

Health at Risk: E-Cigarette or Vaping among Adolescents

Phisitphong Piyapanyamongkhon

Faculty of Medicine, Chulalongkorn University

Received: 2024 May 10

Revised: 2024 Jun 4

Accepted: 2024 Jun 7

Introduction

In recent years, electronic cigarettes or vaping devices have witnessed a surge in popularity among adolescents, along with its novelty, thereby emerging as a new health concern in many nations due to their increasing user base worldwide.⁽¹⁾ Longitudinal studies conducted in the US in 2017 and 2019 have demonstrated a significant rise in e-cigarettes use among high school students who have vaped nicotine in the previous month, with rates roughly doubling since 2017: 12th graders (11% to 25%), 10th graders (8% to 20%) and 8th graders (4% to 9%).⁽²⁾ Notably, despite e-cigarette is illegal in Thailand, the number of active users has been on the rise. The data from a joint survey conducted by the Ministry of Public Health, Ministry of Education, and World Health Organization has illustrated the upward trend of Thai school children aged 13-15, increasing more than twofold in less than a decade.⁽³⁾

The study in Thai participants, with an average age of 31.2±8.4 years, has an objective to determine the reason behind e-cigarette usage, the majority stated using e-cigarettes due to their belief that e-cigarettes are less harmful than traditional cigarettes and to aid in their smoking quit process.⁽⁴⁾

However, the study that was conducted on adolescence (12th graders) in the US suggests that they primarily use e-cigarettes for entertainment purposes, and experiment while intent to replace traditional cigarette purposes ranking lowest among their motivation.⁽⁵⁾ Analyzed data of representative sample active e-cigarette users (grades 6-12 students in the USA) National Youth Tobacco Survey (NYTS), conducted from January to March 2020, identified several reasons associated with entertainment-oriented e-cigarette usage, including product characteristics such as flavors, concealability, and vape tricks.⁽⁶⁾ Other studies have shown that frequency of social media usage by adolescents and peers' usage are significantly associated with an increase in individual e-cigarette use.^(7,8)

Even though e-cigarette is relatively novel and a full understanding of their health hazards in the long term are yet to be developed, despite claims to be a safer alternative to traditional cigarettes, there is enough evidence to prove that the health risk caused by e-cigarette must not be overlooked.⁽⁸⁾ Therefore, this article has an objective to explore various health concerns related to the use of e-cigarettes.

E-cigarette and Addiction

One of the most crucial topics that needs to be discussed regarding the use of substance is addiction, due to the fact that addiction of substance induced patients to crave for drugs and exposure to other harmful aspects of the substance. The addiction of e-cigarette is a consequence of nicotine in e-liquid, which has an action to reinforce usage of nicotine containing products via nAChR complex in central nervous system, especially mesocorticolimbic dopamine system, which has a role in rewarding process of successful behavior. Due to plasticity characteristic of the nervous system, neuroadaptation occurs in the affected regions and altered brain conditions that require the presence of nicotine to be preserved. Nicotine addiction and withdrawal syndromes are the consequences of the substance use.⁽⁹⁻¹²⁾ This is consistent with the other research evidences which illustrated that a degree of addiction to e-cigarette is correlated with a history of uses of tobacco and high intensity nicotine drip.⁽¹³⁾

EVALI

EVALI (e-cigarette or vaping product use-associated lung injury) has emerged as a distinct clinical syndrome characterized by respiratory symptoms and lung abnormalities, typically lacking evidence of bacterial or viral infection. The EVALI patients from several of case reports had a history of vaping, particularly the use of e-cigarettes containing tetrahydrocannabinol (THC) or cannabidiol (CBD), prior to onset symptoms and commonly present with dyspnea, cough, and fever, accompanied by various

constitutional symptoms. Radiographic imaging consistently reveals bilateral lung infiltrates, often characterized as a ground-glass pattern with sparing of the peripheral regions. Additional manifestations include bronchiectasis, pleural effusion, and interstitial opacities. Hypoxemia and respiratory failure are frequently observed, necessitating the administration of supplemental oxygen and mechanical ventilation in severe cases. Results from blood analysis have consistently demonstrated leukocytosis with a predominance of neutrophils, while eosinophilia is observed in some patients. Analysis of bronchoalveolar lavage fluid reveals the presence of lipid-laden macrophages, as well as eosinophils and neutrophils. The underlying histopathological processes associated with EVALI encompass a range of conditions, including lipid pneumonia, acute eosinophilic pneumonia, organizing pneumonia, and diffuse alveolar damage. Hospitalization and the need for mechanical ventilation are frequently required, and fatal outcomes have been documented.⁽¹⁴⁻³¹⁾

A report from the Centers for Disease Control and Prevention in 2019^(32,33) has demonstrated that Vitamin E acetate, Tetrahydrocannabinol (THC), and nicotine are possible causes of EVALI due to their correlation with 29 EVALI patient BAL samples. All of the samples detected vitamin E acetate, and the majority also detected THC or nicotine, which is consistent with a rat model.⁽³⁴⁾ One possible explanation is that Vitamin E acetate has regulatory effects on protein kinase C α (PKC α) in the respiratory endothelial cells, causing airway hyperresponsiveness and lung inflammation as it recruits leukocytes.^(35,36) Other explanations suggest that cause of EVALI potential be ketene gas, one of pyrolysis products

of Vitamin E acetate. Ketene can acetylate free amino groups, especially essential functional groups of enzymes and proteins in the lung, induce irritants at low doses and could be lethal at high doses.^(37,38)

Association of E-cigarette and Cancer

As stated, the pyrolysis products of Vitamin E acetate have been linked to harmful effects on the human body, including the development of cancer caused by carcinogenic hydrocarbons.⁽³⁸⁾ In a study conducted by Zahedi et al., it was discovered that e-liquids and aerosols have the ability to initiate epithelial-to-mesenchymal transition (EMT), which is an initial step in cancer metastasis.⁽³⁹⁾ Furthermore, additional evidence suggests that nicotine present in e-liquids may contribute to the risk of cancer through the production of Nitrosamine compounds during the nitrosation process, leading to DNA damage and inhibiting DNA repair.⁽⁴⁰⁾

Secondhand Exposure

Secondhand e-cigarette aerosols may be perceived to be safe among individuals. Despite not fully understanding its consequences, several pieces of evidence have proven that not only

vapers are at risk, but also those surrounding individuals. Cross-sectional studies by Bayly et al. and Islam et al. have illustrated a correlation between second-hand e-cigarette aerosol exposure and respiratory symptoms, lung dysfunction, bronchitis and asthma.^(41,42) A study by Kaiamba et al. also suggests that there is heavy metal in secondhand aerosols as well.⁽⁴³⁾ A case report has shown similar signs and symptoms of those who use e-cigarette, despite the patient being a secondhand aerosol receiver.⁽⁴⁴⁾ Thus, this is a concrete evidence to confirm that e-cigarette not only harmful for those who use, but also harmful for those in the vicinity.

Conclusion

The rising popularity of e-cigarette among adolescents has become a novel health concern. While some believe that it is less harmful than traditional cigarettes and can aid in smoke quitting, and can relieve smoke cessation, evidence suggests that health hazards from e-cigarette must not be overlooked and should be avoided in all age groups. Further investigation regarding its health adverse effect in Thai population should be conducted along with government policies to control those harmful aspects should be established.

References

1. Jerzynski T, Stimson GV, Shapiro H, Król G. Estimation of the global number of e-cigarette users in 2020. *Harm Reduct J* 2021;18(1):109.
2. Miech R, Johnston L, O'Malley PM, Bachman JG, Patrick ME. Trends in adolescent vaping, 2017-2019. *N Engl J Med* 2019;381(15):1490-1.
3. World Health Organization. Statement on electronic-cigarettes [Internet]. 2021 [cited 2023 May 6]. Available from: https://cdn.who.int/media/docs/default-source/thailand/ncds/who-thailand-statement-on-electronic-cigarettes-as-of-20-october-2021.pdf?sfvrsn=97f44cf_5
4. Chankaew T, Baiya P, Chinwong D, Yoodee V, Chinwong S. Electronic cigarettes in Thailand: behaviour, rationale, satisfaction, and sex differences. *Int J Environ Res Public Health* 2022;19(14):8229.
5. Evans-Polce RJ, Patrick ME, Lanza ST, Miech RA, O'Malley PM, Johnston LD. Reasons for vaping among US 12th Graders. *J Adolesc Health* 2018;62(4):457-62.
6. Lindpere V, Winickoff JP, Khan AS, et al. Reasons for e-cigarette use, vaping patterns, and cessation behaviors among US adolescents. *Nicotine Tob Res* 2023;25(5):975-82.
7. Lee J, Tan ASL, Porter L, Young-Wolff KC, Carter-Harris L, Salloum RG. Association between social media use and vaping among Florida adolescents, 2019. *Prev Chronic Dis* 2021;18:E49.
8. Patanavanich R, Aekplakorn W, Glantz SA, Kalayasiri R. Use of e-cigarettes and associated factors among youth in Thailand. *Asian Pac J Cancer Prev* 2021;22(7):2199-207.
9. National Academies of Sciences, Engineering, and Medicine; Health and Medicine Division; Board on Population Health and Public Health Practice; Committee on the Review of the Health Effects of Electronic Nicotine Delivery Systems, Eaton DL, Kwan LY, Stratton K, editors. *Public health consequences of e-cigarettes*. Washington DC: National Academies Press; 2018.
10. De Biasi M, Dani JA. Reward, addiction, withdrawal to nicotine. *Annu Rev Neurosci* 2011;34:105-30.
11. Gardner EL. Addiction and brain reward and antireward pathways. *Adv Psychosom Med* 2011;30:22-60.
12. Pergadia ML, Der-Avakian A, D'Souza MS, Madden PAF, Heath AC, Shiffman S, et al. Association between nicotine withdrawal and reward responsiveness in humans and rats. *JAMA Psychiatry* 2014;71(11):1238-45.
13. Camara-Medeiros A, Diemert L, O'Connor S, Schwartz R, Eissenberg T, Cohen JE. Perceived addiction to vaping among youth and young adult regular vapers. *Tob Control* 2021;30(3):273-8.
14. Davidson K, Brancato A, Heetderks P, Mansour W, Matheis E, Nario M, et al. Outbreak of electronic-cigarette-associated acute lipid pneumonia - North Carolina, July-August 2019. *Morb Mortal Wkly Rep* 2019; 68(36):784-6.
15. Agustin M, Yamamoto M, Cabrera F, Eusebio R. Diffuse alveolar hemorrhage induced by vaping. *Case Rep Pulmonol*. 2018;2018:9724530.
16. Arter ZL, Wiggins A, Hudspath C, Kisling A, Hostler DC, Hostler JM. Acute eosinophilic pneumonia following electronic cigarette use. *Respir Med Case Rep* 2019;27:100825.
17. He T, Oks M, Esposito M, Steinberg H, Makaryus M. "Tree-in-Bloom": severe acute lung injury induced by vaping cannabis oil. *Ann Am Thorac Soc* 2017;14(3):468-70.
18. Henry TS, Kanne JP, Kligerman SJ. Imaging of vaping-associated lung disease. *N Engl J Med*. 2019;381(15):1486-7.
19. Itoh M, Aoshiba K, Herai Y, Nakamura H, Takemura T. Lung injury associated with electronic cigarettes inhalation diagnosed by transbronchial lung biopsy. *Respirol Case Rep* 2017;6(1):e00282.
20. Khan MS, Khateeb F, Akhtar J, Khan Z, Lal A, Kholodovych V, et al. Organizing pneumonia related to electronic cigarette use: a case report and review of literature. *Clin Respir J* 2018;12(3):1295-9.

21. Maddock SD, Cirulis MM, Callahan SJ, Keenan LM, Pirozzi CS, Raman SM, et al. Pulmonary lipid-laden macrophages and vaping. *N Engl J Med* 2019;381(15):1488-9.
22. Modi S, Sangani R, Alhajhusain A. Acute lipid pneumonia secondary to e-cigarettes use: an unlikely replacement for cigarettes. *Chest* 2015;148:382A.
23. Sommerfeld CG, Weiner DJ, Nowalk A, Larkin A. Hypersensitivity pneumonitis and acute respiratory distress syndrome from e-cigarette Use. *Pediatrics* 2018;141(6):e20163927.
24. Thota D, Latham E. Case report of electronic cigarettes possibly associated with eosinophilic pneumonitis in a previously healthy active-duty sailor. *J Emerg Med* 2014;47(1):15-7.
25. Viswam D, Trotter S, Burge PS, Walters GI. Respiratory failure caused by lipid pneumonia from vaping e-cigarettes. *BMJ Case Rep* 2018;2018:bcr2018224350.
26. Smith E, Cherian R, McGillen B. A case of e-cigarette, or vaping, product use-associated lung injury (EVALI) in a previously healthy patient: case report and literature review. *J Gen Intern Med* 2020;35(9):2767-70.
27. Tumeo CC, Schiavino A, Paglietti MG, Petreschi F, Ottavianelli A, Onofri A, et al. e-cigarette or vaping product use associated lung injury (EVALI) in a 15 year old female patient - case report. *Ital J Pediatr* 2022;48(1):119.
28. Adhikari R, Koritala T, Gotur R, Malayala SV, Jain NK. EVALI - e-cigarette or vaping product use-associated lung injury: a case report. *Cureus* 2021;13(2):e13541.
29. Schäfer M, Steindor M, Stehling F, Dohna-Schwake C. EVALI (e-cigarette or vaping product use associated lung injury): first case report of an adolescent in Europe. *Pediatr Pulmonol* 2021;56(5):1274-5.
30. Marlière C, De Greef J, Gohy S, Hoton D, Wallemacq P, Jacquet LM, et al. Fatal e-cigarette or vaping associated lung injury (EVALI): a first case report in Europe. *Eur Respir J* 2020;56(1):2000077.
31. Layden JE, Ghinai I, Pray I, Kimball N, Layer M, Tenforde MW, et al. Pulmonary illness related to e-cigarette use in Illinois and Wisconsin - final report. *N Engl J Med* 2020;382(10):903-16.
32. Blount BC, Karwowski MP, Morel-Espinosa M, Rees J, Sosnoff C, Cowan E, et al. Evaluation of bronchoalveolar lavage fluid from patients in an outbreak of e-cigarette, or vaping, product use-associated lung injury - 10 cases, August - October 2019. *Morb Mortal Wkly Rep* 2019;68(45):1040-1.
33. Blount BC, Karwowski MP, Shields PG, Morel-Espinosa M, Valentin-Blasini L, Gardner M, et al. Vitamin E acetate in bronchoalveolar-lavage fluid associated with EVALI. *N Engl J Med* 2020;382(8):697-705.
34. Bhat TA, Kalathil SG, Bogner PN, Blount BC, Goniewicz ML, Thanavala YM. An animal model of inhaled Vitamin E acetate and EVALI-like lung injury. *N Engl J Med* 2020;382(12):1175-7.
35. Lal A, Mishra AK, Sahu KK. Vitamin E acetate and e-cigarette or vaping product-associated lung injury (EVALI): an update. *Am J Med* 2020;133(5):e204.
36. Cook-Mills JM, Abdala-Valencia H, Hartert T. Two faces of Vitamin E in the lung. *Am J Respir Crit Care Med* 2013;188(3):279-84.
37. Soto B, Costanzo L, Puskoor A, Akkari N, Geraghty P. The implications of Vitamin E acetate in e-cigarette, or vaping, product use-associated lung injury. *Ann Thorac Med*. 2023;18(1):1-9.
38. Wu D, O'Shea DF. Potential for release of pulmonary toxic ketene from vaping pyrolysis of Vitamin E acetate. *Proc Natl Acad Sci USA* 2020;117(12):6349-55.
39. Zahedi A, Phandthong R, Chaili A, Remark G, Talbot P. Epithelial-to-mesenchymal transition of A549 lung cancer cells exposed to electronic cigarettes. *Lung Cancer* 2018;122:224-233.
40. 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 USA* 2018;115(7):E1560-9.

41. Bayly JE, Bernat D, Porter L, Choi K. Secondhand exposure to aerosols from electronic nicotine delivery systems and asthma exacerbations among youth with asthma. *Chest* 2019;155(1):88-93.
42. Islam T, Braymiller J, Eckel SP, Liu F, Tackett AP, Rebuli ME, et al. Secondhand nicotine vaping at home and respiratory symptoms in young adults. *Thorax* 2022;77(7):663-8.
43. Kapiamba KF, Hao W, Adom S, Liu W, Huang YW, Wang Y. Examining metal contents in primary and secondhand aerosols released by electronic cigarettes. *Chem Res Toxicol* 2022;35(6):954-62.
44. Galiatsatos P, Gomez E, Lin CT, Illei PB, Shah P, Neptune E. Secondhand smoke from electronic cigarette resulting in hypersensitivity pneumonitis. *BMJ Case Rep* 2020;13(3):e233381.