2022	ScienceDirect
18	Öztürk O, Kuru U, Nesil I, et al.	United States of America	2012	PubMed
19	Carvalho C, Amaral C, et al.	Europe	2018	ResearchGate
20	Jaehne A, Unbehaun T, Feige B, et al.	Germany	2012	PubMed
21	Deleanu OC, Pocora D, Mihălcuță S, et al.	China	2016	PubMed
22	Phillips BA, Danner FJ.	United States of America	1995	PubMed
23	McNamara JPH, Wang J, Holiday DB.	United States of America	2010	PubMed
24	McNamara JPH, Wang J, Holiday DB, et al.	United States of America	2013	PubMed
25	Mak KK, Ho S, Thomas GN, et al.	China	2010	PubMed
26	Bellatorre A, Choi K, Lewin D, et al.	United States of America	2017	PubMed
27	Nakata A, Takahashi M, Haratani T, et al.	Japan	2008	PubMed
28	Wetter DW, Young TB, Bidwell TR, et al.	United States of America	1994	PubMed
29	Doornenbal BM, Spisak BR.	Netherlands	2021	ResearchGate
30	Baiden P, Spoor SP, Nicholas JK, et al.	United States of America	2023	PubMed
31	Merianos AL, Jandarov RA, Choi K, et al.	United States of America	2021	PubMed
32	Riehm KE, Rojo-Wissar DM, Feder KA, et al.	United States of America	2019	PubMed
33	Wilson OWA , Bullen C, Duffeya M, et al.	United States of America	2022	PubMed

sleep-related complaints among adolescents and young adults. They also shed light on the asymmetric relationship between smoking and sleep, highlighting insufficient sleep among adolescents using vaping products. Two articles compared the sleep quality of smokers and non-smokers, and one article explored the influence of smoking on sleep and obstructive sleep apnea syndrome. Almost all of the studies used in this review focused on the negative effects of vaping within the adolescent age group. Three articles focused on the potential link between e-cigarette use and sleep deprivation.

There is a growing, false presumption that e-cigarettes or vaping are safe to use. However, it is only considered: 'safer,' as compared to tobacco smoking and does not rule out the short-long term effects of the latter on one's general health and well-being. Although the exact short-term and long-term detrimental effects of e-cigarettes are still under study, certain studies do highlight the association between vape and diminished sleep quality.

A meta-analysis, conducted in 2018 concluded that cigarette smoking was an independent risk factor for sleep-associated problems¹⁶. This analysis also theorised that this association could be attributed to the development of depression and other health concerns triggered primarily by cigarette smoking. Another meta-analytic study involving 10 studies among the adult population showed that tobacco smoking was seen to significantly reduce sleep quality, maintenance and time periods¹⁷.

One study conducted to analyse a variety of parameters to assess sleep quality and sleep disorders among outpatients in a Medical School of SDU found that among 98 patients, a greater Pittsburgh Sleep Quality Index score (PSQI) was found in 26 smokers. The Berlin Sleep Apnea test (BSAT) score showed that 10 smokers were at an increased risk of developing sleep apnea; eight smokers also reported snoring¹⁸. This study concluded that the quality of sleep is adversely affected by smoking

and also increases the risk of sleep apnea. Additionally, this study also touched upon the effect of resolution from such sleep discrepancies in the journey of quitting. A study conducted among 70 workers in Egas Moniz Hospital showed that smoking increased the risk of decreased sleep quality, morning-time sleepiness/drowsiness, depression, and anxiety¹⁹.

Another study conducted among 44 smokers, showed that chronic smokers had shorter time periods of sleep, long sleep latency, rapid eye and leg movements and an increased risk of developing obstructive sleep apnea²⁰. This study also showed smoking is most likely to result in insomnia-like symptoms. However, the relationship is bi-directional. as sleep-related issues can be a cause of both initiation of smoking habits as well as relapse after quitting.

Tobacco smoking has not only been known to disrupt the architecture of sleep during regular use but even after withdrawal, which will in turn prompt a vicious cycle of relapse²¹.

However, the effect of smoking withdrawal on sleep quality is still under ongoing research. Cigarette smokers are more likely to suffer problems, not only in going to sleep, but also in remaining asleep.

In contrast to the above studies, a randomised study conducted among 769 participants showed light smoking²²; instead of heavy smoking, was more likely to cause insomnia-like symptoms and decreased sleep duration. However, the quality of sleep, sleep latency and the number of times one woke up during the night did not differ from smokers to non-smokers²³.

In addition to problems initiating sleep and waking up in the morning, females were more likely to suffer from morning drowsiness than males. Males reported an increased incidence of disturbing dreams in this study. Another similar survey conducted in the US reported that smokers were more likely to suffer from sleep disturbances than non-smokers²⁴. This survey also showed that former

smokers did not suffer from any sleep issues. This most likely suggests that smoking cessation can lead to the restoration of a better quality of sleep. However, currently, there are not enough studies to support this relationship.

In a study conducted among Chinese adolescents aged 12–18, the results showed insomnia was more prevalent among smokers than non-smokers. However, smokers were less likely to suffer from difficulties initiating sleep and waking up in the morning. Smokers were reported to have issues with maintenance of sleep as compared to non-smokers or teen experimenters²⁵.

A prospective cohort study conducted among US adolescents showed an association between smoking and sleep disturbances in Non-Hispanic Blacks more than in Non-Hispanic Whites. While another relation was observed between sleep patterns and smoking behaviours, which was more prevalent among Non-Hispanic Whites than Non-Hispanic Blacks²⁶.

A questionnaire study conducted among the suburban population of Tokyo showed that smokers were more likely to report problems waking up in the morning compared to non-smokers. This association was found to be more significant among women than in men²⁷. This study also showed that people exposed to smoke (passive smokers) were more likely to receive inadequate sleep as compared to people not exposed to smoke. On the contrary, findings from Dutch panel data showed initiation of smoking behaviour was not associated with the development of sleep-related problems. In contrast, quitting smoking was seen to increase the incidence of sleep-related issues²⁸.

While quantitatively sound literature exists as to the association between conventional cigarette smoking and sleep quality, and vice versa, a limited number of articles have focused on the association between vape and sleep.

Data from a Youth Risk Behaviour Survey showed that among 28,135 adolescents, 23% of them used electronic vaping devices²⁹. About three-fourths of smokers reported

of not having received 8 hours of sleep at night. They were also more likely to suffer from sleep disorders if they were older, Black and/or depressed. A survey conducted among US adolescents showed exclusive e-cigarette users were more likely to report insufficient (less than 8 hours) sleep than non-smokers³⁰. Dual use of cigarettes and e-cigarettes has also been reported to cause insufficient sleep and poorer quality of sleep³¹. A study conducted in the US showed that men who vaped reported fewer nights of quality sleep. They also reported greater consumption of alcohol compared to non-smokers³².

The likely explanation for this association could be that the nicotine inhaled via the vape can trigger certain neurotransmitters (dopamine) and hormones (E.g., MSH) that can alter sleep cycle patterns.

Sleep deprivation can lead to short-term effects, such as mood swings, drowsiness, lack of energy and interest in school/work. In addition to such mild effects, poor sleep can lead to long-term complications, including depression, alcohol use and other harmful substance use.

Individual assessment of the articles showed a significantly higher incidence of insufficient sleep, poorer quality sleep, sleep disturbances, and sleep-related disorders among cigarette smokers as compared to non-smokers. This review also concluded that non-conventional methods of smoking, using e-cigarettes or vaping, also had a direct impact on one's sleep.

Thus, this review article concludes that both traditional cigarette smoking and vaping have negative, disadvantageous effects on one's sleep quality and lead to other sleep-related disorders. It is also a contributing factor to small accidents and higher caffeine intake to battle daytime sleepiness²². A sleep cohort study conducted in Madison showed similar results, wherein smokers had an increased risk of snoring and sleep-disordered breathing compared to non-smokers as well as in people having quit smoking³³.

Discussion

Smoking is one of the leading causes of preventable deaths worldwide. Early commencement of smoking during teenage years can prove to be deleterious later in life, following years of exposure to tobacco and nicotine. The recent boom in e-cigarettes or vaping has not helped this situation; instead, it seems to have encouraged people to adopt this modern-age method under the false assumption regarding its safety and, again the false assumption that it is devoid of any harmful effects.

Young adolescents resorting to both tobacco smoking and vaping is a cause of concern. According to this review, both conventional cigarettes and vaping have been proven to cause sleep problems. These issues can range from shortened sleep durations, difficulty falling asleep, trouble waking up in the mornings, daytime drowsiness, long sleep latency, increased awakenings at night, snoring, and even serious complications; such as sleep apnea. Although substantial evidence exists regarding the effects of cigarettes on sleep, limited articles pertaining to the relationship between vaping and sleep exist. However, there is a trend of diminished sleep quality among people using e-cigarettes or vape as well. This review aims to encourage healthcare providers to spread awareness regarding the harmful effects of e-cigarettes along with traditional tobacco use to break the common misconception and negligence of both short and long-term complications associated with these electronic devices. This review also tries to motivate health policymakers to introduce preventive programs and strategies at the primary level (schools/colleges) to educate young children regarding the damaging effects of any kind of smoking on their bodies and minds. This, in turn, will cause an overall increase in the healthcare outcome of the younger population along with the reduction of the morbidity and premature mortality associated with smoking. Additionally, it motivates health researchers to conduct more studies on high-risk populations as well as carry out case-control

studies to attenuate the emphasis on the deleterious impact on adolescent health. This can ensure the deterrence of morbidities and mortality associated with smoking worldwide.

Conclusion

This narrative review conclusively demonstrates the link between e-cigarette smoking and sleep quality; elucidating its impact on sleep patterns and establishing its potential to induce sleep deprivation and depression. It is also proven to be a contributing factor to small accidents and daytime sleepiness. These findings promote the importance of further case-control studies to discover the mechanisms through which smoking contributes to sleep disturbances. Smokers have an increased risk of sleep-related breathing disorders compared to non-smokers. Moreover, it advocates for increased public education to raise awareness about these risks; emphasizing the importance of prevention to mitigate the health consequences associated with smoking.

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