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Review Article

Vaping: A Review of Its Emerging Epidemic Among Youth

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Abstract:
Vaping, the use of e-cigarettes, has become a growing concern among youth, posing significant public health risks. E-cigarettes, often marketed as a safer alternative to smoking, are especially attractive to adolescents due to flavors and the misconception that they are less harmful. This trend is reversing progress made in tobacco control. Youth vaping increases nicotine dependence, disrupts brain development, and exposes users to harmful chemicals, leading to respiratory and cardiovascular issues. Additionally, many adolescents engage in dual-use, combining e-cigarettes with traditional cigarettes, which further complicates efforts to reduce smoking. To address this epidemic, stronger regulations, public education, and youth-focused cessation programs are needed to prevent long-term health consequences.

Keywords: Vaping, E-Cigarettes, Youth, Nicotine Dependence, Public Health, Dual-Use, Addiction, Regulation.

Introduction:

Vaping, the act of inhaling and exhaling aerosols via e-cigarettes, has become alarmingly prevalent among youth, raising significant public health concerns. Worldwide, e-cigarette use has been increasing, with teenagers showing a particularly strong tendency in this regard. Originally marketed as a safer alternative to traditional smoking, e-cigarettes are battery-operated devices that vaporize a liquid solution containing nicotine, flavourings, and other chemicals.[1] Their modern designs and variety of flavours have made them highly attractive to adolescents and young adults, leading to an epidemic that threatens to reverse decades of progress in tobacco control.[2]

Recent statistics highlight the urgency of the issue. Between 2017 and 2018, the Centers for Disease Control and Prevention (CDC) reported a 78% increase in high school students using e-cigarettes. By 2022, over 2.5 million middle and high school students in the United States reported vaping, with 85% using flavoured products. The trend is fuelled by misperceptions about e-cigarettes being safer than combustible cigarettes, coupled with aggressive marketing strategies targeting youth.[3]

Adolescents are particularly vulnerable to the harmful effects of vaping. Nicotine exposure during adolescence can impair brain development, increasing susceptibility to addiction and mood disorders. Furthermore, vaping introduces hazardous substances such as ultrafine particles, volatile organic compounds, and heavy metals into the body, contributing to respiratory and cardiovascular diseases. The World Health Organization (WHO) has emphasized the need for urgent action to address this epidemic.[4]

This paper aims to explore the factors driving youth vaping, the associated health risks, and the implications for public health. By examining current trends, advertising influences, and the dual-use of e-cigarettes and combustible cigarettes, this review underscores the necessity of coordinated efforts to combat this growing crisis.

E-Cigarette Trends and Harms

Trends in E-Cigarette Use: The rising prevalence of e-cigarette use among youth reflects a complex interplay of social, cognitive, and environmental factors. In the United States, e-cigarette usage among adolescents has skyrocketed, with surveys in 2022 reporting that 14.1% of high school students and 3.3% of middle school students used e-cigarettes in the past 30 days. A staggering 85% of these users favoured flavoured products, including sweet, fruity, and dessert-like options that mask the harshness of nicotine.[5]

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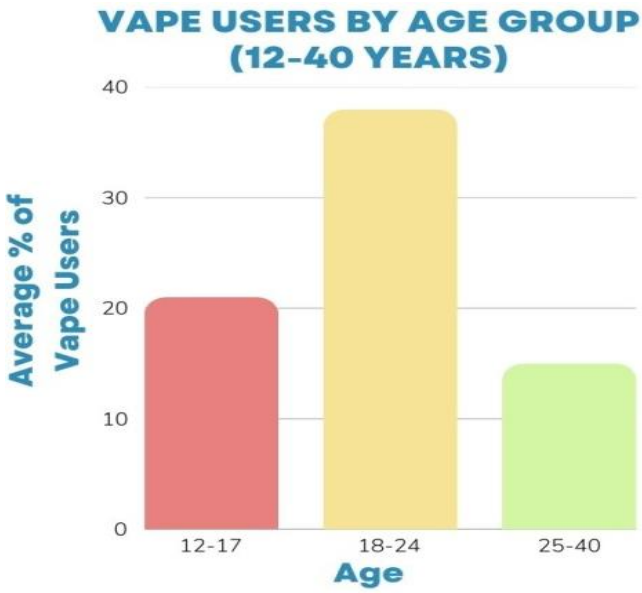
Adults, too, are significant users of e-cigarettes, although their motivations differ. In 2021, 4.5% of U.S. adults reported vaping, with the highest prevalence among young adults aged 18-24. This demographic often uses e-cigarettes as a smoking cessation tool or a perceived safer alternative to traditional cigarettes. However, dual-use—where individuals simultaneously use e-cigarettes and combustible cigarettes—remains prevalent, particularly among adolescents, complicating the narrative of harm reduction.[6]



Graph 1: Vape Users Among Different Age Groups

Globally, the trends are similarly concerning. In Canada, 6.2% of individuals aged 15-24 reported vaping in the past 30 days, and 23.9% had tried e-cigarettes. The market for e-cigarettes continues to grow, with a 44.3% increase in U.S. e-cigarette unit sales from 2020 to 2023, largely driven by non-tobacco-flavoured products. The global nature of these trends underscores the need for comprehensive, cross-border regulatory frameworks.[5,6]

Harms Associated with Vaping: E-cigarettes pose significant health risks, particularly for young users whose bodies and brains are still developing.

1. **Nicotine Dependence:** One of the most concerning harms of vaping is its potential to cause nicotine dependence. Modern e-cigarettes, particularly pod-based devices such as JUUL, are engineered to deliver high doses of nicotine efficiently and discreetly. A single JUUL pod contains as much nicotine as an entire pack of traditional cigarettes, and its high nicotine salt concentration ensures rapid absorption into the bloodstream.[7]

   Nicotine dependence during adolescence poses unique challenges. The adolescent brain is still developing, making it particularly sensitive to the addictive properties of nicotine. Regular exposure can alter the brain's reward pathways, increasing susceptibility to mood disorders such as depression and anxiety. Over time, these changes can result in long-term behavioural and cognitive impairments, including reduced attention spans and diminished impulse control.[8]

   Furthermore, the addictive nature of nicotine often leads to a cycle of dependence that is difficult to break. Many adolescents who begin vaping with flavoured e-cigarettes transition to higher nicotine concentrations or even combustible cigarettes, perpetuating their addiction. This gateway effect undermines public health efforts aimed at reducing tobacco use.[7,8]

2. **Toxicant Exposure:** While e-cigarettes produce fewer harmful chemicals than traditional cigarettes, they still expose users to a range of toxic substances. The aerosol generated by e-cigarettes contains numerous potentially harmful compounds, including:

- **Volatile Organic Compounds (VOCs):** Long-term exposure to VOCs has been linked to respiratory irritation, liver damage, and an increased risk of cancer.[9,10]
- **Ultrafine Particles:** These microscopic particles can penetrate deep into the lungs and enter the bloodstream, contributing to cardiovascular and pulmonary diseases.[10]
- **Heavy Metals:** E-cigarette aerosols have been found to contain metals such as lead, nickel, and cadmium, which are released from the heating elements of the devices. Chronic exposure to these metals is associated with organ toxicity and an elevated risk of neurological disorders.[10]

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- **Diacetyl and Other Flavouring Agents:** Many flavoured e-liquids contain Diacetyl, a chemical linked to "popcorn lung," a rare but severe respiratory condition that damages the smallest airways in the lungs.[10]

The long-term effects of these toxicants are still under investigation, but early evidence suggests that even low-level exposure can have significant health consequences over time.[9,10]

3. **Respiratory and Cardiovascular Effects:** Vaping has been connected to a range of health problems, like breathing issues and heart disease.

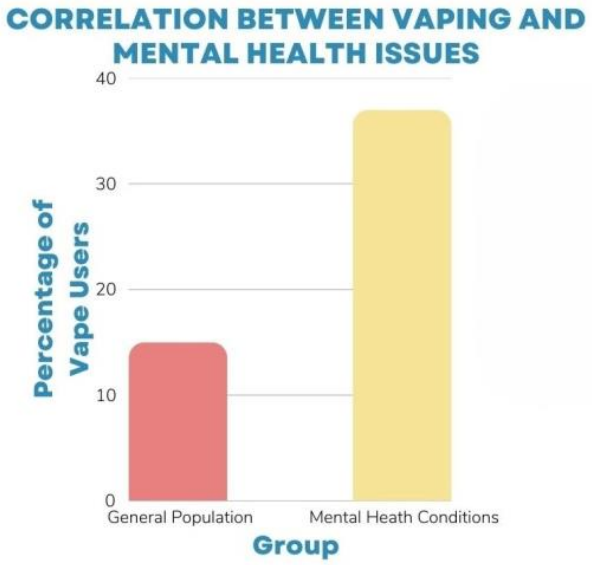
- **Respiratory Health:** Vaping irritates the airways and has been associated with chronic bronchitis-like symptoms, such as coughing, wheezing, and shortness of breath. Severe cases have been linked to e-cigarette or vaping product use-associated lung injury (EVALI), a potentially fatal condition caused by inhaling harmful substances.[11]
- **Cardiovascular Health:** The nicotine and ultrafine particles in e-cigarettes contribute to endothelial dysfunction, a precursor to atherosclerosis and heart disease. Nicotine also increases heart rate and blood pressure, placing additional strain on the cardiovascular system.[12]

Studies have shown that even short-term vaping can impair vascular function, raising concerns about the long-term cardiovascular risks for habitual users.[11,12]

4. **Neurological and Behavioural Impacts:** Nicotine alters the reward pathways in the brain, increasing susceptibility to mood disorders and heightened impulsivity. Nicotine also primes the brain for addiction to other substances, creating a dangerous cycle of dependence. [7] The impact of nicotine on the developing adolescent brain is particularly troubling.[8] Nicotine exposure during critical periods of brain development can disrupt the formation of synaptic connections, leading to:

Impaired memory and learning abilities; The adolescent brain undergoes significant growth and reorganization, with areas such as the prefrontal cortex, which governs decision-making and executive function, developing well into the mid-20s. Nicotine exposure during this time disrupts the normal maturation of these neural circuits.[13] Specifically:

- **Disruption of Synaptic Plasticity:** Synaptic plasticity—the brain's ability to strengthen and reorganize neural connections—is crucial for memory formation and learning. Nicotine interferes with this process by altering neurotransmitter release and receptor activity, particularly in the hippocampus, the region of the brain responsible for memory and learning.[14]
- **Cognitive Impairments:** Adolescents exposed to nicotine show deficits in working memory, verbal reasoning, and attention. This can manifest as difficulties in academic performance, problem-solving, and retaining new information.[13]



Graph 2: Correlation Between Vaping and Mental Health Issues

Increased impulsivity and risk-taking behaviours; Nicotine affects the brain's reward system, which regulates feelings of pleasure and motivation. In adolescents, this system is highly sensitive, and nicotine exposure can amplify tendencies toward impulsivity and risk-taking behaviours.[15]

- **Dopaminergic Deregulation:** Nicotine stimulates the release of dopamine, a neurotransmitter that reinforces rewarding behaviours. This can lead to a heightened preference for immediate rewards over long-

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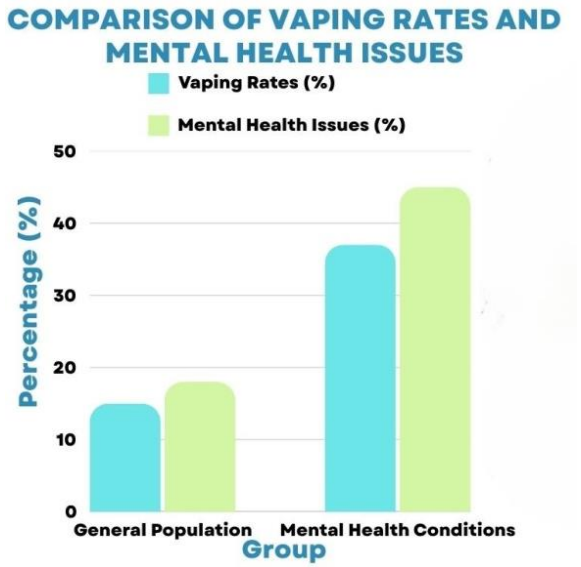
term consequences, increasing impulsive decision-making.[15]

- **Altered Prefrontal Cortex Function:** The prefrontal cortex, which helps regulate self-control and inhibit risky behaviours, is particularly vulnerable to nicotine during adolescence. Disruption of its development can result in poor judgment, difficulty resisting peer pressure, and increased engagement in risky activities such as unprotected sex, reckless driving, or substance abuse.[15]
- **Behavioural Patterns:** Nicotine's impact on impulsivity may create a feedback loop where adolescents engage in vaping despite awareness of its harms, perpetuating the cycle of dependence and risky decision-making.[16]



Graph 3: Comparison Of Vaping and Mental Health Conditions

5. **Dual-Use Concerns:** Dual-use, where individuals simultaneously use e-cigarettes and combustible cigarettes, raises significant concerns about the effectiveness of e-cigarettes as smoking cessation tools. Many adolescents who engage in dual-use are more likely to continue smoking traditional cigarettes over time, contradicting claims of harm reduction.[17]

   Factors such as increased nicotine dependency, behavioural habits that mimic smoking, and misconceptions about reduced harm contribute to this phenomenon. Rather than facilitating smoking cessation, dual-use often delays or prevents it, leading to compounded health risks from exposure to toxins in both products.[18]

   These patterns highlight the need for stricter regulations, better public education on harm, and improved cessation tools to address the limitations of e-cigarettes in reducing youth tobacco use.
6. **Implications for Public Health:** The harms associated with vaping extend beyond individual health outcomes to broader public health implications.

Healthcare Burden: The rise in vaping-related illnesses and nicotine addiction has increased demand for healthcare services, including treatment for respiratory conditions, mental health issues, and cessation support.[19]

Generational Impacts: The normalization of vaping among youth threatens to undo decades of progress in reducing tobacco use, with potential repercussions for future generations.[16]

Conclusion:

Youth vaping poses a critical public health challenge, reversing progress in tobacco control and endangering adolescent health. Marketed as a safer alternative, e-cigarettes have become a gateway to nicotine addiction, impacting neurological and physical well-being.

Multiple factors drive youth vaping, including aggressive marketing and flavoured products that mask nicotine's harshness and create a false sense of safety. Peer influence and the normalization of vaping in social settings further increase its appeal. The perception of vaping as less harmful and the trend of dual-use with traditional cigarettes add to the complexity of this growing issue.

Youth vaping poses serious risks to brain development, as adolescence is critical for cognitive growth. Nicotine exposure during this period impairs memory, learning, and decision-making while increasing susceptibility to mood disorders and impulsive behavior. Its addictive nature fosters long-term dependence, often leading to experimentation with other substances and a broader public health crisis.

The rise in youth vaping questions e-cigarettes' effectiveness as a smoking cessation tool. While some adults use them to quit smoking, they are ineffective for adolescents, who often engage in dual-use of e-

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cigarettes and traditional cigarettes. This behavior reinforces nicotine addiction, increases exposure to harmful toxins, and undermines efforts to reduce overall tobacco use.

Youth vaping impacts public health and society, increasing healthcare burdens from respiratory illnesses, mental health issues, and nicotine dependence. The demand for treatment of vaping-related conditions strains already overwhelmed systems. Additionally, the normalization of vaping risks creating a new generation of nicotine-dependent individuals, with long-term societal costs to healthcare and productivity.

Addressing youth vaping requires immediate action from policymakers, healthcare professionals, and educators. Key measures include stricter regulations on marketing and sales, banning flavoured e-cigarettes, and restricting product access. Comprehensive education campaigns must dispel misconceptions about vaping's safety. Additionally, tailored smoking cessation programs for youth are vital to combat the unique challenges of e-cigarette addiction.

The youth vaping epidemic is not just a passing trend but a significant public health issue that requires urgent attention and action. The rapid adoption of e-cigarettes among adolescents is not without serious health consequences, and its long-term effects could be devastating for future generations. By taking a multi-faceted approach—through regulation, education, and prevention strategies—we can begin to mitigate the impact of this epidemic and protect the health of young individuals. It is only through concerted efforts that we can prevent vaping from reversing the progress made in tobacco control and safeguard the future health of our youth.

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