



Healthy Missoula Youth
Coalition

LONG TERM EFFECTS

+1 (406) 258-3023



www.healthymissoulayouth.org



info@healthymissoulayouth.org



LONG TERM EFFECTS

Purpose of the Section

- Create a basis of knowledge for the effects of substance use
- Explain why underage substance use can produce a stronger negative impact on youth

What Educators Can Do

- Increase knowledge of credible resources for educational purposes
- Educate youth about the effects of substance use

Why is this important?

Youth who begin using substances at a young age are at an increased risk for developing a substance use disorder. Education on these impacts is crucial to guiding youth towards healthy life choices.

When compared with those who have their first drink at age 20 or older, people who use alcohol before age 15 are four times as likely to become addicted^{1,2}.

Due to the increased risk for substance use disorders if initiation starts before 18, prevention efforts are essential for the overall well-being of youth.

LONG TERM EFFECTS

Brain Development

The impact underage substance use can have on brain development and how this can lead to a substance use disorder.

Physical Effects

The negative physical effects that can result from early initiation of substance use.

Mental & Behavioral Health

How substance use can disproportionately effect youth mental and behavioral health.

Lifelong Outcomes

Underage substance use can cause changes that create a lifelong impact.

INTRODUCTION

The World Health Organization classifies psychoactive substances as any drug or substance that actively affects one's mental processes like perception, cognition, or mood and emotions. These drugs can have a variety of effects, both short term and long term, which are intensified when used by an adolescent. In order to fully understand why adolescents are more severely impacted by substance use, it is important to first look at the science of substance use disorders in the developing brain before diving into how these effects are seen in both physical and mental/behavioral health, as well as the potential lifelong outcomes.

BRAIN DEVELOPMENT

According to the CDC, the earlier people try alcohol or other drugs in their life, the more likely they are to develop a substance use disorder. For example, when compared with those who have their first drink at age 20 or older, people who use alcohol before age 15 are four times as likely to become addicted^{1,2}. This is due in part to the development of the brain, which is not complete until age 25.

Imagine the brain is like a puzzle that is slowly being solved. The basic layout with all the pieces is there, but until the age of 25 the puzzle is not yet complete. Each of these "puzzle pieces," or neurons, connects to another and forms a variety of interconnected circuits that control specific functions of the body. The neurons that make up these circuits send neurotransmitters, the "chemical messengers" of the brain, to coordinate specific behaviors. However, drug use can interfere with the transmission of these signals. As the brain matures, the neural pathways used most frequently become solidified, and those used less frequently are "pruned" (depicted as the yellow to blue transition as the brain develops in the images below).

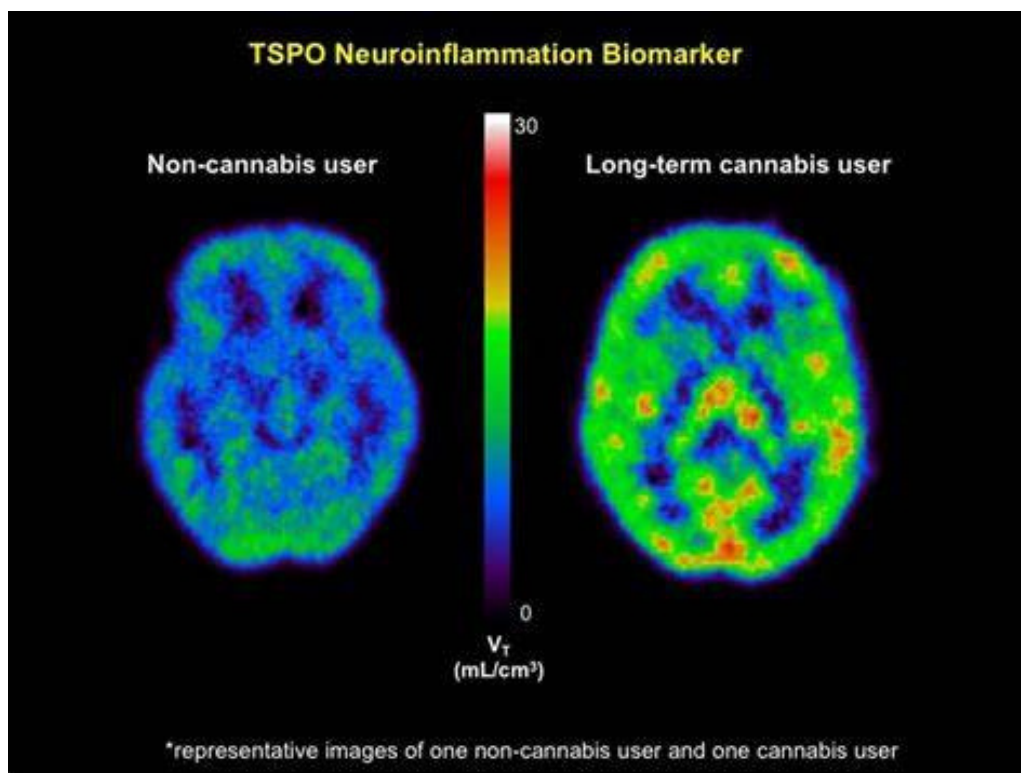
Dynamic mapping of human cortical development



Source: "Dynamic mapping of human cortical development during childhood through early adulthood," Nitin Gogtay et al., Proceedings of the National Academy of Sciences, May 25, 2004; California Institute of Technology.

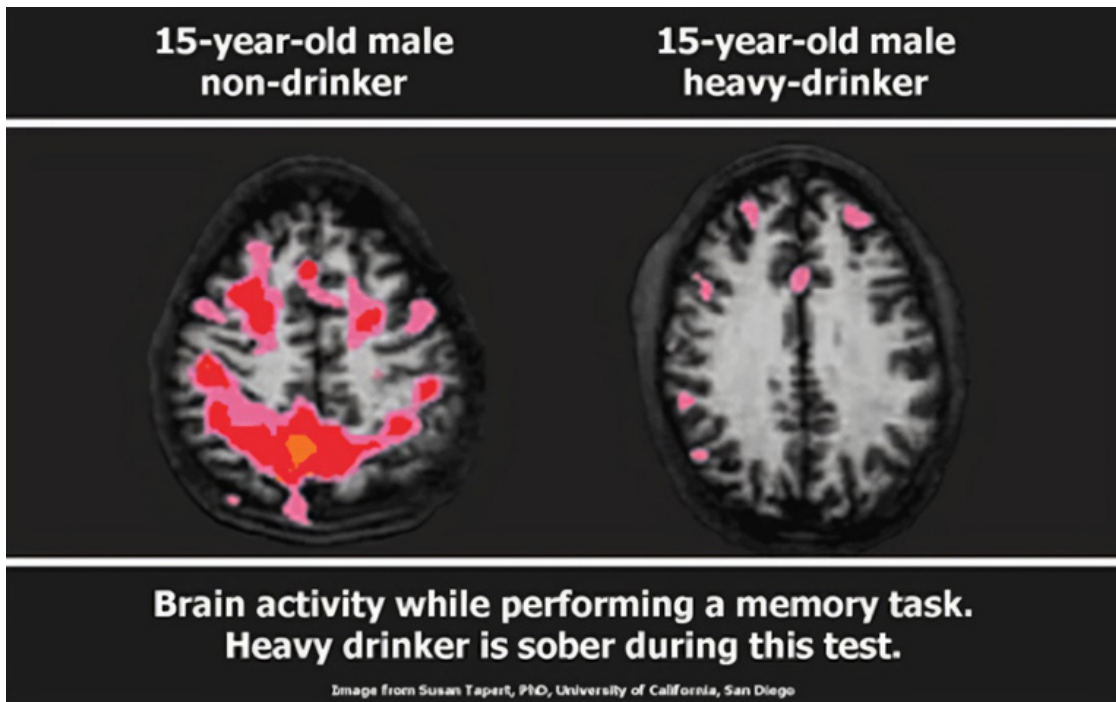
As a result, the brain circuits that emerge become more efficient. This is a process that can be beneficial if an individual practices healthy habits, but could also be detrimental if the brain is exposed to substances before it is fully developed. Not all patterns of behavior are desirable or healthy, yet the brain at this stage cannot differentiate which neural pathways to strengthen or which to prune³.

BRAIN DEVELOPMENT



This can have a large effect on the brain's production of natural hormones and chemicals, as well as on the structure itself. For example, this PET scan shows marijuana use can cause elevated levels of TSP0 in the brain even when not intoxicated⁴. As the protein TSP0 is involved in heart rate and contractile force regulation^{5,6}, increased levels can be dangerous — leading to a limited inflammatory response, and in worse cases the potential for heart disease and a weakened ability to pump blood, which eventually can progress to heart failure and heart attack⁷.

BRAIN DEVELOPMENT



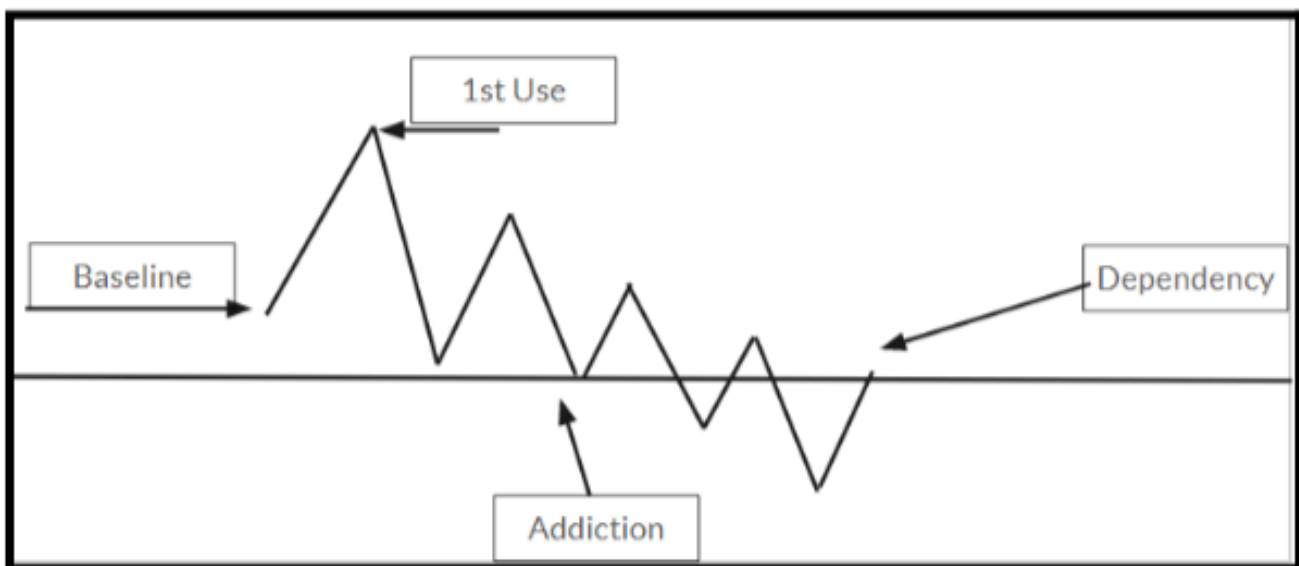
Another such example of the harms caused by substance use while the brain is still developing is seen in these fMRI scans. Alcohol not only degrades the ability for critical thinking and information retention, but it can permanently damage the memory pathways in the brain⁸. The brain scan on the left shows a healthy functioning brain, where the pink areas denote brain activity. The fMRI scan on the right shows an unhealthy level of activity: the brain areas normally activated when working with memory showed significantly less activity. This 15 year-old male's memory ability was permanently affected by heavy drinking - despite being sober at the time of the memory task⁹.

BRAIN DEVELOPMENT

People know substance use is unhealthy, so why does it continue?

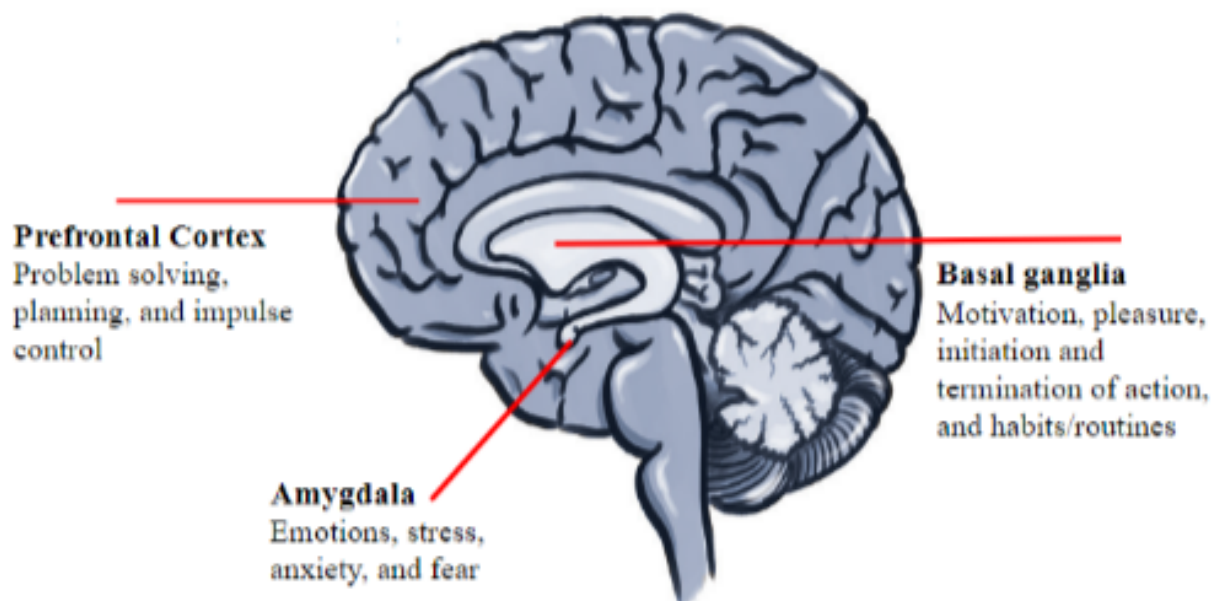
An easy way of looking at the science behind why use continues is to chart the brain's reaction to drugs. When psychoactive substances are used before the brain is done fully developing, it puts youth at a higher risk of becoming addicted. This is because drug use can change the chemical makeup of the brain and interfere with the transmission of signals throughout the neural circuit. Repeated use of substances as an adolescent can permanently impact some of these circuits, such as the reward circuit, due to increased levels of dopamine, aka the "happy" hormone.

Below is the **Line of Addiction**, which demonstrates this process. The Baseline arrow points to the level the brain normally functions at. The 1st Use is the highest "high" the brain will experience with this substance, but once it ends the brain doesn't return to that same baseline. Each subsequent use causes the natural baseline to drop lower and lower. Gradually, the only time the brain feels "normal," is when it is processing substances. When the brain requires these substances to function at a normal level it is called Dependency.



BRAIN DEVELOPMENT

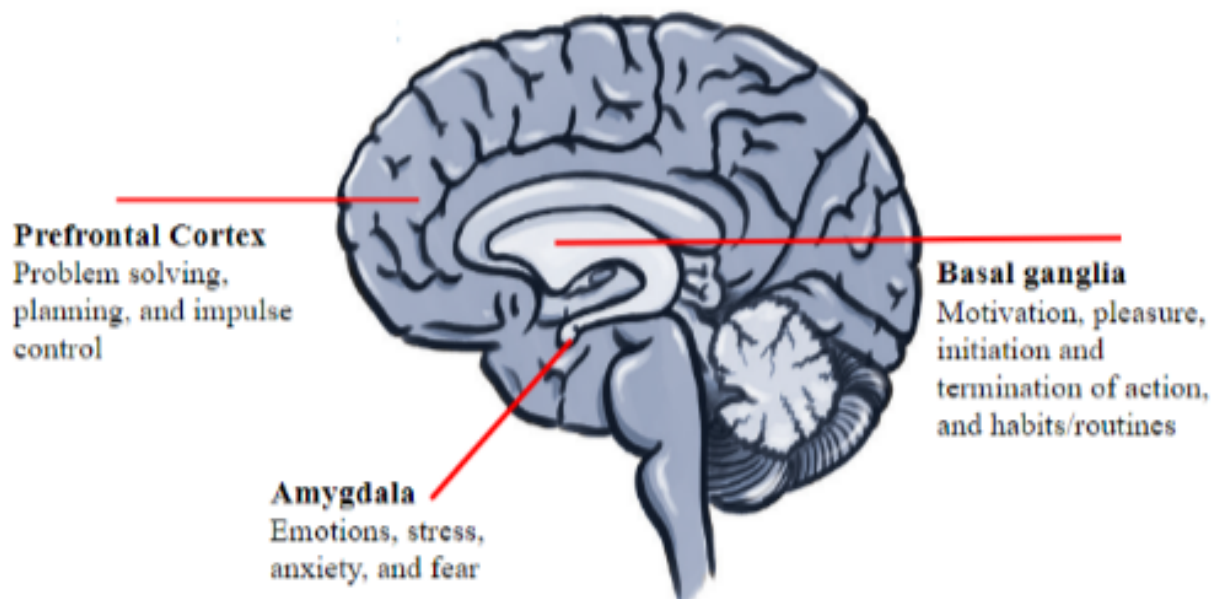
This is primarily due to what is known as the brain's **Reward Circuit**. The reward circuit is one of the areas most affected by drug use and chemical changes in the brain. Increased dopamine levels, when using substances, shifts the balance between the stress and reward circuits, reducing impulse control, which can make a person with a substance use disorder seek the drug compulsively. The reward circuit of the brain is composed of the prefrontal cortex, the amygdala, and the basal ganglia.



The **prefrontal cortex** is one of the areas that is last to develop in an adolescent's brain. This is the lobe in the brain that allows people to assess situations, make sound decisions, and keep emotions and desires under control. As the main area where critical thinking and decision making skills are developed, this portion of the brain is exceedingly important. When the brain is under the influence of substances this area is acutely impacted, which makes adolescents most vulnerable to the effects of drugs in relation to impulse control.

BRAIN DEVELOPMENT

The **amygdala** is the emotional center of the brain. It controls feelings of stress, anxiety, and fear, which is dulled when using drugs. As the body processes the chemicals out of its system, these feelings resurface, characterizing what is known as withdrawal. Over time, with repeated use of drugs, this circuit becomes increasingly sensitive to the point where a person may use drugs simply to get temporary relief from the discomfort.



The **basal ganglia** are a group of structures near the center of the brain that form important connections. These connections allow different areas of the brain to work together. They are a key part of the network of brain cells and nerves that control your body's voluntary movements and process signals that affect your emotions and your motivation. That means it plays a role in learning and forming habits, and affects how you learn and how you feel in response to things happening around you. For example, cannabis causes dopamine levels in the basal ganglia to increase. With regular use, this process can be linked to the development of a substance use disorder.

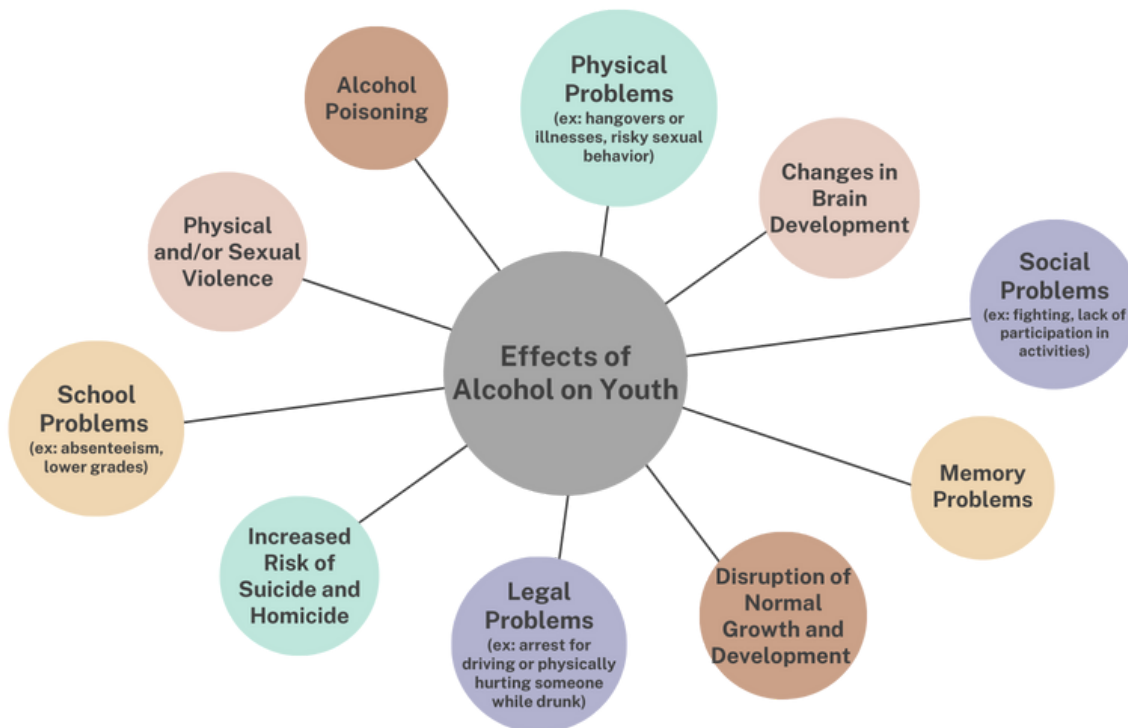
PHYSICAL EFFECTS

As the adolescent brain develops, youth may sometimes make risky or dangerous decisions. The prefrontal cortex is, as previously mentioned, responsible for impulse control and judgment; essentially, it is the “voice of reason”¹⁰. Therefore, since the prefrontal cortex develops last, it is not surprising that teens make some questionable choices, like using drugs or drinking alcohol.

Substance use during this critical developmental period can negatively impact adolescent mental and physical health. For example, alcohol is a Central Nervous System (CNS) depressant, which means it slows down - or depresses - the brain's level of activity. This occurs due to alcohol increasing the effects of Gamma-Aminobutyric Acid (GABA), an inhibitory neurotransmitter that decreases activity within the brain and creates a calming effect. Increasing the effects of GABA can be dangerous; as the brain slows down, so do the parts of the brain responsible for coordination and decision making¹¹. At dangerous levels, parts of the brain may slow or shut down vital bodily functions such as breathing, heart rate, and temperature control¹².

PHYSICAL EFFECTS

When used, alcohol (and most other drugs) increases the levels of dopamine in the brain. Dopamine is the brain's "feel good" chemical; it is responsible for pleasure and reward. Because alcohol causes an increase in dopamine - combined with decreased levels of brain activity - people are prone to drink more to maintain feelings of pleasure and euphoria, which may lead to poor decision-making and negative health outcomes. According to the Centers for Disease Control and Prevention, youth who drink alcohol are more likely to experience:¹³



Source: *Underage Drinking*, Center for Disease Control and Prevention, 2022 - <https://www.cdc.gov/alcohol/fact-sheets/underage-drinking.htm>

As shown above, it is important to note that drinking can lead to decisions that cause harm to not only the individual drinking, but to others. Alcohol and other drugs increase the risk of car crashes, accidents such as drowning, violence, sexual assault, and more. Additionally, drinking too much alcohol can lead to alcohol poisoning. The CDC states, "Alcohol poisoning is caused by drinking large quantities of alcohol in a short period of time. Very high levels of alcohol in the body can shut down critical areas of the brain that control breathing, heart rate, and body temperature, resulting in death"¹⁴.

PHYSICAL EFFECTS

This is only one example of how a single substance can impact the physical health of an adolescent. Other substances including nicotine (via cigarettes or e-cigarettes), marijuana (dabs, shatter, wax), psychedelics, and opioids can cause the same or worse effects. As another example, research shows that repeated use of high-potency THC found in marijuana concentrates, such as dabs, shatter, wax, and budder, can lead to Cannabinoid Hyperemesis Syndrome, also known as cyclical vomiting, and Cannabis-Induced Psychosis¹⁵. Each drug affects areas of the brain vital for learning and development.

As a result of the brain still developing, youth who begin using substances in adolescence may experience higher risks in terms of the physical effects substances have on the body due to changes in the brain's chemical structure. Brain imaging studies show that initiation of drug use at a young age "has more potential to disrupt brain function in areas critical to motivation, memory, learning, judgment, and behavior control," which explains the compulsive nature of substance use disorders¹⁶. Unfortunately, as youth continually use one or more substances, they are also increasing their risk of a substance use disorder.

To learn more about the effects of drugs on the adolescent body, go to:

[Drugs & Alcohol \(for Teens\) - Nemours KidsHealth](#)

This is a resource developed by the Nemours Foundation, which provides articles for parents, kids, and teens about different health topics. The articles for substance use education define what the substance is, the short and long term effects of use, as well as identifying resources for help quitting. There is also an educators section developed for teachers: [Kids Health in the Classroom](#). This covers Pre-K through 12th Grade, and provides free Teacher Guides that include lesson plans, activities, handouts, and discussion topics for in the classroom. These can be found within the "Health Problems" drop-down.

MENTAL & BEHAVIORAL HEALTH

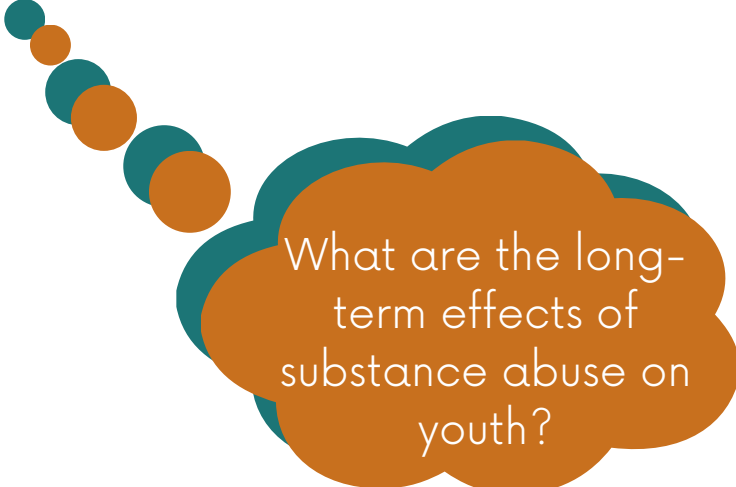
WHY YOUTH "PRE-GAME"

Youth mental health status and substance abuse behavior are interrelated in many cases. Often, substance use is a result of coping mechanisms related to self-medication for a youth's untreated mental health needs. An example is the popular action of "pre-gaming" which can be defined as the use of alcohol or cannabis prior to social situations¹⁷. Data has reflected that there are high rates of comorbid substance use disorders (SUDs) and mental health disorders such as generalized anxiety disorder, post-traumatic stress disorder, depression¹⁸, bipolar disorder¹⁹, and attention-deficit hyperactivity disorder (ADHD)²⁰.

Child and Adolescent psychiatrist Dr. Taskiran states, "The rule of thumb is that almost half of kids with mental health disorders, if they're not treated, will end up having a substance use disorder"²¹. In fact, a study of 10,000 adolescents found that two-thirds of those who developed alcohol or substance use disorders had experienced at least one mental health disorder²². Substance use can also exacerbate long-term prognosis for teenagers struggling with mental health disorders as substance use often interferes with treatment for mental health disorders²¹.

Short-term substance use can feel like an immediate alleviation of mental health struggles for youth like anxiety, hopelessness, and negative thoughts, but long-term effects often are reflected as dependency and abuse. Child Mind Institute also states, "Substance use escalates from experimentation to a serious disorder much faster in adolescents than it does in adults, and that progression is more likely to happen in kids with mental health disorders than in other kids"²¹.

MENTAL & BEHAVIORAL HEALTH



What are the long-term effects of substance abuse on youth?

Mental health problems such as depression, withdrawal, developmental delays, and many other psychosocial dysfunctions are frequently linked to substance abuse among adolescents. Increased rates of suicidal ideation amongst youth, regardless of gender, have also been linked to substance abuse, specifically in the case of marijuana use^{23,24}. Youth who partake in frequent substance use often experience academic difficulties, poor peer relationships, and involvement with the juvenile justice system²⁵.

More recently, substance abuse has shown the potential for increasing a user's risk of developing mental disorders such as the link between adolescent use of marijuana and increased risk of psychosis and schizophrenia^{26,27}. Another example is the frequent use of MDMA (3,4-methylenedioxymethamphetamine), commonly known as ecstasy, on the long-term health of youth. MDMA can result in long-term serotonin deficits within the brain which increase chances of mental disorders such as depression and anxiety²⁸. This is especially true for youth with a genetic predisposition to develop a psychological disorder¹⁵.

LIFELONG OUTCOMES

Chronic substance abuse by adolescents during their developmental years is a major concern because it can interfere with normal socialization and cognitive development, as well as the onset of serious mental health struggles that may affect them for the rest of their life²⁹. These lifelong effects not only play into changes in the brain, but are correlated with suicidal ideation, relationship development, abuse, and violence.

90% of people with a substance use disorder (SUD) start using substances in their teen years³⁰. SUDs can affect anyone regardless of age, ethnicity, or socioeconomic status. When someone struggles with an SUD, their whole family feels the effects. Conflicts may ensue, trust is lost between family members, and tempers rise. Families, relationships, and homes can be strained due to substance use disorders. Research also shows that children who have a parent with a substance use disorder are more likely to develop a SUD themselves³⁰.

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LONG TERM EFFECTS

Conclusion

Substance use is particularly detrimental to youth because the brain is not done fully developing until around the age of 25. This underage use can impact brain development, physical health, as well as mental and behavioral health, producing long term effects that may not be reversible. Teaching youth about these effects is one step educators can take to prevent the associated harms.

Action Items

- **EDUCATE** yourself on the effects of substance use.
- **USE** credible resources when researching.
- **TEACH** your students about the effects of substance use
- **READ** the "Teacher Resources" and "Evidence Based Programs" sections of the Toolkit.

REFERENCES

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