Review Article

Impact of electronic cigarette smoking on the Saudi population through the analysis of literature: A systematic review

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Abstract

Tobacco usage is harming the health, the treasury and the spirit of Saudi Arabia. Every year, more than 7000 of its people are killed by tobacco-caused diseases. Still, more than 20,000 children and 3,352,000 adults continue to use tobacco each day. Likewise, the usage of electronic (e)-cigarette is also increasing; this could be because of the publicity and marketing strategies adopted by the manufacturers of these products which are attracting the younger population. This review was taken up to determine the usage and attitude toward e-cigarette smoking among the Saudi population through the analysis of literature. This review identified peer-reviewed articles using several search terms and databases from 2010 to 2018. PubMed, ISI-Web of Science, Medline and Google Scholar were searched using the following alternate terms for e-cigarettes: electronic cigarettes, electronic nicotine delivery systems following which hand search was conducted through the reference list of articles. The search results only found descriptive data on these e-cigarettes among the Saudi population. This literature review reported that the usage of these e-cigarettes was high among this population and recorded a wide variety of reasons for using e-cigarettes. Reducing tobacco use, considering e-cigarette as less harmful, less addictive, for pleasure and peer influence, lower cost and curiosity were the most commonly reported reasons. Recognizing the dangerous impact of smoking and usage of other type of tobacco, the aggressive marketing of these e-cigarettes needs to be controlled.

Keywords: Addiction, electronic cigarette, nicotine

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INTRODUCTION

Usage of tobacco products is a common practice among people across the world. The manufacturers of these products are best at the marketing skills and strategies and are actively promoting their products by attractive advertisements and products. The young, the adult and the elderly both the male and female population are getting

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attracted toward these products, and among them, the youth are the most common prey for these. Tobacco epidemic is one of the biggest public health threats recognized worldwide, which is killing >7 million people every year. Moreover, around 6 million of these deaths are associated with the direct tobacco use and around 890,000 nonsmokers are being exposed to the second-hand smoke. Tobacco users are hindering the economic development of the nation because of their premature death which will in turn deprive their families of income and also raise the cost on the health-care system.[1]

The excessive usage of the tobacco is affecting the health of the users and the spirit and economic growth of Saudi Arabia. More than 7000 people are killed by disease caused by the tobacco usage. Moreover, around 20,000 children aged between 10 and 14 years old and 3,352,000 adults aged 15+ years old continue to use tobacco. It is estimated around 4545 million riyals of the economic cost of tobacco smoking in Saudi Arabia, which includes direct costs which is related to expenditures in the healthcare and indirect costs which is related due to lost productivity because of the early mortality and morbidity.[2]

The first e-cigarette was developed in 2003 by the Chinese Pharmacist Hon Lik, who was a Former Deputy Director of the Institute of Chinese Medicine at Liaoning Province.[3]

There are various different e-cigarette designs available in the market, but the most basic parts of an e-cigarette include a battery, a compartment for holding an e-juice (a liquid containing flavorants, a solvent, and nicotine) a heating component and a mouthpiece.[3] The heating component is controlled by the battery, which in turn heats the e-juice and creates an aerosol, which is inhaled via the mouthpiece. These e-liquids used in e-cigarettes are most often flavored; a study has reported that there are around 7700 unique flavors that exist and that most often, they are fruit or candy flavors.[4] This widespread availability and popularity of flavored e-cigarettes is a prime concern with respect to the public health implications of these products. The primary concern for youth is the availability of e-cigarettes with sweet flavors, which facilitate the nicotine addiction and simulate smoking behavior and which will eventually lead to the use of conventional tobacco products.[5,6] For decades, the manufacturers are using these flavors just to attract youth toward these tobacco products and this will usually mask the flavor and harshness of these tobacco products.[7]

With this background, it is well documented that there is an increasing prevalence of e-cigarette usage across the world. Considering their popularity, e-cigarettes present a growing concern of public health because these e-cigarettes produce aerosols which contain potentially harmful substances; the most common compounds found within e-cigarette aerosols include propylene glycol, glycerin, toxic metals (e.g., lead, cadmium and nickel) and other carcinogenic carbonyl compounds, including formaldehyde.[8,9]

These compounds may damage DNA reducing its ability to repair itself during replication, as well as cause respiratory disease.[10]

In addition to this, nicotine has been shown to be a harmful component of e-cigarettes, especially in developing youth and pregnant women; the consequences of long-term nicotine exposure may be more pronounced in adolescent users, causing attention deficits, mood disorders and impairment in general cognition.[11]

Interestingly, at all the age groups, nicotine has shown to reduce insulin sensitivity and could, therefore, contribute to insulin resistance and type II diabetes.[12]

The more recent generation devices contain larger batteries which are capable of heating the liquid to a higher temperature, which potentially releases more nicotine which forms additional toxicants and creates larger clouds of particulate matter.[13,14]

One of the primary features of the more recent generation of devices is that they contain larger batteries and are capable of heating the liquid to a higher temperature, potentially releasing more nicotine, forming additional toxicants and there is also exceedingly high levels of formaldehyde formed which is a known carcinogen. The level of tolerance of actual users to the taste of the aerosol heated to this temperature is debated.[14,15]

Knowing these facts about the e-cigarettes and its impact on the health, it was felt that there is a need to address this issue as the harmful effects of the e-cigarette are the neglected element in the e-cigarette debate in Saudi Arabia, where the usage of e-cigarette is high and the youth are being targeted by the marketing strategies adopted by the manufacturing companies. To the best of our knowledge, there were no clinical reports or any randomized trials reported on the Saudi population in the literature with respect to the health implications of this e-cigarette usage.

Objective

This review was taken up to determine the usage and attitude toward e-cigarette smoking among the Saudi population through the analysis of literature.

Data source and data extraction

This literature review identified peer-reviewed articles using several search terms and databases from 2010 to 2018. PubMed, ISI-Web of Science, Medline, and Google Scholar were searched using the following alternate terms for e-cigarettes: electronic cigarettes, electronic nicotine delivery systems following which hand search was conducted through the reference list of articles. The search results only found descriptive data on this e-cigarette among the Saudi population.

The articles resulting from the search of databases were included in this literature review based upon the inclusion criteria. The inclusion criteria for this review emphasized motives for initiation, use of e-cigarettes and followed the flow diagram outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines.

This literature review identified eight published studies through a systematic database search. The title and abstract of these studies were evaluated to determine eligibility for the documents.

Those studies which investigated the smoking hazards of e-cigarette were included in this literature review. Finally, there were only three publications that were included and the remaining five were excluded. These articles were excluded from the review as they failed to address reasons for use of e-cigarettes [Figure 1].

This literature review found variety of reasons which were reported for using e-cigarettes; the number of the participants who selected each survey item as a reason for using e-cigarettes was recorded. Then, each study that used both qualitative and quantitative research methods was reviewed to develop major overarching themes regarding reasons for using e-cigarettes.

Data synthesis

The studies selected for the review varied in methodology. The data were collected from the study participants through direct approach, online forums and survey panels (both physical and online).

Among the studies which were included in this review, the first study reported the data about e-cigarette use among university students which was collected through a self-administered questionnaire, and in the second reported study, Facebook account was used to reach participants; the survey was carried the by direct Facebook messages and by smartphone texting applications, and in the third reported study, the survey was distributed widely through

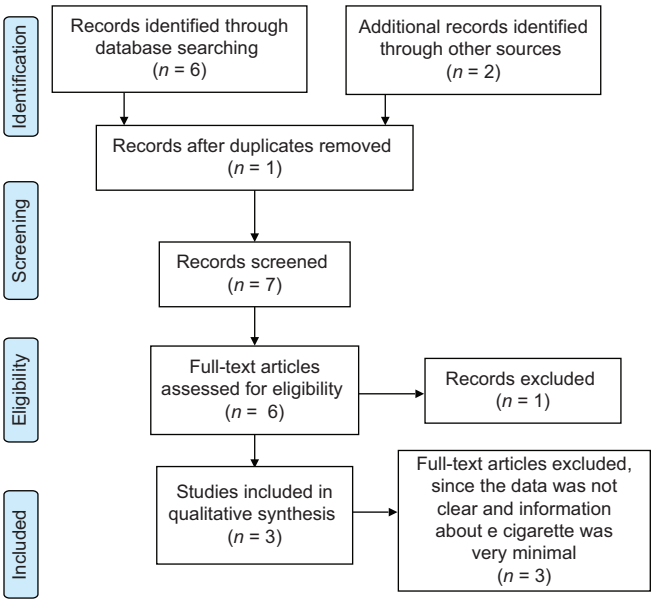

Figure 1: PRISMA flowchart for article inclusion

e-mail and social media and a self-administrated web-based questionnaire was used to collect data.

Among the selected studies, the participant's demographic characteristics about the age, nationality and smoking status were almost similar.

The primary focus of this review was to assess and to determine the reasons for initiation of the use of these e-cigarettes.

These studies reported that participants reported that they used e-cigarettes for a variety of reasons; among them, the most commonly reported reason was the reason for quitting regular cigarettes or reducing tobacco use. The most reported reason for using e-cigarettes was that they considered it could help them in smoking cessation. The second reported reason for using e-cigarettes was that they considered that the e-cigarette is less harmful to health and they did not know the harmful effects of e-cigarettes on health. "Curiosity" was the other most common reason reported. Other reasons reported for using e-cigarettes were that the users considered e-cigarettes were less addictive, for pleasure and peer influence [Table 1].

DISCUSSION

The objective of this paper was to conduct a systematic review of the literature to determine the reasons for usage of the e-cigarettes among the Saudi population so that this report could help us in finding out the actual reasons to know why people are adopting these e-cigarettes, this could help the policymakers in the future to consider

these reasons to plan strategies to reduce the marketing and advertising strategies to reduce the usage and sale of these e-cigarettes.

This literature review discovered that the most popular reason reported in the literature for using e-cigarettes was to quit or reduce tobacco use. AlBaik *et al*. in 2014 reported that 18.2% of the sample considered e-cigarette could help them to quit regular cigarette,[16] Awan in 2015 reported that 67.2% of his study sample considered that e-cigarettes can help in smoking cessation[17] and Karbouji *et al*. in 2018 reported that 70% of their study sample considered e-cigarettes can help quit regular cigarette smoking.[18]

These studies also reported that curiosity is the another reason why people use e-cigarettes. Awan in 2015 reported that 63.4% of his study sample considered that e-cigarettes because of curiosity[17] and Karbouji *et al*. in 2018 reported that 70% of their study sample considered e-cigarettes because of curiosity.[18]

These studies also reported that the people considered using e-cigarettes because they were not aware of the harmful effects of it. AlBaik *et al*. in 2014 reported that only 8.8% thought that the e-cigarette is harmful to health and 44.5% did not know that the e-cigarette is harmful to health.[16] Awan in 2015 reported that 55.8% of his study sample considered e-cigarettes are less dangerous[17] and Karbouji *et al*. in 2018 reported that 32.8% of their study sample considered e-cigarettes have no effect of on health and 50.3% of their study sample did not know the effect of e-cigarettes on health; as a recent invention, e-cigarettes have been of interest to people who want to try something new.[18]

In the studies reported elsewhere reported many other reasons by the users for considering or trying or using e-cigarettes, these included affordability and lower cost than the regular cigarettes[19,20] and another study reported convenience and accessibility as the reasons for using them.[5,21]

Another study reported that the users perceived that these e-cigarettes are "cool," "modern" or "high-tech."[5,21] Studies have also reported that the users adopted e-cigarettes to avoid the smelling cigarette smoke.[5,19,20,22,23] Moreover, some studies also reported that users considered using e-cigarettes because they felt it very easy to hide them from parents/teachers.[5,22]

Studies have also reported that the users perceived that e-cigarettes were more socially acceptable than smoking regular cigarettes in public.[24]

Why the rising usage of electronic cigarette a concern?

The studies reported on ecigarettes, the usage of these cigarettes is markedly increasing because of the value placed for these products and the marketing strategies adopted by the manufacturing companies. Considering the impact of these products on the health of an individual who is using them and also the one who is exposed to the secondhand smoke is the need of this hour. There is good evidence that has been reported on the ability of these e-cigarettes to deliver comparable or higher amounts of nicotine when compared to regular cigarettes, which raises the concerns

Table 1: Describes the usage and reasons for using electronic cigarettes among the participants

Study	Methods	Prevalence/participants	Findings
Mohammed Z AlBaik *et al*., 2014; Electronic cigarette in Saudi Arabia: An Online Survey	3027 participants were included in the analysis of an electronic survey (part of the validated WHO Global Adult Tobacco Survey) was used to reach participants through internet communication applications	33.5% had tried e-cigarettes 7.5% use the e-cigarette in the current period 5.5% use the e-cigarette and regular cigarette together	18.2% use the e-cigarette to help you quit regular cigarette 17.4% who did not try it before was currently willing to try the e-cigarette 8.8% think that e-cigarette is harmful to health 44.5% did not know that the e-cigarette is harmful to health
K.H. Awan, 2015; Experimentation and correlates of electronic nicotine delivery system (electronic cigarettes) among university students -A cross-sectional study	A cross-sectional study was carried out among 480 university students from four faculties at a university in Riyadh using a self-administered questionnaire	33.8% of participants were smokers and 16.6% were ex-smokers 54.2% of smokers had tried e-cigarettes at least once during their lifetimes	55.8% of e-cigarettes are less dangerous 67.2% of e-cigarettes can help in smoking cessation 24.3% smoking cessation 63.4% curiosity 23.9% of peers' influence
Mohammad Ali Karbouji, 2018; Awareness and Attitude toward Smoking E-cigarettes (Vape) among smokers in Saudi Arabia 2017	This cross-sectional study involved 1404 individual living in Saudi Arabia. Adult smoker participants involved in this study were in the age range of 18-60 years. A self-administrated web-based questionnaire was used to collect data	48.2% considered much satisfaction with e-cigarette when compared with regular cigarettes, hookah, shisha 18.9% still continued smoking the traditional cigarettes, hookah, or shisha after switching to e-cigarette	70% of e-cigarette can help quit smoking 41.0% of e-cigarette less addictive than cigarettes 29.1% of e-cigarette not addictive 32.8% no effect of on health 50.3% did not know the effect of on health 16.3% considered (pleasure, curious, etc.)

e-cigarette: Electronic cigarette

about the e-cigarette usage which is generating nicotine dependence among young people.[25-27]

There is also sufficient evidence where it has been reported that the levels of nicotine or cotinine in the blood of the e-cigarette users are likely to cause physiological changes in nicotinic acetylcholine receptors in the brain that would sustain nicotine addiction which of a great concern.[11,28]

These findings are alarming and are of great concern for adolescents and young adults as the reports suggestive of the early exposure to nicotine would increase the nicotine dependence in future.[27,29]

How is this nicotine affecting its users?

There is enough evidence that suggests negatively influence the nicotine on both adolescent and prenatal brain development.[29] Reports from the humans and animals studies and research in this area provide evidence for neuroteratogenic and neurotoxic effects on the developing adolescent brain.[30,31]

Are the people also affected by the secondhand exposure from the electronic cigarette aerosol?

There is sufficient evidence to support the fact that the exposure to second-hand smoke from combustible tobacco products is a known cause of morbidity and mortality as reported in the vast literature. Second-hand smoke is usually a mixture of the side-stream smoke from a lighted cigarette and the mainstream smoke exhaled by a smoker which is known to contaminate both indoor and outdoor environments.

In addition to this, when the constituents of smoke gets deposited on surfaces, nonsmokers can be easily exposed to them via touch, ingestion or inhalation.

In contrast to these combustible tobacco products, e-cigarettes usually do not produce side-stream emissions; however, the aerosols are usually produced during activation of these devices. Some of these aerosols are subsequently exhaled into the environment, where nonusers may be get exposed to them through inhalation, ingestion or dermal contact.

Clinical studies which were conducted to know the effects of second-hand exposure to e-cigarette aerosol on the health have demonstrated that passive exposure to e-cigarettes causes an increase in serum cotinine which is similar to that of the passive exposure to regular cigarette smoke; it is also suggestive that there is a need to examine the impact of passive aerosolized nicotine inhalation on long-term lung function of the exposed.[32]

Final conclusions on the impact of these electronic cigarettes on the health[3]

1. Early exposure to nicotine, especially during the brain developing age, i.e., during adolescence, can cause addiction and can harm the developing brain
2. Reports are suggestive that nicotine can cross the placenta and its effects on fetal and postnatal development. Therefore, nicotine which is delivered by the e-cigarettes during the period of pregnancy can result in multiple adverse consequences, which includes sudden infant death syndrome, altered corpus callosum, deficits in auditory processing and obesity
3. It has been reported that expose users of these e-cigarettes are exposed to several chemicals, including nicotine, carbonyl compounds and volatile organic compounds which adversely affect the health
4. E-cigarette aerosol is harmful even though it contains fewer toxicants than the regular combustible tobacco products
5. Accidental ingestion of liquids of e-cigarette containing nicotine can cause acute toxicity and also death.

Recommendations for future research

The findings from these studies have several implications for future research. The usage of e-cigarettes among Saudi population is high, but there are very few studies reported on this topic; the researchers are focusing more on the regular tobacco products and the research on this topic is slightly neglected; it could be because of the lack of awareness about the harmful effects of these e-cigarettes on the health and well-being. The findings of the studies reported on this topic elsewhere are alarming and are of great concern. It is therefore suggested that there should be more studies in this area to find out the prevalence of the usage among the Saudi population and appropriate measures to be taken after knowing these facts. Comprehensive research on these e-cigarettes is very much required to identify and characterize the potential health risks from the use. Second, future studies using quantitative methods should provide participants with the opportunity to list their own reasons for e-cigarette use, instead of only allowing them to select from a predetermined list.

Public health significance and policy concern

The findings from this systematic review also have important implications for future research and for public health practice and policy. First, a number of articles cited instances where respondents used e-cigarettes are very limited. This is a potentially underestimating the growth of e-cigarettes. If e-cigarettes were taxed as conventional tobacco cigarettes are, there could be a reduction in the

number users, especially the adolescents, who are attracted to these products. The attractiveness of tasty flavoring in e-cigarette liquid is especially attracting the younger populations. The future policy could regulate flavorings used in an attempt to reduce the popularity of these products.

Future regulatory options should consider:

- It is crucial to restrict the promotion, marketing and advertising of these products
- The inclusion of health warnings and pictures on these products
- Mentioning of the nicotine levels in products should be mandatory.

CONCLUSION

This literature review is suggestive of the fact that e-cigarette is not as safe as considered by its users. There is sufficient evidence suggestive of the harmful effects of e-cigarettes and this is almost as harmful as the regular tobacco products. This is an alarming situation and a serious thought has to be given on it. More studies need to be taken up, especially well-designed clinical trials have to be taken up, to examine the safety of e-cigarettes and their efficiency in reducing the usage of regular cigarettes.

The global reports on the usage of the e-cigarette are clear that there has been a dramatic rise in usage of these e-cigarettes among youth and young adults. Henceforth, it is very crucial that the progress made in reducing cigarette smoking among youth and young adults not be compromised.

There is a need for strong policies to be implemented at all levels to address e-cigarette usage. Strict actions should be taken to prevent easy access to e-cigarettes by youth, taxation policies, retail licensure, regulation of e-cigarette marketing which are likely to attract youth and educational initiatives targeting youth and young adults.

The role of health professionals to represent an important channel for education about e-cigarettes, particularly for youth and young adults, is of importance. The health professions should take an active part in creating awareness among the community at large and should play a key role to address this neglected element of the e-cigarette debate in Saudi Arabia.

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Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Available from: https://www.who.int/news-room/fact-sheets/detail/tobacco. [Last accessed on 2018 Nov 18].
2. Available from: https://tobaccoatlas.org/country/saudi-arabia/. [Last accessed on 2018 Nov 27].
3. U.S. Department of Health and Human Services. E-cigarette use among youth and young adults: A report of the Surgeon General. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2016. p. 1-275.
4. Zhu SH, Sun JY, Bonnevie E, Cummins SE, Gamst A, Yin L, *et al*. Four hundred and sixty brands of e-cigarettes and counting: Implications for product regulation. Tob Control 2014;23 Suppl 3:iii3-9.
5. Kong G, Morean ME, Cavallo DA, Camenga DR, Krishnan-Sarin S. Reasons for electronic cigarette experimentation and discontinuation among adolescents and young adults. Nicotine Tob Res 2015;17:847-54.
6. Krishnan-Sarin S, Morean ME, Camenga DR, Cavallo DA, Kong G. E-cigarette use among high school and middle school adolescents in Connecticut. Nicotine Tob Res 2015;17:810-8.
7. U.S. Department of Health and Human Services. Preventing Tobacco Use among Youth and Young Adults: A Report of the Surgeon General. Atlanta (GA): U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2012.
8. Olmedo P, Goessler W, Tanda S, Grau-Perez M, Jarmul S, Aherrera A, *et al*. Metal concentrations in e-cigarette liquid and aerosol samples: The contribution of metallic coils. Environ Health Perspect 2018;126:027010.
9. Sleiman M, Logue JM, Montesinos VN, Russell ML, Litter MI, Gundel LA, *et al*. Emissions from electronic cigarettes: Key parameters affecting the release of harmful chemicals. Environ Sci Technol 2016;50:9644-51.
10. Lee HW, Park SH, Weng MW, Wang HT, Huang WC, Lepor H, *et al*. E-cigarette smoke damages DNA and reduces repair activity in mouse lung, heart, and bladder as well as in human lung and bladder cells. Proc Natl Acad Sci U S A 2018;115:E1560-9.
11. Yuan M, Cross SJ, Loughlin SE, Leslie FM. Nicotine and the adolescent brain. J Physiol 2015;593:3397-412.
12. Bergman BC, Perreault L, Hunerdosse D, Kerege A, Playdon M, Samek AM, *et al*. Novel and reversible mechanisms of smoking-induced insulin resistance in humans. Diabetes 2012;61:3156-66.
13. Bhatnagar A, Whitsel LP, Ribisl KM, Bullen C, Chaloupka F, Piano MR, *et al*. Electronic cigarettes: A policy statement from the American Heart Association. Circulation 2014;130:1418-36.
14. Kosmider L, Sobczak A, Fik M, Knysak J, Zaciera M, Kurek J, *et al*. Carbonyl compounds in electronic cigarette vapors: Effects of nicotine solvent and battery output voltage. Nicotine Tob Res 2014;16:1319-26.
15. Pankow JF, Strongin RM, Peyton DH. More on hidden formaldehyde in e-cigarette aerosols. N Engl J Med 2015;372:1576-7.
16. AlBaik MZ, Abdrabulnabi AA, Aldahan SM, Alkhadhrawi NH. Electronic cigarette in Saudi Arabia: An online survey. Int J Med Sci Clin Inventions 2014;1:411-26.
17. Awan KH. Experimentation and correlates of electronic nicotine delivery system (electronic cigarettes) among university students – A cross-sectional study. Saudi Dent J 2016;28:91-5.
18. Karbouji MA, Abduldaem AM, Allogmani AM, Alharbi AS, Alnozha O, Al-Zalabani AH. Awareness and attitude toward smoking E-cigarettes (Vape) among smokers in Saudi Arabia 2017. Egypt J Hosp Med 2018;70:1346-51.
19. Tucker JS, Shadel WG, Golinelli D, Ewing B. Alternative tobacco product use and smoking cessation among homeless youth in Los Angeles County. Nicotine Tob Res 2014;16:1522-6.

20. Ambrose BK, Day HR, Rostron B, Conway KP, Borek N, Hyland A, *et al*. Flavored tobacco product use among US youth aged 12-17 years, 2013-2014. JAMA 2015;314:1871-3.
21. Choi K, Fabian L, Mottey N, Corbett A, Forster J. Young adults' favorable perceptions of snus, dissolvable tobacco products, and electronic cigarettes: Findings from a focus group study. Am J Public Health 2012;102:2088-93.
22. Peters RJ Jr., Meshack A, Lin MT, Hill M, Abughosh S. The social norms and beliefs of teenage male electronic cigarette use. J Ethn Subst Abuse 2013;12:300-7.
23. Sutfin EL, Reboussin BA, Debinski B, Wagoner KG, Spangler J, Wolfson M. The impact of trying electronic cigarettes on cigarette smoking by college students: A prospective analysis. Am J Public Health 2015;105:e83-9.
24. Trumbo CW, Harper R. Use and perception of electronic cigarettes among college students. J Am Coll Health 2013;61:149-55.
25. Dawkins LE, Kimber CF, Doig M, Feyerabend C, Corcoran O. Self-titration by experienced e-cigarette users: Blood nicotine delivery and subjective effects. Psychopharmacology (Berl) 2016;233:2933-41.
26. Etter JF. A longitudinal study of cotinine in long-term daily users of e-cigarettes. Drug Alcohol Depend 2016;160:218-21.
27. St. Helen G, Havel C, Dempsey DA, Jacob P 3rd, Benowitz NL. Nicotine delivery, retention and pharmacokinetics from various electronic cigarettes. Addiction 2016;111:535-44.
28. Kandel ER, Kandel DB. Shattuck lecture. A molecular basis for nicotine as a gateway drug. N Engl J Med 2014;371:932-43.
29. U.S. Department of Health and Human Services. Smoking-50 Years of Progress: A Report of the Surgeon General. Atlanta (GA): U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2014.
30. Lydon DM, Wilson SJ, Child A, Geier CF. Adolescent brain maturation and smoking: What we know and where we're headed. Neurosci Biobehav Rev 2014;45:323-42.
31. England LJ, Bunnell RE, Pechacek TF, Tong VT, McAfee TA. Nicotine and the developing human: A neglected element in the electronic cigarette debate. Am J Prev Med 2015;49:286-93.
32. Flouris AD, Chorti MS, Poulianiti KP, Jamurtas AZ, Kostikas K, Tzatzarakis MN, *et al*. Acute impact of active and passive electronic cigarette smoking on serum cotinine and lung function. Inhal Toxicol 2013;25:91-101.