

# ***Is vaping a better alternative for our environment?***

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## **I. Introduction**

Traditional smoking has been perceived as culturally and socially inappropriate in some nations and has been banned from many public places. Smoke from tobacco cigarettes can be fatal to both smokers and second-hand smoke inhalers. Electronic cigarettes (also known as e-cigarettes, e-cigs, electronic nicotine delivery systems [ENDS], mods, vapes, or vape pens [Hillstrom, 2019]) were created to imitate the look and sensation of traditional tobacco cigarettes to facilitate the cessation of smoking (Franck et al., 2014).

E-cigarettes have been perceived as a safer alternative to cigarette smoking. They are marketed as a lifestyle choice and have increased in popularity among teenagers and never-smokers (Canistro et al., 2017). However, the health effects of vaping have been a controversial topic of discussion (Canistro et al., 2017; Franck et al., 2014). In addition, the claim that e-cigarettes facilitate the cessation of smoking is still doubtful.

While many articles have been published on the health impacts of vaping, only a limited number of studies have focused on the environmental impacts, which is the focus of this paper. Extensive desk reviews of published articles from academic and governmental institutions have been conducted. Firstly, this paper will provide an overview of vaping and will assess the demographics of groups who are vaping or are likely to vape. Then, it will elucidate the environmental impacts of vaping by examining the materials and substances used in e-cigarettes. Finally, the paper will consider Australia's existing laws on vaping and propose mechanisms for vaping regulation and e-cigarette waste management.

## **II. Vaping**

According to the Lung Foundation Australia (2022), vaping refers to utilising a vape or e-cigarette. E-cigarettes are small devices which use lithium-ion battery power to heat a solution known as vape juice, e-juice, or e-liquid. This solution is then turned into vapour (Hillstrom, 2019) or aerosol and inhaled into the consumer's lungs (Lung Foundation Australia, 2022). E-cigarettes are luxuriously designed cigarettes in the modern world, as pointed out by Papaefstathiou et al. (2019). Therefore, vaping has devolved into a colloquial term for smokeless smoking.

E-cigarettes are a big commercial industry and are a topic of controversy among e-cigarette private sectors, pro-vaping groups, and public health sectors. Pro-vaping advocates portray e-cigarettes as priceless tools for the reduction of tobacco consumption and the facilitation of smoking cessation (Regan et al., 2013). However, some studies, for example, Weaver et al. (2018), found no evidence that adult smokers who used e-cigarettes quit smoking at a higher rate than smokers who did not. Moreover, the U.S. Department of Health & Human Services (2021) affirmed that further evidence is needed to prove that e-cigarettes are an effective tool to help people to quit smoking.

In addition to this, it is found that youth rarely use e-cigarettes as a smoking cessation tool (Fadus et al., 2019). In direct contrast, growing evidence indicates that young people using e-cigarettes tend to smoke tobacco cigarettes in the future (Medland, 2021) or have difficulties fighting nicotine addiction (Huey & Granitto, 2017). Therefore, labelling e-cigarettes as a smoking cessation tool is misleading.

Vaping groups and groups who are likely to vape can be classified into two categories: 1) current smokers who intend to quit by switching to e-cigarettes to facilitate their smoking cessation, along with current smokers who turn to e-cigarettes for a cigarette-like sensation; and 2) young adults, adolescents, and teenagers who are tempted to try and end up addicted to vaping owing to perceived sensory satisfaction, and those who are pressured by their peers or want to fit in with their social circles.

The wide availability and easy access of e-cigarettes, along with the various flavours of vape juice, make vaping very appealing to young adults, adolescents, and children (Huey & Granitto, 2017). According to the Australian Institute of Health and Welfare (2020a), more than half of e-cigarette smokers tried vaping out of curiosity. The study of Zhu et al. (2014) revealed that, as of January 2014, there were 466 e-cigarette brands and 7,776 flavours. In addition to the existing variety of e-cigarette brands and flavours, the study also showed that (on average) 10.5 new e-cigarette brands and 242 flavours were created monthly (Chun et al., 2017). E-cigarettes have been designed in various shapes which resemble objects used in everyday lives, such as USBs, flashlights, or highlighters. Thus, teenagers and adolescents can easily hide them from teachers or guardians, especially as one is able to covertly inhale the vapours (unlike traditional cigarettes).

In Australia, the percentage of e-cigarette users aged 14 and over rose from 6.8% in 2016 to 18.7% in 2019 (Australian Institute of Health and Welfare, 2020a). If regulations are not imposed, the percentage of e-cigarette users is highly likely to rise due to its increasing availability and growing variety of flavours. Table 1 below illustrates the percentage of e-cigarette users by state and territory. According to Table 1, the percentage of e-cigarette users increased remarkably between 2016 to 2019 across the entirety of Australia. If these trends continue, vaping-induced environmental impacts and inappropriate e-cigarette waste management will exacerbate.

	NSW	Victoria	Queensland	NT	SA	ACT	WA	Tasmania
• % of people using e-cigarettes in their lifetime	10.1% (2019) 8.0% (2016)	11.7% (2019) 8.3% (2016)	12.1% (2019) 9.8% (2016)	15.3% (2019) 11.6% (2016)	12.4% (2019) 9% (2016)	11.3% (2019)* 8.1% (2016)	12.1% (2019)	10.3% (2019)* 7.2% (2016)
• % of current e-cigarette users	2.2% (2019) 1.0% (2016)	2.4% (2019) 0.9% (2016)	21% (2019) 13.5% (2016)	N/A	2.9% (2019)* 1.8% (2016)	N/A	3.2% (2019) 1.6% (2016)	N/A
• % of current e-cigarette users among smokers	9.6% (2019) 3.9% (2016)	8.7% (2019) 3.9% (2016)	10.8% (2019) 3.6% (2016)	41% (2019)* 35% (2016)	44% (2019) 33% (2016)	47% (2019) 31% (2016)	12.2% (2019) 6.6% (2016)	30% (2019)* 27% (2016)

**Note:** \* indicate no statistically significant difference

### III. Environmental Impacts of Vaping

In this section of the paper, we will review the e-cigarettes' components and substances and how each affects the environment. Most e-cigarettes are made of four parts: 1) reservoir, cartridge, or pod, which contains an e-liquid or e-juice; 2) an atomiser (heating element); 3) a power source; and 4) a mouthpiece for inhalation (NIDA, 2020).

The reservoirs, cartridges, or pods can be refillable or prefilled and hold the e-liquid (CDC, 2021). They are made from metal or plastic with transparent coverage, allowing the levels of liquid to be seen (CDC, 2021). E-liquids consist of varying proportions of nicotine (a stimulant agent from the tobacco plant), water, flavouring agents, and food additives such as propylene glycol and vegetable glycerine (Chun et al., 2017). E-cigarettes can include or exclude nicotine. However, according to Marynak et al. (2017), 99% of e-cigarettes sold in the U.S. contain nicotine. Talih et al. (2015) unveiled that the amount of nicotine delivered by e-cigarettes could be as high as or higher than that delivered by conventional cigarettes.

The extraction process of nicotine from tobacco plants requires energy and resources which simultaneously release emissions into the atmosphere and harm the surrounding environment. Additionally, the method in which tobacco plants are disposed of after nicotine extraction is unclear (Chang, 2014). Increasing demands for tobacco plantations to ensure sufficient nicotine supplies may lead to an increased interest among farmers to produce more tobacco. Intensified use of chemical fertilisers, along with other substances which assist the growth of the tobacco plants, would have negative effects on air quality, soil, and water sources.

When heated, vegetable glycerine and propylene glycol (the primary components for the e-liquid in e-cigarettes, besides nicotine) form toxic aldehydes. Very little is known about the long-term effects of the inhalation of these substances (Chun et al., 2017). The e-cigarette industry advertises that constituents like vegetable glycerine and propylene glycol are safe or approved by the FDA. However, the recognition only applies to consumption, not inhalation or aerosolisation. Khlystov and Samburova (2016) highlighted that the flavouring substance in the e-liquids was the primary contributor to the toxic carbonyl species production. It goes without saying that use of e-cigarettes also contaminates indoor air quality (Li et al., 2020)

Atomisers (coils which act as heating elements) convert e-liquid to aerosol (CDC, 2021). According to Williams et al. (2019), most atomisers are made of metals like chromium, copper, and nickel. The mouthpieces for inhaling are a cartridge at the end of the e-cigarette tube, with a small plastic cup containing absorbent materials (Brazier, 2020). Brown and Cheng (2014) pointed out that e-cigarettes are made of metals, ceramics, and rubber, all of which take years to decompose and contribute to land degradation. Due to the material composition, e-cigarette disposal potentially poses long-term detrimental environmental threats (Hendlin, 2018).

A recent study found other metal materials, such as zinc, tin, copper, and silver, within the composition of e-cigarette products (Williams et al., 2015). As the metal components of the e-cigarettes undergo heating and cooling cycles repeatedly, traces of these components can leak into the e-liquids, causing metallic nanoparticle emissions (Williams et al., 2013). The metal materials are non-compostable and, if they are discarded inappropriately, can remain on the ground or in water sources. In turn, they can and can pollute soils and contaminate water with flow-on effects to both humans and ecosystems. In addition to soil pollution and water contamination, discarded e-cigarette devices also spoil aesthetic landscapes.

The power sources of e-cigarettes are rechargeable lithium-ion batteries. These batteries ignite current which heats the atomisers to about 204c in a matter of seconds (CDC, 2021). This makes e-cigarettes susceptible to fires and explosions, particularly when charging (Jr, 2017). The medical community have reported that burn injuries from e-cigarette battery explosions are increasing (Quiroga et al., 2019). The study of (Jr, 2017) found that, between 2009 and 2016, there were 195 incidents of e-cigarette explosions and fires in the U.S. It was reported that 68% of the incidents were acute, and ten incidents caused fire and damaged significant proportions of buildings, requiring suppression from the fire department (Jr, 2017). In Australia, an explosion of e-cigarettes damaged seven cars in 2021 (Lucas, 2021). In January 2021, an explosive incident caused severe leg burns to a mine worker (Department of Mines, Industry Regulation and Safety,

2021). E-cigarettes sold in Australia are assembled using various parts that are often imported from overseas where quality and safety control are unknown. This includes the safety and quality of lithium-ion batteries (NSW Health, n.d.). Discarded e-cigarettes have the potential to explode and can cause bushfires, particularly in Australia, a country highly prone to fire (Russell-Smith et al., 2007).

In 2015, over 58 million e-cigarettes and refills were sold by convenience and grocery stores in the United States, excluding online and vape shops. 33% were designed for single use (Marynak et al., 2017). According to Bald et al. (2017), 99 billion pounds of waste from e-cigarettes is discarded annually. Most was shipped from developed to developing countries with poorly designed waste management and infrastructure, leaving the waste to be potentially deserted in landfills, dumping sites, or rivers.

E-cigarette waste is commonly disposed of in kitchen waste or recycling bins. This practice disrupts and affects the processes of decomposition and recycling. As e-cigarettes are not listed as a pharmaceutical product, e-cigarette disposal does not fall under the Resource Conservation and Recovery Act (RCRA) or other programs. Therefore, residual nicotine in used or unused reservoirs, cartridges, or pods can be discarded without removal or treatment (Chang, 2014).

## **IV. Australian State and Territory Vaping Laws**

E-cigarette laws in Australia are complex and differ between jurisdictions (Douglas et al., 2015). For example, non-nicotine e-cigarettes are legal in some states, such as Victoria and New South Wales, but are illegal in Western Australia (McCausland et al., 2020). Selling liquid nicotine and nicotine e-cigarettes must be prescribed by a doctor under current Australian state and territory law. However, this does not indicate that e-cigarettes which are sold legally are nicotine-free (Health Direct Australia, 2020). Etter (2010) pointed out that the US FDA found nicotine in e-liquid labelled as nicotine-free. According to Hughes (2022), the sales of e-cigarettes and vaping in the U.S. rose from 67.05 in 2014 to 125.14 million in 2019. If the non-nicotine e-cigarettes are not free from nicotine as advertised, more Australians are exposed to nicotine addiction.

The federal government regulated *Therapeutic Goods Act (TGA) 1989* allows nicotine e-liquid to be acquired under three schemes:

- 1) Therapeutic Goods Administration Personal Importation Scheme: allows individuals with a prescription from an Australian registered medical practitioner to import nicotine to use as a therapy (for instance, as an aid for smoking cessation) for three month's supply maximum at one time, with the total quantity of nicotine imported not exceeding 15 month's supply in a year (Therapeutic Goods Administration, 2014)
- 2) The Authorised Prescriber Scheme: allows approved Australian pharmacy to be able to prepare nicotine liquid for patients, but this service is available through Nicopharm only (Legalise Vaping, 2010), and
- 3) The Special Access Scheme: enables a medical practitioner to apply for approval from the TGA to give a prescription of nicotine to a particular patient.

Selling non-nicotine e-cigarettes to children under 18 years old is illegal in Victoria, New South Wales, Queensland, Tasmania, Australian Capital Territory; however, there is no age restriction to purchase non-nicotine e-cigarettes in Northern Territory.

## **V. Proposed E-cigarette Laws**

Currently, there is no legislative coherence of vaping laws across Australia. Furthermore, current vaping laws do not include any indication of e-cigarette disposal or e-cigarette waste management. This paper supports the introduction of federalised common vaping laws, as well as stronger implementation of vaping laws within all states and territories. This section proposes laws on vaping and e-cigarette waste management.

### **1. Laws Regarding Vaping**

It is still doubtful as to whether non-nicotine e-cigarettes are completely free from nicotine. Hence, there should be a country-wide ban on selling or supplying e-cigarettes, whether they contain nicotine or not, to children under 18 years old. The current practice in the Northern Territory is that children under 18 years old can purchase and use non-nicotine e-cigarettes.

According to Guerin and White (2020), 14% of students aged between 12 and 17 vaped at least once, whereas 32% of them vaped in the past month. Guerin and White (2020) also found that as the age of the students increased, the percentage of the students vaping also increased (4% of students aged 12 years old compared to 21% of students aged 17 years old). As previously stated, there is no guarantee that non-nicotine e-cigarettes do not contain nicotine. The human brain is not fully developed until the mid-twenties and exposure to nicotine causes disruption to brain development in young teenagers and adolescents, including attention and learning hindrances (U.S. Department of Health and Human Services, 2016). Ideally, vaping should be banned for people under 21 years old.

It is shown that 63% of students who vaped obtained e-cigarettes from friends, 8% received them from siblings, 7% from parents, and 12% bought them for themselves (Guerin & White, 2020). Increasing evidence suggests that young people using e-cigarettes are likely to smoke tobacco cigarettes later in life or become addicted to nicotine (Medland, 2021). Hence, vaping laws should prohibit the provision and distribution of e-cigarettes with or without nicotine to children under 18 years old. This prohibition may help to reduce the number of future tobacco smokers.

Additionally, the law should consider any activities to lure children under 18 years old to use or try e-cigarettes as a legally punishable offence. Promotion and display of e-cigarettes is illegal in Victoria, Queensland, New South Wales (with some exemptions), Tasmania and Australian Capital City. Still, it is legal in Northern Territory and South Australia (*Australian Nicotine Laws*, 2021). The display and promotion of e-cigarettes should be made illegal in all Australian retail outlets, with no exemptions.

All states and territories should classify e-cigarettes as smoking products. They should be banned in smoke-free areas and vehicles with or without children. The Northern Territory and Western Australia do not ban vaping in smoke-free places. This can be potentially toxic to children, the elderly, and other vulnerable groups. Vaping in vehicles presents further risks as the ignition of an e-cigarette produces heat of up to 204c, as reported by CDC (2021), with many explosive e-cigarettes having been reported.

### **2. Laws Regarding E-Cigarette Waste Management**

The trending increase in e-cigarette and vaping sales is ultimately leading to more e-cigarette waste and more environmental impact. E-cigarette waste can present hazardous and harmful effects to health and the environment. To minimise this, all states should categorise e-cigarette waste as hazardous waste which should be handled by hazard waste disposal facilities.

Poor management and disposal of e-cigarette waste inevitably leads to serious environmental problems. Councils should have a supporting scheme, such as a designated place where people can discard the waste of e-cigarettes and their accessories. Councils should also implement programs to raise awareness regarding e-cigarette waste management and to inform residents of how harmful this waste is to both health and the environment.

Law should be introduced to ban the import of single-use e-cigarettes. This should lead to a reduction in e-cigarette waste. E-cigarette littering should be made illegal in all states and territories of Australia. Law should require e-cigarette manufacturers to provide instructions for users on how to manage e-cigarette waste and ensure manufactures are obliged to pay extra for the environment.

## VI. Conclusion

Vaping is an emergent trend in modern society. However, its newness to the market is accompanied by significant uncertainty as to its impact on consumers' health and the environment. E-cigarettes are claimed to facilitate smoking cessation; however, this claim is not validated by the U.S. Food and Drug Administration (FDA) or the Therapeutic Goods Administration (TGA) of Australia. Additionally, some studies suggest that e-cigarette users tend to smoke tobacco cigarettes or be addicted to nicotine in the future.

E-cigarette users can be grouped into two: 1) current smokers who opted for e-cigarettes for smoking cessation purposes or for a vaping experience; 2) teenagers and young adults who vape out of curiosity or a desire to fit in with their peers.

E-cigarettes are not a positive alternative to the environmental impact of traditional smoking. From production to disposal, e-cigarettes have profound environmental impacts. Moreover, each component of and substance used in e-cigarettes presents harmful effects on the environment.

Australian vaping laws are complex and differ greatly among states and territories. Selling non-nicotine e-cigarettes is legal, whereas selling to children under 18 is illegal everywhere except the Northern Territory. The Therapeutical Good Acts 1989 allows the import of nicotine under three schemes. However, in Queensland, the import of nicotine is illegal. There is no current legislation regarding e-cigarette waste management.

This paper proposes the introduction of federal legislation regarding the importation, advertising, and sales of e-cigarettes, along with where vaping can occur. It also proposes legislating e-cigarette waste management. All states and territories should ban the sales of e-cigarettes to children under 18 years old, ban vaping activities in vehicles and smoke-free zones, and ban the promotion and display of e-cigarettes. Additionally, e-cigarettes should be categorised as tobacco products and e-cigarette littering should be classified as an illegal activity. E-cigarette waste should not be disposed of with recycling or kitchen waste and should be managed by hazardous waste disposal facilities.

Further research and regulation into this complex area should be facilitated and encouraged to prevent health and environmental hazards from developing at a detrimental level.

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