# Youth and Mental Health

## A Survey of the Effects of Nutrition, Screen Time, and Substance Use on the Mental Health of American Adolescents


**The Office of Representative Tom Dent, 13th LD**

Produced by: Mark Willard



Winter 2020

# TABLE OF CONTENTS

# EXECUTIVE SUMMARY

This survey was initiated by the office of Washington State Representative Tom Dent, who represents the 13th legislative district. As the ranking minority member of the Human Services & Early Learning committee, Representative Dent has an elevated interest in youth well-being. Representative Dent voiced concern regarding a supposed decline in mental health over the past two decades, specifically how it related to youth. He directed the study to focus on three environmental factors that may be affecting the mental well-being of American adolescents: nutrition, screen time, and controlled substance use.

In this survey, the three factors are examined at the physiological level to better clarify their relationship with the human brain. All three factors cause adverse chemical effects on the brain when interacted with in inappropriate ways. The purpose of establishing this framework was to see how this physiological reaction can affect mental well-being in youth who engage in these activities with little or no boundaries. Studies were used to provide examples of long-term ramifications of risk-based behavior associated with unhealthy diets, excessive screen time usage, and substance use disorder.

Poor nutrition leads to structural weakness on the cellular level, and when established during gestation or within two years of life, poor nutrition can have irreversible negative effects. Moreover, studies show that there is a link between poor nutrition and poor mental health outside of this vital time window of gestation to two years. Screen time has shown to inhibit the development white matter in the brain. It has also been shown to disrupt the pineal gland at night, postponing melatonin production and diminishing the quality of sleep for the user. Controlled or illicit substances produce a variety of profound chemical reactions in the brain. However, substance use was difficult to qualify, as there is little material on the adverse effects on mental well-being from recreational use, and substance use disorder is considered intrinsically a mental illness.

# INTRODUCTION

## Decline in Mental Health in American Adolescents

Mental health is a topic of substantial concern in the United States. According to the National Institute of Mental Health (NIH) “nearly one in five U.S. adults live with a mental illness” and a study performed by the National Comorbidity Survey Adolescent Supplement (NCS-A) between 2001 and 2004 showed that “an estimated 49.5% of adolescents had any mental disorder,” and “of adolescents with any mental disorder, an estimated 22.2% had severe impairment.” (DSM-IV based criteria were used to determine impairment level.)

Several metrics can be used to show the prevalence of poor mental health, three of those being anxiety, depression, and suicide rates. Regarding depression, in 2017 “an estimated 3.2 million adolescents aged 12 to 17 in the United States had at least one major depressive episode.” The 3.2 million adolescents represented “13.3% of the U.S. population aged 12 to 17” (NIH). A study performed over time by the Centers for Disease Control (CDC) showed that the rate of “having been diagnosed with either anxiety or depression among children aged 6-17 years increased from 5.4% in 2003 to 8% in 2007 and to 8.4% in 2011-2012”

Prevalence of suicide among youth has been on the rise as well. The CDC showed that from “1999 through 2017, the age-adjusted suicide rate increased 33% from 10.5 to 14.0 per 100,000.” The female demographic was disproportionately affected by the increase in suicide rates. Suicide rates were significantly higher in 2017 compared with 1999 among male and females, with “females aged 10–14 (1.7 and 0.5, respectively),” and males aged 10–14 (3.3 and 1.9, respectively)”  the increase in suicide rates in youth has translated to suicide being “the second leading cause of death among individuals between the ages of 10 and 34,” as reported by the National Institute of Mental Health.

## Methodology

This report was developed on the findings from multiple peer-reviewed academic journals, and public resources such as the National Institute of Health (NIH) and the Centers for Disease Control (CDC). The journals used were primarily topic-specific to youth, and focused on three areas including: nutrition, screen time, and substance use.

The first step was to identify and clarify the physiological relationship between the individual and these environmental factors. Each section provides a summary of the chemical relationship between the brain and potential biological issues that may impact mental health from improper engagement with the factors.

Once the physiological relationships were clarified, the next step was to see how differing degrees and dynamics of interaction with these factors affected youth. This was done according to the topic. For example, the quality of one’s nutrition depends on their diet. In that sense, a biological breakdown of consumption was merited. In the following two sections, screen time and substance use, statistics were used to show the relationship between youth and the factor.

The third and final step of the inquiry was to show evidence-based links between these environmental factors and mental health indicators among youth. The supporting evidence was primarily anecdotal and pulled from the research journals used for the inquiry.

# NUTRITION

## Brain Physiology and Nutrition

Nutrition plays one of the most vital roles in developing and maintaining good health from a holistic perspective down to the cellular level. While especially vital from gestation to three years, an adequate intake of nutrients throughout one's life is necessary for proper bodily function. A study conducted for Nutrition Reviews by Elizabeth Prado and Kathryn Dewey structured a report by the definition and timing of five processes, by seven key nutrients and one experiential metric. This study used human autopsy studies (fetal and adult), magnetic resonance imaging (MRI), rodent, and other animal studies.

The five processes are neuron proliferation (creation of new cells through cell division), axon and dendrite growth (neuron, or brain cell growth), synapse formation (connections between brain cells), myelination (the fatty tissue surrounding brain cells. The myelin sheath allows electrical impulses to transmit quickly and efficiently along the nerve cells), and apoptosis (programmed cell death).

The seven key nutrients are proteins, fatty acids, iron, iodine, zinc, choline, and b-vitamins. The interaction between these nutrients and an infant's development outlined by the five processes are as follows (note that not all nutrients correspond to all five documented processes);

### Protein:

- Neuron Proliferation: Protein malnutrition is associated with fewer over brain cells and grey matter when comparing to infants who are well-nourished.
- Axon and Dendrite Growth: 3-4-month-old infants with moderate malnutrition had decreased dendritic span and arborization (complexity of branching projections).
- Synapse Formation, Pruning, and Function: Both prenatal and postnatal undernutrition in rodents results in fewer synapses as well as synaptic structural change.
- Myelination: Adults who had been exposed to famine in utero in Holland during WWII showed increased white matter hyperintensities. (White matter hyperintensities are

associated with increased prevalence of stroke, dementia, depression, and decreased physical function.

Fatty Acids:

- Neuron Proliferation: Neurogenesis (the process of stem cells becoming neurons) requires synthesis of phospholipid (a major component of all cell membranes) from fatty acids
- Synapse Formation, Pruning, and Function: Arachidonic acid and docosahexaenoic acid (DHA) are both fatty acids that play a maturation of synapses and in neurotransmission.
- Myelination: Fatty acids are the structural components of myelin.

Iron:

- Neuron Proliferation: Iron is required for the enzyme that regulates central nervous system cell division. Iron deficiency in rodents does not affect overall brain size, but a decrease in the size of the hippocampus has been shown.
- Axon and Dendrite Growth: Gestational and neonatal iron deficiency in rodents results in shortened dendritic branching in the hippocampus, which persists into adulthood.
- Synapse Formation, Pruning, and Function: Gestational and early postnatal iron deficiency in rodents results in decreased synaptic maturity and efficacy in the hippocampus, which persists despite iron repletion.
- Myelination: Iron plays a role in myelin synthesis, even marginal deficiencies during the prenatal and early postnatal development decreases myelin synthesis. This is not corrected with iron repletion.

Iodine and Thyroid Hormones:

- Neuron Proliferation: A sample of fetuses between 6 and 8 months of gestation in an iodine-deficient area of China had lower brain weight than fetuses in an iodine-sufficient area.
- Axon and Dendrite Growth: Gestational iodine deficiency results in reduced dendritic branching in the cerebral cortex in rodents.
- Synapse Formation, Pruning, and Function: Gestational iodine deficiency in sheep resulted in decreased synaptic density, which was not corrected with iodine repletion.
- Myelination: No myelination was detected in the cerebral cortex of fetuses at month 8 of gestation.

Zinc:

- Neuron Proliferation: Zinc is necessary for cell division due to its role in DNA synthesis. Gestational zinc deficiency in rodents results in decreased number of cells.
- Axon and Dendrite Growth: Gestation zinc deficiency in rodents results in reduced dendritic arborization (a multi-step biological process by which neurons form new dendritic trees and branches to create new synapses).
- Synapse Formation, Pruning, and Function: Zinc released into synapses in the hippocampus and cerebral cortex modulates synapse function.
- Apoptosis: In rodent pups, zinc deficiency decreased expression of IGF-1 (a hormone that, along with growth hormone (GH), helps promote normal bone and tissue growth and development) and growth hormone receptor genes.

## Choline:

- Neuron Proliferation: Choline is essential for stem cell proliferation and is involved in transmembrane signaling. In rodents, gestational choline supplementation stimulates cell division.
- Synapse Formation, Pruning, and Function: The neurotransmitter acetylcholine is synthesized from choline. Gestational choline deficiency in rodents has long-term effects on cholinergic neurotransmission despite repletion.
- Apoptosis: Gestational choline deficiency increases the rate of apoptosis in the hippocampus in rodents.

## B-Vitamins:

- Neuron Proliferation: Before neuron proliferation begins, during weeks 2-4 of gestation, the neural tube forms which is comprised of stem cells that give rise to neurons and glial cells (cells that support neurons). Maternal deficiency in folic acid and vitamin B12 is associated with neural tube defects.
- Axon and Dendrite Growth: Gestational and early postnatal vitamin B6 deficiency in rodents results in reduced dendritic branching.
- Synapse Formation, Pruning, and Function: Gestational and early postnatal vitamin B6 deficiency in rodents results in decreased synaptic density, reduced synaptic efficiency, and lowered dopamine levels.
- Myelination: Gestational and early postnatal vitamin B6 deficiency in rodents results in reduced myelination.

Along with the seven nutrients listed in the report, Padro and Dewey reported on these same processes when considering postnatal experience, or environmental stimulation, for the infant. Brain development is affected by experience. The two types of processes listed in the report are “experience-dependent” and “experience-expectant.” Experience-expectant processes requires specific input for normal development. For example, the brain expects visual input through the optic nerve for normal development of the visual cortex. Brains lacking in these expected processes impairs brain development (nutrition falls under this category). Experience-dependent refers to the way the brain organizes itself in response to an individual’s experiences and acquired skills. This process continues throughout one’s life and is unique to the individual.  The category tomorrow is based on experience-dependent development.

## Experience:

- Neuron Proliferation: Rodents raised in enriched environments (large enclosures with objects that allow visual and tactile stimulation) show greater brain weight and cortical thickness (the thickness of the cerebral cortex) than rodents raised in impoverished environments.
- Axon and Dendrite Growth: A human autopsy study showed that individuals with higher levels of education had more dendritic branching than those with lower education. Rodents raised in enriched environments have more dendritic spines than those raised in less complex environments.
- Synapse Formation, Pruning, and Function: Rodents raised in enriched environments show more synapses per neuron in visual and motor cortices than rodents raised in impoverished environments.
- Myelination: Children raised in Romanian orphanages then adopted into US families, thus having experienced a degree of early socioemotional deprivation, showed structural changes in white matter tracts compared to control children who had not spent any time in an orphanage. An enriched rearing environment affects myelination of the corpus callosum (the part of the brain that allows communication between the two hemispheres of the brain) in rodents and monkeys.

A report done by Emily M. Tanner, and Matia Finn-Stevenson titled “Nutrition and Brain Development: Social Policy Implications” stated that in some cases of pregnant women and young children in the United States their diets are “sufficiently poor to cause prolonged hunger, health problems or, potentially, brain damage." And that this fact is related to the trend of "undernourished children" living in "impoverished environments that further undermine their healthy development." The study by Padro and Dewey provides a holistic view on this claim stating that in some cases, stimulation from the environment can protect children from negative effects of undernutrition on development. The report suggests that "nutritional supplementation and psychosocial stimulation together result in greater improvements in child development than either intervention alone." Without proper nutrition and stimulating environments, brain development is impaired. In addition, malnutrition can lead cause impairment in environmental-dependent brain growth.

## Long-Term Implications of Diet

In addition to laying out the physiological impact of nutrient deficiency on the developing brain, the study done by Padro and Dewey follows up on negative health implications later in life from groups that suffered from deficiencies as an infant. The report claims that "many studies have compared school-age children who had suffered from an episode of severe acute malnutrition in the first few years of life." When comparing these children to control groups or siblings who have not experience malnutrition the report claims that "those who had suffered from early malnutrition had poorer IQ levels, cognitive function, and school achievement, as well as greater behavioral problems."

Another example provided followed a group of Korean orphans adopted by middle-class American families. The results showed that "children who were undernourished at the time of adoption (before age 2 years) did not score below the normal range on IQ tests at school age, but their scores were lower than those of Korean adoptees who had not been undernourished." In addition, "children adopted after age 2 years had lower IQ scores than those adopted before age 2 years." This suggests that early intervention is vital when attempting to correct environmental and nutritional insufficiencies.

## Nutrition and Mental Health

In the study titled “Diet Quality and Mental Health in Subsequent Years among Canadian Youth,” authors Seanna E McMartin, Stefan Kuhle, Ian Colman, Sara FL Kirk, and Paul J Veugelers used health-care provider contacts where a primary diagnosis of an internalizing disorder (these include depression, anxiety, low mood, inhibition, excessive worrying, physical complaints, trouble sleeping, and shyness) was given between 2003 and 2006. A child was considered to have an internalizing disorder if he/she received a diagnosis according to the International Classification of Diseases ninth revision (ICD-9) or tenth revision (ICD-10). A final sample of 3757 5$^{th}$ grade students were used in the study, 88% of which had at least one healthcare provider contact in during the study. When controlling for outside factors, the report concluded that “diet quality was not significantly associated with internalizing disorder.” However, the report found that “those with greater variety in their diets had a statistically significant lower rate of receiving a diagnosis of internalizing disorder” when compared to children with little variety in their diets. Further supporting this claim, the study showed that “fish consumption did reveal a statistically significant finding” when considering rates of internalizing disorder diagnosis, with the students who have more fish in their diet having a lower rate of internalizing disorders.

The article “Food Insecurity, Poor Diet Quality, and Suboptimal Intakes of Folate and iron are Independently Associated with Perceived mental Health in Canadian Adults” by Karen M. Davison, Lovedeep Gondara, and Bonnie J. Kaplan seems to disagree with the previous study’s findings that there was no significant association with internalizing disorders and diet. The article uses the Dietary Reference Intakes (DRI), which is a general term for a set of reference values used to plan and assess nutrient intakes of healthy people, and the Acceptable Macronutrient Distribution Ranges (AMDR) to establish a structure for their survey. The article also uses the Canadian Healthy Eating Index (HEI) as a measure. The survey consisted of over 35,000 respondents living across Canada. They used the variable of “perceived mental health” to evaluate whether or not the subject was suffering from mental disorders. The study measured food security and diet quality while controlling for income, education, relationship status, and if the subjects were cigarette smokers. The article concludes that “poor quality diets as defined by the HEI were more prevalent among those with poor mental health.” The report goes on to claim that the results of the study “suggested that food insecurity, poor diet quality, and inadequate intakes of selected micronutrients were independently associated with poor mental health" when observing the general national sample used.

An article produced for the European Journal of Clinical Nutrition titled "Associations between Diet Quality and Mental Health in Socially Disadvantaged New Zealand Adolescents" by AA Kukarni, BA Swinburn and J Utter seems to mirror this previous claim. Their study used over 4000 students from six economically deprived high schools. The article used emotional functioning subscale of the Pediatric Quality of Life (PedsQL) instrument. This assessment was designed and validated for use in child and adolescent populations. The conclusion of the article states that "both increased intake of healthy food and decreased intake of unhealthy food may positively influence adolescent mental health." Another point of interest found in this study showed that there were substantial differences in mental health between the highest and lowest quartiles of healthy and unhealthy eating, showing that the extremes of the sample had the strongest indicators.

The previously stated studies focused on existing populations with established diet trends, and how these diets correlated to mental health outcomes. Alternatively, there are studies that have actively shifted subjects' diets and recorded the results. In the review "Nutritional psychiatry: Towards improving mental health by what you eat" authors Roger A.H. Adan, Eline M. Van Der Beek, Jan K. Buitelaar, John F. Cryan, Johannes Hebebrand, Suzanne Higgs, Harriet, Schellekens, Suzanne L. Dickson look at studies that have recorded implications from these dietary transitions. A few examples in this review show changes in measured results from a change in diet, such as ketogenic diets reducing epileptic episodes in children with epilepsy. When considering mental health indicators, randomized controlled trials (RCT) have shown that the adoption of the so called "Mediterranean diet" has shown "significant improvements in mood and reduced anxiety levels in adults with major depression." However, multi-nutrient supplementation in the "MooDFOOD" RCT "did not reduce episodes of major depression in overweight or obese adults" who suffered from depression.

Aside of the conflicting results from diet change, the review suggests that "nutrition and, in particular, malnutrition and obesity, are closely intertwined with mood regulation and stress sensitivity." A potential component to the link between diet and mental health identified in the review is the importance of the intestinal microbiome. It is suggested that the gut microbiota is a key player in responses to stress and affective disorders such as anxiety and depression. In addition, the review claims “dietary factors have been shown to directly shape the microbiota in both rodents and humans, and diet therefore represents a modifiable determinant of gut microbiota composition.” If the link between gut microbiota and mental well-being is not overstated, then this is an indicator on the importance of proper nutrition.

Physical inflammation is another concern when considering diet and mental health. In the research journal “Diet quality, dietary inflammatory index and body mass index as predictors of response to adjunctive N-acetylcysteine and mitochondrial agents in adults with bipolar disorder: A sub-study of a randomized placebo-controlled trial” authors Melanie M Ashton, Olivia M Dean, Wolfgang Marx, Mohammadreza Mohebbi, Michale Berk, Gin S Malhi, Chee H Ng, Sue M Cotton, Seetal Dodd, Jerome Sarris, Malcolm Hopwood, Keshav Faye-Chauhan, Yesul Kim, Sarah R Dash, Felice N Jacka, Nitin Shivappa, James R Herbert, and Alyna Turner claim that there is a “bidirectional relationship between diet quality and depression.” They further claim that “new meta-analysis supports dietary change as an efficacious treatment for depressive symptoms.” In the trial examined in this research journal, they used a double-blind placebo-controlled RCT on 181 participants with bipolar disorder who were experiencing a current moderate-to-severe depressive episode. They used the Mini International Neuropsychiatric Interview and the Montgomery-Asberg Depression Rating Scale to establish the depressive metric. This study produced results showing that “participants who adhered to a more anti-inflammatory diet had a greater reduction in impairment of function regardless of treatment received,” and that an “anti-inflammatory diet was also associated with an improvement in social and occupational functioning compared to pro-inflammatory diet, regardless of treatment received.”

An article posted to the website of the National Center for Biotechnology Information reviews the topic of diet and brain function titled “Brain foods: the effects of nutrients on brain function” authored by Fernando Gómez-Pinilla concludes that “we now know that particular nutrients influence cognition by acting on molecular systems or cellular processes that are vital for maintaining cognitive function.” Gómez-Pinilla expands on the specific areas of mental ability affected claiming that “brain networks that are associated with the control of feeding are intimately associated with those that are involved in processing emotions, reward and cognition.”

# SCREEN TIME

## Physiology and Screen Time

Screen time, specifically related to mobile devices, is a more recent focus of mental illness in adolescents. Potentially due to the recency, studies that focus on the physiological effects of excess screen time are more limited in size, number, and scope than those of nutrition. However, there are established categories that are used to show negative physiological effects from excessive screen time usage. An article titled “Associations Between Screen-Based Media Use and Brain White Matter Integrity in Preschool-Aged Children” by John S. Hutton, Jonathan Dudley, and Tzipi Horowitz-Kraus, found “an association between increased screen-based media use, compared with the AAP guidelines, and lower microstructural integrity of brain white matter tracts supporting language and emergent literacy skills in prekindergarten children.”

An impact of excessive screen time is on sleep and following psychological and physiological impairments from sleep disturbance. The link between sleep and screen time has causal implications, while a separate physiological indicator of excessive screen time, a sedentary lifestyle, has many contributors outside of screen time. Thus, the scope of this report focuses on sleep aside of the sedentary lifestyle. However, the negative effect on an individual’s psychological and physiological wellbeing from a sedentary lifestyle cannot be understated.

In the journal “Adverse physiological and psychological effects of screen time on children and adolescents: Literature review and case study” author Gadi Lissak looks into the relationship between screen time use and sleep statistics. Lissak claims that “children in 2011 were estimated to sleep, on average, one hour less per night when compared with children of the early 20th century.” Where screen time comes into play is the relationship between screen time and the reduction in length of sleep in adolescents. Lissak found that “findings suggest an inverse association between sleep duration and subsequent screen time.”

One of the potential causes for the association is the body’s response to screen time at night. Lissak brings up the concern of the light emitted by mobile devices and its effect on melatonin production. The National Center for Complimentary and Integrative Health classifies melatonin as “a hormone that your brain produces in response to darkness” and that “it helps with the timing of your circadian rhythms (24-hour internal clock) and with sleep.” Melatonin is a vital component to one’s circadian rhythm and any impairment to its production will adversely affect the quality and duration of an individual’s sleep. In the research article “Blocking nocturnal blue light for insomnia: A randomized controlled trial” authors Ari Shechter, Elijah Wookhyun Kim, Marie-Pierre St-Onge, and Andrew J. Westwood reiterated the concern stating “a 5-hour evening exposer to an LED-backlit computer, compared to a non-LED backlit computer, reduced melatonin secretion and also caused decreased subjective and neurophysiologic sleepiness.” Another area of concern for melatonin production is how the pineal gland senses electromagnetic radiation. Lissak goes on to say that “the pineal gland, producing melatonin, may sense electromagnetic radiation as light. Therefore exposure to electromagnetic radiation from wireless devices may delay melatonin production.”

Additional factors impacting the quality and duration of sleep in how teens interact with screen time are media exposure, media type, engagement type (passive or active), and disturbances by notifications during sleep. In reference to media exposure, Lissak continues “exposure, primarily to video games, may increase children’s psychophysiological arousal, therefore affecting sympathetic regulation.” Video games are an active form of media, along with emotionally or politically charged media content. This relationship causes a stronger physiological response, potentially adding to the sleep disturbance already created by the use of screen time at night. Lissak reflects on this by saying “the combined effect of looking at a bright mobile phone display while involved in an excitement provoking tasks may increase psychophysiological arousal.” Disturbances by mobile notifications are of concern as well. Lissak quotes a study that found that “18% of adolescents were reported to be awakened by mobile phones at least a few times a night.”

## Trends in Screen Time Usage

An online article produced by PBS cites a study titled the “Common Sense Media Report” and shows key statistics of media usage in children aged 0 to 8 years old. The key statistics were:

- American children ages 0 to 8 use screen media for an average of 2 hours and 19 minutes each day. These numbers have changed only slightly in the past 6 years.
- Children under age 2 spend about 42 minutes, children ages 2 to 4 spend 2 hours and 40 minutes, and kids ages 5 to 8 spend nearly 3 hours (2:58) with screen media daily.
- About 35 percent of children's screen time is spent with a mobile device, compared to 4 percent in 2011.
- Nearly all children ages 0 to 8 (98 percent) now live in a home that has a mobile device, a percentage now equal to TV.

A notable takeaway is the stat claiming that there was an increase from 4% to 35% in mobile device share of screen time in children from 2011 to 2017. The Common Sense Media Report also shows that children aged 0-8 spend 48 minutes a day on a mobile device, as opposed to 5 minutes a day in 2011.

Media usage in teens (ages 13-18) and tweens (ages 8-12) is even more alarming. The Kaiser Family Foundation reports that "kids ages 8-18 now spend, on average, a whopping 7.5 hours in front of a screen for entertainment each day." A separate Common Sense Media report brings up the following statistics:

- Teenagers use an average of nine hours of entertainment media per day.
- Tweens use an average of six hours a day, not including time spent using media for school or homework.
- Teen boys average 56 minutes a day playing video games, compared to girls' 7 minutes and teen girls spend 40 minutes more a day than boys on social media.
- There is wide diversity in screen media use: In any given day, 34% of tweens and 23% of teens spend 2 hours or less with screen media, while 11% of tweens and 26% of teens spend more than 8 hours with screens.  Overall, tweens average more than 4.5 hours (4:36) of screen media and teens more than 6.5 hours (6:40) of screen media a day.
- On average among teens 39% of digital screen time (computers, tablets, and smartphones) is devoted to passive consumption (watching, listening, or reading), 25% to interactive content (playing games, browsing the web), 26% to communication (social media, video-chatting), and 3% to content creation (writing, coding, or making digital art or music).

## Screen Time and Mental Health

In the article “Screen time is associated with depression and anxiety in Canadian youth,” authors Danijela Maras, Martine F. Flament, Marisa Murray, Annick Bucholz, Katherine A. Henderson, Nicole Obeid, and Gary S. Goldfield survey over 2400 7th-12th grade students and assessed their mental health. They used the Children’s Depression Inventory and the Multidimensional Anxiety Scale for Children. The study claims that youth in Canada and the U.S. “spend 7 to 8 hours per day engaging in sedentary screen-based activities, drastically exceeding the 2-hour recommended daily maximum” (American Academy of Pediatrics). The research concludes that “the duration of sedentary screen time was associated with more severe symptoms of depression and anxiety in a large sample of Canadian adolescents.” This reflects back to the sedentary nature of screen time usage and the risks associated with the act of engaging with screen-based media.

Diving deeper into the correlation between screen time and mental illness, the article “Corrigendum: Increases in Depressive Symptoms, Suicide-Related Outcomes, and Suicide Rates Among U.S. Adolescents After 2010 and Links to Increased New Media Screen Time” by J. M. Twenge, T. E. Joiner, M. L. Rogers, and G. N. Martin proposes timeline evidence. The article argues that “the timing of the uptick in mental health issues, beginning around 2011-2012” is “noteworthy.” Further arguing that “smartphones were used by about half of Americans by late 2012” and by 2015, “92% of teens and young adults owned a smartphone.” Referring to this timeline, the article claims that “depressive symptoms, suicide-related outcomes, and suicide deaths became more prevalent among American adolescents between 2010 and 2015.” While this indicator is correlational in nature, the article cites the disproportionate decrease in female mental well-being and proposes a relationship between this change and female social media use on various devices.

# SUBSTANCE USE

## Substance Use and Physiology

For the purpose of this study, we will be focusing mainly on marijuana, as the scope of the study focuses on youth, and marijuana is the most used and accessible (NIH). Heroin (opioids fall under this category), stimulants such as methamphetamine, cocaine, MDMA/ecstasy, and hallucinogens will be touched on as well. Below are the chemical processes resulting from use of the substances, as well as potential long-term ramifications of misuse. (Please note, the information provided on physiological responses to substance use was duplicated from the National Institute on Drug Abuse's website.)

### Marijuana

When a person smokes marijuana, THC quickly passes from the lungs into the bloodstream. The blood carries the chemical to the brain and other organs throughout the body. THC acts on specific brain cell receptors that ordinarily react to natural THC-like chemicals. These natural chemicals play a role in normal brain development and function. Marijuana over activates parts of the brain that contain the highest number of these receptors.

Imaging studies of marijuana's impact on brain structure in humans have shown conflicting results. Some studies suggest regular marijuana use in adolescence is associated with altered connectivity and reduced volume of specific brain regions involved in a broad range of executive functions such as memory, learning, and impulse control compared to people who do not use. Other studies have not found significant structural differences between the brains of people who do and do not use the drug.

The NIH citied the Coronary Artery Risk Development in Young Adults Study. The study consisted of 4,000 young adults tracked over a 25-year period until mid-adulthood, cumulative lifetime exposure to marijuana was associated with lower scores on a test of verbal memory but did not affect other cognitive abilities such as processing speed or executive function. Extensive and prolonged use of marijuana in adolescence can have long term effects. Studies indicate that marijuana exposure during development can cause long-term or possibly permanent adverse changes in the brain. Rats exposed to THC before birth, soon after birth, or during adolescence show notable problems with specific learning and memory tasks later in life.

A large longitudinal study in New Zealand found that persistent marijuana use disorder with frequent use starting in adolescence was associated with a loss of an average of 6 or up to 8 IQ points measured in mid-adulthood.43 Those who used marijuana heavily as teenagers and quit using as adults did not recover the lost IQ points. People who only began using marijuana heavily in adulthood did not lose IQ points.

## Heroin (Opioids)

Heroin binds to and activates specific receptors in the brain called mu-opioid receptors (MORs). Our bodies contain naturally occurring chemicals called neurotransmitters that bind to these receptors throughout the brain and body to regulate pain, hormone release, and feelings of well-being. Once heroin enters the brain, it is converted to morphine and binds rapidly to opioid receptors. People who use heroin typically report feeling a surge of pleasurable sensation. The intensity of the sensation is a function of how much drug is taken and how rapidly the drug enters the brain and binds to the opioid receptors

Repeated heroin use changes the physical structure and physiology of the brain, creating long-term imbalances in neuronal and hormonal systems that are not easily reversed. Studies have shown some deterioration of the brain’s white matter due to heroin use, which may affect decision-making abilities, the ability to regulate behavior, and responses to stressful situations.

## Methamphetamine

Methamphetamine misuse has been shown to have negative effects on non-neural brain cells called microglia. These cells support brain health by defending the brain against infectious agents and removing damaged neurons. Too much activity of the microglial cells, however, can assault healthy neurons. A study using brain imaging found more than double the levels of microglial cells in people who previously misused methamphetamine compared to people with no history of methamphetamine misuse.

These and other problems reflect significant changes in the brain caused by misuse of methamphetamine. Neuroimaging studies have demonstrated alterations in the activity of the dopamine system that are associated with reduced motor speed and impaired verbal learning. Studies in chronic methamphetamine users have also revealed severe structural and functional changes in areas of the brain associated with emotion and memory, which may account for many of the emotional and cognitive problems observed in these individuals.

In addition to the neurological and behavioral consequences of methamphetamine misuse, long-term users also suffer physical effects, including weight loss, severe tooth decay, tooth loss, and skin sores.

## Cocaine

Cocaine increases levels of the natural chemical messenger dopamine in brain circuits related to the control of movement and reward. Normally, dopamine recycles back into the cell that released it, shutting off the signal between nerve cells. However, cocaine prevents dopamine from being recycled, causing large amounts to build up in the space between two nerve cells, stopping their normal communication.

This flood of dopamine in the brain’s reward circuit strongly reinforces drug-taking behaviors, because the reward circuit eventually adapts to the excess of dopamine caused by cocaine, and becomes less sensitive to it.

Long-term health impacts of prolonged use include loss of sense of smell, nosebleeds, nasal damage and trouble swallowing from snorting; infection and death of bowel tissue from decreased blood flow; poor nutrition and weight loss; lung damage from smoking.

## MDMA/Ecstasy

MDMA affects the brain by increasing the activity of at least three neurotransmitters (the chemical messengers of brain cells): serotonin, dopamine, and norepinephrine. Like other amphetamines, MDMA enhances release of these neurotransmitters and/or blocks their reuptake, resulting in increased neurotransmitter levels within the synaptic cleft (the space between the neurons at a synapse).

However, by releasing large amounts of serotonin, MDMA causes the brain to become significantly depleted of this important neurotransmitter, contributing to the negative psychological aftereffects that people may experience for several days after taking MDMA

## Hallucinogens

Classic hallucinogens are thought to produce their perception-altering effects by acting on neural circuits in the brain that use the neurotransmitter serotonin (Passie, 2008; Nichols, 2004; Schindler, 2012; Lee, 2012). Specifically, some of their most prominent effects occur in the prefrontal cortex—an area involved in mood, cognition, and perception—as well as other regions important in regulating arousal and physiological responses to stress and panic. Long-term effects of hallucinogen misuse are not well researched or understood.

## Prevalence of Substance Use in American Youth

The following statistics were provided by Statistica and based on a study titled Monitoring the Future. Monitoring the Future is an ongoing study of the behaviors, attitudes, and values of American secondary school students, college students, and young adults. Each year, a total of approximately 50,000 8th, 10th and 12th grade students are surveyed (12th graders since 1975, and 8th and 10th graders since 1991).

- In 1991, approximately 30.4 percent of those in school grades 8, 10, and 12 had used illicit drugs at some point in their lives. This number reached a high of 43.3 percent in 1997, but dropped back to around 34 percent in 2018
- In 2018, more than 11.8 million young adults used marijuana in the past year. (NIH)
- Annual prevalence of use of marijuana/hashish for grades 8, 10 and 12 was 15% in 1991, 30.1% in 1997, 24.3% in 2003, 22.9% in 2009, 23.7% in 2015, and 25.2% in 2019.
- Annual prevalence of use of alcohol for grades 8, 10 and 12 was 67.4% in 1991, 61.4% in 1997, 54.4% in 2003, 48.4% in 2009, 39.9 % in 2015, and 35.9% in 2019.
- As of 2019, the percentage of 12th grade students that had tried Adderall within the past year was around 4 percent. The prevalence of 12th grade students using Adderall has generally decreased since 2012 when usage was more prevalent.
- Number of U.S. substance abuse treatment clients under 18 years of age decreased from 85,518 in 2007 to 62,682 in 2017.
- Over 60 percent of adolescents in community-based substance use disorder treatment programs also meet diagnostic criteria for another mental illness. (NIH)

## Substance Use and Mental Illness

When addressing potential implications of substance use and mental illness, it is difficult to find studies that focus on recreational or casual users as opposed to studies focused on substance use disorder. The National Institute of Mental Health qualifies substance use disorder as a form of mental illness in itself. This convolutes the data on mental illness and substance use disorder. However, according to NIH, among those who suffer from serious mental illness and those who suffer from substance use disorder, “about half of those who experience a mental illness during their lives will also experience a substance use disorder and vice versa" and, as stated in the previous section, "over 60 percent of adolescents in community-based substance use disorder treatment programs also meet diagnostic criteria for another mental illness."

There is a "chicken or the egg" issue with mental illness and substance use disorder. The Child Mind Institute claims that "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." This implies that mental illness may exist prior to substance use, but that substance use may exacerbate the prevalence of mental illness. The research article "Substance use in severe mental illness: self-medication and vulnerability factors" by Jacpo Vttoriano Bizzarri, Paola Rucci, Alfredo Sbrana, Mario Miniati, Federica Raimondi, Laura Ravani, Guido Jacopo Massei, Francesca Milani, Marta Milianti, Gabriele Massei, Chiara Gonnelli, and Giovanni Battista Cassano agrees with the conclusion made by the Child Mind Institute. The article argues that "an early onset of psychosis is associated with subsequent SUD (substance use disorder)."

# RESULTS

## Discussion

The focus of this survey was to address three separate relationships, nutrition and mental health, screen time and mental health, and substance use and mental health. After establishing the relationships, we must relate them to the overall decline in the mental health of adolescents in the United States in the past two decades. Below, we will discuss each topic separately and dive into how they may or may not contribute to this recorded decline in youth mental well-being.

### Nutrition and Mental Health

The research articles sourced for this section of the report stated that nutrition was a noticeable factor in the mental well being of the youth that participated in their studies. There wasn't a debate on whether or not it played a role, it was a debate on to what degree of importance nutrition's role was in adolescent mental health. The correlational link between diet and mental health provides us with reason to improve diet quality for children and youth. However, even the sources that claimed the link between diet and mental health was substantial, it did not appear that their findings could readily explain the decline in mental health in the past 20 years. A healthy diet appears to set us up to better deal, both physically and physiologically, with outside stressors and stimulants. However, it doesn't appear that mental illness arises solely from a poor diet.

### Screen Time and Mental Health

Screen time appears to contribute to the decline in mental health more than the other two factors measured in this survey. The timing of screen time usage increases coincides with the decline in mental well-being in American youth. The reduction in the quality and length of sleep are contributing factors, as is the dynamic of online interaction with differing forms of media. Emotionally charged news articles, social media interactions, and stimulation from active gaming can all provide adverse effects on an individual's psyche. The sedentary lifestyle promoted by excess screen time is also a contributing factor to screen time's role in the decline in youth mental well-being. This subject has only recently received attention from academia, and it requires further study to fully establish causal trends.

## Substance Use and Mental Health

The scope of this section of the study aimed to locate any links between substance use, both recreational and addictive, to the decline of mental well-being in youth. There are many sources that cover substance use disorder and mental health. However, we were unable to locate any data on recreational use and mental illness rates. This could be an area that merits more study. However, the trends of illicit substance use in teens has fluctuated between approximately 30%-40% from 1991-2018. With the 2018 rate falling within that range at 34%, it does not seem that there is a trend in illicit drug use that matches the decline in mental health. Marijuana rates follow a similar trend as the overall illicit rate, which may take away from the merit of recreational drug use on recent increases on mental illness. That is not to say that recreational drug use does not negatively impact mental well-being in children and youth, it is to say that it does not link to the decline in mental health.

## Recommendations

Poor nutrition, excess screen time, and substance use all have the potential to provide adverse effects to the mental well-being of adolescents. Below are recommendations on potential steps to take on nutrition, screen time, and mental illness.

### Nutrition

Locate or fund studies that look to:

- Develop policies that improve access to nutritional foods.
- Develop policies that encourage diet diversity.
- Develop policies that disincentivize purchase and consumption of foods with little to no nutritional value.

### Screen Time

Locate or fund studies that look to:

- Develop policies that disincentivize excessive screen time usage.
- Develop policies that disincentivize screen time usage at night.
- Develop policies that encourage young users to limit their exposure to media that causes adverse stimulation (social media, emotionally charged news, certain types of video games etc.)

### Substance Use

Locate or fund studies that look to:

- Examine the potential link between recreational substance use and mental illness in youth.
- Examine the potential link between the legalization of recreational marijuana and a change in access rates of the substance to youth.

# BIBIOLIOGRAPHY

Adan, Roger A.h., et al. "Nutritional Psychiatry: Towards Improving Mental Health by What You Eat." *European Neuropsychopharmacology*, vol. 29, no. 12, 2019, pp. 1321–1332., doi:10.1016/j.euroneuro.2019.10.011.

Ashton, Melanie M, et al. "Diet Quality, Dietary Inflammatory Index and Body Mass Index as Predictors of Response to Adjunctive N-Acetylcysteine and Mitochondrial Agents in Adults with Bipolar Disorder: A Sub-Study of a Randomised Placebo-Controlled Trial." *Australian & New Zealand Journal of Psychiatry*, vol. 54, no. 2, 2019, pp. 159–172., doi:10.1177/0004867419882497.

Bizzarri, Jacopo Vittoriano, et al. "Substance Use in Severe Mental Illness: Self-Medication and Vulnerability Factors." *Psychiatry Research*, vol. 165, no. 1-2, 2009, pp. 88–95., doi:10.1016/j.psychres.2007.10.009.

"Corrigendum: Increases in Depressive Symptoms, Suicide-Related Outcomes, and Suicide Rates Among U.S. Adolescents After 2010 and Links to Increased New Media Screen Time." *Clinical Psychological Science*, vol. 7, no. 2, 2019, pp. 397–397., doi:10.1177/2167702618824060.

"Corrigendum: Increases in Depressive Symptoms, Suicide-Related Outcomes, and Suicide Rates Among U.S. Adolescents After 2010 and Links to Increased New Media Screen Time." *Clinical Psychological Science*, vol. 7, no. 2, 2019, pp. 397–397., doi:10.1177/2167702618824060.

"Data and Statistics on Children's Mental Health." *Centers for Disease Control and Prevention*, Centers for Disease Control and Prevention, 19 Apr. 2019, www.cdc.gov/childrensmentalhealth/data.html.

Davison, Karen, et al. "Food Insecurity, Poor Diet Quality, and Suboptimal Intakes of Folate and Iron Are Independently Associated with Perceived Mental Health in Canadian Adults." *Nutrients*, vol. 9, no. 3, 2017, p. 274., doi:10.3390/nu9030274.

Gómez-Pinilla, Fernando. “Brain Foods: the Effects of Nutrients on Brain Function.” *Nature Reviews Neuroscience*, vol. 9, no. 7, 2008, pp. 568–578., doi:10.1038/nrn2421.

Hutton, John S., et al. “Associations Between Screen-Based Media Use and Brain White Matter Integrity in Preschool-Aged Children.” *JAMA Pediatrics*, vol. 174, no. 1, June 2020, doi:10.1001/jamapediatrics.2019.3869.

“Infographics - Screen Time vs. Lean Time.” *Centers for Disease Control and Prevention*, Centers for Disease Control and Prevention, 29 Jan. 2018, www.cdc.gov/nccdphp/dnpao/multimedia/infographics/getmoving.html.

Jiang, Jingjing. “How Teens and Parents Navigate Screen Time and Device Distractions.” *Pew Research Center: Internet, Science & Tech*, Pew Research Center, 31 Dec. 2019, www.pewresearch.org/internet/2018/08/22/how-teens-and-parents-navigate-screen-time-and-device-distractions/.

Kulkarni, A A, et al. “Associations between Diet Quality and Mental Health in Socially Disadvantaged New Zealand Adolescents.” *European Journal of Clinical Nutrition*, vol. 69, no. 1, 2014, pp. 79–83., doi:10.1038/ejcn.2014.130.

“Landmark Report: U.S. Teens Use an Average of Nine Hours of Media Per Day, Tweens Use Six Hours: Common Sense Media.” *Common Sense Media: Ratings, Reviews, and Advice*, 3 Nov. 2015, www.commonsensemedia.org/about-us/news/press-releases/landmark-report-us-teens-use-an-average-of-nine-hours-of-media-per-day.

Laporte, John. “Topic: Adolescent Drug Use in the U.S.” *Www.statista.com*, www.statista.com/topics/3907/adolescent-drug-use-in-the-us/.

Lissak, Gadi. “Adverse Physiological and Psychological Effects of Screen Time on Children and Adolescents: Literature Review and Case Study.” *Environmental Research*, vol. 164, 2018, pp. 149–157., doi:10.1016/j.envres.2018.01.015.

"Major Depression." *National Institute of Mental Health*, U.S. Department of Health and Human Services, www.nimh.nih.gov/health/statistics/major-depression.shtml.

Maras, Danijela, et al. "Screen Time Is Associated with Depression and Anxiety in Canadian Youth." *Preventive Medicine*, vol. 73, 2015, pp. 133–138., doi:10.1016/j.ypmed.2015.01.029.

"Melatonin: What You Need To Know." *National Center for Complementary and Integrative Health*, U.S. Department of Health and Human Services, 15 Oct. 2019, nccih.nih.gov/health/melatonin.

"Mental Illness." *National Institute of Mental Health*, U.S. Department of Health and Human Services, www.nimh.nih.gov/health/statistics/mental-illness.shtml.

Miller, Caroline, and Child Mind Institute. "Mental Health Disorders and Teen Substance Use." *Child Mind Institute*, childmind.org/article/mental-health-disorders-and-substance-use/.

Miller, Caroline, and Child Mind Institute. "Mental Health Disorders and Teen Substance Use." *Child Mind Institute*, childmind.org/article/mental-health-disorders-and-substance-use/.

"NAMI." *NAMI*, www.nami.org/learn-more/mental-health-by-the-numbers.

National Institute on Drug Abuse. "Drugs of Abuse." *NIDA*, www.drugabuse.gov/drugs-abuse.

Prado, Elizabeth L, and Kathryn G Dewey. "Nutrition and Brain Development in Early Life." *Nutrition Reviews*, vol. 72, no. 4, 2014, pp. 267–284., doi:10.1111/nure.12102.

"Screen Time and Kids: Insights from a New Report." *PBS*, Public Broadcasting Service, 10 Mar. 2020, www.pbs.org/parents/thrive/screen-time-and-kids-insights-from-a-new-report.

Shechter, Ari, et al. "Blocking Nocturnal Blue Light for Insomnia: A Randomized Controlled Trial." *Journal of Psychiatric Research*, vol. 96, 2018, pp. 196–202., doi:10.1016/j.jpsychires.2017.10.015.

"Suicide." *National Institute of Mental Health*, U.S. Department of Health and Human Services, www.nimh.nih.gov/health/statistics/suicide.shtml.

"The Common Sense Census: Media Use by Kids Age Zero to Eight, 2017: Common Sense Media." *Common Sense Media: Ratings, Reviews, and Advice*, 19 Oct. 2017, www.commonsensemedia.org/research/the-common-sense-census-media-use-by-kids-age-zero-to-eight-2017.

Twenge, Jean M., and W. Keith Campbell. "Associations between Screen Time and Lower Psychological Well-Being among Children and Adolescents: Evidence from a Population-Based Study." *Preventive Medicine Reports*, vol. 12, 2018, pp. 271–283., doi:10.1016/j.pmedr.2018.10.003.