

Philadelphia College of Osteopathic Medicine

DigitalCommons@PCOM

---

PCOM Capstone Projects

Student Dissertations, Theses and Papers

---

2020

## Adolescents and E-cigarette Use: Long-term Effects, Behaviors and Lung Injury

Sarah Congdon

*Philadelphia College of Osteopathic Medicine*

Follow this and additional works at: [https://digitalcommons.pcom.edu/capstone\\_projects](https://digitalcommons.pcom.edu/capstone_projects)



Part of the [Public Health Commons](#)

---

### Recommended Citation

Congdon, Sarah, "Adolescents and E-cigarette Use: Long-term Effects, Behaviors and Lung Injury" (2020). *PCOM Capstone Projects*. 18.

[https://digitalcommons.pcom.edu/capstone\\_projects/18](https://digitalcommons.pcom.edu/capstone_projects/18)

This Capstone is brought to you for free and open access by the Student Dissertations, Theses and Papers at DigitalCommons@PCOM. It has been accepted for inclusion in PCOM Capstone Projects by an authorized administrator of DigitalCommons@PCOM. For more information, please contact [library@pcom.edu](mailto:library@pcom.edu).

Philadelphia College of Osteopathic Medicine  
Graduate Program in Biomedical Sciences  
School of Health Sciences

**ADOLESCENTS AND E-CIGARETTE USE: LONG-TERM EFFECTS, BEHAVIORS  
AND LUNG INJURY**

A Capstone in Public Health by Sarah Congdon

Copyright 2020 Sarah Congdon

Submitted in Partial Fulfillment of the Requirements for the Degree of  
Master of Science in Biomedical Sciences, Public Health Concentration

May 2020

## ABSTRACT

The use of Electronic Nicotine Delivery Systems (ENDS)<sup>1</sup>, commonly referred to as e-cigarettes, has become a deadly habit among adolescents across the nation. These devices are attractive with their sleek design, fun flavors, and youthful advertisements. E-Cigarettes entered the marketplace around 2007, and since 2014, they have been the most commonly used tobacco product among U.S. youth<sup>2</sup>. In 2018, more than 3.6 million U.S. youth, including 1 in 5 high school students and 1 in 20 middle school students, currently use e-cigarettes<sup>3</sup>. There have been increasing lung infections and chronic lung diseases rising in the younger community. The strong adolescent appeal for E-cigarettes began in the latter half of 2019, when the US investigated an outbreak of lung injuries associated with the use of E-cigarettes or vaping products, and as of February 2020 there have been 2,807 hospitalized E-cigarettes, or vaping, product-use associated lung injury (EVALI) cases or deaths<sup>4</sup>. There is an increasing concern of the threat of COVID-19 on the younger community because they have been exposing their lungs to these aerosol devices.

Researchers have looked into E-cigarette advertisements, especially the community to which they appeal, as well as how E-cigarette use increases an adolescent's chance of smoking regular cigarettes in the future<sup>5</sup>. Regulations and laws are needed to control and keep the tobacco companies accountable for their sales of the products. Schools need the proper curriculum in order to educate students on the danger of ENDS. A concern with E-cigarettes is the potential gateway effect to other dangerous drugs. E-cigarettes can contain nicotine and THC components causing multiple health and lung problems among its chronic users. The longevity of E-cigarette use is unknown, and it is important to consider the developing adolescent brain and how nicotine exposure can affect memory, attention, motivation, and many other functions<sup>5</sup>. Scientists and

physicians should be emphasizing the importance of conveying the dangers to parents in regard to the clinical observations such as any physiological changes in an adolescent body from exposure to high doses of nicotine and THC. Simultaneously, educating students to understand the significant life-altering changes from continual E-cigarette use is vital at this stage in their lives.

Objective: Improving adolescent education on the effects of E-cigarette and emphasizing importance in the classrooms as well as in society in order to help prevent any detrimental long-term effects.

*Keywords:* E-cigarettes, nicotine, THC, conventional cigarettes, adolescents, curriculum, COVID-19, advertisements

## BACKGROUND

Conventional cigarette use has been researched and studied for several decades, yet the tobacco industries continue to produce the products and consumers continue to purchase them. Lung cancer is the leading cause of cancer-related death in the United States, with an average five-year survival rate of 15 percent, and smoking being the leading risk factor<sup>6</sup>. People of all ages are smokers and they seem to ignore the risks that follow with the chronic use. A case study report of an 18-year-old Caucasian male who presented in January 2019 to an Emergency Department for evaluation of sudden-onset right-sided chest pain while sleeping, revealed that he had denied excessive coughing, recent upper respiratory infection, or any trauma to the chest<sup>7</sup>. However, the patient reported multiple episodes of vaping daily, intermittent marijuana use and denied conventional cigarette smoking<sup>7</sup>. After receiving a chest X-ray, the patient was diagnosed with a right sided pneumothorax. At this time, he had a chest tube placed and was eventually admitted into the hospital. After 2 weeks he had a reoccurring pneumothorax and was admitted again for treatment. This is just one example of an adolescent suffering from the consequences of excessive E-cigarette use.

ENDS have few comprehensive studies to assess the long-term effects of the vaporized solvents entering into a person's lungs. Madison et al. 2019 recently studied the effects the vapor from these products had on mice lungs. They concluded "ENDS exposure, independent of nicotine, altered lung lipid homeostasis in alveolar macrophages and epithelial cells. In addition to ENDS-induced lipid deposition, chronic ENDS vapor exposure downregulated innate immunity against viral pathogens in resident macrophages"<sup>1</sup>. The mice lungs became more

susceptible to disease and unable to properly protect the body from invading infections. The conclusion of Madison et al. 2019 findings revealed that chronic E-cigarette vapor aberrantly alters the physiology of lung epithelial cells and resident immune cells and promotes poor response to infectious challenges.

Knowledge on the effects of cigarette smoke is well researched and understood. In fact, inhaling cigarette smoke has been shown to produce acute changes in the lung including alterations in resistance to airflow, cough, and irritation of the airway. Additionally, early stages of smoking likely affect the respiratory function of youths<sup>8</sup>. The electronic devices presented a new problem since the aerosols being inhaled from the cartridges differ from the conventional cigarettes. A large case series of EVALI documented the symptoms and laboratory findings from several patients with a known vaping history and without prior medical problems. Imaging patterns that have been described include a diffuse alveolar damage pattern with predominant basal consolidation with areas of diffuse ground glass opacities; an acute eosinophilic pneumonia pattern with patchy nodular areas of consolidation; an acute hypersensitivity pneumonitis pattern with extensive areas of ground glass infiltrates accompanied by mosaic attenuation; and an interstitial pneumonia pattern with peripheral reticulation, ground glass opacity and traction bronchiectasis<sup>9</sup>. Those descriptions sound complicated, but in the end, they are all variations of lung damage and lung injury that are more commonly seen in patients with COPD, emphysema, or an extensive smoking history. The lung injuries are usually irreversible, so educating society on how detrimental these devices is important to help prevent them from damaging their health.

Cigarette products have gone through upgrades and changes over the years, but the recent market of E-cigarettes became exceedingly popular within the last couple of years. The advertisements around the devices were clearly tailored towards a younger audience and

heightened the appeal. The appeal to the E-cigarettes starts with the mechanics behind the devices, which administer a “heated aerosol of nicotine that mimics conventional cigarettes. These cigarettes deliver lower levels of toxins than a conventional combusted cigarette” in a variety of flavors<sup>8</sup>. Consumers began using the products as an aid to move away from conventional cigarette use. However, adolescents began using the products with nicotine as well as traces of THC as a popular recreational tool, thus, sparking an epidemic in the nation. The behavioral factors and motivation behind using these devices have been studied into in order to comprehend the appeal adolescents have. The CDC’s website states, “syndromic data on emergency department visits suggests that E-cigarette, or vaping, product use-associated lung injury (EVALI) outbreak began in June 2019”<sup>10</sup>. As more studies come out on the effects of E-cigarette on lungs, the FDA creates more regulations on the devices to help diminish the existing crisis the country is facing. Certain socioeconomic groups experience tobacco-related disparities including higher risk for cigarette smoking, more difficulty quitting, and greater tobacco-related morbidity and mortality<sup>11</sup>. These novel ENDS products have become easily accessible and also began as a harm reduction product for conventional smokers, however they are not always affordable for low-socioeconomic smokers who bear the greatest burden from tobacco use<sup>11</sup>.

The media has been reporting less and less on the crisis due to the recent regulations limiting adolescent access. The appeal of E-cigarettes with adolescents is unsettling and hard to comprehend even with all the information published on the conventional cigarette effects and the current epidemic. Education on the effects of E-cigarette use needs to be emphasized in the classrooms as well as in society in order to help prevent any detrimental long-term effects.

## **RESEARCH STRATEGIES**

The research strategy for this capstone began with evaluating the topic of electronic E-cigarette use in adolescents. Key words such as conventional cigarettes, electronic cigarettes, physiological effects, nicotine and THC were all targeted during preliminary library research. Philadelphia College of Osteopathic Medicine online library database via Google Scholar and E-Journals were searched for articles and publications on the main topic. The research was focused on observing and understanding the appeal adolescents have with these nicotine and THC products. Socioeconomic groups and race were also studied and documented while researching the databases for information on electronic cigarettes. Literature review is the primary source of the data collected in this paper.

## RESULTS AND DISCUSSION

Adolescents spend a majority of their days at school with their friends, teachers and administrators. Schools are where youth develop important interpersonal relationships, including friendships, and are where students are exposed to new knowledge, social norms, and organizational policies<sup>12</sup>. E-cigarettes quickly became a popular social norm among the youths with little knowledge from the students as well as the teachers. Several universities and health departments have developed toolkits for teachers and administrators, which include policy guidelines and educational resources<sup>13</sup>. With these toolkits teachers and administration can create infographics that are tailored to the specific interests of their students and include information that is relevant to the school's sociodemographic. Posting the infographics around the school is a great way to inform the students about the vaping dangers and allows the information to be visible to the students every day of the week. A personalized infographic is listed at the end of the "Recommendation for Future Studies" section as an example of something eye catching yet informative that could be placed in the schools. This is step in the right direction because teachers and administrators express concern for their students and want to make prevention of lung injury a high priority in the schools.

The appeal in E-cigarette use in adolescents stems from a similar appeal in using conventional cigarettes. Behavioral and psychosocial factors contribute to the constant use of these devices despite their harmful effects. In fact, E-cigarette use is comparable to risk factors such as problem drinking and illicit drug use. One study looked into behavioral risk factors, such as problem drinking and marijuana use, compared to greater academic achievement and support protection from family amongst college students<sup>14</sup>. Among the college students it was

determined students with greater academic achievement and support protection from family had lower smoking involvement compared to those who partook in the behavioral risk factors who were associated with greater smoking involvement<sup>14</sup>. The study provides a conceptual framework to comprehend why college students engage in such behaviors involving tobacco use, which is comparable to using E-cigarettes which can deliver nicotine and THC.

Recently there have been studies evaluating the level of appeal with ENDS between males and females. The study discovered males prefer fruit flavored E-cigarettes, and females prefer both menthol and fruit flavored E-cigarettes<sup>15</sup>. With this knowledge females are more likely to partake in using these devices since they prefer a wider range of flavors, as per the study. Future studies could focus on female's biological preferences for the analgesic effects of menthol and their levels of nicotine dependence compared to men<sup>15</sup>. Once there is more information collected it would be worthwhile to study the number of female cases vs male cases who were e-cigarette dependent and how the virus damaged their lungs.

A main concern for adolescent use of E-cigarettes stems from the behaviors exhibited by the parents, guardians and other family members in the household. A systematic review and meta-analysis of the magnitude of these effects discovered parental and sibling smoking is a strong and significant determinant of the risk of smoking uptake by children and young people<sup>16</sup>. Smoking is an entirely avoidable health risk with proper knowledge and understand of the consequences from all tobacco products as well as electronic products.

## RECOMMENDATIONS FOR FUTURE STUDIES

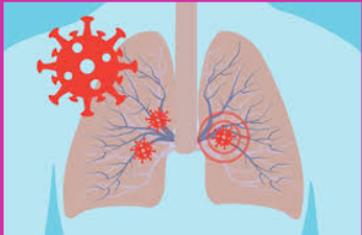
The current COVID-19 pandemic causing less jobs, online classes and take-home work from pre-K to doctorate programs has left adolescents and young adults bored at home with much more free time. This boredom can easily invite the temptation of bad habits amongst this population since they have more access to products with the convenience of online shopping and marketing on social media. This is a stressful time for adolescents, and they might be turning to ENDS, as well as other substances that may be put in the electronic delivery systems as a distraction from the world. Without the constant supervision from teachers, professors and other members of educational administrations, the students could be at home in their rooms, basements, and backyards using vaping products. Studying adolescent's behavior is just as important as studying the physiological effects from E-cigarettes. The concern is that the increase use of ENDS will cause an increase in the number of COVID-19 cases since the lungs can be damaged and become more susceptible to a viral infiltrate.

The younger community is not only putting their health at risk, but they are also putting their wallets at risk. The consequences of smoking uptake in these young individuals are likely to include significant morbidity and premature mortality, and also the financial poverty arising from a regular habit<sup>16</sup>. The financial burden from vaping and smoking can be tough to sustain with little to no income for adolescents. Any income these individuals make could be spent in an instant on these devices, cartridges, etc. It's more financially responsible to put any income into savings, but if no one explains this importance to the younger generation their first instinct will be to spend the money.

As adolescents spend more time isolated at home in quarantine, they are left unsupervised for longer periods of times in the day. They can be sitting on their phones or computers not completing their schoolwork. Thanks to the social media platform, *TikTok<sup>TM</sup>*, the youth have been creating videos of themselves or spend hours a day watching other's videos on the app. Creating a video with real life people who have suffered from the dangers of vaping and smoking could potentially affect the adolescents if they come across it on the app. Getting the message across to youth from people similar to them, could help make them more aware of the weight of their decisions.

The science around vaping is still evolving and constantly being explored. As mentioned throughout the paper, several studies have reported lung complications and other health problems from the use of vaping products, but long-term effects from the devices is still a mystery. Now with the COVID-19 outbreak, the science around this virus which did not exist several months ago, is also still evolving. These two topics create a lot of uncertainty in the science community, as well as a lot of fear for what the future holds. Keeping the youth away from the damaging E-cigarettes is more vital now more than ever. Fear is one tactic to successfully help them avoid using the devices but educating them on the importance from abstaining from them can potentially help generations to come.

Yeah vaping is cool, but have you ever seen what your **future** will look like from chronic e-cigarette use?



More susceptible to **Coronavirus**



**Brain Development**  
Issues



Damaging your health could lead to a **Financial Burden**

Sport scholarship in your future? Good luck keeping up with **Compromised Lungs!**





Vaping is only the **beginning**. Realize what you're putting in your body and what your decisions could lead to next...

So what can you do?...

KNOW THE **FACTS**

**QUIT NOW**



**STAY HEALTHY AND KEEP SAFE**

You only have one life, so make it a good one! 😊

Here is an original example of an infographic for schools to post in hallways, classrooms, etc.

## REFERENCES

1. Madison M., Landers C., Gu B., Chang C., Tung H., Hong M., Baghaei N., Song L., Porter P., Putluri N., Salas R., Gilbert B., Levental I., Campen M., Corry D., and Kheradmand F. Electronic cigarettes disrupt lung lipid homeostasis and innate immunity independent of nicotine. 2019. *J Clin Invest*. <https://doi.org/10.1172/JCI128531>.
2. Office of the Surgeon General. E-cigarette Use Among Youth and Young Adults; A Report of the Surgeon General. *U.S. Department of Health and Human Services, Centers for Disease Control and Prevention*; 2016.
3. Cullen KA, Ambrose BK, Gentzke AS, Apelberg BJ, Jamal A, King BA. Notes from the Field: Increase in use of electronic cigarettes and any tobacco product among middle and high school students – United States, 2011-2018. *MMWR Morbidity & Mortality Weekly Report* 2018; 67(45):1276-1277.
4. St Claire S., Gouda H., Schotte K., Fayokun R., Fu D., Varghese C. and Prasad V. Lung Health, Tobacco and Related Products: Gaps, Challenges, New Threats and Suggested Research. *AM J Physiol Lung Cell Mol Physiol* in press, 2020.
5. Dutra L. and Glantz S. Electronic Cigarettes and Conventional Cigarette Use Among US Adolescents. *JAMA Pediatr*. 2014; 168(7):610-617.
6. Collins L., Haines C., Perkel R., and Enck R. Lung Cancer: Diagnosis and Management. *American Family Physician*. 2007; 75(1):56-63.
7. Bonilla A., Blair A., Alamro S., Ward R., Feldman M., Dutko R., Karagounis T., Johnson A., Folch E. and Vyas J. Recurrent spontaneous pneumothoraces and vaping in an 18-year-old man: a case report and review of literature. *Journal of Medical Case Reports*. 2019; 13(283):1-6.

8. Tantisuwat A. and Thaveeratitham P. Effects of Smoking on Chest Expansion, Lung Infection and Respiratory Muscle Strength of Youths. *J. Phys. Ther. Sci.* 2014; 26:167-170.
9. Hilton R., Summer R., Roman J., Sundaram B. and George G. E-Cigarettes and Vaping Associated Lung Injury: A Case Series and Brief Review. 2020. *American Journal of the Medical Sciences.* 359(3); 137-139.
10. CDC website: [https://www.cdc.gov/tobacco/basic\\_information/E-cigarettes/severe-lung-disease.html](https://www.cdc.gov/tobacco/basic_information/E-cigarettes/severe-lung-disease.html)
11. Spears C., Jones D., Weaver S., Huang J., Yang B., Pechacek T. and Eriksen M. Sociodemographic Correlates of Electronic Delivery Systems (ENDS) Use in the United States, 2016-2017. *AJPH.* 2019; 109(9):1224-1232.
12. Ennett, S. T., Foshee, V. A., Bauman, K. E., Hussong, A., Faris, R., Hipp, J. R., & Cai, L. A social contextual analysis of youth cigarette smoking development. *Nicotine & Tobacco Research.* 2010; 12:950-962.
13. Schillo B., Cuccia A., Patel M., Simard B., Donovan E., Hair E. and Vallone D. JUUL in School: Teacher and Administrator Awareness and Policies of E-Cigarettes and JUUL in U.S. Middle and High Schools. *Health Promotion Practice.* 2019; 1:20-24.
14. Costa F., Jessor R. and Turbin M. College student involvement in cigarette smoking: The role of psychosocial and behavioral protection and risk. *Nicotine and Tobacco Research.* 2005; 9(2):213-224.
15. Pang R., Goldenson N., Kirkpatrick M., Barrington-Trimis J., Cho J. and Leventhal A. Sex Differences in the Appeal of E-Cigarettes Among Young Adult E-Cigarette Users. *Psychology of Addictive Behaviors.* 2020; 34(2):303-307.

16. Leonardi-Bee J., Jere M. and Britton J. Exposure to parental and sibling smoking and the risk of smoking uptake in childhood and adolescence: a systematic review and meta-analysis. *Thorax*. 2011; 66:847-855.