National Institute on Drug Abuse

en español

Cannabis (Marijuana)

Highlights

- Cannabis refers to the dried leaves, flowers, stems, and seeds of the cannabis plant. The plant has many different chemical compounds, including tetrahydrocannabinol (THC), which has intoxicating—mind altering—effects.
- Cannabis products with THC can cause changes in mood, thoughts, and perceptions of reality. These products can also cause harmful health effects on the brain and other parts of the body. In recent years, there have been big increases in the variety of cannabis products and how much THC they have, as well as a greater variety of ways people can consume them. **Unless mentioned otherwise, the information on this webpage is about cannabis products with THC.**
- NIDA funds research on the health effects of cannabis products, including impacts on the developing brain and on mental health. The institute also supports research on prevention and treatments for cannabis use disorder, the potential therapeutic uses of cannabis, and the public health impacts of cannabis policies.

What is cannabis?

Cannabis, which some people call marijuana, refers to the dried leaves, flowers, stems, and seeds of the *Cannabis sativa* L plant. The plant contains at least 125 different cannabinoids,[1] including delta-9 tetrahydrocannabinol (THC). Delta-9 THC is the most abundant form of THC in the cannabis plant. It has intoxicating effects, meaning it can temporarily alter a person's mood, thoughts, and perceptions.

The *Cannabis sativa* L plant also contains non-intoxicating cannabinoid compounds like cannabidiol (CBD). CBD products are marketed for a variety of uses. *Cannabis sativa* L plants co
small, non-intoxicating amounts of delta-9 THC, which are also called hemp, are ma

Back to Top

textile fiber and for their edible seed oils. **Unless mentioned otherwise, the information on this webpage is only about cannabis products containing intoxicating amounts of delta-9 THC.**

How do people use cannabis?

People commonly use cannabis by smoking dried plant material ("buds" or "herb") in joints like a cigarette, in blunts—cigars or cigar wrappers that have been partly or completely refilled with cannabis—or in pipes or bongs (water pipes). Dried cannabis can also be vaped using electronic vaporizing devices such as dry herb vaporizers and vape pens.

However, along with the cannabis plant flower, there are many products made from the cannabis plant and new ones are constantly being developed and sold. These include:

- **Oils and concentrates.** Compounds in cannabis can also be extracted to make oils and concentrates that can be vaped or inhaled with devices that are like e-cigarettes. Smoking or vaporizing highly concentrated oils or extracts, also called wax or shatter, from the cannabis plant is known as dabbing. Dabbing can rapidly deliver large amounts of THC to the body, which increases the risk of negative side effects.
- **Edibles.** Cannabis can also be mixed or added to foods like baked goods, candies, gummies, and drinks. Edibles typically take longer to show effects. People may use more of a product as a result, increasing the likelihood of serious negative health effects.
- **Tinctures.** Tinctures are cannabis-infused alcohol or oils consumed in small amounts under the tongue or by adding to foods or drinks. This form of cannabis can also deliver large amounts of THC to the body.
- **Lotions and balms.** These are products applied directly to the skin.[2]

Are cannabis products getting stronger?

Yes. Between 1995 and 2022 the delta-9 THC potency (strength) in illegal cannabis products seized by law enforcement quadrupled from 3.96% to 16.14%. Cannabis flower and concentrates in dispensaries can have THC concentrations of more than 40%.[3] Higher THC concentrations have been associated with a greater likelihood of cannabis use progressing to cannabis use disorder, among other health concerns.[4]

What is Delta-8 THC?

Delta-8 THC is another intoxicating cannabinoid found in the cannabis plant. Delta-8 THC products have not been FDA-approved for safe use. Eating large amounts of products containing delta-8-THC has led to medical emergencies, including breathing problems[5,6]. There is limited research on the health effects delta-8-THC and other intoxicating cannabinoids and related compounds, including delta-10-THC, THC-O-acetate, THCV, THCP, HHC, HHC-O-acetate, HHCP, and CBN.

What is CBD?

Cannabidiol (CBD) is a compound found in the cannabis plant. CBD is marketed as an ingredient in many consumer products, including supplements, foods, oils, and lotions. CBD is not intoxicating like THC.[7] However, it may have side effects including drowsiness, decreased appetite, vomiting and diarrhea.[8] Products have been found to contain different amounts of CBD than their labels show, and some products marketed as CBD have been found to contain THC.[9] Read more about CBD on the U.S. Centers for Disease Control and Prevention (CDC) website.

What are synthetic cannabinoids?

Synthetic cannabinoids, which are lab-made substances that are chemically similar to compounds found in the cannabis plant, can produce serious negative health effects.[10] These products, which are also known as Spice or K2, may have a much higher concentration of THC and can be much more powerful. Use of synthetic cannabinoids is associated with severe, potentially life-threatening health effects.[11,12]

Cannabis has a wide variety of effects

Cannabis may affect people differently depending on: [13,14,15,16]

- The amount taken.
- Potency (concentration of THC).
- A product's ingredients.
- The way it is ingested.
- Other drugs a person may have taken.
- A person's underlying medical conditions.

- Age, sex, and genetic differences.
- A person's experience with cannabis use.

What are the short-term health effects of cannabis use?

Intoxication

Many people use cannabis to feel intoxicated or "high".[17] Cannabis can make people feel more happy or relaxed. Cannabis can cause altered time perception, and impaired thinking, memory, and body movement. It can also it can also make people feel more irritable or restless.[18]

Anxiety, Fear, Distrust, Panic, or Hallucinations

These effects are more common when a person takes a large amount, the cannabis product is strong (has a high level of THC), or the person has little experience with using cannabis.[19,20,21]

Physical Side Effects

Commonly reported symptoms of cannabis use include increased appetite.[22] Research shows that cannabis use may help manage symptoms of nausea or vomiting, common side effects of chemotherapy.[23] However, other side effects may include an elevated heart rate and respiratory problems.[20,24]

Children eating cannabis edibles, such as gummies, is a growing health concern. This usually happens by accident and can result in hospitalization and serious illness.[25,26] Eating large amounts of products containing delta-8-THC has led to medical emergencies, including among children.[27,28]

What are the long-term health risks of cannabis use?

Harms to Lung Health

The smoke from cannabis products contains many of the same toxins, irritants, and carcinogens as tobacco smoke, and smoking cannabis can also harm lung tissue.[29,30] Long-term cannabis smoking is

associated with respiratory issues such as large airway inflammation, increased airway resistance, lung hyperinflation, and chronic bronchitis.[31,32,33] However, more research is needed, as high rates of tobacco use among people who also use cannabis make it hard to distinguish the effects of cannabis alone.[34,33]

Mental Health Effects

Cannabis use has been linked to certain mental health conditions. Read more about cannabis use and mental health.

Cardiovascular Effects

Cannabis can increase heart rate and blood pressure right after use. Some research shows an association between long-term cannabis use and an increased risk of stroke, heart attack, and arrythmias.[35,36] However, more research is needed to determine if there is a direct connection between cannabis use and cardiovascular disease, or if other factors are involved.[37]

Gastrointestinal Problems

These include cannabinoid hyperemesis syndrome (CHS), which is when a person has nausea, vomiting, and abdominal pain after long-term, heavy cannabis use.[38] Other potential gastrointestinal issues include acid reflux, pancreatitis, and peptic ulcer disease.[39]

Increased Cancer Risk

Research has linked the use of cannabis products with an increased likelihood of developing head, neck, or throat cancer,[40] particularly in people who smoke cannabis.[41]

What is the relationship between cannabis use and mental health?

Frequent or heavy cannabis use has been linked to problems in cognitive functions like learning and memory, attention, processing speed, perceptual motor function, and language.[42,43,44,45]

Some evidence has linked cannabis use to earlier onset of psychosis in people with genetic risk factors for psychotic disorders, including schizophrenia, as well as worse symptoms in people who

already have these conditions. The association between heavy cannabis use and schizophrenia has been found to be especially strong in young males compared to females. Cannabis intoxication can also induce a temporary psychotic episode in some people, especially at high doses. Experiencing such an episode may be linked with developing a psychotic disorder later in life.[46]

Some research has also shown an increased risk of depression in people who use cannabis during adolescence.[47] Research has also linked cannabis use with suicidal thoughts and behaviors among teens[48] and military veterans in the United States.[49,50]

While people with mental health disorders and related symptoms are more likely to use cannabis,[51] many factors that influence mental health—such as genes, trauma, and stress—also influence how likely someone is to use drugs, including cannabis. Given these related genetic and environmental vulnerabilities, additional data from prospective, longitudinal research (studies that measure participants' health over long periods of time) are needed to determine whether, to what extent, and for whom cannabis may cause or contribute to poor mental health outcomes.

What is cannabinoid hyperemesis syndrome?

Cannabinoid hyperemesis syndrome (CHS) is when a person has nausea, vomiting, and abdominal pain after long-term, heavy cannabis use.[40] It can recur and often requires medical attention. People sometimes try to temporarily relieve their symptoms by taking hot showers or baths. However, CHS only resolves when a person stops using cannabis completely.[52,53]

What are the effects of secondhand exposure from cannabis smoke or vapor?

Secondhand smoke from cannabis products has many of the same toxins, irritants, and carcinogens as secondhand tobacco smoke.[54] In some environments, secondhand cannabis smoke can produce positive cannabis drug test results.[55] One study in a well-ventilated coffee shop found low levels of THC in the blood of non-smoking bystanders.[56]

Secondhand exposure can also produce positive urine tests.[57,58] This is also true for children. Positive urine tests have been reported in children exposed to secondhand cannabis in their homes or in attached homes,[59] which can lead to respiratory infections.[60]

Does cannabis use during pregnancy affect a developing baby?

The use of cannabis during pregnancy may have harmful effects on a baby's health after birth. Research has linked it with lower birth weight, preterm birth, hospitalization, death within one year of birth, and other negative outcomes.[61,62] Given the potential of cannabis to negatively impact the developing brain, the American College of Obstetricians and Gynecologists recommends that obstetrician-gynecologists counsel women against using cannabis while trying to get pregnant, during pregnancy, and while they are breastfeeding.

NIDA supports the HEALthy Brain and Child Development (HBCD) Study, which will follow a large population of mothers and their infants from the prenatal period through age 10. This study aims to better understand healthy development and shed light on how early exposure to cannabis and other substances, stressors, and trauma affect brain development and mental health, and how to reduce adverse outcomes.

Is cannabis addictive?

Chronic, heavy—every day or almost—use of cannabis products with THC is associated with developing cannabis use disorder, a type of substance use disorder. Studies have estimated that 22% to 30% of people who use cannabis have the disorder.[63,64] The strongest predictor of cannabis use disorder is how often someone uses it, but other factors, like a family history of drug use and how long a person has been using cannabis, can also play a role.[65]

The Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5)—a reference text published by the American Psychiatric Association that health professionals use to diagnose substance use disorders and other psychiatric disorders—defines cannabis use disorder as a pattern of use that leads to clinically significant impairment or distress. This means a person has had two or more of the following symptoms in a 12-month period:

- Using cannabis in larger amounts or over a longer period than was intended.
- Persistent desire or unsuccessful efforts to cut down or control cannabis use.
- Spending a lot of time getting, using, or recovering from the effects of cannabis.
- Craving, or a strong desire or urge to use cannabis.

- Using cannabis even though it causes problems at work, school, or home.
- Continuing to use cannabis despite social or relationship problems.
- Giving up important hobbies, or activities with friends and family, or in the workplace to use cannabis.
- Using cannabis in situations with risk of injury.
- Continued use despite knowing that ongoing physical or psychological problems have been caused or worsened by cannabis use.
- Cannabis tolerance, which is a need for increased amounts of cannabis to achieve the desired effect.
- Withdrawal symptoms after stopping cannabis use.

Cannabis use disorder can be diagnosed as mild (when a person has two or three of these symptoms), moderate (four or five of these symptoms), or severe (six or more of these symptoms).

Can people have cannabis withdrawal symptoms?

A person may have withdrawal symptoms after stopping or significantly decreasing heavy or long-term cannabis use, even if they don't have cannabis use disorder. One study estimated that 12.1% of people who frequently use cannabis experience cannabis withdrawal.[66] Withdrawal symptoms may include anger, irritability, aggression, feeling nervous or anxious, restlessness, decreased appetite or weight, depression, insomnia, experiencing strange or unsettling dreams, headaches, sweating, abdominal pain, and tremor. [65,67]

Are there treatments for cannabis use disorder?

Research shows that behavioral interventions such as cognitive behavioral therapy, motivational enhancement therapy, and contingency management can be effective in treating cannabis use disorder.[68] Read more about behavioral treatments for substance use disorders on the National Institute of Mental Health website. There are currently no FDA-approved medications for the treatment of cannabis use disorder or for medically assisted withdrawal,[69] but research is ongoing.

Is cannabis a "gateway" drug?

Cannabis products are among the first substances along with alcohol and tobacco that a person will likely encounter in their life (MTF, 2023), and people who use substances commonly use these

before trying others. Still, most people who use or have used cannabis do not go on to use other substances later in life.[71]

However, risk factors for cannabis use are similar to risk factors for use of other drugs with addiction potential,[72] and studies have associated use of cannabis with developing cannabis use disorder. Using these products at a younger age in particular increases the likelihood of developing a cannabis use disorder later in life.[73,74] In addition, using cannabis may cause brain changes that can make a person more likely to develop an addiction to other drugs.[75]

Does cannabis use affect driving?

Studies have found that using cannabis may affect a person's ability to drive.[76] It is the drug most frequently found in the blood of drivers involved in motor vehicle crashes, including fatal ones.[77] A number of research analyses have found that the risk of being involved in a crash increased after cannabis use.[76,78,79] However, a study conducted by the National Highway Traffic Safety Administration found no significant increased crash risk attributable to cannabis use.[80]

How does cannabis use impact adolescents?

Adolescence is an important period of brain development, and cannabis use may influence the brain in ways that could lead to long-term harmful effects.[81,82] Studies show that regular, heavy cannabis use in adolescence is associated with negative effects on working memory, processing speed,[83] verbal memory,[84] and academic functioning.[85] It is also associated with negative effects on educational attainment, employment, and income in young adulthood.[86]

Cannabis use at a young age has also been linked to other mental health conditions, including the likelihood of developing psychosis[87] and to developing cannabis use disorder later in life.

The NIDA-funded Monitoring the Future survey measures drug and alcohol use and related attitudes among adolescent students nationwide. Find recent survey data related to cannabis use here. NIDA supports the Adolescent Brain Cognitive Development℠ Study (ABCD Study®), which follows nearly 12,000 children ages 9 and 10—before substance use typically begins—into young adulthood.

The ABCD Study® explores the effects of environmental, social, genetic, and other biological factors on the developing adolescent brain. This study will provide critical insights into risk and resilience

factors for cannabis and other substance use to inform future prevention interventions. See ABCD Study® results on cannabis exposure for more information.

How does cannabis use impact older adults?

In recent years, adults aged 50 years or older have had the largest increase in cannabis use compared to any other age group, with the greatest increase among those 65 years or older.[88,89] Studies suggest that older adults mainly use cannabis to self-treat chronic conditions such as pain and musculoskeletal disorders, sleep disturbances, anxiety and depression, cancer, glaucoma, Parkinson's disease, and HIV/AIDS.[90,91,92]

Some research suggests that cannabis use may have different effects on the brain in older adults compared to adolescents or young adults who use cannabis.[93,94] Cannabis may also interact with other medicines older adults may be taking such as warfarin, opioids, and benzodiazepines.[95,96]

Are some cannabis products safe and effective medicines?

The U.S. Food and Drug Administration (FDA) has not approved the use of any product containing whole cannabis plant material for any purpose, even though cannabis and cannabinoid products are marketed for various therapeutic uses and are available in many states from medical cannabis dispensaries.

However, the FDA has approved synthetic THC-based medications (dronabinol and nabilone) to treat nausea and vomiting associated with cancer chemotherapy. Dronabinol is also approved to treat anorexia and weight loss associated with HIV/AIDS. The FDA has also approved a plant derived cannabidiol-based medication to treat seizures associated with rare forms of epilepsy.

There is evidence that cannabis can be effective in treating some forms of pain, and there is emerging evidence that it may have additional therapeutic uses. Research will continue to explore potential therapeutic effects of cannabis to help inform individual and public health decisions, including strategies to minimize potential harms associated with cannabis use.

It is important to consult with a doctor before consuming cannabis and cannabinoid products to treat medical conditions. Although research shows that people in the United States increasingly view cannabis use as low risk, it may cause negative health effects and can interact with other drugs a person is taking.[97]

How is NIDA researching cannabis?

- NIDA funds research on the endocannabinoid system, cannabinoid compounds, and health effects of cannabis to support individual and public health.
- The Institute's research supports development of new treatments for cannabis use disorder. It also includes research on the factors underlying substance use and substance use disorders, and on developing new ways to prevent substance use disorders.
- NIDA supports epidemiology, policy research and public health outcomes research related to cannabis use, including the Monitoring the Future survey and a medicinal cannabis use registry.
- NIDA also helps support the HEALthy Brain and Child Development (HBCD) Study, the largest long-term study of early brain and child development in the United States. The study will collect information about participants during pregnancy, at birth, and through early childhood. A subset of participants will include babies that were exposed during pregnancy or infancy to cannabis.
- The Adolescent Brain Cognitive Development℠ Study (ABCD Study®) researches the impacts of cannabis exposure across the lifespan, from the prenatal period through adolescence and young adulthood, and later adulthood.
- NIDA also funds research on potential therapeutic uses of cannabis and cannabinoids to reduce use of other substances, including opioids.

Read More About Cannabis

- Read more about cannabis on the CDC web site.
- Learn more about the regulation of products containing cannabis or cannabis-derived compounds from the FDA.
- Find information and statistics on drug-impaired driving from the National Highway Traffic Safety Administration.
- Find basic cannabis information from MedlinePlus, a service of the National Library of Medicine.

References

1. Radwan MM, Chandra S, Gul S, ElSohly MA. Cannabinoids, Phenolics, Terpenes and Alkaloids of Cannabis.*Molecules*. 2021;26(9):2774. Published 2021 May 8. doi:10.3390/molecules26092774
2. Martins AM, Gomes AL, Vilas Boas I, Marto J, Ribeiro HM. Cannabis-Based Products for the Treatment of Skin Inflammatory Diseases: A Timely Review [published correction appears in Pharmaceuticals (Basel). 2022 Jul 11;15(7):849. doi: 10.3390/ph15070849]. *Pharmaceuticals (Basel)*. 2022;15(2):210. Published 2022 Feb 9. doi:10.3390/ph15020210
3. Cash MC, Cunnane K, Fan C, Romero-Sandoval EA. Mapping cannabis potency in medical and recreational programs in the United States. *PLoS One*. 2020;15(3):e0230167. Published 2020 Mar 26. doi:10.1371/journal.pone.0230167
4. Arterberry BJ, Treloar Padovano H, Foster KT, Zucker RA, Hicks BM. Higher average potency across the United States is associated with progression to first cannabis use disorder symptom. *Drug Alcohol Depend*. 2019;195:186-192. doi:10.1016/j.drugalcdep.2018.11.012
5. Babalonis S, Raup-Konsavage WM, Akpunonu PD, Balla A, Vrana KE. Δ8-THC: Legal Status, Widespread Availability, and Safety Concerns. *Cannabis Cannabinoid Res*. 2021;6(5):362-365. doi:10.1089/can.2021.0097
6. LoParco CR, Rossheim ME, Walters ST, Zhou Z, Olsson S, Sussman SY. Delta-8 tetrahydrocannabinol: a scoping review and commentary. *Addiction*. 2023 Jun;118(6):1011-1028. doi: 10.1111/add.16142. Epub 2023 Feb 13. PMID: 36710464.
7. Schouten M, Dalle S, Mantini D, Koppo K. Cannabidiol and brain function: current knowledge and future perspectives. *Front Pharmacol*. 2024;14:1328885. Published 2024 Jan 15. doi:10.3389/fphar.2023.1328885
8. U.S. Food and Drug Administration. What you need to know (and what we're working to find out) about products containing cannabis or cannabis-derived compounds. FDA. Published March 5, 2020. Accessed September 13, 2024. https://www.fda.gov/consumers/consumer-updates/what-you-need-know-and-what-were-working-find-out-about-products-containing-cannabis-or-cannabis
9. Miller OS, Elder EJ Jr, Jones KJ, Gidal BE. Analysis of cannabidiol (CBD) and THC in nonprescription consumer products: Implications for patients and practitioners. *Epilepsy Behav*. 2022;127:108514. doi:10.1016/j.yebeh.2021.108514
10. de Oliveira MC, Vides MC, Lassi DLS, et al. Toxicity of Synthetic Cannabinoids in K2/Spice: A Systematic Review. *Brain Sci*. 2023;13(7):990. Published 2023 Jun 24. doi:10.3390/brainsci13070990
11. Cohen K, Weinstein AM. Synthetic and Non-synthetic Cannabinoid Drugs and Their Adverse Effects-A Review From Public Health Prospective. *Front Public Health*. 2018;6:162. Published 2018 Jun 7. doi:10.3389/fpubh.2018.00162
12. Castaneto MS, Gorelick DA, Desrosiers NA, Hartman RL, Pirard S, Huestis MA. Synthetic cannabinoids: epidemiology, pharmacodynamics, and clinical implications. *Drug Alcohol Depend*. 2014;144:12-41. doi:10.1016/j.drugalcdep.2014.08.005
13. Lucas CJ, Galettis P, Schneider J. The pharmacokinetics and the pharmacodynamics of cannabinoids. *Br J Clin Pharmacol*. 2018;84(11):2477-2482. doi:10.1111/bcp.13710

14. Tagen M, Klumpers LE. Review of delta-8-tetrahydrocannabinol (Δ8-THC): Comparative pharmacology with Δ9-THC. Br J Pharmacol. 2022;179(15):3915-3933. doi:10.1111/bph.15865

15. Sholler DJ, Strickland JC, Spindle TR, Weerts EM, Vandrey R. Sex differences in the acute effects of oral and vaporized cannabis among healthy adults. *Addict Biol*. 2021;26(4):e12968. doi:10.1111/adb.12968

16. Thorpe HHA, Talhat MA, Khokhar JY. High genes: Genetic underpinnings of cannabis use phenotypes. *Prog Neuropsychopharmacol Biol Psychiatry*. 2021;106:110164. doi:10.1016/j.pnpbp.2020.110164

17. Ramaekers JG, Mason NL, Kloft L, Theunissen EL. The why behind the high: determinants of neurocognition during acute cannabis exposure. *Nat Rev Neurosci*. 2021;22(7):439-454. doi:10.1038/s41583-021-00466-4

18. Sharma P, Murthy P, Bharath MM. Chemistry, metabolism, and toxicology of cannabis: clinical implications. *Iran J Psychiatry*. 2012;7(4):149-156.

19. Carvalho C, Vieira-Coelho MA. Cannabis induced psychosis: A systematic review on the role of genetic polymorphisms. *Pharmacol Res*. 2022;181:106258. doi:10.1016/j.phrs.2022.106258

20. Shelton SK, Mills E, Saben JL, et al. Why do patients come to the emergency department after using cannabis?. *Clin Toxicol (Phila)*. 2020;58(6):453-459. doi:10.1080/15563650.2019.1657582

21. Keung MY, Leach E, Kreuser K, et al. Cannabis-Induced Anxiety Disorder in the Emergency Department. *Cureus*. 2023;15(4):e38158. Published 2023 Apr 26. doi:10.7759/cureus.38158

22. Kirkham TC. Cannabinoids and appetite: food craving and food pleasure. *Int Rev Psychiatry*. 2009;21(2):163-171. doi:10.1080/09540260902782810

23. Grimison P, Mersiades A, Kirby A, et al. Oral Cannabis Extract for Secondary Prevention of Chemotherapy-Induced Nausea and Vomiting: Final Results of a Randomized, Placebo-Controlled, Phase II/III Trial. *J Clin Oncol*. Published online August 16, 2024. doi:10.1200/JCO.23.01836

24. Latif Z, Garg N. The Impact of Marijuana on the Cardiovascular System: A Review of the Most Common Cardiovascular Events Associated with Marijuana Use. *J Clin Med*. 2020;9(6):1925. Published 2020 Jun 19. doi:10.3390/jcm9061925

25. Tweet MS, Nemanich A, Wahl M. Pediatric Edible Cannabis Exposures and Acute Toxicity: 2017-2021. *Pediatrics*. 2023;151(2):e2022057761. doi:10.1542/peds.2022-057761

26. Roehler DR, Smith H 4th, Radhakrishnan L, et al. Cannabis-Involved Emergency Department Visits Among Persons Aged <25 Years Before and During the COVID-19 Pandemic - United States, 2019-2022. *MMWR Morb Mortal Wkly Rep*. 2023;72(28):758-765. Published 2023 Jul 14. doi:10.15585/mmwr.mm7228a1

27. Babalonis S, Raup-Konsavage WM, Akpunonu PD, Balla A, Vrana KE. Δ8-THC: Legal Status, Widespread Availability, and Safety Concerns. *Cannabis Cannabinoid Res*. 2021;6(5):362-365. doi:10.1089/can.2021.0097

28. LoParco CR, Rossheim ME, Walters ST, Zhou Z, Olsson S, Sussman SY. Delta-8 tetrahydrocannabinol: a scoping review and commentary. *Addiction*. 2023;118(6):1011-1028. doi:10.1111/add.16142

29. Dryburgh LM, Bolan NS, Grof CPL, et al. Cannabis contaminants: sources, distribution, human toxicity and pharmacologic effects. *Br J Clin Pharmacol*. 2018;84(11):2468-2476. doi:10.1111/bcp.13695

30. Yayan J, Rasche K. Damaging Effects of Cannabis Use on the Lungs. *Adv Exp Med Biol*. 2016;952:31-34. doi:10.1007/5584_2016_71

31. Owen KP, Sutter ME, Albertson TE. Marijuana: respiratory tract effects. *Clin Rev Allergy Immunol*. 2014;46(1):65-81. doi:10.1007/s12016-013-8374-y

32. Tashkin DP, Roth MD. Pulmonary effects of inhaled cannabis smoke. *Am J Drug Alcohol Abuse*. 2019;45(6):596-609. doi:10.1080/00952990.2019.1627366

33. Kaplan AG. Cannabis and Lung Health: Does the Bad Outweigh the Good?. *Pulm Ther*. 2021;7(2):395-408. doi:10.1007/s41030-021-00171-8

34. Schauer GL, Berg CJ, Kegler MC, Donovan DM, Windle M. Assessing the overlap between tobacco and marijuana: Trends in patterns of co-use of tobacco and marijuana in adults from 2003-2012. *Addict Behav*. 2015;49:26-32. doi:10.1016/j.addbeh.2015.05.012

35. Jeffers AM, Glantz S, Byers AL, Keyhani S. Association of Cannabis Use With Cardiovascular Outcomes Among US Adults. *J Am Heart Assoc*. 2024;13(5):e030178. doi:10.1161/JAHA.123.030178

36. Pacher P, Steffens S, Haskó G, Schindler TH, Kunos G. Cardiovascular effects of marijuana and synthetic cannabinoids: the good, the bad, and the ugly. *Nat Rev Cardiol*. 2018;15(3):151-166. doi:10.1038/nrcardio.2017.130

37. Ghosh M, Naderi S. Cannabis and Cardiovascular Disease. *Curr Atheroscler Rep*. 2019;21(6):21. Published 2019 Apr 12. doi:10.1007/s11883-019-0783-9

38. Perisetti A, Gajendran M, Dasari CS, et al. Cannabis hyperemesis syndrome: an update on the pathophysiology and management. *Ann Gastroenterol*. 2020;33(6):571-578. doi:10.20524/aog.2020.0528

39. Adenusi AO, Magacha HM, Nwaneki CM, Asifat OA, Annor EN. Cannabis Use and Associated Gastrointestinal Disorders: A Literature Review. *Cureus*. 2023;15(7):e41825. Published 2023 Jul 13. doi:10.7759/cureus.41825

40. Gallagher TJ, Chung RS, Lin ME, Kim I, Kokot NC. Cannabis Use and Head and Neck Cancer. *JAMA Otolaryngol Head Neck Surg*. Published online August 8, 2024. doi:10.1001/jamaoto.2024.2419

41. Bhattacharyya S, Mandal S, Banerjee S, Mandal GK, Bhowmick AK, Murmu N. Cannabis smoke can be a major risk factor for early-age laryngeal cancer--a molecular signaling-based approach. *Tumour Biol*. 2015;36(8):6029-6036. doi:10.1007/s13277-015-3279-4

42. Scott JC, Slomiak ST, Jones JD, Rosen AFG, Moore TM, Gur RC. Association of Cannabis With Cognitive Functioning in Adolescents and Young Adults: A Systematic Review and Meta-analysis. *JAMA Psychiatry*. 2018;75(6):585-595. doi:10.1001/jamapsychiatry.2018.0335

43. Burggren AC, Shirazi A, Ginder N, London ED. Cannabis effects on brain structure, function, and cognition: considerations for medical uses of cannabis and its derivatives. *Am J Drug Alcohol Abuse*. 2019;45(6):563-579. doi:10.1080/00952990.2019.1634086

44. Zhornitsky S, Pelletier J, Assaf R, Giroux S, Li CR, Potvin S. Acute effects of partial CB1 receptor agonists on cognition - A meta-analysis of human studies. *Prog Neuropsychopharmacol Biol Psychiatry*. 2021;104:110063. doi:10.1016/j.pnpbp.2020.110063

45. Dellazizzo L, Potvin S, Giguère S, Dumais A. Evidence on the acute and residual neurocognitive effects of cannabis use in adolescents and adults: a systematic meta-review of meta-analyses. *Addiction*. 2022;117(7):1857-1870. doi:10.1111/add.15764

46. Murrie B, Lappin J, Large M, Sara G. Transition of Substance-Induced, Brief, and Atypical Psychoses to Schizophrenia: A Systematic Review and Meta-analysis. *Schizophr Bull*. 2020;46(3):505-516. doi:10.1093/schbul/sbz102

47. Gobbi G, Atkin T, Zytynski T, et al. Association of Cannabis Use in Adolescence and Risk of Depression, Anxiety, and Suicidality in Young Adulthood: A Systematic Review and Meta-analysis [published correction appears in JAMA

Psychiatry. 2019 Apr 1;76(4):447. doi: 10.1001/jamapsychiatry.2019.0464]. *JAMA Psychiatry*. 2019;76(4):426-434. doi:10.1001/jamapsychiatry.2018.4500

48. Han B, Compton WM, Einstein EB, Volkow ND. Associations of Suicidality Trends With Cannabis Use as a Function of Sex and Depression Status. *JAMA Netw Open*. 2021;4(6):e2113025. Published 2021 Jun 1. doi:10.1001/jamanetworkopen.2021.13025

49. Kimbrel NA, Meyer EC, DeBeer BB, Gulliver SB, Morissette SB. The Impact of Cannabis Use Disorder on Suicidal and Nonsuicidal Self-Injury in Iraq/Afghanistan-Era Veterans with and without Mental Health Disorders. *Suicide Life Threat Behav*. 2018;48(2):140-148. doi:10.1111/sltb.12345

50. Chester LA, Valmaggia LR, Kempton MJ, et al. Influence of cannabis use on incidence of psychosis in people at clinical high risk. *Psychiatry Clin Neurosci*. 2023;77(9):469-477. doi:10.1111/pcn.13555

51. Rup J, Freeman TP, Perlman C, Hammond D. Cannabis and mental health: Prevalence of use and modes of cannabis administration by mental health status. *Addict Behav*. 2021;121:106991. doi:10.1016/j.addbeh.2021.106991

52. Cue L, Chu F, Cascella M. Cannabinoid Hyperemesis Syndrome. In: *StatPearls*. Treasure Island (FL): StatPearls Publishing; July 3, 2023.

53. Sorensen CJ, DeSanto K, Borgelt L, Phillips KT, Monte AA. Cannabinoid Hyperemesis Syndrome: Diagnosis, Pathophysiology, and Treatment-a Systematic Review. *J Med Toxicol*. 2017;13(1):71-87. doi:10.1007/s13181-016-0595-z

54. Tashkin DP, Roth MD. Pulmonary effects of inhaled cannabis smoke. *Am J Drug Alcohol Abuse*. 2019;45(6):596-609. doi:10.1080/00952990.2019.1627366

55. Holitzki H, Dowsett LE, Spackman E, Noseworthy T, Clement F. Health effects of exposure to second- and third-hand marijuana smoke: a systematic review. *CMAJ Open*. 2017;5(4):E814-E822. doi:10.9778/cmajo.20170112

56. Röhrich J, Schimmel I, Zörntlein S, et al. Concentrations of delta9-tetrahydrocannabinol and 11-nor-9-carboxytetrahydrocannabinol in blood and urine after passive exposure to Cannabis smoke in a coffee shop. *J Anal Toxicol*. 2010;34(4):196-203. doi:10.1093/jat/34.4.196

57. Cone EJ, Bigelow GE, Herrmann ES, et al. Non-smoker exposure to secondhand cannabis smoke. I. Urine screening and confirmation results. *J Anal Toxicol*. 2015;39(1):1-12. doi:10.1093/jat/bku116

58. Herrmann ES, Cone EJ, Mitchell JM, et al. Non-smoker exposure to secondhand cannabis smoke II: Effect of room ventilation on the physiological, subjective, and behavioral/cognitive effects. *Drug Alcohol Depend*. 2015;151:194-202. doi:10.1016/j.drugalcdep.2015.03.019

59. Sangmo L, Braune T, Liu B, et al. Secondhand marijuana exposure in a convenience sample of young children in New York City. *Pediatr Res*. 2021;89(4):905-910. doi:10.1038/s41390-020-0958-7

60. Johnson AB, Wang GS, Wilson K, et al. Association between secondhand marijuana smoke and respiratory infections in children. *Pediatr Res*. 2022;91(7):1769-1774. doi:10.1038/s41390-021-01641-0

61. Shi Y, Zhu B, Liang D. The associations between prenatal cannabis use disorder and neonatal outcomes. *Addiction*. 2021;116(11):3069-3079. doi:10.1111/add.15467

62. Grzeskowiak LE, Grieger JA, Andraweera P, et al. The deleterious effects of cannabis during pregnancy on neonatal outcomes. *Med J Aust*. 2020;212(11):519-524. doi:10.5694/mja2.50624

63. Hasin DS, Saha TD, Kerridge BT, et al. Prevalence of Marijuana Use Disorders in the United States Between 2001-2002 and 2012-2013. *JAMA Psychiatry*. 2015;72(12):1235-1242. doi:10.1001/jamapsychiatry.2015.1858

64. Leung J, Chan GCK, Hides L, Hall WD. What is the prevalence and risk of cannabis use disorders among people who use cannabis? a systematic review and meta-analysis. *Addict Behav*. 2020;109:106479. doi:10.1016/j.addbeh.2020.106479

65. Binkowska AA, Ruban A, Gogolewska M, Sawicz P, Rychlewski L, Brzezicka A. Who Is at Risk of Developing Cannabis Dependence? Findings From an Extensive Online Study on Cannabis Users. *J Addict Nurs*. 2022;33(1):37-44. doi:10.1097/JAN.0000000000000448

66. Livne O, Shmulewitz D, Lev-Ran S, Hasin DS. DSM-5 cannabis withdrawal syndrome: Demographic and clinical correlates in U.S. adults. *Drug Alcohol Depend*. 2019;195:170-177. doi:10.1016/j.drugalcdep.2018.09.005

67. Patel J, Marwaha R. *Cannabis Use Disorder*. StatPearls Publishing; 2024

68. Winters KC, Mader J, Budney AJ, Stanger C, Knapp AA, Walker DD. Interventions for cannabis use disorder. *Curr Opin Psychol*. 2021;38:67-74. doi:10.1016/j.copsyc.2020.11.002

69. Sherman BJ, McRae-Clark AL. Treatment of Cannabis Use Disorder: Current Science and Future Outlook. *Pharmacotherapy*. 2016;36(5):511-535. doi:10.1002/phar.1747

70. Johnston LD, Miech RA, O'Malley PM, Bachman JG, Schulenberg JE, Patrick ME. Monitoring the Future: National Survey Results on Drug Use, 1975-2023: Overview, Key Findings on Adolescent Drug Use. Ann Arbor, MI: Institute for Social Research, The University of Michigan; 2024. Available at: https://monitoringthefuture.org/wp-content/uploads/2024/01/mtfoverview2024.pdf. Accessed September 13, 2024.

71. Jorgensen C, Wells J. Is marijuana really a gateway drug? A nationally representative test of the marijuana gateway hypothesis using a propensity score matching design. J Exp Criminol. 2022;18:497-514. doi:10.1007/s11292-021-09464-z.

72. Marel C, Sunderland M, Mills KL, Slade T, Teesson M, Chapman C. Conditional probabilities of substance use disorders and associated risk factors: Progression from first use to use disorder on alcohol, cannabis, stimulants, sedatives and opioids. *Drug Alcohol Depend*. 2019;194:136-142. doi:10.1016/j.drugalcdep.2018.10.010

73. Winters KC, Lee CY. Likelihood of developing an alcohol and cannabis use disorder during youth: association with recent use and age. *Drug Alcohol Depend*. 2008;92(1-3):239-247. doi:10.1016/j.drugalcdep.2007.08.005

74. Volkow ND, Han B, Einstein EB, Compton WM. Prevalence of Substance Use Disorders by Time Since First Substance Use Among Young People in the US. *JAMA Pediatr*. 2021;175(6):640-643. doi:10.1001/jamapediatrics.2020.6981

75. Morie KP, Potenza MN. A Mini-Review of Relationships Between Cannabis Use and Neural Foundations of Reward Processing, Inhibitory Control and Working Memory. *Front Psychiatry*. 2021;12:657371. Published 2021 Apr 22. doi:10.3389/fpsyt.2021.657371

76. Pearlson GD, Stevens MC, D'Souza DC. Cannabis and Driving. *Front Psychiatry*. 2021;12:689444. Published 2021 Sep 24. doi:10.3389/fpsyt.2021.689444

77. Brady JE, Li G. Trends in alcohol and other drugs detected in fatally injured drivers in the United States, 1999-2010. *Am J Epidemiol*. 2014;179(6):692-699. doi:10.1093/aje/kwt327

78. Li MC, Brady JE, DiMaggio CJ, Lusardi AR, Tzong KY, Li G. Marijuana use and motor vehicle crashes. *Epidemiol Rev*. 2012;34(1):65-72. doi:10.1093/epirev/mxr017

79. Asbridge M, Hayden JA, Cartwright JL. Acute cannabis consumption and motor vehicle collision risk: systematic review of observational studies and meta-analysis. *BMJ*. 2012;344:e536. Published 2012 Feb 9. doi:10.1136/bmj.e536

80. Compton RP, Berning A. Drug and Alcohol Crash Risk [Traffic Safety Facts]: Research Note. Washington, DC: National Highway Traffic Safety Administration; 2015. Report No.: DOT HS 812 117.

81. Lichenstein SD, Manco N, Cope LM, et al. Systematic review of structural and functional neuroimaging studies of cannabis use in adolescence and emerging adulthood: evidence from 90 studies and 9441 participants. *Neuropsychopharmacology*. 2022;47(5):1000-1028. doi:10.1038/s41386-021-01226-9

82. Peters KZ, Zlebnik NE, Cheer JF. Cannabis exposure during adolescence: A uniquely sensitive period for neurobiological effects. *Int Rev Neurobiol*. 2022;161:95-120. doi:10.1016/bs.irn.2021.07.002

83. Frolli A, Ricci MC, Cavallaro A, et al. Cognitive Development and Cannabis Use in Adolescents. *Behav Sci (Basel)*. 2021;11(3):37. Published 2021 Mar 17. doi:10.3390/bs11030037

84. Ellingson JM, Ross JM, Winiger E, et al. Familial factors may not explain the effect of moderate-to-heavy cannabis use on cognitive functioning in adolescents: a sibling-comparison study. *Addiction*. 2021;116(4):833-844. doi:10.1111/add.15207

85. Meier MH, Hill ML, Small PJ, Luthar SS. Associations of adolescent cannabis use with academic performance and mental health: A longitudinal study of upper middle class youth. *Drug Alcohol Depend*. 2015;156:207-212. doi:10.1016/j.drugalcdep.2015.09.010

86. Schaefer JD, Hamdi NR, Malone SM, et al. Associations between adolescent cannabis use and young-adult functioning in three longitudinal twin studies. *Proc Natl Acad Sci U S A*. 2021;118(14):e2013180118. doi:10.1073/pnas.2013180118

87. Ross JA, Levy S. The Impact of Cannabis Use on Adolescent Neurodevelopment and Clinical Outcomes Amidst Changing State Policies. *Clin Ther*. 2023;45(6):535-540. doi:10.1016/j.clinthera.2023.03.009

88. Lloyd SL, Striley CW. Marijuana Use Among Adults 50 Years or Older in the 21st Century. *Gerontol Geriatr Med*. 2018; 4:2333721418781668. Published 2018 Jun 21. doi:10.1177/2333721418781668

89. Han BH, Palamar JJ. Trends in Cannabis Use Among Older Adults in the United States, 2015-2018. *JAMA Intern Med*. 2020;180(4):609-611. doi:10.1001/jamainternmed.2019.7517

90. Brown JD, Costales B, van Boemmel-Wegmann S, Goodin AJ, Segal R, Winterstein AG. Characteristics of Older Adults Who Were Early Adopters of Medical Cannabis in the Florida Medical Marijuana Use Registry. *J Clin Med*. 2020;9(4):1166. Published 2020 Apr 18. doi:10.3390/jcm9041166

91. Haug NA, Padula CB, Sottile JE, Vandrey R, Heinz AJ, Bonn-Miller MO. Cannabis use patterns and motives: A comparison of younger, middle-aged, and older medical cannabis dispensary patients. *Addict Behav*. 2017;72:14-20. doi:10.1016/j.addbeh.2017.03.006

92. Yang KH, Kaufmann CN, Nafsu R, et al. Cannabis: An Emerging Treatment for Common Symptoms in Older Adults. *J Am Geriatr Soc*. 2021;69(1):91-97. doi:10.1111/jgs.16833

93. Mueller RL, Ellingson JM, Bidwell LC, Bryan AD, Hutchison KE. Are the Acute Effects of THC Different in Aging Adults?. *Brain Sci*. 2021;11(5):590. Published 2021 May 1. doi:10.3390/brainsci11050590

94. Kurtzman ET, Dowling NM, Beebe SL. Marijuana Use and Older Adults' Self-Reported Difficulty Concentrating, Remembering, or Making Decisions. *J Stud Alcohol Drugs*. 2022;83(6):893-900. doi:10.15288/jsad.21-00318

95. Briscoe J, Casarett D. Medical Marijuana Use in Older Adults. *J Am Geriatr Soc*. 2018;66(5):859-863. doi:10.1111/jgs.15346

96. Lopera V, Rodríguez A, Amariles P. Clinical Relevance of Drug Interactions with Cannabis: A Systematic Review. *J Clin Med*. 2022;11(5):1154. Published 2022 Feb 22. doi:10.3390/jcm11051154

97. Antoniou T, Bodkin J, Ho JM. Drug interactions with cannabinoids. *CMAJ*. 2020;192(9):E206. doi:10.1503/cmaj.191097

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