

## JAMA Insights

## Vaping in Youth

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**Adolescent and young adult vaping** presents a common clinical challenge. Vaping nicotine has a mean age of onset of approximately 14 years, and, according to the 2023 [National Youth Tobacco Survey](#), which included 22 069 students, 10% of US secondary school students currently vape nicotine, exceeding all other tobacco product use combined.



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Among students who had ever used an e-cigarette, nearly half (46.7%) reported current use and, among those reporting current use, 89.4% used flavored products and 25.2% used an e-cigarette daily. Nicotine vaping devices contain a cartridge or tank that holds a liquid that is atomized into an aerosol by heat from a battery, allowing nicotine to be inhaled. These devices have been engineered to deliver higher, more addictive doses of nicotine with fruit, candy, and mint flavors that appeal to youth and reduce [perception of harm](#). Because many vaping devices are easily concealed, youth can discreetly use them in classrooms and other supervised settings, allowing more frequent dosing than possible for tobacco smoking, which increases the risk for nicotine addiction. Most vape liquids (e-liquid, e-juice) contain 5% nicotine (39-48 mg/pod); propylene glycol; glycerin; flavorings; carcinogens, such as aldehydes; heavy metals, such as nickel, tin, and lead; and other chemicals such as diacetyl, which have been linked with serious lung disease. Newer disposable devices with a 10-mL well of 5% nicotine (500-600 mg/device) e-juice deliver the nicotine equivalent of more than 10 packs of cigarettes.<sup>1</sup> This Insights reviews the health effects of youth vaping in the US and current recommendations for screening and treatment.

## Health Effects

### Addiction

Preadolescence and adolescence are associated with increased susceptibility to addiction, and exposure to nicotine during these periods may lead to lasting [brain changes](#). Adolescents who begin nicotine vaping often progress to increased frequency and intensity of nicotine use over time per [Office of the Surgeon General](#) and [Centers for Disease Control and Prevention](#) reports. Nicotine addiction is characterized by altered synaptic transmission in the nucleus accumbens and prefrontal cortex that is associated with compulsive use and reduced interest in nondrug rewards. A nationally representative cohort of 6123 adolescents aged 12 to 15 years was followed up for 3 years to estimate the likelihood of subsequent combusted tobacco use. A multivariable model predicted that 13.8% of those with prior nicotine vaping would try cigarettes (compared with 4.3% with no prior vaped tobacco use), while 4.0% of those with prior nicotine vaping were predicted to report cigarette smoking in the past 30 days (compared with 1.5% with no prior vaped tobacco use).<sup>2</sup> Nicotine exposure, particularly in adolescence, also increases transcription of proteins that potentiate reward from other

addictive substances such as cocaine, opioids, alcohol, and methamphetamine, accelerating addictive processes with these drugs, consistent with a gateway-drug effect.<sup>3</sup>

### Other Cognitive and Mental Health Effects

Adolescent nicotine use alters acetylcholine and glutamate receptor signaling in the maturing prefrontal cortex, resulting in long-term increases in impulsivity and impaired attention. High and irregular doses of nicotine from vaping interfere with attention regulation, and nicotine withdrawal further impairs concentration, with both phenomena making medication management of attention-deficit/hyperactivity disorder less effective.<sup>4</sup>

Nicotine exposure increases brain concentrations of serotonin and endorphins, which are important for mood regulation. Youth nicotine vaping is associated, in a dose-dependent way, with higher validated symptom ratings of suicidal thoughts, depression, anxiety, and inattention/hyperactivity.<sup>5</sup>

### Pulmonary and Other Health Effects

Vape liquid aerosolizes into ultrafine particles, with contaminants that have been associated with hypersensitivity pneumonitis that may [result in death](#). A 2024 random-effects meta-analysis of 107 cross-sectional and longitudinal studies reported that current nicotine vaping, compared with no nicotine use, was associated with increases in prevalence ratios and incident rate ratios of asthma, chronic obstructive pulmonary disease, periodontitis, cardiovascular disease, and stroke (pooled odds ratios of 1.24-1.47).<sup>6</sup> A single vaping session can cause inflammation, with a study reporting a 30% increase in oxidative stress as measured by CD45+ cell markers.<sup>7</sup>

### Screening

The American Academy of Pediatrics recommends universal substance use screening. The Screening to Brief Intervention and Brief Screen for Tobacco Alcohol and Drugs have been validated in adolescent primary care. These 3- to 7-item surveys are easily administered, with sensitivities ranging from 0.89 to 1.0 for identifying tobacco use disorder (which encompasses nicotine vaping).<sup>8</sup> In a study of more than 500 adolescent primary care patients, the Screening to Brief Intervention and Brief Screener for Tobacco, Alcohol, and Drugs identified 92% (23/25) and 100% (16/16) of nicotine vaping and 100% (16/16) and 95.5% (21/22) of cannabis vaping, respectively.<sup>8</sup> The tools may also capture use of newer products targeting adolescents, such as nicotine pouches (non-US Food and Drug Administration approved nicotine products placed between cheek and gum for mucosal absorption).

A survey conducted in the US from January to May 2021 that included 20 413 adolescents aged 12 to 17 years reported that more than half of adolescents who vaped want to quit vaping but fewer than 1 in 25 reported receiving cessation help from a clinician.<sup>9</sup> The American Academy of Pediatrics recommends brief intervention for every adolescent: advice not to start for those who have not initiated nicotine use; health education about the physical and mental

Table. Recommended Treatments for Tobacco Use Disorder<sup>a</sup>

| Treatment type <sup>b</sup>                                                                   | Strength of evidence                                                                                                                                                                     |
|-----------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Counseling programs</b>                                                                    |                                                                                                                                                                                          |
| This is Quitting (chatbot)                                                                    | Available for no cost; strong evidence for small cessation effect in adolescents and young adults                                                                                        |
| My Life, My Quit (online quit coach and live chat)                                            | Available for no cost; based on standard counseling modalities                                                                                                                           |
| <b>Medication options<sup>c</sup></b>                                                         |                                                                                                                                                                                          |
| Nicotine patch plus gum or lozenge                                                            | Available by prescription for any age to reduce nicotine craving and withdrawal; mixed evidence for cessation in adolescents and strong evidence for a strong cessation effect in adults |
| Varenicline (standard dosing: 0.5 mg/d for 3 d; 0.5 mg twice per d for 4 d; 1 mg/d for 11 wk) | FDA approved for those older than 16 y; vaping cessation evidence in adolescents forthcoming; strong evidence for a strong cessation effect in adults                                    |
| Bupropion (standard dosing: 150 mg twice per d)                                               | FDA approved for those 18 y or older; some evidence for a moderate short-term cessation effect in adolescents and strong evidence for a moderate cessation effect in adults              |
| Cytisine                                                                                      | FDA approval pending; strong evidence for a strong vaping cessation effect in adults                                                                                                     |

Abbreviation: FDA, US Food and Drug Administration.

<sup>a</sup> Responses of "monthly" or "weekly or more" to the following screening question are considered a positive result for nicotine/tobacco use disorder in adolescents (response options were never, once or twice, monthly, and weekly or more): In the past year, how many times have you used nicotine/tobacco (including cigarettes, electronic cigarettes, or vapes)?

<sup>b</sup> Recommended treatments for tobacco use disorder (including those dependent on nicotine vapes, pouches).

<sup>c</sup> Medications may be combined to increase effectiveness: nicotine replacement therapy plus bupropion, nicotine replacement therapy plus varenicline, and varenicline plus bupropion have all been studied and found more effective than single agents alone. Existing recommendations are mostly derived from treating tobacco use and dependence to nicotine in combustible form.

health harms of vaping, advice to quit, and follow-up for patients who have tried vaping but screen at low risk for a disorder; and medications combined with counseling and treatment follow-up for youth

who screen positive for tobacco use disorder. Adolescents should be treated for co-occurring mental health symptoms such as anxiety and depression.

### Treatment of Nicotine Addiction in Adolescents and Young Adults

Free vaping cessation text messaging apps provide behavioral support for vaping cessation (eg, *This is Quitting* and *My Life, My Quit*). Pharmacotherapy, including prescribed nicotine replacement therapy (patch, gum, lozenge), varenicline, and bupropion, is recommended for adolescents and young adults with any nicotine craving, nicotine withdrawal symptoms, or daily use in any amount. These treatments should be acceptable at school, allowing students to participate in class, sports, and related activities without vaping (Table).

### Dual Nicotine and Cannabis Vaping

More than half of youth who vape nicotine report also vaping cannabis, often at the same time.<sup>10</sup> Simultaneous treatment for cannabis and nicotine vaping, including behavioral support and medications to treat nicotine withdrawal symptoms and suppress cravings, is recommended. Some youth will be interested in addressing use of one substance and not the other. Offering medications and encouraging any engagement in behavioral health counseling can help youth participate in a long-term process to support behavioral change.

### Conclusions

Nicotine vaping is common among adolescents and is associated with nicotine addiction; negative effects on mental, pulmonary, and oral health; cannabis co-use; and increased uptake of cigarette smoking, reversing 20 years of declining youth tobacco use. Discreet, easily concealed vaping devices, with concentrated nicotine and youth-friendly features and flavors, present new clinical challenges. Delivering effective treatments systematically will be critical to minimizing the harm of vaping among adolescents and young adults.

### ARTICLE INFORMATION

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