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Viewpoint

E-Cigarettes in Historical Context—Innovation, Risk, and Regulation

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People have consumed nicotine, which stimulates the brain, for thousands of years.[1] By the 1800s, tobacco consumption in the US was dominated by products such as pipes, cigars, and various forms of smokeless tobacco. These delivered nicotine primarily through absorption via the oral mucosa,[1] resulting in relatively slow-onset and low-intensity psychoactive effects.

The Evolution of Nicotine Delivery

The unintended discovery of flue-curing in the 19th century reduced the alkalinity of tobacco smoke, producing a milder, more acidic smoke that was less harsh and easier to inhale.[1] It also led to higher nicotine concentration in tobacco by reducing nicotine degradation compared with longer drying techniques. The flue-curing technique therefore improved nicotine delivery both by increasing nicotine amounts and allowing it to be inhaled into the lungs where nicotine's psychoactive effects could take hold more quickly. By relying on flue-cured tobacco, cigarettes were able to deliver nicotine more rapidly, which was a major catalyst in cigarettes coming to dominate the marketplace.[1]

The consequences of cigarettes displacing other forms of tobacco have been catastrophic from a public health perspective. Cigarette smoking is the leading cause of tobacco-related mortality and is responsible for most of the more than 8 million smoking-related deaths reported annually by the World Health Organization. While people's desire for nicotine is what indirectly leads to most of these deaths, the direct cause is generally not from nicotine but from the combustion of tobacco leaf, paper, and chemical additives. This complex mixture of toxicants, including oxidizing chemicals, tar, carbon monoxide, volatile organic compounds, heavy metals, and many known carcinogens, is a byproduct of the primary goal of delivering nicotine to the lungs.

Tobacco manufacturers developed patents to extract nicotine from tobacco in the 1920s and 1930s.[2] Despite this technical advance, little effort was made to bring nicotine products (without tobacco leaf) to market, potentially due to industry stalling tactics[1,2] and also because of the absence of portable noncombustion technology capable of delivering nicotine to the lungs. The development of compact, reliable, and affordable lithium-ion batteries in the 1990s, which provided enough power to generate a nicotine-containing aerosol through heating, changed this, and paved the way for the first commercial e-cigarette in 2003. By avoiding combustion—except in the case of product defects—e-cigarettes eliminate many of the harmful byproducts found in cigarette smoke. In addition, they rely on cleaner (and far fewer) chemical constituents—such as propylene glycol, vegetable glycerin, flavorings, and purified nicotine—rather than the products of combusted tobacco leaf, paper, and additives. For the first time in history, consumers had a choice of nicotine products with rapid nicotine delivery.

E-cigarettes are not without risk, but evidence indicates "e-cigarettes are likely to be far less harmful than combustible tobacco cigarettes" according to a National Academies of Sciences, Engineering, and Medicine report.[3] E-cigarettes could theoretically improve population health by satiating long-standing demand for nicotine in a form that is less harmful than cigarettes. Emerging evidence supports this view, as 2 population-level studies find regulations restricting e-cigarette availability and use are associated with increased mortality.[4,5]

Public Reaction to E-Cigarettes Generally Misaligned With Scientific Consensus

The public takes a dim view of e-cigarettes. Much of the opposition centers on reasonable concerns about youth use, but recent data suggest these concerns may be overstated. For example, use of any tobacco product (using the US definition including e-cigarettes according to the National Youth Tobacco Survey data) over the past 30 days has decreased substantially among US high school students: from 24.2% in 2011 to 10.1% in 2024. Focusing just on current e-cigarette use risks obscuring a laudable achievement: in the US, youth tobacco use (including e-cigarettes) is 60% lower than it was in 2011, and among youth who do use tobacco, an increasing share now use less dangerous forms such as e-cigarettes. A recent systematic review finds that greater availability of e-cigarettes reduces youth smoking rates, though it cautions that this evidence is of very low certainty due to limited pre-registration of study protocols and unexplained differences between studies.[6]

Public perception of product risk is misaligned with the evidence. According to the USA 2022 Health Information National Trends Survey, only 10.0% of adult smokers correctly identified e-cigarettes as less harmful than combustible cigarettes. Even in England, which has historically adopted a more supportive role for e-cigarettes for tobacco harm reduction, only 26.7% of smokers in 2023 recognized e-cigarettes as less harmful.[7] This widespread misperception represents a missed opportunity for public health. Closing the gap between perception and evidence, particularly for people who smoke, could help move people down the continuum of risk by decreasing cigarette smoking, increasing vaping in people who would otherwise have smoked, and reducing tobacco-related disease and death.

Unintended Effects of E-Cigarette Regulation

Despite growing evidence that e-cigarettes offer a less harmful alternative to smoking, many regulatory actions send the opposite message. One of the most restrictive policies is banning e-cigarette sales while continuing to allow traditional cigarette sales, a policy currently in place in more than 40 countries, including Malaysia, Thailand, and Turkey, where smoking rates remain high.[8] There are arguably extremely negative unintended effects from not allowing safer technology to compete against cigarettes. In lower-key but similar ways, e-cigarette taxes and other restrictions may also impede consumer access, which risks increasing smoking.

In addition to access effects, these regulations may also have information effects that discourage switching from more-dangerous nicotine products to less-dangerous products. For example, e-cigarette taxes have been found to increase e-cigarette perceptions of risk relative to cigarettes.[9] The CDC's decision to include e-cigarettes in the name of lung injuries caused by tetrahydrocannabinol-containing products, also increased these misperceptions.[10] In the US, the Food and Drug Administration (FDA) is in the unique position to correct these misperceptions by authorizing more e-cigarettes that have submitted Premarket Tobacco Product Applications, thereby communicating to the public that these products are "appropriate for the protection of public health." At the time of writing, the FDA has authorized only a few dozen e-cigarettes despite thousands of combustible products being legally available for sale, arguably contributing to confusion and misperceived risks.

Plausibly exogenous innovations—from flue-curing tobacco to lithium-ion batteries—have had a major role in the changing nicotine marketplace. Just as advancements typically drive progress, in today's more health-conscious world, the emergence of e-cigarettes represents a substantial public health opportunity: offering a less harmful alternative to combustible cigarettes, which remain the leading preventable cause of death and disease in the US and globally. The disruptive technology of e-cigarettes provides an opportunity to dramatically transform the cigarette business in ways that were previously unimaginable.[2] While a cautious approach to new technologies is understandable,

e-cigarettes have been commercially available for more than 2 decades, and there is increasing evidence of their potential to improve population health.[4,5] Getting more adult smokers to try e-cigarettes, through careful attention to how regulations influence access and perceptions of risk across tobacco products, could provide immense public health benefit. At the same time, targeted regulation for youth who do not use tobacco, without compromising access for adult smokers, could also help minimize harms.

ARTICLE INFORMATION

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