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An Analysis of The Implications of The Use of E-Cigarette or Vaping Products on Adolescence Health

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ABSTRACT

This study analyzes the implications that the use of e-cigarette or vaping products has on adolescence health (i.e. lungs) to inform medical practices, and public health policy by using two separate patients' medical reports. Statistically, most of the use of vaping products is reportedly seen among the male population, with a male to female predominance ratio of 2 is to 1 (i.e. 2:1), whereby the majority of the patients fall under young adult population (i.e. age less than 35 years but greater than or equal to age 18 years). Two separate cases report among different patients were used for the analysis of this study. The first case took into account a vaping related issue for 29-year-old male, while the second case considered a report for 28-year-old female. Deductively, the study revealed that vaping can cause breathing problems, organ damage, addiction and other conditions irrespective of gender type. Specifically, the analysis of the two cases revealed to readers that vaping causes lungs injury or damage, while most of the injury appears to be chemical in nature, and superadded viral or bacterial infections are rare as most of the testing of E-cigarettes fluids showed no bacterial contamination. The study further revealed that vaping related complications or effects are the same for both males and females. Above all, the study revealed that the tetrahydrocannabinol products are most commonly implicated in causing vaping-induced lung injury in almost 75 to 80% of the morbidity cases.

Keywords: Vaping, E-cigarette, Lungs, Injury, Adolescence, Health, Morbidity, Bibasilar Infiltrates, EVALI, Respiratory, Hypothyroidism, and Tetrahydrocannabinol

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INTRODUCTION

Historically, the modern e-cigarette or vaping product was invented in 2003 by Chinese pharmacist Hon Lik, but tobacco companies had been developing nicotine aerosol generation devices since as early as 1963 (Dutra, Grana, & Glantz, 2016). the earliest e-cigarette or vaping product can be traced to American Herbert A. Gilbert (Charney, 2014), who in 1963 applied for a patent for *a smokeless non-tobacco cigarette* that involved replacing burning tobacco and paper with heated, moist, flavored air (Bellis, 2015). Additionally, Bellis (2015) underscored in the literature that the earliest vaping device produced flavored steam without nicotine (Bellis, 2015).

Vaping is when a person uses a handheld electronic device to breathe a mist ("vapor") into one's lungs. An e-cigarette, vape pen or other electronic nicotine delivery system (ENDS) heats a liquid of nicotine, flavoring, propylene glycol and other additives into an aerosol that you inhale through a mouthpiece. Vaping can cause breathing problems, organ damage, addiction and other conditions. Vaping is when an individual uses a small, handheld device (like e-cigarettes, vape pens or mods) to inhale a mist of nicotine and flavoring (e-liquid). It is similar to smoking a cigarette, but vaping heats tiny particles out of a liquid rather than burning tobacco. An electronic cigarette (e-cigarette) is a device that heats up the liquid nicotine and flavoring for a person to breathe in. There are many varieties of e-cigarettes that go by different names, including vapes, vape pens or sticks, e-hookahs, hookah sticks, mods and personal vaporizers (PVs). All these vaping products or e-cigarette can also be collectively called electronic nicotine delivery systems (ENDS). Very importantly, most types of e-cigarettes have the following features/characteristics: (a) A cartridge, tank or pod that holds liquid (can be refillable). (b) A heating element for turning the liquid into breathable particles (aerosol, commonly called "vapor"). (c) A battery to power the heating element. (d) A power or control button (some are activated by sensors when you inhale). (e) A mouthpiece to breathe in the aerosol.

According to the Centers for Disease Control and Prevention (2021), most of the use of vaping products or e-cigarette is seen and reported among the male population, with a male to female predominance ratio of 2:1,

and the majority of patients were reported to age less than 35 years (i.e. among the young adults). Also, National Heart, Lung, and Blood Institute (2022) underscored in the literature that the long-term use of electronic cigarettes, or vaping products, can significantly impair the function of the body's blood vessels, increasing the risk for cardiovascular disease. Additionally, the use of both e-cigarettes and regular cigarettes may cause an even greater risk than the use of either of these products alone. These findings come from two new studies supported by the National Heart, Lung, and Blood Institute (NHLBI), part of the National Institutes of Health (NIH). Additionally, the findings, which appear today in the journal *Arteriosclerosis, Thrombosis, and Vascular Biology*, add to growing evidence that long-term use of e-cigarettes or vaping products can harm a person's health (National Heart, Lung, and Blood Institute, 2022). Researchers have known for years that tobacco smoking can cause damage to blood vessels. However, the effects of e-cigarettes on cardiovascular health have been poorly understood.

E-cigarette or vaping product use-associated lung injury (EVALI), initially recognized in 2019, is becoming one of the leading causes of lung damage in the young adult population (Centers for Disease Control and Prevention, 2021; Williams et al., 2022). EVALI, a form of acute lung injury, presents pathologically as a spectrum of disease processes such as acute fibrinous pneumonitis, diffuse alveolar damage, or organizing pneumonia accompanied by bronchiolitis (Williams et al., 2022; Butt et al., 2019). Most of the injury appears to be chemical in nature, and superadded viral or bacterial infections are rare as most of the testing of E-cigarettes fluids showed no bacterial contamination (Christiani, 2020; Williams et al., 2022). The tetrahydrocannabinol products are most commonly implicated in causing vaping-induced lung injury in almost 75 to 80% of the cases (Williams et al., 2022; Layden et al., 2020). However, it was noted by Zulfiqar and Rahman (2022) in the literature that vitamin E and nicotine have also been found to be possible contributors to lung injury as well. While, Williams et al. (2022) also argued in the literature that most patients with EVALI present with respiratory symptoms, including shortness of breath and cough, along with constitutional symptoms of fever and chills. However, some patients have also presented with chest pain, hemoptysis, and gastrointestinal symptoms such as nausea and vomiting (Layden et al., 2020; Centers for Disease Control and Prevention, 2021; Williams et al., 2022). In order to effectively contribute to the body of medical literature, this study presents an analysis on two separate cases of young male and female who presented with EVALI after vaping tetrahydrocannabinol (THC) in one teaching hospital in Nigeria.

LITERATURE REVIEW

About E-Cigarette

According to Center for Disease Control and Prevention (2021), e-cigarette, or vaping products can be used to deliver nicotine, cannabis (THC, CBD), flavorings, chemicals, and other substances. E-cigarette, or vaping products are known by many different names and come in many shapes, sizes and device types. Some of the vaping or e-cigarette devices may be referred to as: (1) E-cigs, (2) Vapes, (3) Vape pens, dab pens, and dab rigs, (4) Tanks, (5) Mods, (6) Pod-Mods, and (7) Electronic nicotine delivery systems (ENDS) (Center for Disease Control and Prevention, 2021). Use of e-cigarette, or vaping, products is sometimes referred to as "vaping" or "juuling." E-cigarette, or vaping products used for dabbing are sometimes called "dab" pens (see Table 1 for more details).

Table 1: The Evolution of E-Cigarette or Vaping Products

Vaping Product	Evolution of Vaping/E-Cigarette	Types of Vaping/ E-Cigarette	Description of Use
	First (1st) Generation	Disposable e-cigarettes	A type of e-cigarette designed to be used one time, only. These devices are not rechargeable or refillable. They are discarded when it runs out of charge or e-liquid. They are designed to mimic the look and feel of combustible cigarettes. These are sometimes referred to as "cigalikes"
	Second (2nd) Generation	E-cigarettes with prefilled or refillable Cartridge	A type of rechargeable e-cigarette, or vaping, product designed to be used multiple times. E-liquid comes in prefilled or refillable cartridges. Substances may include nicotine, cannabis (THC, CBD), flavoring, solvents, or other substances. The cartridge is attached to a battery pen—which contains the battery. Cartridge and battery pen are typically purchased separately. They can be bought in starter packs.
	Third (3rd) Generation	Tanks or Mods (refillable)	A type of rechargeable e-cigarette, or vaping, product designed to be used multiple times. They are modifiable devices ("mods"), allowing users to customize the substances in the device.
	Fourth (4th) Generation	Pod Mods (prefilled or Refillable)	Pod Mod is an e-cigarette, or vaping, product with a prefilled or refillable ''pod'' or pod cartridge with a modifiable (mod) system ("Pod-Mods"). These are other examples of fourth generation devices. Pod Mods come in many shapes, sizes, and colors. Common Pod Mod brands include JUUL, and Suorin. There are compatible prefilled pod cartridges that contain nicotine, THC, or CBD with or without flavoring.

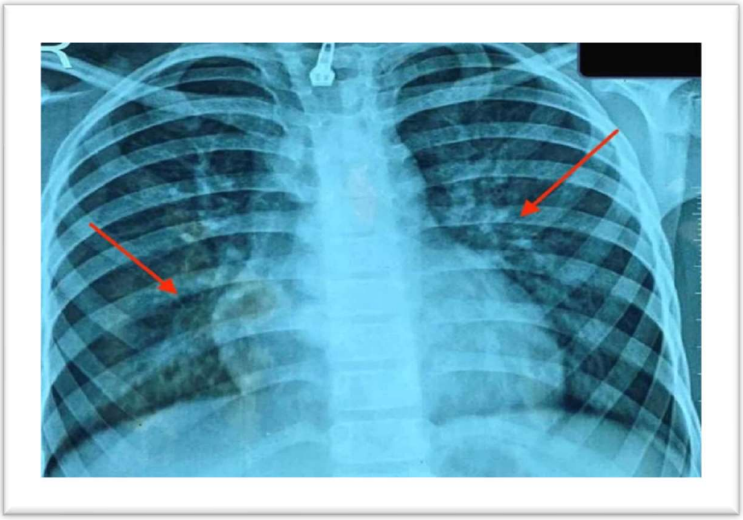
Source: Author's modification of "The Evolution of E-Cigarette or Vaping Products" by Center for Disease Control and Prevention (2021)

DATA ANALYSIS AND CASES PRESENTATIONS

Male Case Report

A 29-year-old male patient who was diagnosed with fever, chills, and non-radiating midline lower abdominal pain (i.e. visceral pain) associated with vaping THC was considered for the analysis of this study. The patient medical records showed that the patient has a past medical history significant for hypothyroidism and active vaping THC ongoing for eight (8) months. During this period the patient was presented to the hospital emergency unit with the usual complaints of fever, chills, and non-radiating midline lower abdominal pain, ongoing for three days with urinalysis concerning for a urinary tract infection. The laboratory testing and reports on the patient medical records revealed that the blood and urine cultures were negative, and the patient was discharged home on levofloxacin. Surprisingly, this same male patient returned to the clinic emergency unit after 5 days with complaints of palpitations and shortness of breath associated with a cough productive of brown sputum. On presentation in this time around, the patient was afebrile (i.e. no fever), tachycardic with a heart rate in 156 BPM, tachypneic with oxygen saturation in the low 90s, requiring nasal canula. On the physical examination, the patient had labored breathing with decreased breath sound bilaterally (similar to the female patient report presented by Williams et al., 2022). Per the medical report, the hospital commenced labs on the patients. The labs reports were significant for mild white blood cell (WBC) elevation, 11.3/uL. Also, the computed tomography (CT) abdomen and pelvis to evaluate for underlying pyelonephritis or renal abscess was done. Surprisingly, the result was negative for any intrabdominal pathology but revealed bilateral pulmonary ground-glass opacities (see Figure 2 for more details). As part of the patient diagnosis, he was asked to go for chest X-ray scan.

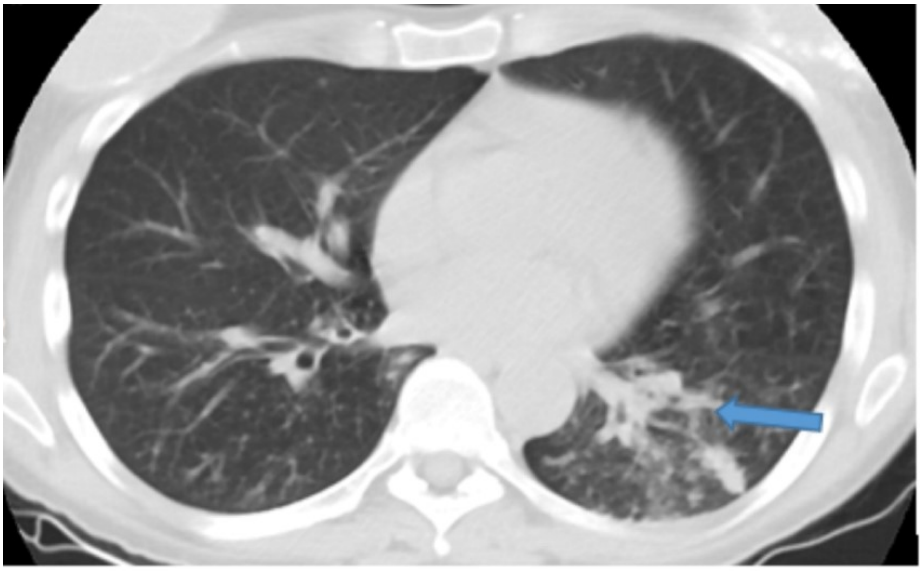
Figure 1: CXR Showing Bilateral Infiltrates in a Male Patient



Source: Author's modification of Patient's CXR Records from a Teaching Hospital in Nigeria

Figure 1 presents the male patient chest X-ray scan result. The chest X-ray scan result revealed multifocal bilateral pulmonary infiltrates or consolidations. As a result, the patient was placed on empiric antibiotics and was admitted to the *intensive care unit* (ICU) in anticipation of respiratory decompensation given the continued respiratory distress and increased work of breathing. As part of the interventions, a computed tomography pulmonary angiogram (CTPA/CTPE) to evaluate for a pulmonary embolism was applied on the patient. The CTPA/CTPE that was to evaluate for a pulmonary embolism was negative but showed extensive ground-glass bibasilar opacities with superimposed reticular changes (see Figure 2 for more details).

Figure 2: CT Chest Showing Extensive Ground-Glass Bibasilar Opacities in a Male Patient



Source: Author's modification of Patient's CXR Records from a Teaching Hospital in Nigeria

The next diagnosis that followed CTPA/CTPE was the diagnosis of EVALI. Since there is no single test for EVALI. Diagnosis is mostly a process of elimination because symptoms can be similar to many other respiratory diseases. These include shortness of breath, fever and chills, cough, vomiting, diarrhea, headache, dizziness, rapid heartrate and chest pain. Nevertheless, in this case the diagnosis of EVALI was established after ruling out lung infections with negative respiratory cultures and viral panel, urine legionella antigen, and negative workup for connective tissue and autoimmune disease (similar to the female patient report presented by Williams et al., 2022). As part of the medical treatment after the diagnosis, the patient was commenced on methylprednisolone, which led to improvement in respiratory status, and he was eventually discharged on a prednisone taper.

Female Case Report

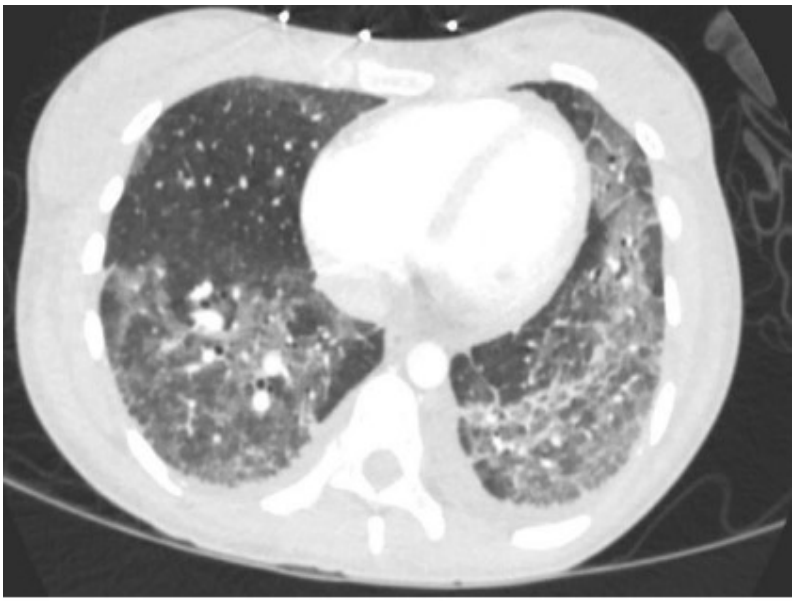
A report of a 28-year-old female patient who was diagnosed with fever, chills, and non-radiating midline lower abdominal pain (i.e. visceral pain) associated with vaping THC was included in the analysis of this study. The patient medical records showed that the patient has a past medical history significant for hypothyroidism and active vaping THC ongoing for over nine (9) months. During this period the patient was presented to the clinic emergency unit with the usual complaints of fever, chills, and non-radiating midline lower abdominal pain, ongoing for three days with urinalysis concerning for a urinary tract infection. The laboratory testing and reports on the patient medical records revealed that the blood and urine cultures were negative, and the patient was discharged home on levofloxacin. Surprisingly, this same female patient returned to the clinic emergency unit after 4 days with complaints of palpitations and shortness of breath associated with a cough productive of brown sputum. On presentation in this time around, she was afebrile (i.e. no fever), tachycardic with a heart rate in 155 BPM, tachypneic with oxygen saturation in the low 90s, requiring nasal canula. On the physical examination, the patient had labored breathing with decreased breath sound bilaterally (similar to the male case presented in this study, and the female patient report presented by Williams et al., 2022). Immediately, after the physical examination the report revealed that the hospital commenced labs on the patients. The labs reports were significant for mild white blood cell (WBC) elevation, 11.3/uL. Computed tomography (CT) abdomen and pelvis to evaluate for underlying pyelonephritis or renal abscess was done. It was negative for any intrabdominal pathology but revealed bilateral pulmonary ground-glass opacities. As part of the patient diagnosis, she was asked to go for chest X-ray scan.

Figure 3: CXR Showing Bilateral Infiltrates in a Female Patient

Source: Author's modification of Patient's CXR Records from a Teaching Hospital in Nigeria

Figure 3 presents the female patient chest X-ray scan result. The chest X-ray scan revealed multifocal bilateral pulmonary infiltrates or consolidations. As a result, the patient was placed on empiric antibiotics and was admitted to the *intensive care unit* (ICU) in anticipation of respiratory decompensation given the continued respiratory distress and increased work of breathing (i.e. similar to the male case presented in this study). As part of the interventions, a computed tomography pulmonary angiogram (CTPA/CTPE) to evaluate for a pulmonary embolism was applied on the patient. The CTPA/CTPE that was to evaluate for a pulmonary embolism was negative but showed extensive ground-glass bibasilar opacities with superimposed reticular changes (see Figure 4 for more details).

Figure 4: CT Chest Showing Extensive Ground-Glass Bibasilar Opacities in a Female Patient



Source: Author's modification of Patient's CXR Records from a Teaching Hospital in Nigeria

The next diagnosis that followed CTPA/CTPE was the diagnosis of EVALI. Since there is no single test for EVALI. Diagnosis is mostly a process of elimination because symptoms can be similar to many other respiratory diseases. These include shortness of breath, fever and chills, cough, vomiting, diarrhea, headache, dizziness, rapid heartrate and chest pain. Notwithstanding, diagnosis of EVALI was established after ruling out lung infections with negative respiratory cultures and viral panel, urine legionella antigen, and negative workup for connective tissue and autoimmune disease (similar to the female patient report presented by Williams et al., 2022). As part of the medical treatment after the diagnosis, the patient was commenced on methylprednisolone, which led to improvement in respiratory status, and she was eventually discharged on a prednisone taper.

CONCLUSION

Toward this end, it was observed by the researcher from Schier et al. (2019) study that EVALI is primarily a diagnosis of exclusion requiring a thorough history. Particularly, with regards to the CDC criteria, EVALI is classified as a clinical diagnosis requiring the use of an e-cigarette in the past 90 days before symptoms start (Williams et al., 2022), pulmonary infiltrates on chest x-ray or CT chest, and the absence of any other plausible explanation, including infectious or rheumatologic process (Blount et al., 2019). With specific references to the two cases, it was observed from the cases that laboratory (i.e. labs) evaluation is done to exclude other potential causes, including but not limited to community-acquired pneumonia, COVID-19 pneumonia, and acute eosinophilic pneumonia (see Henry, Kanne, & Kligerman, 2019). It was also observed from the two cases that the symptoms and implications associated with e-cigarette or vaping products are the same for both males and females. Also, vaping causes lungs injury or damage, while most of the injury appears to be chemical in nature, and superadded viral or bacterial infections are rare as most of the testing of E-cigarettes fluids showed no bacterial contamination for both males and females. It was also observed from the study that vaping related complications or effects are the same for both males and females.

Kopsombut et al. (2022) also argued in the literature that majority of patients presenting with THC-associated EVALI have mild leukocytosis, elevated inflammatory markers including C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR), and coagulation abnormalities including elevated prothrombin time. Additionally, Henry, Kanne, and Kligerman (2019) also argued that most of EVALI patients have mainly basilar lung involvement, appearing as consolidation and ground-glass opacities on imaging, often with areas of lobular or subpleural sparing. As observed from the two cases, hospitalization is recommended for any patient who presents with the diagnosis of suspected EVALI with dyspnea, has reduced oxygen saturation, or has significant

co-existing comorbidities (Williams et al., 2022; Siegel, 2019). In the nut-shell, and with specific reference to the two cases, it was observed that the respiratory status of the patients for both males and females improved significantly with the introduction of IV steroids. Finally, it was also observed from the literature that an early diagnosis with thorough patient history, including the source of THC (Williams et al., 2022), initial workup ruling out other lung pathologies (Williams et al., 2022), and early start on systemic glucocorticoids can lead to reduced hospital duration and better outcomes (Williams et al., 2022).

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